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# TENTH ANNUAL REPORT

of the

AID-ARS Project

Major Cereals in West Africa
1973

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# GENERAL RESUMÉ

S. A. Eberhart
USDA, ARS Research Leader
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After 24 years of continuous cropping, adequate yields can still be maintained at Samaru by the use of chemical fertilizers. The principle effect of farmyard manure on maize yields was as a source of N and P; and there was still no response to potassium even though all residue had been removed each year.

Moisture stress and reduced nitrogen availability are two of the dominant factors contributing to the lower yield from late planting of maize at Samaru. Other factors may be important on some sites and some years, however, such as excess moisture at planting on poorly drained sites.

When chemical fertilizers are applied continuously at Samaru, the ratios of exchangeable cations can easily be upset. Application of excess potassium can reduce the ratio of exchangeable Mg:exchangeable K in the topsoil to dangerously low levels. In fact yield was negatively correlated ($r = -.48^{**}$) with % potassium saturation of the exchange complex.

In an intercropping experiment involving maize, millet, and sorghum, yields were 23% higher from the intercropped plots than for the mean of corresponding single-crop plots. All combinations involving maize were better than the standard millet/sorghum intercrop, and sorghum/maize outyielded maize alone by only 6%.

From screening 3,000 lines in the World Sorghum Collection, 45 were identified as having midge resistance at Samaru. These lines have been sent to the USA for inclusion in the sorghum conversion program and breeding populations and to ICRISAT.

Date of planting studies with sorghum indicated that early planted sorghum (June 11) escaped shoot fly attack. There was a gradual buildup of shoot fly however, until the last planting (August 20) in which 90% of the plants were attacked. Similar results were obtained for maize with maize streak virus with an 80% infection on the last planting (August 20).

In recent years it has become apparent that significant advantages, both in terms of drought avoidance and yield potential, could be gained by using early maturing, photoinsensitive varieties of sorghum instead of the late maturing, photosensitive varieties presently in use throughout much of West Africa. But the early maturing varieties produce their grain under wet and humid conditions and can be severely infected with grain molds. Hence, the early maturing varieties must have resistance to grain molds. After screening many lines from the World Sorghum Collection, 40 lines with grain mold resistance

were identified. Generally, the more resistant types, particularly among the light colored varieties, had a higher proportion of corneous endosperm than did unsusceptible types. Several of these lines are agronomically acceptable varieties, and 10 of these are being increased for more extensive testing.

Under severe Striga infection five susceptible sorghum varieties yielded 5% to 37% of the yield obtained under Striga-free conditions. Lines with resistance to Striga have been identified, and these yielded 53% to 78% as much under Striga infection as they did on Striga-free soil.

Further evidence for possible physiologic variability in downy mildew of millet (Sclerospora graminicola) was obtained. Several millet lines showed significant difference in levels of mildew obtained when grown at Kano compared to the level obtained at Samaru. Materials resistant in Senegal have been susceptible in Nigeria. A cooperative trial with the IRAT pathologist at Bambey, Senegal, has been planned to further investigate the possibility of variability of S. graminicola in West Africa.

Downy mildew (Spherecelotheca sorghi) has been observed on maize in the Samaru area for the past several years. Although downy mildew can cause serious losses in Asia, it has only rarely been noticed in West Africa.

The NCA x NCB variety cross, the corresponding IITA variety cross, and the Pioneer double cross hybrid, XB101A, continued to give high yields in Nigeria and in the West African Uniform Maize Trials (WAUMT). The yields of short Tuxpeno Planta Baja from CIMMYT were similar to those for NCA and 88% as much as TCB(S)C2 at five locations in the WAUMT.

In maize package trials for local farmers, the improved variety appeared to be the most important input as yields with a local variety were 49% of the improved variety even though all other inputs were supplied. Individual farmers obtained yields as high as 40 q/ha with the recommended package of practices.

Population improvement was continued in NCA, NCB, SC123, and 096 with full-sib selection for increased yields and reduced lodging. A selection program for increased amounts of high quality protein was initiated based on Udy readings. When the amino acid contents were determined by the amino acid analyzer for 14 breeding populations in a preliminary study, Udy readings were highly correlated with lysine content and total basic amino acids.

Seed increases were made of the released varieties SC123, NCA, NCB, and 096 in order to have seed available to the extension service for the maize demonstration plots. Because the demand from the extension service was so large, the 220 quintals produced will not be adequate.

Problems involved with hybrid seed production in sorghum continue to limit production. The low yields and photoperiod sensitivity of the local lines appear to make dry-season production uneconomical. In contrast, the nonsensitive U.S. lines gave good yields in the dry season.

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Dr. King will be leaving in February 1974 and is to be replaced by Dr. N. Zummo. Dr. Barry will be leaving in July 1974 and hopefully will be replaced. Also, an assistant to handle administrative matters and seed production activities is expected this spring.

Mr. Adeniyi will transfer to Extension Research Liaison Section in Ilorin in March 1974, and Mr. Adedzwa will be going to Iowa State University for additional training in March 1974. As a result, the only maize breeder left will Be Dr. Goodrich until Mr. Adedzwa returns in the fall of 1975.

The assistance and support of numerous senior and junior staff of the Institute for Agricultural Research and the helpful cooperation of Mr. Michael Harrison of the International Institute for Tropical Agriculture, the maize workers of the Federal Division of Research at Moor Plantation, and the Division of Quarantine and Plant Protection of the Federal Ministry is gratefully acknowledged. The friendly reception we have received from IRAT personnel has been very helpful in our travels in Francophone Africa.

## SOILS AND AGRONOMY

K. R. Stockinger

For the fourth year in a row rainfall was below normal and maldistributed. The rains were late and slow in starting, but the early end of the rains was disastrous. At Samaru the effective rains ended the middle of September, and the crops had to finish on stored moisture. This did not affect early maturing crops, but sorghum and late-planted maize yields were reduced. Further north the late start and very early end of the rains were disastrous with another severe drought and failure of many groundnut and sorghum crops. At Kano the groundnuts in the DNPK experiment were a complete failure. Rainfall figures for Samaru are given in Table 1 of the maize report.

Several official trips were taken in 1973 to coordinate project activities with other agencies, to increase cooperation, and to become acquainted with the research and exchange ideas with workers in related fields. The return from home leave was routed through Hawaii, the Philippines, Thailand, and India to confer with scientists working in tropical agriculture.

In Hawaii, I visited with the Soil Science Department of the University of Hawaii in Honolulu. I was especially interested in the research being done on phosphorus fixation by Dr. Fox. The concept of determining the amount of phosphorus fertilizer needed to bring the water-soluble phosphorus to a critical level, which varies with the crop, was most interesting. Dr. Mokwunye, Soil Chemist with IAR Samaru, is now using this concept to study phosphate fertilization of Nigerian soils.

In the Philippines, I visited the International Rice Research Institute at Los Banos. In addition to the work on rice, they are working on increasing the efficiency of land use by multiple cropping. By interplanting during the final stages of one crop with the succeeding crop, irrigation, and fertilization they have gotten five crops a year from the same plot of ground. It was interesting to see that the combination of outstanding facilities combined with a top-notch staff was producing results by concentrating on all aspects of one crop.

In Thailand, I visited the Southeast Asia Corn Improvement program of the Rockefeller Foundation. I met Dr. Renfro who is in charge of the program, and he introduced me to various staff members and also the soils and agronomy staffs of the University in Bangkok. I visited the field site where plant breeding was going on and was very impressed with the low ear height of their improved varities. It would be desirable to test these varieties in Nigeria if some way could be found to get them through plant quarantine.

In India, I visited the International Crops Research Institute for Semi-Arad Tropics at Hyderabad. The Institute is just getting started, and no permanent buildings have been completed as yet. The land has been acquired, and some research is already started. In the farming systems side of the program ratooning of millet was a quick and economical means of getting two crops from the same piece of land in a rainy season. Nigerian varieties do not ratoon well, and Indian varieties need to be introduced to test this for Nigeria. Also the scheme for watershed management, where all the water is

either stored in the soil or the runoff is stored in a pond for supplemental irrigation or to extend the growing season, was interesting. It might be useful in West Africa under special conditions. ICRISAT hopes to establish substation in West Africa working on sorghum and millet about the time the Major Cereals Project is scheduled to phase out. There was considerable discussion about our ongoing research program and the proposed research program of the West African substations.

In October 1973, a trip was made by automobile to Niger, Upper Volta, and Ivory Coast with Dr. Barry and Dr. King to confer with agricultural scientists and look at research in progress in the various countries. A detailed trip report has been distributed, but the trip was invaluable in finding out what the problems are and what work is being done in these countries.

In December 1973, a trip to Bambey, Senegal, was taken as part of an annual exchange of visits between scientists of IAR/Samaru and IRAT/Bambey. This program was between soil scientists and was especially interesting to us because Mr. Adeoye, a JP-26 participant who returned in June from Iowa State with a Masters degree, is planning to study the effects of tillage on soil conditions and crop growth. Since Bambey has done many tillage experiments, a review of their work was helpful in planning tillage studies for Nigeria. Their work emphasizes the importance of fall tillage and the incorporation of organic matter. Pits dug in some of the plots showed moist soil below six to eight inches in the tilled plot and bone dry in the untilled plots. Other topics discussed included long-term effects of fertilizer on soil, effect of continuous farming on productivity of soils, and the nutrient supplying power of the soil. It was a very rewarding interchange of ideas and should be continued in other disciplines.

From Senegal, I went to the Ivory Coast to join Drs. Barry and Goodrich to determine what assistance was needed to increase maize production and grow soybeans. This was in response to a request for help from the President of Ivory Coast to Dr. Butz, the Secretary of Agriculture. It was found that they needed and wanted little or no help with maize production but did want help with soybeans. We referred them to the International Soybean Program at the University of Illinois for help in starting a breeding and production research program for soybeans. A detailed trip report on this phase has been submitted.

## Long-Term DNPK Experiment

This experiment has been continuously cropped now for 24 years. In 1972, the rates of N, P, and K were increased sixfold so that the yield potential of a crop such as maize could be more fully utilized to test the treatment effects.

After 24 years of continuous cropping, with all the residues removed, there is still no effect of potassium on yield. Chemical tests have shown that the soils of this site are naturally high in potassium. Also, because of the low yield level of the crops before 1972, the amount removed has been

relatively low. It will be necessary to continue this experiment to find out if the soil potassium can be reduced to a point where it limits yields.

Table 1 shows the effect of the different levels of manure and nitrogen on yield of maize from plots receiving phosphorus fertilizer. The response to 67 ($N_1$) and 132 ($N_2$) kg/ha of nitrogen is much greater than the response to 2½ and 5 metric ton/ha. Examination of the data indicates that 2½ tons ($D_1$) of manure supplies the equivalent of about 20-25 kg/ha of nitrogen fertilizer. There was no interaction, and the two effects are additive.

Table 1. Yield of maize in kg per hectare of the farmyard manure and nitrogen treatments receiving phosphorus fertilizer.

| | No | N1 | N2 |
|---|---|---|---|
| Do | 330 | 2660 | 3900 |
| $D_1$ | 920 | 3750 | 4500 |
| $D_2$ | 2000 | 3730 | 5180 |

Table 2 shows the effect of the various levels of phosphorus and dung in the presence of nitrogen fertilizer on the yield of maize. The results show that 67($P_1$) kg of $P_2O_5$ is sufficient for maximum yields, and the 5 metric tons of manure also supplies nearly enough $P_2O_5$ for maximum yields under the conditions of the experiment. Since not enough nitrogen fertilizer was used for maximum yields, the effect of the nitrogen from the manure is evident in the $D_1$ and $D_2$ treatment levels of this table. Because of this effect it is not possible to estimate the amount of P O supplied by the manure treatment from the yield results.

Table 2. Yield of maize for 1973 in kg per hectare of the farmyard manure and phosphorus treatments receiving nitrogen fertilizer.

| | Po | $P_1$ | $P_2$ |
|---|---|---|---|
| Do | 660 | 3350 | 3210 |
| $D_1$ | 2160 | 4200 | 4060 |
| $D_2$ | 3820 | 4640 | 4270 |

The results show that after 24 years of continuous cropping the principal effect of farmyard manure on the yield of maize is as a source of nitrogen and phosphorus. Adequate yields can still be maintained by the use of nitrogen and phosphorus chemical fertilizers.

## Maize Date of Planting Experiments

by

K. R. Stockinger and M. J. Jones

For a fourth year, maize was planted at four dates from mid-May to mid-July under a range of fertilizer regimes and growth and development followed by plant sampling and chemical analysis. Movement of mineral nitrogen was followed in cropped and uncropped plots by frequent sampling of the soil down to 75 cm.

As in previous years, in those treatments receiving both N and P fertilizers, highest yields were obtained from the second planting:

| Planting: | I | II | III | IV |
|---|---|---|---|---|
| Planting date: | 15-24 May | 3-9 June | 24 June-2 July | 14-15 July |
| Yields, kg per ha dry grain: | | | | |
| 1970 | 3207 | 4518 | 2683 | 1808 |
| 1971 | 5981 | 6512 | 4349 | 2577 |
| 1972 | 3480 | 5061 | 3963 | 2076 |
| 1973 | 4552 | 5262 | 4337 | 1938 |
| Mean | 4305 | 5338 | 3833 | 2100 |

(Mean daily yield decline: Period II - III - 68 kg per ha
Period III - IV -102 kg per ha)

Thereafter yield decline by 70-100 kg per ha for every day delay in planting.

As between the third and fourth plantings, the major factor behind the yield decline each year was the high-water stress at the grain-filling stage of the fourth planting. The importance of this effect was demonstrated in 1973 in a separate experiment in which supplementary irrigation, supplied during the last weeks of growth to a crop of maize planted on 6th July, increased the yield by 48 percent:

With irrigation: 3754 kg per ha
Without irrigation: 2535 kg per ha

However, the loss of yield between the second and third planting was probably mainly due to other factors. Soil and nutrient uptake studies have shown that where the nitrogen fertilizer is all applied to the seedbed, it is more rapidly lost from the rooting zone in later plantings. In 1973, the response to splitting the fertilizer (½ seedbed; ½ in six weeks) was three times as great in the third planting as in the first and second:

| | I | II | III |
|---|---|---|---|
| Unsplit N | 4603 | 4837 | 3854 |
| Split N | 4926 | 5191 | 4666 |
| % increase from splitting | 7.0 | 7.3 | 21.1 |

Another experiment to determine if the reduction in yield due to delay in time of planting was due to lack of nitrogen fertilizer at critical stages of plant growth was also carried out. Late plantings are subject to intense leaching and possible nitrogen deficiency in August and September during the flowering and grain formation period. To study this, six fertilizer timing regimes were compared at two dates of planting.

The table below gives the effect of these treatments on yield of maize grain. All treatments received 240 kg/ha of nitrogen as nitrochalk.

Table 3. The effect of date of planting and nitrogen timing on yield of maize in kg per hectare.

| | Time N applied after planting | Date of Planting June 11 | July 2 | Mean |
|---|---|---|---|---|
| 1. | all at 0 | 4990 | 4550 | 4760 |
| 2. | ½ at 0 and 8 weeks | 7070 | 3580 | 5330 |
| 3. | ½ at 0 and 10 weeks | 5070 | 4100 | 4590 |
| 4. | ½ at 0, ¼ at 8, 10 weeks | 5150 | 3520 | 4330 |
| 5. | 1/8 at 0, 3, 6, 7, 8, 9, 10, and 12 weeks | 6260 | 4920 | 5590 |
| 6. | ¼ at 0, 4, 8, and 10 weeks | 6160 | 4880 | 5520 |

Time of nitrogen application resulted in a significant effect on yield of maize with treatments 2, 5, and 6 being better than the other treatments. Treatment 2 gave the best yield with the first planting and one of the lowest on the second planting. The second application of nitrogen was applied to the June planting in early August and the July planting in early September. Since the most intense period of rain occurred right after the second application to the July planting, most of this nitrogen may have been lost by leaching. Also, in the second planting the yield potential was determined by the lack of rain after the middle of September with only about 25 mm of rain occurring after September 15. Any fertilizer applied after this date was not very effective. In general, the split application was not as important for the late planting because the yield ceiling in this experiment was determined by moisture and not by availability of nitrogen in the latter stages of growth.

Moisture stress and nitrogen availability are two of the dominent factors behind the "date planting effect" at Samaru. However, other factors may be important on some sites and some years such as excess moisture at planting on poorly drained sites resulting in poor stands and slow growth.

## Long Term Management Trials

by

M. J. Jones and K. R. Stockinger

### Cation balance experiment (Samaru)

This experiment was started in 1970 to follow changes in the distribution of exchangeable cations in the soil brought about by the application of mineral fertilizers (sources of calcium and potassium, and urea); and, in the longer term, the effect of these changes on crop growth and yield. Fertilizer treatments were applied for the three years, 1970-72; and in 1973 the cumulative effects were tested with a maize crop which received only a uniform dressing of nitrogen, as urea.

The most significant change in the soil was a large increase in exchangeable potassium, attributable largely to the practice followed in 1970-71 of returning the ash of crop residues to the soil (from cotton and sorghum crops, respectively) but also to potassium fertilizers where these were applied. One effect of this increase has been to reduce the ratio of exchangeable Mg: exchangeable K in the topsoil to dangerously low levels. Magnesium status of the maize crop was generally very low; index leaf Mg-content was very significan correlated with the soil ratio and yield.

Potassium is now almost certainly oversupplied in these soils, for maize grain yield was negatively correlated with the percentage potassium saturation of the exchange complex ($r = -0.481^{**}$).

Calcium effects have also been noticed. Joint application of nitrogen and potassium fertilizer significantly depressed exchangeable calcium levels in the topsoil and also depressed yields and shelling percentage of the 1972 crop of groundnuts. Groundnut yields were significatly correlated with exchangeable calcium.

Analysis of the results of this experiment are not yet complete, but it is already clear that the ratios of exchangeable cations in soils of this type are very easily upset and that this has serious implications for soil productivity.

### Residue management experiment

This experiment was started in 1971 to compare the effects of different crop residue management treatments (remove, burn, incorporate) in a continuous millet-maize rotation on (i) soil properties, and (ii) crop growth and yield.

Soil samples taken in 1973 showed that:
(a) there had been a small but general decline in soil pH, but the magnitude of the decline was significantly ($p = 0.05$) related to the crop residue treatment:

| Treatment | 2-yr pH change |
|---|---|
| Burn | -0.20 |
| Incorporate | -0.32 |
| Remove | -0.42 |
| S.E. | ±0.03 |

(b) residue treatments also affected levels of exchange cations:

| Treatment | 2-yr changes in each cations, me per 100 g | | |
|---|---|---|---|
| | Ca | Mg | K |
| | n.s. | * | ** |
| Burn | +0.09 | -0.034 | +0.019 |
| Incorporate | +0.04 | -0.026 | -0.001 |
| Remove | +0.08 | -0.068 | -0.057 |
| S.E. (±) | - | 0.007 | 0.008 |

(c) routine fertilizer applications of single superphosphate and calcium ammonium nitrate also had significant effects on these soil parameters. In particular, soil acidification was encouraged by the nitrogen source but discouraged by the superphosphate. Both, however, caused a significant reduction in the level of exchangeable magnesium.

The millet crop in 1973 lodged badly, and yields were rather low. Inter plot variability was high, and there was no significant effect due to residue management treatments; but as with maize in 1972, yields were in the order:

Burn > > Incorporate > Remove

In 1973, this order was most marked in those plots that received a high rate of nitrogen fertilizer but no phosphate:

| Treatment | Grain yield, kg per ha |
|---|---|
| Burn | 1075 |
| Incorporate | 843 |
| Remove | 706 |
| S.E. | ± 115 |

It seems likely that this effect derives from the phosphate content of the crop residues.

## Sorghum Variety and Nitrogen Timing Experiment

by

K. R. Stockinger

Since there appears to be a leaching loss of nitrogen and a probable deficiency of nitrogen late in the season when nitrogen is applied at planting, it was thought that long seasoned sorghums might respond to delayed application of nitrogen. To study this, five nitrogen timing variables of 160 kg/ha of nitrogen were applied to five varieties in a split plot design. The results are given below in quintals per hectare.

| Timing | C9357 | SK5912 | 2123 | 181 | 453 | Mean |
|---|---|---|---|---|---|---|
| A All at 0 wks | 17.8 | 33.5 | 20.0 | 17.0 | 17.2 | 21.1 |
| B ½ at 0, ½ head initiation | 17.0 | 33.0 | 25.2 | 21.8 | 18.2 | 23.0 |
| C ½ at 0 ½ Sept. 15 | 18.0 | 36.0 | 23.8 | 20.2 | 19.5 | 23.5 |
| D ½ at head initiation, ½ September 15 | 17.0 | 31.8 | 20.5 | 24.2 | 21.8 | 23.0 |
| E Eight equal applications during season | 21.0 | 33.8 | 22.8 | 24.0 | 24.5 | 25.2 |
| Mean | 18.2 | 33.6 | 22.4 | 21.4 | 20.2 | 23.2 |

and the analysis of variance of the experiment

| Source of variation | Degree of Freedom | Mean Square | F |
|---|---|---|---|
| Replication | 3 | 165 | |
| Variety (V) | 4 | 730 | 12.44 |
| Error (a) | 12 | 58.7 | |
| Nitrogen (N) | 4 | 42.8 | 2.07 |
| A vs B,C,D,E, | 1 | 108.2 | 5.23 |
| N x V | 16 | 16.7 | |
| Error (b) | 60 | 20.7 | |

The results show a small but significant increase in yield due to splitting the application. The effect is largest in the three short-statured long-seasoned varieties. The taller variety Short Kaura, SK 5912, gave the best overall yield and was apparently not effected by the timing of the nitrogen application.

Yields in general were disappointing. The yields were undoubtedly reduced by the early end of the rains. Rain had effectively stopped two weeks before pollination, and the variety effect observed may be an expression of their drought tolerance. If this is so, SK 5912 has outstanding drought tolerance because it was the last to head. Yield of C9357, a Northrup King hybrid, was low because of the drought and also a poor stand. It was planted in mid-August during a period of cool, wet weather and got off to a slow start as a result.

More detailed physiology work is needed to see if the local varieties can use late application of nitrogen or if most of its nigrogen needs during

grain filling are supplied by translocation. Such work is in progress, but the chemical analyses have not been completed.

## Lysimeter Leaching Experiment

K. R. Stockinger

In 1973, the nitrogen leaching experiment was again carried out. In 1972, the nitrogen rate applied was 375 kg/ha and in 1973, 240 kg/ha. Treatments A and E were switched so that the rate of the nitrogen applied in 1972 could be followed and the loss from 1973 applied nitrogen could be measured under fallow conditions. All other treatments were the same, and the results are given below:

| 1973 Treatment Date of Planting | Nitrogen | Leachate in mm | N in leachate kg/ha 1973 | N in leachate kg/ha 1972 | Yield kg/ha |
|---|---|---|---|---|---|
| A Fallow | All July[1/] | 266 | 100 | 24 | |
| D Fallow | All June 9 | 278 | 191 | 41 | |
| E Fallow | None[2/] | 304 | 221 | 51 | |
| H June 9 | None | 280 | 1 | 3 | 13.5 |
| B June 9 | All | 213 | 50 | 7 | 59.8 |
| C June 9 | Split | 264 | 26 | 3 | 54.4 |
| F July 1 | All | 286 | 101 | 25 | 52.2 |
| G July 1 | Split | 285 | 62 | 20 | 41.0 |

[1/] No N in 1972

[2/] 375 kg/ha N in 1972 applied in a split application

The results show that much more nitrogen was lost in 1973 than in 1972. This was probably due to the more intense leaching during the first two weeks in September when 257 mm of rain fell. Also, last year the nitrogen was just starting to leach out of the profile when the rains stopped, so this year the nitrogen from last year was in a position to be leached and was removed. This is illustrated by treatments A and E. Although no nitrogen was applied to E in 1973, it lost the most nitrogen of any treatment. The concentration reached a peak of about 100 ppm and had declined to 65 ppm in one of these plots. In treatment A, it wasn't until the last storm that an appreciable concentration showed in the leachate. Early planting reduced the loss of nitrogen because of the longer period of growth before leaching started. Splitting the application also helps reduce the loss. The yield results show little or no effect from date of planting or split application. The split application on the July 1 planting has a low yield because of the poor stand in one plot due to rodent damage.

