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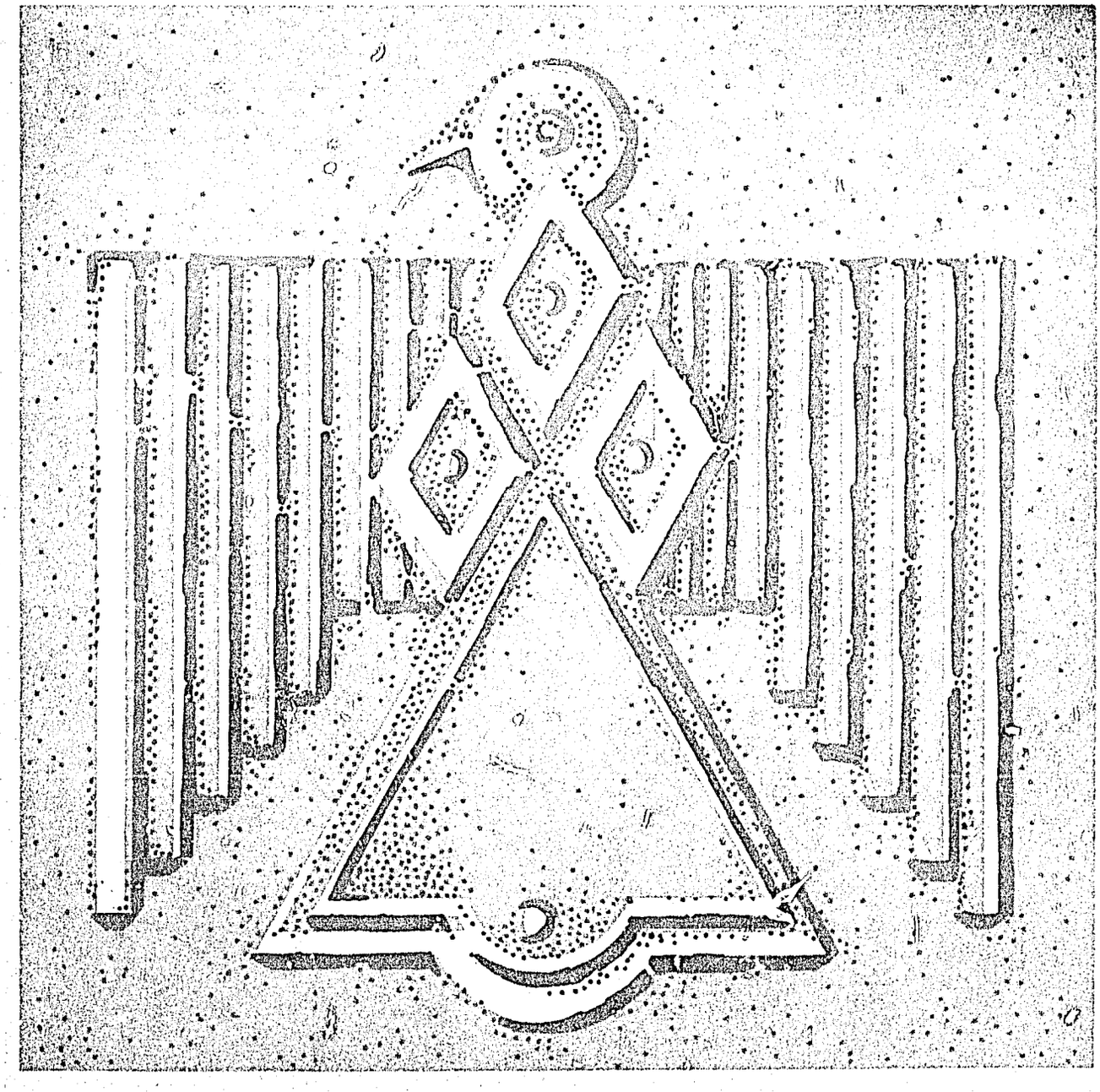
1970-73 Supplement to

Nutrition of Maize



TENNESSEE VALLEY AUTHORITY

Prepared for

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by the

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FOREWORD

Nutrition of Maize is one of a series of bibliographies being prepared and supplemented at intervals of 2-3 years, at the request and with the financial support of the Agency for International Development. A basic goal is to make available the most recent literature published on selected crops, particularly in regions where library facilities are limited or absent.

This *1970-1973 Supplement* contains abstracts of many important articles written during those years and also articles that were inadvertently omitted in the original publication. In addition, under the section titled "Books and Reviews," attention is called to publications from research centers that would be of particular interest to persons working in maize agronomy.

The bibliography itself is arranged into sections according to geographic regions suggested by the *Worldmark Encyclopedia of Nations*, 3rd ed. (Harper & Row, New York, 1967). Within sections, abstracts are arranged alphabetically by country in which the work was done or, if unknown, the country in which the work was published.

Nutrition of Maize would not have been possible without the cooperation and assistance of many individuals and organizations. Several institutions were particularly helpful in furnishing information and in permitting use of abstracts from their publications. They and their identifying notations are:

1. The Commonwealth Agricultural Bureaux (publishers of *Soils and Fertilizers*, shown as Soils Fert., and *Field Crop Abstracts*, shown as Field Crop Abstr.).
2. Chemical Abstracts Service (shown as CA).
3. Royal Tropical Institute, Amsterdam (shown as Trop. Abstr.).
4. Dissertation Abstracts International (shown as Diss. Abstr.).

Other abstracts were taken from TVA's *Fertilizer Abstracts* (shown as FA).

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GHANA

1 Effects of Spacing and Fertilizer on Growth and Yield of Maize. S. E. Koli (Crops Res. Inst., Kumasi, Ghana). *Ghana J. Agr. Sci. 4* (2), 145-51 (1971) (Eng). *Soils Fert. 35*, 5411. Seven plant spacings were tested at three fertilizer levels (F_0 = no fertilizer, F_1 = 48 lb/acre each of N, P_2O_5, and 20 lb of K_2O, F_2 = 96 lb/acre each of N, P_2O_5, and 40 lb of K_2O) for the variety Mexican 17. The F_1 treatment significantly increased yields compared to no fertilizer and there was no advantage in applying the higher fertilizer rate F_2.

KENYA

2 Grain and Mulch Production from Maize in Coffee-Growing Areas of Kenya. Effects of Spacing, Fertilizer Application, and Variety. A. M. Kabaara and B. S. Kimeu (Coffee Res. Sta., Ruiru, Kenya). *East Afr. Agr. Forest. J. 38* (4), 334-42 (1973) (Eng). *CA 80*, 13984. Growing maize in coffee areas having ⩾ 1000 mm rainfall is suggested for economic yields of both grain and stover. This stover as a mulching material is superior to Napiergrass (*Pennisetum purpureum*) which has undesirable high K levels. H 612 and 613 B maize hybrids responded better to increased N-P rates, increased plant density, and rainfall than the local maize variety.

NIGERIA

3 Maize Research in Western Nigeria. A. A. Agboola (Univ. Ibadan, Nigeria). *Agrokem. Talajtan 19* (3), 255-70 (1970) (Hung). *CA 74*, 111023. Corn cultivated on virgin land should be given 27 kg N/ha at tasseling, and that grown on 3-4 yr soils should receive 54 kg N/ha. A split application of N fertilizers is needed for the second, late summer corn crop. Soil mulching increased the yield of the late corn crop. Some Nigerian soils showed Mg, B, and Zn deficiencies and all of them should be supplied with P.

4 Preliminary Investigation on the Use of Leaf Analysis to Evaluate Fertilizer Recommendation for Maize. A. A. Agboola (Univ. Ibadan, Nigeria). *West Afr. J. Biol. Appl. Chem. 12* (2), 35-43 (1969). *Soils Fert. 34*, 1684. On three series of ferruginous tropical soils in the forest zone of western Nigeria, the general-purpose fertilizer recommendation of 50 lb N, 14 lb P, and 50 lb K/acre for continuous maize was insufficient to maintain high yields, leaf-N and leaf-P content being below Tyner's critical nutrient level of 3.09% N and 0.31% P. Leaf-N and leaf-P at the silking stage reflected fertilizer treatment and leaf-N was positively correlated with crop yield.

5 Effect of Soil Management on Corn Yield and Soil Nutrients in the Rain Forest Zone of Western Nigeria. A. A. Agboola and A. A. Fayemi (Univ. Ibadan, Nigeria). *Agron. J. 64* (2), 641-4 (1972). *CA 77*, 125274. The experiment was conducted in Ibadan which has an annual rainfall of 140 cm and average temperature of 25°. The experiment was located on two soil series with unusually high available P (100 kg/ha) and exchangeable K (600 kg/ha), soil pH of 6.5, and cation exchange capacity of 15 meq/100 g. The results show that fertilizer [N-P-K (55:10:55 kg/ha)] increased yields of corn (*Zea mays*) from 1510 to 2460 kg/ha. Greengram (*Phaseolus aureus*), cowpea (*Vigna sinensis*), and calopo (*Calopogonium muccunoides*) either interplanted or rotated also increased the yield of corn. The magnitude of the increase for calopo was equivalent to that for the fertilizer. Legumes tended to conserve available P and exchangeable K in the surface soil.

6 Interplanting of Maize with Legume. II. The Effect of Phosphorus and Intercropping of Tropical Legumes on the Yield of Maize. A. A. Agboola and A. A. Fayemi (Univ. Ibadan, Nigeria). *West Afr. J. Biol. Appl. Chem. 13* (2), 31-8 (1970). *Soils Fert. 34*, 2496. Maize associated with *Calopogonium mucunoides, Vigna sinensis* and *Phaseolus aureus* and treated with single superphosphate yielded equally well as maize alone with single superphosphate plus 80 lb N/acre, and significantly higher than maize without either legume or fertilizer or with superphosphate only.

7 Preliminary Trials on the Intercropping of Maize with Different Tropical Legumes in Western Nigeria. A. A. Agboola and A. A. Fayemi (Univ. Ibadan, Nigeria). *J. Agr. Sci. 77* (2), 219-25 (1971). *Soils Fert 35*, 685. Maize yield was lowered by interplanting with popondo (*Phaseolus lunatus*) and mucuna (*Mucuna utilis*) while calopo (*Calopogonium muconoides*), cowpea (*Vigna sinensis*) and greengram (*Phaseolus aureus*) had less effect. Interplanted maize did not respond significantly to 50 lb N/acre. Maize with legumes but no fertilizer yielded almost as well as maize grown with fertilizer but no legumes, while after four growing seasons the yield of maize with neither fertilizer nor legume was reduced by half.

8 Interrelations Between Potassium, Calcium, and Magnesium Nutrition of *Zea mays*. J. A. Falade (Univ. Ife, Ile-Ife, Nigeria). *Ann. Bot. (London) 37* (150), 345-53 (1973). *CA 79* 30869. Seedlings of *Zea mays* (corn), 1 week old, were grown 17 days in Hoagland culture solutions containing combinations of K^+ (1.5, 6.0, 24, and 48), Ca^{2+} (2, 8, and 32), and Mg^{2+} (1, 4, 16, and 32 meq/l.). Then the plants were cleansed, divided into roots and tops, dried, weighed and ground; samples were ashed at 500° and P, Ca, Mg, and K were determined. Calcium stimulated the uptake of K and Mg at some ratios of the cations but inhibited it at others, as did K for the uptake of Ca and Mg for the uptake of Ca and K. The uptake of Mg was generally enhanced by K. The sum of cations in the plants was fairly constant at the low to moderate levels of K, but at considerably higher levels (> 24 meq K/l.) the constancy was not dependent on K concentration. Potassium depressed but Mg stimulated the accumulation of P. Calcium increased the uptake of P at certain cation ratios but had no effect at others. The dry wt of the plants increased with increasing K concentrations. The dry wt was also increased by Ca. At some cation ratios Mg increased the yield and at others either it depressed or had no effect on plant yield. The combination of cations for best yield seemed to be K 48, Ca 2, and Mg 1 meq/l. A combination of K 24 Ca 8, and Mg 32 meq/l. gave similar results.

9 Effects of Plant Population and Fertilizer Nitrogen on Growth and Components of Yield of Maize Grown for Silage in Nigeria. R. J. Haggar and D. C. Couper (Shika Agr. Res. Sta., Zaria, Nigeria). *Exp. Agr. 8* (3), 251-63 (1972). *Soils Fert. 35*, 5422. In a 1-yr field experiment maize growing at spacings of 6 x 6, 12 x 12, 18 x 18, and 36 x 4 in. (174,200, 43,500, 19,300, and 43,500 plants/acre, respectively) was fertilized with 0, 75, and 150 kg N/ha. Dry matter yields (at 75

days) of plants at 6 x 6 in. and 12 x 12 in. spacings were significantly increased by N but N did not increase yields at the other 2 spacings. Plant population had a greater effect on plant yields than N and highest yields were given by the highest plant population and lowest yields by the lowest population.

10 Zinc Response of Maize (*Zea mays* L.) Grown on Sandy Inceptisols. O. A. Osiname *et al. Agron. J. 65* (6), 875-7 (1973). Field experiments were conducted with IITA maize (*Zea mays* L.) composite B at six locations ranging from forest to savannah in the Western State of Nigeria to assess the level of Zn response on sandy Inceptisols. Zinc, as Na_2 Zn EDTA, was applied as broadcast application at 0, 1.0, 2.0, 4.0, and 8.0 kg/ha. Zinc response in terms of growth development and grain yield was limited to the savannah where yield increases of 1747 kg/ha of grain were obtained with application of Zn at 1-2 kg/ha. For optimum grain yield, 12 ppm Zn in tissue appeared minimal. Maize response to Zn application was most probable when the 0.1*N* HCl soil-extractable Zn was less than 1.0 ppm when measured at silking time.

RHODESIA

11 Responses of Maize to Varying Spacings, Populations, and Nitrogen Levels in the Lowveld. K. E. Cackett and P. C. Wall. *Rhodesia Agr. J. 67* (4), 101-7, 109 (1970) (Eng). *Trop. Abstr. 26*, 849. During the period 1960-68, a considerable number of field trials were conducted in Rhodesia at four sites in the lowveld. The effects were studied of N (0 to 224 kg/ha), row spacing (60 and 90 cm), and population density (15, 22.5, and 30 cm inter-row spacing) on the yield of early- and late-maturing maize varieties. The results obtained are reviewed. It is concluded that the mean yields of early maize varieties were 6-55% higher than those of the late varieties; seasonal variation accounted for the differences.

12 Effects of Nitrogen, Phosphate, and Season on Flowering and Grain Maturation in Maize. J. L. Manson (Univ. Rhodesia, Salisbury). *Rhodesian J. Agr. Res. 8* (2), 109-21 (1970) (Eng). *CA 75*, 4732. Four field experiments with the single-cross *Zea mays* (corn) hybrid SR 52, were carried out in consecutive seasons. In a later experiment, in which individual plants uniformly well nourished and watered were used, precision was improved by using prematurity ear measurements as indicators of potential postmaturity ear parameters. Average grain dry matter yields in the four experiments were: no fertilizer, 2350 kg/ha; with 53 kg P/ha, 2900 kg/ha; with 90 kg N/ha, 4600 kg/ha; with 180 or 270 kg N/ha, 5350 kg/ha; with NP 6050 kg/ha. Average interval between planting and half-silk with no fertilizer was 94.3 days; average nutrient effects on this interval were: P 2.6 days, N 5.3 days, N + P 10.7 days. These effects were smaller in drier conditions. In dry post-silking conditions little or no grain growth occurred later than 70 to 80 days after half-silk, when the water content in grain reached about 26%. In the two experiments that had an optimal soil moisture after silking, grain of N-fed plots grew until about 100 days after silking. In the final experiment, the rate of CO_2 production by newly-harvested grain was determined. It decreased steadily from 50 to 110 days after silking, apart from a temporary increase at 70 to 80 days, when the grain growth rate began to diminish noticeably.

SIERRA LEONE

13 Maize as a Second Crop for the Uplands of Sierra Leone, West Africa. E. Brams and R. Weibel. *Prairie View, Texas:* Prairie View A and M College, University Consortium on Soils of the Tropics, Bull. No. 1, 16 pp. (1971). This paper describes a series of experiments that tested the effects of planting date, density of stand, fertilizer treatment, and variety on maize yields growing on uplands river terrace soils of the humid tropics of Sierra Leone.

SOUTH AFRICA

14 The Effect of Zinc Fertilization on the Yield of Maize and the Mineral Composition of the Leaves. C.P.L. De Beyers and F. J. Coetzer (Navorsingsinstituut van die Winterreenstreek, Stellenbosch, South Africa). *Agroplantae 1*, 41-6 (1969) (Afr). *Soils Fert. 34*, 2486. Zinc sulfate, ZnO and Zn powder were broadcast at 10 lb Zn/morgen onto a fine sandy loam of pH 6. Over a period of 3 yr, maize utilized the different forms of Zn equally well. Zinc uptake from banded fertilizer was less than from broadcast Zn, although banding of P and Zn together slightly increased Zn uptake. Zinc deficiency decreased cob yield, but not stover yield. Zinc-deficient index leaves contained 17.2-22.7 ppm Zn. Zinc applied to Zn-deficient soil containing 0.22 ppm Zn extractable in $MgCl_2$ increased uptake of P, Cu, Fe, Mn, and B by the plants, but on an adjacent soil, containing 0.49 ppm extractable Zn, it had no such effect. Zinc at 10 lb/morgen controlled Zn deficiency for 3 yr. Foliar application of 0.2% $ZnSO_4$ solution increased the Zn content of the index leaf but did not increase yield in 1963-64.

15 Maize Nutrition. I. Nitrogen and Phosphorus Content. H. C. Hahne and E. R. Orchard (Univ. Natal, Pietermaritzburg, South Africa). *Agrochemophysica 2* (3), 53-9 (1970) (Eng). *Soils Fert. 35*, 1620. In a factorial field experiment 79, 132, 185, or 238 kg N/ha as urea, 47 or 93 kg P/ha as superphosphate plus rock phosphate, 44, 88, 132, or 176 kg K/ha as KCl, and 3.2 or 6.4 tons lime/ha were applied. A subplot treatment of trace elements was also applied. Nitrogen content of leaves increased linearly with increased N additions but grain yield did not increase correspondingly. Phosphorus applications only increased leaf P slightly but increased grain yield markedly. There were significant NP and N-lime interactions.

16 Maize Nutrition. II. Potassium, Calcium, and Magnesium Content of Maize Leaves in Relation to Fertilizer Treatment and Grain Yield. H. C. Hahne and E. R. Orchard (Univ. Natal, Pietermaritzburg, South Africa). *Agrochemophysica 2* (4), 85-91 (1970) (Eng). *Soils Fert. 35*, 1621. The treatments and experimental design were as in Part I. Potassium fertilizer increased K content of leaves and the grain yield. Lime increased the Ca and Mg contents of the leaves but depressed leaf K. The effect of N fertilizing on K and Ca contents of leaves depended on the level of P and lime applications. The Mg content increased with increasing N-applications.

17 Leaf Composition and Yield Response of Corn in Relation to Quantity Intensity Parameters for Potassium. J. T. Koch, E. R. Orchard, and M. E. Sumner (Coll. Agr., Cedara, South Africa). *Soil Sci. Soc. Amer. Proc. 34* (1), 94-8 (1970). *Field Crop Abstr. 23*, 3226. In field trials in 1965-66, the value of the quantity/intensity approach for characterizing the K status of the soil, in which the energy level or intensity of K in the labile pool in the soil is related to the quantity of K

present, was assessed. Maize was given 0, 21, and 42 kg N/ha, 0, 19, and 37 kg P, 0, 53, and 106 kg K/yr, and lime containing 60% $CaCO_3$ and 38% $MgCO_3$ at 0, 2118, and 4237 kg/ha every 5 yr. Potassium content of the leaf increased with increasing K, but at any one level of K the content was decreased by liming. The relationship between leaf K and exchangeable K indicated that as the amount of exchangeable K increased, uptake of K per unit of exchangeable K decreased. The leaf content of K was closely related to the soil pool of labile K. Yield data showed that luxury consumption of K occurred at K levels above 53 kg/ha. It was concluded that the pool of labile K as measured by the quantity/intensity technique is a good index of the amount of K available to maize on soils of the Clifford series.

18 Nutrient Balance in the Soil in Relation to Fertilizer Treatment and Maize Yield. I. Nitrogen. J. M. Marques. *Rev. Cienc. Agron. (Univ. Lourenco Marques) 2*, 61-73 (1969). *Trop. Abstr. 26*, 586. In the Republic of South Africa, field experiments were conducted with maize grown in leached acid lateritic soil with an annual rainfall of more than 890 mm, and treated with various amounts of NPK fertilizers, trace elements, and lime. The main object was to study the nutrient balance in the soil, as affected by the fertilizer treatments, and nutrient uptake by the crop. Soil samples were analyzed for total mineral N in the field samples and that formed during incubation, exchangeable cations, pH, and available P. Only the factors affecting the N balance are discussed.

TANZANIA

19 Responses of Maize to Application of Compound Fertilizers on Farmers' Fields in Ten Districts of Tanzania. G. D. Anderson (North. Res. Cent., Arusha, Tanzania). *East Afr. Agr. Forest. J. 34* (3), 382-97 (1969) (Eng). *Biol. Abstr. 51*, 132889. Maize trials from 10 districts of Tanzania have proven the feasibility of 100 lb of compound fertilizer/acre. Responses from localities around villages were significant in all but one case, where there were only four trials. The mean responses per acre for the districts ranged from 1010 lb in Lusboto to 318 lb in Dodoma. Responses were largely influenced by the rainfall during the growing period, soil moisture retentivity and the acuteness of deficiencies of N, P, and K. In most areas, the response was thought to be due to N and P and their interaction. In Arusha and parts of south Kilimanjaro and Lushoto, however, P is thought to have played a very minor role, while at Tanga and east Kilimanjaro K also probably increased yields considerably.

20 Response of Maize Varieties in Tanzania to Different Plant Populations and Fertilizer Levels. A. Bolton (Res. Training Inst., Ukiriquru, Mwanza, Tanzania). *Exp. Agr. 7*, 193-203 (1971). *Soils Fert. 34*, 5210. In trials conducted for three seasons at a range of altitudes, maize responded well to N and P fertilizing at sites over 900 m but there was little response below 900 m.

UNITED ARAB REPUBLIC

21 Influence of Soil Moisture on Phosphorus Uptake by Corn and on the Efficiency of Added Superphosphate. F. M. Abdou *et al* (Univ. Ain Shams, Cairo, UAR). *J. Soil Sci. U.A.R. 9* (2), 175-83 (1969) (Eng). *CA 74*, 99017. Two pot experiments were made to study the effect of soil moisture on uptake of P by corn and on the efficacy of added superphosphate. The wt of the dry matter, P uptake, and the fraction of P derived from the superphosphate increased with increasing soil moisture. Reducing the water content had a greater effect on the absorption of P from the fertilizer than from the soil. Plants could absorb small, but definitely measurable amounts of P from air-dry soil, or from soils with a moisture content less than the wilting percentage, provided that part of the roots of the plants can take up water from another site.

22 Effect of Nitrogen Fertilization on Increasing the Nutritive Value of Corn Grains with Respect to Their Protein and Tryptophan-N Content. M. A. Ali *et al* (Min. Agr., Cairo, UAR). *Agr. Res. Rev. 49* (6), 49-63 (1971) (Eng). *CA 78*, 123207. Nitrogen fertilizer requirements of corn for maximum increase in protein and tryptophan content of the edible kernels, and the effect of this increase on germination energy and growth rate of seedlings were investigated. Nitrogen (0-75 kg/feddan) was applied at the vegetative stage. Total, protein-, free tryptophan- and total tryptophan-N were determined by standard methods. The protein content and hence the nutritive value of corn could be increased by N fertilization by ~48.5% in the American Early, but only by 12.5% in the Cross Hybrid 67 variety. Calcium content was not the limiting factor of protein increase in the second variety. The yield of corn protein per unit N depended on the level of N applied

23 Nitrogen Balance Sheet and Ammonium Sulfate Gypsum Pellets and Mixtures and Urea-Formaldehyde Applied to Corn in Pots of Sand. A. M. Balba and T. H. Sheta (Univ. Alexandria, UAR). *Plant Soil 39* (2), 293-302 (1973) (Eng). *CA 79*, 145279. Nitrogen utilization by corn plants from $(NH_4)_2SO_4$-gypsum pellets was greater than that from $(NH_4)_2SO_4$-gypsum mixture from powdered $(NH_4)_2SO_4$-gypsum pellets, or from ureaform. No significant difference was observed among the amounts of N leached from the pellets, $(NH_4)_2SO_4$ applied in three portions, and ureaform. These three forms of N sources gave lower N leaching than did other $(NH_4)_2SO_4$ treatments. The amounts of residual N were much higher in pots fertilized with ureaform than in those fertilized with all other $(NH_4)_2SO_4$ treatments. Loss of N in gaseous form was observed in all N treatments, the loss from $(NH_4)_2SO_4$-gypsum pellets being the lowest. In ureaform- and urea-sand systems, the pH increased, NO^{2-} accumulated, and considerable loss of N took place. Increased gypsum additions to the $(NH_4)_2SO_4$ fertilizer decreased the pH, NO^{2-} accumulation, and N losses from the fertilizer-sand system.

24 Use of Labeled Nutrient Elements in a Coordinated Maize Fertility Program. I. Use of ^{15}Nitrogen in Studying Method of Nitrogen Application to Corn. M. T. Eid *et al* (Min. Agr. Agrar. Reform, UAR). *Agr. Res. Rev. 48* (6), 94-122 (1970) (Eng). *CA 77*, 150903. The efficiency of $(NH_4)_2SO_4$-^{15}N as a N fertilizer for maize was studied. Nitrogen, 100 kg/ha, was applied as single and split treatments by plowing in (2 days before planting), banding (at planting time), and sidedress (when plants were 30-cm high). The dry plant material obtained from plants harvested just after tasseling was highest in the treatments: plowing in plus sidedress, plowing in plus banding, banding plus sidedress, and banding. However the dry plant material obtained at maturity varied less with regard to the N application method, plowing in plus banding giving the best results. The total N content in plants harvested at maturity was markedly increased over that of plants of the first harvest and controls. Differences among the N application methods were not significant. Fertilizer N utilization was low after 23 days of plant growth but increased considerably after 67 days. The highest fertilizer N utilization

was noted in the banding + sidedress treatment.

25 Needs of Sandy and Calcareous Soils with Respect to Iron Supply. A. M. Elgala (Univ. Ain Shams, Cairo, UAR). *J. Soil Sci. U.A.R. 11* (1), 39-46 (1971) (Eng). *CA 79*, 65136. Iron chlorosis in maize grown on reclaimed calcareous or alkaline sandy soils was prevented by two foliar applications, 2 and 3 weeks after planting, of 0.2% $FeSO_4$ solution or 0.1% ethylenediamine-*N,N'*-bis[α-(2-hydroxyphenyl)acetic acid] (Fe EDDHA). Chlorosis was prevented also by application of Fe EDDHA to the soil to provide 5 ppm Fe, but $FeSO_4$ applied to the soil was ineffective.

26 Nitrogen Balance Studies for Different Egyptian Soils Cropped with Corn. M.H.A. El-Shakweer, A. S. Abdel-Ghaffar, and M. A. Barakat (Fac. Agr., Univ. Alexandria, UAR). *Plant Soil 39* (2), 341-9 (1973) (Eng). *CA 79*, 145306. Corn was gorwn in pots in four soils (clay loam, calcareous sandy loam, sandy loam, and sand) fertilized with increasing amounts of $(NH_4)_2SO_4$. Nitrogen added as fertilizers and insecticides and contained in seeds and irrigation water, N removed by corn plants including thinned plants and fallen leaves, and N content of the soils before sowing and after the harvest were determined, and the N balance was calculated. Nitrogen loss ranged 6.8-51.5% depending mainly on soil type and to some degree on the rate of applied $(NH_4)_2SO_4$. Nitrogen uptake by corn plants was lowest from the clay loam soil and highest from the sandy soil. In all cases it was increased slightly by $NH_4)_2SO_4$ application.

27 Iron and Phosphorus Interaction in Calcareous Soils. I. Effect on the Growth and Phosphorus and Iron Content of Plants. M. Omar *et al* (Univ. Ain Shams, Cairo, UAR). *J. Soil Sci. U.A.R. 11* (2), 245-57 (1971) (Eng). *CA 79*, 65104. Interaction between P and Fe in relation to growth and mineral composition of corn plants grown in a calcareous soil was investigated in a greenhouse at three levels of soil moisture: 50, 100, and 150% of field capacity. Iron was added in concentrations of 0, 1, 5, and 10 ppm and P was added at a rate of 0, 0.033, 0.066, and 0.132 g P/pot. Plants showed chlorotic symptoms depending on P and soil moisture levels. Iron application did not prevent chlorosis development. Increase in P and soil moisture increased the plant dry wt and increase in P increased the plant P concentration. Neither combined application of P and Fe nor increase in moisture levels had any significant effect on plant Fe concentration. Plant P uptake was not affected by Fe treatment. The percentage and total active Fe decreased with increasing P level.

THE AMERICAS

BRAZIL

28 Plant Nutrient Study on a Dark Red Latosol Under Cerado Vegetation. D.P.P. Britto *et al* (Inst. Pesqui. Exp. Agropecuar. Cent.-Sul, Univ. Fed. Rural, Rio de Janeiro, Brazil). *Pesqui. Agropecuar. Brasil., Ser. Agron. 6*, 17-22 (1971) (Port). *CA 78*, 96514. On a dark latosol soil, N-P-K was applied to corn, soybeans, and cotton in various combinations with lime, Mg, and trace elements (Cu, Zn, Mo, Mn, and B). Corn and cotton responded best to an application of N-P-K supplemented with B, Mo, Mn, and Zn; similar results were obtained for inoculated soybeans. However, only Zn gave favorable results, consistent for all crops. The optimum Zn level on a background of 90 N, 150 P_2O_5, and 120 kg K_2O, was 10 kg $ZnSO_4$/ha.

29 Fertilizing Maize. XXVII. Trials with Different Phosphate Fertilizers (10th Series). L. T. De Miranda *et al* (Inst. Agron., Sao Paulo, Brazil). *Bragantia 29*, 301-8 (1970) (Port). *Soils Fert. 35*, 683. In experiments testing six P fertilizers at four localities in Sao Paulo on red latosols, red-yellow latosols and alluvial soil, P had little effect on the alluvial soil but increased yields by 13 and 18% (at 60 and 120 kg P_2O_5/ha, respectively) on the other sites. The mean increase in grain yield due to superphosphate was 683 kg/ha. The relative increases due to the other P fertilizers were: thermophosphate, 127%; a mixture of two-thirds superphosphate and one-third Araxa phosphate, 75%, Olinda, Alvorada, and Araxa rock phosphates, 71, 56, and 37%, respectively.

30 Fertilizing Maize. XXVI. Trials with Different Phosphate Fertilizers (9th Series). G. P. Viegas, L. T. De Miranda, and E. S. Friere (Inst. Agron., Sao Paulo, Brazil). *Bragantia 29*, 191-8 (1970) (Port). *Soils Fert. 35*, 684. In phosphate fertilizer trials at various locations in Sao Paulo, superphosphate increased maize grain yields by 1030 kg/ha. The relative increases due to the other P fertilizers tested were: triple superphosphate, 98%; dicalcium phosphate, 71%; Alvorada, Olinda, and Araxa rock phosphates, 51, 50, and 40%, respectively.

31 Effect of Copper Sulfate on Potassium Absorption by Corn (*Zea mays*) Cultivated in a Red Latosol Dark Ortho Soil. J. R. Gallo, Ruter Hiroce, and L. T. De Miranda (Secao Quim. Anal., Inst. Agron., Campinas, Brazil). *Cienc. Cult. (Sao Paulo) 24* (4), 375-6 (1972) (Port). *CA 80*, 58899. A significant positive effect of $CuSO_4$ on K absorption by corn was found by leaf analysis. However, leaf analysis did not demonstrate significant increases in Cu content of the plants growing on $CuSO_4$-treated plots.

CANADA

32 Response of Corn to Small Amounts of Fertilizer Placed with the Seed. II. Summary of 22 Field Trials. T. E. Bates (Univ. Guelph, Ontario, Canada). *Agron. J. 63*, 369-71 (1971). *Soils Fert. 34*, 4224. Nitrogen, P, and K banded with maize seeds at rates of 3.1, 5.4, and 2.5 g/m of row delayed and reduced emergence in several trials. On the average it increased dry wt of 36-day-old plants by 36%, decreased the time of silking by 1.2 days, and increased grain yield by 2.9%. The effect on lodging was variable.

33 Response of Corn to Small Amounts of Fertilizer Placed with the Seed. III. Relation to Phosphorus and Potassium Placement and Tillage. T. E. Bates (Univ. Guelph, Ontario, Canada). *Agron. J. 63*, 372-5 (1971). *Soils Fert. 34*, 4225. Grain yield was slightly greater when P was side banded than when it was disked or plowed down. When accompanied by fertilizer with the seed, P was as effective when plowed down as when it was side banded. Disked K produced low yields.

Fertilizer with the seed reduced the yield response to preplanting tillage in one out of five trials.

34 Response of Corn to Small Amounts of Fertilizer Placed with the Seed. IV. Comparison of Dry and Liquid Forms. A. S. Baweja and T. E. Bates (Univ. Guelph, Ontario, Canada). *Agron. J. 63*, 376-80 (1971). *Soils Fert. 34*, 4226. Powdered and granular fertilizers containing 13.3, 23.1, and 11.0% N, P, and K, respectively, were prepared along with water solutions containing 10.5 and 4.4% P. These fertilizers were banded with maize seeds in glasshouse trials. There were no differences in nutrient availability between the dry and liquid fertilizers. Both granular and powdered materials were equally toxic and they were more toxic to maize seedlings than the less concentrated liquid fertilizers applied at rates providing the same total quantities of plant nutrients.

35 Optimum Ratios of Nitrogen and Phosphorus Fertilizers for Corn Determined by Homes' Method of Systematic Variations. E. G. Beauchamp and H. A. Hamilton (Canada Dept. Agr. Res. Sta., St. Jean, Quebec, Canada). *Can. J. Plant Sci. 50*, 141-50 (1970). *Soils Fert. 33*, 4854. The greenhouse experiment involved applications of KNO_3 and KH_2PO_4 with variable N:P ratios to a loam (pH 5.17). Maximum dry-matter yields were associated with N:P ratios of 9-18 in the tissues of maize at the highest level of NP application.

36 Influence of Nitrogen Source on Phosphorus Uptake by Corn from Soils Differing in pH. G. J. Blair, C. P. Mamaril, and M. H. Miller (Univ. Guelph, Ontario, Canada). *Agron. J. 63*, 235-8 (1971). *Soils Fert. 34*, 4234. In greenhouse experiments with maize, application of $(NH_4)_2SO_4$ with MCP (monocalcium phosphate) increased fertilizer-P uptake compared to MCP alone on soils of pH 8.2, 7.4, and 5.5, but not at pH 4.2. Accumulations of Ca and P occurred on root surfaces in alkaline soils and Ca, Fe, and P accumulations at pH 5.5 but no root surface accumulations were found at pH 4.2. Phosphorus uptake was greatest when the accompanying N-fertilizer was NH_4 rather than NO_3.

37 Response of Corn to Nitrogen, Phosphorus, and Potassium. R. F. Bishop, G. G. Smeltzer, and C. R. MacTachern (Res. Sta., Can. Agr., Kentville, Nova Scotia, Canada, *Can. J. Soil Sci. 52* (1), 27-42 (1972) (Eng). *CA 76*, 152529. Fertilizer trials with hybrid corn (*Zea mays*) were conducted on six soil series at a total of 14 locations during a 6-yr period. Treatments consisted of various rates of N, P, and K applied in all possible combinations. The effect of N on both leaf composition and yield was predominately linear and was much greater than the effect of either P or K. Applied N had an effect on leaf N at 10 locations, applied P on leaf P at 5, and applied K on leaf K at 6. In the case of yield, there was an effect from N at 10 locations, P at 4, and K at 1. The results indicate that factors other than nutrient supply also affected yield and that N, P, and K at 100-150, 30-45, and 30-40 kg/ha, respectively, were generally adequate.

38 Rapid Determination of Nitrate-Nitrogen in Corn Leaves and Sugar Beet Petioles as an Indicator of Sidedressing Nitrogen Need. E. Chamberland and E. B. Doiron (Div. Soils, Minist., Quebec, Canada). *Commun. Soil Sci. Plant Anal. 4* (4), 293-306 (1973) (Eng). *CA 79*, 145256. In 26 trial fields covering 12 different types of soils in the Montreal-St. Lawrence area, NO^{3-} analysis revealed there was a marked positive correlation between crop yield and nitrate-N from the 5th to 7th week for corn and 7th to 8th week for sugar beet. A negative correlation was found between NO^{3-} and total sugar yield before the 7th week. The critical concentration value for corn was $\geqslant$ 150-200 ppm NO^{3-}; however, 2000 ppm appeared to be the minimum NO^{3-} concentration. For the sugar beet 10,000 to 20,000 ppm NO^{3-} in petioles during the initial 50-56-day period gave maximum sugar yields.

39 Effects of Light Intensity and Nitrogen Level and Source on the Growth of Corn (*Zea mays*) in a Controlled Environment. Wing-To Chan and A. F. Mackenzie (Macdonald Coll., McGill Univ., Montreal, Quebec, Canada). *Plant Soil 35* (1), 173-8 (1971). *CA 75*, 87584. An interrelated growth response to light intensity and N source was shown by corn under controlled humidity, photoperiod, and temperature conditions. At 21,250 lx with 10 and 100 ppm nitrate N, vegetative growth (dry matter production) of leaf, stalk, and root of 4-week-old plants was increased, especially in the stalks. A significant, positive correlation between light intensity and nitrate N was determined. A light intensity of 5380 lx was less effective than the 21,250 lx. Light intensity also increased growth with ammonium N but the ammonia N by itself had no effect under the experimental conditions, and thus no positive interaction.

40 Effects of Rate and Placement of Phosphorus, pH, and Temperature on the Early Growth, Phosphorus, Boron, and Zinc Content of Corn. E. A. Grant, A. A. MacLean, and U. C. Gupta (Res. Sta., Can. Agr., Fredericton, New Brunswick). *Can. J. Plant Sci. 52* (1), 35-40 (1972). *Soils Fert. 35*, 3473. In a greenhouse experiment yield of maize grown on a podzol was 5 to 10 times greater at 20° than at temperatures progressing from 9.6 to 19.3° over 8 weeks. Response to applied P was also greater at higher temperatures. At low temperatures 17 kg P/ha placed with the seed was as effective as much larger amounts banded. Liming increased P uptake, and in one experiment decreased growth due to greatly reduced Zn uptake. Applied P reduced Zn content, but not uptake. Boron content was not affected.

41 Quality and Quantity Factors of Nutrition of Hybrid Corn. Y. P. Kalra and A. N. Pathak (Can. Forest Serv., Edmonton, Alberta). *Z. Pflanzenernaehr. Bodenk. 130* (2), 108-17 (1971) (Eng). *Soils Fert. 35*, 3466. Tabular data are presented on the foliar contents of N, P_2O_5, and K_2O (and grain and stover yields) in hybrid-maize varieties at five different stages of growth. Deviations from the optimum physiological balance of N and P at low rates (20 lb/acre) and high rates (80 lb) of N, and changes in the N-P-K equilibrium during the growth cycle (at low or high fertility) are also shown on triangular diagrams.

42 Effects of Ammonium on the Uptake of Phosphorus, Sulfur, and Rubidium by Corn. C. P. Mamaril and M. H. Miller (Univ. Guelph, Ontario, Canada). *Agron. J. 62* (6), 753-8 (1970). *CA 74*, 12194. Four controlled-environment experiments were conducted to elucidate the influence of NH_4 on P absorption and to determine if this phenomenon is specific only to P. The variables investigated were concentrations of P and NH_4, proportion of the soil treated, and proportion of the root system exposed to treated soil. In one experiment, ^{35}S labeled $(NH_4)_2SO_4$, and K_2SO_4 were applied to determine the effect of NH_4 on SO_4^{2-} absorption. In another experiment $^{86}RbCl$ was added as well as ^{32}P labeled phosphate to determine if the absorption of cations would be increased by NH_4, as is that of P. The concentration of P in the soil, rather than the proportion of soil treated or the proportion of the root system exposed to the treated soil, determined the influence of NH_4 on P absorption. The effect of NH_4

increased with increasing concentrations of NH_4. The absorption of SO_4^{2-} and Rb^+ were not influenced by NH_4 to the same degree as was absorption of P. With the exception of one experiment, the effect of NH_4^+ on P absorption was much less pronounced than reported previously. The reason for this difference cannot be adequately explained.

43 Response of Corn to Small Amounts of Fertilizer Placed with the Seed. I. Greenhouse Studies. M. H. Miller *et al* (Univ. Guelph, Ontario, Canada). *Agron. J. 63*, 365-8 (1971). *Soils Fert. 34*, 4227. The effects of NPK fertilizer banded with the seed were followed in three trials. With the side band there was little uptake of applied P at the 4th week after seeding, but at the 7th week there was a height and wt response. A small percentage of K was considered desirable in fertilizer application with the seed (except the soils high in K). When fertilizer was sprayed on the seed only, the response was small compared to that with the same concentration sprayed in a band across the seed and soil. The 6-10.5-5 fertilizer banded with the seed at rates above 56 kg/ha in 91-cm rows produced an appreciable delay in emergence.

44 Effect of Stover Mulch on Soil Temperature, Corn Root Weight, and Phosphorus Fertilizer Uptake. J. J. Onderdonk and J. W. Ketcheson (Univ. Guelph, Ontario, Canada). *Soil Sci. Soc. Amer. Proc. 37* (6), 904-6 (1973) (Eng). *CA 80*, 69701. Bands of corn stover placed on soil in different positions relative to corn rows decreased soil temperature at a 10-cm depth, doubled the proportion of root growth in the surface 5 cm of soil, and tripled fertilizer uptake from a surface-applied band of ^{32}P-labeled P fertilizer. The greatest increase in uptake occurred with the band of stover on both sides of the row. Total root growth to a depth of 15 cm was not greater with stover than without it. The increase in uptake was credited to the relatively intensive root growth near the surface, which in turn was believed to result from the temperature depression and a tendency for an increased horizontal direction of root growth. While a favorable soil moisture level, as found under mulch, would be necessary for root growth and proliferation, it was not considered initially responsible for directing roots closer to the soil surface.

45 Response of Corn to Small Amounts of Fertilizer Placed with the Seed. V. Seed Coating Compared with Banding. A. E. Smid and T. E. Bates (Univ. Guelph, Ontario, Canada). *Agron. J. 63*, 380-4 (1971). *Soils Fert. 34*, 4228. The complete NPK fertilizer was more efficient in its effect on P uptake and growth of seedlings when coated on the seed, though it was more toxic than when banded. Thus, banded fertilizer gave a greater growth response when applied at rates which did not delay or reduce emergence. Sucrose and polyvinyl acetate reduced the toxicity of coated fertilizer but not enough to make seed coating practical for maize.

COLOMBIA

46 Preliminary Studies of Fertilizer Trials with Maize in the Cauca Valley. C. A. Flor. *Agr. Trop. 26* (3), 127-35 (1970) (Span). *Trop. Abstr. 26*, 587. Fertilizer trials with N, P, and K were carried out in 52 locations of this part of Colombia. Nitrogen increased yields considerably in 36% of the locations. Urea and ammonium sulfate were equally efficient. P increased yields in 17% of the locations, but only in one case the increase was economical. Potassium application affected yield in only 13% of the locations, either up or down. Boron deficiency may be responsible for the downward effect of K.

COSTA RICA

47 Factors Affecting Zinc Absorption by Corn from Volcanic Ash Soils. M. L. Marinho and K. Igue (Inter-Am. Inst. Agr. Sci., Turrialba, Costa Rica). *Agron. J. 64* (1), 3-8 (1972). *CA 76*, 58182. In high P-fixing soils, such as volcanic ash soils and tropical oxisols, the need for heavy P application may be of consequence in the absorption of Zn. The amount of Zn extracted with 0.01*M* Na-EDTA and 0.1*N* HCl increased with Zn applications and decreased as the free R_2O_3 content increased. Phosphate applications increased the amount of Zn extracted by the EDTA method, but did not show any definite trend in the case of the HCl method, although higher amounts of Zn were extracted by the latter. The total amount of Zn absorbed by corn (*Zea mays*) plants increased with Zn application and decreased as the free R_2O_3 present in the soil increased. The effect of P was not statistically significant. However, Zn concentration in the tissue decreased as the free R_2O_3 content and applied P increased. The *L* value also increased with Zn application, but P application had no definite effect on it. High correlation coefficients between Zn absorption and soil-extracted Zn were obtained from the EDTA method as compared to the HCl method. The EDTA method also correlated better with the *L* value than with the HCl method.

GUYANA

48 Effect of Fertilizer Nitrogen, Phosphorus, and Potassium on Hybrid Corn, *Zea mays*, Pioneer X304, on Arakaka Clay Loam, Guyana. H.A.D. Chesney (Cent. Agr. Sta., Demerara, Guyana). *Agr. Res. Guyana 3*, 63-7 (1969). *Soils Fert. 34*, 3317. On a well-drained red-yellow podzolic soil developed mainly from manganiferous quartzites and mudstones, optimum fertilizing rates were 110 kg N, 80 kg K_2O, and apparently about 50 kg P_2O_5/ha, respectively. A significant NK interaction occurred.

49 Time of Fertilizer Application Trials with Corn, *Zea mays* L., Pioneer X304. H.A.D. Chesney (Cent. Agr. Sta., Demerara, Guyana). *Agr. Res. Guyana 3*, 68-70 (1969). *Soils Fert. 34*, 3320. Trials on a red-yellow podzolic soil suggested that the practice customary in other areas of Guyana of applying one-half N and one-half K at planting and the remainder at about 35-40 days after planting was applicable to the north-west district.

50 Effect of Different Levels of Nitrogen and Phosphorus on Yield, Soil Properties, and Nutrients of Corn. G. C. Shukla (Cent. Agr. Sta., Min. Agr., Guyana). *Agron. J. 64* (2), 136-9 (1972). *Soils Fert. 35*, 3472. In field experiments on marine sediments or alluvial soil the effects on maize of five levels of N up to 180 kg N/ha and three levels of P up to 40 kg P/ha were studied. A yield response to N and P was recorded at only one site and to N alone also at only one site. The responses depended on the native soil nutrient level. The changes in soil pH, total N, available P, and exchangeable K, Ca, and Mg from the first planting to the second harvest are described. Nitrogen fertilizers increased N and K and decreased P uptake, but P fertilizers had no effect on nutrient uptake.

MEXICO

51 Combined Analysis of Yield Data from Fertilizer Experiments. R. J. Laird and F. B. Cady (CIMMYT, Londres,

Mexico). *Agron. J. 61* (6), 829-34 (1969). *Field Crop Abstr. 23*, 3219. General yield equations for estimating fertilizer recommendations were developed from yield data in field trials in which four levels of N were applied to maize at 76 locations in Mexico during 1962-65. The use of multiple linear regression for this type of analysis was examined. Attention was primarily given to the error terms to be employed in testing the significance of regression coefficients and the procedure for obtaining the reduced model most useful for prediction. Three regression procedures, stepwise, backward elimination, and an approach based on agronomic considerations were used, of which the last gave the best predictions.

52 **Proceedings of the First Maize Workshop.** Editors: A. Carballo Q. and Dean Bork. Held Sept. 1971, El Batan, Mexico. *Mexico D.F., Mexico, International Maize and Wheat Improvement Center*, 107 pp. Papers are presented by key maize scientists from around the world and cover the specific purposes of: reviewing the present research and training activities underway in the core program; promoting a better understanding among participants of work in progress and the common problems and limitations to maize and wheat production in the areas or regions in which they are working; discussing CIMMYT's role and how this role can be made more useful; and planning ahead, regionally and globally.

TRINIDAD

53 **Phosphate Studies on the Jamaican Bauxite Soils.** C. C. Weir (Univ. West Indies, St. Augustine, Trinidad). *Trop. Agr. (Trinidad) 49* (1), 89-96 (1972) (Eng). *CA 76*, 84798. The adsorption of added phosphate, the release of native bound phosphate, and the availability of released and applied P to maize plants were studied. Phosphate adsorption followed closely the Langmuir isotherm when P solution concentrations were < 20-25 ppm. Additions of a commercial organic product, aqua humus, resulted in a marked reduction of the amount of P fixed by the soils. Of the four organic complexing agents used in studying phosphate release from the two bauxite soils, 4,4'-dipryidyl and aqua humus solutions released much more P than citric acid and 8-hydroxyquinoline. Also, much more P was released from the brown than from the red bauxite soil. In greenhouse experiments with corn, additions of aqua humus to the two soils significantly increased dry matter yields and phosphate uptake. Superphosphate in red soil treated with aqua humus resulted in significantly increased corn yields and P uptake.

UNITED STATES

54 **Influence of Nutrition on Stalk Rot Development of *Zea mays* (Corn).** T. S. Abney and D. C. Foley (Iowa State Univ., Ames). *Phytopathology 61* (9), 1125-9 (1971) (Eng). *CA 75*, 109325. Breaking strength at 10 days after mid-silk was used as an estimate of inherent stalk strength, which was highest for plants of resistant and susceptible hybrids grown on plots receiving K. The hybrid of intermediate resistance to stalk rot had a higher inherent stalk strength in plots receiving N. Stalk strength decreased late in the growing season. Incidence of stalk rot was negatively correlated with stalk strength, and was positively correlated with pith condition ratings. The difference in rotting of stalks grown on N and no-N treatments was not significant. Nitrogen consistently increased the pith condition ratings, and K consistently decreased the pith condition ratings 10 days after mid-silk. Both fertilizer treatments reduced the pith condition ratings after frost. Stalk rot development in plants grown on K treatments was reduced at 60 days past mid-silk, but all hybrids were severely rotted by 10 days after the first killing frost. Measurements of stalk strength, pith condition, and natural rotting indicated that stalk rot was delayed in plants grown on K-treated plots.

55 **Effect of Cropping Systems and Nitrogen Levels on Corn (*Zea mays*) Yields in the Southern Piedmont Region.** W. E. Adams, H. D. Morris, and R. N. Dawson (Univ. Georgia, Athens). *Agron. J. 62*, 655-9 (1970). *Soils Fert. 34*, 1692. The 7-yr field trial was conducted on sloping (1-3%) sandy loam (limed to pH 6.5), comparing 11 cropping systems (maize-rye, 3-yr perennial grass or legume and 1-yr maize, etc.) and annual applications of 45-270 kg N/ha (or no N). Removal of stalks did not decrease yields when maize was grown continuously with or without green-manure crops: lucerne and fescue were equally effective in the rotations, but bermudagrass competed with maize during the growth season. Residual effects of sod on maize yields lasted for at least 4 yr after turning-down the sod. Maximum yields of maize were obtained from 90 kg N/ha, but N applied at > 45 kg was only slightly more productive for maize in rotation with lucerne or grass-legume sod, and there was no response to N in maize-vetch rotation.

56 **Phosphorus-Iron and Phosphorus-Zinc Relations in *Zea mays* (Corn) Seedlings as Affected by Mineral Nutrition.** D. C. Adriano, G. M. Paulsen, and L. S. Murphy (Dept. Agron., Kansas Agr. Exp. Sta., Manhattan). *Agron. J. 63* (1), 36-9 (1971). *CA 74*, 75651. The P-Zn and P-Fe relations in corn seedlings as affected by high P levels and low and high levels of other nutrients were determined. With high P levels, shoot growth was increased only by high Zn, but was decreased by deficiencies of other nutrients. Nitrogen and K favored P nutrition more than Fe or Zn nutrition. Calcium antagonized P, Zn, and Fe, while Mg synergized P and Zn but not Fe. Similarly, Cu and Mn antagonized shoot P and Fe concentrations and had little effect on shoot Zn concentrations. The most marked interaction at high P levels was between Fe and Zn, which mutually antagonized translocation more than absorption.

57 **Genetic Analysis of Response of Maize (*Zea mays*) Genotypes to Various Levels of Applied Potassium.** J. M. Arnold (Univ. Tennessee, Knoxville). *Diss. Abstr. Int. B 31* (4), 1651 (1971). Avail. Univ. Microfilms. Ann Arbor, Michigan, Order No. 70-17,795, 1969, 136 pp. *CA 75*, 19268.

58 **Yield and Uptake of Nutrients by Selected Corn Genotypes as Influenced by Nitrogen Fertilization.** E. L. Ashburn (Univ. Tennessee, Knoxville). *Diss. Abstr. Int. B 32* (1), 33 (1971). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 71-17,708, 1970, 111 pp. *CA 75*, 97823.

59 **Effect of Leaching the Fertilizer Band on Nutrient Uptake and Growth of Sweet Corn.** A. S. Baker and W. P. Mortensen (West. Washington Res. Ext. Cent., Washington State Univ., Puyallup). *Northwest Sci. 47* (1), 61-5 (1973). *CA 79*, 4329. The fertilizer used was a 28:15.5:40:16.5 mixture of superphosphate, $(NH_4)_3PO_4$, $(NH_4)_2SO_4$, and KCl, respectively. It was found that even when soil moisture appeared adequate for maximum plant growth, it was expedient to apply supplemental water when natural precipitation did not follow planting. Leaching and dilution of the fertilizer resulted in an increased nutrient uptake by plants. Leaching by natural

precipitation beginning 41 days after planting did not result in sufficient stimulation of plant growth on the previously nonirrigated or slightly irrigated soils as compared to those growing on well irrigated soils.

60 Chemical Element Concentrations in Leaves of Double-Cross Corn Hybrids (*Zea mays* L.) as Affected by Stand Densities and Different Rates of Nitrogen. D. E. Baker *et al* (Pennsylvania Agr. Exp. Sta., University Park). *Soil Sci. 110*, 339-45 (1970). *Soils Fert. 34*, 2489. On Hagerstown silt loam, four double-cross maize hybrids were grown under field and greenhouse conditions in order to determine their inherent differences with respect to element concentrations in ear leaves. Nitrogen concentrations in ear leaves of all hybrids increased with additions of N (applied as NH_4NO_3) and were lower for higher stand densities. Additions of N resulted also in higher concentrations of Ca, Sr, Mg, Mn, and B in ear leaves and in an increase in grain yield. Changes in Ca:Sr ratios in the ear leaves were associated with variable depths of rooting. It was suggested that the relative availability of several elements in soil might not be closely related to the composition of ear leaves.

61 Residual Effect of Zinc Fertilizer on Corn Grain Yield. A. Bauer. *N. Dak. Farm Res. 26* (4), 21-2 (1969). Zn from Na_2Zn EDTA applied broadcast at planting in 1966 at a rate of 2 lb/acre increased the 1967 corn grain yield at one of two sites at which yields were increased by Zn in 1966.

62 Phosphorus Absorption by Sod-Planted Corn (*Zea mays*) from Surface-Applied Phosphorus. C. R. Belcher and J. L. Ragland (Univ. Kentucky, Lexington). *Agron. J. 64* (6), 754-6 (1972). *CA 78*, 56954. The no-till method of planting makes it difficult to incorporate fertilizer into the surface soil. Therefore, the effect of surface-applied P on corn was studied. Corn was planted in a fescue sod killed with herbicides. Superphosphate (0, 56, 112, and 224 kg P/ha) was applied by two methods and the effects were measured in terms of corn grain yield and P content in the forage at four stages of plant development. All P broadcasted on the soil surface was compared with P partly broadcasted and partly (28 kg P/ha) placed into the soil near the seed. At 29 days after emergence dry matter accumulation was greater on plots receiving surface-applied P than on plots receiving no P fertilizer. Although the percentage of P in the plants increased with increasing rates of applied P, maximum yields of dry matter were attained with 56 kg P/ha, as were yields of grain and stover. Applying all of the P on the soil surface was equally effective to banding part of the P in the row and the remainder on the soil surface. The data support the conclusion that under conditions of no-till, corn planted in a killed sod can effectively absorb surface-applied P.

63 Response of the Corn Plant to Foliar Applications of Nitrogen and Phosphorus Under Different Environment Conditions. G. O. Benson (Iowa State Univ., Ames). *Diss. Abstr. Int. B 32* (7), 3737 (1972). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 72-5173; 1971, 152 pp. *CA 76*, 125827. Under low levels of moisture stress a significant 4.5 bu/acre yield response from an ammonium phosphate spray was achieved. Also under very low levels of stress, an ammonium phosphate spray increased yields significantly more than an urea spray, but not more than the control. In an experiment where the level of moisture stress could be controlled by irrigation, an ammonium phosphate spray at the tassel-silk interval increased yields. In the same experiment, there was no indication of superior yield response from foliar sprays under moisture stress as compared with nonstress conditions. Leaf phosphorus levels were increased over the control in all experiments. The percent increase ranged from 5% to nearly 40%. It was observed that the leaf build-up of phosphorus was greatest in moisture stress environments.

64 Zonal Salinization of the Root System with NaCl and Boron in Relation to Growth and Water Uptake of Corn Plants. F. T. Bingham and M. J. Garber (Univ. Calif., Riverside). *Soil Sci. Soc. Amer. Proc. 34*, 122-6 (1970). *Soils Fert. 33*, 4851. In greenhouse experiments, maize seed was germinated in the top part of a soil column separated by thin amber wax layers into three equal horizons. Each soil unit contained 500 g stabilized soil aggregates prepared from a Yolo loam, a tensiometer and tubing for irrigation and drainage. Each horizon was irrigated with a nutrient solution with and without NaCl to give an EC of 12 mmho/cm (for the NaCl treatments) and with H_3BO_3 to give concentrations of 10-, 20-, and 40-mg B/l. (for the B treatments). Results showed that NaCl treatments were associated with reductions in root growth and water use/plant in proportion to the percentage of the root system treated but that they did not restrict NPK uptake. Soil solution levels of 20 mg B/l. or more produced injuries in maize plants.

65 Effect of Time and Rate of Nitrogen Application to Corn (*Zea mays*) on Nitrate Leaching. A. A. Bomke (Univ. Illinois, Urbana). *Diss. Abstr. Int. B 33* (10), 4617 (1973). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 73-9884; 1972, 112 pp. *CA 79*, 4250. On well drained soils, rates of N which exceed that required for optimum grain yield resulted in an increase in residual NO_3 at the end of the growing season and prior to the peak drainage period. Either denitrification, leaching, or a combination of the two results in rather complete removal of residual NO_3 from those soils in which a water table fluctuates within the top 150 cm of the profile. In many cases NO_3 tends to maintain a normal distribution as it leaches through the soil profile. A period of approximately two years from the time of application was required for NO_3 maxima (zones of maximum NO_3 concentration) to move below 150 cm in the Drummer silty clay loam at Urbana. Soil drainage has an important influence on the magnitude of leaching and denitrification processes and the quantity of residual NO_3 found in the soil.

66 Effects of Weather, Nitrogen, and Population on Corn Yield Response. B. Bondavalli, D. Colyer, and E. M. Kroth. *Agron. J. 62*, 669-72 (1970). *Soils Fert. 34*, 2488. Observations made over a period of 8 yr at three sites showed that temperature and rainfall variables affected maize yields significantly, with the first half of August being most significant with respect to rainfall and the second half of May with respect to temperature. Optimum economic inputs at the mean rainfall for the growing season were 41,850 plants/ha and 163 kg N/ha.

67 Comparison of Fall, Winter, or Spring N-P-K Fertilizer Applications for Corn or Cotton. F. C. Boswell. *Agron. J. 63* (6), 905-7 (1971). *Soils Fert. 35*, 2541. Field studies compared yields of maize and cotton between plowdown and sidedress N and autumn, winter, and spring applied P-K. Over 3 yr on an acid soil, winter- and spring-applied P and K were superior to autumn-applied, and sidedress N was better than plowdown N. There was no difference between autumn- and winter-applied P and K, but spring application yielded more lint cotton than the other treatments.

68 Zinc-Phosphorus Interactions as Measured by Plant Response and Soil Analysis. A. L. Brown, B. A. Krantz, and J. L. Eddings (Univ. California, Davis). *Soil Sci. 110* (6), 415-20 (1970). *CA 74*, 52570. Greenhouse studies with sweet corn revealed that applications of P accentuated Zn-deficiency symptoms and, conversely, Zn applications tended to accentuate P-deficiency symptoms. The deficiency in either case was readily corrected by applying the appropriate element. Phosphate tended to reduce corn growth in Zn treated plants. Increasing rates of P did not greatly affect extractable Zn but tended to increase the Zn rather than decrease it. The first increment of applied Zn caused the greatest reduction in P concentration in the corn plants, and additional increments caused further slight reductions in P concentration. The method of soil analysis used correlated very well with plant response and uptake of Zn and P. The significant differences in soil analysis for Zn and P due to fertilizer treatment all occurred in the adequate to luxury range for corn plants.

69 Influence of Soil Treatments on Elemental Composition of Corn and on Zinc Soil Tests on Two Missouri Soils. J. R. Brown and R. W. McCormick (Univ. Missouri, Columbia). *Commun. Soil Sci. Plant Anal. 2* (3), 207-18 (1971). *CA 75*, 128889. Corn (*Zea mays*) was grown at three locations on soil treated with Zn at 10 and 20 lb/acre. Yields were not affected by the level of Zn treatment, but leaf Zn concentrations were increased. The 0.1*N* HCl-extractable Zn accurately reflected the Zn treatments. DTPA appeared to extract a more soluble component of soil Zn, which became more unextractable with time. In general, the extractable soil Zn was poorly correlated with Zn concentrations in the corn levels. High soil fertility levels resulted in a pronounced increase in Zn concentration in the corn leaves at late sampling dates, but this was not carried over into the following yr.

70 Effects of Mineral Nutrient Levels on the Inorganic Composition and Growth of Corn (*Zea mays* L.). R. B. Clark (Ohio Agr. Res. Dev. Cent., Wooster). *Ohio Agr. Exp. Sta., Res. Circ. 181*, 21 pp., 1970. *Soils Fert. 34*, 3322. Seven to ten day old seedlings were grown in nutrient solutions containing five levels of NH_4-N, NO_3-N, K, P, Ca, Mg, S, Mn, Fe, B, Cu, and Zn. Visual deficiency symptoms appeared 3-7 days after the treatments were administered. Reductions in growth of 62, 44, 25, 23, and 21% were given for Mn-, K-, Fe-, Mg-, and NO_3-N deficient plants, respectively, between full and one-tenth strength solutions. Growth reductions at the most severe level of each mineral deficiency followed the sequence $K > Mn \geqslant Mg \geqslant Ca > P > S > Zn > NO_3N \geqslant Fe > NH_4\text{-}N \geqslant Cu$.

71 Response of Corn in the Greenhouse to Soil Applied Zinc and a Comparison of Three Chemical Extractions for Determining Available Zinc. C. B. Coffman and J. R. Miller (Maryland Agr. Exp. Sta., Beltsville). *Soil Sci. Soc. Amer. Proc. 37* (5), 721-4 (1973). *CA 79*, 125131. Zinc was thoroughly mixed with soils at the rate of 0, 1.25, 2.5, 5, 10, 20, and 40 ppm Zn as $ZnSO_4$. Corn was grown for 30 days after emergence and dry matter yields were determined. The plant tissue was analyzed for Zn, Ca, Mg, K, and P. Zinc application increased the dry matter yield of corn on only one of the 12 soils. As the Zn rate was increased, the Zn content of the corn usually increased. The level of Zn in the corn tissue above which no further significant increase in yield was obtained was ~ 12 ppm. Three chemical soil extractants were compared for determining available soil Zn. The Zn extracted by each of the three extractants was correlated with the Zn content of the aboveground portions of the corn plants. The correlation coefficient for the 0.05*N* HCl plus 0.025*N* H_2SO_4 extractant was 0.834, the 0.1*N* HCl extractant 0.854, and the 0.01*M* EDTA plus 1.0*M* $(NH_4)_2CO_3$ extractant 0.787, respectively. The level of extractable Zn in an Othello soil which gave a significant dry wt increase in corn following the application of Zn was 0.3 ppm for the HCl plus H_2SO_4 extractant, 0.2 ppm for the HCl extractant, and 0.1 ppm for the EDTA plus $(NH_4)_2CO_3$ extractant, respectively.

72 Nitrogen and Sulfur Nutrition of Sweet Corn in Relation to Fertilization and Water Composition. L. A. Daigger and R. L. Fox (Univ. Nebraska, Scotts Bluff Sta.). *Agron. J. 63* (5), 729-30 (1971). *Soils Fert. 35*, 1623. Maize was grown in a sandy loam with 4 ppm extractable sulfate-S; the irrigation water contained 3 ppm S. It was fertilized with five N levels and three S levels. Increases in yields from S fertilizing were observed at low N rates. Critical S and N levels in the ear leaf were 0.24 and 2.9% respectively. Yields were closely related to N percentage in the ear leaf and were increased by both N and S fertilizing. When no S was added, 225 kg N/ha was required for maximum yield; with 66 kg S/ha, yield was maximum at 135 kg N/ha. Results indicate that the external requirement for SO_4-S in the soil solution is 3 ppm.

73 Comparative Response of Soybeans and Corn to Phosphorus and Potassium. C. DeMooy (Iowa State Univ., Ames). *Agron. J. 65* (6), 851-5 (1973). Grain yields of soybeans and corn grown side by side and in response to direct and residual P and K fertilizer applications were compared on an energy basis over 4 yr of field experimentation. Corn was significantly more responsive than soybeans to direct and residual fertilizer P and to direct application of K. The corn responded to the second increment of P and to a second cycle of P fertilization. Soybeans showed little difference between the effect of direct and residual fertilizer on yield. Corn responded to K in the yr of application, but not to residual fertilizer. Differential response of corn from direct and residual P application was dependent on seasonal conditions. In the corn-soybean cropping sequence on Webster silty clay loam where direct response from fertilizers occurred, P and K applications in alternate yr were more effective for corn than for soybeans. The advantage of corn fertilization was relatively insensitive to soybean:corn price ratios.

74 Effect of Form and Proximity of Added Nitrogen on Crop Uptake of Phosphorus. O. P. Engelstad and S. E. Allen (Tennessee Valley Authority, Muscle Shoals, Ala.). *Soil Sci. 112* (5), 330-7 (1971). *CA 76*, 13132. Conventional and split-root experiments were conducted in greenhouse pots to evaluate the effects of N sources and placement on dry matter yield and P uptake by corn from concentrated superphosphate. As previously reported, NH_4^+ produced distinctly higher P uptake than did NO_3^-. The position of N fertilizer was important only when the P fertilizer was banded, for example, stimulation of growth and P uptake occurred only when N fertilizers were associated with banded P. No such stimulation occurred with mixed P, regardless of N source or location. At heavy rates of application (375 ppm), N mixed with the soil was as effective as banded N in stimulating top growth and P uptake from banded P. Yield of roots was generally higher in the partitioned sections of the pot where N was added.

75 Physiological Aspects of Iron-Phosphorus Nutrition in Two Varieties of Maize. I. Uptake and Accumulation Characteristics Under Greenhouse and Field Conditions. G. O. Estes and T. F. Bruetsch (Univ. New Hampshire, Durham). *Soil Sci.*

Soc. Amer. Proc. 37 (2), 243-7 (1973). *CA 78*, 134949. Two varieties of corn (*Zea mays*) showed differences in efficiency of Fe utilization when grown in hydroponic solutions and under field conditions. Under hydroponic conditions, Seneca XX155 showed greater susceptibility to P-induced Fe stress than Wisconsin 335A, although its foliage contained more Fe. This susceptibility was related to reduced Fe translocation caused by relatively high P concentrations. Levels of P > 22 ppm in the nutrient solution produced a significant reduction in foliage Fe of both varieties. Field studies showed a significant reduction of tissue Fe at a fertilization level of 50 kg/ha compared to controls. Unlike results from hydroponic studies, no change in Fe status occurred at progressively higher rates of applied P (50-400 kg/ha) under field conditions. Levels of tissue Fe were never < 160 ppm following soil P applications.

76 Corn Yield as Affected by Fertilization and Tillage System. R. J. Fink and Dean Wesley (Western Illinois Univ., Macomb). *Agron. J. 66* (1), 70-1 (1974). Two soil types, an Ipava and a Clinton silt loam, were selected for a completely randomized experimental design with four replications. Soil samples were taken at four depths of the soil profile at initiation of the studies and again during the final yr. Soils were analyzed for P and K in order to determine the movement of surface applications of these nutrients. Movement of P and K into the soil profile following surface application on untilled areas was slow with both nutrients–K moved more rapidly than P. Following 2 yr without P or K, yield levels were restored on plots receiving one annual application of both nutrients. Average yields of corn were similar on both tillage systems on both soil types. Yield trials produced similar yields with conventional and with zero-tillage systems, although some problems occurred with reduced-tillage systems. Surface application of P and K was a satisfactory method of meeting the plant needs for these nutrients.

77 Effect of Levels of Soil Potassium, Fertilizer Potassium, and Season on Yield and Ear Leaf Potassium Content of Corn Inbreds and Hybrids. R. N. Gallaher, W. L. Parks, and L. M. Josephson (Univ. Tennessee, Knoxville). *Agron. J. 64* (2), 645-7 (1972). *CA 77*, 125270. Three corn (*Zea mays*) genotype groups including: inbreds T101, T105, T111, T115; their six possible single cross hybrids; and three double cross permutations were grown on a Hartsells loam soil at four rates of K fertilization for three years to evaluate their K requirements. The hybrids responded to higher rates of K fertilization than the inbreds. However, the leaf K values for the inbreds should be > 1.5%, the critical level of hybrids for maximum yields. Seasonal variation in rainfall, temperature, and sunlight caused large differences in yield and ear leaf content of K. A quadratic regression model was fitted to yield of corn and percent K content of the ear leaf for each genotype group. Results indicated that the model would be more useful in accounting for variation in yield and K concentration for double-cross hybrids than for single-cross hybrids or inbreds. The linear effect of fertilizer K accounted for more yield and ear leaf K content differences than any other factor studied.

78 Recovery of Residual Nitrogen by Corn Plants from Various Soil Depths as Measured by ^{15}Nitrogen Tracer Techniques. W. B. Gass *et al* (Univ. Nebraska, Lincoln). *Soil Sci. Soc. Amer. Proc. 35*, 290-4 (1971). *Soils Fert. 33*, 2377. ^{15}Nitrogen-labeled KNO_3 was applied at 0.3, 2, 4, and 6 ft depths in a loess-derived silty-clay loam under maize. The plots had accumulated 364, 417, or 520 lb residual soluble-N in the 6 ft profile. Maize absorbed ^{15}N at progressively deeper placement depths with continued growth, but most ^{15}N was present in mature stover from the 0.3 ft placement. More grain-^{15}N was absorbed from the 2 and 4 ft placements. ^{15}Nitrogen recovery from the 6 ft placement decreased with increase in amount of residual soil-N, but recovery from shallower depths was less affected by residual soil-N.