The results show that approximately 400 mm (300 in 1973 and 100 in 1972) of leachate are required to remove most of the nitrogen from a single large application. In dry years, with the rainfall well distributed (1972), leaching

losses are small. In dry years, with a short period of heavy rains (1973), leaching losses can be quite high. Early planting and split application will minimize losses. In years with above average rainfall leaching could become a serious problem.

## Intercropping Experiment

by

A. Kassam and K. R. Stockinger

An experiment utilizing knowledge of the growth pattern of millet and sorghum and predicting that maize could fit into this as an intercrop was carried out at Samaru. All combinations of two- and three-crop mixtures (millet/sorghum, millet/maize/sorghum, and millet/maize/sorghum) were compared with a sole crop of each. It was originally intended to include cotton and cowpea as relay crops, but because of the very late start to the season, these were omitted. It was not considered worthwhile to delay these crops because they would either have to be sown a month late or suffer abnormally heavy competition from the later-than-usual sown maize and millet. Yields from the sole and mixed crops sown are given in Table 1.

Table 1. Yields in kg grain $ha^{-1}$ when intersown with:

| Crop | Millet (a) | Maize (b) | Sorghum (c) | Both Other Crops |
|---|---|---|---|---|
| Millet | 1,607 | 838 | 780 | 606 (b,c) |
| Maize | 2,947 | 4,844 | 2,844 | 1,882 (a,e) |
| Sorghum | 2,488 | 2,301 | 3,998 | 1,798 (b,c) |

Varieties were 096 maize, ex Bornu millet and Short Kaura sorghum

To make valid comparisons between sole and intercropped yields, it is best to use the total grain yield obtained from a unit of land. In table 2, yields are given as kg grain $ha^{-1}$ on a comparative basis. For example, one ha of a millet/sorghum intercrop is compared with yield from ½ ha of sole millet plus ½ ha sole sorghum.

Table 2. Grain yields in $kg/ha^{-1}$.

| Crop | Sole Crop | Mixed Crop | % Gain from mixing |
|---|---|---|---|
| Millet | 804 | 838 | + 4.2 |
| Maize | 2,436 | 2,947 | + 21.0 |
| Total | 3,240 | 3,785 | + 16.8 |
| Millet | 804 | 780 | - 3.0 |
| Sorghum | 2,000 | 2,488 | + 24.4 |
| Total | 2,804 | 3,268 | + 16.6 |
| Maize | 2,436 | 2,844 | + 16.8 |
| Sorghum | 2,000 | 2,301 | + 15.0 |
| Total | 4,436 | 5,145 | + 16.0 |
| Millet | 536 | 606 | + 13.1 |
| Maize | 1,624 | 1,882 | + 15.9 |
| Sorghum | 1,333 | 1,798 | + 34.9 |
| Total | 3,493 | 4,286 | + 22.7 |

All combinations with maize were better than the standard millet/sorghum intercrop, and if farmers are loth to discard either millet or sorghum they can, by injecting maize, increase total grain yield even further.

# PLANT PATHOLOGY

S. B. King

## Sorghum

### 1. Grain mold resistance

In recent years it has become apparent that significant advantage, both in terms of drought avoidance and yield potential, could be gained by using early maturing, photoinsensitive varieties instead of the late maturing, photosensitive varieties presently in use throughout much of West Africa. Late maturing varieties produce grain under the dry conditions following the rains and, as a result, have good grain quality with little or no infection by grain molds. On the other hand, early maturing varieties produce their grain under wet and humid conditions of the rainy season and, as a result, can be severely infected by grain molds. Grain mold damage reduces grain quality, and such grain is especially undesirable for human consumption. Hence, if early maturing sorghums are to succeed as a source of human food in West Africa, it is essential that they have resistance to grain molds.

During the past three growing seasons, an effort was made to identify resistance to grain molds in the World Sorghum Collection and elsewhere. In 1973, a total of 174 promising lines were tested. Both light- and dark-colored grain types were included, although the greatest interest lies in light-colored types since these are more acceptable as human food.

Grain was evaluated for resistance on the basis of visual appearance of grain from bagged panicles harvested six weeks after flowering and open panicles harvested nine weeks after flowering. All grain developed under wet, humid conditions. Difficulties were encountered in evaluating grain; hence thrashed grain was evaluated using each of the following three techniques.

1. Two 100-seed samples were randomly selected from both open and bagged panicles, and each seed was separately evaluated for degree of mold discoloration using a 1-4 severity scale. The number of seeds falling into each category was multiplied by the severity value of each category, and all products were summed. A low total indicated a greater amount of grain mold resistance than did a high total.

2. This technique was much like number one above except that individual seeds were not evaluated, but instead an attempt was made to mentally divide the seed into 10 units and estimate the number of units which fit into each of the four severity categories.

3. This technique involved placing a seed sample of each entry into open petri dishes and lining up the petri dishes in order of least to most mold discoloration by comparison.

Results obtained by each of the three techniques were similar; however, the third technique was considerably less time consuming than either of the others.

The 40 best lines, each of the light- and dark-colored seeds, are presented in Table 1. They are ranked in order of their resistance based on technique three evaluation of grain from open panicles. All of these lines flowered in 49 to 70 days after planting. All samples were evaluated for the proportion of corneous to soft endosperm in the seed. Generally, the more resistant types, particularly among light-colored varieties, had a higher proportion of corneous endosperm than did susceptible types. The appearance of the grain of some of the better lines compared very favorabley with locally grown grain from late maturing varieties. Several lines are agronomically acceptable in their present form, and seed of 10 of these is being increased under irrigation for possible use in drought affected areas.

Table 1. Forty best grain mold-resistant lines of light- and dark-colored seed arranged in relative order of the best to poorest. Evaluation based on grain from open panicles using technique three.

| Light-colored seed | | | | Dark-colored seed | | | |
|---|---|---|---|---|---|---|---|
| Rank | Pedigree* | Rank | Pedigree | Rank | Pedigree | Rank | Pedigree |
| 1 | 2722 | 21 | 469 | 1 | 2361 | 21 | 2849 |
| 2 | 473 | 22 | 452 | 2 | 2596 | 22 | 8193 |
| 3 | 9225 | 23 | 453 | 3 | 3547 | 23 | 3171 |
| 4 | 472 | 24 | 466 | 4 | 8064 | 24 | 2240 |
| 5 | 3959 | 25 | 9672 | 5 | 660 | 25 | 2867 |
| 6 | 3958 | 26 | 519 | 6 | 9353 | 26 | 7618 |
| 7 | 8574 | 27 | 9676 | 7 | 2283 | 27 | 9326 |
| 8 | 9747 | 28 | 3443 | 8 | 7202 | 28 | 6992 |
| 9 | 3947 | 29 | 9607 | 9 | 2451 | 29 | Damouguri 55‡ |
| 10 | 8160 | 30 | 2210 | 10 | 931 | 30 | 7294 |
| 11 | 10398 | 31 | 2227 | 11 | 2444 | 31 | 9921 |
| 12 | 3956 | 32 | 455 | 12 | 2832 | 32 | 8575 |
| 13 | 3955 | 33 | 577 | 13 | 7353 | 33 | 9434 |
| 14 | 3555 | 34 | 2723 | 14 | 3821 | 34 | 8966 |
| 15 | CE-90† | 35 | 2430 | 15 | 8191 | 35 | 9388 |
| 16 | 468 | 36 | 3823 | 16 | 8143 | 36 | 12567C |
| 17 | 470 | 37 | 2213 | 17 | 7975 | 37 | 2334 |
| 18 | 3421 | 38 | 2219 | 18 | 3504 | 38 | 2365 |
| 19 | 2232 | 39 | 4707 | 19 | 3029 | 39 | 7775 |
| 20 | 474 | 40 | 2209 | 20 | 2438 | 40 | 6953 |

*I.S. number unless otherwise stated.
†From Senegal
‡From Cameroun

2. Striga resistance

a. State II screening.--A total of 176 lines from the world collection were planted in two replications, but the level of Striga infection was too low for a reliable resistance evaluation. This will need to be repeated in 1974.

b. Stage III--A total of 404 lines from the world collection were planted in four replications and evaluated for their reaction to Striga on the basis of leaf symptons and emerged Striga plants associated with the host. Fifty-six of these lines were identified for further testing in State IV in 1974.

c. Stage IV screening.--A lattice design was used for the first time in 1973 for field screening of Striga resistance in sorghum. It was felt that this type of design would be well suited to handle several replications of a large number of entries on a minimum amount of Striga-infested land. Both 9 x 9 and 11 x 11 lattices were used, and each was replicated eight times. A total of 197 different entries were tested with a set of five control entries appearing in both lattices. Plots consisted of single stands, each with three plants, and were spaced 0.71 m apart in each direction. All entries had passed through three previous field screenings except those listed in Table 4 which were generally tested for the first time in 1973.

Striga reaction was scored in terms of leaf symptons on the host and number of emerged Striga plants within a 0.30 m radius of each plot. The following 0 to 5 scale was used to score leaf symptoms:

0 = no symptons
1 = very slight symptons, possibly not noticeable to untrained eye.
2 = distinct symptoms, easily detected.
3 = moderate symptoms, very obvious.
4 = severe symptoms
5 = very severe symptoms, entire leaves killed

As much as possible, plants were scored for leaf symptoms during the first three weeks following blooming.

An average leaf symptom score of one or less is considered very good, and one as high as two is acceptable. Resistance of plants having leaf symptoms of two to three is questionable, and symptoms on the order of three or more likely cause significant yield loss, although the relationship between leaf symptom severity and yield loss is not clearly understood.

Counts were made on emerged Striga plants in mid-September and late October. The October counts were generally lower than the mid-September counts. This may have been due to accidental removal of some Striga plants along with weeds in early October and destruction of young Striga plants without subsequent recovery due to trampling.

Data presented in Tables 2, 3, and 4 represent the average of six replications which grew in Striga-infested soil in Block 4 at University Farm. This was planted on June 21 and 22. The level of Striga infection on the other two replications planted on the IAR Farm (filed V-2) was too low to obtain any useful information. Average emerged Striga plants associated with each three plant plot.

Each entry was given a relative resistance rating using a scale of one (highest) to four (lowest). This required a judgment decision which, in addition to data on Striga symptoms and number of emerged Striga plants, also took into consideration factors such as fewer than three plants per plot and varying lengths of growth cycles of the entries. Generally fewer emerged Striga plants are found associated with short-season sorghums than with long-season ones. This is likely most often due to "escape" rather than host resistance. Hence, long-season sorghums having few emerged Striga plants received a somewhat higher resistance rating than shorter season sorghums having comparable numbers of emerged Striga plants. Number of days to flowering is presented in the tables according to the following scale:

1 = less than 60 days from planting to flowering
2 = 60 to 80 " " " " "
3 = 80 to 100 " " " " "
4 = more than 100 " " " " "

It is felt that the technique described here is the best found to date for identifying Striga resistance in the field, but eight replications are recommended over six. Entries which fit into the first and second relative resistance categories are believed to have a very high level of resistance to Striga hermonthica. Entries in category four likely do not have sufficient resistance for further consideration. In Table 4, lines 181, 187, and RCS, are Nigerian sorghums, developed through breeding at Samaru, which showed a surprisingly high level of Striga resistance. CE-90 is a variety developed at Bambey, Senegal, which also appears to have good resistance at Samaru. The material from India was likely evaluated in India against Striga asiatica or S. densiflora or both. N-13 and Bouganhilo showed good resistance to S. hermonthica, but resistance in the other varieties from India did not exceed that of the susceptible Indian Check, Surat.

d. Yield at two dates of planting.--In 1972 there was evidence that sorghum, if planted very late (two months), would escape Striga infection. An attempt was made to study this in two early maturing sorghums, SA7706 and C 9357. A randomized split-plot design with five replications was used. The trial was located on land with heavy Striga infestation, and planting was done on June 20 and August 1. Due to poor establishment in the second planting and early termination of the rains, the yield of the second planting was extremely low. No useful comparative information was obtained.

e. Striga resistance and yield.--Little is known about the relationship of the Striga resistance identified at Samaru to yield. In 1973, a trial involving 11 resistant lines and five susceptible lines was planted in three types of soil: 1) soil heavily infested with Striga; 2) soil free of Striga; and 3) soil with an intermediate level of Striga. Identical randomized blocks with five replications were used at each location, and plots consisted of two 4.3 m rows. The trial was planted on June 25.

Results of the experiment are presented in Table 5. All yields were reduced by the intermediate level of Striga infestation, but resistant lines generally out performed susceptible lines. Under heavy Striga infestation, the best of the resistant lines yielded 78% of its yield on Striga-free soil, whereas the poorest of the resistant lines yielded 53% of its yield in Striga-free soil. On the other hand, the five susceptible check varieties yielded 37.2 to 4.6% of their yield obtained on Striga-free soil. Some yield loss in late maturing varieties was likely due to early termination of the rains. Shortage of moisture late in the season likely had a more adverse effect on Striga-susceptible than Striga-resistant material. Fewer emerged Striga plants were found associated with Striga-resistant lines than the susceptible checks, and generally more Striga plants were associated with late maturing types than with the early maturing types. The"percent of expected yield" decreased 2.6% with an increase of $1.0 \times 10^4$ Striga plants/ha for both the intermediate and high levels of infection ($r = -0.84$ for intermediate and $r = -0.92$ for high level).

Table 2. Summary results of stage IV field testing of world collection for *Striga* resistance in 9 x 9 lattices, 1973.

| Entry | | | Striga reaction | | | Relative |
|---|---|---|---|---|---|---|
| SRN | ISN | Flowering | Avg. leaf symptom score | Average *Striga* emerged score 1st count | 2nd count | *Striga* resistance category |
| 99 | 61 | 2 | 0.50 | 1.17 | 0.50 | 1 |
| 1325 | 1258 | 1 | 0.83 | 0.67 | 0.17 | 1 |
| 1542 | 6340 | 1 | 1.25 | 0.25 | 0.00 | 1 |
| 1571 | 1546 | 1 | 1.00 | 0.17 | 0.33 | 1 |
| 1705 | 2045 | 2 | 0.00 | 1.17 | 0.17 | 1 |
| 2248 | 7011 | 2 | 0.67 | 0.17 | 0.00 | 1 |
| 3226 | 7547 | 4 | 1.17 | 1.17 | 0.17 | 1 |
| 3299 | 7596 | 4 | 0.83 | 1.33 | 0.33 | 1 |
| 3338 | 7610 | 4 | 0.83 | 1.00 | 0.50 | 1 |
| 3585 | 7756 | 4 | 1.17 | 0.17 | 0.00 | 1 |
| 93 | 5550 | 2 | 0.83 | 1.67 | 0.17 | 2 |
| 134 | 5572 | 2 | 0.00 | 1.33 | 1.50 | 2 |
| 286 | 5670 | 3 | 0.20 | 2.20 | 1.80 | 2 |
| 333 | 5697 | 4 | 0.50 | 1.50 | 0.25 | 2 |
| 923 | 0932 | 2 ? | 1.33 | 1.80 | 0.40 | 2 |
| 941 | 6015 | 1 | 1.50 | 1.25 | 0.00 | 2 |
| 1013 | 1030 | 1 | 1.67 | 0.50 | 0.17 | 2 |
| 1082 | 6085 | 2 | 1.00 | 0.83 | 1.33 | 2 |
| 1083 | 6086 | 2 | 1.20 | 0.25 | 0.25 | 2 |
| 1151 | 1107 | 2 | 0.40 | 1.83 | 0.50 | 2 |
| 1244 | 6175 | 1 | 1.17 | 1.17 | 1.17 | 2 |
| 1280 | 6189 | 2 | 0.83 | 2.00 | 0.67 | 2 |
| 1596 | 6369 | 3 | 1.00 | 1.80 | 1.80 | 2 |
| 2091 | 6918 | 2 | 0.80 | 1.17 | 0.80 | 2 |
| 2163 | 2374 | 1 | 2.00 | 1.00 | 0.00 | 2 |
| 2189 | 6973 | 2 | 0.67 | 2.00 | 1.50 | 2 |
| 2423 | 2537 | 1 | 0.40 | 1.00 | 0.40 | 2 |
| 2598 | 7214 | 4 | 0.67 | 1.67 | 1.17 | 2 |
| 3636 | 7787 | 4 | 1.00 | 2.50 | 0.67 | 2 |
| 88 | 5541 | 2 | 0.80 | 3.00 | 2.80 | 3 |
| 107 | 0119 | 1 | 0.75 | 2.25 | 1.25 | 3 |
| 290 | 5474 | 3 | 0.17 | 5.50 | 3.67 | 3 |
| 292 | 5677 | 3 | 1.25 | 4.00 | 2.50 | 3 |
| 321 | 348 | 1 | 1.00 | 2.67 | 2.00 | 3 |
| 344 | 5710 | 2 | 0.33 | 4.00 | 3.67 | 3 |
| 352 | 0364 | 1 | 1.00 | 2.40 | 1.40 | 3 |
| 390 | 5733 | 1 | 1.84 | 1.50 | 0.17 | 3 |
| 1064 | 1052 | 2 | 1.17 | 2.33 | 1.50 | 3 |
| 1076 | 6079 | 2 | 1.60 | 0.60 | 0.40 | 3 |
| 1087 | 6090 | 2 | 1.60 | 2.60 | 1.20 | 3 |
| 1181 | 6136 | 1 | 2.00 | 2.50 | 1.00 | 3 |

Table 2 continued

| Entry | | | Striga reaction | | | Relative |
|---|---|---|---|---|---|---|
| | | | Avg. leaf symptom score | Average emerged Striga score | | Striga resistance category |
| SRN | ISN | Flowering | | 1st count | 2nd count | |
| 1194 | 6149 | 2 | 1.33 | 1.83 | 0.83 | 3 |
| 1402 | 1325 | 3 | 1.00 | 3.00 | 2.50 | 3 |
| 1584 | 6357 | 3 | 1.00 | 3.00 | 3.25 | 3 |
| 1734 | 6692 | 4 | 0.67 | 4.83 | 1.83 | 3 |
| 1778 | 6724 | 4 | 0.67 | 4.00 | 1.83 | 3 |
| 1819 | 2174 | 1 | 0.75 | 2.25 | 1.00 | 3 |
| 2063 | 2305 | 1 | 1.40 | 2.60 | 0.60 | 1 |
| 2136 | 6942 | 2 | 1.33 | 2.33 | 1.67 | 3 |
| 2286 | 7027 | 2 | 0.67 | 3.67 | 1.67 | 3 |
| 2356 | 2477 | 2 | 1.17 | 2.33 | 1.33 | 3 |
| 2524 | 2607 | 1 | 1.17 | 1.83 | 1.33 | 3 |
| 2564 | 2633 | 1 | 0.67 | 3.00 | 1.50 | 3 |
| 2643 | 7234 | 2 ? | 2.00 | 3.20 | 1.80 | 3 |
| 2755 | 2811 | 1 | 1.20 | 3.17 | 0.67 | 3 |
| 3443 | 7681 | 4 | 1.80 | 5.00 | 2.00 | 3 |
| 3556 | 3471 | 2 | 1.33 | 0.83 | 0.67 | 3 |
| 3647 | 7800 | 4 | 1.17 | 2.50 | 2.50 | 3 |
| 226 | 5627 | 2 | 2.00 | 4.67 | 7.33 | 4 |
| 230 | 5634 | 2 | 1.67 | 3.50 | 3.17 | 4 |
| 234 | 5638 | 3 ? | 2.00 | 3.33 | 3.50 | 4 |
| 246 | 5655 | 2 ? | 1.83 | 6.00 | 7.50 | 4 |
| 1285 | 6194 | 2 ? | 0.80 | 4.20 | 2.80 | 4 |
| 1466 | 1458 | 2 | 1.80 | 4.80 | 2.80 | 4 |
| 1570 | 1545 | 2 | 2.00 | 11.67 | 3.33 | 4 |
| 1613 | 1580 | 1 | 1.25 | 6.50 | 2.83 | 4 |
| 1922 | 2231 | 2 | 1.00 | 4.50 | 1.50 | 4 |
| 2068 | 2313 | 1 | 1.16 | 4.20 | 1.80 | 4 |
| 2093 | 6921 | 2 | 1.00 | 4.83 | 5.17 | 4 |
| 2368 | 2498 | 2 | 2.20 | 4.00 | 2.00 | 4 |
| 2479 | 7140 | 2 | 1.00 | 5.00 | 4.33 | 4 |
| 2504 | 2579 | 2 | 1.50 | 6.67 | 2.83 | 4 |
| 2712 | 2766 | 4 | 2.25 | 7.00 | 1.50 | 4 |
| 2803 | 2835 | 1 | 1.50 | 4.00 | 1.50 | 4 |
| 3103 | 3076 | 2 | 0.75 | 5.20 | 2.80 | 4 |
| *1352 | 1266 | 2 | 1.00 | 0.33 | 0.17 | 1 |
| *3172 | 3167 | 2 | 1.00 | 1.33 | 0.67 | 2 |
| *SK5912 | -- | 4 | 1.00 | 4.33 | 3.00 | 3 |
| *2072 | 2319 | 1 | 2.00 | 8.00 | 3.00 | 4 |
| *DFF2123 | -- | 4 | 2.00 | 7.33 | 4.17 | 4 |

*Control entries repeated in 11 x 11 lattices.