79 Distribution of Soil- and Fertilizer-Nitrogen in Corn (*Zea mays*) as Related to Time and Amount of Tagged Nitrogen Fertilizer Applied. W. B. Gass (Univ. Nebraska, Lincoln). *Diss. Abstr. Int. B 32* (11), 6160 (1972). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 72-15,982; 1971, 100 pp. *CA 77*, 113029. The accumulation, distribution, and redistribution of soil- and fertilizer-N in corn plants from silking to physiological maturity were studied as influenced by time and level of N application. Tagged N was used to trace the movement of N in the plants and to determine whether N was derived from the fertilizer or the soil. One field study evaluated the distribution of tagged N in corn plants at physiological maturity when tracer N was applied 11 days before silking, at silking, or 14 days after silking at four fertility levels of the soil. Plants grown on plots with the lowest fertility level showed a significant increase in ^{15}N in the grain with a delay in time of N application while ^{15}N levels decreased in the mature grain when plants were grown on plots with the highest fertility level. No statistical significant differences in tagged N levels in the grain were observed due to time of N application when plots were fertilized at the two intermediate rates. Results of a greenhouse investigation and a second field study showed that the total N and the relative proportion of the total N derived from the fertilizer generally increased as the time of N application was delayed. Considering both total N uptake and grain yield, tagged N fertilizer supplied as sidedressings immediately preceding or during the early stages of the vegetative corn plant's optimum N uptake and leaf development period (approximately 5 to 7 weeks after emergence) generally was more efficiently absorbed than either earlier or later applications.

80 Nitrogen Effects on Photosynthesis of Barley and Corn. J. L. Green (Colorado State Univ., Fort Collins). *Diss. Abstr. Int. B 34* (6), 2396-7 (1973). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 73-29,037; 1973, 91 pp. *CA 80*, 107201.

81 Response of Corn to Plowed-Down and Disked-Zinc as Zinc Sulfate. G. W. Hawkins, D. C. Martens, and G. D. McCart (Virginia Polytech. Inst., Blacksburg). *Commun. Soil Sci. Plant Anal. 4* (5), 407-12 (1973). *CA 80*, 46855. A field investigation was conducted to compare the efficacy of plowed-down and disked-in Zn as $ZnSO_4 \cdot H_2O$ in correcting Zn deficiency of corn (*Zea mays* L.). Application of 6.72 kg Zn/ha as $ZnSO_4 \cdot H_2O$ to a low in Zn Buchanan fine sandy loam soil corrected Zn deficiency of corn plants. Corn grain yields and Zn concentrations in tissue samples indicated that the plowed-down and disked-in Zn were about equally effective in correcting Zn deficiency when the level of Zn application was 6.72 kg/ha.

82 Residual Mineral N Accumulation in Soil and Its Utilization by Irrigated Corn (*Zea mays* L.). G. M. Herron *et al* (Univ. Nebraska, Lincoln). *Agron. J. 63*, 322-7 (1971). *Soils Fert. 34*, 4223. At N rates of 168 and 252 kg/ha there was substantial N gain in the 180 cm soil profile and limited loss below that depth. Delayed fertilizer application gave greater crop use efficiency and more residual N than preplant

application, suggesting greater loss by leaching and gaseous evolution with the latter before there are roots to absorb it. Less residual N remained in the soil after maize grown in 51 cm rows for 3 yr than with 72 and 102 cm row widths. Grain yield was related to residual soil N when no additional fertilizer was used.

83 Effects of Potassium Nutrition on Protein and Total Free Amino Acids in *Zea mays*. T. C. Hsiao, R. H. Hageman, and E. H. Tyner (Univ. Illinois, Urbana). *Crop Sci. 10* (1), 78-82 (1970). *CA 72*, 89318. Corn seedlings were grown in nutrient solutions that ranged in K contents from 0 to sufficient. In comparison with K-sufficient plants, the shoots of K-deficient plants exhibited up to 40% increase in protein concentration, while the amount of protein/shoot was much reduced. The concentration of free amino acids was increased by ~ 3-fold in extreme deficiency, but was hardly affected by moderate deficiency, although growth in the latter case was much retarded. During the development of K deficiency, the ratio of free amino acids/protein in leaves of two different ages did not increase until growth was retarded; similarly, the amount of protein/leaf in the maturing leaf was not affected until growth was substantially reduced. When K was added to deficient plants to permit their recovery, the ratio of free amino acids/protein in the shoot did not decrease for many hr after K was detected in adequate amounts in the shoots. The ratio decreased only after the added K had induced an increase in growth. This suggested that there was no acceleration of polymerization of amino acids resulting directly from the added K. The specific activities of aldolase and triosephosphate dehydrogenase were some 30% lower in deficient than in sufficient shoots. The level of nitrate reductase in the tissue, however, appeared to be related to the supply of nitrate. The data did not support the contention of K levels in deficient plants being low enough to directly limit the polymerization of amino acids and of a reduced rate of protein synthesis being the primary factor limiting the growth of K-deficient plants.

84 Nitrification Inhibitors, Leaching, and Time of Nitrogen Application for Corn. T. D. Hughes (Univ. Illinois, Urbana). *Diss. Abstr. Int. B 31* (2), 469 (1970). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 70-13,358; 1969, 111 pp. *CA 74*, 111092.

85 Evaluation of Irrigation Water and Nitrogen Fertilizer in Corn Production. P. C. Huszar, M. D. Skold, and R. E. Danielson. *Colo. Agr. Exp. Sta. Tech. Bull. 107*, 38, 1970. *Soils Fert. 34*, 1688. A 5 x 5 incomplete factorial design was used to generate the basic yield data; the variables were 0, 50, 100, 150, or 200 lb N/acre and 0.7, 1.0, 3.0, 6.0, or 9.0 bars maximum soil-water tension. The quadratic, square-root, and three-halves algebraic forms of functions were fitted to the data and the quadratic form was selected for more detailed analyses. The most profitable point of operation for alternative price relations was presented and a static short-run demand curve for water was estimated.

86 Arsenic-Phosphorus Interactions of Corn. L. W. Jacobs and D. R. Keeney (Univ. Wisconsin, Madison). *Commun. Soil Sci. Plant Anal. 1*, 85-93 (1970). *Soils Fert. 34*, 1691. In greenhouse experiments, a silt loam and a sand, both deficient in P, were treated with 20 or 80 ppm As and 50, 100, or 300 ppm P in factorial combination and cropped twice for 40 days to maize. As showed greater toxicity on the sand. At 80 ppm As, P had little effect on As toxicity on the silt loam but enhanced toxicity on the sand, and increasing P increased As uptake by the plants. At 20 ppm As, P did not affect As toxicity or uptake. Soil As extracted by NH_4OAc (pH 7.0) decreased with time but increased with increasing applied P. Bray P1 extractable As was not greatly affected by applied P or time and appeared to be a more suitable available soil As test. Apparently P applications are not the solution to As toxicity.

87 Nitrate and Labeled Fertilizer Nitrogen Uptake By and Distribution in Corn (*Zea mays*). J. W. Johnson (Univ. Illinois, Urbana). *Diss. Abstr. Int. B 33* (10), 4614 (1973). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 73-9955; 1972, 131 pp. *CA 79*, 4245. The two greenhouse studies and the first field study were conducted on Drummer silty clay loam. The second field study was conducted on Catlin silt loam. Fertilizer N was applied in bands midway between rows for the field studies. Only the center band within each plot had labeled fertilizer N applied. All the labeled fertilizer N absorbed by plants was found in plants in the two rows adjacent to the labeled band; therefore, this field design proved adequate for N uptake studies. When nitrate N concentration was high, it accumulated in the lower stalk of corn plants regardless of whether the nitrate N was derived from native soil N or fertilizer N sources. This accumulation was most pronounced near maturity. The nitrate N concentrations were highest in stalk, intermediate in midrib tissue, and lowest in leaf tissue. The nitrate N concentration was highest in the lower portions of the plant and lowest in the upper portions of the plant. When nitrate N concentration was low, the amount of nitrate N in given fractions of the plant was about the same once all or almost all the available N had been depleted from the soil. Nitrate N concentration in the leaves was approximately the same as in plants which had adequate N, but nitrate N accumulation in conductive tissue was much lower than in plants having adequate N. When side-dressed N was applied to corn, highest concentrations of fertilizer N were usually found in the upper and middle portions of the corn plant. When N was applied as a preemergence treatment, lower portions of the plant had the highest concentrations of fertilizer N. As the plants reached maturity, the accumulation of nitrate N in lower stalks corresponded to a buildup of side-dressed fertilizer N. As grain formation neared maturity, a net loss of side-dressed fertilizer N by the total plant occurred, coming from the stover portion of the plant. A continued buildup of side-dressed fertilizer N occurred in the grain. The total uptake of fertilizer N by corn is a function of time of application, amount of N applied, and available soil N. As available soil N increased, uptake of fertilizer N decreased. When fertilizer was applied as a preemergence treatment, the rate of uptake was most pronounced before tasseling and decreased after tasseling. When fertilizer N was applied as a side-dressed treatment, the uptake rate did not begin decreasing until after silking.

88 Response of Irrigated Corn to Time, Rate, and Source of Applied Nitrogen on Sandy Soils. P. E. Jung, Jr., L. A. Peterson, and L. E. Schrader (Univ. Wisconsin, Madison). *Agron. J. 64* (2), 668-70 (1972). *CA 77*, 125275. Three sources of N (urea, NH_4NO_3, and KNO_3) were applied to corn at four rates (56, 112, 168, and 224 kg N/ha) and 6 times of application in all combinations. Wisconsin 273 and Wisconsin 433 were grown. Response was measured as grain yield, tissue yield (aerial portion at early dent), percentage N in tissue, percentage N in grain, and N uptake. The N applied during either the 5th, 6th, 7th, or 8th week after planting was the most effective as shown by increased grain and tissue yields. Nitrogen applied after the 8th week was associated with a distinct reduction in N uptake and grain and tissue yields.

Generally, percentage N in the grain and tissue increased with later N applications. The responses to urea and NH_4NO_3 were similar and both sources were significantly better than KNO_3. Nitrate reductase activity in the leaves and percentage N in grain and tissue increased with increasing rate of applied N. Yields of grain and tissue for Wisconsin 273 and Wisconsin 433 leveled off at the 112 and 168 kg/ha rates of N, respectively.

89 Nitrogen Management, Plant Population, and Row Width Studies with Corn. E. J. Kamprath *et al* (North Carolina Agr. Exp. Sta., Raleigh). *N.C. Agr. Exp. Sta. Tech. Bull.*, No. 217, 19 pp. (1973). *Soils Fert. 36*, 4786. Maize yields on the Coastal Plain tended to be constant at populations of 21,000 and 28,000 plants/acre for short season or full season hybrids. Yields of full season hybrids on upland Piedmont soils were not greatly increased by using populations greater than 12,000 to 16,000 plants/acre. Yields of full season hybrids were not increased by use of 21-inch rows as compared with 42-inch rows, but yields of short season hybrids were higher in the 21-inch rows. A rate of 150 lb/acre N was adequate for high maize yields on sandy Coastal Plain soils. Nitrogen at a rate of 120 lb/acre was adequate on upland Piedmont soils. Yields were much lower when N was applied in December than with application at planting or sidedressing. Application just prior to planting was as effective as at sidedressing.

90 Influence of Soil Characteristics and Fertilizer Treatments on Trace Element Composition of Sweet Corn Grain. R. F. Keefer and R. N. Singh (West Virginia Univ., Morgantown). *W.V. Acad. Sci., Proc. 1970*, pp. 42, 20-8 (1971). *CA 78*, 96534. Sweet corn was grown to the edible stage in the greenhouse on three soils using high rates of N, P, and K. Iron, Mn, and Zn contents of the grain were related to the amount of P applied. For the Monongahela soil the correlation was positive and highly significant for Fe and Mn. The Huntington soil showed no correlation for Fe and Mn, but the Wharton soil gave a negative significant correlation between Mn and amount of P applied. Zinc content of the grain was negatively correlated with amount of P applied for the Monongahela soil only. No consistent relations between the trace element content of the corn and N or K fertilization were noted. These results were explained upon the basis of the properties of these soils. Implications from a human health standpoint were discussed.

91 Response of Corn to Time and Rate of Phosphorus and Zinc Application. R. F. Keefer *et al* (West Virginia Univ., Morgantown). *Soil Sci. Soc. Amer. Proc. 36* (4), 628-32 (1972). *CA 77*, 87057. Corn (*Zea mays*) was grown in the greenhouse on two soils, Monongahela, a Typic Fragiudult (TF) and Wharton, an Aquic Hapludult (AH), which differed in available Zn, available P, exchangeable Mg, total Zn, and organic matter (OM). Dry matter yield and Zn concentration and content of plant parts were increased where Zn was applied with P regardless of time to soil TF (low in available Zn, total Zn, exchangeable Mg, and OM). Zinc-EDTA was a better source of Zn since it increased Zn concentration in leaves and stems more than $ZnSO_4$ on soil TF. However, with soil AH (high in available Zn, exchangeable Mg, and OM), response to $ZnSO_4$ application was obtained only when P was applied at high rates 8 weeks before planting. Application of ZnEDTA produced no significant response by corn on soil AH, probably due to instability of ZnEDTA under acid conditions resulting in appreciable amounts being fixed on the clays in this soil. The relative response to Zn with increasing levels of P (0-200 mg P/kg soil) was greater on soil TF than on the soil AH. Addition of Zn in the former decreased the P percentage and content in both leaves and stems at high levels of P application; however, application of Zn to the latter did not show any noticeable effect on percent P at all levels of P application.

92 Protein and Amino Acid Composition of Maize Grain as Influenced by Variety and Fertility. D. R. Keeney (Univ. Wisconsin, Madison). *J. Sci. Food Agr. 21* (4), 182-4 (1970). *Field Crop Abstr. 23*, 3216. In a field trial in 1966, maize cultivars Wisconsin 273, 1694, 1710, and 1718 were given 50 kg P/ha, alone or in combination with 200 kg N/ha or 200 kg N + 278 kg K/ha. Grain yields were increased by N, but addition of K gave a further increase in yield only in cultivar Wisconsin 1694. The average crude protein content of the grain was 7.0, 7.7, and 8.4% in plots given P, NP, and NPK, respectively; the increase in crude protein in the NP and NPK plots was due mainly to an increase in zein. The grain content of all essential amino acids, except methionine, was highest in grain from plots given NPK. There were no differences between cultivars in the amino-acid composition of the protein.

93 Influence of Nitrogen Fertilization and Plant Population on Nutrient Uptake, Several Yield Components and Some Agronomic Characteristics of Five Corn (*Zea mays*) Hybrids. D. W. Kemper (Univ. Nebraska, Lincoln). *Diss. Abstr. Int. B 32* (11), 6160-1 (1972). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 72-15,994; 1971, 122 pp. *CA 77*, 113028. Five corn (*Zea mays* L.) hybrids were grown to determine the effect of applied N (0 to 538 kg/ha) and plant population (39,520 to 158,080 plants/ha) on nutrient uptake, yield, several yield components, and several agronomic characteristics of corn. Nitrogen uptake per unit area was doubled by increasing the plant population from 39,520 to 158,080 plants/ha. Nutrient concentrations (percentage) remained fairly constant but total dry matter production/unit area increased greatly as plant populations increased, thus greatly increasing uptake of the elements on a unit area basis. Nitrogen fertilization increased N and K uptake on a unit area basis. Stalk diameter and leaf area/plant decreased as plant population stress increased. Leaf area index increased linearly as the plant population increased. Corn stalk strength resulting from low plant populations or N fertilization, reduced lodging but increased leaf stripping due to wind. Nitrogen applications increased per unit area dry matter production for high plant populations but not low plant populations. Nitrogen fertilization increased protein content of the grain in most instances.

94 Comparative Effects of N and S Fertilization and Liming on Three Crops Grown on Four Soils. D. W. Kemper and R. C. Sorensen (Agr. Exp. Sta., Univ. Nebraska, Lincoln). *Agron. J. 66* (1), 92-7 (1974). Two consecutive crops of corn (*Zea mays* L.), soybeans [*Glycine max* (L.) Merrill], and bromegrass (*Bromus inermis*) were grown in the greenhouse on four soils to (1) compare degree of response of these three crops to N and S fertilizations as affected by overall soil characteristics; (2) evaluate the effect of soil characteristics on the relationship of dry matter production and plant N content; and (3) evaluate the N:S ratio and plant N content as indicators of adequacy of N for maximum dry matter production of these crops. Response to N was common for corn and bromegrass but occurred to a smaller extent for soybeans. Although the magnitudes of N responses varied with the soil type, they were not closely related to soil organic matter or nitrate levels. Response to S was more evident during the second growing period than during the first period. The curves relating dry matter production to N content of the

corn plants were essentially the same for all but one soil.

95 Fate of Nitrate from Manure and Inorganic Nitrogen in a Clay Soil Cropped to Continuous Corn. J. M. Kimble *et al* (Univ. Vermont, Burlington). *J. Environ. Quality 1* (4), 413-15 (1972). *CA 78*, 96500. Laboratory incubation studies of depth fractions of soils that were fertilized with dairy manure (0 or 66 tons/ha) or NH_4NO_3 (0 or 224 kg/ha) showed denitrification to be greater in plots treated with manure than in those treated with NH_4NO_3. Denitrification decreased with depth to 96 cm, below which energy for anaerobic microbial activity appeared to be limiting. The NO_3^-:Cl^- ratios of profile samples at all depths decreased from fall to spring, so that denitrification rather than leaching caused a significant amount of the NO_3^- loss during this period. Abrupt decreases in the NC_3^-:Cl^- ratio from the surface to the 45-71 cm depth showed that denitrification had taken place, and an increase in the ratio at 96-122 cm probably reflected denitrification above that depth. More NO_3^- was lost by leaching from NH_4NO_3 than from manure because more NO_3^- was applied and it was less susceptible to denitrification.

96 Several Factors Affecting Element Accumulation in Genotypes of Corn Selected for Differential Phosphorus Uptake. G. N. Korman (Pennsylvania State Univ., University Park). *Diss. Abstr. Int. B 32* (2), 667-8 (1971). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 71-21,766; 1970, 76 pp. *CA 75*, 139759.

97 Nonuniform Distribution of Fertilizer and Its Effect on Corn Yields. G. W. Langdale, D. L. Myhre, and R. J. Miller (South Carolina Agr. Exp. Sta., Florence). *Agron. J. 63*, 415-17 (1971). *Soils Fert. 34*, 5211. On a Plinthic Paleudult soil of pH 5.7, fertilizer variations greater than 40% were required to obtain significant ($P \leqslant 0.5$) experimental yield losses of maize. Standard partial regression coefficients and plant tissue nutrient contents suggested that nonuniform distribution of N provided a primary influence on yield loss rather than P or K. Concomitant losses of N in leaf tissue and grain yields due to nonuniform distribution were related.

98 Effect of Soil pH on Element Concentration and Uptake by Maize. II. Copper, Boron, Zinc, Manganese, Molybdenum, Aluminum, and Iron. J. A. Lutz, Jr., C. F. Genter, and G. W. Hawkins (Virginia Polytech. Inst., Blacksburg). *Agron. J. 64* (2), 583-5 (1972). *CA 77*, 125324. Selected maize inbreds and single crosses were grown in the greenhouse on Greendale silt loam that were adjusted to pH levels of 3.9, 5.1, and 6.1 with appropriate amounts of pulverized dolomitic limestone. Adequate plant nutrients were applied. Maize was harvested 36 days after planting, dried, and later analyzed for Cu, B, Zn, Mn, Mo, Al, and Fe. Entries differed significantly in concentration of each analyzed element at one or more pH levels, thus showing differential absorption of specific elements at various pH levels. Soil pH had a highly significant effect on the concentration of all elements studied except Fe. The entry-pH interactions were significant only for B and Al concentrations. Entries differed in the uptake of all elements studied. Uptake of all elements except B was affected by pH, and entry-pH interactions were significant for each of the elements considered.

99 Yield of Corn on Frederick Silt Loam as Affected by Slope and Fertility Treatments. J. A. Lutz, Jr. *et al* (Virginia Polytech. Inst., Blacksburg). *Agron. J. 61* (6), 945-7 (1969). *Field Crop Abstr. 23*, 3191. In field trials on a B slope (2.5-7.5%) and a C slope (7.5-15%) in 1963-65 on Frederick silt loam with 5 levels of applied N and 3 of K, there was a grain and silage yield response only to 67 kg N/ha on the B slope, whereas 134 kg N/ha was needed for maximum yields on the C slope. Dry matter yields at the ensiling stage were increased by 70 and 140 kg K/ha on the B and C slopes, respectively. Grain yields responded to 70 kg K/ha on the C slope. Grain and fodder yields in 1963 were similar on both slopes, but were higher on the B slope in 1964-65.

100 Chemical Composition and Yield of Corn as Affected by Deep Placement of Dolomitic Limestone. J. A. Lutz, Jr. and G. D. Jones (Virginia Polytech. Inst., Blacksburg). *Agron. J. 63* (1), 9-11 (1971). *CA 74*, 75648. An experiment was conducted on Tatum silt loam to measure the effects of placement of 0, 10, and 20 tons/acre of dolomitic limestone on the plow sole (30.5 cm) in the spring of 1968 on the yield and chemical composition of *Zea mays* (corn). Treatments consisted of 0, 12.2, 24.4, and 48.8 kg P/ha without K; 24.4 and 48.8 kg P/ha with 23 kg K/ha; and 48.8 and 97.6 kg P/ha with 46 kg K/ha with each rate of lime. The P and K treatments were surface applied and disked in. Placement of lime on the plow sole increased the yield of corn. The P, K, and Ca contents of corn leaves were increased, the Mg content decreased, and the N content was unaffected by deep lime placement. Corn yields were affected by P and K treatments.

101 Effect of Fertilization and Irrigation Upon NPK Composition of Corn Leaves, on Corn Yields, and Available K in the Soils. J. A. Lutz, Jr., and G. D. Jones (Virginia Polytech. Inst., Blacksburg). *Commun. Soil Sci. Plant Anal. 1*, 197-204 (1970). *Soils Fert. 34*, 2483. In a 3-yr experiment on Congaree loam, graduated rates of N, P, and K and irrigation had no effect on leaf composition of *Zea mays*. A rapid decrease in available soil K in the 0-15 cm depth was evident in the first yr with all rates of added K. The decline in available soil K was unaffected by irrigation and levels of applied N and P. There were consistent yield responses each yr to added N, no response to added P, and a response to added K only during the second yr.

102 Effects of Irrigation and Fertilization on Yields and Chemical Composition of Corn and on the Changes in the Available Potassium Contents of a Cecil Soil. J. A. Lutz, Jr., C. I. Rich, and E. B. Hale (Virginia Polytech. Inst., Blacksburg). *Commun. Soil Sci. Plant Anal. 3* (3), 231-42 (1972). *CA 77*, 112995. The field studies were carried out with corn (*Zea mays*) grown for 5 consecutive yr on Cecil fine sandy loam. Fertilizers in rates of 0, 56, 140, 224, and 280 N; 0, 15, 37.5, 60, and 75 P; and 0, 28, 70, 112, and 140 K kg/ha were applied in various combinations in each of the 5 yr. Plant residues were removed each yr when the corn was harvested and the plots were seeded without fertilization to rye as a cover crop. One-half of the experiment was irrigated when there was a 50% depletion of available soil moisture in the 0-45-cm soil depth. The available K content of the 0-15-cm soil depth was not significantly affected by irrigation but decreased with cropping at all rates of applied K. Decreases in available K were less pronounced with increased rates of applied K. The available K content of the 90-120-cm depth was similar where 0 and 140 kg K/ha were applied. Irrigation, as compared with no irrigation, decreased the level of available K throughout the profile on uncropped and unfertilized plots. Irrigation increased the N content of corn leaves but did not increase the P and K contents. Corn responded to N during the last 4 yr, to K only in the 5th yr and there was no response to P fertilization. The results suggest that K in excess of 140 kg/ha must be applied annually if the initial K content of the

0-15 cm soil layer is to be maintained. However, the yield data indicate that a high corn yield can be obtained without maintaining of the observed initial level of K in the soil.

103 Comparison of the Effects of Nitrate and Ammonium Nitrogen on Growth and Ionic Balance of Corn (*Zea mays*) Grown in Various Nutrient Media. J. A. Macleod (Cornell Univ., Ithaca, N.Y.). *Diss. Abstr. Int. B 32* (10), 5572 (1972). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 72-13,164; 1971, 122 pp. *CA 77*, 47255. Corn was grown in several nutrient solutions and sand culture systems to compare the effect of nitrate and ammonium N on growth and ionic balance. Ammonium N was as effective as nitrate N for growth of young corn plants in nutrient systems where decreases in solution pH with ammonium N utilization were minimized either by the citrate anion, by calcium carbonate, or by partially base saturated cation exchange resins. Where no pH control was used or where solutions were maintained at pH 5.0 ± 0.3 by daily titration, ammonium was inferior to nitrate. With extreme K deficiency, in the calcium carbonate system, ammonium N resulted in death of the plants within one week of initiation of the treatment, while plants which received nitrate N grew slowly. The reason for the decreased yields sometimes observed with ammonium N was not established but may have been associated with decreases in pH at the root-solution interface or with abnormal N metabolism associated with low K levels since the decreases were not observed in well buffered media where adequate K was supplied.

104 Municipal Compost. Effects on Crop Yields and Soil Properties. D. A. Mays, G. L. Terman, and J. C. Duggan (Natl. Fert. Dev. Cent., Tennessee Valley Authority, Muscle Shoals, Ala.). *J. Environ. Qual. 2* (1), 89-92 (1973). *CA 79*, 4321. The compost was a mixture of sewage sludge solids and garbage (< 80%); it contained approximately 1.2 N, 0.24 P, 0.80 K, 34.2 C, 3.6 Ca, 0.49 Na, 0.49 Mg, 0.4 S, and 0.13% Zn. The Sango silt loam was high in P and medium in K, and had a pH 5.4. Positive responses of sorghum, corn, and bermudagrass compost applications of ≤ 143, 112, and 80 tons/ha, respectively, were observed. However, the highest bermudagrass or sorghum yields attained from compost application were surpassed by application of 180 kg N/ha together with adequate P and K. Incorporation of compost over a 2-yr period, significantly increased the moisture-holding capacity of the soil and decreased bulk density and compression strength of the soil. The pH and organic matter, K, Ca, Hg, and Zn levels of the soil also increased. Toxic Zn amounts could accumulate in soil if compost were applied at rates totaling several hundred tons/ha over a few yr.

105 Field Response of Corn to Zinc Sulfate and Zinc-EDTA Placed with the Seed. D. C. Martens, G. W. Hawkins, and G. D. McCart (Virginia Polytech. Inst., Blacksburg). *Agron. J. 65* (1), 135-6 (1973). *CA 78*, 123198. The effect of placement of a small amount of Zn in a band with seed on Zn deficiency correction in corn was studied. Each method of Zn application under study increased corn grain yield as compared to the check. Corn grain yields were similar for 26.88 kg Zn/ha applied as broadcast $ZnSO_4$ and for 0.34, 0.67, or 1.34 kg Zn/ha as Zn-EDTA, or 1.34 kg Zn/ha as $ZnSO_4$ applied in a band in contact with the seed. Higher corn grain yields were obtained with 26.88 kg Zn/ha as $ZnSO_4$ broadcast and disked in the soil, than with 6.72 kg Zn/ha banded beside the row at seed depth. The levels of Zn banded with seed did not affect corn populations. Band application of a small amount of Zn with seed could be used as a procedure for correcting Zn deficiency of corn. The procedure probably would be most applicable where it is desirable to minimize Zn accumulations in soil.

106 Yield and Chemical Composition of Corn and Nitrate Movement in the Soil as Influenced by Time of Application and Source of Nitrogen. R. D. Meyer (Iowa State Univ., Ames). *Diss. Abstr. Int. B 34* (4), 1341 (1973). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 73-25,239; 1973, 152 pp. *CA 80*, 14043. Field experiments were conducted at five sites in north central and northeast Iowa to evaluate the influence of time of applying different rates and sources of N fertilizer for the corn crop. Anhydrous ammonia was studied at rates of 0, 40, 80, and 160 lb N/acre at two sites and at rates of 0, 80, 160, and 240 lb N/acre at a third site in late fall, early spring, and early summer applications. Ammonium nitrate, urea, and S-coated urea were evaluated at two sites at similar times of application. The influence of time of N application on grain yields varied with individual sites and season but response gradually increased with the later applications of fertilizer N. The advantage for the later applications was most evident at the lower N rates and diminished as more nearly optimum rates were used. Relative efficiency curves developed from 6 site-yr of data from 3 sites showed a range of 82-98% effectiveness for fall versus summer and nearly 100% efficiency for spring versus summer applied N. Rates of 150 lb/acre or greater generally resulted in efficiency values of above 90% for fall compared to summer applications of N. In a few comparisons fall applications were superior to summer applications, indicating the variability to be found from such comparisons with different weather conditions. At the two sites involving N sources, ammonium nitrate and urea were found to be of equal effectiveness and superior to S-coated urea. Nitrogen was apparently released too slowly from the latter material for maximum efficiency, even when it was applied in the fall. Analyses of soil samples taken both in early summer and shortly after silking at the two sites involving N sources revealed significant differences in degree of nitrification and in depth of N movement.

107 Comparative Yield and Fertilizer Efficiency of No-Tillage and Conventionally Tilled Corn. W. W. Moschler *et al* (Virginia State Univ., Blacksburg). *Agron. J. 64* (2), 229-31 (1972). *Soils Fert. 35*, 3463. In field experiments for up to 9 yr on a silt loam and two clay loam soils the effects on continuous maize of NPK fertilizers applied to no-tillage or conventionally tilled plots were studied. Surface-applied fertilizer on no-tillage plots was more efficient than disked-in fertilizer on tilled plots. No-tillage resulted in an average yield increase of 13.7-39.0% depending on soil type. The no-tillage soils contained more N, P, K, and orgaic matter than the tilled soils.

108 Mechanism of the Differential Response of Wf9 and Oh40B Corn Seedlings to Iron Nutrition. S. O. Odurukwe and D. N. Maynard (Univ. Massachusetts, Amherst). *Agron. J. 61* (5), 694-7 (1969). *Field Crop Abstr. 23*, 3283. In greenhouse experiments in which two maize inbred lines were grown in sand and water cultures to study the mechanism of resistance and susceptibility to Fe chlorosis, the inbred maize line Oh40B was inefficient and the line Wf9 efficient in using Fe. Wf9 had a higher tissue concentration of Fe than Oh40B at several concentrations of Fe in the nutrient medium, but the difference was not enough to account for the difference in chlorosis. In tests of the effects of Fe with other ions, Oh40B seedlings accumulated more P and Mn and showed more chlorosis than Wf9. Iron toxicity symptoms appeared in Wf9 but not in Oh40B grown at high levels of Fe. It was concluded

that Oh40B is more susceptible to chlorisis in the seedling stage than Wf9 because of its low Fe:P and Fe:Mn ratios and consequently lower amounts of available Fe. Conversely, Wf9 is more prone to Fe toxicity because of its greater concentra tion of available Fe in the tissues, as indicated by the higher Fe:P and Fe:Mn ratios. Oh40B recovered from chlorosis at tasseling with a concomitant decrease in P and Mn concentrations.

109 Influence of Root-Zone Temperature and Phosphorus Supply on Total and Inorganic Phosphorus, Free Sugars, Aconitate, and Soluble Amino Nitrogen in Corn. R. P. Patterson, D. L. Grunes, and D. J. Lathwell (New York State Coll. Agr., Cornell Univ., Ithaca). *Crop Sci. 12* (2), 227-30 (1972). *CA 76*, 4259. Corn was grown for 4 and 6 weeks in sand culture at root-zone temperatures of 15°, 20°, and 25° and P levels of 2, 9, and 30 ppm to test the hypothesis that increased P could overcome the effects of low root-zone temperature. Growth of roots, sheaths, and blades was restricted when plants were exposed to root-zone temperatures of 15° or 20°, and P levels of 2 or 9 ppm, compared to growth at 25° and 30 ppm P. The concentration of P in all plant parts was as high at 15° as at 25°. The harmful effects of low root-zone temperature were not overcome by the application of higher P rates. When the data were expressed as the percentage of the total P that was inorganic, it was clear that under P-deficient conditions (2 ppm P) less absorbed P was combined organically at the lower temperature for both roots and shoots. Free sugar levels in roots were lower at 25° than at 15° at all P levels. Sugar levels in sheaths and blades, however, were lower at the higher temperature only under P-deficient conditions. Concentrations of aconitate and soluble amino acids were highest at 15° regardless of P supply. Since metabolism of photosynthate to the level of organic and amino acids was not impeded by low root-zone temperature, it was suggested that low-temperature stress depressed growth by restriction of incorporation of amino acids into protein.

110 Air Containing ^{15}Nitrogen (Labeled) Ammonia. Foliar Absorption by Corn Seedlings. L. K. Porter, F. G. Viets, Jr., and G. L. Hutchinson (Soil Water Conserv. Res., Agr. Res. Serv., Fort Collins, Colo.). *Science 175* (4023), 759-61 (1972). *CA 76*, 125763. Thirty-day-old corn seedlings, grown in the greenhouse with different concentrations of supplemental nitrate-N, were moved to a constant temperature growth chamber and sealed in a 560-liter tent made of polyvinyl chloride. The plants were exposed to air containing NH_3 (1, 10, and 20 ppm) for 24 hr and then harvested. The ^{15}N content of the tops and roots showed that at 1 ppm 43% NH_3 was absorbed, whereas at 10 and 20 ppm 30% NH_3 was absorbed. The results demonstrate that growing plants may be a natural sink for atmospheric NH_3.

111 Effect of High Rates of Nitrogen, Phosphorus, and Potassium of Fertilizer on Corn (*Zea mays*) Grain Yields. R. D. Powell and J. R. Webb (Univ. Wisconsin, Madison). *Agron. J. 64* (2), 653-6 (1972). *CA 77*, 125266. The experiment was conducted to observe the growth of corn grown on soils which received annual applications of fertilizer at rates above those normally recommended. Annual applications of high rates of N, P, and K fertilizer to Clarion-Webster Soil Association soils in central (Ames) and north central (Kanawha) Iowa planted to corn produced variable yield results. Incremental rates of N, P, and K fertilizers up to 1344, 504, and 1008 kg/ha, respectively, were applied annually for three consecutive yr. It was observed that a log function fitted the data best in all 3 yr at both sites. A 2nd order quadratic yield prediction equation was developed which included independent variables for fertilizer N, K, N^2, interactions of N with soil-available P, K, with soil exchangeable K and K with soil pH, a variable for soil N supplying power and a variable for measuring climatic influences. Increases in yields resulted from N fertilization. Yield decreases the final yr were attributed to high salt concentrations and acid soil reactions. The surface soil pH decreased at a rate of 0.05 pH units per 112 kg N/ha and yields decreased the final yr as salt concentrations increased. Yields decreased at N rates > 224 kg/ha at the Ames site and above 448 kg/ha at the Kanawha site.

112 Effect of Nitrogen Source on Corn and Bromegrass Production, Soil pH, and Inorganic Soil Nitrogen. J. F. Power *et al* (North. Great Plains Res. Cent., Agr. Res. Serv., Mandan, North Dakota). *Agron. J. 64* (3), 341-4 (1972). *CA 77*, 47250. A field experiment was conducted for 4 yr to assess the relative merits of $(NH_4)_2SO_4$, NH_4NO_3, $Ca(NO_3)_2$, and urea applied annually at 55 and 110 kg N/ha to both corn (*Zea mays*) and bromegrass (*Bromus inermis*) grown on a fine sandy loam with surface pH of 6.5 and no free carbonates. Plants were harvested at maturity and soils were periodically sampled for water content, inorganic N content, and pH. Corn production was highest for $(NH_4)_2SO_4$ and NH_4NO_3 at 110 kg N/ha. Leaf tissue at silking from all fertilized corn contained over 2.8% total N. Soil inorganic N accumulating during the first 3 yr under corn was leached below the root zone by 514 mm of precipitation during the fourth growing season.

113 Nitrogen and Potassium Fertilization of Corn as Related to Grain Yield and Leaf Composition. M. E. Raja (North Carolina State Univ., Raleigh). *Diss. Abstr. Int. B 32* (10), 5572 (1972). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 72-11,990; 1971, 163 pp. *CA 77*, 47254. For optimum corn yields, 150 lb N/acre were required for Norfolk and Marlboro soils and 100 lb N/acre for Portsmouth soil was adequate when moisture was adequate. The recommended fertilizer rates gave the best plant response at 21,000 plants/acre on all soils. Sodium nitrate fertilizer was equally effective as urea in influencing grain yields on Norfolk and Marlboro soils, but it was less efficient on Portsmouth soil. Nitrogen fertilization not only increased corn yield but also improved grain quality. The total N in corn leaves was correlated with percent N (crude protein) in corn grain. Increasing rates of N increased the leaf P, but depressed the K, Ca, and Mg concentrations of corn leaves to various magnitudes depending on the levels of N and supply of other nutrients in the soil, especially K. Various levels of K increased the K concentration, but decreased the Mg and Ca concentrations of corn leaves. However, the decrease in Ca and Mg was not enough to affect grain yields, even with high N and K rates.

114 Influence of Nitrogen, Phosphorus, and Plant Population on Yield and Quality of Forage Corn. D. L. Robinson (Kansas State Univ., Manhattan). *Diss. Abstr. Int. B 32* (4), 1962 (1971). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 71-26,620; 1971, 70 pp. *CA 76*, 58201.

115 Site and Mechanism of Phosphorus-Zinc Interaction in Corn (*Zea mays*) Seedlings. L. A. Rudgers (Kansas State Univ., Manhattan). *Diss. Abstr. Int. B 30* (12) (Pt. 1), 5331 (1970). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 70-9885; 1969, 124 pp. *CA 74*, 31238. Induction of Zn deficiency by high P in corn seedlings grown with normal Zn was most often associated with P and Zn accumulation in roots and retardation of Zn translocation to leaf blades.

Quantity of Zn exuded by decapitated corn seedlings and Zn concentrations in leaf blades tended to decrease as P level was increased. Those effects were caused by excess P immobilizing Zn in roots instead of inhibiting Zn uptake as evidenced by accumulation of both P and Zn in roots of corn seedlings grown with high P. Placing corn seedlings grown with high P in solutions lacking P, however, did not remove significant quantities of P from the roots or appreciably affect Zn translocation within the corn plant. High P accentuated Zn deficiency in corn seedlings grown with low Zn without greatly affecting plant Zn concentrations. Thus, location of P-Zn interaction was not always restricted to the roots.

116 High-Yielding Cereals and Fertilizer Demand. D. A. Russel *et al. Muscle Shoals, Ala.*: National Fertilizer Development Center, Tennessee Valley Authority, Bull. Y-4, 22 pp. (1970). Yield responses to fertilizer are reviewed for high-yielding and native varieties of rice, wheat, maize, and grain sorghum. Universally, these cereals respond to nitrogen but less frequently to phosphorus and potassium. Generalized yield curves were computed for the response of high-yielding and native varieties of these crops but not to P or K because of the scarcity of data. The curves define no specific response of either type of variety for any country but are examples of expected relative responses between high-yielding and native varieties.

117 Factors Affecting Uptake and Translocation of Iron in *Zea mays.* A. K. Sarkar (Univ. Washington, Seattle). *Diss. Abstr. Int. B 30* (11), 4939 (1970). Avail. Univ. Microfilms, Ann Arbor, Michigan. Order No. 70-8428; 1969, 152 pp. *CA 74*, 12215. It was observed that the low-Fe maize plant can take up a sufficient amount of Fe in 72 hr from a dilute solution in which Fe was maintained as low as 0.10 ppm to completely recover from Fe-deficiency chlorosis. An optimal uptake appears to be between 300 to 440μg of Fe per plant in 72 hr. Above this optimum, with any further increase in Fe concentration the plants took up more Fe, resulting in decreased yield.

118 Response of Corn to Residual and Applied Zinc as Zinc Sulfate and Zn-EDTA in Field Investigations. M. G. Schnappinger, Jr. *et al* (Virginia Polytech. Inst., Blacksburg). *Agron. J. 64* (1), 64-6 (1972). *CA 76*, 58180. Corn yields were increased on the Litz silt loam soil in 1969, where 7 and 14 kg Zn/ha as broadcast $ZnSO_4$ and 4.4 kg Zn/ha as broadcast Zn-EDTA were applied in 1968. A low level of broadcast Zn-EDTA (2.2 kg Zn/ha) was inadequate to increase the yield. The residual Zn from application of 14 kg Zn/ha as $ZnSO_4$ increased the yield more than residual Zn from application of 4.4 kg Zn/ha as Zn-EDTA. Residual Zn from application of 7 kg Zn/ha as $ZnSO_4$ was intermediate between these treatments in increasing yield. More than 13.6 kg Zn/ha as broadcast $ZnSO_4$ was required to correct Zn deficiency of corn on a Westmoreland silty clay loam.

119 Influence of Soil Fertilization on the Nutritive Value of Corn and Alfalfa. B. A. Schneider (Univ. Maryland, College Park). *Diss. Abstr. Int. B 32* (10), 5581 (1972). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 72-12,853; 1971, 273 pp. *CA 77*, 47257. An experiment was established with corn during the summers of 1968-70. The design was a randomized complete block with four replications and ten fertility treatments. These consisted of N at 336, K at 336, Mg at 336, and Ca at 3584 kg/ha arranged as an incomplete factorial. Corn varieties 'Pioneer 1097,' 'DeKalb XL66,' and 'Pioneer 3306' were used in 1968, 1969, and 1970, respectively. Corn plants were sampled at the twelve-leaf silking, and silage stages in 1968, and the silking and silage stages in 1969 and 1970. Whole plant, stover, cob, and grain samples were collected at the silage stage. Corn leaf samples were high in acid detergent fiber (ADF) under K and low under Mg treatments. Nitrogen was associated with decreased cell-wall constituents (CWC), ADF, and cellulose. Leaf tissue was higher in cell solubles, carbohydrates, and digestible dry matter (DDM) than whole plant samples. Potassium applications reduced carbohydrate levels in both leaf and whole plant tissues. Leaf samples taken early were not good estimators of mature whole plant DDM. Stover was high in all minerals except P and N. Cob samples were highest in CWC, ND insoluble ash, hemicellulose (HC), and usually ADF and cellulose. Cobs were low in P, K, Mg, N, and silica. Grain samples were highest in P, N, DDM, and dry matter but low in Ca, NO_3-N, and CWC. Potassium, Ca, N, and NO_3-N levels decreased with maturity. Several positive mineral correlations were found in the whole plant. These were Ca with Mg and N, Mg with P, Mg with N, N with NO_3-N, Ca with NO_3-N, and K with NO_3-N. 'Pioneer 1097' accumulated higher amounts of silica than 'Pioneer 3306.' Ear-stover ratios were highest with 'Pioneer 1097.' Magnesium treatments had the highest ear-stover ratios, while N and K had low ear-stover ratios. Ear-stover ratios were not an accurate predictor of digestibility. Calcium was positively correlated with CWC and ADF and negatively with silica. Potassium was positively correlated with ADF and silica and negatively with Mg, HC, and dry matter. The CWC was decreased by K in the grain. Lodging was increased by N and Ca treatments, but reduced by K applications. Both N + K and N + K + Mg were the highest yielding treatments.

120 Uptake and Assimilation of Ammonium-Nitrogen and Nitrate-Nitrogen and Their Influence on the Growth of Corn (*Zea mays*). L. E. Schrader *et al* (Wisconsin Agr. Exp. Sta., Madison). *Agron. J. 64* (2), 690-5 (1972). *CA 77*, 125255. Corn was grown in nutrient solutions under greenhouse conditions to investigate (1) the uptake of NH_4 and NO_3^- from the solutions and (2) the effect of NH_4 and NO_3^- on growth, nitrate reductase activity, and accumulation of total N and NO_3^- in leaves, stems, and roots at 4 stages of development (21, 28, 40, and 47 days after planting). The nutrient solution treatments were as follows (ppm nitrate-N/ppm ammonium-N): 0/50, 0/100, 0/150, 50/0, 100/0, 150/0, 25/75, 50/50, and 75/25. Fresh and dry wt per plant generally increased more rapidly when plants were provided 100 ppm N as a combination of nitrate-N and ammonium-N (25/75, 50/50, or 75/25) than when 100 ppm of either nitrate-N (100/0) or ammonium-N (0/100) was supplied alone. When both nitrate-N and ammonium-N were supplied, uptake rates of the two forms were similar. Uptake of NO_3^- was not retarded by the presence of NH_4, but assimilation of NO_3^- into organic N was retarded by NH_4. When both forms of N were absorbed, NH_4 was used preferentially for synthesis of amino acids and protein. Nitrate reductase activity was localized principally in the leaf blades and tended to be highest in plants provided a combination of nitrate-N and ammonium-N. Total N in the leaf and root tissues generally was higher in plants grown in NH_4 alone or in combination with NO_3^- than in plants grown on NO_3^- alone. More NO_3^- accumulated in stem tissue than in leaf or root tissues. Amino acid composition of leaf tissue was not affected by the N treatments.

121 Availability of Zinc, Copper, and Iron in Fusions with Sulfur. K. W. Sharpee, A. E. Ludwick, and O. J. Attoe (Univ.

Wisconsin, Madison). *Agron. J. 61* (5), 746-9 (1969). *Field Crop Abstr. 23*, 3229. In pot trials with four successive crops of maize, pellets of S fused with Zn, Cu, and Fe, respectively, increased, reduced, and did not affect yields. Uptake of Zn applied directly fell with successive crops and varied according to the size of the fused pellets; with all sizes it fell after the first and rose to a maximum in the fourth crop. Tissue concentrations and recovery of elemental S were inversely related to granule size. It is suggested that fusions with S hold promise for the prolonged release of Mn, Zn, and Cu for plants.

122 Zinc Absorption by Corn Hybrids from Solutions, Clay Suspensions, and Soil. L. M. Shuman (Pennsylvania State Univ., University Park). *Diss. Abstr. Int. B 31* (9), 5096-7 (1971). Avail. Univ. Microfilms, Ann Arbor, Michigan, Order No. 71-6360; 1970, 96 pp. *CA 75*, 97827. The uptake of Zn by seedling plants cannot be used to predict the relative concentrations of Zn to be expected in the ear leaves removed at 20 to 30 days post silk from plants grown in the field. The concentration of Zn in seedling plants is related to the amounts of Zn in the seed and the vigor of the seedling. The uptake of Zn from solutions is related directly to their Zn concentrations at pH 5.7.

123 Alteration of Micronutrient Composition of Corn (*Zea mays*) by Heavy Nitrogen, Phosphorus, and Potassium Application. R. N. Singh and R. F. Keefer (West Virginia Univ., Morgantown). *W. Va. Acad. Sci. Proc. 1970*, 42, 100-8 (1971). *CA 78*, 96533. Application of high rates of N, P, and K to two soils in which corn was grown in the greenhouse affected yield and nutrient composition. Phosphate application significantly increased P, Cu, Fe, and Mn and decreased Zn content of corn leaves on Monongahela soil, but increased only P, Mn, and Mg content of corn leaves on Wharton soil. Nitrogen and K less influenced the leaf nutrient composition on these soils. Changes in nutrient element composition of corn leaves from fertilization of the two soils were explained on the basis of the differences in the soil properties. A P-Zn antagonism in plants became apparent on the Zn-deficient Monongahela soil and was discussed on the basis of leaf, stem, and root analysis.

124 Amino Acid Content of Corn Produced with Different Fertilizer Treatments. E. L. Stephenson, J. O. York, and D. B. Bragg (Univ. Arkansas, Fayetteville). *Poultry Sci. 49* (6), 1729-30 (1970). *CA 74*, 75671. Nitrogen fertilizer ($NaNO_3$, $(NH_4)_2SO_4$, and urea at rates 40, 120, and 180 lb N/acre each) were applied to corn and the amino acids determined. Of the 17 amino acids investigated, alanine showed the highest (1.28 lb/acre) and cystine the lowest (0.127 lb/acre) level of accumulation. The amino acid content in corn was not affected by either type or rate or fertilization.

125 Nitrogen-Sulfur Relationships in Wheat (*Triticum aestivum* L.), Corn (*Zea mays*), and Beans (*Phaseolus vulgaris*). B. A. Stewart and L. K. Porter (Colorado Agr. Exp. Sta. Fort Collins). *Agron. J. 61* (2), 267-71 (1969). *FA 2*, 925. The N-S ratios in the tops and roots of wheat (*Triticum aestivum*), corn (*Zea mays*), and beans (*Phaseolus vulgaris*) were studied in relation to N and S supplies in soil. Greenhouse studies showed that when S became limiting, additional N did not affect either the yield or protein level of the plants, but the nonprotein N (nitrates, amides, and amino acids) increased. There was a close relationship between the amounts of N and S metabolized in the plants. The data indicated that one part S was required for every 12-15 parts N to insure maximum production of both dry matter and protein. As the use of N fertilizers increases, the possibility that S may become limiting also increases, and adequate consideration of S becomes necessary. This is especially true in greenhouse studies, where S may become limiting very quickly.

126 High Rates of Urea Fertilizer for Corn (*Zea mays*) on Two Soils, 1969-71. R. K. Stivers (Purdue Univ., Lafayette, Indiana). *Indiana Acad. Sci. Proc. 81*, 306-11 (1972). *CA 78*, 134962. Five rates of urea-N with accompanying rates of agricultural limestone were compared for continuous corn on Fincastle silt loam soil and on Chalmers silty clay loam soil. The effects of urea were similar on both soils, but they were more pronounced on the Fincastle soil which was lower in both organic matter and in cation exchange capacity. In 1969 on the Fincastle soil the highest rate of urea (1344 kg N/ha), applied a day before planting, reduced stands of corn to 32% and yields of corn grain to 37% of those plantings which received 336 kg N/ha. In 1970, there was no stand, vegetative growth or meaningful grain yield reduction when the same high fertilizer rates were plowed under on the same plots in November prior to seeding in May. In 1971, soluble salts in the Fincastle soil were more than doubled, height of plants was reduced by 20%, and soil pH was reduced by 0.9 unit with 1944 kg N/ha as compared with the 336 kg N/ha rate.

127 Relation of Time and Method of Applying Urea Nitrogen for Corn on Odell and Chalmers Soils, 1968-69. R. K. Stivers (Purdue Univ., Lafayette, Indiana). *Indiana Agr. Exp. Sta., Res. Prog. Rep.*, No. 388, 4 (1971). *Soils Fert. 35*, 2540. June side-dressed application gave higher yields than side-dressed or broadcast application in February or April. Grain yields increased significantly with increasing urea application rates (0, 45, 90, 180 lb N/acre).

128 Response of Corn to Fertilization on Brookston and Crosby Silt Loam and on Chalmers Silt Loam. R. K. Stivers (Purdue Univ., Lafayette, Indiana). *Indiana Agr. Exp. Sta., Res. Prog. Rep.*, No. 392, 2 pp. (1971). *CA 77*, 60743. Corn grown on Chalmers, Brookston, and Crosby soils did not respond to applications of P and K. Soil tests indicated a very high level of P and medium level of K. Increases in corn yields were highly and significantly related to increasing rates of N fertilizer on the Chalmers soil but were small on the Brookston and Crosby soils due to a heavy application of N the previous year.

129 Relations Between Dry Matter Yields and Concentrations of Zinc and Phosphorus in Young Corn Plants. G. L. Terman, P. M. Giordano, and S. E. Allen (Soils Fert. Res. Br., Natl. Fert. Dev. Cent., Tennessee Valley Authority, Muscle Shoals, Ala.). *Agron. J. 64* (2), 684-7 (1972). *CA 77*, 125256. Yield-Zn or P concentration relations were studied in corn (*Zea mays*) grown in greenhouse pot experiments conducted to compare various rates and sources of Zn and P on soils deficient in these nutrients. The usual result was for corn forage yields to increase at a minimum Zn concentration of 7 to 9 ppm in the dry forage until P or other growth factor became limiting. Then yields leveled off and Zn concentrations increased at sufficiently high levels of applied Zn. Similarly, yields increased at a minimum P concentration near 0.10% until Zn or other growth factor became limiting; P concentrations then increased. Critical concentrations in the dry corn forage were estimated at ~14 ppm Zn and 0.14% P. Variation from this near-optimum P/Zn ratio of 100 was largely a result of dilution of one nutrient caused by growth response to the second nutrient. Rather complex relations resulted when growth response occurred simultaneously to both P and Zn.

Poor translocation from roots to tops may be involved when either P or Zn is so extremely deficient that application of one causes a decrease in uptake of the other.

130 Nutrient Concentration Changes in Corn as Affected by Dry Matter Accumulation with Age and Response to Applied Nutrients. G. L. Terman and J C Noggle (Soils Fert. Res. Br., Natl. Fert. Dev. Cent., Tennessee Valley Authority, Muscle Shoals, Ala.). *Agron. J. 65* (6), 941-5 (1973). Hybrid corn (*Zea mays* L.) was sampled each week on field plots of soil testing adequate in P and K at Muscle Shoals, Ala., in 1972, to relate plant analyses results to growth and maturity. Treatments of N compared were no N, 28 kg/ha at planting + 84 kg/ha topdressed at tasseling, 56 kg/ha at planting, and 112 kg/ha at planting. Plots of cumulative yields versus nutrient concentrations were used to evaluate the results. Corn yields increased markedly with amount of applied N, but single and split applications of N resulted in similar yields. Concentrations of N in the top leaves, ears, and entire topgrowth also increased at each harvest date with amount of applied N. Applied N also resulted in higher concentrations of P, Ca, and Mg, but lower K concentrations in the top leaves at most sampling dates. At each rate of applied N, concentrations of N in leaves, ears, and entire tops decreased with maturity. Concentrations of P remained about the same; Ca and Mg first decreased and then increased to maturity, whereas the opposite trends resulted for K concentrations. These opposite trends in results from this experiment and from other studies illustrate the strong reciprocal relationship between concentrations of K and Ca + Mg in plants. Nutrient concentration trends with increasing yields and age of plant are influenced in general by amounts of available nutrients and various growth-limiting factors.

131 Municipal Waste Compost. Effects on Crop Yields and Nutrient Content in Greenhouse Pot Experiments. G. L. Terman, J. M. Soileau, and S. E. Allen (Soils Fert. Res. Br., Natl. Fert. Dev. Cent., Tennessee Valley Authority, Muscle Shoals, Ala.). *J. Environ. Qual. 2* (1), 84-9 (1973). *CA 79*, 4314. The following materials were mixed into 3 kg of Mountview silt loam soil before being placed into a pot: 3.75 g of a 2:1 mixture of $CaCO_3$ and $MgCO_3$; 0, 15, or 30 g dry compost (1.0% N); 0, 200, 400, or 800 mg N; 500 mg P as superphosphate; 200 mg K as K_2SO_4; and 300 mg of a mixture containing B, Cu, Fe, Mn, and Zn. The growth of *Zea mays* (corn) was increased linearly with applied N. The 15 and 30 g rates of compost decreased growth 10 to 20%. In a second experiment, each sample of soil was adjusted to have a low level of N, or P, or K. The other elements were at high levels. Compost (27% C, 1.3% N, 0.26% P, 0.97% K) was applied at 0, 12.5, 25, and 50 g/3 kg soil and N, P, and K fertilizers were added to other pots at equivalent rates. The yields of corn indicated that the N, P, and K in the compost were 16, 71, and 64% as effective as the inorganic fertilizer. In a third experiment, placements of concentrated superphosphate were compared. The soil was Davidson clay loam. Phosphorus was added at 60, 120, and 240 mg/3 kg soil and either mixed through the soil or placed in a band of sand or compost. There was no yield response by corn to P placement. In a fourth experiment, the yield response of tall fescue (*Festnea arundinacea*) to addition of compost was similar to the liming response. In a fifth experiment, a high concentration of Zn in the compost did not decrease corn and bean yields when the pH of the soil was > 6.

132 Effect of Nitrogen on Phosphorus Transport Systems in *Zea mays*. S. J. Thien and W. W. McFee (Purdue Univ., Lafayette, Indiana). *Soil Sci. Soc. Amer. Proc. 36* (4), 617-20 (1972). *CA 77*, 87056. The effect of N preconditioning on P uptake and translocation was studied using 10-day-old corn (*Zea mays*) in solution culture. Nitrogen-preconditioned plants had significantly higher P uptake rates and translocation. Plants remained capable of stimulated P absorption and translocation for periods dependent upon the time interval between N pretreatment and P uptake. The degree to which P uptake was stimulated was dependent upon the N level used for preconditioning. A rather low level 4m*M* resulted in maximum increase in P uptake over control plants. Phosphorus transport to the upper part of the plant increased as N levels in the pretreatment increased. Nitrogen preconditioning stimulated P uptake and translocation maximum when P was supplied at 0.1m*M*. At lower concentrations only uptake was stimulated, whereas at higher levels only translocation was stimulated. Observations suggest involvement of more than one P uptake mechanism and separate physiological influence of N on uptake and translocation.

133 Influence of Nitrogen on Phosphorus Absorption and Translocation in *Zea mays*. S. J. Thien and W. W. McFee (Purdue Univ., Lafayette, Indiana). *Soil Sci. Soc. Amer. Proc. 34* (1), 87-90 (1970). *Field Crop Abstr. 23*, 3275. In growth-chamber experiments, 2-week-old maize plants were placed in various N and P solutions for 24 hr to induce high nitrate N + low P contents, high ammonium N + low P contents, high P but low metabolized N contents, or low contents of both N and P. The plants were then placed in solutions containing ^{32}P alone or with N. Absorption of P and rate of translocation were significantly increased by pretreatment of the maize plants in the N solutions. This effect was absent when N was omitted from the pretreatment solution, indicating that there was no companion effect of these two nutrients on movement into the root cells. Phosphorus absorption and translocation were stimulated to different degrees, indicating that two separate systems are involved in P uptake and translocation.

134 Effect of Phosphorus, Potassium, Copper, and Zinc on the Yields of Corn (*Zea mays*) and Soybeans (*Glycine max*) and on Soil Fertility for a Drained Spodosol. L. G. Thompson, Jr. and W. K. Robertson (Florida Agr. Exp. Sta., Gainesville). *Soil Crop Sci. Soc. Fla., Proc.*, 31, 141-4 (1972). *CA 80*, 94631. At the three highest levels of application, P leached to a depth of 60 cm but the amount below 30 cm, except at the highest rate of application, was negligible. After 5 yr, very little K was left in the surface 15 cm, except at the highest rate of application, and residual K to the 60 cm depth was negligible. Soybeans and corn roots permeated much deeper than 45 cm, and hence leaching from the root zone of relatively large amounts of applied P was evidently negligible. Phosphorus and K in the seed increased with rates of application of P and K, but the treatments had very little effect on Ca and Mg contents of the seed. Applied Cu moved into subsoil; in 3 yr, much of Cu had moved out of the surface 15 cm and was concentrated in the 15-30 and 30-45 cm layers. The Cu movement was enhanced by increasing acidity with depths in the profiles. Zinc leached similarly to Cu. Since there were no consistent yield responses to Cu and Zn for soybeans and corn, the levels in the untreated soils were probably adequate. Soybean seed contents of 7.8 ppm Cu and 39 ppm Zn and corn ear leaf contents of 8.8 ppm Cu and 23 ppm Zn were at least sufficient.

135 Long-Term Effects of Manure, Fertilizer, and Plow Depth on Chemical Properties of Soils and Nutrient Movement

in a Monoculture Corn System. J. L. Vitosh, J. F. Davis, and B. D. Knezek (Michigan Agr. Exp. Sta., East Lansing). *J. Environ. Qual. 2* (2), 296-9 (1973). *CA 79*, 52252. Soil chemical properties, organic matter and nutrient accumulation, and nutrient movement and recovery after 6 and 9 yr of annual fertilizer and manure applications to continuous corn were studied on two soil types (Conover-Hodunk loam and Metea sandy loam). Plow depths of 18 versus 30 cm had little or no effect on soil test values or nutrient accumulation patterns. The pH value of both sides decreased > 0.1 pH unit/yr with annual application of 168 kg N/ha as $(NH_4)_2SO_4$. Soil organic matter, available P, and exchangeable K, Ca, and Mg increased with increasing manure rates. The organic matter in the Metea sandy loam was increased ~ 0.1% each yr by yearly application of 67.2 tons cattle manure/ha. Removal of nutrients by grain and silage crops had no effect on soil-available P. Soil test changes for K, Ca, and Mg were proportional to the net addition of each nutrient, but < 30% of the net nutrients added could be accounted for in surface samples from the silage area where 67.2 tons of manure was annually applied. The most favorable rate of manure for the Metea sandy loam soil was 22.4 tons/ha. Larger applications caused buildup of exchangeable K in the surface and subsurface horizons and resulted in inefficient use of all nutrients. The K buildup was less critical on the loam soil or where silage rather than grain was removed.

136 Relationship Between Grain Yield and Leaf N, P, and K Concentrations for (*Zea mays* L.) and the Factors That Influence This Relationship. R. E. Voss, J. J. Hanway, and L. C. Dumenil (Univ. California, Davis). *Agron. J. 62*, 726-8 (1970). *Soils Fert. 34*, 3321. In trials with NH_4NO_3, concentrated superphosphate and KCl on silt-loam soils, the observed grain yields could not be satisfactorily predicted by a regression model containing only N, P, and K concentration terms, but the addition of several environmental factors, as linear terms and as interactions with leaf concentrations, provided a model that gave satisfactory predictions from the lowest to highest observed values. Because of the general adequacy of K, leaf-K content was not necessary in the model. Leaf nutrient concentrations associated with maximum predicted yield varied with past cropping, plant population, soil yielding potential, and soil moisture, but nutrient levels associated with 95% of maximum predicted yields did not vary as widely as levels associated with maximum predicted yields. Irrespective of environmental conditions, a nearly constant 10:1 %N:%P ratio existed for these nutrient levels. Under most probable environmental conditions for this area and these soils, nutrient levels of approximately 2.9% N and 0.28% P were predicted for 95% of maximum yields.

137 Influence of Soil, Management, and Climatic Factors on the Yield Response by Corn (*Zea mays* L.) to Nitrogen, Phosphorus, and Potassium Fertilizer. R. E. Voss, J. J. Hanway, and W. A. Fuller (Univ. California, Davis). *Agron. J. 62*, 736-40 (1970). *Soils Fert. 34*, 3319. A multiple-regression equation for yield, fitting data from 575 plots, contained 40 terms and achieved an R^2 of 0.80. It contained interactions among applied fertility, indigenous fertility, management, and climatic factors. Response to applied N was influenced most by past cropping and soil moisture stress. Response to applied P was influenced less by environmental factors than was response to N, but available soil P, soil N, and soil moisture stress influenced P responses. These soils, which rate medium or high in exchangeable K responded only slightly and negatively to applied K. Significant interactions were measured between soil moisture and plant population and between soil moisture and planting date. The necessity for this type of field experimentation is discussed. Methods of interpretation and practical applications of yield-prediction equations are suggested and exemplified.

138 Evaluation of Phosphorus Nitrogen Compounds as Fertilizers. Z. T. Wakefield, S. E. Allen, J. F. McCullough, R. C. Sheridan, and J. J. Kohler (Natl. Fert. Dev. Cent., Tennessee Valley Authority, Muscle Shoals, Ala.). *J. Agr. Food Chem. 19* (1), 99-103 (1971). *CA 74*, 41469. Thirty-four P and N compounds were prepared and compared in the greenhouse as high-analysis sources of fertilizer N and P for corn. The compounds included phosphonitrilic derivatives, metaphosphimates, metaphosphates, S-containing compounds, and amido- and imidophosphates. The metaphosphates, amidophosphate, thioamidophosphates, and phosphoryl triamide were excellent sources of both N and P, but metaphosphimates were poor sources. Several of the S compounds were toxic in early growth stages, but thereafter were effective sources of plant nutrients. Of the phosphonitrilic derivatives, only phosphonitrilic hexaamide was an effective source of both N and P.

139 Micronutrient Uptake and Mobility Within Corn Plants (*Zea mays* L.) in Relation to Phosphorus-Induced Zinc Deficiency. R. E. Warnock (Chevron Chem. Co., Richmond, Calif.). *Soil Sci. Soc. Amer. Proc. 34*, 765-9 (1970). *Soils Fert. 34*, 2485. In pot experiments using Sacramento clay loam low in available Zn, P was applied at rates of 0 to 520 ppm, with concomitant additions of Zn (decreasing from 40 to 0 ppm), to maize plants. Zinc deficiency occurred at high P and low Zn with maximum growth at 130 ppm P and 2.5 ppm Zn applied. Phosphorus and Zn fertilizing altered the mobility of Zn, Fe, and Mn within the plant. High P and low Zn increased Fe and Mn mobility. Applied P reduced Zn concentration in tissue but not the uptake per plant. DTPA-extractable Zn in soil was not decreased by applied P, but it increased with applied Zn. A large excess of Fe was accumulated by Zn-deficient plants. It was suggested that excess Fe interference was contributing to physiological malfunction within Zn-deficient maize plants.

140 Comparison of Zinc Uptake by Two Inbred Lines and Ten Corn Hybrids as Influenced by Zinc and Lime Applications. R. L. Waters (Univ. Georgia, Athens). *Diss. Abstr. Int. B 33* (7), 2897 (1972). Avail. Univ. Microfilms. Ann Arbor, Michigan, Order No. 72-34,160; 1972, 71 pp. *CA 78*, 109785. A greenhouse investigation was conducted on the effect of zinc and lime applications on forage yield, chemical composition, and carbonic anhydrase activity of two inbred and 10 corn hybrids. Application of Zn increased forage yield and Zn content in all corn lines tested. A genetic effect was apparent, since considerable variation was noted among genotypes. Lime tended to reduce forage yield when no Zn was applied, but no differences were noted between lime treatments with application of Zn. Lime application at the 3 tons/acre rate decreased Zn content in corn compared to 1 ton/acre level. Phosphorus, K, Ca, Mg, Mn, and Fe content were reduced in all corn lines by the application of 15 lb Zn/acre. Carbonic anhydrase activity was increased by the application of Zn with the maximum increase occurring at the 0-4 lb/acre level. Forage yield, chemical composition, and carbonic anhydrase activity varied among the lines tested, with and without Zn, and this variation was concluded to be controlled by genetic factors.

141 Corn Yields with Fall, Spring, and Sidedress Nitrogen. L. F. Welch *et al* (Univ. Illinois, Urbana). *Agron. J. 63*, 119-23 (1971). *Soils Fert. 34*, 4238. Zero-268 kg N/ha as NH_4NO_3

was applied in autumn or spring to maize at two sites on silty clay loam and silt loam soils. At two sites on a second silty clay loam soil, 0-360 kg N/ha was applied in autumn or spring and 0-224 kg N was applied in autumn, spring, or as a sidedressing after emergence. At the first two sites yields increased with increasing N up to 201 kg N/ha; at 67 and 134 kg N spring application was more effective than autumn application but at 201 and 268 kg N there was very little difference between spring and autumn application. On the site receiving 0-360 kg N there was very little difference at all levels of N application between spring- and autumn-applied N and very little increase in yield with applications of 180 kg N or more. On the fourth site yields were greatest with sidedressed N and least with autumn applied N, but at 168 and 224 kg N there was very little difference between yields from sidedressed N and yields from spring applied N.

ASIA AND AUSTRALIA

AUSTRALIA

142 Methods of Correcting Zinc Deficiency in Irrigated Maize Grown on a Black Earth Soil, Darling Downs, Queensland. D. E. Hibberd (Queensl. Dept. Primary Ind., Toowoomba). *Queensl. J. Agr. Anim. Sci. 27*, 89-94 (1970). *Soils Fert. 34*, 2487. Applications of 28-42 lb/acre $ZnSO_4 \cdot 7H_2O$ or 12 lb/acre ZnO gave grain yield increases approaching significance when drilled about 1 in. below the level of seed placement, or when pure ZnO was applied to the seed as dust or in pelleted form. These treatments were more effective than single or successive sprays of 1% $ZnSO_4$. Soaking the seed in 3% $ZnSO_4$ for 12 hr before planting reduced grain yields.

143 Nutritional Investigations in Irrigated Maize on Some Black Earth Soils, Darling Downs, Queensland. D. E. Hibberd, R. B. Brinsmead, and J. W. Littler (Queensl. Dept. Primary Ind., Toowoomba). *Queensl. J. Agr. Anim. Sci. 27* (2), 177-82 (1970). *CA 74*, 99024. In five field trials with maize at four localities, nutrients suspected of being deficient were applied singly and in combination. Significant grain yield responses were obtained only to N, and to P on one soil deficient in P. Applications of P, Mn, B, Mo, and Fe had no effects on foliage or grain yields. A temporary unavailability of Zn may occur sporadically on irrigated soils.

CEYLON

144 Fertilizer Experiments with Maize (*Zea mays*) on a Bibile Soil. S. Kathirgamathaiyah and N. Dharmarajah. *Trop. Agr. 126* (2), 91-4 (1970). *Trop. Abstr. 26*, 850. With the advent of high-yielding varieties, it has become necessary to investigate the nutrient requirements of cereal crops under local soil and climatic conditions in Ceylon. On soils in Bibile, maize was found to respond to both N and P fertilizers. An application of 45 kg N, 68 kg P_2O_5, and 34 kg K_2O/ha can be recommended.

IRAN

145 Effect of Sulfur and Residual Sulfur on pH and Availability of Phosphorus in Calcareous Soils and Effect of Applied Nitrogen on Yield and Chemical Composition of Corn. A. Kashirad (Coll. Agr., Pahlavi Univ., Shiraz, Iran). *Z. Pflanzenernaehr. Bodenk. 133* (1-2), 93-8 (1972). *CA 79*, 135869. Application of S to calcareous soils with an initial pH 8.3 was not economically feasible. In a field experiment, S was applied 1.5 yr before corn planting at rates of 0, 750, 1500, 2250, 3000, 3750, 4500, 5250, 6000, and 6750 kg/ha. The main plot treatment was N at rates of 0, 100, and 200 kg/ha (~ 66% N was applied at planting time and ~ 34% N when corn was 30-40 cm tall). Applications of S at all levels were significantly more effective in reducing soil pH and increasing available P through the first yr of the experiment than thereafter. Application of N increased the yields of stover and grain significantly. Yield changes were probably a consequence of N concentration in the plant rather than of other element concentrations. There was no indication of an antagonistic effect of S on the uptake of N, which was the case in the first yr of the experiment.

146 Effect of Sulfur on pH and Availability of Phosphorus in Calcareous Soils, Influence of Sulfur and Nitrogen on Yield and Chemical Composition of Corn. A. Kashirad and J. Bazargani (Coll. Agr., Pahlavi Univ., Shiraz, Iran). *Z. Pflanzenernaehr Bodenk. 131* (1), 6-13 (1972) (Eng). *CA 77*, 100085. Various S amounts (0-6750 kg/ha) were added in a field experiment to an alluvial calcareous silty clay soil with pH 8.3. Sulfur application reduced considerably the soil pH and increased the available P of the soil. Nitrogen application increased the green and dry matter of the corn crop in contrast to S which reduced the yield at all levels of N. Sulfur and N had no special effect on P, K, and Ca content of the plant, but a considerable one on its N and S contents. All levels of S application increased the S content and decreased the N content of the plant. The yield reduction was caused by an adverse effect of S on N uptake.