Table 3. Summary results of stage IV field testing of world collection sorghums for *Striga* resistance in 11 x 11 lattices, 1973.

| Entry | | | Striga reaction | | | Relative |
|---|---|---|---|---|---|---|
| SRN | ISN | Flowering | Avg. leaf symptom score | Average emerged *Striga* score 1st count | 2nd count | *Striga* resistance category |
| 155 | 0146 | 1 | 1.00 | 0.60 | 1.00 | 1 |
| 2014 | 2278 | 1 | 0.40 | 0.60 | 0.00 | 1 |
| 2045 | 6895 | 4 | 0.00 | 0.83 | 0.67 | 1 |
| 2752 | 2807 | 1 | 1.00 | 1.00 | 0.20 | 1 |
| 2773 | 2830 | 1 | 1.00 | 0.80 | 1.00 | 1 |
| 2829 | 7329 | 4 | 1.00 | 2.67 | 0.83 | 1 |
| 2836 | 7336 | 4 | 0.00 | 1.83 | 0.83 | 1 |
| 3168 | 3161 | 1 | 1.00 | 0.50 | 0.00 | 1 |
| 3172 | 3167 | 2 | 0.83 | 1.00 | 0.17 | 1 |
| 3554 | 3469 | 4 | 0.67 | 2.00 | 1.50 | 1 |
| 3821 | 3692 | 2 | 0.50 | 0.25 | 0.00 | 1 |
| 1192 | 6147 | 2 | 1.40 | 1.40 | 0.40 | 2 |
| 1250 | 6184 | 2 ? | 1.00 | 2.17 | 1.00 | 2 |
| 1352 | 1260 | 2 | 0.50 | 2.00 | 1.67 | 2 |
| 1880 | 6787 | 3 | 1.50 | 3.00 | 2.67 | 2 |
| 2074 | 2322 | 1 | 1.60 | 1.80 | 2.20 | 2 |
| 2083 | 6909 | 2 | 0.80 | 2.00 | 1.67 | 2 |
| 2370 | 2510 | 2 | 0.17 | 2.00 | 0.50 | 2 |
| 2388 | 7088 | 2 | 0.75 | 2.25 | 1.50 | 2 |
| 2391 | 7091 | 2 | 1.00 | 2.00 | 1.17 | 2 |
| 2461 | 2554 | 3 | 1.17 | 1.50 | 1.67 | 2 |
| 2696 | 7265 | 4 | 1.33 | 3.17 | 1.17 | 2 |
| 2709 | 2763 | 3 | 0.67 | 2.50 | 2.33 | 2 |
| 2839 | 7339 | 2 | 1.17 | 1.67 | 1.17 | 2 |
| 2844 | 7345 | 3 ? | 1.33 | 3.17 | 3.17 | 2 |
| 2896 | 7375 | 4 | 0.80 | 3.20 | 0.80 | 2 |
| 2939 | 7396 | 4 | 0.67 | 3.33 | 2.16 | 2 |
| 3414 | 3390 | 1 | 1.00 | 1.84 | 0.50 | 2 |
| 3467 | 3423 | 2 | 0.67 | 1.17 | 1.00 | 2 |
| 3506 | 3442 | 3 | 0.00 | 2.50 | 1.00 | 2 |
| 3575 | 3496 | 1 | 0.50 | 1.50 | 1.00 | 2 |
| 3876 | 7910 | 4 | 0.60 | 1.40 | 2.80 | 2 |
| 72 | 109 | 1 | 1.25 | 2.50 | 1.75 | 3 |
| 316 | 0312 | 1 | 1.20 | 4.20 | 1.40 | 3 |
| 336 | 5701 | 2 | 1.20 | 2.40 | 0.80 | 3 |
| 337 | 5702 | 2 | 1.00 | 6.83 | 2.67 | 3 |
| 354 | 0368 | 1 | 1.50 | 2.17 | 0.50 | 3 |
| 530 | 5798 | 2 | 0.67 | 1.33 | 0.67 | 3 |
| 908 | 0908 | 1 | 1.00 | 2.83 | 0.67 | 3 |
| 922 | 0931 | 2 | 0.00 | 0.36 | 0.80 | 3 |
| 1059 | 1047 | 1 | 1.17 | 4.50 | 1.67 | 3 |
| 1986 | 6089 | 2 | 1.17 | 2.67 | 1.00 | 3 |
| 1134 | 6114 | 2 ? | 0.60 | 2.83 | 3.33 | 3 |

| Entry | | | Striga reaction | | | Relative |
|---|---|---|---|---|---|---|
| | | | Avg. leaf symptom | Average emerged Striga score | | Striga resistance |
| SRN | ISN | Flowering | score | 1st count | 2nd count | category |
| 1513 | 1497 | 1 | 1.33 | 3.67 | 1.67 | 3 |
| 1552 | 1517 | 1 | 1.60 | 2.83 | 1.33 | 3 |
| *1568(light) | 1542 | 2 | 1.60 | 3.00 | 2.00 | 3 |
| 1639 | 6390 | 3 | 1.17 | 5.67 | 3.33 | 3 |
| 1864 | 2196 | 3 | 1.67 | 6.17 | 2.83 | 3 |
| 1873 | 2205 | 2 | 0.50 | 3.33 | 0.83 | 3 |
| 1875 | 2208 | 2 | 1.50 | 3.17 | 2.33 | 3 |
| 2177 | 6959 | 2 | 0.83 | 4.83 | 3.17 | 3 |
| 2229 | 6991 | 2 | 0.80 | 4.80 | 2.40 | 3 |
| 2393 | 7093 | 2 | 0.67 | 3.00 | 1.50 | 3 |
| 2414 | 2526 | 2 | 0.83 | 3.17 | 1.00 | 3 |
| 2422 | 2536 | 2 | 1.00 | 3.00 | 1.33 | 3 |
| 2591 | 7207 | 4 | 0.50 | 5.67 | 2.33 | 3 |
| 2613 | 2680 | 2 | 0.83 | 3.00 | 1.83 | 3 |
| 2642 | 7233 | 2 | 1.25 | 3.20 | 1.00 | 3 |
| 2699 | 7269 | 4 | 1.00 | 5.00 | 2.33 | 3 |
| 2708 | 7262 | 2 | 0.40 | 3.60 | 1.80 | 3 |
| 2714 | 7271 | 2 | 0.33 | 3.33 | 1.33 | 3 |
| 2766 | 2823 | 1 | 0.67 | 3.00 | 2.00 | 3 |
| 2867 | 2875 | 1 | 1.00 | 5.60 | 1.20 | 3 |
| 2888 | 7367 | 4 | 0.83 | 4.17 | 3.17 | 3 |
| 2897 | 7377 | 4 | 1.50 | 5.67 | 3.00 | 3 |
| 2904 | 2890 | 1 | 1.60 | 2.67 | 2.00 | 3 |
| 3434 | 7671 | 4 | 1.40 | 2.80 | 1.60 | 3 |
| 3610 | 3512 | 2 | 2.00 | 4.83 | 1.16 | 3 |
| 3629 | 7775 | 2 | 0.20 | 2.80 | 0.40 | 3 |
| 3915 | 3792 | 2 | 0.60 | 1.40 | 2.80 | 3 |
| 76 | 5528 | 2 | 1.50 | 6.16 | 2.50 | 4 |
| 142 | 5583 | 2 | 2.16 | 5.67 | 2.16 | 4 |
| 339 | 5704 | 2 | 1.20 | 5.00 | 4.00 | 4 |
| 1419 | 1382 | 1 | 1.50 | 3.67 | 1.50 | 4 |
| 1566 | 1537 | 1 | 1.50 | 4.75 | 3.50 | 4 |
| *1568(dark) | 1542 | 2 | 0.67 | 4.33 | 2.67 | 4 |
| 1684 | 6421 | 3 | 1.33 | 9.16 | 5.67 | 4 |
| 1753 | 2120 | 2 | 1.20 | 5.80 | 1.00 | 4 |
| 1754 | 2122 | 2 | 2.20 | 10.40 | 3.80 | 4 |
| 1877 | 6774 | 1 | 1.00 | 5.00 | 4.00 | 4 |
| 2003 | 2265 | 3 | 1.20 | 9.20 | 2.60 | 4 |
| 2072 | 2319 | 1 | 1.50 | 4.50 | 2.50 | 4 |
| 2090 | 6917 | 2 | 1.00 | 10.67 | 2.67 | 4 |
| 2282 | 7022 | 4 | 0.67 | 13.00 | 4.16 | 4 |
| 2288 | 7029 | 2 | 0.84 | 10.33 | 7.16 | 4 |
| 2417 | 2530 | 1 | 1.00 | 10.00 | 3.00 | 4 |
| 2527 | 7166 | 4 | 2.40 | 9.33 | 5.67 | 4 |

Table 3 continued

| Entry | | | Striga reaction | | | Relative Striga resistance dategory |
|---|---|---|---|---|---|---|
| SRN | ISN | Flowering | Avg. leaf symptom score | Average emerged Striga score 1st count | 2nd count | |
| 2560 | 2628 | 1 | 1.50 | 5.50 | 2.25 | 4 |
| 2713 | 2770 | 4 | 2.20 | 9.60 | 5.20 | 4 |
| 2831 | 7331 | 2 | 0.83 | 4.67 | 1.67 | 4 |
| 2890 | 7369 | 4 | 1.33 | 8.17 | 3.50 | 4 |
| 2899 | 7379 | 4 | 1.00 | 10.00 | 3.83 | 4 |
| 2960 | 2943 | 1 | 2.00 | 3.00 | 3.80 | 4 |
| 3433 | 7669 | 4 | 1.33 | 8.00 | 1.83 | 4 |
| 3438 | 7678 | 4 | 0.83 | 8.17 | 5.17 | 4 |
| 3748 | 7855 | 4 | 1.50 | 8.33 | 3.17 | 4 |

*Light- and dark-seed selections in I.S. 1542.

Table 4. Summary results of *Striga* reaction of some common Samaru sorghums and resistant lines from India. Tested in field along with some world collection sorghums in 11 x 11 lattices, 1973.

| Entry | Flowering | Avg. leaf symptom score | Avg. *Striga* | emerged score | Relative *Striga* resistance category |
|---|---|---|---|---|---|
| Line 181 | 4 | 1.00 | 2.17 | 1.83 | 2 |
| Line 187 | 4 | 0.50 | 2.33 | 1.00 | 2 |
| CE-90 | 2 | 0.84 | 2.00 | 0.50 | 2 |
| RCS | 4 | 0.84 | 2.50 | 1.00 | 2 |
| *N-13 | 2 | 1.50 | 0.67 | 0.17 | 2 |
| *Bouganhilo | 2 | 2.33 | 1.50 | 0.50 | 2 |
| Line 316 | 4 | 1.25 | 3.50 | 2.50 | 3 |
| Line 455 | 4 | 1.83 | 5.67 | 3.50 | 3 |
| Line 5764 | 4 | 0.83 | 3.67 | 1.50 | 3 |
| SA 7706 | 1 | 1.80 | 2.20 | 1.00 | 3 |
| RCF | 4 | 1.17 | 3.33 | 1.17 | 3 |
| SK 5912 | 4 | 1.17 | 6.00 | 3.00 | 3 |
| *Variety 16-1 | 2 | 1.83 | 4.00 | 1.50 | 3 |
| *Surat | 2 | 2.00 | 3.33 | 1.50 | 3 |
| DFF 2123 | 4 | 1.33 | 8.17 | 5.50 | 4 |
| Line 401 | 4 | 1.20 | 8.60 | 4.80 | 4 |
| Variety 137-62 | 2 | 2.00 | 5.00 | 4.17 | 4 |
| U-10 | 2 | 1.40 | 6.40 | 2.60 | 4 |
| CK-60 | 1 | 4.17 | 3.33 | 1.00 | 4 |
| 4 DWFK x 7706 | 1 | 2.83 | 3.33 | 0.84 | 4 |
| Line 618 | 2 | 4.83 | 5.83 | 1.83 | 4 |
| ISNI | 4 | 1.00 | 13.60 | 7.00 | 4 |
| *GC 9 | 2 | 2.00 | 6.50 | 5.33 | 4 |

*Lines from India. All reportedly resistant to *Striga* in India except Surat which is Indian susceptible check. Resistance in India likely based on number emerged *Striga* plants.

Table 5. Mean grain yield, percent of expected yield, and mean emerged *Striga* number of 16 sorghum varieties grown in *Striga*-free soil and two levels of *Striga* infestation at Samaru in 1973.

| | | Level of *Striga* infestation of soil | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | None | Intermediate | | | High | | |
| Entry | Days to blooming | Yield (kg/ha) | Yield (kg/ha) | % of expected yield | No. emerged *Striga*/ha x $10^4$ | Yield (kg/ha) | % of expected yield | No. emerged *Striga* x $10^4$ |
| I.S. 3692 | 61 | 1647 | 1504 | 91.3 | 1.38 | 1285 | 78.0 | 3.39 |
| I.S. 3469 | 90 | 1548 | 1482 | 95.7 | 1.98 | 1202 | 77.6 | 4.78 |
| I.S. 2278 | 48 | 2026 | 1696 | 83.7 | 1.12 | 1548 | 76.4 | 3.03 |
| I.S. 6909 | 54 | 1828 | 1729 | 94.6 | 1.35 | 1351 | 73.9 | 3.10 |
| I.S. 1261 | 63 | 3376 | 3031 | 89.8 | 2.31 | 2372 | 70.3 | 5.73 |
| I.S. 7329 | 105 | 1466 | 1400 | 95.5 | 1.81 | 1021 | 69.6 | 5.57 |
| I.S. 3167 | 64 | 2619 | 2553 | 97.5 | 1.32 | 1779 | 67.9 | 4.02 |
| I.S. 2762 | 90 | 1976 | 1812 | 91.7 | 4.71 | 1301 | 65.8 | 9.06 |
| I.S. 2771 | 78 | 3475 | 3294 | 94.8 | 2.04 | 2240 | 64.5 | 5.04 |
| I.S. 6959 | 63 | 2372 | 1678 | 70.7 | 4.22 | 1449 | 61.1 | 14.53 |
| I.S. 7040 | 93 | 1960 | 1581 | 80.7 | 4.28 | 1038 | 53.0 | 9.65 |
| *CK 60 | 55 | 2701 | 1976 | 73.2 | 4.25 | 1005 | 37.2 | 10.61 |
| *I.S. 2654 | 60 | 3475 | 2438 | 70.2 | 4.88 | 1219 | 35.1 | 11.27 |
| *SK 5912 | 104 | 2009 | 1400 | 69.7 | 10.15 | 675 | 33.6 | 16.54 |
| *DFF 2123 | 98 | 2108 | 1318 | 62.5 | 13.41 | 181 | 8.6 | 26.55 |
| *ISNI | 100 | 1795 | 1087 | 60.6 | 13.31 | 82 | 4.6 | 31.75 |

*Susceptible check varieties.

$y = 94.58 - 2.63(ST)$
$r = -.84$

$y = 81.81 - 2.62(ST)$
$r = -.92$

f. Striga-resistant composite.--In 1972, work was initiated on developing a Striga-resistant sorghum composite. Sterile plants within the WABC (Bulk x) were pollinated with pollen from entries of over 60 sorghum lines believed to have some resistance to Striga. In 1973, the second backcross was made onto steriles using pollen from 40 Striga-resistant entries. Seed was obtained from over 300 selected panicles. Five-hundred panicles would have been more desirable, but this was not possible due to midge, ergot, and the early termination of the rains. Equal quantities of seed from each panicle were bulked, and the first recombination cycle of the bulk was planted during the 73/74 dry season. This material has been turned over to the sorghum breeder.

g. Striga-resistant crosses.--A second cross of Striga-resistant lines was made onto sterile panicles of plants which came from crosses in 1972 between resistant lines and selected plants within the WABC (Bulk x) composite. Fifty-nine of the best lines have been planted under irrigation. Selection for good plant characters is to be made at harvest, and progeny are to be grown on Striga-infested soil in 1974.

h. Control of Striga by insecticides.--Work in 1972 indicated possible control of Striga with a soil application of the insecticide phorate which is used to control shoot fly.

In 1973, in cooperation with the entomologist, a replicated trial was planted on land heavily infested with Striga in which both phorate and carbofuran were used as soil applicants before planting. Due to extremely heavy Striga attack and the early termination of the rains, practically no grain was obtained regardless of the treatments. There was no evidence for Striga control by either of the chemicals.

3. Smuts.

Eight isolates of covered smut (Sphecelotheca sorghi) collected from transplanted, dry-season sorghum grown in the heavy clay soils south of Lake Chad were tested for their virulence against 10 differential hosts. Two isolates behaved very much like isolates from wet-season sorghums; however, six isolates were quite different in that they did not infect either Dwarf Hengari or White Yolo. One isolate of loose smut (S. cruenta) from the same area was tested in six differential hosts and found to infect, in a manner similar to that observed for Nigerian isolates, from wet-season sorghum.

4. Stalk rot of sorghum.

A wet stalk rot of sorghum, which has not been identified for certain, is found associated with sorghum in most years. Though it is not considered serious, it can kill plants and severely reduce yields of others. It is usually first noticed in the latter part of July or in August, 45-90 days after planting. Occasionally I have noticed what I thought was the same thing on plants as early as 28 days after planting. The rot appears to spread from the stalk to leaf sheaths. This leads to chlorotic leaves (generally lower ones) and subsequent premature death. Plants sometimes seem to grow out of this condition.

The rotted areas are generally light tan in color and sometimes show some hollow portions, and a putrid odor is associated with the rot. This odor sometimes has somewhat of a fish smell. Rotted portions of stalks were mixed in a Warring Blender with water, filtered through cheesecloth, and injected into stalks of healthy Short Kaura plants by several jabs using a hypodermic syringe and needle. Within three days the rot had developed in inoculated stalks, and within two weeks leaf sheaths were affected and leaves were beginning to turn chlorotic. Bacteria have been most clearly associated with the rot. In 1973, several bacterial isolates were sent to the Commonwealth Mycological Institute for identification. They reported Erwinia herbicola, Bacillus sp., and a mixture of several Pseudomones sp.

## Millet

Disease resistance was further evaluated in the field for 808 millet lines using natural infection. Except for 69 $S_1$ lines of Ex Bornu, all material previously had been evaluated and selected for disease resistance during two to six rainy seasons. Samaru Disease Nursery (SDN) numbers were assigned to each line. A breakdown description of this material follows:

1. SDN 1-200
   Lines from a world millet collection or elsewhere which had previously shown potentially high levels of resistance to either ergot (Claviceps microcephala) or smut (Tolyposporium penicillariae), or both. These lines previously showed little or no resistance to downy mildew (Sclerospora graminicola).

2. SDN 201-370
   Lines selected from West Africa material from Dr. G. Burton (Tifton, Georgia) which were first planted at Samaru in 1968. Selection and evaluation for disease resistance have been continued in this material up to the present. These lines have shown promising resistance to downy mildew, and in some cases to ergot or smut, or both.

3. SDN 371-428
   Lines selected from material which Dr. O. J. Webster noted in 1969 and 1970 as having possible disease resistance. This material showed little or no mildew infection in 1972.

4. SDN 429-736
   Lines selected from among over 2500 entries of world millet collection which, in initial screening in 1967 and subsequent selection and screening, showed possible mildew resistance. These lines may or may not have shown resistance to ergot or smut, or both.

5. Sixty-nine $S_1$ lines from plants within the Ex Bornu population which showed no mildew symptoms under high mildew disease pressure in 1972.

All the above lines were planted in single rows of approximately 25 plants each in two replications at Kano and three replications at Samaru, except for SDN 1-200 which were planted at Samaru without replication. A downy mildew-susceptible check, M-2 (Ghana), was planted after every 10 rows.

Scoring for downy mildew was conducted in all replications after grain on primary heads of plants had reached the dough stage. Each infected plant was rated for symptom severity as either slightly infected or moderate-severely infected. Slight infection generally involved symptoms limited to axillary leaves or a few leaves of a small tiller, whereas moderate-severe infection involved plants showing green ear or severe leaf symptoms, or both, on at least one tiller. Yield was likely reduced some on moderate-severely infected plants but not in slightly infected ones. Results of all replications were summarized and a downy mildew index (DMI) calculated for each line. DMI values were calculated the same as percent infection would be calculated except that each slightly infected plant was given a value of ½ instead of 1.

Scoring for ergot was done just prior to harvest by two independent observations in all replications planted at Samaru. The following 0-5 severity scale was used to rate level of ergot infection:

0 = no ergot sclerotia present
1 = less than 1% florets infected
2 = 1 to 5% florets infected
3 = 5 to 13% " "
4 = 14 to 30% " "
5 = more than 30% of florets infected

One ergot score was given for the entire row and scores were weighted toward the most severely infected spikes within the row. All scores on a given line were summarized and converted to a 0 to 10 ergot index (EI), i.e. 0.0 average severity score = 0 EI, 0.5 average severity score = 1 EI, 1.0 average severity score = 2 EI... and 5.0 average severity score = 10 EI.

Scoring for smut was done after harvest and was based on infection level of smut on six bagged spikes from one replication. The following 0-5 severity scale was used and was taken as the smut index (SI):

0 = no smut sori present
1 = less than 1.0% of florets with smut
2 = 1 to 2% " " " "
3 = 2 to 10% " " " "
4 = 10 to 30% " " " "
5 = more than 30.0%" " " "

Smut scores were weighted toward most severely infected spikes.

The natural disease challenge during the 1973 season was adequate for downy mildew and ergot screening but less than desired for smut. The reduction in smut might have been partially due to late planting (early July instead of early June) in 1973, but this is not known for certain.

It would be desirable in a breeding program to have, as sources of resistance, lines which have a very high level of resistance to more than one disease. Four such lines were identified in 1973. These are SDN 351 (DMI 0.0, EI 2, SI 1), SDN 303 (DMI 0.9, EI 2, SI 1), SDN 329 (DMI 1.2, EI 2, SI 1), and SDN 268 (DMI 1.3, EI 2, and SI 1). Many more lines with high levels of multiple resistance or resistance to a single disease were also identified. A summary of this information is presented in Table 6. For comparison, an advanced population of Ex Bornu planted in early July at four locations at Samaru showed mean DNI, EI, and SI values ranging from 14.6 four to six, and two to three, respectively.

Further evidence for possible physiologic variability in Sclerospora graminicola in West Africa was obtained during the 1973 growing season. Several lines showed significant differences in levels of mildew obtained between Kano and Samaru. Also, the new dwarf millet population developed at Bambey, Senegal, was severely infected (over 70%) by downy mildew in Nigeria; whereas the same population showed little or no infection at Bambey. Other materials exchanged between Samaru and Bambey in 1971 and 1973 showed little or no infection at Bambey, whereas they became severely infected at Samaru. Arrangements have been made with the IRAT pathologist at Bambey to conduct a cooperative regional trial in 1974 to gain an understanding of virulence of S. graminicola throughout the West African region.

Table 6. Summary of number of millet lines having the most desirable types of resistance.

| Type of resistance | Maximum values DMI | EI | SI | No. of lines |
|---|---|---|---|---|
| Multiple resistance | 7.0 | 4 | 2 | 135 |
| | 7.0 | 4 | - | 34 |
| | 7.0 | - | 2 | 86 |
| | - | 4 | 2 | 84 |
| Good resistance to one disease | 5.0 | - | - | 272 |
| | - | 3 | - | 103 |
| | - | - | 1 | 186 (89)* |
| Excellent resistance to one disease | 1.0 | - | - | 73 |
| | - | 2 | - | 19 |
| | - | - | 0 | 6 (24)* |

*Figures in parenthesis include lines from SDN 1-200. These lines were not adequately tested for downy mildew or ergot resistance because they were not replicated.

## Maize

### Striga resistance

A total of 169 selections of maize were tested for their reaction to Striga hermonthica. Seed for 134 entries came from single, open-pollinated plants in 096, NCA, NCB, and $SC_3$ populations which showed possible resistance

to Striga in 1972. Twenty-eight entries were full-sib selections of 096 which showed possible resistance in a yield trial which happened to be planted on Striga-infested land in 1972. Two other entries were similar to these but were full-sibs of $SC_3$. Five additional entries from the breeding program were also included in the trial.

A 13 x 13 lattice design with nine replications was used. Plots consisted of single, three-plant stands spaced 0.7 m in both directions. Observations were to have been made before tasseling on number of emerged Striga plants and severity of leaf symptoms so that selfs and crosses could be made of the better looking material. However, few emerged Striga plants appeared, and leaf symptoms were so slight before tasseling that all plants were allowed to open pollinate. Evaluation of leaf symptom severity was delayed as long as possible to insure maximum development of symptoms. These did not develop as fully as hoped for, nor was there any significant emergence of Striga plants. Hence, far less information was obtained than anticipated.

Planting of the trial was delayed until the first week of July due to a dry June. It is felt that the lack of Striga infection may have been largely due to late planting. The data have been sent to the U.S. for analysis, and it appears that some genetic differences for Striga reaction were present and that resistance can be further improved through additional selection cycles.

Streak virus disease

Maize streak was generally not as severe in Samaru and other parts of northern Nigeria as it was in 1972. The infection level for plantings in early June generally did not exceed about 3%. However, maize planted in mid- to late July and August commonly showed more than 50% infection. In 1972, four grasses (Digitaria ciliaris, Eleusine indica, Seteria barbhata, and Eragrostis gangotica) were found in the Samaru area to have intermittent streak symptoms similar to maize streak. In 1973, typical streak symptoms were also found on Digitaria horizontalis and Chloris gayana and pearl millet (Pennisetum typhoides).

No experimental work was carried out on maize streak in 1973.

Downy mildew

For the past several years, downy mildew (Sclerospora sorghi) has been observed on maize in the Samaru area. Generally, only a few plants are observed, and these are usually noticed only during the first four weeks' growth. In 1973, about 10% of the maize plants in a small discard area of a field at University Farm were found to have mildew symptoms. Observations were made on the development of symptoms. Although typical streaking was very obvious on early leaves (leaves 3, 4, and 5), symptoms became very indistinct on later leaves. Close observations indicate that in many plants streaking completely disappeared in later leaves. Affected plants were occasionally barren but generally produced some grain. Oospores were found in lower leaves but no upper leaves or tassels.

Downy mildew can be a serious problem on maize in certain parts of Asia and North America. It has only rarely been noticed in West Africa, and it is not known whether it is likely to develop into a serious problem on maize in this area.

Ear rot

An ear rot of maize was found in a seed production field in Ghana. The precise cause of the rot is not known, although the pathologist at Crops Research Institute, Kumasi, suspects that a species of Rhizoctonia is involved. A diseased ear with similar symptoms was also found at Mokwa in 1973. Macrophomina sp. was consistently isolated from diseased tissue. On the basis of symptoms and the presence of Macrophomina it was concluded that the disease is quite possibly grey ear rot caused by Physalospora zeae (=Macrophomina zeae). The disease has on occasion been observed on maize growing in the Ibadan area, but it has not been considered an important problem.

## Cereal Entomology

Dean Barry

During 1973, the primary efforts in entomological work have been to select for plant resistance to sorghum shoot fly, Atherigona varia soccata; maize stem borer, Busseola fusca; and sorghum midge, Contarinia sorghicola. Other work consisted of advancing the breeding of selected materials and date of planting studies.

### Screening for resistance

Sorghum midge--Observations of materials from the world collection of sorghum have been made by Dr. Stan King for diseases for several years, and he noticed that some of the lines consistently had less midge damage than the more susceptible ones at harvest. Last year he suggested that we make joint observations of these materials to consider them for the entomology program. From over 3000 lines, 61 were selected for further evaluation in 1973. Of these, 45 were selected (Table 1) as midge-resistant lines. Since these are very tall varieties and probably photosensitive, they should be sent to Puerto Rico to be placed in the conversion program. It is suggested that these selected lines be used for conversion rather than the original I.S. lines since selection has taken place within each line. Currently, eight converted I.S. lines, selected for midge resistance in the USDA/ARS program in Oklahoma, are being increased in our irrigated nursery so they may be included in our program in 1974.

Maize stem borer--During 1973, screening for maize stem borer resistance in sorghum was continued from materials selected in 1972. Although artificial infestation was not practical this year and the natural infestation did not reach the level of 1972, an adequate population of this insect did develop to do some screening. From 613 lines selected from single replicated trials in 1972, 307 lines were selected from 1973 replicated trials to be reevaluated in 1974. It is still possible that these materials may be escapes, but they are the lines which were rated as intermediate or resistant.

Several promising or locally released varieties plus CK-60 (Table 2) were evaluated for resistance during 1973, but those rating resistant (R) or intermediate (I) should be reevaluated.

As indicated in our 1972 report, leaf feeding is not a good character for selection for resistance, but it has its utility in indicating plants which have been attacked by B. fusca and eliminating some of the possible confusion with Sesemia spp. when dissecting stems for tunneling. Tunneling is presently the best character for resistance evaluation.

Seven varieties and hybrids of maize and Mr. Harrison's maize composite lines were planted for evaluation of stem borer resistance, but none of them were attacked. All varieties were planted early enough to escape maize streak virus. At present, early planted maize in the rainy season does not have significant insect pests in northern Nigeria (north of Zaria).

Sorghum shoot fly--Screening trials were planted for both recovery (tolerance) and primary resistance, but although planting was delayed until July 2 and 3 and spreader rows were used, no significant infestation of shoot fly developed in these plots. Some shoot fly populations did develop on plantings made after July 20 (see date of planting studies), but this date was too late for the varieties screened to develop. All of these trials will be repeated in 1974.

Fifty-one lines of sorghum from East Africa which had been selected for recovery resistance to shoot fly, plus CK-60, were planted in a replicated trial to be evaluated here at Samaru. Due to the very low insect populations this was not possible, but relative yields per plot are presented in Table 3. (The yield of CK-60 would be about 1200 pounds per acre as compared to 3940 for 14-P-4-2-1, the best selection.) These lines could possibly make a significant contribution to the sorghum program since they are short season and matured better than most of the materials in the current program (this growing season was very short since the rains did not start until mid-June and quit in mid-September). However, these lines are primarily of the red-seeded type and are not the choice of the local people for food if the white-seeded type is available.

Composite populations--The WABC population (ms7) has been under observation particularly for shoot fly and midge resistance for two seasons, and so far there is no evidence of resistance to either insect in this population. This season's observations also indicated the population to be quite susceptible to the maize stem borer. I feel that further effort in screening this population for resistance to these insects will be a waste of time until specific insect-resistant germplasm has been introduced into it. We have crossed primary shoot fly-resistant lines to selected sterile plants of this population (see under Breeding). Next year we will be introgressing population 110 into WABC. This is a population with ms 3 (sterility) initially developed by Dr. Hugh Doggett and later selected by myself for recovery resistance to the sorghum shoot fly.

## Breeding

In the absence of a sorghum breeder to work with during the last growing season, two approaches have been taken to introgress identified sources of primary shoot fly resistance into more acceptable varieties of sorghum. This was begun in 1972, in cooperation with Mr. David Andrews, when we crossed 12 lines of sorghum from India (shoot fly-resistant) to four promising local varieties (hand emasculation) and to selected sterile plants of the WABC population. The breeding status of this program is summarized in Tables 4 and 5 along with some plant characteristics. These materials have been planted in the irrigation nursery during the dry season to increase seed, to check for further segregation, and to verify plant characteristics. They will be screened for shoot fly resistance during 1974.

## Date of Planting Studies

Two similar factorial experiments, replicated six times with date of planting and varieties as the factors, were conducted with sorghum and maize during 1973. The results of these trials are summarized in Tables 6 and 7.

These trials have indicated several things.

For sorghum

1. The later sorghum was planted, the shorter the time to bloom except for very late planted shorter season varieties which tended to require a longer time.

2. The earliest planted sorghum (June 11) completely escaped sorghum shoot fly attack, but the succeeding five plantings at two-week intervals had a gradual buildup of shoot fly until about 90% of the plants were attacked in the last planting (August 20).

3. The yields tended to be higher in the early plantings of the longer season varieties while it was higher in the mid-season plantings of the short-season varieties. Practically no yields were obtained from any of the varieties planted after August 1. The later dates of planting had considerable midge damage.

For maize

1. Except for leafhoppers transmitting maize streak virus, no other insects of significance were found on maize at Samaru.

2. The earliest planted maize (June 12) had practically no infection of maize streak virus, but the incidence gradually built up in later plantings until about 80% of the plants were infected in the last planting (August 20).

3. The time required for 50% of the plants to bloom decreased in the second and third plantings (June 25 and July 9) but slightly increased in the last three plantings (July 23 - Aug. 20).

4. No significant difference in yields were noted in the first three dates of planting (June 12, 25, and July 9), but it was less in the July 23 planting and no yield in the August 6 and 20 plantings.

## General

Insect rearing--We have not been able to rear Busseola fusca successfully on an artificial diet. In the limited facilities that we have, we have continued to study this stem borer in the laboratory using sorghum stems as a diet. Data from this work are not ready for summarizing.

The laboratory which was to be renovated by September 1972 for rearing the maize stem borer has not been completed yet.

Insecticide to control witchweed--Thimet granules (10%) failed to control witchweed. This was tried only after a field observation in 1972 indicated that it may have been responsible for reducing the indidence of this pest.

Education--About four hours a week from mid-August until the last of October were devoted to teaching and conducting exercises for graduate sutdents. We were teaching ecology and biology of insects of importance on cereal and some field techniques in host plant resistance.

Vehicle and equipment maintenance--This has been done as required.

Table 1. Selected lines of sorghum from the World Collection which are resistant to sorghum midge and some plant characteristics.

| Pedigree | Seed Color | Seed Size | Glume | Head |
|---|---|---|---|---|
| IS10733 | White | Medium | White | Open |
| IS2499 | White | Medium-large | Black | Open |
| IS10841 | White | Medium | Black | Small, open |
| IS10676 | White | Medium | Black | Closed |
| IS10756 | Red-white | Medium | Black | Semi-open |
| IS8905 | Whitish-red | Small | Black | Small, closed |
| IS6998 | Reddish-brown | Medium | Reddish | Small, open |
| IS8104 | Reddish | Medium | Red | Closed |
| IS3900 | Purplish | Med-large, flat | White | Small, open |
| IS7422* | Yellow | Large, flat | White | Open |
| IS7855 | Red-white | Small, flat | Reddish | Open |
| IS7273 | White | Medium | Black-red | Open |
| IS10757 | Red | Medium | Black | Open |
| IS7276 | White | Medium | White | Open |
| IS6844 | White | Medium-variable | White, long | Open |
| IS10838 | White | Medium, flat | Reddish | Open |
| IS7590 | Cream | Medium, flat | White | Open |
| IS7917 | White-Reddish | Medium | Black | Large, open |
| IS3832 | Purplish | Medium | White | Open |
| IS7232 | White-orange | Medium | Red | Small, open |
| IS7309 | White | Medium | Black | Open |
| IS9016 | White, Red spots | Small | White | Long, closed |
| IS7007 | Brown | Medium | Black | Very open |
| IS7467 | Reddish | Small, flat | Reddish | Open |
| IS7006 | White | Large | Black | Open |
| IS10746 | Pearly | Medium | Black | Semi-open |
| IS7306 | White | Medium | Black | Open |
| IS8898 | White | Small | Black | Closed |
| IS7191 | White | Medium-small | Black | ? |
| IS7168 | Purplish | Medium | White | Open |
| IS10788 | Yellow | Medium | White | Closed |
| IS3898 | White | Medium | Black | Open |
| IS7408 | Reddish | Medium, flat | Reddish | Open |
| IS6858 | White | Medium | White | Open, long |
| IS7420 | Reddish | Medium, flat | Reddish | Open |
| IS3867 | Purplish-Reddish | Medium | Red | Semi-open |
| IS2493 | White | Medium-large | Black-white | Open |
| OS8893 | White | Variable | White | Very open |
| IS8902 | Red | Small | Black | Closed |
| IS10759 | Orange | Medium | Black | Semi-closed |
| IS6843 | White | Medium | White | Open |
| IS7415 | White | Large, flat | White | Open |
| IS7569 | White | Variable | Red | Open |
| IS2757 | Brown | Medium | Black | Open |
| IS8910 | Reddish | Small | Black | Long, closed |

*Selected although it had slight midge infestation.

Table 2. Evaluation of various lines and varieties of sorghum for resistance to *Busseola fusca* during 1973 at Samaru, Nigeria.

| Variety | Tunneling (% of plants)* | Resistance rating** (severity) |
|---|---|---|
| 181 | 47 | S |
| 187 | 26 | I-R |
| 618B | 50 | S-I |
| ISNIB | 25 | I-R |
| 316 | 33 | I |
| 455 | 57 | S-I |
| U-10 | 53 | S-I |
| CE90 | 17 | I-R |
| 401 | 40 | I |
| 7706 | 36 | I |
| RCS-B | 47 | S-I |
| RCF-B | 33 | I-R |
| 5764 | 12 | R |
| CK-60 | 40 | I |
| 137-62 | 43 | S-I |

*100% of the plants used in resistance evaluation showed typical *B. fusca* leaf feeding. This was done to reduce the chances of confusing *B. fusca* with *Sesmia* spp.

**S = susceptible, I = intermediate, R = resistant

Table 2. Evaluation of various lines and varieties of sorghum for resistance to *Busseola fusca* during 1973 at Samaru, Nigeria.

| Variety | Tunneling (% of plants)* | Resistance rating** (severity) |
|---|---|---|
| 181 | 47 | S |
| 187 | 26 | I-R |
| 618B | 50 | S-I |
| ISNIB | 25 | I-R |
| 316 | 33 | I |
| 455 | 57 | S-I |
| U-10 | 53 | S-I |
| CE90 | 17 | I-R |
| 401 | 40 | I |
| 7706 | 36 | I |
| RCS-B | 47 | S-I |
| RCF-B | 33 | I-R |
| 5764 | 12 | R |
| CK-60 | 40 | I |
| 137-62 | 43 | S-I |

*100% of the plants used in resistance evaluation showed typical *B. fusca* leaf feeding. This was done to reduce the chances of confusing *B. fusca* with *Sesmia* spp.

**S = susceptible, I = intermediate, R = resistant

Table 3. Average yields of shoot fly-tolerant lines of sorghum selected in East Africa at Samaru, Nigeria, in 1973.*

| Pedigree | Ave. yield (kg/plot) | Pedigree | Ave. yield (kg/plot | Pedigree | Ave. yield (kg/plot) |
|---|---|---|---|---|---|
| 14-P-4-2-1 | 2.56 | 37-P-1-1-1 | 1.79 | 71-P-2-2-1 | 1.52 |
| 39-P-4-2-1 | 2.45 | 33-P-3-2-1 | 1.75 | 29-P-1-1-1 | 1.45 |
| 15-P-1-1-1 | 2.39 | 35-P-2-1-1 | 1.72 | 102-P-4-1-1 | 1.42 |
| V-2-1-1-1 | 2.36 | 156-P-5-2-1 | 1.71 | 12-P-1-2-1 | 1.42 |
| 2-P-1-2-1 | 2.32 | 1-P-4-1-1 | 1.71 | 25-P-3-1-1 | 1.42 |
| 3-P-5-1-1 | 2.22 | 45-P-2-1-1 | 1.69 | 14-P-3-2-1 | 1.40 |
| 143-P-2-1-1 | 2.22 | 221-P-3-1-1 | 1.69 | 26-P-2-1-1 | 1.36 |
| 107-P-6-1-1 | 2.17 | 218-P-3-2-1 | 1.68 | 71-P-1-2-1 | 1.36 |
| 210-P-5-2-1 | 2.09 | 31-P-4-1-1 | 1.66 | 28-P-4-1-1 | 1.33 |
| 37-P-3-2-1 | 2.03 | 165-P-6-2-1 | 1.63 | 28-P-1-1-1 | 1.31 |
| 45-P-2-2-1 | 1.97 | 78-P-2-1-1 | 1.63 | 14-P-6-1-1 | 1.27 |
| 2-P-3-1-1 | 1.96 | 234-P-5-2-1 | 1.62 | V-100-1-1-1 | 1.24 |
| 31-P-1-2-1 | 1.90 | V-63-1-1-1 | 1.62 | V-3-1-1-1 | 1.23 |
| V-4-1-1-1 | 1.90 | 135-P-5-2-1 | 1.60 | 35-P-5-2-1 | 1.22 |
| 211-P-3-1-1 | 1.87 | 135-P-5-1-1 | 1.57 | 228-P-1-2-1 | 1.19 |
| 217-P-1-2-1 | 1.87 | 157-P-3-1-1 | 1.56 | 7-P-1-1-1 | 1.10 |
| 210-P-4-1-1 | 1.81 | 50-P-2-1-1 | 1.52 | 48-P-1-1-1 | 1.07 |

*Error of difference of 2 means is 0.357
(L.S.D. = 0.71)

Table 4. The breeding situation and plant characteristics of crosses between primary shoot fly-resistant materials (12) from India and Nigerian varieties (4) in 1973.*

| Pedigree | Seed | Glume | Head Tightness |
|---|---|---|---|
| IS8315 x 453, selfed 2x | white | red | open |
| IS8315 x SK5912, selfed 2x | white | white | medium |
| IS5604 x 453, selfed 2x | white | white | closed |
| IS5604 x 23/2, selfed 2x | white | long, white | closed |
| IS5622 x 23/2, selfed 2x | white | white | large, closed |
| IS5622 x SK5912, selfed 2x | cream | white | small, medium |
| IS5622 x R960, selfed 2x | white | reddish | medium |
| IS5622 x 453, selfed 2x | white | white | medium |
| IS5072 x 453, selfed 2x | white | white | small, closed |
| IS5072 x 23/2, selfed 2x | white | white | small, closed |
| IS3962 x 453, selfed 2x | white | reddish | medium |
| IS3962 x R960, selfed 2x | white | brown | medium |
| IS5383 x SK5912, selfed 2x | cream | white | open |
| IS5383 x 23/2, selfed 2x | white | black | open |
| IS5383 x R960, selfed 2x | brown | reddish-brown | medium |
| IS5383 x 453, selfed 2x | white | reddish | loose |
| IS4646 x R960, selfed 2x | white | black | medium |
| IS4646 x 23/2, selfed 2x | white | black | open |
| IS4646 x 453, selfed 2x | white | black | medium |
| IS1082 x R960, selfed 2x | brown | reddish | open |
| IS1082 x 453, selfed 2x | white | white | open |
| IS5642 x 23/2, selfed 2x | white | purplish | small, closed |
| IS1054 x 23/2, selfed 2x | white | red | open |
| IS1054 x R960, selfed 2x | brown | reddish | open |
| IS1054 x 453, selfed 2x | white | white | open |

*These selected materials were still segregating, but the characteristics are of selected heads for irrigated nursery plantings.

Table 5. The breeding situation of primary shoot fly-resistant varieties from India crossed to selected male-sterile plants of WABC population and characteristics of entries.*

| Pedigree** | Seed | Glume | Head |
|---|---|---|---|
| IS5622 x WABC $401_1$ | white | white | closed |
| IS5622 x WABC $204_1$ | white | dark | closed |
| IS5622 x WABC $309_1$ | white | red | open |
| IS5622 x WABC $112_1$ | white | white | open |
| IS5642 x WABC $111_1$ | white | black | closed |
| IS5642 x WABC $111_2$ | white | black | closed |
| IS5642 x WABC $215_2$ | white | black | open |
| IS5642 x WABC $410_2$ | white | black | closed |
| IS5383 x WABC $303_1$ | white | reddish-white | open |
| IS5383 x WABC $110_2$ | white | red | open |
| IS5383 x WABC $211_2$ | white | white | open |
| IS5383 x WABC $402_1$ | white | white | open |
| IS5072 x WABC $101_1$ | white | black | closed |
| IS5072 x WABC $101_2$ | white | black | open |
| IS5072 x WABC $314_2$ | white | reddish-white | closed |
| IS5072 x WABC $404_1$ | white | white and black | closed |
| IS3962 x WABC $102_3$ | white | red | closed |
| IS3962 x WABC $102_2$ | white | red | closed |
| IS3962 x WABC $102_1$ | white | black | open |
| IS3962 x WABC $209_1$ | white | reddish-black | open |
| IS3962 x WABC $307_1$ | white | red | open |
| IS3962 x WABC $307_2$ | white | white | medium |
| IS3962 x WABC $412_1$ | white | white-red | closed |
| IS5566 x WABC $202_1$ | white | red | medium |
| IS2123 x WABC $312_1$ | white | red | medium |

Table 5 continued

| Pedigree** | Seed | Glume | Head |
|---|---|---|---|
| IS2123 x WABC $103_2$ | white | red | closed |
| IS2123 x WABC $408_1$ | white | white | closed |
| IS2123 x WABC $408_2$ | white | black | open |
| IS8315 x WABC $105_1$ | white | red | medium |
| IS8315 x WABC $206_1$ | white | white | open |
| IS8315 x WABC $302_1$ | white | reddish | open |
| IS8315 x WABC $302_2$ | white | white | open |
| IS8315 x WABC $407_2$ | white | dark red | medium |
| IS5604 x WABC $106_1$ | white | white | medium |
| IS5604 x WABC $311_1$ | white | white | medium |
| IS5604 x WABC $403_1$ | white | reddish | open |
| IS4646 x WABC $214_1$ | white | black | medium |
| IS4646 x WABC $308_1$ | white | black | medium |
| IS4646 x WABC $411_1$ | white | reddish-white | medium |
| IS1054 x WABC $108_1$ | white | reddish | medium |
| IS1054 x WABC $203_2$ | white | white | medium |
| IS1054 x WABC $305_1$ | white | reddish | medium |
| IS1054 x WABC $305_2$ | white | white | medium |
| IS1054 x WABC $414_2$ | white | white | med.-open |
| IS1082 x WABC $109_1$ | white | white | medium |
| IS1082 x WABC $109_2$ | white | reddish | medium |
| IS1082 x WABC $109_3$ | white | reddish | med.-open |
| IS1082 x WABC $207_1$ | white | reddish | medium |
| IS1082 x WABC $310_1$ | white | white | medium |
| IS1082 x WABC $406_1$ | white | white | med.-open |
| IS1082 x WABC $406_2$ | white | white | small, medium |

*Characteristics of selected heads. **WABC = West Africa Base Composite

Table 6. Results of sorghum variety date of planting studies relative to days to flowering, shoot fly infestation, and yield at Samaru, Nigeria, in 1973.

| | Variety | | | | | |
|---|---|---|---|---|---|---|
| | R960 | 2123 | U-10 | 5112SK | 453 | CK-60 |
| Date of Planting | Average days to flower (50%) | | | | | |
| Jun 11 | 86.7 | 131.0 | 91.7 | 129.0 | 119.0 | 74.0 |
| Jun 25 | 82.0 | 117.0 | 90.3 | 117.0 | 115.0 | 72.2 |
| Jul 9 | 81.6 | 108.0 | 89.0 | 103.0 | 103.0 | 72.0 |
| Jul 23 | 79.0 | 105.2 | 87.0 | 105.0 | 95.2 | 77.0 |
| Aug 6 | 82.5 | 93.3 | 75.5 | 93.3 | 92.7 | 86.5 |
| Aug 20* | - | - | - | - | - | - |
| | Average Plants infested with Sorghum Shoot fly (%) | | | | | |
| Jun 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Jun 25 | 35.5 | 18.7 | 18.1 | 13.7 | 25.7 | 18.0 |
| Jul 9 | 49.6 | 46.1 | 35.9 | 34.0 | 34.6 | 38.7 |
| Jul 23 | 77.7 | 85.4 | 55.7 | 84.2 | 82.2 | 82.6 |
| Aug 6 | 81.3 | 82.7 | 62.3 | 79.2 | 76.0 | 71.1 |
| Aug 20 | 89.0 | 87.1 | 76.0 | 92.1 | 87.9 | 82.7 |
| | Average Relative Yield (kg/plot) | | | | | |
| Jun 11 | 2.84 | 5.68 | 2.98 | 8.88 | 3.00 | 1.85 |
| Jun 25 | 1.49 | 4.10 | 1.23 | 4.00 | 1.74 | 1.72 |
| Jul 9 | 1.29 | 3.27 | 2.14 | 2.83 | 1.88 | 1.41 |
| Jul 23 | 2.14 | 1.72 | 3.44 | 2.14 | 1.32 | 1.54 |
| Aug 6 | 1.08 | 0.44 | 1.66 | 1.09 | 0.86 | 0.89 |
| Aug 20 | 0.19 | 0.04 | 0.42 | 0.11 | 0.00 | 0.00 |

*Planting was made too late to obtain data.