ISRAEL

147 Rates of Growth and Nutrient Uptake of Irrigated Corn as Affected by Nitrogen and Phosphorus Fertilization. B. Bar-Yosef and U. Kafkafi (Volcani Cent., Agr. Res. Organ., Bet Dagan, Israel). *Soil Sci. Soc. Amer. Proc. 36* (6), 931-6 (1972). *CA 78*, 28428. Growth rates of corn and weekly uptake of major nutrients were measured in a long-term fertilization experiment. High levels of nitrates in the soil (140 ppm nitrate-N) during the first month of growth suppressed dry matter production. An increase in soil-P concentration resulted in higher P uptake and early appearance of male flowers. On the control plots, which had not received any phosphatic fertilizer for 8 yr, the plants took up more P than the amount estimated by $NaHCO_3$ extraction. The high levels of nitrates which were found in the soil four weeks after seeding (140 and 70 ppm N) dropped within the fifth week to a level of 20-10 ppm N. Denitrification to gaseous compounds in the presence of living plants due to 68 mm of sprinkler-applied water is suggested as an explanation of this phenomenon. Uptake flux values for P and N ranged between 2.6 and 22.8 x 10^{-6} μg P cm^{-2} sec^{-1} and between 4.1 and 22.5 x 10^{-5} μg N cm^{-2} sec^{-1}, and were affected by plant age and fertilizer application.

INDIA

148 Comparative Study of Calcium Ammonium Nitrate and Urea Application on Two Maize Varieties. B. S. Banga and S. S. Khanna (Punjab Agr. Univ. Hissar, India). *Indian Soc. Soil Sci. Bull.*, No. 8, 211-17 (1970) (Eng). *CA 75*, 47927. A field trial was conducted on two maize varieties to compare the efficiency of $CaNH_4$ nitrate and urea. Urea was slightly inferior to $CaNH_4$ nitrate, particularly at 150 kg N/ha. Hybrid maize gave a yield triple that of the local variety. The highest uptake of N was found at 100 kg N/ha in both varieties Although the concentration of N was higher in the local variety, total uptake was considerably higher in the hybrid maize. Nitrogen uptake was found to be slightly greater with $CaNH_4$ nitrate application up to 100 kg N/ha than with urea application.

149 Effect of Nitrogen Fertilizers on the Uptake and Utilization of Fertilizer Phosphorus by Maize (*Zea mays*). D. K. Bhandari and S. M. Virmani (Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Sci. 42* (5), 375-80 (1972) (Eng). *CA 77*, 74161. A greenhouse experiment was conducted with maize on a Karnal soil to evaluate the effects of N fertilizers alone or with P on the uptake and utilization of soil and fertilizer P. NH_4NO_3 and $(NH_4)_2SO_4$ were superior to $NaNO_3$ in affecting yield and total P uptake. The order of efficiency of N fertilizers was $(NH_4)_2SO_4 > NH_4NO_3 > NaNO_3$. The concentration of N in the plant was more when no P was added than when it was added at the rate of 100 ppm. Even though $(NH_4)_2SO_4$ produced more dry matter than NH_4NO_3, the difference was not significant.

150 Effect of Fertilizers and Plant Densities on Plant Barrenness in Hybrid Maize, Deccan Double. R. J. Bhosale and V. S. Khuspe (Coll. Agr., Dapoli, India). *Res. J. Mahatma Phule Agr. Univ. 1* (2), 82-4 (1970) (Eng). *CA 79*, 145319. Both increasing N application to 225 kg/ha and decreasing the plant density decreased the percentage of barren stalks in stands of the Deccan Double hybrid maize. Application of P had no effect on the percentage of barren plants.

151 Response of NPK (Nitrogen-Phosphorus-Potassium) on the Fodder Yield of Hybrid Maize. A. S. Gill *et al* (Indian Grass. Fodder Res. Inst., Jhansi, India). *Indian J. Agr. Res. 6* (2), 159-62 (1972) (Eng). *CA 79*, 30891. The effect of N or P fertilization on dry matter yields of maize grown on a black soil of Jhansi was studied. The dry matter yield was increased by 100 kg N/ha over no N by 52 and over 50 kg N/ha by 26.2%. Application of P gave a significant increase in only 1 of the 3 yr of the study.

152 Effect of Different Varieties and Levels of Nitrogen on the Yield and Chemical Composition of Maize Fodder. S. Kareem and L. L. Relwani (Natl. Dairy Res. Inst., Karnal, India). *Indian J. Dairy Sci. 24* (3), 119-27 (1971) (Eng). *CA 77*, 60746. The application of N as $CaNH_4(NO_3)_3$ at 30, 60, and 90 kg/ha to several varieties of hybrid corn produced a linear response. Ganga 101 (F_1) hybrid outyielded Ganga 101 (F_2), N.P.2, and local corn varieties, the F_1 hybrid producing the highest yields of green and dry matter, Ca and P.

153 Effect of Graded Doses of Nitrogen and Phosphate Supplied Through Different Sources on Growth, Yield, and Quality of Hybrid Maize (*Zea mays*), Deccan Double. R. M. Kharche and V. S. Khuspe (Coll. Agr., Poona, India). *Res. J. Mahatma Phula Agr. Univ. 1* (2), 85-91 (1970) (Eng). *CA 79*, 145321. The testing of 9 different levels of N and P_2O_5, from varying sources, on Deccan Double hybrid maize showed that applications of N and P_2O_5 together gave better yields than N alone although P_2O_5 alone had no effect. The optimum N rate, given as $(NH_4)_2SO_4$, was 242 kg N/ha. However, when N was applied together with superphosphate, 197 kg N/ha was optimum. The combination of N and P_2O_5 as nitrophosphate gave optimum growth at 207 kg N and P_2O_5/ha. Estimates of economic returns per ha indicated that nitrophosphate was superior to a combined application of $(NH_4)_2SO_4$ and superphosphate.

154 Nitrogen, Phosphorus, and Potassium Fertilization of Hybrid Maize in an Intensive Rotation with Wheat and Fodder Cowpea. III. Optimum Fertilizer Rates for Hybrid Maize. B. G. Khare and O. P. Gautam (Indian Agr. Res. Inst., New Delhi, India). *Indian J. Agron. 14*, 253-7 (1969). *Soils Fert. 34*, 5209. Optimum fertilizer rates for hybrid maize at different crop and fertilizer prices were 125-135 kg/ha N and 45 kg/ha each of P_2O_5 and K_2O.

155 Responses of Maize and Wheat Crops to Soil and Spray Applications of Copper in the Ludhiana Soils. C. Lal, J. S. Grewal, and N. S. Randhawa (Punjab Agr. Univ., Ludhiana, India). *J. Res. Punjab Agr. Univ. 8*, 52-6 (1971). *Soils Fert. 35*, 1627. In pot experiments, application of 10 ppm Cu in the form of $CuSO_4$ on various loamy sand and sandy loam soils significantly increased the yield and Cu uptake of both crops. With maize, spraying with 0.2% $CuSO_4$ caused leaf scorching and decreased the yield significantly; Cu uptake was considerably greater with spraying than with application to the soil. With wheat (*Triticum aestivum*) 0.1 $CuSO_4$ spray caused no leaf injury and increased the yield and Cu uptake significantly. In field experiments on loamy sand, application of 5 or 10 kg/ha Cu increased the grain yields of wheat significantly; spraying with 0.2 or 0.4% $CuSO_4$ did not increase the yield significantly and caused leaf scorching.

156 Comparative Efficiency of Zinc from Various Sources for Maize (*Zea mays* L.). O. P. Meelu and N. S. Randhawa (Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Sci. 40*, 637-44 (1970). *Soils Fert. 34*, 4235. In pot experiments maize was grown in a serozem soil fertilized with 0, 5, and 10% FYM and 10 ppm Zn as $ZnSO_4$, Zn dust, ZnO, Zn rayplex or 475 kg/ha spartin. All Zn sources except spartin increased maize yields, plant Zn contents and Zn uptake but the increases were reduced by the application of FYM. In the absence of FYM maize yields from Zn dust were significantly lower than from $ZnSO_4$, ZnO, and Zn rayplex but the decrease with the application of FYM was smaller with Zn dust and at 10% FYM it gave the highest yield.

157 Response of Maize to Nitrogen. J. Pandey and K. C. Das (Orissa Univ. Agr. Tech., Bhubaneswar, India). *Fert. News 15* (6), 38-9 (1970) (Eng). The grain yield of maize increased progressively with increasing levels of N up to 180 kg N/ha. The yield contributing characters, namely, number of cob bearing plants, weight of 1000 grains showed significant increase with increasing levels of N, whereas barren plants were significantly reduced. Application of 180 kg N/ha produced 13.48 q/ha.

158 Effect of Nitrogen with and without Phosphorus on the Yield of Hybrid Maize (Ganga-3). B. S. Panwar and B. V. Singh (Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Res. 5* (1), 19-22 (1971) (Eng). *CA 76*, 112027. The yield of maize (corn) increased with the increase in the levels of N and 80 kg N/ha produced significantly higher yields in both yr, 1967-69; 50 kg

P_2O_5 also increased the yield significantly. The combination of these two rates was better only in the second yr.

159 Antagonism Between Potassium, Calcium, and Magnesium in Several Varieties of Hybrid Corn. A. N. Pathak and Y. P. Kalra (Uttar Pradesh Inst. Agr. Sci., Kanpur, India). *Z. Pflanzenernaehr. Bodenk. 130* (2), 118-24 (1971) (Eng). *Soils Fert. 35*, 3469. Leaf samples of hybrid varieties, grown on sandy loam (pH 7.4) that was treated with $(NH_4)_2SO_4$ at 40 lb or 100 lb/acre N, were collected and analyzed 25-79 days after sowing and at maturity. Contents of total K_2O, CaO, and MgO at five stages of growth are shown in tables. There were antagonistic relations between K and Ca, and between K and Mg; there was a reciprocal interaction between NH_4-N application and foliar K.

160 Chemical Composition and Nutrient Uptake of Maize in Relation to Nitrogen and Sowing Dates. A. N. Pathak and K. N. Tiwari (Uttar Pradesh Inst. Agr. Sci., Kanpur, India). *Indian J. Agr. Res. 6* (2), 147-50 (1972) (Eng). *CA 79*, 30890. The effect of N rates and sowing dates on the chemical composition and nutrient uptake by three hybrids and two open-pollinated maize varieties were studied. Increased levels of N usually increased N and P contents of the plant and decreased that of K. Concentration of N, P, and K decreased with plant age. Nutrient concentration and total uptake were higher in hybrids than in open-pollinated varieties.

161 Effect of Zinc Application of Phosphorus Concentration and Uptake in Maize (*Zea mays*). K. G. Prasad, U. C. Shukla, and N. M. Safaya (Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Sci. 41* (12), 1068-73 (1971) (Eng). *CA 76*, 152536. The effect of soil- versus leaf-applied Zn on P uptake by corn was studied. Phosphorus absorption decreased with Zn application. The effect of Zn on stem-P concentration was less in the spray than in the soil treatment. A highly significant negative relation occurred between P and Zn concentrations of different portions of corn plants. The possibility of P and Zn interaction is discussed. Corn response to Zn application was positively related to the P:Zn ratio. A P:Zn ratio of 15.4:25 in the dry matter (leaf + stem) of 6-week-old plants had an adverse effect on plant growth.

162 Relative Efficiency of Nitrogen Fertilizers for "Ganga 101" Maize (*Zea mays* L.) as Influenced by Rainfall. R. Prasad and B. B. Turkhede (Indian Agr. Res. Inst., New Delhi, India). *Indian J. Agr. Sci. 41* (5), 485-9 (1971). *Soils Fert. 35*, 1633. Field experiments on loam soil (pH 7.9) indicated that $(NH_4)_2SO_4$, calcium ammonium nitrate, urea and sodium nitrate were equally effective during dry years. In wet years the order of efficiency was $(NH_4)_2SO_4 <$ urea $\leqslant$ calcium ammonium nitrate.

163 Suitability of Closer Spacing with High Fertilizers for Composite and Hybrid Maize (*Zea mays* L.). P. Raj *et al* (Reg. Res. Sta., Dharwar, Mysore, India). *Indian J. Agr. Sci. 41* (11), 944-7 (1971). *Soils Fert. 35*, 5414. On a red loam of pH 7.43 no significant difference between 60 x 18 cm and 60 x 36 cm spacing with respect to grain yield was observed during 1967-70, but stover yields were 37% higher with closer spacing. At a low fertilizer rate (90 kg N + 45 kg P_2O_5 + 22 kg K_2O/ha) "Deccan" gave significantly higher grain yields than the composite "Amber". "Deccan" also showed significant yield responses between the low and high fertilizer rate (135 kg N + 67 kg P_2O_5 + 45 kg K_2O/ha).

164 Effect of Zinc and Phosphorus Application on the Response and Chemical Composition of Hybrid Maize Grown on Torana Soils. V. Rajagopal and B. V. Mehta (Inst. Agr., Anand, India). *Indian J. Agr. Sci. 41* (2), 156-66 (1971) (Eng). *CA 75*, 75470. The response of hybrid maize (corn) to different levels of Zn and P and its effects on other mineral nutrients of corn were studied on a soil moderately deficient in Zn and P under greenhouse conditions. The yield of dry matter was increased significantly by the application of PO_4^{3-}, but not from Zn. Zinc at 5 ppm combined with 100 kg P_2O_5/ha produced a higher yield of dry matter than when applied alone. Added Zn increased the concentration and uptake of Zn significantly. Phosphate application reduced the concentration of Zn by 34.3%, but it had no effect on the total uptake of Zn by the plant. The highest level of Zn (20 ppm) reduced considerably the concentration of Fe and Cu, but at low levels (5 ppm) the concentration and uptake of Mn increased. There was a beneficial effect on the uptake of most of the elements with the combined application of Zn and PO_4^{3-}.

165 Response of Maize (*Zea mays* L.) to Levels of Nitrogen and Spacing. V. S. Rajput *et al* (Agr. Coll., Rewa, M.P., India). *JNKVV Res. J. 4* (1-2), 62-6 (1970, publ. 1971). *Soils Fert. 35*, 680. Sona, local, Ganga 101, and Ganga 3 maize varieties were planted 15, 23, and 30 cm apart in rows 60 cm apart and fertilized with 80, 120, and 160 kg N/ha. 120 and 160 kg N gave significantly higher grain yields than 80 kg N but the yield from 160 kg N was not significantly greater than that from 120 kg N. Yields of Ganga 101 and Sona varieties were significantly higher than yields of the local variety and yields of Ganga 3 were significantly higher than those of Sona but not significantly higher than those of Ganga 101. Spacing had no significant effect on grain yield/ha but wider spacing significantly increased grain yield/plant.

166 Effect of Phosphorus and Zinc on Yield and Attributes of Maize. D. N. Rathore, B. P. Singh, Kirpal Singh (Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Res. 6* (2), 111-14 (1972) (Eng). *CA 79*, 30875. Varying amounts of P (0, 50, 75, and 100 kg P_2O_5/ha) had no effect on corn yield and yield constituents except the 1000-grain wt. Applied Zn increased the cob girth, the 1000-grain wt, and the grain yield. The optimum Zn dose was 20 kg $ZnSO_4$/ha. Phosphorus-Zn interaction did not significantly affect the corn yield.

167 Protein Content in Maize as Influenced by Nitrogen Application. M. R. Reddy, M. M. Husain, and R. S. Rao (Coll. Agr., Rajendranagar, India). *Andhra Agr. J. 15* (2), 35-7 (1968) (Eng). *CA 73*, 3052. The N content of 1 local and 2 hybrid (Ganga 3 and Deccan) varieties of maize, fertilized with 56, 112, or 168 kg N/ha applied as $(NH_4)_2SO_4$, was determined. Maximum protein content was reached in the local variety with 112 kg N/ha. Except at 168 kg N/ha, the protein content in the local variety was higher at all levels of fertilization than in the hybrids. Heavy N fertilization is reported to increase the protein content in the hybrids.

168 Response of Maize to Zinc Application in Some Sierozem Soils. N. M. Safaya, K. G. Prasad, and U. C. Shukla (Dept. Soils, Haryana Agr. Univ., Hissar, India). *Haryana Agr. Univ. J. Res. 1* (2), 20-6 (1971) (Eng). *CA 77*, 33424. An experiment using soils from the sierozem belt of the Hissar district was conducted to study the effect of Zn addition on corn. Soil given 10 ppm $ZnSO_4 \cdot 7H_2O$, 3 sprays of 0.3% $ZnSO_4 \cdot 7H_2O$ + 0.15% $Ca(OH)_2$, and control were compared. The effect of the Zn addition was recorded by measuring the height of the plants and their dry matter yields. Zinc,

irrespective of the mode of application, caused a significant increase in the height of plants but soil application was superior to foliar application. Soil application led to an increase in leaf, stem, and total dry wt whereas spray application failed to produce any such beneficial effects. The effect was more marked upon the leaf than upon the stem due to the fact that Zn deficiency causes leaf chlorosis. Spray-applied Zn was accumulated mainly in the epidermal and mesophyll cells of the leaves.

169 Effect of Micronutrients on Maize Yields. K. S. Sandhu, D. Sharma, and O. P. Singh (Dept. Plant Breed., Punjab Agr. Univ., Ludhiana, India). *J. Res., Punjab Agr. Univ. 8* (1), 26-8 (1971) (Eng). *CA 76*, 45102. Field trials showed that the application of $ZnSO_4$ to soil at 16 kg/ha Bajaura (Kulu Valley) and 24 kg/ha at Ludhiana significantly increased the grain yield of maize. Magnesium, Fe, and Mn did not significantly affect yields at either place.

170 Comparative Response of an Open-Pollinated Variety and a Double-Cross Maize Hybrid to Nitrogen, Phosphorus, and Potassium. V. H. Shah, O. P. Gautam, and A. Singh (Indian Agr. Res. Inst., New Delhi, India). *Indian J. Agr. Sci. 41* (11), 932-7 (1971). *Soils Fert. 35*, 5412. Both varieties responded linearly to up to 180 kg N/ha; the response rate was greater in the double cross hybrid (Ganga 101) than in KT 41. Significant responses to P and K were obtained with Ganga 101 in 1963 when higher rates of N were applied. 180 kg N + 45-50 kg P_2O_5 + 90 kg K_2O/ha gave the maximum grain yield. The residual effects of 180 kg N, 45 kg P_2O_5, and 90 kg K_2O/ha on grain yield were 3.3, 3.5 (with 180 kg N), and 0.4 q/ha, respectively.

171 Efficiency of Three Sources of Fertilizer Nitrogen As Affected by the Method of Application. M. C. Sarkar and A. S. Azad (Soils Dept., Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Chem. 4* (1), 63 (1971). *Soils Fert. 35*, 1631. From field and laboratory experiments with maize it was found that urea, ammonium sulfate nitrate, and calcium ammonium nitrate were equally effective at 120 kg/ha. Yields were improved by placement 7.5 cm from the rows compared to broadcasting. Three split applications increased N uptake, but not yields, as compared with 2 split applications.

172 Studies of the Effects of Time and Method of Nitrogen Application on the Yield of Hybrid Maize. S. C. Shukla and M. Wassay. *Indian J. Sci. Ind. 4* (1), 15-18 (1970). *Trop. Abstr. 26*, 851. Field experiments were conducted in India to study the effect of different methods of N application on the grain yield of the maize variety Ganga 101 grown in a sandy loam soil. Three equal split-applications of 112 kg N/ha at sowing, at knee-high stage, and at tasseling gave a higher grain yield than when applying the entire dose at sowing, and at 2 equal split-applications at sowing and at knee-high stage. Broadcasting or side placement of N had no effect on the yield. There were no significant interactions between times and methods of N applications.

173 Effect of Vanadium on Hybrid Maize. B. B. Singh (Cellular Physiol. Lab., Fac. Agr., Banaras Hindu Univ., Varanasi, India). *J. Indian Bot. Soc. 50* (2), 179-82 (1971). *Soils Fert. 35*, 3470. The effects of up to 1.25 ppm V on various growth parameters of maize growing in sand culture were studied. Vanadium deficiency affected growth more than net assimilation rate. Dry matter production and photosynthetic area were also significantly affected by V application.

174 Note on the Time and Methods of Urea Application to Maize (*Zea mays* L.) Grown on Soils with Undulating Topography. H. G. Singh and M. S. Saroha (Agr. Coll., Udaipur, India). *Indian J. Agr. Sci. 40* (5), 470-3 (1970) (Eng). Compared with the standard method of N application, for example, 50% at sowing and 50% at tasseling, foliar application of N as urea in 3 equal splits, for example 1/3 at first irrigation, 1/3 at the knee-high stage, and 1/3 at tasseling, significantly increased the yield of grain and stover of maize and the uptake of N by 29, 49, and 44% respectively, without diluting the protein content of grain or stover on soils with undulating topography. Application of 60 kg N/ha gave significantly higher yield of grain and stover and higher uptake of N than 40 kg N/ha.

175 Effect of Different Levels of Nitrogen and Plant Density on the Yield of Maize Hybrids Under Spring Conditions. B. S. Verma and R. R. Singh (R.B.S. Coll., Bichpuri, Agra, India). *Indian J. Agron. 15* (4), 391-2 (1970, publ. 1971). *Soils Fert. 35*, 681. In a plot experiment, Ganga 3, Ganga 101, and T41 maize varieties were planted at 45,000, 60,000, and 90,000 plants/ha and fertilized with 0, 50, 100, 150, and 200 kg N/ha. Yields from the 3 varieties increased in the order: T41, Ganga 101, and Ganga 3 and the yield differences between the varieties were significant. Grain yields were significantly increased by N up to 150 kg N and were significantly higher from a plant density of 90,000 plants/ha than from 60,000 plants/ha which in turn gave significantly higher yields than 45,000 plants/ha.

176 Relative Effect of Nitrogenous Fertilizers and Graded Doses on the Yield and Quality of Maize. R. N. Verma, B. P. Singh, and R. L. Ahuja (Haryana Agr. Univ., Hissar, India). *Indian J. Agr. Res. 6* (2), 99-106 (1972) (Eng). *CA 79*, 30904. The effect of urea, $(NH_4)_2SO_4$, $(NH_4)_3NO_3SO_4$, and $CaNH_4(NO_3)_3$ doses on corn yield and quality was studied. The highest N content occurred at the first leaf and shoot stages, decreasing with subsequent plant growth. With increasing N rates, the N content of all plant parts and the grain yield increased. $CaNH_4(NO_3)_3$ was superior to other fertilizers for increasing the N content and the grain yield of the plant.

177 Effect of Nitrogen on the Uptake and Utilization of Soil and Fertilizer Phosphorus. S. M. Virmani, A. S. Dhaliwal, and N. S. Randhawa (Dept. Soils, Punjab Agr. Univ., Hissar, India). *J. Res., Punjab Agr. Univ. 7* (3), 308-11 (1970) (Eng). *CA 75*, 4754. A greenhouse study with maize and soybean crops was conducted on a chernozem soil to evaluate the increased uptake and utilization of soil and fertilizer P due to the application of ammonium-N in relation to the forms of soil P. The results showed that the mobilization of soil P affected by the incorporation of acid-forming N fertilizer, significantly accounted for the high uptake and utilization of the soil and fertilizer P. Among the crops, the legumes utilized P better than the nonlegumes.

PAKISTAN

178 Interrelationships of Phosphorus, Zinc, Boron, and Plant Population on the Yield and Leaf Composition of Maize. N. Ahmad (W. Pakistan Agr. Univ., Lyallpur, Pakistan). *Pak. J. Soil Sci. 6* (1), 1-14 (1970). *Soils Fert. 35*, 2539. In field experiments on a calcareous clay soil, irrigated maize at plant populations of 40-93 thousand/ha was fertilized with 37-600

kg P/ha, 11-180 kg Zn and 11-180 kg B. Grain yields were 0.69-14.43 tons/ha. At low population levels, P depressed yields at low Zn and increased yields at high Zn levels but this effect was slight at high plant-population levels. There was a positive interaction between Zn, B, and plant population. Phosphorus uptake was reduced at high population rates and by high Zn rates. Boron increased P uptake at low Zn levels but decreased it at high Zn levels. Boron uptake was decreased by Zn except at high levels of B and plant population. Zinc uptake was increased by Zn application but depressed by P and B.

179 Effect of Biuret in Urea on the Germination and Growth of Wheat, Maize, and Cotton. T. M. Choudhry and M. A. Khan (Agr. Res. Inst., Tandojam, Pakistan). *J. Agr. Res. (Lahore) 9* (2), 148-50 (1971) (Eng). *CA 77*, 150935. To determine the toxicity of biuret to wheat, cotton, and maize, a series of pot experiments was conducted during 1968-69, using different levels of biuret. Since biuret incorporated into the soil had no detrimental effect on germination and growth of wheat when applied at the 5% level, tests were made with urea containing up to 8% biuret; similar results were obtained with maize. Urea, NH_4NO_3, or urea at the lower rates and mixed with the soil had no bad effect in most of the tests on wheat; for higher rates of application, it was recommended that split applications of N be applied. Germination of cotton was not affected, even up to 10% biuret in the urea when broadcast and thoroughly mixed into the soil. When biuret was drilled along with the seed, however, germination was seriously affected. After irrigation, however, and reseeding the seed in the same field, germination was normal and the growth was better than that of the control.

180 Effect of Plant Population and Phosphorus Fertilization on Grain Yield and Plant Composition of Spring Maize. Muhammad Hanif, M. A. Mian, and Shah Mohammad (Dept. Soil Sci., W. Pak. Agr. Univ., Lyallpur, Pakistan). *Pak. J. Sci. Res. 21* (3-4), 73-5 (1969) (Eng). *CA 75*, 97759. A factorial experiment was conducted with 3 plant populations of 16,000, 24,000, and 32,000 plants/acre and P rates of 0, 20, 40, and 60 lb/acre. Of the 3, the 24,000 population was the optimum level for grain and total dry matter yield. Grain yield showed a poor response to applied P while total dry matter increased significantly only at the 60 lb rate. Added P increased P percentage and uptake by the crop while different plant stands showed a nonsignificant effect on these plant characters. Phosphorus fertilization and plant population did not show any significant effect on protein, Ca + Mg, and ash contents of maize plants or grain.

181 Effect of Biuret Content of Urea on the Germination and Growth of Maize. I. Haque, H. M. Bhatti, and M. Bashir (W. Pak. Agr. Univ., Lyallpur, Pakistan). *Pak. J. Soil Sci. 6* (1), 21-30 (1970). *Soils Fert. 35*, 2544. In pot experiments on a clay loam soil, maize was fertilized with 200 lb/acre reagent grade urea and urea containing 0.5-5.0% biuret placed in contact with the seed or 1 in. from the seed or incorporated into the top 2 in. of soil. Urea was also applied in the irrigation water when the plants were 6-18 in. high. Emergence was significantly reduced by urea containing more than 1.5% biuret and placement in direct contact with the seed reduced emergence with both reagent grade urea and urea + biuret treatments. Urea containing biuret also delayed emergence and increased plant mortality after emergence. No seedlings survived after urea containing 5% biuret was placed in direct contact with them. Biuret applied in irrigation water after the plants attained a height of 6 in. had no effect on growth. Dry matter yields at the tasseling stage were reduced by 18, 40, and 63% by 1.5, 2.5, and 3.5% biuret, respectively, applied in direct contact with the seed. 1.5% biuret did not significantly reduce yields when placed 1 in. from the seed or when incorporated into the top 2 in. of soil.

182 Effect of Nitrogen and Potassium Fertilizers on Leaf Composition and Yield of Maize. M. T. Saleem and Ali Gohar (Soil Fert. Soil Test. Inst., Dept. Agr., Lahore, Pakistan). *Pak. J. Sci. Res. 22* (3-4), 145-50 (1970) (Eng). *CA 77*, 47276. The effect of N and K fertilizers on leaf composition and yield of maize was studied at 3 sites. Leaf contents decreased with the development of the plants and, especially N and K contents, were inversely related to plant growth. The fertilizer applications were significantly reflected in leaf composition; the N application also increased the K contents. Moreover, a significant N-K interaction was observed on K contents of the leaves. Also, the initial levels of soil P and K were reflected in leaf composition. The yield results indicated response to N alone.

JAPAN

183 Photosynthetic Rate of Leaves. III. Effect of Potassium Status on the Photosynthetic Rate in Corn Plants. Akira Tanaka and Tetsuo Hara (Hokkaido Univ., Sapporo, Japan). *Nippon Dojo-Hiryogaku Zasshi 43* (4), 132-6 (1972) (Japan). *CA 77*, 47247. Corn plants were cultured in water at 6 K concentrations, and photosynthetic ability of the leaves was studied. Growth increased with increasing K up to 150 ppm, and decreased at 500 ppm. At 0-5 ppm of K, the plant had signs of K deficiency, plant height was lowered, and leaves were chlorotic; soluble N compounds accumulated in the leaves and chlorophyll and protein decreased. With leaves in the same position and age, photosynthesis increased in the plants with K ranging 0-50 ppm, and did not change in plants containing > 50 ppm of K; growth was not hindered even at 500 ppm K. With young leaves, photosynthesis increased with increasing K in the leaves up to 1%, weakly increased in the range, 1.0-1.5% K, and little changed at > 1.5% K. Photosynthesis decreased with aging of leaves, and it was less than in young leaves containing the same amount of K. Respiration was correlated with photosynthesis, but not to K nutrition, leaf position, or leaf age.

TURKEY

184 Effects of Various Forms of Sulfur Applied in Different Rates and Times on the Growth of Corn. Burhan Kacar (Fac. Agr., Univ. Ankara, Turkey). *Yearb. Fac. Agr., Univ. Ankara 10*, 20-40 (1970) (Eng). *CA 78*, 42176. In pot experiments, S in 3 sizes (8-mesh, 0.05-0.10 mm, and powdered) was added to a sandy loam soil at rates of 10, 20, 40, and 80 ppm, N and P were also added. Corn was harvested after 2 and 6 weeks. Pots were incubated at field capacity at 26°. Incubation had highly significant effects on crop yield, S yield, and percentage S. Different rates and forms of S had highly significant effects on S yield and concentration in both harvests. The experimental soil was deficient in S. There was a highly significant correlation between total S yield of plants at both harvests and rates of application of 8-mesh and 0.05-0.10 mm S sizes. Uptake from 0.05-0.1 mm S, higher than that from 8-mesh S, showed a curvilinear relation with rates of application; uptake from powdered S was 4 times higher, showing the importance of particle size of S. The various forms of S and incubations had highly significant effects on S utilization by the 6-week-old corn.

EUROPE

ALBANIA

185 Influence of Manganous Sulfate on Beet and Maize Crops. Edibe Ohri. *Bul. Shkencave Bujqesore 4*, 81-92 (1971) (Albanian). *CA 77*, 150929. $MnSO_4$ applied before plowing improved the yield of sugar beet and corn on neutral to slightly alkaline soils (pH 6.8-7.4, 0.11-0.12% N, 0.68-1.49 mg P_2O_5/100 g) having a low carbonate and humus content; Mn spraying during plant growth was not effective.

BELGIUM

186 Effect of Copper-Zinc Interaction on the Weight Development of Corn. J. P. Delhaye, M. V. Homes, and G. Van Schoor (Univ. Bruxelles, Belgium). *Atti Simp. Int. Agrochim. 9*, 391-5 (1972) (Fr). *CA 79*, 135862. A regression curve characterizing corn yield in relation to Cu:Zn ratios in the nutrient solution was established. The curve shows the same pattern as does the interaction curve for 2 major nutrients. The results extend the theory of balanced macroelement nutrition of M. Homes and G. Van Schoor to trace element nutrition.

BULGARIA

187 Effect of Magnesium Fertilizer on Wheat and Corn Grown on Forest Soils. Ivanka Buchvarova (N. Pushkarov Inst. Soil Sci., Sofia, Bulgaria). *Pochvozn. Agrokhim. 8* (1), 111-18 (1973) (Bulg). *CA 79*, 125218. Magnesium application caused the highest increase in corn and wheat yields on N-P-K-treated podzolized cinnamonic-forest and gray-forest soils when CaO was also given.

188 The Timing and Placement of Ammonium Nitrate for Maize. D. Ilkov (Inst. Soil Sci., N. Pushkarov, Sofia, Bulgaria). *Pochvozn. Agrokhim. 6* (4), 51-60 (1971) (Bulg). *Soils Fert. 35*, 1634. A review with 13 references on research in Bulgaria from 1960 onwards is given. On heavy soils with favorable sorptive properties (leached smonitsa, leached cinnamon forest soil, leached chernozem, dark grey forest soil) the time of application did not affect maize yields within the period from deep plowing to first hoeing. Under these conditions, at rates of up to 100 kg/ha, a single application at seed-bed preparation is recommended; at higher rates, ½ should be applied at deep plowing and ½ before sowing (the effectiveness of N applied later is reduced because of summer drought). With lighter soils, NH_4NO_3 should be applied before seed-bed preparation and as one or two dressings, because there is a risk of N leaching owing to poor sorptive capacity of the soil.

189 Reciprocal Action Between Mineral and Organic Fertilization in Simultaneous Application. D. Ilkov *et al* (Pushkarov-Inst. Soil Res., Sofia, Bulgaria). *Int. Z. Landwirt. 4*, 407-14 (1971) (Ger). *CA 76*, 84809. In 4-year field experiments carried out on various soils, the combined influence of organic and mineral fertilization and additional irrigation on the corn yield was investigated. Without irrigation the used annual fertilizer rates were: manure 0-50 tons/ha, N 0-120, P 0-120, and K 0-60 kg/ha. With additional irrigation higher amounts of fertilizers were also used. The efficiency of mineral fertilization was reduced by increased organic fertilization. This was more pronounced on light soils and almost insignificant on irrigated heavy soils. The effect of manure increased with increasing amounts of mineral fertilizers. The contents of total C and humic acids as well as the pH were highest, when organic fertilization, especially combined with additional irrigation, was used.

190 Leaf Spraying of Maize Grown for Silage with Urea. A. Khristozov and I. Dobreva (Inst. po Zhivotnov dstvo, Stara Zagora, Bulgaria). *Pochvozn. Agrokhim. 7* (3), 101-9 (1972) (Bulg). *Soils Fert. 35*, 5423. Foliar application of urea at concentrations of 2 or 4% at a rate of 1000:1 of solution/ha increased the fresh weight and dry-matter yield, but concentrations of 6% or more decreased the yields. The ratio of crude protein to fresh weight increased with increasing urea concentration. The growth stage at which spraying was carried out affected both crude protein content and yield. Spraying favorably affected the coefficient of digestibility and amounts of digestible nutrients in the silage. The digestible protein content/kg silage increased in the range 8.6 to 29.6% depending on the stage of harvesting.

191 A Study on the Effect of the Levels of Nitrogen with Macro and Micro Elements on the Nitrate Content of Maize Grown for Silage and of Lettuce in Pot Experiments. N. Mitreva (Inst. Soil Sci., N. Pushkarov, Sofia, Bulgaria). *Dokl. Akad. Sel'skokhoz. Nauk Bolg. 4* (4), 433-8 (1971) (Eng). *Soils Fert. 35*, 3467. In pot experiments with maize on leached cinnamon forest soil of low fertility, the toxic NO_3^- content for ruminants (0.77%) was reached with an application rate of 500 mg N/kg soil. In lettuce the increases in NO_3^- at this N rate were 2 or 3 times greater than in maize, but different dates of culture prevented a direct comparison. Gramoxone application in conjunction with N helped to reduce the effect of the latter on the N content of maize but with lettuce the effect of Gramoxone was inconsistent.