Table 7. Results of maize variety date of planting studies relative to days to flowering, maize streak virus and infection, and yield at Samaru, Nigeria, in 1973.

| Date of Planting | Variety | | | | | |
|---|---|---|---|---|---|---|
| | Days to Flower (50%) | | | | | |
| Jun 12 | 73 | 68 | 68 | 66 | 68 | 66 |
| Jun 25 | 64 | 42 | 61 | 59 | 59 | 61 |
| Jul 9 | 63 | 58 | 57 | 58 | 57 | 58 |
| Jul 23 | 62 | 60 | 60 | 60 | 60 | 60 |
| Aug 6 | 63 | 60 | 59 | 59 | 59 | 59 |
| Aug 20 | 66 | 66 | 66 | 66 | 66 | 66 |
| | Maize Streak Virus Infection (%) | | | | | |
| Jun 12 | 0.0 | 0.3 | 0.0 | 0.0 | 1.1 | 0.6 |
| Jun 25 | 4.8 | 5.1 | 6.4 | 6.0 | 4.5 | 4.0 |
| Jul 9 | 11.6 | 8.4 | 6.6 | 12.0 | 7.6 | 5.9 |
| Jul 23 | 22.0 | 20.8 | 16.7 | 22.3 | 23.2 | 17.2 |
| Aug 6 | 58.6 | 64.0 | 70.0 | 62.3 | 60.0 | 60.6 |
| Aug 20 | 84.8 | 79.3 | 82.8 | 81.2 | 80.8 | 75.4 |
| | Relative Yields (kg/plot) | | | | | |
| Jun 12* | 5.68 | 4.69 | 4.31 | 4.44 | 3.95 | 4.43 |
| Jun 25* | 6.82 | 4.17 | 4.19 | 5.38 | 4.26 | 3.89 |
| Jul 9 | 4.33 | 5.10 | 4.42 | 5.06 | 4.90 | 4.38 |
| Jul 23 | 2.35 | 2.58 | 3.68 | 3.55 | 3.44 | 3.36 |
| Aug 6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Aug 20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Some grain from plots of these dates of planting were prematurely harvested by local people (stolen).

# MAIZE BREEDING

Gideon I. Adeniyi, Maize Breeder, IAR

Chester L. Goodrich, Cereal Breeder, ARS-USAID, OAU-STRC

As in previous years, recurrent selection in composite populations continued to receive the major emphasis of the maize breeding program in the Institute for Agricultural Research, Samaru. In 1973, more U.S. early maturing materials were introduced. Also, a number of the developed inbreds were evaluated for hybridization programs.

Most of the breeding materials were tested at Samaru. some were tested at Mokwa, while a few were tested at Kano and at Pankshin on the Plateau. All the trials at Kano failed because of drought. There was a break in rainfall at anthesis time in Mokwa. This might have affected the yields greatly. Also, at Pankshin there was a lack of rainfall for three weeks after planting, and the rains stopped for another three weeks after germination. As a result, many plants were lost in each plot; the surviving seedlings were uneven in growth.

The cooperative maize trials, i.e., Federal Zonal, West African, East African, and F.A.O., were conducted as in previous years.

In March 1973, Dr. L. A. Tatum departed for the USA upon completion of his tour of Nigeria. After Dr. Tatum's departure, Mr. G. I. Adeniyi looked after the maize breeding programs in Samaru. Dr. C L. Goodrich joined the project in September 1973.

## Climatic Data

The daily rainfall figures for Samaru are given in Table 1. Although the rains started as early as March, they did not become steady until June, The rains arrived rather late compared to last year. This is the reason for delaying all Samaru plantings until June. The total precipitation for the year was 974.14 mm which was below average rainfall for Samaru.

The 1973, meteorological observations along with the long-term average at Samaru are summarized in Table 2. The yearly mean temperature was 25.5°C which was slightly higher than the long-term average of 25.0°C.

## Experimental Procedures

Field Locations: All the maize performance trials in Samaru were planted on fields T-14, T-16 and T-17 that were previously cropped with groundnuts, cowpeas, and cotton, respectively. Field T-9 was used for the breeding nursery. Field T-14 and part of T-16 were used for the early plantings while the remainder of fields T-16 and T-17 was used for the late plantings (about eight to 13 days after the early plantings).

Land Preparation: The T fields were ripped in early May to break the soil to allow good water infiltration. The compound fertilizer 15:10:10 was applied to all fields on May 29. The fields were tilled on the same day. The fields were left for the weeds to germinate after which they were retilled for weed control, raked to level, and marked lengthwise with a tractor-drawn marker. The marks were 51.3 cm (28 in apart. A hand-drawn marker spaced 31.0 cm (24 in) apart was used to cross mark for the performance trial fields.

Table 1. Daily rainfall (mm), Samaru, 1973. Year total = 974.20 mm.

| Date | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | 10.90 | | | | |
| 2 | | | | | | | | 1.00 | 7.60 | 1.50 | | |
| 3 | | | | | | | | 24.40 | 24.40 | | | |
| 4 | | | | | 1.02 | 40.40 | | 0.30 | 0.80 | | | |
| 5 | | | | Tr | | 35.30 | 7.62 | 5.80 | | | | |
| 6 | | | | | 3.81 | 27.90 | | 13.20 | 1.00 | | | |
| 7 | | | | | | | | 11.40 | 43.70 | | | |
| 8 | | | | | | | 0.25 | | 52.30 | | | |
| 9 | | | | | | | 21.08 | 3.80 | 33.00 | | | |
| 10 | | | | | | 2.80 | 30.73 | 9.40 | 51.60 | | | |
| 11 | | | | | 3.81 | | | 7.60 | | | | |
| 12 | | | | Tr | 2.54 | | | 15.20 | 13.70 | | | |
| 13 | | | | | | | | 2.50 | 20.80 | | | |
| 14 | | | | | | | | 27.90 | 8.60 | | | |
| 15 | | | | | | | | 16.50 | | | | |
| 16 | | | | | | | 9.40 | 0.30 | | | | |
| 17 | | | | 7.11 | | 0.30 | | 7.40 | | | | |
| 18 | | | | | | | 36.07 | | | | | |
| 19 | | | | 14.47 | | | | | | | | |
| 20 | | | | | | | | 3.30 | | | | |
| 21 | | | | | | | Tr | 22.40 | 13.00 | | | |
| 22 | | | | | | 2.50 | | 24.90 | 3.80 | | | |
| 23 | | | | | 31.24 | 29.70 | 14.99 | 0.80 | | | | |
| 24 | | | | | | | 1.52 | | | | | |
| 25 | | | | | | | 24.13 | | | | | |
| 26 | | | | | | 11.40 | 2.03 | | | | | |
| 27 | | | 0.51 | Tr | 4.57 | | | 13.20 | 18.30 | | | |
| 28 | | | | | | 39.90 | 13.21 | | | | | |
| 29 | | | | | | 1.50 | 1.27 | | | | | |
| 30 | | | | | | | | 5.30 | | | | |
| 31 | | | | | | | 29.46 | | | | | |
| Total | Nil | Nil | 0.51 | 21.58 | 47.01 | 191.80 | 191.80 | 227.50 | 292.60 | 1.50 | Nil | Nil |

Table 2. Meteorological observations, Samaru 1973.

| | Rainfall (mm) | | Days of rain | | Relative humidity | | | | Air temperatures °C | | | | | | Sunshine Daily mean hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1973 | | 1938 - 1973 | | 1973 | | | 1938-1973 | | | | |
| | 1973 | 1924 to 1973 | 1973 | 1924 to 1973 | am | pm | am | pm | min | max | mean | min | max | mean | 1973 | 1954 – 1973 |
| Jan | 0.0 | 0.2 | 0 | 0.1 | 15.3 | 10.8 | 23.8 | 13.3 | 15.2 | 31.6 | 23.4 | 14.1 | 30.6 | 22.3 | 8.5 | 8.9 |
| Feb | 0.0 | 1.1 | 0 | 0.2 | 15.5 | 9.7 | 21.4 | 11.3 | 16.7 | 34.8 | 25.8 | 16.0 | 32.7 | 24.4 | 9.0 | 9.5 |
| Mar | 0.5 | 7.6 | 1 | 1.0 | 22.0 | 8.7 | 31.3 | 14.6 | 19.8 | 25.5 | 27.7 | 19.5 | 35.4 | 27.5 | 7.3 | 8.6 |
| Apr | 21.8 | 35.2 | 2 | 3.8 | 28.8 | 19.1 | 52.1 | 27.4 | 22.5 | 37.2 | 29.9 | 21.7 | 35.8 | 28.8 | 8.2 | 8.0 |
| May | 47.0 | 121.8 | 6 | 9.9 | 58.2 | 31.4 | 68.9 | 44.2 | 22.0 | 35.3 | 28.7 | 21.2 | 33.2 | 27.2 | 7.9 | 8.2 |
| June | 191.7 | 162.4 | 10 | 13.0 | 66.4 | 48.3 | 77.7 | 58.0 | 20.4 | 32.6 | 26.5 | 19.4 | 30.8 | 25.5 | 7.8 | 7.8 |
| July | 191.8 | 224.8 | 13 | 16.2 | 75.2 | 61.9 | 83.4 | 67.0 | 19.5 | 29.6 | 24.4 | 19.4 | 28.5 | 23.9 | 6.2 | 6.2 |
| Aug | 227.5 | 284.2 | 22 | 20.6 | 81.9 | 65.8 | 85.5 | 71.1 | 18.6 | 28.7 | 23.7 | 19.3 | 27.7 | 23.5 | 6.0 | 5.1 |
| Sept | 292.6 | 226.9 | 14 | 16.4 | 76.2 | 63.9 | 81.4 | 63.7 | 18.8 | 29.9 | 24.4 | 19.1 | 29.3 | 24.2 | 7.0 | 6.9 |
| Oct | 1.5 | 35.7 | 1 | 3.9 | 54.7 | 36.1 | 68.3 | 43.0 | 17.8 | 32.4 | 25.1 | 17.6 | 31.5 | 24.9 | 9.0 | 9.0 |
| Nov | 0.0 | 1.2 | 0 | 0.2 | 19.8 | 18.6 | 36.5 | 21.2 | 16.0 | 30.0 | 23.0 | 15.7 | 31.7 | 25.7 | 8.9 | 9.5 |
| Dec | 0.0 | 0.1 | 0 | 0.0 | 19.7 | 14.2 | 25.7 | 15.9 | 14.6 | 31.7 | 23.2 | 14.1 | 30.7 | 22.4 | 9.4 | 9.3 |
| Total | 974.2 | 1101.2 | 69 | 85.3 | - | - | - | - | - | - | - | - | - | - | 95.2 | 97.0 |
| Mean | - | - | - | - | 44.5 | 32.4 | 54.7 | 37.6 | 18.5 | 32.4 | 25.5 | 18.1 | 31.5 | 25.0 | 7.9 | 8.1 |

Note (1) Before 1953 observations taken at 0800 and 1300 G.M.T.
After 1953 observations taken at 0900 and 1500 G.M.T.

(2) Sunshine records from Campbell-Strokes recorder.

Table 3. The list of 1973 trials in Samaru and out-stations.

| Exp. No. | Title | No. of entries | Site |
|---|---|---|---|
| 73004 | NCA full-sib | 121 | Samaru |
| 73005 | NCB full-sib | 121 | " |
| 73006 | SC 123 full-sib | 81 | " |
| 73012 | 096 full-sib | 49 | " |
| 73002 | XB 101 topcrosses | 36 | " |
| 73003 | Biu Yellow topcrosses | 20 | " |
| 73007 | Inbred topcrosses | 121 | " , Mokwa |
| 73008 | Diallel crosses of populations | 49 | Mokwa, Samaru |
| 73009 | Variety x fertilizer trial | 7 | " " , Kano |
| 73010 | Early maize variety trial | 12 | Samaru, Kano |
| Cooperative trials | | | |
| 73001 | Federal Zonal trial | 12 | Samaru |
| 73011 | West African regional trial | 13 | " |
| 73013 | East African maize variety trial | 30 | " |
| 73014 | FAO regional cooperative yield nursery | 20 | " |
| 73015 | FAO regional cooperative obs. nursery | 36 | " |
| Out-station trials | | | |
| BN644 (73) | Early maize variety observation | 12 | Kafinsoli |
| FP364 (73) | " " " " | 12 | Damaturu |
| YP310 (73) | " " " " | 12 | Mubi |
| DP181 (73) | Advanced maize breeding line trial | 49 | Pankshin |

Fertilizer: 406.4 kg of 15:10:10 "cereal mixture" was applied per hectare, broadcast before raking and marking. Nitrochalk was used to topdress all trials at the time of final cultivation at the rate of 116.0 kg/hectare.

Plot Size: Except for the cooperative trials, the standard plot size for 1973 trials was 424.2 cm (14 ft) long in two 51.3-cm (28 in) wide rows. However, 91.4-cm alleyways were left between ranges.

Cultivation: A tractor-drawn cultivator passed through all fields once. "Moulding up" was done at the same time. Also, the second "moulding up" was done at the time of fertilizer sidedressing. Weeds were removed by hand hoeing.

Note Taking: Stand counts were taken after thinning and about two to three weeks before harvest. The late count was used for all calculations. Lodging count was recorded following August and September storms. Notes were made on ears with open tips; at the same time,notes on ear height were made. No notes were taken on rust and blight infection due to a lack of infection in 1973. However, observations of the degree of infection by Storey Streak virus disease were made on the late-planted full-sib trials 4(b), 5(b), 6(b), and 12(b). Except for the cooperative trials with special harvest instruction, all ears from each plot were harvested, the useable ears counted, and weighed. An ear or two were taken at random from each plot for obtaining both the shelling percentage and moisture content. However, in smaller trials such as two, three, and some cooperative trials, all ears were saved. Weights were taken with a spring balance which is accurate to 1/10 of a

pound. After shelling, a 200-gm sample was taken per entry or per plot, as appropriate, and dried in an oven at 80°C for 48 hours to estimate the moisture content.

All data were analyzed at A.B.U. Computer Center.

## Results

### A. Population Improvement

The populations involved in the program are Nigerian Composite A (NCA), Nigeria Composite B (NCB), Samaru Composite 123 (SC 123), 096, and Biu Yellow. The recombination of Biu Yellow lines selected in 1972 was made in 1973 main growing season. The full-sib lines will be tested in 1974. The recombination of 1972-selected lines for the other composite varieties was made in 1972-73 winter and tested in 1973. The 1973-selected lines are being recombined in the 1973-74 irrigated nursery for testing in the 1974 main season.

#### NCA Full-Sib Trial (Expt. 73004) Samaru, 1973

One hundred and eight full-sib families from 1972-73 recombination were tested in this trial. Eleven varieties and two variety hybrids were included in the trial as checks. An 11x11 simple lattice design was used. A total of eight replications were planted. Four of the replications were planted early, and the other four were planted late. The lines to be recombined for the next cycle were selected on yield performance, ear height, and lodging percentage. Agronomic characters for the selected families and two check varieties for the two planting dates are listed in Tables 4(a) and 4(b). There was much variation in the population yields, varying from 3666 kg/ha to 8080 kg/ha; ear height ranged from 152.5 cm to 182.5 cm; and lodging percentage varied from 15.9 to 64.4% in the early planting. The general yield was lower in the late plantings where yields ranged from 2567 kg/ha to 6667 kg/ha. The ear height and lodging were also lower than in the early plantings.

The 18 selected lines, or 15% of the lines tested, are to be recombined in 1973-74 dry season for testing in 1974.

The performance of NCA ($S_1$) $C_1$ was disappointing, especially in the early planted trial. The seed of NCA ($S_1$) $C_1$ (F/S)$C_1$ was not available at the time this trial was planted. The seed of this will be available for the 1974 trial.

#### NCB Full-Sib Trial (Expt. 73005) Samaru, 1973

Thirty $S_1$ lines were selected for recombination in 1972-73. Half of the lines were used as males, and the rest were used as females. Only 118 full-sib families from the recombination had sufficient seed set for the trials. This was because of lack of water at anthesis time due to water pump breakdown. Three other varieties used as checks were tested with 118 lines using an 11x11 simple lattice design. There were eight replications, four planted early and four planted late, resulting in two widely different environments.

There was much variation in yields as well as in other agronomic characters studied. The selected lines for the next recombination were chosen primarily on mean yield performance for the two environments. More vigorous selection for the root and stalk strength was done at the breeding nursery. Also selections for

Table 4(a). Yields and other important agronomic characters of Nigerian Composite A (NCA) full-sib selected families, Samaru, 1973. (Expt. 73004) planted June 11, 1973.

| 73004 Entry | Yields | Stand | Lodging | B. Tip | U. Ear | Ear height | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 36 | 8080 | 93.0 | 32.4 | 10.2 | 135 | 157 | 57 |
| 42 | 7502 | 93.0 | 15.9 | 18.6 | 121 | 163 | 57 |
| 44 | 7045 | 100.8 | 25.9 | 9.8 | 116 | 166 | 57 |
| 67 | 6984 | 96.1 | 58.6 | 10.0 | 123 | 165 | 56 |
| 68 | 6949 | 98.4 | 32.4 | 20.4 | 136 | 160 | 55 |
| 32 | 6922 | 89.8 | 40.6 | 23.1 | 127 | 152 | 54 |
| 54 | 6879 | 109.4 | 31.1 | 12.4 | 108 | 172 | 57 |
| 34 | 6765 | 95.3 | 39.7 | 23.4 | 116 | 161 | 59 |
| 29 | 6763 | 93.8 | 47.6 | 15.5 | 110 | 175 | 56 |
| 39 | 6665 | 92.2 | 23.5 | 10.5 | 115 | 166 | 54 |
| 87 | 6647 | 92.2 | 37.4 | 9.2 | 144 | 171 | 57 |
| 46 | 6551 | 103.9 | 30.6 | 2.9 | 125 | 170 | 57 |
| 85 | 6398 | 96.9 | 36.7 | 11.8 | 145 | 157 | 55 |
| 19 | 6375 | 98.4 | 54.8 | 22.9 | 106 | 175 | 57 |
| 52 | 6270 | 92.2 | 38.5 | 21.6 | 117 | 175 | 57 |
| 118 | 6251 | 96.1 | 44.3 | 17.5 | 115 | 162 | 54 |
| 90 | 6137 | 105.5 | 33.0 | 18.9 | 88 | 162 | 57 |
| 91 | 6106 | 91.4 | 52.7 | 10.4 | 140 | 167 | 58 |
| Checks: | | | | | | | |
| NCA ($S_1$) $C_1$ | 5052 | 84.4 | 48.8 | 13.6 | 119 | 180 | 61 |
| 096(Soil Sc) | 6212 | 88.3 | 45.5 | 5.0 | 159 | 192 | 62 |
| Means | 5557 | 93.74 | 40.99 | 16.42 | 116 | 164 | 56 |
| L.S.D.(05) | 938 | 11.38 | 24.67 | 11.24 | 20 | 12 | - |
| C-V (%) | 11 | 8.58 | 41.55 | 48.39 | 12 | 5 | - |

Lattice eff = 120.28

low ear height and rust resistance were done at the breeding nursery. Eighteen full-sib families were selected for recombination in 1973-74 irrigated nursery, and these will be tested in 1974. Yields and other agronomic characters considered important for the selected families are summarized in Tables 5(a) and 5(b).

Different versions of NCB were included as checks to determine which were superior and the existence of differences. NCB IITA was the International Institute for Tropical Agriculture developed population; NCB Daudawa was the bulk made at Samaru following one year of $S_1$ testing. NCB B.M.F. was the bulk of Samaru-Ibadan material made at the second cycle of $S_1$ testing. NCB from the Botany Main Farm appears to be the best of the three. This is to be increased for purposes of any extensive trials and distribution.

Table 4(b). Yields and other important agronomic characters of Nigerian Composite A (NCA) full-sib selected families, Samaru, 1973. (Expt.73004) planted June 26, 1973.

| 73004 Entry | Yields | Stand | Lodging | B. Tip | U. Ear | Ear height | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 36 | 6667 | 96.9 | 13.6 | 10.3 | 127 | 140 | 55 |
| 67 | 6234 | 99.2 | 22.7 | 10.4 | 113 | 138 | 55 |
| 44 | 6113 | 97.7 | 16.0 | 17.5 | 109 | 148 | 55 |
| 54 | 6029 | 99.2 | 10.2 | 14.0 | 113 | 105 | 56 |
| 90 | 6017 | 98.4 | 18.9 | 17.0 | 114 | 141 | 56 |
| 87 | 5969 | 95.3 | 16.4 | 8.3 | 121 | 157 | 55 |
| 19 | 5897 | 98.4 | 30.9 | 26.6 | 98 | 167 | 56 |
| 34 | 5873 | 99.2 | 19.7 | 24.5 | 103 | 151 | 57 |
| 29 | 5740 | 98.4 | 15.1 | 18.6 | 101 | 158 | 54 |
| 91 | 5704 | 96.9 | 22.2 | 14.5 | 133 | 147 | 54 |
| 32 | 5584 | 97.7 | 16.1 | 24.8 | 106 | 133 | 54 |
| 52 | 5512 | 96.9 | 21.4 | 24.6 | 107 | 158 | 55 |
| 42 | 5464 | 99.2 | 17.3 | 18.2 | 115 | 146 | 55 |
| 68 | 5331 | 100.8 | 18.6 | 21.5 | 123 | 138 | 54 |
| 39 | 5271 | 96.1 | 19.7 | 14.2 | 109 | 142 | 54 |
| 118 | 5259 | 92.2 | 16.8 | 20.3 | 122 | 140 | 53 |
| 46 | 5247 | 98.4 | 13.5 | 16.5 | 113 | 151 | 55 |
| 85 | 5163 | 97.7 | 19.1 | 13.7 | 129 | 141 | 55 |
| Checks: | | | | | | | |
| NCA ($S_1$) $C_1$ | 5391 | 99.2 | 20.6 | 11.2 | 111 | 168 | 57 |
| 096(Soil Sc) | 4802 | 96.1 | 23.1 | 5.5 | 128 | 170 | 60 |
| Means | 4797 | 96.91 | 19.83 | 18.21 | 109 | 144 | 55 |
| L.S.D.(05) | 917 | 10.70 | 9.66 | 10.39 | 20 | 14 | - |
| C-V (%) | 13 | 7.81 | 34.45 | 40.33 | 13 | 7 | - |

Lattice eff = 103.50

SC 123 Full-Sib Trial (Expt. 73006) Samaru, 1973

Only 73 full-sib families of the 120 possible crosses made in 1972-73 irrigated nursery had enough seeds to plant the preplanned eight replication of SC 123 trials. This was because the temperature became very high at anthesis stage and some tassel dried up. In fact, one-way crosses were made where there were no paired plants. Furthermore, some of the entries tested were a bulk of two or more individual pair line crosses. This procedure precludes identifying the best pair in the bulk. However, it was assumed that plants from the best pair will look better in the nursery and stand better chances of being selected during inbreeding.

Table 5(a) Yields and other agronomic characters of NCB, full-sib, selected lines, Samaru, 1973. (Expt. 73005) planted June 12, 1973.

| 73005 Entry | Yields | Stand | Lodging | B. Tip | U. Ear | Ear height | Days to 50 anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 83 | 8834 | 92.2 | 84.5 | 7.0 | 174 | 166 | 59 |
| 80 | 8195 | 96.9 | 62.9 | 5.3 | 193 | 175 | 61 |
| 32 | 8038 | 98.4 | 62.2 | 25.7 | 154 | 155 | 57 |
| 56 | 7914 | 97.7 | 71.7 | 16.7 | 188 | 156 | 61 |
| 31 | 7825 | 96.9 | 66.4 | 5.4 | 149 | 158 | 60 |
| 117 | 7746 | 96.1 | 45.4 | 8.8 | 166 | 170 | 57 |
| 71 | 7735 | 93.8 | 67.6 | 9.9 | 169 | 167 | 59 |
| 90 | 7735 | 95.3 | 63.4 | 10.4 | 169 | 158 | 59 |
| 86 | 7533 | 88.3 | 86.3 | 11.7 | 159 | 187 | 61 |
| 67 | 7275 | 89.1 | 68.7 | 11.3 | 166 | 168 | 60 |
| 34 | 7118 | 85.2 | 64.0 | 8.4 | 169 | 172 | 61 |
| 74 | 7085 | 89.1 | 86.0 | 8.6 | 162 | 187 | 62 |
| 60 | 7062 | 78.1 | 61.3 | 12.3 | 182 | 162 | 61 |
| 35 | 7006 | 93.0 | 75.8 | 7.6 | 159 | 180 | 61 |
| 5 | 6704 | 85.2 | 70.6 | 8.3 | 161 | 170 | 60 |
| 21 | 6636 | 74.2 | 75.4 | 8.8 | 167 | 178 | 63 |
| 48 | 6580 | 82.0 | 87.5 | 17.9 | 149 | 182 | 64 |
| 82 | 6401 | 85.9 | 74.0 | 6.7 | 172 | 173 | 62 |
| Checks: | | | | | | | |
| NCB Daudawa | 5257 | 92.2 | 74.5 | 15.9 | 124 | 163 | 59 |
| NCB B.M.F. | 6304 | 93.0 | 60.9 | 6.3 | 138 | 166 | 60 |
| NCB IITA | 5659 | 90.6 | 61.8 | 10.6 | 122 | 158 | 59 |
| Means | 5797 | 82.13 | 70.28 | 12.24 | 157 | 166 | 60.29 |
| L.S.D. (05) | 1704 | 17.44 | 29.08 | 14.51 | 30 | 18 | - |
| C.V. (%) | 20 | 15.01 | 29.26 | 82.46 | 13 | 7 | - |

Lattice eff = 102.5

The yield ranged from 5264 kg/ha to 8203 kg/ha in the early-planted trial and from 3675 kg/ha to 6200 kg/ha in the late-planted trial. SC 123 (Daudawa) which was the initial bulk of $SC_1$, $SC_2$, and $SC_3$ yielded below the mean yield of both the early- and the late-planted trials. Columbian Composite, which was originated from the same composites as SC 123, proved superior to SC 123. This was confirmed in other trials in 1973. It is recommended that consideration be given to merging the elite materials from SC 123 with the best selections from Columbia Composite following the 1974 trials.

Fourteen (19%) of the tested families were selected for the recombination in 1973-74. Yield was the prime criterion of the selection. The yields and other traits of the selected lines and the check varieties are available in Tables 6(a) and 6(b).

Table 5(b). Yields and other agronomic characters of NCB, full-sib, selected lines, Samaru, 1973. (Expt. 73005) planted June 26, 1973.

| 70005 Entry | Yields | Stand | Lodging | B. Tip | U. Ear | Ear height | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 48 | 7753 | 97.7 | 16.2 | 22.4 | 133 | 168 | 60 |
| 32 | 7639 | 92.2 | 17.0 | 12.8 | 141 | 158 | 58 |
| 34 | 7637 | 96.1 | 17.1 | 4.6 | 143 | 168 | 61 |
| 83 | 7427 | 89.1 | 17.0 | 5.1 | 156 | 158 | 58 |
| 86 | 7356 | 98.4 | 27.0 | 6.1 | 123 | 172 | 59 |
| 5 | 7290 | 96.1 | 7.3 | 9.2 | 139 | 156 | 58 |
| 21 | 7270 | 97.7 | 25.7 | 8.9 | 162 | 173 | 61 |
| 82 | 7209 | 98.4 | 11.1 | 6.6 | 145 | 155 | 59 |
| 31 | 6920 | 94.5 | 19.6 | 6.2 | 136 | 141 | 59 |
| 74 | 6879 | 100.8 | 15.4 | 14.3 | 137 | 158 | 58 |
| 90 | 6831 | 100.8 | 17.1 | 8.2 | 132 | 168 | 57 |
| 80 | 6819 | 96.9 | 7.3 | 5.2 | 157 | 156 | 55 |
| 67 | 6814 | 125.8 | 13.0 | 12.4 | 116 | 151 | 55 |
| 35 | 6580 | 96.1 | 13.0 | 8.9 | 144 | 161 | 58 |
| 117 | 6569 | 102.3 | 10.4 | 11.9 | 128 | 151 | 60 |
| 60 | 6531 | 100.0 | 18.7 | 12.2 | 144 | 157 | 59 |
| 71 | 6224 | 95.3 | 19.2 | 14.3 | 142 | 158 | 57 |
| Checks: | | | | | | | |
| NCB Daudawa | 5542 | 97.7 | 16.0 | 19.9 | 119 | 165 | 55 |
| NCB BMF | 5497 | 100.0 | 19.6 | 11.4 | 126 | 153 | 54 |
| NCB IITA | 5041 | 99.2 | 15.1 | 10.7 | 108 | 153 | 54 |
| Means | 6021 | 94.74 | 18.23 | 11.99 | 135 | 156 | 57 |
| L.S.D. (05) | 997 | 13.37 | 11.94 | 80.44 | 24 | 15 | - |
| C.V. (%) | 11 | 9.98 | 46.30 | 49.81 | 12 | 7 | - |

096 Full-Sib Trial (Expt. 73012), Samaru, 1973

Only 10 families were selected in 1972. These were recombined in 1972-73, but only 39 full-sib families had enough seeds for the 1973 trials. The 39 full-sib families with enough seed for eight replications were tested along with 10 other entries as checks. There was much variation in yields. Ten full-sib families were selected for recombination in 1973-74. The recombined lines will be bulked to constitute the improved population which will be maintained by mass selection. The variety cross 096 x $BS_3$, mass selected for low ear height, is responding without much loss of yield. Using 096 in variety crosses, as suggested by Dr. Tatum, will be a good approach to overcome some of its weaknesses.

Results of other trials in 1973 demonstrated that 096 produces low-eared, high yielding hybrids when combined with Biu Yellow, NCB, and XB101.

Table 6(a). Yields and other agronomic data of SC 123. Full-sib, selected families, Samaru, 1973. (Expt. 73006) planted June 13, 1973.

| 73006 Entry | Yield | Stand | Lodging | B. Tip | U. Ear | Ear height | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 52 | 8203 | 102 | 43.1 | 11.6 | 102 | 147 | 55 |
| 34 | 7974 | 96 | 44.8 | 22.3 | 125 | 147 | 56 |
| 25 | 7519 | 102 | 50.7 | 12.1 | 120 | 143 | 53 |
| 43 | 7284 | 101 | 36.1 | 16.5 | 110 | 145 | 53 |
| 30 | 7145 | 97 | 44.9 | 14.2 | 121 | 141 | 54 |
| 23 | 7023 | 95 | 55.2 | 11.7 | 131 | 145 | 54 |
| 68 | 7063 | 96 | 62.4 | 13.3 | 133 | 153 | 55 |
| 40 | 6961 | 89 | 58.4 | 17.0 | 117 | 157 | 55 |
| 26 | 6956 | 96 | 53.6 | 16.5 | 121 | 140 | 52 |
| 14 | 6942 | 98 | 48.1 | 14.7 | 103 | 133 | 54 |
| 17 | 6928 | 97 | 54.8 | 12.8 | 129 | 145 | 57 |
| 47 | 6924 | 96 | 44.8 | 7.2 | 114 | 147 | 55 |
| 38 | 6860 | 99 | 52.6 | 10.8 | 120 | 152 | 56 |
| 51 | 6705 | 100 | 39.5 | 32.4 | 83 | 148 | 55 |
| Checks: | | | | | | | |
| Columbian Comp. | 6599 | 92.2 | 56.2 | 8.9 | 140 | 191 | 60 |
| 096(Soil Sc) | 6515 | 96.1 | 72.5 | 15.0 | 146 | 167 | 60 |
| SC 123 Daudawa | 6345 | 96.1 | 56.0 | 17.3 | 109 | 152 | 55 |
| 096x$BS_3$(M)$C_2$ | 6316 | 96.1 | 44.5 | 14.4 | 120 | 145 | 57 |
| OP2 Mass Sel. | 6308 | 100.8 | 38.1 | 21.9 | 117 | 141 | 57 |
| C10 x BY | 5562 | 90.6 | 44.6 | 27.1 | 106 | 150 | 58 |
| XB101xL.White | 4870 | 83.6 | 67.2 | 18.9 | 147 | 146 | 60 |
| $SC_3$ (L.T.C.) | 4557 | 90.6 | 64.5 | 19.0 | 98 | 157 | 58 |
| Means | 6431 | 96.87 | 53.34 | 16.58 | 117 | 147 | 55 |
| L.S.D. (05) | 1180 | 11.16 | 27.48 | 13.53 | 22 | 14 | - |
| C.V. (%) | 12 | 8.15 | 36.43 | 57.67 | 13 | 6 | - |

## Hybridization

The main emphasis of the hybridization program at Samaru is on developing high yielding crosses with at least one parent being an acceptable composite variety. The reasons for this approach are that the varieties as parents of hybrids are high yielding and are easier to maintain, thereby reducing seed costs. Also, these types of hybrids should have greater stability over a range of environments and thereby be more widely adapted.

Twenty-eight varieties were topcrossed to XB101, 14 were topcrossed to Biu Yellow (BY), and 113 materials (some of which were long-time inbreds) $S_1$ lines and straight varieties were topcrossed to NCA. The three groups of topcrosses were tested in 1973 in three trials. The main objective was to find which of the crosses form good hybrid combinations.

Table 6(b). Yields and other agronomic characters of SC 123. Full-sib, selected families, Samaru, 1973 (Expt. 73006) planted June 27, 1973.

| 73006 Entry | Yields | Stand | Lodging | B. Tip | U. Ear | Ear height | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 38 | 6199 | 99.7 | 10.9 | 8.9 | 120 | 137 | 53 |
| 30 | 5971 | 101.6 | 6.6 | 13.1 | 105 | 118 | 53 |
| 51 | 5962 | 101.6 | 11.5 | 19.7 | 100 | 116 | 52 |
| 52 | 5932 | 94.5 | 13.9 | 17.8 | 98 | 123 | 53 |
| 26 | 5718 | 100.8 | 7.7 | 12.1 | 102 | 111 | 52 |
| 14 | 5711 | 94.5 | 5.0 | 13.9 | 101 | 115 | 52 |
| 43 | 5679 | 102.3 | 8.4 | 27.0 | 104 | 121 | 52 |
| 23 | 5592 | 93.0 | 14.2 | 12.5 | 126 | 122 | 52 |
| 47 | 5426 | 99.2 | 10.2 | 16.3 | 111 | 123 | 53 |
| 40 | 5421 | 96.1 | 10.9 | 17.5 | 112 | 128 | 51 |
| 68 | 5342 | 96.9 | 20.0 | 16.7 | 110 | 125 | 52 |
| 17 | 5306 | 99.2 | 8.8 | 15.9 | 111 | 130 | 53 |
| 34 | 4756 | 99.2 | 11.0 | 27.6 | 103 | 125 | 52 |
| 25 | 4727 | 94.5 | 9.0 | 18.8 | 106 | 113 | 52 |
| Checks: | | | | | | | |
| C10 x BY | 6175 | 95.3 | 13.0 | 14.2 | 107 | 118 | 54 |
| Columbian Comp. | 5263 | 93.0 | 16.1 | 12.7 | 116 | 146 | 53 |
| 096x$BS_3$(M)C2 | 4823 | 95.3 | 15.6 | 22.5 | 107 | 116 | 53 |
| SC 123 Daudawa | 4449 | 92.2 | 12.2 | 10.5 | 107 | 121 | 54 |
| $OP^2$ Mass Pol. | 4344 | 97.7 | 11.9 | 20.2 | 84 | 115 | 54 |
| 096 (Soil Sc) | 3900 | 96.1 | 5.8 | 1.6 | 105 | 132 | 54 |
| $SC_3$ (L.T.C.) | 3593 | 85.2 | 17.3 | 5.4 | 109 | 121 | 55 |
| XB101xL.White | 3443 | 94.5 | 14.1 | 13.4 | 109 | 121 | 55 |
| Mean | 4797 | 95.96 | 12.36 | 16.50 | 106 | 121 | 52 |
| L.S.D. (05) | 1135 | 8.34 | 8.66 | 11.85 | 20 | 12 | - |
| C.V. (%) | 16 | 6.14 | 49.54 | 50.79 | 13 | 7 | - |

Lattice eff = 110.24

The yields and the other agronomic characters studied from XB101 topcrosses, Biu Yellow topcrosses, and for the 25 highest yielders of NCA topcrosses are reported in Tables 8(a) and 8(b), Tables 9(a) and 9(b), and Tables 10(a) and 10(b), respectively.

Judging from the performance of variety crosses, Mexican Comp. 1 x XB101, C-33 x XB101, and H501 x XB101 looked promising in the early-planted trial; it is recommended that they be tested again in 1974. They are potentially high yielding when planted at the optimum time.

Table 7(a). Yield and other agronomic data of 096 full-sub, selected families, Samaru, 1973. (Expt. 73012) planted June 13, 1973.

| 73012 Entry | Yield | Stand | Lodging | B. Tips | U. Ears | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 8 | 7727.1 | 94.5 | 50.9 | 9.3 | 110.8 | 171.3 | 65 |
| 39 | 7316.5 | 89.1 | 63.2 | 3.9 | 134.6 | 165.0 | 63 |
| 9 | 7304.0 | 95.3 | 58.7 | 1.9 | 133.7 | 153.7 | 60 |
| 29 | 7254.3 | 83.6 | 69.1 | 1.4 | 125.7 | 167.5 | 64 |
| 20 | 7042.7 | 93.0 | 58.1 | 0.7 | 132.8 | 171.3 | 66 |
| 31 | 6968.1 | 94.5 | 65.0 | 2.9 | 141.5 | 165.0 | 64 |
| 32 | 6943.2 | 96.1 | 58.9 | 5.5 | 132.6 | 161.2 | 68 |
| 35 | 6681.9 | 88.3 | 70.6 | 1.1 | 157.8 | 165.0 | 60 |
| 12 | 6632.1 | 88.3 | 83.3 | 0.6 | 143.4 | 165.0 | 64 |
| 33 | 6184.2 | 79.7 | 65.0 | 4.9 | 120.7 | 175.0 | 63 |
| Checks: | kg/ha | | | | | | |
| Columbian Comp. | 6980.5 | 89.8 | 73.5 | 8.6 | 157.7 | 170.0 | 64 |
| Bulk-3 | 6445.5 | 98.4 | 61.7 | 1.3 | 120.0 | 177.5 | 63 |
| 096x$BS_3$(M)$C_2$ | 6034.9 | 92.2 | 71.7 | 2.8 | 117.9 | 155.0 | 57 |
| C10 x BY | 5835.8 | 83.6 | 75.8 | 13.2 | 122.6 | 152.5 | 60 |
| SC 123 | 5586.9 | 97.7 | 69.9 | 16.0 | 106.9 | 148.7 | 57 |
| 096 (Soil Sc) | 5114.1 | 78.1 | 70.6 | 3.5 | 149.4 | 167.5 | 66 |
| SC3 | 5089.2 | 91.4 | 89.5 | 12.0 | 115.1 | 160.0 | 59 |
| NCB Daudawa | 4964.8 | 93.0 | 85.0 | 12.5 | 116.2 | 167.5 | 61 |
| XB101xL.White | 4877.7 | 89.1 | 72.1 | 10.8 | 135.1 | 156.3 | 61 |
| NCB IITA | 4255.5 | 75.8 | 69.4 | 8.5 | 107.2 | 176.2 | 66 |
| Means | 6130.08 | 90.61 | 65.82 | 4.55 | 127.15 | 166.33 | 62.50 |
| L.S.D. (05) | 1297.22 | 15.96 | 30.98 | 5.35 | 31.73 | 15.05 | - |
| C.V. (%) | 14.96 | 12.96 | 33.28 | 83.27 | 17.65 | 6.40 | - |

In the Biu Yellow topcrosses, Variety Crosses H507 x BY, 096 x BY, C-33 x BY, and C-12 x BY appeared to be good hybrid combinations (Tables 9(a) and 9(b)). Further testing is needed to confirm the 1973 data.

Twenty-five lines out of the 113 tested lines were higher yielding than the present C-10 x BY which has been the best variety hybrid until the present time (Tables 10(a) and 10(b)). These 25-line topcrosses, the top yielding XB101 and BY topcrosses, should be tested in a single trial in 1974 using C-10 x BY and Line 7 x C-10 as checks. More testing of variety cross line 7 x C-10 is recommended because of its outstanding performance in 1972 trials.

Table 7(b). Yields and other agronomic characters of 096 full-sib, selected families Samaru, 1973. (Expt. 73012) planted June 27, 1973.

| 73012 Entry | Yield | Stand | Lodging | B. Tips | U. Ears | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 29 | 5964.4 | 95.3 | 12.5 | 0.9 | 96.5 | 135.0 | 60.0 |
| 33 | 5479.8 | 93.0 | 11.8 | 5.1 | 105.2 | 137.5 | 60.0 |
| 8 | 5288.5 | 96.9 | 6.7 | 2.4 | 98.3 | 150.0 | 62.0 |
| 35 | 5134.2 | 96.9 | 12.9 | 1.4 | 112.2 | 140.0 | 58.0 |
| 12 | 5116.2 | 96.9 | 6.2 | 3.2 | 104.0 | 140.0 | 59.0 |
| 20 | 5075.6 | 101.6 | 2.3 | 2.8 | 109.4 | 152.5 | 61.5 |
| 39 | 5067.8 | 94.5 | 6.6 | 3.5 | 113.1 | 131.2 | 62.0 |
| 9 | 4861.4 | 96.1 | 9.6 | 2.1 | 106.4 | 146.2 | 57.0 |
| 32 | 4702.8 | 93.8 | 10.5 | 6.6 | 103.0 | 146.2 | 60.0 |
| Checks: | | | | | | | |
| C10 x BY | 4806.2 | 83.6 | 6.8 | 9.3 | 110.4 | 132.5 | 54.0 |
| NCB IITA | 4610.6 | 80.5 | 14.2 | 11.5 | 109.0 | 146.2 | 60.0 |
| Bulk - 3 | 4573.9 | 86.7 | 18.8 | 3.7 | 127.1 | 150.0 | 59.0 |
| SC 123 | 4552.7 | 93.8 | 12.6 | 18.0 | 106.5 | 135.0 | 54.0 |
| 096 (Soil Sc) | 4518.6 | 92.2 | 7.7 | 0.6 | 130.1 | 155.0 | 61.5 |
| 096 x $BS_3$ (M) $C_2$ | 4446.6 | 96.1 | 7.4 | 10.4 | 95.3 | 126.3 | 55.0 |
| Columbian Comp. | 4302.5 | 100.8 | 14.8 | 3.5 | 103.9 | 147.5 | 61.0 |
| NCB Daudawa | 4058.6 | 89.1 | 14.9 | 9.1 | 113.6 | 138.8 | 55.0 |
| XB101 x L. White | 3580.2 | 94.5 | 6.4 | 20.3 | 105.5 | 122.5 | 57.0 |
| S. Comp. 3 | 3267.0 | 80.5 | 9.4 | 8.6 | 106.5 | 132.5 | 54.0 |
| Means | 4523.21 | 92.92 | 8.67 | 6.68 | 106.06 | 140.36 | 58.5 |
| L.S.D.(05) | 1013.15 | 15.76 | 9.50 | 10.06 | 20.56 | 114.17 | - |
| C.V. (%) | 15.84 | 11.99 | 77.46 | 106.50 | 13.71 | 7.14 | - |

Lattice eff = 105.58

Table 8(a). Yields and other agronomic data from varieties, topcrosses to XB101, Samaru, 1973. (Expt. 73002) planted June 11, 1973.

| 73002 Entry | Yield | Stand | Lodg-ing | B. Tips | U. Ear | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| Mexican Comp. 1 x XB101 | 7874.9 | 95.3 | 56.0 | 16.7 | 134.5 | 191.2 | 62.0 |
| C-33 x XB101 | 7396.7 | 91.4 | 69.3 | 17.7 | 132.7 | 163.7 | 59.0 |
| H501 (A 196) x XB101 | 7347.6 | 97.7 | 60.0 | 11.7 | 122.9 | 181.2 | 60.0 |
| 096 | 6959.1 | 96.1 | 63.8 | 7.8 | 143.9 | 190.0 | 60.0 |
| NCB ($S_1$) C2 Ib x XB101 | 6784.4 | 92.2 | 69.7 | 12.9 | 126.3 | 157.5 | 56.0 |
| NCB | 6676.6 | 90.6 | 73.9 | 7.6 | 132.5 | 171.3 | 58.0 |
| Lagos White x XB101 | 6623.1 | 93.0 | 74.4 | 15.9 | 130.1 | 176.2 | 58.0 |
| NCA (1971) x XB101 | 6611.0 | 93.0 | 78.2 | 18.6 | 117.4 | 166.2 | 58.0 |
| NCB (1971/72) x XB101 | 6608.0 | 93.0 | 64.7 | 15.1 | 120.3 | 157.7 | 56.0 |
| NCARb x XB101 | 6565.6 | 96.9 | 67.8 | 13.1 | 104.0 | 182.5 | 60.0 |
| UCA Streak Res. x XB101 | 6551.3 | 89.8 | 60.2 | 17.4 | 110.4 | 182.5 | 59.0 |
| SR 52 x XB101 | 6369.8 | 96.9 | 76.0 | 30.6 | 103.2 | 175.0 | 57.0 |
| C-12 (white) x XB101 | 6340.7 | 87.5 | 75.5 | 12.3 | 125.5 | 172.5 | 60.0 |
| NCARb (white) x XB101 | 6340.4 | 88.3 | 78.9 | 16.5 | 126.9 | 173.7 | 58.0 |
| A154 Diacol V-101 x XB101 | 6250.2 | 100.0 | 58.5 | 15.1 | 95.9 | 170.0 | 59.0 |
| Columbian Comp. x XB101 | 6234.4 | 89.8 | 66.0 | 20.1 | 125.5 | 178.7 | 61.0 |
| NCBRb (white) x XB101 | 6208.6 | 93.0 | 71.5 | 17.9 | 132.0 | 187.5 | 58.0 |
| Bulk 3 | 6165.8 | 88.3 | 77.6 | 2.8 | 104.3 | 185.0 | 59.0 |
| Eafro 231 x XB101 | 6127.8 | 93.0 | 62.7 | 21.4 | 115.8 | 198.7 | 60.0 |
| UCA (f) C4 white x XB101 | 6012.5 | 94.5 | 67.2 | 22.8 | 100.5 | 185.0 | 61.0 |
| 096 (1971) x XB101 | 5937.2 | 85.9 | 72.3 | 43.3 | 98.7 | 157.5 | 58.0 |
| C-12 x XB101 | 5934.2 | 88.3 | 63.4 | 24.8 | 126.0 | 166.2 | 59.0 |
| C-5 x Xb101 | 5849.8 | 80.5 | 74.5 | 15.2 | 138.2 | 163.7 | 59.0 |
| BY (S1) C2 x XB101 | 5788.7 | 93.0 | 65.7 | 22.3 | 110.2 | 172.5 | 59.0 |
| $SC_3$ x XB101 | 5716.0 | 98.4 | 69.9 | 13.5 | 104.8 | 170.0 | 55.0 |
| Ukuriguru Comp.B/WGxXB101 | 5522.9 | 91.4 | 78.9 | 20.5 | 112.5 | 187.5 | 60.0 |
| SC3 | 5486.7 | 97.7 | 68.4 | 18.0 | 104.2 | 167.5 | 57.0 |
| H507 (A195) x XB101 | 5273.8 | 73.4 | 63.3 | 11.9 | 132.8 | 180.0 | 62.0 |
| BY x C-10 | 5267.5 | 88.3 | 92.2 | 16.8 | 103.6 | 162.5 | 56.0 |
| SC 123 | 5190.3 | 92.2 | 72.0 | 21.0 | 102.9 | 153.7 | 56.0 |
| NCA | 5117.8 | 88.3 | 92.2 | 16.8 | 103.6 | 162.5 | 56.0 |
| XB101 | 4988.6 | 93.8 | 80.9 | 22.8 | 119.2 | 161.2 | 59.0 |
| Bomo Local x XB101 | 4882.0 | 86.7 | 80.9 | 24.5 | 110.7 | 158.7 | 58.0 |
| Tsolo (5003) x XB101 | 4830.9 | 93.0 | 62.5 | 33.9 | 90.0 | 170.0 | 59.0 |
| Comp. B. $C_2$ x XB101 | 4806.1 | 82.8 | 68.4 | 18.9 | 125.4 | 172.5 | 62.0 |
| Kitale Comp. F x XB101 | 4656.3 | 91.4 | 75.2 | 32.4 | 92.6 | 172.5 | 59.0 |
| Means | 6036.19 | 91.25 | 70.17 | 19.11 | 115.73 | 173.19 | 59.0 |
| L.S.D. (05) | 1333.09 | 11.94 | 24.97 | 15.02 | 27.51 | 17.43 | - |
| C.V. (%) | 15.62 | 9.25 | 25.16 | 55.58 | 16.81 | 7.12 | - |