192 The Water Consumption of Maize as Influenced by Density of Growth and Level of Fertilizing. G. Nikolov (Cotton Res. Inst., Chirpan, Bulgaria). *Rast. Nauki 9* (4), 69-82 (1972) (Bulg). *Soils Fert. 35*, 5417. A 4-yr field experiment was conducted involving irrigated maize on leached chernozem-smolnitza soil. Increasing the density from 32,000 to 58,000 plants/ha increased yields and the water consumption by about 4.5%, but decreased the consumption/unit photosynthetic area. Doubling the N, P, and K fertilizer rates to 200, 160, and 80 kg/ha, respectively, increased yields and the water consumption by about 5%, but did not affect the consumption per unit photosynthetic area. Row spacing (70 or 90 cm) did not affect water consumption. Irrigation and rainfall each supplied about 37% of the water requirement which was 523 mm with 44,000 plants/ha and the higher fertilizer rate.

CZECHOSLOVAKIA

193 Band Fertilizing of Corn. Jan Bizik, Viera Galova, and Emilia Veresova (Vys. Sk. Pol'nohospod., Nitra, Czechoslovakia). *Agrochemia 11* (8), 243-6 (1971) (Slovak). *CA 75*, 128862. In pot experiments with fertilizer banding, the initial growth of corn was markedly influenced, the dry matter production and N, P, and K uptake were high, P and K migration from the bands was minimal, and osmotic pressure of the soil solution rose only in the proximity of the bands. In

field trials, band application of fertilizers increased the grain yield by 3.5-7.8 q/ha. Of the total fertilizer rates, 1/3 of N, 2/3 of P, and 1/3 of K were band-applied; the remaining amounts were broadcasted. Corn-growth rates, contents of N, P_2O_5, K_2O, CaO, and MgO in the plant and the osmotic pressure and N, P, K, and Ca contents in the soil solutions were determined.

194 Influence of Increased Rates of N on Quality Changes of Fodder and Silage Maize During Its Period of Growth and Development. J. Dobrovodsky (Maize Res. Inst., Trnava, Czechoslovakia). *Ved. Pr. Vysk. Ust. Kuk. Trnave 4*, 183-95 (1969) (Slovak). *Field Crop Abstr. 23*, 3221. In field trials at Trnava in 1964-66, maize hybrid LSP Ms (Lednice Medium Late) was sown at densities of (a) 57,000 or (b) 200-280,000 plants/ha for silage or fodder production, respectively, and was given 0, 100, 150, or 200 kg N/ha. In 1964 (below-average rainfall) increase in N decreased DM yield, but in 1965 and 1966 (above-average rainfall) N at up to 100-150 kg/ha increased DM yield. Dry matter yields were higher in (b) than in (a) up to tasseling, but DM production in (b) decreased so that at the dough stage DM yields were higher in (a) than in (b).

195 Relations Between the Changes of Osmotic Potential of Soil Solutions and the Sap of Cells of Corn and Wheat Under the Effect of Fertilizing with Increased Doses of Fertilizers. Jan Hampl and Jan Bizik (Univ. Agr., Nitra, Czechoslovakia). *Pol'nohospodarstvo 16* (4), 310-20 (1970) (Slovak). *CA 74*, 22223. Wheat and corn were grown in pots containing brown loess and sandy loam soils with various levels of fertilizers. Significant correlation was observed between osmotic potentials of soil solutions and those of cell sap, which linearly increased with increased osmotic potentials of soil solutions. The osmotic potentials of wheat cell sap averaged 4.2 atm higher than those of corn, and the wheat was significantly more resistant to increased soil osmotic potential. Changes in osmotic potential of cell sap were caused mainly by K^+ and Cl^-. The proportion of Ca^{2+}, K^+, and Na^+ to Cl^- originally with a higher content of cations was decreased to values close to 1 under the influence of increased levels of fertilizers, especially with the Cl^- form of K. With the osmotic potential of soil solution at 3-4 atm (determined from soil saturated to its full water capacity) or 6-8 atm (determined according to Bizik), germination, growth, and development were inhibited and the formation of dry matter of corn and wheat decreased to ~ 50%. The sorption capacity of soil was primarily responsible for changes in the concentration of soil solution, in addition to the doses of fertilizers applied and the content of water in the soil. The complex fertilizers NPK-2 and NPK-B gave significantly greater production of dry matter as compared with equivalent amounts of single fertilizers due to the lower content of balast substances and a decrease of osmotic potential of the soil solution as compared with simple fertilizers.

196 Assimilation of Nitrogen by Maize Roots and the Transport of Some Major Nitrogen Compounds by Xylem Sap. I. Nitrate and Ammonia Uptake and Assimilation in the Major Nitrogen Fractions of Nitrogen-Starved Maize Roots. Stefan Ivanko and J. Ingversen (Dept. Radiobiol. Biochem., Univ. Agr., Nitra, Czechoslovakia). *Physiol. Plant. 24* (1), 59-65 (1971) (Eng). *CA 74*, 124235. Corn (*Zea mays* variety dentiformis) was grown in a Knop nutrient solution for 15 days. A part of the plants was then transferred to a N-deficient solution, and after 5 days the starved plants were divided into 3 groups grown on solutions containing (1) no N (P-K variant), (2) P-K-NH_4^+, and (3) P-K-NO_3^-. The unstarved plants (N-P-K variant) were supplied with a new nutrient solution. All supplied N contained ^{15}N excess. The plants were decapitated and plastic tubes were fitted on the stumps. Root samples were taken for analysis 6 and 24 hr from the start of exudation and the major N compounds were determined. Nitrogen-starved corn roots were capable of accumulating a potential capacity for N uptake. Reestablishment of N supply led to intense uptake which reached 154% of the reference (N-P-K) variant level after 24 hr when NO_3^- was supplied, and 121% when NH_4^+ was given. After 24 hr the insoluble N fraction accounted for 80, 54, and 55% of total N taken up in the PK + NO_3^-, PK + NH_4^+, and NPK (unstarved) variants, respectively.

197 Nutrient Uptake by Silage Corn Grown in Monoculture and in Crop Rotation. N. Petrickova (Univ. Agr., Brno, Czechoslovakia). *Rostl. Vyroba 18* (11), 1117-22 (1972) (Czech). *CA 78*, 158273. On a degraded chernozem soil, less N, P, Mg, Ca, and Na were absorbed by silage corn grown in monoculture than by rotated corn. Only the K uptake by corn grown in monoculture was higher than that by corn grown in a crop rotation. Manure and N-P-K fertilization caused an increased uptake of N which resulted in widening the ratio between N and other nutrients in the plant; this may indicate a relative insufficiency of some other elements. All plant N-other nutrient ratios, except the N:P ratio, were wider in corn grown in monoculture than in that grown in a crop rotation. Rotated silage corn gave the highest yields; N-P-K fertilization was more effective than application of manure alone.

198 Agronomic Efficiency of a Method of Fertilizing Maize. E. Spaldon and I. Zuzi (Univ. Agr., Nitra, Czechoslovakia). *Pol'nohospodarstvo 18* (1), 3-13 (1972) (Czech). *Soils Fert. 35*, 3465. Responses were greater when ½ the N and ¾ of the P were applied to the seedbed, the balance being applied later and preferably worked deeply into the soil.

199 Effect of Fertilization on Grain Production of Different Maize Hybrids. J. Truska (Maize Res. Inst., Trnava, Czechoslovakia). *Ved. Pr. Vysk. Ust. Kuk Trnave 4*, 143-56 (1969) (Slovak). *Field Crop Abstr. 23*, 3230. In three field trials in 1965-67, six maize hybrids were sown at different spacings and given different rates of NPK and f.y.m. and the responses of the crop and a following unfertilized crop were studied. Grain yields were increased by NPK in the treatment year in some hybrids, but in others there was a residual effect on the second crop. The yield of the early hybrid CR (Cejac Early) was increased more by f.y.m. than that of the late hybrid LSP Ms (Lednice Medium Late). Early hybrids gave a better response to sowing at close spacing than late hybrids.

200 Effect of Fertilizers in the First and in the Second Year of Successive Cultivation of Maize. J. Truska (Maize Res. Inst., Trnava, Czechoslovakia). *Ved. Pr. Vysk. Ust. Kuk. Trnave 4*, 157-68 (1969) (Slovak). *Field Crop Abstr. 23*, 3210. In four field trials in 1965-67 at Trnava and Michaloviec, two successive crops of the maize hybrid LSP Ms (Lednice Medium Late) were given 25 rates of f.y.m. and different forms of NPK, alone or in combination, mostly in the first yr only. Yields were increased by fertilizers in the treatment year if climatic conditions were favorable for growth, but if conditions were unfavorable the yield increase was given in the second yr. There was a suggestion that slow-acting forms of N had a higher residual effect than fast-acting forms.

201 The Effect of Some Nutritive Substances on Maize in Many-Year Planting. J. Truska (Maize Res. Inst., Trnava, Czechoslovakia). *Agrochemia, Bratislava 10* (3), 68-71 (1970) (Slovak). *Field Crop Abstr. 23*, 3218. In a field trial at three sites in Slovakia in 1965-68 in which continuously-cropped maize was given combinations of 100 kg N/ha, 60 kg P_2O_5/ha, 100 kg K_2O/ha and 25 tons f.y.m./ha, the highest yields of grain and stover were given by applications of NK.

202 Productiveness of Crop Rotations with Different Representation of Maize Grown for Grain and for Silage Under the Conditions of Intensive Fertilization. J. Zaborsky and J. Truska (Maize Res. Inst., Trnava, Czechoslovakia). *Ved. Pr. Vysk. Ust. Kuk. Trnave 4*, 131-41 (1969) (Slovak). *Field Crop Abstr. 23*, 3193. In a field trial at Trnava in 1965-67 maize was grown for grain or for silage in two 6-yr rotations (lucerne/lucerne/maize/winter wheat/sugar beet/spring barley and lucerne/lucerne/winter wheat/maize/maize/spring barley) given an average of 200 kg NPK (10:9:12)/ha annually. SE yields of grain and silage maize equaled those of sugar beet roots, but it was concluded that the yield of the sugar beet tops should also be taken into account.

FRANCE

203 Effect of Several Factors on the Fixation and Migration of ^{42}Potassium Applied to Maize Leaves. A. Chamel (Pl. Biol. Lab., Cent. Nucl. Stud., Grenoble, France). *Potash Review 3* (43), 7 pp. (1972). *Soils Fert. 35*, 5418. Fixation of ^{42}K from KNO_3 solution applied to leaves of 15-76 day-old maize plants growing in nutrient solution was not greatly affected by leaf age but movement of ^{42}K from the zone of application showed progressive differences according to the stage of development. The greater part of the fixed ^{42}K remained in the treated leaf-blade but the mobile ^{42}K moved rapidly and was present throughout the plant 1 hr after application. Potassium deficiency in the nutrient solution had no significant effect on the fixation of applied ^{42}K but movement of K decreased in K-deficient plants. Migration of ^{42}K from the treated leaf-blade was greatly reduced at 4°C and increased with temperature up to 30°C. Root temperature also affected fixation of ^{42}K but much less clearly than migration.

204 Comparative Effects of Irrigation and Nitrogen Fertilizer on Qualitative and Quantitative Yields of Different Maize Varieties. I. Grain Yields. J. Decau (Sta. Agron. Oenol., INRA, 31-Toulouse, France). *Ann. Agron. 21*, 335-49 (1970) (Fr). *Soils Fert. 34*, 3323. In a factorial experiment testing a maize variety under dry or irrigated conditions with N fertilizer at 0, 50, 150, and 300 kg/ha, irrigation with or without N increased the mineralization of soil N or its utilization by the plant. Nitrogen fertilizer with or without irrigation was optimal at 200-220 kg/ha. The cumulative effect of fertilizer N + irrigation doubled yields. The effect of N fertilizer was due only to increased uptake of N by the plant, but the action of irrigation was more complex, partly through N and partly through specific effects. Nitrogen increased the number of grains per ear while irrigation increased both the number of grains per ear and the weight of individual grains, and also the number of ears per plant. Effects due to variety as opposed to those resulting from ecological and cultural differences are discussed with reference to experiments with two other maize varieties.

205 Influence of Nitrogen Fertilization and Irrigation on Yield and Protein Production in Maize Grain With and Without the Opaque-2 Gene. J. Decau and M. Pollacsek (Sta. Agron., Inst. Natl. Rech. Agron., Toulouse, France). *Impr. Plant Protein Nucl. Tech., Proc. Symp. 1970*, 357-66IAEA: Vienna, Austria. *CA 75*, 97782. A hybrid maize (corn) with the opaque-2 gene, which increases the lysine content of the grain, and a normal variety were compared. Irrigation and 0, 100, 200, and 300 kg N/ha were applied. The normal maize produced higher grain yields from 15% under normal treatment to 50% under the best fertilization and irrigation conditions than the hybrid corn. There was a similar but smaller divergence (30%) between the crude protein production of the two varieties. The zeine content of the normal grain was 1.8-2.8-fold that of the mutant and increased by 50% under high N fertilization, while it increased hardly in the mutants. Independently of the N fertilization and irrigation the glutelin/(nonprotein N + albumin + globulin) quotient was highest in the normal maize. The lysine content of the mutant was about 1.5-fold that of the normal variety and increase with N fertilization, whereas in the normal variety its content was decreased by high N rates.

206 Premature Germination in Immature Grains of Maize. Preliminary Results. W. Routchenko, J. P. Soyer, and R. Chignon (Sta. Agron., Cent. Rech. Bordeaux, Pont-de-la-Maye, France). *Ann. Agron. 22* (2), 241-55 (1971) (Fr). *CA 75*, 128863. Some varieties of maize (corn) are genetically inclined to premature germination. The grains of these varieties are very rich in K, poor in Fe, very poor in Mn, and their ability to reduce NO_3^- is low. Premature germination can be largely avoided by fertilizing with P and a mixture of trace elements. Zinc and Cu are ineffective when added alone. Germination of immature grains is caused probably by a genetic factor and by disturbances in Fe and Mn, and probably also in Mo and Co nutrition.

WEST GERMANY

207 Nitrogen Fertilization and Protein Production in Corn. G. Geisler (Inst. Pflanzenbau Pflanzenzuecht., Christian-Albrechts-Univ. Kiel, Germany). *Landwirt. Forsch., Sonderh. 28* (2), 260-3 (1973) (Ger). *CA 80*, 107214. The highest yield of corn-plant dry matter was obtained when 100-200 kg N/ha was applied; such a dry matter yield was also obtained when 100 kg N/ha was applied in one dose at the knee-high growth stage of the plants. Grain and protein yields were increased only when high N rates (200 kg/ha) were applied; late N fertilization at the knee-high stage was especially effective in increasing the yield of corn grain. High fertilizer rates (200-300 kg N/ha) and late N application (at the knee-high stage) increased the protein content of the grain significantly. At all N rates and application times, significant positive correlations between grain and protein yields were found. The correlations between grain yields and protein contents or between protein yields and protein contents were negative for low and early N fertilization and positive for high N rates and late fertilization.

208 Agronomic Investigations on the Application of NH_3 as Nitrogen Fertilizer to Maize. G. Geisler and H. Gutzmann (Univ. Hohenheim, Stuttgart, Germany). *Z. Acker-Pflanzenbau 131*, 226-32 (1970) (Ger). *Soils Fert. 33*, 4861. The effects of NH_3 and calcium ammonium nitrate were compared in 4-yr field trials, involving applications of 150 kg N/ha either (a) before sowing or (b) to a knee-high stand or (c) split into 20 + 130 kg between these two dates. There was no difference between the N sources at (a), but calcium ammo-

nium nitrate was preferable to NH_3 at (b); late dressings, as compared to application at sowing, tended to depress yields under very dry and warm conditions unless split application (c) was followed.

209 Zinc Uptake in Water Culture by Corn in Relation to Phosphorus Content and pH Value of the Nutrient Solution. W. Hoefner and I. Kovanci (Inst. Pflanzenernaehrung, Justus Liebig-Univ., Giessen, Germany). *Phosphorsaeure 30* (1), 9-26 (1973) (Ger). *CA 80*, 94589. The uptake of Zn by corn from $ZnCl_2$ was higher than that from $Zn_2P_2O_7$ at both pH values (5 and 7) of the nutrient solution. Zinc deficiency could not be observed even in plants without Zn fertilization. Increasing P rates up to 8 mmole P/l. did not cause a decrease in Zn content of the plants at both values. The solubility of both Zn compounds in the nutrient solution was lower at the high than at the low pH value, but despite that at the end of the experiment there was still ~ 0.1 ppm Zn found in the solution at pH 6.8.

210 The Effect of Soil Moisture Upon the Availability of Potassium and Its Influence on the Growth of Young Maize Plants (*Zea mays* L.). K. Mengel and L. C. Von Braunschweig (Landwirtschaftliche Forschungsanstalt Buntehof, Hannover, Germany). *Soil Sci. 114* (2), 142-8 (1972) (Eng). *Soils Fert. 36*, 700. Plants were grown with a split root system so that half the roots were in contact with a nutrient solution and the other half in contact with soil maintained at different pF values and providing the only K source. Maximum growth was observed at a pF value of 2. Potassium deficiency symptoms were apparent only at 7.5 and 11.0 mg exchangeable K/100 g soil at pF 2.7 eight days after transplanting, but disappeared after 2-3 days. A highly significant linear relationship was obtained between the K diffusion rates and the total K uptake of the plants.

HUNGARY

211 Uptake and Distribution of Nitrogen by Means of ^{15}Nitrogen-Labeled Fertilizer. Mrs. T. Bartfai *et al* (Talajtani Agrokem. Kut. Intez., Mogy. Tud. Akad., Budapest, Hungary). *Izotoptechnika 14* (10), 452-7 (1971) (Hung). *CA 77*, 60723. The path of the reactive part of an N-containing fertilizer during the growing season, and its role in protein synthesis were studied by using NH_4NO_3 labeled with ^{15}N. The experiments were carried out on loess soil with corn. The N content of the leaf decreases during growth, but it does not change in the stem. In protein synthesis, the important factors are ammonia and amide N. In the initial development stage there is a large accumulation of amides, whose content decreases after protein synthesis. Maximum and minimum N concentrations in the various plant parts are given for different development phases. The total N concentration of the plant is maximum during flowering; it then decreases or remains unchanged.

212 Yearly Seasonal Dynamics of the Soluble Phosphorus Content of the Soil and Slow-Release Phosphorus Fertilization on the Sandy Soil Between the Danube and Jisza Rivers (Hungary). Imre Cserni (Zoldsegtermesztesi Kut. Intez., Kecskemet, Hungary). *Agrartud. Kozlem. 30* (4), 511-14 (1971) (Hung). *CA 79*, 30888. Under a corn monoculture nonfertilized with P, soil-available P content decreased steadily with time. Continuous application of 90 kg P_2O_5/ha caused an increase in content of soil available P. The P content of the soil decreased during corn growth from spring to the blossoming time, then increased again. Similar effects on content of soil-available P were observed also in wheat monocultures. A content of 4-6 mg available P_2O_5/100 g soil indicates P reserves sufficient for 1-2 years of cereal cultivation without P application.

213 Effect of Irrigation and Fertilization on the Yield of Some Crops and on Their Nutrient Uptake. B. Debreczeni (Univ. Agr. Sci., Godollo, Hungary). *Agrokhimiya 11*, 58-62 (1972) (Russ). *CA 78*, 70669. Interrelations between irrigation and fertilization were studied on solonetz-meadow, brown-forest and sandy meadow chernozem soils in field experiments with corn, winter wheat and sugar beets and in pot experiments with oats. Nitrogen fertilization had the highest effect on corn and winter wheat yields, whereas P-K and N-P-K application gave the highest sugar beet yield increase. The effect of irrigation on corn yield was not dependent on the fertilizer form and rate, but combined irrigation and N fertilization increased the N and P uptake by corn. Combined irrigation and N fertilization gave the highest yield increase of winter wheat (19% without and 36% with irrigation). Nitrogen fertilization increased highly the nutrient uptake by wheat, the relative nutrient uptake increase being higher than the yield increase.

214 Influence of Different Top Soil Moistures on Nitrogen and Phosphorus Uptake by Maize. J. Dombovari (Res. Inst. Irrig., Szarvas, Hungary). *Acta Agron. (Budapest) 22* (1-2), 95-8 (1973) (Eng). *CA 79*, 135815. Increased soil moisture levels increased the N content of the plant but had small effect on the P content of the plant. The effect of soil moisture on the N and P percentage derived from the added fertilizer was significant. Further, the soil moisture content had no significant influence on the labeled N uptake from the solution but the P uptake increased with decreasing soil moisture level. This experiment has also proved that the nutrients uptake by a plant takes place when adequate water supply is present around the root system.

215 Trials with Maize on the Method and Time of Nitrogen Application. T. A. Hussien (Agr. Res. Inst., Nyiregyhaza, Hungary). *Novenytermeles 18* (3), 69-74 (1969) (Hung). *Soils Fert. 33*, 4859. In one experimental year out of three on calcareous loam (pH 7.6), application of calcium ammonium nitrate (Pet salt) at 100 kg N/ha at the time of sowing was superior to row application or to foliar spraying with urea. Foliar sprays of 1% Pet salt solution injured leaves and depressed yields, and foliar sprays of 1% urea solution did not produce significant yield increases.

216 Foliar Application of Trace Elements in a Field Experiment on a Peat Soil in the Surroundings of Enying (Hungary). Laszlo Landy *et al* (Inst. Nucl. Res., Hung. Acad. Sci., Debrecen, Hungary). *Agrokem. Talajtan 21* (1-2), 193-6 (1972) (Hung). *CA 77*, 150913. Trace element deficiency in a peat soil can be corrected in corn by foliar application of trace elements. At least three applications of a solution containing 0.25% Fe, 0.25% Mn, and 0.10% Cu, respectively, or higher concentrations are needed.

217 Ammonium and Nitrate-Nitrogen Uptake of Young Maize Plants Studied by ^{15}Nitrogen Isotopic Labeling. Irene Latkovics and Gyula Varga (Res. Inst. Soil Sci. Agr. Chem., Hung. Acad. Sci., Budapest, Hungary). *Agrokem. Talajtan 20* (4), 559-65 (1971) (Hung). *CA 77*, 74164. The N uptake from labeled NH_4NO_3 (both NH_4 and NO_3) by 3-week-old corn plants on 7 various soil types was studied. The plants took up

considerably more ammonium- than nitrate-N on sand, sandy brown forest soil, and on two types of salt-affected soils, whereas on an acid brown forest soil, and brown forest soil with a clay illuvial horizon the reverse was observed. No difference in uptake from both N sources was observed on chernozem soils. Plants utilizing mainly ammonium-N took up less fertilizer N than those utilizing nitrate-N mainly.

218 Effect of Irrigation and Fertilizing on the Protein and Other Nutrient Contents of Maize. Jozsef Molnar, Bela Debreczeni, and Gyorgyi Baskay (Univ. Agr., Godollo, Hungary). *Agrartud. Egyet. Kozlem. 1*, 303-13 (1971) (Hung). *CA 79*, 90958. Irrigation decreased whereas fertilization increased the crude protein content of maize. To obtain maximum protein yield, irrigation must be combined with simultaneous fertilization. Irrigation increased the lysine and arginine and decreased the leucine contents of corn protein; fertilizing caused a decrease in lysine and arginine but an increase in leucine content. Irrigation increased the fat and fiber content; fertilizing decreased the content of these plant constituents.

219 Effect of Increasing Doses of Phosphorus Fertilizers on the Yield and on the Manganese, Zinc, and Copper Content of the Corn Grown on Sandy Soils in the Region Between the Tisza and the Danube. Karoly Prohaszka and Imre Cserni (Agr. Res. Inst., Kecskemet, Hungary). *Novenytermeles 18* (3), 75-81 (1969) (Hung). *CA 72*, 54273. The effect of increasing P fertilizer dressings on the Mn, Zn, and Cu content of corn grains was studied. Increased P increased the N and P_2O_5 of the corn. The K_2O content showed no measurable increase. Manganese increased, Zn decreased, and Cu did not change.

220 Fertilizer Effect on Nutrient Changes in Leaf and Grain of Maize. Karoly Prohaszka and Gyula Gurabi (Spec. Serv. Sta. State Farms Cty. Bacs, Res. Inst. Veg. Grow., Kecskemet, Hungary). *Novenytermeles 21* (4), 339-48 (1972) (Hung). *CA 78*, 134988. The effect of fertilization on the nutrient content of leaves located opposite the ear and of grain was studied. Leaf samples were taken at the time of flowering and grain samples at ripening. Fertilization had a greater effect on the nutrient content of leaves than on that of the grain. Manganese and Cu reserves in corn increased after increased N, P, and K applications. Increasing the N level in fertilizers to that of P and K increased the plant contents of Mn, Zn, and Cu, but decreased those of Fe and B. An increase in P level decreased the Zn and B contents in leaves and increased the Fe concentration. Increases in K levels increased the Fe content of corn leaves only. There were positive correlations between the N content of the leaves and the yield and between the Mn content of the leaves and yield. The trace element content was affected by increasing applications of N-P-K; that of Fe increased and that of Zn decreased.

221 Problems of Development and Utilization of Fertilizers. Janos Sarkadi (MTA Talajtani Agrokem. Kutato Int., Budapest, Hungary). *Agrartud. Kozlem. 28* (1-2), 177-82 (1969) (Hung). *CA 72*, 54186. Nitrogen application has the greatest effect on wheat and corn yield. Phosphorus and K may be applied in one dose to last for 3-4 yr, but N fertilization must be carried out each year, primarily as a result of NH_3 losses. Urea can be used for both acid and alkaline soils. The soluble N content changes with climatic conditions and other factors.

222 Effect of Mineral Nitrogen Fertilizer on Nutrient Uptake by Maize. V. Szirtes (Mezog. Kiserl. Int., Karcag, Hungary). *Novenytermeles 19*, 373-84 (1970) (Hung). *Soils Fert. 34*, 4239. In outdoor experiments using pots filled with a chernozem (pH 7.15 and 3.6% humus in the top 20 cm), application of 140-560 kg N/ha caused a linear increase in the N and Ca contents of maize seedlings, and a linear decrease in K and Cl concentrations. Of the nutrients taken up by the crops, 79% of the P, 65.4% of the N, 20% of the K, 5.9% of the Cl, and 1.2% of the Ca were recovered in the grain. The importance of properly balanced fertilizing is stressed (ratio of N:P:K:Ca uptake averaging 1:0.29-0.32:0.88-1:0.41-0.45).

223 Effect of Phosphorus Fertilizing on Nutrient Uptake by Maize. V. Szirtes (Talaj. Kut. Int., Karcag, Hungary). *Novenytermeles 20* (2), 157-70 (1971) (Hung). *Soils Fert. 35*, 1626. In outdoor pot experiments with a P-deficient chernozem (pH 7.1) treated with 70-560 kg P_2O_5/ha (granular superphosphate) in the presence of 420 kg N and 280 kg K_2O or with 140-560 kg P_2O_5 in the presence of 280 kg N and 140 kg K_2O, application of P increased the uptake of N, P, and Ca and had a depressing effect on K uptake; increasing rates of up to 350 kg P_2O_5 increased the P content of the grain and increased the N contents of the plants. Increased P dressings apparently favorably affected the efficiency of the N fertilizer. Graphs showing the effects of P on nutrient uptake are presented.

224 Effect of Potassium Fertilizing on Nutrient Uptake by Maize Seedlings. V. Szirtes (Talaj. Kut. Int., Karcag, Hungary). *Novenytermeles 20*, 43-57 (1971) (Hung). *Soils Fert. 34*, 4236. In outdoor experiments using pots filled with a chernozem (pH 7.15 and 3.6% humus in the top 20 cm), application of K salt at 140-420 kg K_2O/ha caused a linear increase in K and Cl contents, and sometimes decreased N and Ca. Very high K dressings depressed grain yields at any level of N fertilizing (140-560 kg N/ha). Uptake of K was linearly correlated with that of Cl.

225 Nutrient Uptake of Maize and Effect of Fertilization of Various Soil Layers. Viktoria Szirtes (Talaj. Kut. Int., Karcag, Hungary). *Novenytermeles 20* (4), 355-68 (1972) (Hung). *CA 76*, 152544. Various layers of the humus horizon of a chernozem soil were examined for their effect on nutrient uptake and yield of corn. Potassium, N, P, and Cl^- uptake by corn plants decreased linearly with soil depth, whereas that of Ca increased linearly. In corn plants grown on the 40-60 cm soil layer, the Ca content was almost doubled, whereas the K content was only 50% of the K absorbed from the plowed layer. This can be ascribed to the very high concentration in soil solutions of the 40-60 cm layer which inhibits the K uptake by plants. Increased K fertilization did not reduce essentially the Ca uptake by plants from this soil layer. Heavy K fertilizer dressings affected corn yields unfavorably in all three soil layers. Maximum yields were obtained in the plowed layer at a N:K ratio 1:0.67, in the 20-40 cm layer at a 1:0.5 ratio, and in the 40-60 cm layer with a high Ca content at a 1:0.8 ratio.

226 Changes in the Amino Acids of Maize Grain as a Response to Nitrogen Fertilization. Imre Veress (Univ. Agr. Sci., Debrecen, Hungary). *Novenytermeles 22* (2), 125-36 (1973) (Hung). *CA 79*, 135850. The corn-grain amino acids were represented quantitatively by non-essential amino acids mainly. Of the essential amino acids, the leucine content was highest and that of tryptophan lowest. Of the non-essential amino acids, the glutamic acid and proline contents were highest and the cystine percentage content was lowest. With an increase in N rates, the amino acid content, especially that of

non-essential amino acids, increased considerably.

227 Effect of Fertilization on Changes in Composition of Corn Grain, Leaf, and Stalk. Imre Veress (Dept. Appl. Farm. Manage., Univ. Agr. Sci., Debrecen, Hungary). *Novenytermeles 21* (3), 241-54 (1972) (Hung). *CA 78*, 42175. Nitrogen, P_2O_5, and K_2O were determined in corn parts during the phenophase. In all fertilizer treatments, N accumulation was linearly related to the doses applied. Phosphate application had a positive effect on N uptake. Phosphorus uptake was positively influenced by K fertilization and the K uptake by N treatment. Potassium fertilization affected the plant growth only up to the phase of full grain ripening. Phosphorus accumulated at a low rate and other nutrients had no effect on its concentration in the grain. Potassium up to the grain-ripening stage accumulated mainly in the leaves which indicated the role the element is playing in regulating the water status of the plant; thereafter K was easily translocated from the leaves.

ITALY

228 Comparison of Liquid and Traditional Fertilizers for Maize. Raffaele Barbieri and Pasquale Tedeschi (Ist. Agron. Gen. Coltiv. Erbacee, Univ. Napoli, Italy). *Riv. Agron. 5* (4), 287-92 (1971) (Ital). *CA 77*, 47280. Liquid fertilizers had no advantage over solid ones in experiments with corn on an alluvial sandy clay soil of the Salerno district. Addition of the fertilizer at seeding gave similar or significantly better results than the application of 1/3 at seeding and 2/3 of the fertilizer when the plants were 50 cm high. Addition of superphosphate to N had almost no effect.

229 Agronomic Trials and Soil Fertility Balance on a Farm Continuously Cropped to Maize for Grain. F. Lanza *et al* (Inst. Exp. Agron., Bari, Italy). *Maydica 15* (3), 75-95 (1970) (Ital). *Soils Fert. 35*, 2504. Continuous cropping over a 5-yr period in conjunction with the use of fertilizers (560 kg N/ha + P_2O_5 K_2O at a ratio of 2:1:1) and incorporation of crop residues had no adverse effect on yields or soil fertility.

230 Possibilities and Limitations of the Monoculture of Maize for Grain. F. Lanza *et al. Ann. Ist. Sper. Agron., Bari 1* (2), 215-31 (1970) (Ital). *Soils Fert. 35*, 1636. On a well-drained lime-free sandy loam of pH 6.8, annual plowing down of the stover (10 tons/ha) and annual application of NPK at 500 kg/ha increased yields in the first 3-yr period from an annual average of 6 to 7.5-9 tons/ha; treatments resulted in positive balances of organic matter and mineral nutrients.

231 Experiment on Irrigation and Nitrogen Fertilizing of Maize for Grain. G. F. Marras. *Studi Sassar. Sez. 3, 18*, 251-69 (1970) (Ital). *Soils Fert. 34*, 5215. $(NH_4)_2SO_4$, NH_4NO_3, or urea at 120 and 240 kg N/ha was applied at sowing or was split equally between sowing, thinning of the plants, and setting of the seed to furrow-irrigated or sprinkled maize. Furrow irrigation gave a higher yield than sprinkling did. The higher rate of N was more effective than the lower rate for furrow-irrigated but not for sprinkled maize. The type of N fertilizer and its time of application did not affect yield.

THE NETHERLANDS

232 Boron and Maize. K. W. Smilde, E. Jongman and B. Van Luit (Inst. Bodemvruchtbhd, Haren-Groningen, Netherlands). *Rapp. Inst. Bodemvruchtbhd.*, No. 1, 10 pp. (1969) (Neth). Water-culture, field and pot experiments showed that the occurrence of poor cob development and grain setting on sandy soils in dry summers is due mainly to B deficiency. For plots with < 0.30 ppm B the application of 10 kg/ha borax is recommended.

POLAND

233 Effect of Nitrogen Fertilizers and Harvesting Time on Yields and Contents of Protein and Carotenes in Maize. Wincenty Balcerek (Wyzsz. Szk. Roln. Szczecin, Poland). *Zesz. Nauk. Wyzsz. Szk. Roln. Szczecinie 6* (32), 3-18 (1970) (Pol). *CA 75*, 47884. Nitrogen fertilizers applied to corn at 30, 60, and 100 kg/ha increased the plant yield up to the time of flowering and increased the protein and carotene content.

234 Response of Forage Corn Varieties to Nitrogen Fertilization. II. Content and Yield of Nitrogen Compounds, Carotene, Oil, and Fiber. Zofia Barszczak (Lab. Biochem., Inst. Hodowli Aklimatyzacji Rosl., Radzikow, Poland). *Hodowla Rosl., Aklim. Nasien. 15* (6), 541-57 (1971) (Pol). *CA 77*, 74165. The studied three corn varieties contained nitrate-N 0.016-0.024, oil 3.36-4.23, and carotenes 5.07-8.88 mg/100 g. The content of total N, protein N, nonprotein N, and fiber was similar in all varieties studied. Increased levels of N up to 300 kg/ha increased the total N by 27, protein N by 21, nonprotein N by 113, nitrate N by 314, and the carotene content by 26; it decreased the content of fiber by 8, and that of oil by 3%. At fertilizer levels 175-200 kg N/ha, the nitrate-N content was 0.03% (the limiting NO_3^- content considered as harmful was 0.07%). When the level of 300 kg N/ha was split-applied, the content of N compounds was increased by 5-16% as compared to a single, presowing application. When the corn stand was doubled (from 41,000 to 82,000 plants/ha), its content of total N decreased by ~ 10%, and that of nitrate-N by 29%.

ROMANIA

235 The Influence of Nitrogen-Phosphorus Ratio on the Quantity and Quality of Irrigated Maize Yields Grown on an Alluvial Soil from the Prut Meadow. E. Albinet *et al* (Inst. Agron. Iasi, Romania). *Probl. Agr. 12* (1), 9-19 (1970) (Rom). *Soils Fert. 33*, 4860. On a chernozemic soil highest yields were obtained with the treatment combinations $N_{128}P_{64}$, $N_{128}P_{96}$, and $N_{160}P_{96}$.