Table 8(b). Yields and other agronomic data from varieties, topcrosses to XB101, Samaru, 1973. (Expt. 73002) planted June 27, 1973.

| 73002 Entry | Yield | Stand | Lodg-ing | B. Tips | U. Ear | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| 096 (1971) x XB101 | 5733.1 | 96.9 | 3.9 | 17.0 | 100.9 | 141.3 | 60 |
| Tsolo (5003) x XB101 | 4816.8 | 96.1 | 7.2 | 9.8 | 108.1 | 145.0 | 56 |
| $SC_3$ x XB101 | 4136.4 | 83.6 | 2.5 | 17.8 | 110.1 | 131.2 | 58 |
| UCA Streak Res. x XB101 | 5597.9 | 96.9 | 5.6 | 8.7 | 114.5 | 162.5 | 61 |
| XB101 | 5500.9 | 100.0 | 1.6 | 13.5 | 128.1 | 140.0 | 61 |
| BY x C-10 | 5466.4 | 96.1 | 4.8 | 15.6 | 100.7 | 142.5 | 59 |
| BY (S1) C2 x XB101 | 5294.6 | 96.1 | 6.2 | 20.5 | 111.4 | 145.0 | 60 |
| NCARb x XB101 | 5275.9 | 94.5 | 6.3 | 10.6 | 123.6 | 152.5 | 60 |
| SR 52 x XB101 | 5200.2 | 97.7 | 8.9 | 16.4 | 108.8 | 145.0 | 60 |
| Mexican Comp. 1 x XB101 | 5004.7 | 88.3 | 5.9 | 14.3 | 113.8 | 160.0 | 64 |
| H501 (A196) x XB101 | 4996.4 | 95.3 | 0.8 | 14.1 | 123.1 | 156.3 | 64 |
| NCA (1971) x XB101 | 4941.4 | 95.3 | 2.4 | 12.0 | 131.2 | 145.0 | 60 |
| H507 (A195) x XB101 | 4933.6 | 89.8 | 3.9 | 15.5 | 118.8 | 150.0 | 63 |
| C-12 (white) x XB101 | 4911.3 | 93.0 | 4.2 | 12.0 | 108.6 | 157.5 | 61 |
| Kitale Comp. F x XB101 | 4910.5 | 99.2 | 11.0 | 13.0 | 118.8 | 157.5 | 61 |
| NCB (S1) C2 Ib x XB101 | 4889.9 | 95.3 | 0.0 | 11.8 | 110.1 | 141.3 | 57 |
| NCARb (white) x XB101 | 4857.8 | 95.3 | 4.8 | 12.2 | 122.1 | 160.0 | 61 |
| Columbian Comp. x XB101 | 4826.7 | 83.6 | 6.1 | 12.3 | 126.5 | 155.0 | 63 |
| Bomo Local x XB101 | 4816.8 | 96.1 | 7.2 | 9.8 | 108.1 | 145.0 | 56 |
| NCA | 4814.2 | 93.0 | 2.5 | 11.6 | 101.7 | 142.5 | 58 |
| NCB (1971/72) x XB101 | 4714.3 | 103.1 | 3.0 | 11.7 | 104.3 | 146.2 | 58 |
| SC 123 | 4693.7 | 92.2 | 5.7 | 12.1 | 105.4 | 142.5 | 58 |
| Ukuriguru Comp.B/WGxXB101 | 4642.7 | 93.8 | 6.5 | 19.5 | 107.4 | 147.5 | 61 |
| C-12 x XB101 | 4640.8 | 100.0 | 1.5 | 11.5 | 113.4 | 147.5 | 59 |
| Bulk - 3 | 4596.6 | 85.2 | 6.7 | 9.3 | 122.7 | 167.5 | 64 |
| UCA(F) C4 White x XB101 | 4583.6 | 83.6 | 11.3 | 17.6 | 121.6 | 166.2 | 63 |
| Lagos White x XC101 | 4571.8 | 86.7 | 1.0 | 13.4 | 138.3 | 145.0 | 60 |
| 096 | 4557.8 | 85.9 | 8.1 | 6.4 | 138.1 | 153.7 | 64 |
| C-33 x XB101 | 5528.9 | 90.6 | 8.3 | 12.8 | 114.2 | 162.5 | 62 |
| Eafro 231 x XB101 | 4505.2 | 93.0 | 11.0 | 9.2 | 111.6 | 168.7 | 65 |
| C-5 x XB101 | 4475.9 | 87.5 | 12.2 | 15.9 | 124.4 | 152.5 | 61 |
| A 154 Diacol N-101 x XB101 | 4375.7 | 96.1 | 7.8 | 11.5 | 108.9 | 163.7 | 61 |
| NCBRb (white) x XB101 | 4345.8 | 100.8 | 1.5 | 7.6 | 123.0 | 150.0 | 60 |
| $SC_3$ | 4136.4 | 83.3 | 2.5 | 17.8 | 110.1 | 131.2 | 58 |
| NCB | 4112.0 | 88.3 | 7.7 | 12.7 | 127.5 | 157.5 | 61 |
| Comp. B C2 CA x XB101 | 4058.4 | 80.5 | 3.7 | 16.0 | 121.7 | 151.2 | 61 |
| Means | 4856.22 | 92.69 | 5.47 | 12.97 | 116.93 | 151.32 | 60.5 |
| L.S.D. (05) | 801.05 | 14.09 | 7.93 | 11.55 | 17.51 | 14.72 | - |
| C.V. (%) | 11.66 | 10.75 | 107.59 | 62.95 | 10.59 | 6.88 | - |

Table 9(a). Yields and other agronomic data from varieties, topcrosses to Biu Yellow, Samaru, 1973 (Expt.73003) planted June 11, 1973.

| Entry 73003 | Yield | Stand | Lodg-ing | B. tip | U. ear | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| H507 x BY | 8295.2 | 91.4 | 25.8 | 24.8 | 116.9 | 147.5 | 59.0 |
| 096 x BY | 7510.3 | 95.3 | 16.3 | 20.6 | 128.6 | 145.0 | 57.0 |
| C-33 x BY | 7171.7 | 93.8 | 21.9 | 28.3 | 107.7 | 147.5 | 57.0 |
| C10 x BY | 7141.0 | 96.1 | 17.8 | 28.8 | 110.7 | 137.5 | 56.0 |
| C-12 x BY | 6910.1 | 99.2 | 19.6 | 26.6 | 104.7 | 147.5 | 52.0 |
| SC 123 x BY | 6479.2 | 94.5 | 13.2 | 29.2 | 113.9 | 128.7 | 52.0 |
| 096 | 6448.4 | 95.3 | 17.5 | 14.0 | 134.7 | 165.0 | 63.0 |
| NCB (71/72) x BY | 6371.5 | 98.4 | 12.7 | 24.9 | 99.8 | 140.0 | 57.0 |
| NCA (W/F) x BY | 6202.2 | 96.9 | 18.3 | 28.0 | 98.5 | 141.3 | 54.5 |
| NCA | 6032.9 | 98.4 | 14.4 | 21.5 | 94.1 | 150.0 | 55.0 |
| Tsolox BY | 6017.5 | 94.5 | 16.6 | 31.9 | 100.9 | 142.5 | 53.5 |
| NCB | 5879.0 | 93.8 | 13.0 | 18.2 | 119.2 | 146.2 | 57.0 |
| Iowa Rootworm Syn. x BY | 5032.5 | 99.2 | 14.9 | 24.1 | 92.1 | 128.7 | 53.0 |
| $BS_3$ x BY | 5032.5 | 96.9 | 14.4 | 29.7 | 90.9 | 122.5 | 52.5 |
| SC 123 | 4971.0 | 93.8 | 17.3 | 32.5 | 93.5 | 138.8 | 54.0 |
| $BS_4$ x BY | 4709.3 | 88.3 | 28.7 | 32.6 | 93.7 | 126.3 | 50.0 |
| $SC_3$ | 4693.9 | 100.0 | 12.5 | 25.5 | 98.4 | 133.7 | 53.5 |
| Biu Yellow (BY) | 4432.3 | 94.5 | 13.7 | 29.0 | 89.2 | 131.2 | 57.0 |
| $BSSS_2$ x BY | 4447.7 | 95.3 | 19.9 | 28.4 | 86.8 | 126.3 | 52.0 |
| $SC_3$ | 3832.1 | 86.7 | 31.1 | 29.2 | 99.7 | 138.8 | 61.0 |
| Means | 5880.52 | 95.12 | 17.98 | 26.89 | 103.64 | 139.25 | 55.3 |
| L.S.D. (05) | 932.91 | 8.94 | 11.21 | 11.40 | 16.61 | 14.61 | - |
| C.V. (%) | 11.22 | 6.50 | 44.09 | 30.04 | 11.33 | 7.42 | - |

Table 9(b). Yields and other agronomic data from variety topcrosses to Biu Yellow, Samaru, 1973 (Expt. 73003) planted June 27, 1973.

| Entry 73003 | Yield | Stand | Lodg-ing | B. tip | U. ear | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| C-33 x BY | 7479.5 | 93.8 | 59.7 | 27.6 | 106.2 | 165.0 | 57.0 |
| C-10 x BY | 7048.6 | 93.8 | 59.2 | 31.7 | 101.5 | 168.7 | 55.0 |
| 096 x BY | 6940.9 | 96.9 | 80.8 | 20.4 | 127.4 | 163.7 | 55.0 |
| NCB (71/72) x BY | 6894.7 | 96.1 | 57.8 | 25.2 | 112.4 | 172.5 | 53.5 |
| Tsolo x BY | 6848.6 | 96.9 | 46.7 | 23.5 | 94.3 | 165.0 | 53.0 |
| NCA x BY | 6740.8 | 95.3 | 56.8 | 16.7 | 107.0 | 172.5 | 53.0 |
| H507 x BY | 6525.4 | 91.4 | 69.6 | 22.3 | 109.4 | 192.5 | 58.0 |
| 096 | 6233.0 | 95.3 | 62.9 | 2.9 | 134.6 | 182.5 | 59.0 |
| SC 123 x BY | 6125.2 | 93.0 | 47.0 | 33.5 | 98.2 | 156.3 | 53.0 |
| $BS_4$ x BY | 6017.5 | 96.9 | 51.1 | 22.0 | 108.0 | 140.0 | 49.0 |
| $BS_3$ x BY | 5863.6 | 93.8 | 69.5 | 28.3 | 89.3 | 152.0 | 49.0 |
| Iowa Rootworm M Syn. x BY | 5848.2 | 92.2 | 54.1 | 27.4 | 100.5 | 152.5 | 50.0 |
| $BSSS_2$ x BY | 5832.8 | 96.1 | 58.0 | 35.4 | 95.2 | 146.2 | 49.0 |
| NCB | 5525.0 | 89.8 | 63.6 | 16.5 | 117.4 | 173.7 | 54.0 |
| SC 123 | 5494.2 | 92.2 | 65.4 | 26.8 | 105.3 | 156.3 | 54.0 |
| NCA | 5324.9 | 88.3 | 68.9 | 11.8 | 115.2 | 171.3 | 55.0 |
| $SC_3$ x BY | 5140.3 | 94.5 | 66.0 | 39.0 | 104.2 | 150.0 | 51.0 |
| Biu Yellow (BY) | 4909.4 | 94.5 | 64.5 | 31.9 | 93.2 | 151.2 | 55.0 |
| $SC_3$ | 4324.0 | 85.2 | 61.1 | 25.5 | 93.0 | 157.5 | 57.0 |
| Means | 6102.90 | 93.40 | 60.73 | 24.70 | 106.75 | 162.31 | 53.5 |
| L.S.D. (05) | 1148.16 | 9.74 | 20.39 | 14.01 | 19.09 | 19.86 | - |
| C. V. (%) | 13.30 | 7.38 | 23.74 | 40.10 | 12.65 | 8.65 | - |

Table 10(a). Yields and other agronomic characters from inbreds topcrossed to Nigeria Composite A (NCA), Samaru (Expt. 73007) planted June 12, 1973.

| Entry 73007 | 1972 source | Yield | Stand | Lodg-ing | B. tip | U. ears | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|
| | | kg/ha | % | % | % | % | dy |
| 69-1-1-1-1 x NCA | 7001-164 | 8477.9 | 101.0 | 37.5 | 13.2 | 137.3 | 59 |
| 67-1-1-1-1 x NCA | " -166 | 8075.0 | 95.8 | 61.0 | 3.2 | 147.0 | 60 |
| 67-1-1-1-1-2-1 x NCA | " -120 | 8072.3 | 95.8 | 49.3 | 1.4 | 135.8 | 60 |
| NCA ($S_1$) x NCA | " - 87 | 7559.6 | 94.8 | 49.5 | 7.0 | 127.3 | 58 |
| 97-1-2-2-2-1 x NCA | " -122 | 7507.2 | 100.0 | 74.0 | 6.9 | 120.0 | 59 |
| NCA ($S_1$) x NCA | " - 67 | 7480.5 | 99.0 | 63.5 | 7.9 | 123.2 | 58 |
| NCB ($S_1$) x NCA | " - 32 | 7472.9 | 92.7 | 58.4 | 3.2 | 138.8 | 61 |
| 19-2-1-1-1-1 x NCA | " -113 | 7417.4 | 95.8 | 87.1 | 9.5 | 114.1 | 58 |
| 475-2-2-1-1-3x NCA | " -157 | 7380.8 | 101.0 | 30.2 | 16.7 | 107.2 | 57 |
| 41-4-2-1 x NCA | " - 96 | 7375.7 | 91.7 | 71.9 | 15.3 | 135.6 | 59 |
| NCA ($S_1$) x NCA | " - 88 | 7301.9 | 96.9 | 46.0 | 28.2 | 122.8 | 60 |
| NCA ($S_1$) x NCA | " - 70 | 7299.6 | 92.7 | 68.3 | 6.7 | 130.3 | 58 |
| 334-2-1-2-1-1 x NCA | " -138 | 7293.6 | 96.9 | 50.3 | 10.3 | 139.2 | 61 |
| NCA ($S_1$) x NCA | " - 51 | 7268.6 | 99.0 | 45.5 | 2.9 | 106.5 | 58 |
| $SC_2$ ($S_1$) x NCA | " - 8 | 7238.5 | 100.0 | 48.3 | 15.2 | 116.1 | 57 |
| NCA ($S_1$) x NCA | " - 45 | 7209.3 | 91.7 | 55.2 | 11.1 | 113.4 | 58 |
| NCA ($S_1$) x NCA | " - 50 | 7146.1 | 99.0 | 37.0 | 25.6 | 118.0 | 56 |
| 137-1-1-1-1-2 x NCA | " -125 | 7138.2 | 80.2 | 66.9 | 11.9 | 126.5 | 60 |
| 27-1-1-1-1 x NCA | " -116 | 7097.8 | 95.8 | 81.1 | 3.5 | 123.3 | 61 |
| 19-2-1-1-2-1 x NCA | " -114 | 7094.7 | 96.9 | 51.6 | 17.2 | 109.4 | 60 |
| 38-4-2-1-1 x NCA | " - 93 | 7079.7 | 99.0 | 56.7 | 8.3 | 125.8 | 59 |
| NCA ($S_1$) x NCA | " - 57 | 7003.5 | 110.4 | 36.8 | 6.8 | 97.4 | 58 |
| $SC_2$ ($S_1$) x NCA | 72:700 - 7 | 6977.4 | 92.7 | 58.6 | 6.6 | 136.7 | 57 |
| $SC_1$ ($S_1$) x NCA | 72:700 - 1 | 6928.9 | 93.8 | 65.2 | 21.7 | 118.1 | 57 |
| Checks: | Biu Yellow x C10 | 6993.6 | 94.8 | 68.3 | 28.4 | 105.5 | 59 |
| | Line 7 x C10 | 6207.3 | 97.9 | 80.7 | 8.8 | 105.3 | 57 |
| | NCA | 5727.2 | 88.5 | 69.0 | 6.4 | 121.3 | 58 |
| Means | | 6295.08 | 95.44 | 66.09 | 12.26 | 113.53 | 58.79 |
| L.S.D. (05) | | 1529.45 | 12.99 | 33.80 | 11.95 | 25.79 | - |
| C.V. (%) | | 14.88 | 8.34 | 3132 | 59.69 | 13.91 | - |

Lattice eff = 108-77

Populations Diallel Crosses (Expt. 73008) Samaru and Modwa, 1973

The adjusted mean yields and other agronomic characters studied are listed in Table 11(a) for Samaru and in Table 11(b) for Modwa. The general yield in Mokwa was much lower than in Samaru. The results of this same trial at Pankshin were not received when these results were compiled. However, the stand at Pankshin was very poor, and the results would be unreliable. The yields of the same trial in Kano varied from almost nothing to about five pounds per plot due to drought and was considered a failure.

Table 10(b). Yields and other agronomic characters from inbreds topcrossed to Nigeria Composite A (NCA) Mokwa, 1973 (Expt.73007) planted May 9, 1973.

| 73007 Entry | | 1972 source | Yield | Stand | Lodging | B. tip | U. ear | Ear ht. | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|---|---|
| | | | kg/ha | % | % | % | % | cm | dy |
| 71 | 67-1-1-1-1-2-1 x NCA | 72:7001-120 | 3530.5 | 83.3 | 3.9 | 1.2 | 90.0 | 97.0 | 58 |
| 23 | NCB ($S_1$) x NCA | " " - 33 | 3474.9 | 103.1 | 12.3 | 3.3 | 72.0 | 100.0 | 58 |
| 95 | 475-2-2-1-1-3 x NCA | " " -157 | 3204.6 | 103.1 | 1.9 | 14.2 | 77.6 | 84.3 | 58 |
| 65 | 19-2-1-1-2-1 x NCA | " " -114 | 3038.5 | 108.3 | 2.0 | 0.0 | 68.8 | 78.0 | 59 |
| 64 | 19-2-1-1-1-1 x NCA | " " -113 | 2999.1 | 105.2 | 2.9 | 6.4 | 68.0 | 93.3 | 60 |
| 84 | 334-2-1-2-1-1 x NCA | " " -138 | 2955.1 | 96.9 | 2.1 | 7.5 | 97.0 | 95.3 | 60 |
| 70 | 67-1-1-1-1-2 x NCA | " " -119 | 2925.4 | 91.7 | 4.9 | 0.0 | 86.9 | 94.7 | 62 |
| 104 | 67-1-1-1-1 x NCA | " " -116 | 2864.6 | 99.0 | 3.9 | 1.8 | 76.5 | 83.7 | 62 |
| 38 | NCA($S_1$) x NCA | " " - 51 | 2813.3 | 90.0 | 1.0 | 3.7 | 84.3 | 86.7 | 58 |
| 7 | $SC_2$ ($S_1$) x NCA | " " - 7 | 2742.9 | 108.3 | 4.7 | 5.2 | 69.1 | 105.7 | 58 |
| 72 | 97-1-2-2-2-1 x NCA | " " -122 | 2638.8 | 95.8 | 3.2 | 12.7 | 66.1 | 86.3 | 61 |
| 36 | NCA ($S_1$) x NCA | " " - 57 | 2628.6 | 101.0 | 4.1 | 5.2 | 83.5 | 89.0 | 55 |
| 8 | $SC_3$ ($S_1$) x NCA | " " - 20 | 2488.0 | 88.5 | 10.2 | 15.1 | 83.4 | 79.3 | 58 |
| 67 | 27-1-1-1-1 x NCA | " " -116 | 2474.2 | 76.0 | 5.1 | 1.4 | 93.9 | 93.7 | 60 |
| 44 | NCA ($S_1$) x NCA | " " - 67 | 2435.0 | 87.5 | 12.9 | 11.1 | 98.5 | 87.3 | 56 |
| 58 | 38-4-2-1-1 x NCA | " " - 93 | 2424.6 | 103.1 | 3.1 | 3.7 | 89.9 | 99.0 | 56 |
| 28 | NCA ($S_1$) x NCA | " " - 45 | 2408.9 | 105.2 | 2.1 | 4.1 | 69.7 | 83.7 | 60 |
| 1 | $SC_1$ ($S_1$) x NCA | " " - 1 | 2368.7 | 107.3 | 6.9 | 13.8 | 67.7 | 87.7 | 58 |
| 54 | NCA ($S_1$) x NCA | " " - 87 | 2345.9 | 89.6 | 4.2 | 6.0 | 69.3 | 81.0 | 59 |
| 55 | NCA ($S_1$) x NCA | " " - 88 | 2223.7 | 101.0 | 8.1 | 15.2 | 58.9 | 79.7 | 57 |
| 32 | NCA ($S_1$) x NCA | " " - 49 | 2146.0 | 95.8 | 9.2 | 10.6 | 69.6 | 99.3 | 57 |
| 45 | NCA ($S_1$) x NCA | " " - 70 | 2103.0 | 93.8 | 11.5 | 10.8 | 77.1 | 99.7 | 58 |
| 102 | 69-1-1-1-1 x NCA | " " -164 | 2073.6 | 93.8 | 1.2 | 14.0 | 83.2 | 89.3 | 60 |
| 73 | 173-1-1-1-1-2 x NCA | " " -125 | 2065.1 | 83.3 | 9.6 | 2.0 | 58.2 | 85.3 | 62 |
| 60 | 41-4-2-1 x NCA | " " - 96 | 1996.4 | 104.2 | 8.1 | 2.1 | 60.2 | 109.0 | 60 |
| Checks: | Biu Yellow x C-10 | | 1973.1 | 80.2 | 11.0 | 13.1 | 70.1 | 65.7 | 59 |
| | Line 7 x C-10 | | 2138.1 | 82.3 | 4.7 | 1.6 | 77.5 | 84.0 | 57 |
| | NCA | | 2379.9 | 106.2 | 12.6 | 13.4 | 63.0 | 86.3 | 56 |
| Means | | | 2284.5 | 96.25 | 6.62 | 8.57 | 71.59 | 85.27 | 58.8 |
| L.S.D. (05) | | | 1146.18 | 20.64 | 10.86 | 15.96 | 28.88 | 15.88 | - |
| C.V. (%) | | | 30.72 | 13.13 | 100.47 | 113.96 | 24.71 | 11.40 | - |

Lattice eff = 104.99

The detailed analysis of the trials were not made. However, the variety crosses NCA x NCB, 096 x NCB, Columbian Comp. x NCA, $SC_3$ x Columbian Comp., and SR 52 x $BS_4$ were among the top yielders of the diallel crosses over the two locations reported here. This trial needs to be repeated to aid in decisions such as which of the present composites could be consolidated.