236 Efficiency of Fertilizers, Including Potassium, Applied to Maize on a Secondary Podzol Treated with Various Amounts of Lime at Horodnic, Suceava District. I. Buzdugan (Sta. Exp., Suceava, Romania). *Cerc. Agron. Moldova*, No. 2, 43-50 (1969) (Rom). *Field Crop Abstr. 23*, 3213. Applying N, P, and K at 48, 54, and 80 kg/ha and $CaCO_3$ at 10 tons/ha resulted in yields of 3305 kg maize/ha, an increase of 136% over the unfertilized control. Liming reduced the mobility of K in the soil; plant K content fell after liming.

237 Utilization of Sulfur from ^{35}Sulfur-Labeled Ammonium Sulfate and from Calcium Sulfate in Superphosphate Fertilizer by Corn. D. Davidescu *et al* (Inst. Chim. Agric., Univ. Bucarest, Romania). *Agrochimica 16* (1-2), 13-22 (1971; publ. 1972) (Eng). *CA 77*, 47275. Corn gave yields of 70-77 q/ha when fertilized with 160 kg N/ha [as $(NH_4)_2SO_4$ containing ^{35}S (183 kg S/ha), and 40 kg P/ha (as superphosphate

containing $Ca^{35}SO_4$ (54 kg S/ha)]. The total S taken up by the seeds was 8-9 kg/ha, of which 2.9 kg/ha came from the applied fertilizers. The S utilization coefficients in the seeds ranged 1.21-2.05%, and were higher than those calculated by difference. Application of S in fertilizers reduced adsorption of soil S.

238 Effect of Rotation on Yield, Utilization of Fertilizers, and the Biological Quality of Wheat and Corn Crops on Reddish Brown Forest Soil. D. Dinca *et al* (Inst. Cercet. Cereale Plante Teh., Fundulea, Romania). *Probl. Agr. 23* (9), 12-22 (1971) (Rom). *CA 76*, 45027. Yields of corn and wheat were higher in short (2-4 years) rotations on brown-reddish forest soils of Saftica (Romania) than in monocultures, especially when moderate amounts of fertilizers (N-P; 48:32 kg/ha) were applied. The amino acid, Zn, Mn, and some vitamin contents of the cereals were increased. Higher fertilizer rates (N 96 and P 64 kg/ha) in the one-crop system decreased the amino acid content in the cereals.

239 Determination with the Help of ^{15}Nitrogen of the Utilization of Nitrogen by Corn. Residual Effect of Nitrogen Fertilizer. C. Hera, G. Suteu, and M. Bologa (Res. Inst. Cereals Ind. Plants, Bucharest, Romania). *Atti Simp. Int. Agrochim. 8*, 395-410 (1971) (Fr). *CA 77*, 47341. During four successive years the uptake and utilization coefficients of N were determined in maize grown on moderate chernozem soils. $(NH_4)_2SO_4$, $CO(NH_2)_2$, and NH_4NO_3, applied by different ways, served as N carriers. No significant differences in N uptake and yield were found. Generally, N sidedressing led to a better utilization of N than the same quantity banded or broadcasted at seeding time. A combination of sidebanding and sidedressing is recommended if an adequate water supply can be maintained. In the seeds there was a carry-over effect of N (8-26%) into the next year wheat crop.

240 Variation of Sulfur/Nitrogen and Sulfur/Phosphorus Ratios in Forage Corn Plants and in Barley Grains After Sulfur Application. Alina Idriceanu, Silvia Stan, and C. Caramete. *An. Inst. Cercet. Cereale Plante Teh.-Fundulea, Acad. Stiinte Agr. Silvice, Ser. B 37*, 387-95 (1969; publ. 1971) (Rom). *CA 77*, 33430. Forage corn and barley were grown on a brown podzol soil from Albota, Romania, in Mitscherlich pots (5 kg) supplied with N-P-K and 6 rates of S (S_0-S_5) (0 and multiples of 0.8 g/pot). In forage corn with S_0 the yield per pot was 330 g, the total S of the plant 0.104%, the S:N ratio 0.101, and S:P_2O_5 ratio 1.48; with S_1 the yield was 360 g, total plant S 0.164, S:N 0.155, and S:P_2O_5 2.34. When the S amount was increased, the amount of total S increased in plants, being 0.19 with S_4, and 0.201% with S_5. When high S was given, the amount of S in barley grains increased (from 0.171 total S at S_1 to 0.212% at S_5). In barley grains high amounts of S slightly decreased the amount of P_2O_5; S_5 gave 0.75% P_2O_5 compared to 0.873% with S_0.

241 Role of Fertilizers in Increasing the Proteic Value of Annual Plants. D. Isfan (Inst. Cercet. Cereale Plante Teh., Fundulea, Romania). *Rev. Zooteh. Med. Vet. 23* (10), 15-20 (1973) (Rom). *CA 80*, 119565. Nitrogen fertilization (50-100 kg/ha) resulted in an increase in protein content of corn from 10.96 to 11.86%. Nitrogen fertilization increased also the contents of grain aspartic acid, serine, glycine, glutamic acid, threonine, alanine, and leucine. Very high N doses (180-220 kg/ha) caused a decrease in lysine, histidine, methionine, and valine contents. Late application of N fertilizers (during early spring) caused an increase in grain content of proteins, lysine, histidine, and methionine + valine.

242 Nutrition of Some Corn Hybrids in Relation to Fertilizer Application. T. Muresan *et al* (Lab. Agrochem. Methodics, Fundulea Res. Inst. Cereals Ind. Plants, Fundulea, Romania). *Probl. Agr. 25* (5), 5-18 (1973) (Rom). *CA 79*, 135913 In pot experiments with corn hybrids the rates of applied fertilizers were: N 1-5 and P 0.5-2.5 g/pot; the N:P ratio was constant (2:1); K at a rate of 2.5 g/pot was applied only together with N 5 and P 2.5 g/pot. Increasing amounts of N and P fertilizers increased the corn yields, the percentage of N accumulation and the crude protein content of all hybrids; the roots of late-maturing hybrids were better developed than those of the early maturing hybrids. The hybrids differed in their ability to utilize fertilizer nutrients.

243 Zinc Deficiency in Corn Grown on Chernozems After Long-Term Fertilizer Application. D. Plesa and D. Dornescu (Lab. Agrochim. Pedol., Iasi, Romania). *Probl. Agr. 25* (9), 61-72 (1973) (Rom). *CA 80*, 94624. Effects of increasing P rates (32-64 kg/ha) on a N-K background and of increasing N rates (0-128 kg/ha) on a P-K background were noted. With increasing time of P fertilizer application, the content of available P in the soil increased and the effect of P fertilizers on corn yield decreased; application of P fertilizers at an excess level of available P in soil led to a decrease in corn yield the decrease resulting from a Zn deficiency observed at high contents of available P in the soil. High N rates on a background of high P application also led with time to a decreased yield of corn. Zinc application reversed the negative effects of long-term applied high N and P rates and increased the fertilizer efficacy.

244 Application of Chemical Fertilizers to Irrigated Corn. I. Picu *et al. Probl. Agr. 23* (4), 40-9 (1971) (Rom). *CA 75*, 87608. Chemical fertilizers increased the corn yield by 30-45%. On chestnut chernozems 50, 100, 150, and 200 kg N/ha increased the yield by 18, 25, 29, and 31%, respectively. On levigated chernozems the same amounts of N gave increases of 19, 29, 35, and 40%, respectively; on alluvial soils 25, 38 42, and 42%, respectively. Nitrogen fertilizers were applied in 2 steps 1/3-1/2 in the fall, and the rest in the spring except in regions with high annual rainfall where the whole amount was applied in the spring. The amount of P_2O_5 incorporated in the soil was 50-60 kg/ha depending on the amount of mobile P existing in each variety of soil. Fertilizers with K did not show significant yield increases, except in levigated chernozems.

245 Efficiency of Urea as Compared with Ammonium Nitrate on Maize Yields, on a Strongly Leached Chernozem. N. Popa and M. Olaru (Agr. Exp. Sta., Caracal, Romania). *Probl. Agr. 22* (11), 30-37 (1970) (Rom). *Soils Fert. 34*, 4240. Both urea and NH_4NO_3 similarly increased maize yields, best results being obtained with N_{120} or $P_{50}N_{120}$.

246 Chemical-Industry Wastes Which Can be Used in Agriculture. Ionela Popescu and M. Dima (Agron. Inst., Iasi, Romania). *Bul. Inst. Politeh. Iasi 17* (1-2), 63-70 (1971) (Rom). *CA 77*, 100146. Boron slime, a waste product of B extraction from minerals, used as a fertilizer increased the yields of corn by 10.2, of winter wheat by 6.9, and of sugar beet by 6.2%. The production of sunflower seeds remained unchanged. The most efficient doses were 100 for corn, 300 for wheat, and 200 kg/ha for sugar beet. The contents of B, Mn, Cu, Co, Zn, and Mo in corn, wheat sugar beet, and sunflower seeds were affected by the use of B slime. The composition of B slime used is also tabulated.

247 Zinc Requirements of Agricultural Crops. D. Sandoiu.

Probl. Agr. 23 (4), 82-6 (1971) (Rom). *CA 75*, 87609. On corn HD 409 in soils with high amounts of P, Zn gave yield increases. In pots (21.5 l. capacity) with 20 kg soil, N 4 g, K 4 g, and with P as P_2O_5 administered 2-14 g/pot, the yield decreased with higher amounts of P. When Zn was added the yield increased, corresponding to a field increase of 7100 kg/ha, compared to P without Zn. The yield of corn leaves and stems also increased. Zinc administration without P did not show changes in the yield of stems and leaves. Phosphorus administration after Zn increased the yield. At maximum P administration, Zn doubled the stem yield, and almost tripled the leaf yield. The Zn needs were different for each corn variety.

248 Zinc Application to Irrigated Maize Under the Baragan Plain Conditions. G. Stefan (Marculesti Exp. Agr. Sta., Romania). *Probl. Agr. 22* (4), 18-25 (1970) (Rom). *Soils Fert. 33*, 4858. On chestnut-chernozem soils (pH 7.2-7.5, 3.5% organic matter, rich in K, and moderately supplied with P and N), Zn deficiency in maize was controlled by: (a) 18-22 kg $ZnSO_4$/ha incorporated into the soil every 3-4 yr; (b) spraying with a 0.2% $ZnSO_4$ solution at 7-10 day intervals after the first Zn deficiency symptoms appeared; and (c) application of 20-30 tons/ha farmyard manure only.

249 Influence of Certain Fertilizers on Yields on Dune Sands of the "Valea lui Mihai" State Farm. E. Stepanescu, Maria Colibas, and Ilona Bront. *An. Inst. Stud. Cercet. Pedol. 39*, 103-12 (1971) (Rom). *CA 79*, 114482. The physicochemical and chemical properties of dune and interdune soils before and after leveling are described. After leveling there was no difference between yields of corn and rye grown on the dune and interdune sandy soils. NH_4NO_3 was the best fertilizer, increasing the grain production by 311-314%; at 6.24 mg P_2O_5/100 g soil, the cereal yield increased by 13-16%. KCl effected a significant corn-yield increase only when the soil contained very little mobile K_2O (< 7.17 mg K_2O/100 g soil). Water consumption by cereals was reduced by 49-55% when NH_4NO_3 was applied. Minimum plant transpiration was observed when equilibrated N, P, and K amounts were applied.

250 Dynamics of Phosphorus Nutrition as Influenced by Some Microelements. Mihai Trifu (Univ. Babes-Bolyai, Cluj, Romania). *Stud. Univ. Babes-Bolyai, Ser. Biol. 16* (2), 61-8 (1971) (Rom). *CA 76*, 13121. The influence was studied of B, Cu, Zn, and Mn, on P absorption and accumulation in HD-208 and HD-2311 corn hybrids. The microelements were administered by soaking the seeds for 24 hr before planting. Copper, Zn, and B alone or in combinations favorably influenced the absorption and accumulation of P. The results confirm the existence of a synergism between B and Cu, B and Zn, and B, Cu, and Mn, as well as an additive effect and antagonism between B and Mn, according to the combination.

251 Effect of Some Microelements on Nitrogen Nutrition of Corn. Mihai Trifu (Univ. Babes-Bolyai, Cluj, Romania). *Stud. Univ. Babes-Bolyai, Ser. Biol. 18* (2), 69-75 (1973) (Rom). *CA 80*, 26296. Seed treatment with Zn, Mn, and Co + Mn (by soaking the seed in salt solutions) affected positively the N absorption and accumulation by HD-101 and HD-311 corn hybrids. Nitrogen absorption was inhibited when seeds were treated with Co alone but Co applied together with Mn had a synergistic effect on N absorption by corn. Seed treatment with Zn or Mn alone gave good results, but a combined Zn and Mn treatment was not effective.

252 Influence of Some Microelements Upon the Dynamics of Nitrogen Nutrition in Some Maize Hybrids. Mihai Trifu (Univ. Babes-Bolyai, Cluj, Romania). *Stud. Univ. Babes-Bolyai, Ser. Biol. 16* (1), 63-9 (1971) (Rom). *CA 75*, 117583. Experiments with maize (corn) hybrids showed that a synergism exists between B and Mn, and between B and Mn and N. Boron as H_3BO_3 0.05% and Mn as $MnSO_4$ 0.005% were applied by soaking the seeds of 3 hybrid varieties (HD-101, HD-208, and HD-311) for 24 hr before sowing. Sap exudates were taken from 15-130-day old plants. The N concentration in the sap of the 15-day-old plant of the HD-101 hybrid was the highest (521.6 compared to 386.7 mg N/l. in the control) when B + Mn was applied. In the sap of HD-208 and HD-311 hybrids the concentrations were 327 and 506.4 mg N/l., respectively. In 30-130-day old plants the amount of N decreased gradually, but in variants with B, Mn, and B + Mn, the amount of N in the exuded sap was always higher than in controls. In leaves of treated plants the content of B and Mn increased in all variants. A correlation between the N concentration in exuded sap, and in leaves was observed.

253 Effect of Phosphorus x Zinc x Manganese Interaction on Forage Corn Chemical Composition and Yield. Iuliana Vines *et al. An. Inst. Cercet. Cereale Plante Teh.-Fundulea, Acad. Stiinte Agr. Silvice, Ser. B 37*, 371-8 (1969; Publ. 1971) (Rom). *CA 77*, 33415. The effect of P, Zn, and Mn on corn composition was studied in mitscherlich pots (5 kg) at 70% of the water capacity. The pots contained a chestnut-chernozem soil of Jegalia (Ialomitza district, Romania), humus 3.5%, and pH 7.5. Zinc was given 25 and 50 mg/pot, Mn 50 and 100 mg/pot, and P 0 and 1600 mg/pot; N was applied uniformly (500 mg/pot). When high amounts of P were applied the Zn absorption decreased, and when Zn was applied the amount of absorbed P decreased. The P-Zn interaction influenced the Mn content of the plant; it decreased when Zn and P were applied together. High P rates increased the content and accumulation of Mn in plants. Treatments with trace elements did not change the composition of main elements in plants.

SPAIN

254 Correlation Between Toxicity Symptoms and Ionic Relationships in Maize and Rates of Applied Humic Acid. V. Hernando, M. P. Sanchez Conde, and B. C. Ortega (Inst. Edafol. Biol. Veg., Madrid, Spain). *An. Edafol. Agrobiol. 29*, 657-72 (1970) (Span). *Soils Fert. 34*, 5213. Humic acid was applied to maize in sand culture at the rate of 6, 12, 24, 48, and 96 mg humic acid per kg sand. Each rate of humic acid was tested with nutrient solutions of normal (N), 2N, and 3N concentrations corresponding to conductivities of 1.80, 3.37, and 10.00 mmhos/cm, respectively. The 2N and 3N solutions produced chlorotic symptoms which were corrected by applications of humic acid in the 2N but not the 3N solution. Highly chlorotic plants had a $(NO_3 + PO_4)$/Mg ratio of 7 compared with 5.2 in normal plants. There was an optimum rate of humic acid for each solution concentration. Humic acid stimulated root development.

SWITZERLAND

255 Effect of Stand Density on Maize Yields. II. Effect of Plant Population and Nitrogen Fertilizing on Yields. J. Nosberger (Tech. Hochschule, Zurich, Switzerland). *Z. Acker-Pflanzenbau 134* (1), 42-9 (1971) (Ger). *Soils Fert. 35*, 1630 Treatments included 40 tons/ha dung, alone or in conjunction with NH_4NO_3 at 120 kg N/ha. Tassel development was

accelerated by N, and delayed by increasing plant population (6-12 plants/m^2). Both N and stand density positively affected leaf-area index (LAI) until flowering, but additional mineral N had thereafter no significant effect on the relationship between LAI and stand density; with treatments that included mineral N, a significant multiple regression of net assimilation rate and LAI accounted for most (69%) of the variance in grain yields.

U.S.S.R.

256 Use of Ammonium Nitrate on Eroded Chernozems of the Voroshilovgrad Region. L. I. Akent'eva and V. F. Malykhina (Voroshilovgrad. S.-Kh. Inst., Voroshilovgrad, U.S.S.R.). *Khim. Sel. Khoz. 11* (3), 170-3 (1973) (Russ). *CA 78*, 146677. Application of 45-60 kg N/ha as NH_4NO_3 on eroded chernozems in autumn at plowing increased the yield of corn grain and its protein and P contents significantly. The yields as well as the grain protein and P contents were higher on non-eroded than eroded soils, but the utilization of fertilizer-N was highest on eroded soils, especially at optimum moisture conditions and when NH_4NO_3 was applied in autumn.

257 Studies by the Plant Physiology and Biochemistry Department of the Gorki State University on Trace Element Application on Gray Forest Soils of the Gorki Region. A. A. Anisimov *et al. Uch. Zap. Gor'k. Gos. Univ.*, No. 139, 73-6 (1971) (Russ). *CA 78*, 146745. Seed treatment with 0.1% trace element solutions (6.1/100 kg seed) caused an increase in crop yield and quality. The yield of corn green mass was increased by Zn, Cu, B, Co, and Mo application by 11.5-45.8, 12.1-39.8, 14.2-27.3, 11.8-17.7, and 11.2-37.9%, respectively. Trace-element treatment increased the sugar and vitamin C content of the silage corn. Both Co and Zn increased the rate of photosynthate translocation from corn leaves into the stems, decreased the α-glucan phosphorylase activity and increased that of aldolase and polyphenol oxidase in the leaves, and stimulated oxidation-reduction processes in the plants.

258 Effect of Trace Nutrients on the Yield and Quality of Corn Under Ararat Plain Conditions. B. N. Astvatsatryan and S. A. Ashkhbabyan (Arm. NII Zemledel, Echmiadzin, U.S.S.R.). *Khim. Sel. Khoz. 9* (10), 737-9 (1971) (Russ). *CA 76*, 24016. One l. of 0.05% solutions of the trace element salts was used for soaking 10 kg seeds before sowing. Salts of Co and Zn were most effective, increasing the yield of corn by 20%.

259 Action of the Sodium Salt of 2,4-D on Corn During Top Dressing with Various Doses of Mineral Fertilizers. V. B. Bagaev, Y. P. Zhukov, and S. E. Shkel. *Primen. Pestits. Sel. Khoz., Mater. Nauch. Knof.* , 5-9 (1969; Publ. 1970) (Russ). Edited by G. S. Gruzdev. Mosk. Sel'skokhoz. Akad.: Moscow, U.S.S.R. *CA 74*, 139835. The effect on corn of Na salt of 2,4-D and of simultaneous topdressing with N-P-K in amounts 15, 30, and 45 kg/ha was studied. Fertilizers increased the dry matter content of corn in all cases. The herbicide had no toxic effect on the plants up to the 15th day after spraying, whereas a toxic effect on the 40th day after spraying was evident at 45 kg/ha N-P-K. At all fertilizer rates, 2,4-D lowered the relative content of N in the plants on the 15th day after spraying and increased it on the 40th day, whereas the absolute content of N was increased by it at both periods except for the 45 kg/ha N-P-K dose. The contents of P and K was increased by 2,4-D; they were, however, reduced on the 15th day at the doses 30 and 45 kg/ha N-P-K. With increasing amounts of N-P-K the yields of corn not treated with 2,4-D were increased, while a statistically reliable increase on application of 2,4-D was obtained only at the 15 kg/ha fertilizer dose. The utilization of N and yields of protein and carbohydrates were raised by 2,4-D in the absence of fertilizers and at 15 kg/ha N-P-K, but were lowered when higher rates of fertilizers were used. The utilization of P was increased by the herbicide at all amounts of fertilizers used, while the content of K in the green mass remained unchanged.

260 Spray Dressing of Corn with Nitrogen, Phosphorus, and Potassium at Different Levels of Root Nutrition and Water Requirement. S. E. Bazilevich. *Tr. Khar'kov. Sel'skokhoz. Inst. 90*, 48-50 (1970) (Russ). *CA 77*, 33474. Pot experiments with tomatoes and corn, grown at 35 and 75% soil moisture (in relation to field capacity) from specific retention, and fertilized with 1 or 2 doses of N, P, and K, were conducted. During the growth period, the plants were sprayed with 0.1*N* urea, $Ca(NO_3)_2$, and KCl 10 times within 20 days; control plants were not sprayed. Phenological observations, and biometric measurements were carried out; leaf water content and dry wt of the plants were determined each time before and after spraying. At low soil moisture, an excess of nutrients in the soil affected the crop yield negatively. At optimal soil moisture, spray dressings with nutrients affected the plant yield positively, especially when a single fertilizer dose only was soil-applied. Efficacy of spray dressings depended also on the plant growth phase and on the number of applied spray dressings.

261 Effect of Manganese on the Levels of Protein and Improvement of Its Composition in Grain of Maize Hybrid VIR 42. I. M. Belokobyl'skii (Agr. Inst., Voroshilovgrad, U.S.S.R.). *Fiziol. Biokhim. Kul't. Rast. 4* (2), 176-8 (1972) (Russ). *CA 77*, 86991. Soaking maize seeds of the variety Slava in a 0.02% $MnSO_4$ solution increased the plant productivity and the accumulation of protein and improved the protein quality by increasing the content of water- and salt-soluble fractions by 1.9 and 0.7%, respectively, and by decreasing the amount of zein (alcohol-soluble fraction) by 2.07%.

262 Effect of Manganese and Zinc on the Yield of Corn and Its Quality in Leached Chernozem. E. D. Bobina. *Zap. Voronezh. Sel'skokhoz. Inst. 40*, 240-9 (1969) (Russ). *CA 75*, 19283. The effect of Zn and Mn was studied on corn in field and pot trials applying N-P-K (60:60:60). Solutions of $MnSO_4$ and $ZnSO_4$ (0.05-0.1%) were tried in 3 ways: (1) moistening of seeds; (2) introduction into the seed beds; and (3) as leaf-feeding spray. Variant (1) produced the highest increase in yield. The highest increase both in yield and protein content was obtained by addition of Zn. Application of a 0.05% $ZnSO_4$ solution to seeds increased the yield by 5.2 cwt/ha and the protein concentration by 1.2% (from 10.1-11.3).

263 Effect of Zinc on the Biochemical Composition of Corn. V. S. Dibrova. *Sb. Nauch. Tr., Donskoi Sel'skokhoz. Inst. 4* (1) (Agron.; Primen. Udobr. Gerbits. Polevom Sevooborote), 57-62 (1968; Publ. 1969) (Russ). *CA 77*, 74187. Hybrid corn seeds VIR-156 were powdered with 45 g $ZnSO_4$ or with 400 g PMU/q seed or 3-8 kg PMU (a Zn fertilizer) or 3 kg $ZnSO_4$/ha were banded with the seed at sowing. The chlorophyll (Chl), vitamin C (VC), tryptophan (I), and Zn contents of corn were determined during various phases of the plant growth. The effect of Zn fertilizers was dependent on the level of available

Zn in the soil. Zinc application increased the Chl and VC contents of leaves of corn grown in a Zn-deficient soil only. A high correlation between the I and Zn content of the plants was observed. Presowing powdering of seeds with Zn or PMU, affected insignificantly the Chl and VC contents in the final yield, but increased the VC content of the plant during the early phases of its growth.

264 Ammonium Chloride as a Nitrogen Fertilizer on Donbas Common Chernozems. M. I. Efimtsev (Voroshilovgrad. S.-Kh. Inst., Voroshilovgrad, U.S.S.R.). *Mater. Soveshch. Primen. Kloristogo Ammoniya Kach. Udobr.*, 47-61 (1970) (Russ). Edited by V. I. Panov. Gos. Nauch.-Issled. Proekt. Inst. Osn. Khim.: Kharkov, U.S.S.R. *CA 79*, 135856. On eroded soils, NH_4Cl was as effective as a N fertilizer for corn, barley, and wheat as NH_4NO_3. Ammonium chloride was more effective when plowed in in autumn than when given in spring. Accumulation of chlorides in 1-m deep soil layers in amounts harmful to plants was not observed. On noneroded chernozems at optimum N levels (45 kg N/ha for sunflower and 60 kg N/ha for barley and millet), higher increments in grain yields were obtained with NH_4Cl than when NH_4NO_3 or urea was applied. On that soil type, NH_4Cl was a less effective fertilizer for corn and spring wheat than NH_4NO_3 or urea. No increase in Cl^- content of noneroded chernozems was noted, when NH_4Cl was applied.

265 Effect of Trace Nutrients on the Cold Hardiness, Growth Development, and Yield of Corn. B. I. Gerasenkov (Sib. Nauchno-Issled. Inst. Sel'sk. Khoz., Omsk, U.S.S.R.). *Mikroelem. Biosfere Primen. Ikh. Sel. Khoz. Med. Sib. Dal'nego Vostoka Dokl. Sib. Konf., 3rd*, 273-6 (1969; Publ. 1971) (Russ). Edited by V. R. Filippov. Akad. Nauk SSSR. Sib. Otd., Buryat. Filial: Ulan-Ude, U.S.S.R. *CA 79*, 135926. Seeds starting to germinate, which were treated for 24 hr with H_3BO_3 0.01, $CuSO_4$ 0.06, and $MnSO_4$, $ZnSO_4$, $CoSO_4$, and $(NH_4)_2MoO_4$ 0.04% solutions, were kept for 16 and 48 hr at low temperatures (-5° to -7°) and their cold resistance was determined. The cold hardiness of the seedlings was increased by trace element treatment in order: Mn > Cu > Zn, B. Boron and Mn increased also the corncob wt, the number of grains in cob, and the wt of 1000 grains.

266 Effect of Ammonium Molybdate on the Yield and Quality of Corn Grain. A. B. Gnilitskaya (Voroshilovgrad. S.-Kh. Inst., Voroshilovgrad, U.S.S.R.). *Khim. Sel. Khoz. 10* (10), 736-8 (1972) (Russ). *CA 78*, 42166. Seed treatment with $(NH_4)_2MoO_4$ resulted in an increase in the chlorophyll and carotene contents, in an increased nitrate reductase activity, and in a crop increase of 1.6-2.6 q/ha. The protein content of the grain increased by 0.7-1.0, that of starch by 2.4-5.8, and that of fat by 0.4-0.6%. The Mo effect was highest on a N-P-K (30:30:30 kg/ha) background.

267 Effectiveness of Complex Fertilizers Applied to Corn Grown for Grain. I. B. Godunov (Nauchno-Issled. Inst. S.-Kh. Tsentr. Chern. Polosy im. Dokuchaeva, Voronezh, U.S.S.R.). *Mater. Zon. Nauch.-Metod. Soveshch. Rab. Nauch.-Issled: Uchrezhd. Sel. Khoz. Tsent.-Chernozem. Polosy*, 27-34 (1970; Publ. 1972) (Russ). Edited by I. K. Vinokurova. Izd. "Kommuna": Voronezh, U.S.S.R. *CA 79*, 65107. On soils of the Central-Chernozem Zone high in available P and K, simple and complex fertilizers increased grain yields of Voronezhskaya 76 corn variety by 10-15%. At equivalent nutrient amounts, nitrophoska and diammonitrophoska were somewhat more effective than mixtures of simple N, P, and K fertilizers. The difference in N:P:K ratio in the 2 complex fertilizers (1:1:1 in nitrophoska and 0.8:1:1 in diammonitrophoska) had no effect on corn grain yield. Economically most recommendable was diammonitrophoska.

268 Effect of Nitrogen Fertilizers on the Dynamics of Available Nitrogen and Yield of Corn on Dark Chestnut Soils of Zavolzhe During Irrigation. V. D. Golubev and I. F. Medvedev (Sarat. S.-Kh. Inst., Saratov, U.S.S.R.). *Agrokhimiya* (4), 3-8 (1972) (Russ). *CA 77*, 74128. In spring after a dry autumn and winter, nitrates from fall-applied N fertilizers were found at a depth of 40-50 cm. After a wet fall they migrated to a depth of 80 cm and even > 1 m. In spring, drying of the soil was accompanied by a backward transport of nitrates to the soil surface. Nitrogen fertilizers increased also significantly the available NH_4 content in the soil. Nitrogen fertilizers applied during a dry fall had the same effect on the yield of corn green matter as those applied in spring. After a wet autumn, fall-applied N was less effective than spring-applied N fertilizer. The highest yield of green corn matter was obtained after spring application of 90 kg of N/ha and 2 additional topdressings of 30 kg of N/ha each. Repeated application of low doses had advantage over a single application of the same total amount of N fertilizers (150 kg/ha).

269 Effect of Nitrogen Spray Dressings on the Yield and Quality of Corn. P. A. Gorshkov and S. N. Kravchenko (Ukr. S.-Kh. Akad., Kiev, U.S.S.R.). *Khim. Sel. Khoz. 10* (11), 806-9 (1972) (Russ). *CA 78*, 57011. Additional spring urea or NH_4NO_3 fertilization (20 kg/ha) of a sufficiently moist dark-gray light loamy soil increased corn grain yield by 320 and 550 kg/ha, respectively. Leaf treatment with fertilizer sprays did not affect the corn yield but increased the grain protein content from 7.70 to 9.15-9.50%. Both N fertilizers stimulated the formation of essential amino acids in grain.

270 Effectiveness of the Application of Organic and Chemical Fertilizers for Maize. G. Grinblat (Latviiskii Nauch.-Issled. Inst. Zeml., Riga, SSR). *Augsne Raza 18*, 57-72 (1971) (Russ). *Soils Fert. 35*, 1624. On derno slightly podzolized moderately cultivated sandy loams of the Latvian SSR, dung gave higher yield increases when applied in autumn at basal plowing than when applied in spring. In the absence of dung, high yields were obtainable with applications of $N_{140}P_{70}K_{100}$ kg/ha. Additional N did not increase yields significantly except when the high rate (140 kg/ha) was split into 70 kg before sowing + 70 kg in an additional dressing. NH_4NO_3 applied without dung or with a basal dressing of 40 tons/ha dung increased green matter yields by 59-124 kg/ha per kg of N applied. Aqueous ammonia was only slightly less effective than NH_4NO_3, and in dry summers it surpassed the latter in effectiveness.

271 Effect of Soil Conditions and Potassium Requirement on the Uptake and Distribution of ^{86}Rubidium in Corn Plants. S. N. Ivanov and N. F. Nikitenko (Nauchno-Issled. Inst. Pochvoved. Agrokhim., Minsk, U.S.S.R.). *Dokl. Akad. Nauk Beloruss. SSR 16* (2), 141-3 (1972) (Russ). *CA 76*, 15272. Growth tests were conducted on limed and nonlimed 3 sod-podzolic soils to which the following fertilizer levels were applied: N 1.5-2.0, P_2O_5 1.0-1.4, and K_2O 0.45-0.5 g/pot (the latter as a KCl solution labeled with ^{86}Rb, actitivy 110-130 μCi/pot). Liming of acid soils gave a 2-3 fold yield increase as compared to variants without liming. Plants growing on soils with a low content of exchangeable K were able to assimilate ^{86}Rb most intensively, ^{86}Rb activity being lower on limed than on nonlimed soils (by a factor of 1.5-2 in the first growth phase, and by a factor of 4-5 at harvest). ^{86}Rubidium

distribution in corn varied with the plant growth; after the appearance of reproduction organs a translocation of ^{86}Rb activity from the stalks to the leaves, panicles, and corn cobs was observed.

272 Synthesis and Liberation of Amino Acids by Isolated Corn Plant Roots Dependent on Various Sources of Nitrogen Nutrition. S. F. Izmailov, I. I. Lyzhenko, and A. M. Smirnov (Inst. Fiziol. Rast. im. Timiryazeva, Moscow, U.S.S.R.). *Kul't. Izolirovannykh Organov, Tkanei Kletok Rast., Tr. Vses. Konf., 1st*, 78-80 (1968; Publ. 1970) (Russ). Edited by R. G. Butenko. "Nauka": Moscow, U.S.S.R. *CA 74*, 99021. Roots 4-50 mm long isolated from 7-day-old plants, grown on a medium without N under sterile conditions, were cultivated on White medium containing glucose and vitamins at 27° and 70% humidity. Sources of N were NO_3 and NH_4 (45 mg of N/l.). The acidity of medium with NO_3 and NH_4 was pH 4.9 and 6.8-7.0, respectively. After 6 days of cultivation free amino acids in roots and in medium were determined by paper chromatography. The following amino acids were found: lysine, histidine, arginine, asparagine, aspartic acid, serine, glycine, glutamic acid, threonine, alanine, tyrosine, γ-aminobutyric acid, valine, methionine, phenylalanine, and leucine. Practically no amino acids were found in roots grown on a medium without N. The factor which determines the intensity of the amino acid excretion is the intercellular process which detoxifies the NH_3.

273 Growth and Nitrogen Metabolism by Corn and Peas in Relation to Nitrogen Sources and Salinization Conditions. T. Z. Kabisheva (Inst. Bot., Alma-Ata, U.S.S.R.). *Izv. Akad. Nauk Kaz. SSR, Ser. Biol. 11* (4), 24-31 (1973) (Russ). *CA 79*, 145242. Irrespective of the N source Cl^- and especially SO_4^{2-} salinization inhibited corn growth, accumulation of dry matter, and accumulation of nitrogenous compounds in the plant roots. With regard to dry matter and protein content, NO_3^- was a better source of N for corn than NH_4^+. Nitrate-N application induced nitrate reductase activity in corn. Pea roots contained more ammonium-N than corn roots, especially when $(NH_4)_2SO_4$ was applied; the NH_4^+ content of roots of 15-day-old seedlings was less affected by salinization than that of corn.

274 Relation Between Two Types of Chloroplasts in Corn Leaves When the Plants are Fed Different Nitrogen-Phosphorus Combinations. Y. S. Karpilov and K. Y. Bil (Mold. Nauch.-Issled. Inst. Oroshaemogo Zemled. Ovoshch., U.S.S.R.). *Dokl. Akad. Nauk SSSR 193* (5), 1198-200 (1970) [Plant Physiol] (Russ). *CA 74*, 12264. Corn plants were grown in natural light in sand with or without the usual nutrients (Knopp mixture without P or N for experimental plants). After 2 weeks of growth plant leaves under conditions of nutrient deprivation served as a source of chloroplasts used for study of surface and size changes. As the fraction of the plastids of mesophilic type in the total photoactive surface of leaf chloroplasts decreased under conditions of N deprivation, the integral change in photochemical and biochemical reactions of photosynthesis of the plant suffered changes. Reduced N supply decreased the dimensions of the mesophilic cells and increased the xeromorphic nature of the whole structure. Deficiency of P reduced somewhat the content of both types of chloroplasts but the plastids of mesophilic type were increased in size.

275 Effect of Nickel on the Intensity of Photosynthesis and Some Indexes of the Water Regime of Corn. V. K. Kashin. *Mikroelem. Biosfere Primen. Ikh. Sel. Khoz. Med. Sib. Dal'nego Vostoka, Dokl. Sib. Konf., 3rd*, 235-9 (1969; Publ. 1971) (Russ). Edited by V. R. Filippov. Akad. Nauk SSSR, Sib. Ltd., Buryat. Filial: Ulan-Ude, U.S.S.R. *CA 79*, 135902. The photosynthesis rate and yield of corn were increased when seeds were treated with a 0.03% $NiCl_2$ solution. The effect of Ni treatment on dry-matter yield was positive only at a low soil moisture common for field conditions. Nickel pretreatment decreased water losses by plants (maximum effect was noted at the 5-leaf stage) and increased the rate of photosynthesis at the heading stage by 29%.

276 Effect of Exogenous Nitrogen on the Activity of Nitrate Reductase and Glutamate Dehydrogenase in Roots of Corn Seedlings. E. E. Khavkin, A. A. Peshkova, and F. E. Reimers (Sib. Inst. Fiziol. Biokhim. Rast., Irkutsk, U.S.S.R.). *Dokl. Akad. Nauk SSSR 208* (3), 745-8 (1973) [Plant Physiol] (Russ). *CA 78*, 123215. Corn seedlings, 2-day-old were transferred for a period of 3 days to a NO_3^- or NH_4-containing medium (244 mg KNO_3/l. or 160 mg $(NH_4)_2HPO_4$/l.) and grown in dark. In the nitrate-supplied seedlings, the content of free NO_3^- almost doubled and that of NH_4 increased by 30-80%; in the $(NH_4)_2HPO_4$-containing medium, the NH_4 content of the seedlings increased by 25-50%. The NH_4 content of the plant probably does not depend on uptake rate but on its assimilation rate. The specific activity of nitrate reductase and glutamate dehydrogenase in the root increased in the presence of NO_3^-; the activity of glutamate dehydrogenase decreased with the seedling age, but the uptake of exogenous NH_4 tended to raise its activity. In the presence of Actidione, a suppressor of protein synthesis, there was no induction of glutamate dehydrogenase activity by exogenous NH_4 in the basal part of the root but the total protein content of the tissue was unchanged. The mechanism of enzymes regulating N metabolism by plants is discussed.

277 Protein, Phosphorus, and Sulfur Levels Based on the Phases of Corn Development and Dependent on Soil Fertilizer. M. I. Kniga and N. M. Kniga (Khar'k. Zoovet. Inst., Kharkov, U.S.S.R.). *Dokl. Vses. Akad. Sel'skokhoz. Nauk* (12), 2-4 (1970) (Russ). *CA 74*, 86899. Seeds of a corn variety and of its hybrid were sown in a soil fertilized with N-P-K, N-P, N-K, and P-K fertilizers containing N 90, P_2O_5 60, K_2O 40, and S 23-4 kg/ha. A positive correlation between the yield of the dry matter and plant S content was observed after an introduction of N-P-K and N-P fertilizers, especially during the flowering phase. The optimal N level increased the corn yield. The increased organic matter accumulation was associated with an increased carotene content, which reached its maximum during the beginning of flowering and pericarp formation. The S content decreased with plant growth more rapidly in the plants from plots treated with S. At the end of the growth period the P uptake decreased more rapidly in the plants without S application.

278 Effect of Thallium on Plants. S. S. Kolotova and N. I. Kharitonova. *Uch. Zap., Perm. Gos. Univ.*, No. 206, 161-5 (1970) (Russ). *CA 76*, 2855. Traces of Tl stimulated the growth of maize, feed beans and carrots. Seeds were wet with Tl_2SO_4 solution before sowing; 0.001% Tl gave the best results, and 0.05% was toxic. Traces of Tl promoted germination and the growth of leaves, stems, and roots in greenhouse and field experiments. The yield of seeds from maize was increased by 13%, and that of carrot roots by 43%. This stimulating effect of Tl on plants contrasts with its extreme toxicity to animals.

279 Conversion of Slow-Acting Nitrogen Fertilizers in Podzols and Their Effect on the Yield of Corn. D. A.

Koren'kov and V. P. Zolotarev. *Byull. Vses. Nauch.-Issled. Inst. Udobr. Agropochvoved.*, No. 9, 42-51 (1971) (Russ). *CA 78*, 146737. Nitrogen of ureaform fertilizers is transformed more slowly in the soil into available ammonium- and nitrate-N than that of urea fertilizers. It was found that a single application at a high rate of ureaform (600 kg N/ha) can supply N to corn for a period of 6 yr, but somewhat better results were obtained with a halved dose of ureaform fertilizers applied in 3-yr intervals. The index of N availability of the investigated ureaform fertilizers varied from 19.8 to 52.1 and the efficacy of these fertilizers increased with an increase in the availability index. The average, for 6 yr, yield of corn green mass was less only by ~2.5% when ureaform was applied in two 300-kg-N rates in 3-yr intervals than when urea or NH_4NO_3 were applied at a rate of 100 kg N/ha each yr.

280 Effect of Sulfur-Containing Fertilizers on the Chemical Composition of Corn and Lupine Grown at Different Supply of Soil Phosphorus. T. N. Kulakovskaya and E. D. Vladimirova (Beloruss. Nauchno-Issled. Inst. Pochvoved. Agrokhim., Minsk, U.S.S.R.). *Vestsi Akad. Navuk Belarus. SSR, Ser. Sel'skagaspad. Navuk* (2), 52-6 (1973) (Beloruss). *CA 79*, 77426. The S content of corn leaves and stems did not depend on the content of available P in the soil, but the S, N, and P contents of lupine increased with increasing content of available P in the soil. The S content of corn and lupine increased with increasing rates of S fertilizers (1-8 g/pot), especially when S fertilizers were given in the form of gypsum. The S:P ratio in both plants was higher at a low (11.2 mg P_2O_5/100 g) than at a high (26.4 mg P_2O_5/100 g) content of available P in soil. The S:P ratio at the high soil-P level increased with increasing S in corn, but it was highest in lupine at the lowest S (1 g/pot) rate.

281 Zinc Level in Spring Wheat and Corn Plants in Connection with the Use of Zinc, Copper, and Manganese Fertilizers. A. A. Lamanov *et al. Tr. Perm. Gos. Sel'skokhoz. Inst. 60*, 22-5 (1970) (Russ). *CA 77*, 87076. Field experiments with spring wheat and corn were carried on light forest-steppe soils of the Perm district, insufficiently provided with Zn (0.6-0.9 mg/kg). As trace element fertilizers $ZnSO_4$ 1, $CuSO_4$ 1, and $MnSO_4$ 2 kg/ha were used. Also Zn (2 kg/ha) in a polymicronutrient fertilizer was used. Fertilization with Zn increased its uptake and removal from soils by plants and this was independent of the form of the Zn fertilizer used.

282 Yield and Biochemical Composition of Green Yield of Maize at Different Fertilizer Rates. A. I. Lappo, I. V. Misko, and G. A. Lashuk. *Izv. Akad. Nauk BSSR*, No. 3, 55-65 (1969) (Russ). *Soils Fert. 33*, 668. On White Russian derno-podzolic soil without application of organic manure, the yield and percentage contents of N, P, and K were highest with $N_{180}P_{80}K_{180}$.

283 Determination of the Nutrient Requirements of Plants Grown in Chernozems of the Ukrainian Forest-Steppe Zone. P. P. Levenets and E. P. Yurko (Ukr. Nauchno-Issled. Inst. Pochvoved. Agrokhim. im. Sokolovskogo, Kharkov, U.S.S.R.). *Diagn. Potrebnosti Rast. Udobr.*, 284-8 (1970) (Russ). Edited by A. V. Sokolov. "Kolos": Moscow, U.S.S.R. *CA 74*, 31111. With corn and winter wheat grown on the title soils it was established that the Tserling method of sap analysis in the earlier phases of plant development provides a practically exact evaluation of the degree of provision of the plant with N, P, and K. A more complete insight is gained for the whole growth period by combining the leaf analysis with tha of the soil. Introducing small fertilizer doses in the earlier growth phases facilitates the uptake of nutritional elements by winter wheat. In the later periods the nutritive contents of the plants on soil with and without a fertilizer basis approach each other.

284 Effect of Different Presowing Treatments of Seeds with Trace Nutrients on Formation of a Corn Crop Under Altai Territory Forest Steppe Conditions. G. A. Makarova and E. F. Marochkina (Altai. S.-Kh. Inst., Barnaul, U.S.S.R.). *Mikroelem. Biosfere Primen. Ikh. Sel. Khoz. Med. Sib. Dal'nego Vostoka, Dokl. Sib. Konf., 3rd*, 263-8 (1969; Publ. 1971) (Russ). Edited by V. R. Filippov. Akad. Nauk. SSSR, Sib. Otd. Buryat. Filial: Ulan-Ude, U.S.S.R. *CA 79*, 135824. At low temperatures and soil-moisture deficiency during the initial growth stages of corn, wet treatment of seeds with trace elements inhibited the growth, development, viability, and resistance of seedlings to diseases, and thus decreased the corn yield. Powdering seeds with trace elements (Mn, Zn, Cu, Co) gave positive results. Zinc, Co, and trace element mixtures protected corn plants against *Physoderma maydis* infection, while Mn and Cu controlled the ear bacterial disease (*Bacterium stewarti*) and *Sclerotinia* wilt (*S. sclerotiorum*).

285 Effect of Zinc and Manganese on the Biochemical Processes and Productivity of Corn Grown on Meadow-Chernozem Podzolized Soil. V. V. Mar'ina (Ukr. Nauk-Dosl. Inst. Gidrotekh. Melior., U.S.S.R.). *Visn. Sil's'kogospod. Nauki* (8), 43-7 (1972) (Ukrain). *CA 78*, 70705. Presowing application of Mn and Zn together with N-P-K fertilizers or seed treatment with these micronutrients increased the activity of catalase, peroxidase, and polyphenol oxidase and the content of chlorophyll, carotene, and ascorbic acid in leaves and the protein content and yield of corn grain.

286 Effect of Trace Nutrients on the Yield and Quality of Corn. V. T. Medvedeva and S. V. Panova (Nauk.-Dosl. Inst. Tvarinnitsva Lisostepu Polissya, Kharkov, U.S.S.R.). *Visn. Sil's'kogospod. Nauki* (6), 33-6 (1972) (Ukrain). *CA 77*, 87075. Corn was grown on a deep chernozem soil treated with N-K fertilizers uniformly. Normal and granulated superphosphates were used with or without addition of B, Mn, Mo, or Zn. Trace element addition increased the corn yield, and the P_2O_5, Mo, and S contents of the grain ash. The Cu, Mn, and Mg contents were increased mainly by Mn addition, and Ca and K by the application of Mo.

287 Effect of Mineral Fertilizers on the Yield and Quality of Corn Under the Conditions of Gray-Cinnamonic and Meadow-Alluvial Soils of Kartli. T. V. Nanobashvili (Gruz. Nauchno-Issled. Inst. Pochvoved. Agrokhim. Melior., Tbilisi, U.S.S.R.). *Mater. Respub. Nauch. Konf. Agrokhim. Gruz., 3rd*, 215-51 (1972; Publ. 1972) (Russ). Edited by I. F. Sarishvili. Izd. Tbilis. Gos. Univ.: Tiflis, U.S.S.R. *CA 80*, 119516. On the gray-cinnamonic soil, the highest yield of dry matter of corn was obtained when N 120 and P 120 kg/ha were applied, while on the meadow alluvial soil, N 120 and P 60 kg/ha gave the best results. Residual P remaining in the soil after 3-yr corn fertilization could not assure a high yield of successive crops without P fertilization. Nitrogen application increased the protein content of corn but P had no effect on corn proteins.

288 Assimilation by Corn, Fixation by Soil, and Losses of Nitrogen During the Application of Ammonium Nitrate on Chernozem Soil in the Eastern Georgian SSR. A. V. Peterburgskii and V. G. Tetruashvili. *Dokl. TSKHA (Timiryazev. Sel'skokhoz. Akad.)*, No. 188, 71-4 (1972) (Russ). *CA 80*, 36237. On a chernozemlike soil of Georgia, corn utilized 40.8-50.4% of applied N; 26% of applied N was fixed in the

soil as nonhydrolyzable N, and N losses from soil were 6-11.7% of applied fertilizer-N.

289 Development of Corn and Its Intake of Nutrients Dependent on the Calcium-Potassium Ratio in the Nutrient Medium. A. V. Peterburgskii, N. N. Zhitneva, and L. N. Mararenko. *Dokl. TSKHA (Timiryazev. Sel'skokhoz. Akad.)*, No. 162, 161-6 (1971) (Russ). *CA 75*, 97752. Excess of K in the nutrient medium increased the corn yield in water cultures, in soil cultures it had a negative effect on plant (mainly seedling) development. A relative increase of Ca increased the content of dry matter in plants. Potassium slowed down the Ca penetration into plants. Increase of K in nutrient medium reduced the accumulation of Mg in plants.

290 Results of Testing Superphosphate with Trace Element (Manganese, Cobalt) Additives. M. P. Petukhov and A. A. Lamanov. *Tr. Perm. Gos. Sel'skokhoz. Inst.*, 60, 83-7 (1970) (Russ). *CA 77*, 87078. Superphosphate with and without addition of trace elements was applied on a N-K background to sugar beet, corn, and spring wheat. The superphosphate trace element mixture increased the yield of corn and sugar beet but not of spring wheat, for which no difference between superphosphate with and without trace elements was observed.

291 Effect of Trace Elements on the Yield of Corn and on Some Physiological Processes Determining Drought Resistance. G. N. Popov. *Tr. Bot. Inst., Akad. Nauk SSSR, Ser. 4*, No. 20, 208-15 (1970) (Russ). *CA 74*, 63512. Tests were conducted in 1963-65 in a dry region (Saratov district) on a chernozem soil with pH in KCl 7.1, humus content 8.5%, water-soluble B 0.6-0.8; available Mn 28-30, available Mo 0.15-0.30 mg/kg of dry soil. Boron was introduced into the soil in the form of a borodatolite fertilizer (15 kg/ha), mixed with nitrophoska (50 kg/ha). Corn seeds were soaked 2 days before sowing during 24 hr in a salt solution, containing 3 g boric acid, 5 g Mn sulfate, 5 g Al nitrate, dissolved in 25 l. of water per 1 g of seeds. In addition topdressing of plants was carried out with 600 l./ha of the solution. The concentration of trace elements in the solution was similar to that used for seed soaking. The highest increase in green wt yield (29 g/ha; 15.7%) was obtained upon soaking the seeds in boric acid and sowing them in a field fertilized with N-P-K (60:60:60); the increase in yield was lower on a nonfertilized field. Extra topdressing of plants with trace elements was less effective.

292 Effect of Mineral Fertilizers on the Change in Grain Chemical Composition During Ripening and on the Yield of Corn. E. A. Prokudin. *Sb. Nauch.-Issled. Rab. Aspir. Molodykh Uch., Stavropol. Nauch.-Issled. Inst. Sel. Khoz.*, No. 4, 40-5 (1971) (Russ). *CA 78*, 70636. The N concentration of corn grain decreases during ripening, especially the concentration of nonprotein-N; the P concentration is also reduced but less than that of N. Nitrogen and N-P fertilization increased the N content of the grain; P and N-P fertilization increased the grain P content; the corn yield was mostly affected by P and N-P fertilization; K had no effect on corn yield. Phosphorus (60 kg/ha) application increased the yield by 630 and N-P (60:60 kg/ha) application by 830 kg/ha. The protein yield was increased with N fertilization by 67, with P by 110, and with N-P treatment by 170 kg/ha.

293 Effectiveness of the Use of Ammonium Chloride in Comparison with Other Forms of Nitrogen Fertilizers on Deep Chernozems Low in Humus. V. V. Pshebel'skii (Drabov. Opytn. Stants. Polevod., Drabov, U.S.S.R.). *Mater. Soveshch. Primen. Khloristogo Ammoniya Kach. Udobr.*, 35-46 (1970) (Russ). Edited by V. I. Panov. Gos. Nauch.-Issled. Proekt. Inst. Osn. Khim.: Kharkov, U.S.S.R. *CA 79*, 135931. Ammonium chloride as a N fertilizer for corn was as effective as other N sources; no difference in protein content of the grain between the N sources was observed. Ammonium chloride inhibited somewhat nitrification processes and increased the mobility of organic substances in chernozem soils. However, these phenomena are subject to changes during the growing period and, therefore, cannot be regarded as an evidence of the negative effect of NH_4Cl on soil fertility.

294 Effect of Potassium Fertilizers on Maize. S. I. Pshenichnaya (Ukrain. Nauch.-Issled. Inst. Rast., Selektsii i Genetiki, Khar'kov, U.S.S.R.). *Agrokhimiya*, No. 5, 40-6 (1972) (Russ). *Soils Fert. 35*, 5421. In a 3-yr pot experiment with thick leached chernozem to which NP was applied, K decreased cob yield when the soil moisture content was 60% of the moisture capacity. At 40% of the moisture capacity, K at 0.1 g/kg of soil increased yield but K at 0.15 g did not. Splitting the K application between basal application and 2 topdressings did not increase its effectiveness compared with basal application.

295 Nutrient Removal By Maize and Grain Quality in Relation to Fertilizers on Dark Chestnut Soils of the Central Foothills of Dagestan. V. V. Savotskii and A. B. Salmanov (Dagestanskii Nauch.-Issled. Inst. Sel. Khoz., Makhachkala, U.S.S.R.). *Agrokhimiya*, No. 6, 81-5 (1972) (Russ). *Soils Fert. 35*, 5416. In a 2-yr experiment $N_{90}P_{90}$ (as superphosphate and NH_4NO_3) increased grain yield, but K had little effect. NP and NPK increased N, P, and K removal by the subaerial mass. $N_{120}P_{120}K_{60}$ gave the highest protein content (11.7%) in the grain, and $N_{90}P_{90}K_{60}$ the highest oil content (5.5%); NP and NPK decreased the starch content.

296 Effect of Phosphorus and Potassium on Corn Productivity in the Colchis Plain. A. A. Shengeliya. *Subtrop. Kul't.* (3), 113-16 (1972) (Russ). *CA 77*, 150894. Corn was fertilized with P rates (40, 80, 120, 160 kg/ha) on a N-K background or with K rates (20, 40, 60, 80 kg/ha) on a N-P background. The 120 P rate and the 60 kg/ha K rate were optimal for corn. The efficiency of P and K fertilizers was higher on heavy loamy soils than on medium-loamy ones. Soils of excessively humid regions responded better to P than to K fertilization.

297 Effect of Soil Moisture on the Intensity of Nitrogen Uptake Into the Aboveground Organs of Corn. O. E. Shvedova (Inst. Fiziol. Ros., Kiev, U.S.S.R.). *Dopov. Akad. Nauk Ukr. RSR, Ser. B33* (7), 657-61 (1971) (Ukrain). *CA 75*, 95443. Nitrogen utilization was inhibited in corn grown at low soil moisture, 35% of capacity, due to inhibited uptake by the roots and inhibited movement from stem to leaves and reproductive organs. Experiments were done with the hybrid VIR 156 at the above and 70% soil humidity and root nutrition with NH_4NO_3. At various growth stages NH_4NO_3 was labeled with $NH_4{}^{15}NO_3$. In early growth no visible effect of moisture level was found, but the utilization of N and other mineral nutrients was sharply decreased at 35% soil moisture, resulting in reduced growth during the later stages. The amount of ^{15}N decreased with increasing distance of the corn tissue from the roots.

298 Effect of Nutritive Status on Assimilation of Nitrogen, Phosphorus, and Potassium and on the Productivity of Corn. A. I. Siritsa and E. V. Belyaeva. *Tr. Prikl. Bot., Genet. Selek. 48* (1), 63-74 (1972) (Russ). *CA 80*, 36273. Fertilizer

experiments with various combinations of N 65, K 40, and P 90 kg/ha were carried out on chestnut soils. In field experiments the yield of corn grain and dry matter depended mainly on P and partially on N application, whereas in pot experiments, N and N-P applications were most effective. In pot experiments the maximum grain yield was obtained with N-P fertilizers. The protein content of the grain was highest when N or N-K fertilizers were applied; that of oil increased when P and N-P fertilizers were given; and the ash content of the grain increased when P and P-K fertilizers were supplied.

299 Ratio of the Photosynthetic Apparatus and Corn Productivity Indexes Under the Effect of Trace Elements. M. V. Sivtsev and L. S. Kolpina (Krym. Pedagog. Inst. im. Frunze, Simferopol, U.S.S.R.). *Fiziol. Biokhim. Kul't. Rast. 3* (4), 434-40 (1971) (Russ). *CA 76*, 24047. Results of field experiments during 8 yr in the Crimean foot-hills on calcareous chernozem were given. The seeds were soaked (20 mg of salts/l. water) with the following solutions: $MnSO_4$, $ZnSO_4$, $(NH_4)_2MoO_4$, $Na_2B_4O_7$. Manganese, Zn, Mo, and B increase the surface area of leaves, the protein content, and the yield.

300 Use of Urea Under Corn in Field and Pot Experiments. N. P. Smykova. *Zap. Voronezh. Sel'skokhoz. Inst. 40*, 210-18 (1969) (Russ). *CA 75*, 19314. Urea (I) was compared in field trials with NH_4NO_3 (II). N-P-K was applied in ratios 60:60:60 and 90:90:90. Control plots received no fertilizers. The highest yield of grains was observed in 60:60:60 fertilized plots. The height of I-fertilized plants and the wt of their cobs and grains in pot tests was 5-10% higher as compared with II fertilization. Examination of the chemical composition of grains showed a higher content of protein N in I-fertilized corn than in that given II.

301 Effect of Nutrition Conditions on the Amino Acid Level in Corn Plants. L. I. Sulimova. *Tr. Khar'kov. Sel'skokhoz. Inst. 90*, 51-6 (1970) (Russ). *CA 77*, 33475. Corn plants were grown in a soil fertilized with various doses (30, 60, or 90 kg/ha) of N-P-K fertilizers enriched with Mo or Zn. Determination of free and bound amino acids was done after usual methods during the 6-7 leaf stage, and in kernels in the full ripeness phase. Application of mineral and trace elements affected the amino acid content in both plants and seeds. With an increase of fertilizer doses, the content of free and bound amino acids increased. Trace elements only affected the amino acid content when they were applied together with high doses of mineral fertilizers. The free amino acid content in mature seeds was slightly decreased after the application of Mo. Content of bound amino acids in the seeds increased in variants fertilized with high fertilizer doses. Young plants and mature seeds contained 17 free and 14 bound amino acids. The main free amino acids present in young plants, were alanine (I), aspartic acid(II), serine, and glycine; in mature seeds, II and glutamic acid (III). Bound amino acids were represented in young plants mainly by I, II, III, leucine (IV), and proline (V), and in mature seeds by tyrosine, and II-V.

302 Application of N-P-K, Calcium, and Magnesium Fertilizers to Corn and Potato Crops Under Polessie Conditions. V. I. Verzhbitskii. *Nauch. Tr., Zhitomir. Sel'skokhoz. Inst. 16*, 175-81 (1969) (Ukrain). *CA 75*, 75440. Since most of the sandy and sandy loamy sod-podzol soils contain insufficient amounts of available Mg, which is the main reason for their low productivity, the effects were studied of MgO applied in combinations with N-K, N-P-K, and N-P-K-Ca at levels corresponding to 40 kg/ha to potatoes and corn grown in pot cultures and under field conditions. The best results were with N-P-K-Mg and N-P-Ca-Mg, which in corn increased the yields of grain by 120.4 and 105.1%, total green mass by 33.0 and 38.6%, yields of ears at milky stage by 27.6 and 38.5%, and content of crude protein in grain by 10.22 and 9.53%, respectively.

303 Artificially Producing Zinc Deficiency and Excess in Corn Plants. P. A. Vlasyuk *et al* (Inst. Fiziol. Rast., Kiev, U.S.S.R.). *Mikroelem. Biosfere Primen. Ikh. Sel Khoz. Med. Sib. Dal'nego Vostoka, Dokl. Sib Konf., 3rd*, 240-7 (1969; Publ. 1971) (Russ). Edited by V. R. Filippov. Akad. Nauk SSSR, Sib. Otd., Buryat. Filial: Ulan-Ude, U.S.S.R. *CA 79*, 135903. Corn plants were grown in salt solutions containing no Zn or Zn in optimal or toxic concentrations (0.5 and 5.0 mg/l., respectively). Zinc deficiency or excess retarded corn growth, the leaves became small and the plants perished at the blooming stage. Zinc deficiency caused more marked changes in the plant appearance than its excess.

304 Corn in Fodder Crop Rotations and in Monoculture. S. A. Vorob'ev and Y. D. Ivanov (Mosk. S.-Kh. Akad. im. Timiryazeva, Moscow, U.S.S.R.). *Izv. Timiryazev. Sel'skokhoz. Akad.* (1), 25-34 (1973) (Russ). *CA 78*, 96550. The effect of fertilization [manure 30 tons/yr/ha, N-P-K (80:100:100 kg/ha) and manure 15 tons/ha + N-P-K (40:50:50 kg/ha)] on the green mass and protein yields and on mineral nutrition of corn in crop rotations (winter wheat-potato-corn-bean, winter wheat-beet-potato-corn, and beet-potato-corn-potato) and in monoculture was studied. The highest green mass and protein yields of corn were obtained in the beet-potato-corn-potato crop rotation. N-P-K fertilization was more effective than manure alone; in the monoculture the half-manure and half-N-P-K treatment gave the best results. The N:P:K ratio in corn on nonfertilized soils was 3:1:3.1 and on fertilized soils 2.6-2.8:1:2.8-3. The nutrient accumulation by corn depended on the yield level and it was N 40-110, P_2O_5 13-42, and K_2O 41-119 kg/ha.

305 Use of Ammonium Chloride as Fertilizer for Farm Crops. A. M. Vyshinskii *et al* (Ukr. Nauchno-Issled. Inst. Zemled., Kiev, U.S.S.R.). *Mater. Soveshch. Primen. Khloristogo Ammoniya Kach. Udobr.*, 10-34 (1970) (Russ). Edited by V. I. Panov. Gos. Nauch. Issled. Proekt. Inst. Osn. Khim.: Kharkov, U.S.S.R. *CA 79*, 135858. The use of NH_4Cl as a N fertilizer for winter wheat, corn, potatoes, sugar beets, long-fiber flax, lupine, perennial grasses, and rice was studied on various soils and in various climatic zones of the Ukraine. Ammonium chloride was successfully used in early spring for winter wheat topdressing, especially on chernozem, dark-gray, and gray podzolized soils, and on flooded and dryland meadows of the Ukrainian Polesie. Ammonium chloride was as effective as $(NH_4)_2SO_4$ as a N fertilizer for rice. However, NH_4Cl was less suitable as a N fertilizer for corn and completely unsuitable for potatoes. No conclusive results were obtained in experiments with sugar beets, flax, and lupine. In view of the fact that the action of Cl^-, present in NH_4Cl, on the physical properties of soils and on particular crops is not yet sufficiently clear, the use of NH_4Cl in Ukrainian agriculture should be limited.

306 Effect of Uranium on the Yield of Corn. V. F. Yakobenchuk. *Nauk. Pr., L'viv. Sil's'kogospod Inst. 27*, 108-12 (1970) (Ukrain). *CA 77*, 87040. The corn plants were grown in soil fertilized with single, double, or triple doses of N-P-K fertilizers with or without an addition of uranyl acetate salts (I) in quantities of 10^{-5} and 10^{-6}%. An addition of I to the N-P-K fertilizers increased the yield of plant green mass

2-fold due to activation of the plant biochemical processes. A I application to the soil without the N-P-K inhibited plant growth and development. An addition of N-P-K diminished especially the α- and β-radioactivity of the plants.

307 Effect of Ammonium Polyphosphate on Corn Dependent on Soil Properties. F. V. Yanishevskii, O. G. Fomina, and A. P. Chernukhina (Ramensk, Agrokhim. Opytn. Stants., Nauchno-Issled. Inst. Udobr. Insektofungits., Ramenskoe, U.S.S.R.). *Agrokhimiya*, No. 5, 3-7 (1972) (Russ). *CA 77*, 74190. Ammonium polyphosphate and NH_4 orthophosphate gave similar results with corn on sod-podzolic and chernozem soils. The first fertilizer was more effective than the second one on a sierozem soil, probably because of an enhanced uptake of P, Zn, Fe, and B by the plants.

308 Effect of the Long-Term Use of Phosphorus Fertilizers on Zinc Availability. N. V. Yarovoi, V. A. Meshcherina, and V. P. Garkushin (Donskoi S.-Kh. Inst., Persianovka, U.S.S.R.). *Khim. Sel. Khoz. 11* (6), 411-12 (1973) (Russ). *CA 79*, 77452. Application of 780 kg P/ha during a period of 15 years (an amount higher than that utilized by cultivated crops during that period of time) increased the content of available P in a chernozem soil and decreased the amount of available Zn (from 1.2 mg/kg soil to traces in the 0-20 cm layer). Corn cultivated on soils with a high level of available P requires an application of 5-8 kg Zn/ha. Application of high rates of P fertilizers increased all P forms in the soil, but especially the content of HCl-extractable P.

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309 Effect of Various Amounts of Nitrogen, Phosphorus, and Potassium Fertilizers on the Level of Nitrogen, Phosphorus, and Potassium in the Aboveground Parts of the Corn Plant. Radivoj Curic (Inst. Poljopr. Istraz., Novi Sad, Yugoslavia). *Agrohemija*, 9-12, 381-94 (1972) (Croat). *CA 79*, 30896. Application of N rates up to 100 kg N/ha resulted in an increase in the N content of corn. The N content of the cob, and the P and K content of the entire plant did not visibly change, regardless of the amount of N fertilizers applied; high N amounts tended, however, to decrease the K content of corn plants. Phosphorus fertilizers, regardless of the rate applied, had no effect on P nutrient accumulation by corn but the K content in corn plants decreased with increased K doses.

310 Testing of Various Combinations, Amounts, and Methods of Application of Some Trace Elements for Certain Characteristics and Yield of Corn on Chernozem-Type Soil. Stevan Jeftic (Poljopr, Fak., Inst. Poljopr. Istraz., Novi Sad, Yugoslavia). *Agron. Glas. 31* (10-12), 675-88 (1969) (Croat). *CA 75*, 109335. The effects of B, Cu, Zn, Mn, Mo, and Co (applied separately or in combinations) on yield and quality of corn (Kansas 1859 variety) grown on a chernozem soil were studied over a period of 3 yr. Three methods of applying the trace elements were compared: (1) presowing dusting of seeds; (2) application of a N-P-K fertilizer as the trace element carrier; and (3) spraying plants with aqueous solutions of the trace elements. The trace elements were always given at 3 dosages (low, medium, and high; for example 0.25, 0.5, and 1.0 g B/kg of seeds). Treated seed germinated poorly. The methods (2) (at all 3 dosages) and (3) (at the medium rate) gave comparable yields of grain that were higher as compared with those of controls. Generally, the best results were obtained when trace elements were mixed with the N-P-K fertilizer.

311 Effect of Fertilizer Nitrogen on Normal and Opaque-2 Corn. Danica Jelenic and Vesna Hadzitaskovic-Sukalovic (Inst. Kukuruz, Belgrade, Yugoslavia). *Agrohemija*, 9-12, 411-15 (1972) (Croat). *CA 79*, 30897. The effect of N rates on N nutrition and metabolism by Opaque-2 and normal corn varieties was studied. As an indicator of kernel quality, the contents of protein and essential amino acids were determined. Nitrogen application at the growth phase before tasseling caused an increase in the total protein, albumin, and globulin contents, and may be recommended for protein enrichment of high-lysine corn forms. High N doses strongly influenced the composition of proteins in Opaque-2, increasing especially the zein and free amino acid content and decreasing that of most essential amino acids; this decreased the biological value of the corn protein. Normal corn forms were less sensitive to high N doses.

312 Available Zinc Levels in the Soils of Macva and the Effect of Zinc Fertilization on the Yield of Corn. R. Kovacevic and M. Glintic (Inst. Soil Sci., Belgrade, Yugoslavia). *Agrohemija*, 9-12, 469-80 (1972) (Croat). *CA 79*, 30889. The content of soil-available Zn varied from 1.5 to 18 ppm and the Zn variability was not dependent on soil type. Zinc content of chernozem and black marshy soils seemed not to influence the effect of Zn fertilization on corn yield on these soils. Zinc fertilization affected positively the corn yield on the marshy soil but had no effect on corn on the chernozem soil. Best results on the former soil were obtained with a rate of 2 kg. The fact that Zn was not effective on chernozem may be explained by antagonistic relations between P and Zn. It is possible that higher Zn rates could be effective also on chernozem soils.

313 Effect of the Time of Fertilizer Use on Maize Yields on Kosovo Smonitsa Soil. D. Stanisavljevic (Inst. Agr. Res., Pristina, Yugoslavia). *Savr. Poljopr. 17* (4), 313-18 (1969) (Slovak). *Field Crop Abstr. 23*, 3223. Fertilizer experiments are reported, as a result of which it is recommended that in the region concerned N should be applied to maize at 40-60 kg/ha at sowing and 40-60 kg subsequently in 1 or 2 topdressings.

BOOKS AND REVIEWS

314 Fertilizer Guide for Food Grains in the Tropics and Subtropics. J. G. deGeus *Centre d'Etude de l'Azote, Zurich*, 2nd Ed. (1973) (Eng).

315 Bibliography of Corn. *International Maize and Wheat Improvement Center*, Mexico and George Washington University, Washington, D.C., Biological Sciences Communication Project. Metuchen, N.J.: Scarecrow Press, 3 Vol., 1887 pp. (1971). (Fertilizers for Corn, Vol. 2, 633-735).

316 Plant Analysis as an Aid in Fertilizing Corn and Grain Sorghum. J. B. Jones, Jr. and Harold V. Eck (Univ. Georgia, Athens). *Soil Test. Plant Anal., Rev. Ed.*, 349-64 (1973) (Eng). Edited by Leo M. Walsh. Soil Sci. Soc. Amer.: Madison,

Wisconsin. *CA 79*, 125043. A review with 63 refs. Proper sampling of the corn plant is necessary for reliable analysis, and the nutrient concentrations vary widely in different parts of the plant and with different genotypes. Research is needed to improve sampling techniques, and the distribution of a particular element among different plant parts and cells may be more useful than a single determination of that element.

317 Anhydrous Ammonia for Field Crops; An Evaluation of Anhydrous Ammonia as a Nitrogen Supply for Cotton, Corn, Rice, and Wheat. M. T. Eid. *Cairo, Egypt:* General Organization for Agricultural Crops Equilization (sic) Find, 257 pp. (1972).

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J. Indian Bot. Soc. (Journal of the Indian Botanical Society)
JNKVV Res. J. (Jawaharlal Nehru Krishi Vishi Vidyalaya Research Journal)
J. Res. Punjab Agr. Univ. (Journal of Research, Punjab Agricultural University)
J. Sci. Food Agr. (Journal of the Science of Food and Agriculture)
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Rostl. Vyroba [Rostlinna Vyroba (Praha)]

Savr. Poljopr. (Savremena Poljoprivreda)
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Subtrop. Kul't. (Subtropicheskie Kul'tury)

Tr. Bot. Inst., Akad. Nauk SSSR, Ser. 4 (Trudy Botanicheskogo Instituta Akademiya Nauk SSSR, Seriya 4)
Tr. Khar'kov. Sel'skokhoz. Inst. (Trudy Khar'kovskogo Sel'skokhozyaistvennogo Instituta)
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Zap. Voronezh. Sel'skokhoz. Inst. (Zapiski Voronezhskogo Sel'skokhozyaistvennogo Instituta)

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