In this trial a significant heterosis was observed in $SC_3$ x Columbian Comp. in Samaru and Mokwa. Further study is necessary before deciding whether or not to merge these two populations as previously proposed.

Table 11(a). Yields and other agronomic characters from diallel crosses of populations, Samaru, 1973 (Expt. 73008) planted June 13, 1973.

| 73008 Entry | Yield | Stand | Lodging | B. tip | U. ear | Days to 50% anthesis |
|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | dy |
| $SC_3$ x Columbian Comp. | 7265.4 | 102.1 | 76.5 | 11.2 | 127.5 | 58 |
| NCA x NCB | 7160.7 | 103.1 | 69.7 | 7.1 | 127.3 | 56 |
| 096 x NCB | 7053.6 | 89.6 | 68.9 | 7.0 | 157 | 56 |
| Columbian Comp. x Biu Yellow | 6566.4 | 100.0 | 82.2 | 17.0 | 104.2 | 60 |
| Columbian Comp. | 6566.4 | 96.9 | 73.1 | 5.3 | 146.2 | 62 |
| 096 x Samaru Comp. III | 6545.2 | 95.8 | 83.2 | 7.6 | 134.6 | 59 |
| Columbian Comp. x NCA | 6502.9 | 96.9 | 83.8 | 7.5 | 131.8 | 60 |
| SR 52 x $BS_4$ | 6375.8 | 102.1 | 79.6 | 12.3 | 131.6 | 54 |
| Kitale Comp. F x $BS_3$ | 6291.1 | 102.1 | 88.0 | 14.7 | 119.7 | 52 |
| Biu Yellow x NCB | 6121.6 | 96.9 | 89.1 | 15.4 | 109.8 | 55 |
| Columbian Comp. x NCB | 6015.7 | 94.8 | 96.1 | 6.7 | 135.1 | 60 |
| NCA x Biu Yellow | 5994.5 | 102.1 | 87.7 | 13.9 | 101.6 | 57.3 |
| 096 x $BS_3$ | 5931.0 | 117.7 | 58.8 | 9.1 | 92.2 | 54 |
| 096 x NCA | 5909.8 | 103.1 | 65.0 | 5.3 | 126.9 | 57 |
| 096 x Biu Yellow | 5867.4 | 99.0 | 79.4 | 4.7 | 110.5 | 57 |
| ($SC_3$ x Iowa Rootworm syn.) x Iowa Rootworm syn. | 5846.2 | 99.0 | 79.5 | 13.2 | 104.4 | 53 |
| $BS_4$ x XB101 | 5825.0 | 102.1 | 82.4 | 23.9 | 108.5 | 50 |
| NCB x $BS_3$ | 5740.3 | 97.9 | 83.0 | 7.7 | 111.8 | 52 |
| 096 x Columbian Comp. | 5676.8 | 97.9 | 100.7 | 5.3 | 130.0 | 63 |
| $SC_3$ x NCA | 5655.6 | 96.9 | 90.4 | 13.2 | 97.8 | 54 |
| Columbian Comp. x $BS_4$ | 5655.6 | 101.0 | 87.7 | 10.0 | 116.4 | 55 |
| $SC_3$ x NCB | 5634.4 | 99.0 | 84.0 | 12.3 | 110.7 | 53 |
| NCA x $BS_3$ | 5613.2 | 104.2 | 75.2 | 11.2 | 96.9 | 52 |
| NCA x $BS_4$ | 5592.0 | 101.0 | 85.5 | 9.4 | 98.0 | 52 |
| NCB | 5592.0 | 91.7 | 90.4 | 9.6 | 123.2 | 57 |
| SC 123 (Daudawa) | 5528.5 | 99.0 | 82.2 | 13.2 | 119.0 | 54 |
| $SC_3$ x $BS_3$ | 5486.1 | 101.0 | 85.7 | 18.7 | 112.9 | 50 |
| NCB x $BS_4$ | 5401.4 | 102.1 | 84.7 | 8.3 | 111.1 | 51 |
| Nigerian Comp. A | 5401.4 | 94.8 | 88.0 | 11.9 | 107.6 | 59 |
| ($SC_3$ x $BS_4$) x $BS_4$ | 5274.3 | 92.7 | 62.5 | 17.3 | 105.8 | 50 |
| Columbian Comp. x $BS_3$ | 5020.1 | 100.0 | 93.0 | 14.0 | 104.7 | 59 |
| ($SC_3$ x $BSSS_2$) x $BSSS_2$ | 4956.6 | 97.9 | 63.1 | 12.0 | 109.1 | 54 |
| 096 x $BS_4$ | 4829.5 | 99.0 | 75.1 | 8.0 | 130.2 | 50 |
| $SC_3$ x $BS_4$ | 4744.8 | 99.0 | 79.6 | 11.5 | 100.2 | 56.6 |
| Biu Yellow x $BS_3$ | 4681.2 | 101.0 | 87.5 | 20.6 | 84.8 | 59 |
| $BS_4$ x (ICA x ICB) | 4660.0 | 95.8 | 91.5 | 12.1 | 92.6 | 53 |
| $BS_4$ | 4638.9 | 99.0 | 66.1 | 14.3 | 95.7 | 51 |
| ($SC_3$ x $BSSS_2$) x $SC_3$ | 4427.0 | 92.7 | 89.5 | 13.9 | 104.8 | 55 |
| 096 | 4342.3 | 92.7 | 94.1 | 4.3 | 134.8 | 63 |
| $BS_3$ x XB101 | 4342.3 | 101.0 | 89.8 | 19.6 | 87.5 | 57 |
| $BS_3$ x $BS_4$ | 4321.1 | 99.0 | 84.8 | 10.1 | 95.7 | 48 |
| ($SC_3$ x $BS_4$) x $BS_4$ | 4321.1 | 97.9 | 53.6 | 20.4 | 103.1 | 52 |
| Biu Yellow x $BS_4$ | 4299.9 | 103.1 | 84.8 | 14.7 | 83.8 | 50 |
| ($SC_3$ x $BS_3$) x $BS_3$ | 4257.6 | 102.1 | 81.7 | 15.6 | 82.7 | 49 |
| ($SC_3$ x $BS_3$) x $SC_3$ | 3939.9 | 99.0 | 57.9 | 20.7 | 110.3 | 50 |
| $BS_3$ | 3749.2 | 89.6 | 73.2 | 18.6 | 91.9 | 49 |
| ($SC_3$ x Iowa Rootworm Syn)x$SC_3$ | 3600.9 | 97.9 | 80.4 | 11.1 | 96.4 | 52 |
| $SC_3$ (L. T. C.) | 3495.0 | 96.9 | 81.7 | 11.7 | 86.8 | 62 |
| Iowa Rootworm Syn. | 2372.4 | 95.8 | 55.5 | 19.4 | 75.9 | 52 |
| Means | 5328.79 | 98.81 | 80.12 | 12.29 | 109.83 | - |
| L.S.D. (05) | 1436.63 | 12.08 | 21.22 | 9.38 | 26.51 | |
| C.V. (%) | 16.51 | 7.49 | 16.22 | 46.71 | 14.78 | |

Table 11(b). Yields and other agronomic characters from diallel crosses of populations, Mokwa, 1973 (Expt. 73008) planted May 14, 1973.

| 73008 Entry | Yield | Stand | Lodging | B. tip | U. ear | Ear ht. | Days-50% anthesis |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | | |
| NCA x NCB | 2709.7 | 99.0 | 0.9 | 6.2 | 51.9 | 98.7 | 56 |
| Columbian Comp. x NCB | 2704.9 | 82.3 | 1.1 | 30.8 | 60.7 | 98.7 | 60 |
| 096 x $BS_4$ | 2694.6 | 84.4 | 17.5 | 19.7 | 59.1 | 82.7 | 50 |
| Columbian Comp. x NCA | 2560.6 | 89.6 | 2.6 | 26.9 | 50.1 | 94.7 | 60 |
| $SC_3$ x NCA | 2513.3 | 86.5 | 17.9 | 36.4 | 47.1 | 92.3 | 54 |
| SR 52 x $BS_4$ | 2434.4 | 88.5 | 19.8 | 29.9 | 52.2 | 73.0 | 54 |
| 096 x $SC_3$ | 2390.3 | 100.0 | 8.4 | 14.6 | 40.3 | 95.7 | 59 |
| 096 x Columbian Comp. | 2343.6 | 88.5 | 4.1 | 34.6 | 64.2 | 85.0 | 63 |
| Columbian Comp. x $BS_4$ | 2311.5 | 81.2 | 3.8 | 25.5 | 58.7 | 83.0 | 55 |
| 096 x BY | 2228.2 | 92.7 | 3.5 | 28.2 | 56.3 | 79.3 | 58 |
| Nigerian Comp. A | 2225.7 | 83.3 | 10.1 | 15.6 | 45.7 | 87.3 | 56 |
| $SC_3$ x NCB | 2186.3 | 77.3 | 3.0 | 45.1 | 49.1 | 84.7 | 53 |
| BY x NCB | 2184.0 | 30.2 | 1.4 | 22.9 | 46.6 | 89.3 | 55 |
| NCA x BY | 2147.0 | 101.0 | 4.2 | 19.3 | 51.3 | 78.7 | 57 |
| 096 x $BS_3$ | 2108.4 | 78.1 | 13.7 | 16.2 | 40.7 | 81.0 | 55 |
| 096 x NCB | 2097.7 | 87.5 | 12.3 | 30.2 | 44.4 | 97.7 | 57 |
| $SC_3$ x Columbian Comp | 2095.8 | 94.8 | 10.0 | 23.5 | 56.4 | 83.3 | 58 |
| NCB x $BS_4$ | 2020.5 | 88.5 | 8.3 | 18.8 | 50.7 | 79.7 | 51 |
| ($SC_3$ x $BS_3$) x $BS_3$ | 2019.8 | 83.3 | 18.0 | 23.1 | 48.9 | 75.0 | 49 |
| Columbian Comp. | 1996.0 | 78.1 | 2.7 | 53.7 | 44.2 | 80.7 | 62 |
| NCA x $BS_4$ | 1978.8 | 77.1 | 26.0 | 43.3 | 44.7 | 90.7 | 52 |
| NCB | 1973.2 | 71.9 | 3.4 | 15.6 | 59.9 | 84.7 | 56 |
| $BS_4$ x XB101 | 1942.8 | 66.7 | 4.3 | 29.4 | 54.0 | 75.0 | 50 |
| Columbian Comp. x BY | 1896.7 | 81.2 | 7.1 | 32.7 | 66.4 | 80.3 | 60 |
| NCA x $BS_3$ | 1876.2 | 68.7 | 8.7 | 23.2 | 45.6 | 73.7 | 52 |
| Kitale Comp. F x $BS_3$ | 1811.6 | 91.7 | 5.6 | 13.2 | 56.9 | 86.0 | 57 |
| $BS_3$ x XB101 | 1789.3 | 90.6 | 4.0 | 28.7 | 60.4 | 86.7 | 52 |
| ($SC_3$ x $BSSS_2$) x $BSSS_2$ | 1671.2 | 84.4 | 8.7 | 24.9 | 60.4 | 70.3 | 54 |
| 096 x NCA | 1650.4 | 78.1 | 13.1 | 27.7 | 46.9 | 84.0 | 57 |
| 096 | 1588.7 | 63.5 | 9.2 | 16.7 | 65.1 | 100.0 | 63 |
| ($SC_3$ x Iowa Rootworm Syn.) x Iowa Rootworm Syn. | 1543.8 | 85.4 | 4.7 | 42.9 | 39.4 | 86.0 | 52 |
| ($SC_3$ x $BS_4$ x $SC_3$ | 1543.3 | 78.1 | 0.0 | 49.1 | 45.6 | 63.0 | 50 |
| $SC_3$ x $BS_3$ | 1541.4 | 83.3 | 3.6 | 35.2 | 47.3 | 70.7 | 55 |
| NCB x $BS_3$ | 1467.6 | 82.3 | 12.7 | 26.6 | 44.5 | 78.3 | 52 |
| $SC_3$ x $BS_4$ | 1382.1 | 92.7 | 5.8 | 19.6 | 38.8 | 69.3 | 50 |
| Columbian Comp. x $BS_3$ | 1354.0 | 58.3 | 19.6 | 31.9 | 61.1 | 66.7 | 58 |
| ($SC_3$ x $BSSS_2$) x $SC_3$ | 1341.5 | 53.1 | 7.9 | 44.1 | 42.6 | 73.0 | 55 |
| SC 123 (Daudawa) | 1286.8 | 83.3 | 3.9 | 40.0 | 41.1 | 71.3 | 54 |
| Biu Yellow x $BS_4$ | 1274.5 | 78.1 | 3.5 | 19.1 | 47.8 | 66.3 | 50 |
| $BS_4$ x (ICA x ICB) | 1245.9 | 60.4 | 17.2 | 51.8 | 27.7 | 70.3 | 53 |
| Iowa Rootworm Syn. | 1195.3 | 68.7 | 3.3 | 27.3 | 55.8 | 60.0 | 52 |
| $SC_3$ (L.T.C.) | 1161.1 | 66.7 | 0.0 | 38.4 | 41.0 | 75.3 | 62 |
| ($SC_3$ x $BS_4$) x $BS_4$ | 1099.5 | 77.1 | 1.9 | 84.8 | 40.8 | 62.3 | 52 |
| $BS_4$ | 1075.9 | 81.2 | 5.8 | 141.1 | 26.3 | 73.0 | 50 |
| Biu Yellow x $BS_3$ | 932.6 | 63.5 | 4.9 | 31.6 | 51.3 | 62.3 | 48 |
| $BS_3$ x $BS_4$ | 771.3 | 83.3 | 5.8 | 21.4 | 49.9 | 57.3 | 48 |
| $BS_3$ | 770.2 | 53.1 | 11.4 | 17.6 | 44.3 | 44.0 | 49 |
| ($SC_3$ x Iowa Rootworm Syn) x $SC_3$ | 653.3 | 65.6 | 9.0 | 93.1 | 28.7 | 67.0 | 52 |
| ($SC_3$ x $BS_3$) x $SC_3$ | 330.7 | 77.1 | 0.0 | 57.1 | 29.4 | 54.0 | 50 |
| Means | 1757.60 | 79.80 | 7.62 | 33.63 | 48.62 | 78.00 | - |
| L.S.D. (05) | 1061.73 | 28.04 | 13.93 | 58.79 | 22.18 | 20.38 | - |
| C.V. (%) | 36.99 | 21.52 | 111.85 | 107.06 | 27.94 | 16.00 | - |

Lattice eff = 109.85

## Early Maize Variety Trial, 1973

The objective of this trial was to select early maturing maize varieties that would yield well in the dry parts of the Northern states. The early maize varieties and hybrids were grown in observation plots at Kafinsoli in the North Central State, Mubi and Damaturu in the Northeastern State. Hybrids Bomo Local x $BS_3$, $BS_3$ x SS, and BY x $BS_3$ and varieties $BS_3$ and $BS_4$ looked suitable for the areas. It is planned to increase the number of the sites for performance observations in 1974.

Table 12 reports the yields and the other agronomic character of the varieties and the hybrids tested in Samaru. The same trial at Kano failed because of drought in 1973.

The current drought situation has created a great deal of interest in early maize varieties for the northern parts of Nigeria. The Botany Section of IAR has an arrangement to supply seed of promising early maize varieties to the Agronomy Section to study optimum production practices for these early varieties. It is recommended that $BS_3$, $BS_3$ x BL, and Early Flint Synthetic be supplied in 1974.

Table 12. Yields and other agronomic data from early Maize Variety Trial, Samaru, 1973, planted June 13, 1973.

| Entry | Yield | Stand | R ldg. | S. ldg. | B. tip | U. ear | Ear ht. | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | % | cm. | dy |
| NCB | 5891.2 | 90.3 | 0.0 | 17.8 | 13.8 | 124.0 | 147.5 | 55.0 |
| BY x $BS_3$ | 5671.5 | 89.6 | 1.6 | 10.1 | 31.2 | 97.7 | 120.0 | 51.2 |
| Bomo Local x $BS_3$ | 5396.9 | 88.9 | 0.8 | 15.6 | 27.2 | 104.7 | 135.0 | 50.2 |
| BS x SS | 5383.1 | 86.8 | 1.6 | 7.1 | 22.0 | 104.6 | 132.5 | 52.0 |
| White $BS_3$ x BL | 5259.5 | 88.2 | 0.8 | 15.7 | 26.4 | 106.3 | 132.5 | 51.0 |
| $BS_3$ | 4490.5 | 87.5 | 0.0 | 16.7 | 32.8 | 103.1 | 115.0 | 49.0 |
| $BS_4$ x BL | 4353.3 | 90.3 | 0.7 | 17.2 | 18.3 | 104.6 | 132.5 | 52.2 |
| Iowa Rootworm Syn. | 4147.2 | 89.6 | 0.0 | 6.9 | 24.5 | 111.6 | 117.5 | 51.5 |
| $BS_4$ | 3996.2 | 93.1 | 0.8 | 13.5 | 18.5 | 95.9 | 120.0 | 42.0 |
| Bomo Local | 3886.3 | 89.6 | 1.6 | 14.6 | 22.9 | 94.0 | 140.0 | 54.5 |
| Badankama | 3488.1 | 86.8 | 2.4 | 6.4 | 19.3 | 90.4 | 122.5 | 47.2 |
| Fara | 3103.5 | 84.7 | 2.5 | 14.4 | 22.0 | 84.7 | 130.0 | 50.0 |
| Means | 4588.94 | 88.77 | 1.06 | 13.01 | 22.24 | 101.86 | 128.75 | 50.5 |
| L.S.D. (05) | 856.32 | 4.38 | 1.57 | 9.58 | 11.63 | 13.98 | 11.91 | 2.32 |
| C.V. (%) | 13.19 | 3.39 | 104.99 | 52.10 | 35.38 | 9.71 | 6.54 | 3.24 |

## Cooperative Trials

As in previous years, the Federal Zonal Maize Trial (four reps) and the West African Uniform Maize Trial (four reps) were grown in Samaru in 1973. Also East African Maize Variety Trial (three reps), FAO Yield Nursery (three reps), and FAO Observation Nursery (two reps) were grown. The detailed reports on the later four trials are not given here. These will be reported by the coordinators

of the trials. However, notes taken on the performance of the entries in the West African Uniform Maize Trial, East African Maize Variety Trial, FAO Yield, and Observation Nurseries are as summarized in Tables 14, 15, 16, and 17, respectively.

Yields and some other agronomic characters from the Federal Zonal Maize Trial are reported in Table 13. This trial is coordinated by the Federal Department of Agricultural Research, Moor Plantation, Ibadan. Samaru has been reporting the highest yields for this trial. Some ears were stolen from some plots of this trial. Adjustments were made for the missing ears. Each of the composites NCD, NCARb, SC 123, and hybrid XB101 x Lagos White yielded over 6000 kg/ha. SC 123 yielded over 1000 kg/ha higher than $SC_3$. NCD (white seeded) was the top yielder of the trial, 6881 kg/ha. It is strongly recommended that NCD and SC 123 be included in this trial in the next growing season.

Table 13. Yields and some other agronomic data from Federal Zonal Maize Trial, Samaru, 1973 (Expt.73001) planted June 11, 1973.

| 73001 Entry | Yield | Stand | Lodging | U. Ear | Days to 50% anthesis |
|---|---|---|---|---|---|
| | kg/ha | % | % | % | dy |
| NCD | 6880.9 | 91.7 | 29.2 | 111.2 | 55.0 |
| XB101 x Lagos White | 6643.8 | 92.1 | 31.1 | 125.5 | 51.0 |
| Local (SC 123) | 6319.9 | 98.3 | 18.7 | 103.1 | 49.0 |
| NCARb | 6019.8 | 87.5 | 17.7 | 113.1 | 55.0 |
| NCC | 5877.5 | 89.6 | 25.3 | 114.8 | 54.0 |
| NCA | 5822.2 | 85.4 | 21.5 | 121.5 | 55.0 |
| NCB | 5482.6 | 79.1 | 25.5 | 112.1 | 51.0 |
| Bulk - 3 | 5395.6 | 58.3 | 11.9 | 127.6 | 58.0 |
| NS-1 | 5364.0 | 84.2 | 36.7 | 119.7 | 56.5 |
| $SC_3$ | 5150.7 | 87.5 | 21.9 | 98.4 | 51.0 |
| NS-5 | 4921.6 | 85.8 | 29.1 | 102.5 | 55.0 |
| NCBRb | 4084.3 | 90.4 | 18.8 | 102.7 | 49.0 |
| Means | 5663.57 | 85.83 | 23.93 | 112.69 | 53.29 |
| L.S.D. (05) | 1458.05 | 8.35 | 15.22 | 19.79 | - |
| C.V. (%) | 18.20 | 7.33 | 44.97 | 12.42 | - |

Table 14. Yields and other agronomic data from West African Uniform Maize Trial, Samaru, 1973 (Expt. 73011) planted June 13, 1973.

| 73011 Entry | Yield | Stand | Lodg-ing | B. tip | U. ear | Ear height | Days to 50% pollen shed |
|---|---|---|---|---|---|---|---|
| | kg/ha | % | % | % | % | cm | dy |
| NCA x NCB | 7345.1 | 100.00 | 58.80 | 9.20 | 131.20 | 170.00 | 57.00 |
| XB101 A | 6729.6 | 93.60 | 49.40 | 11.00 | 132.30 | 150.00 | 57.00 |
| NCB | 6719.3 | 100.00 | 55.40 | 10.10 | 110.60 | 175.00 | 60.00 |
| 515 (Jamaica) | 6647.5 | 100.00 | 26.10 | 11.90 | 114.00 | 152.50 | 52.00 |
| Western Yellow | 6483.4 | 91.20 | 67.50 | 8.00 | 128.50 | 167.50 | 59.00 |
| T.P.B. (Mexico) | 6462.9 | 100.00 | 45.40 | 12.50 | 106.00 | 160.00 | 60.00 |
| NCARb | 6257.7 | 99.30 | 58.70 | 7.30 | 120.80 | 172.50 | 58.00 |
| NCA | 5570.4 | 100.00 | 68.00 | 11.80 | 100.20 | 160.00 | 55.00 |
| Improved Var. (S123) | 5437.0 | 99.30 | 59.60 | 12.30 | 99.90 | 162.50 | 53.00 |
| N7 x ATC (Dahomey) | 4975.4 | 92.70 | 52.60 | 10.40 | 111.30 | 152.50 | 51.00 |
| C.P.J. (Ivory Coast) | 4380.4 | 92.70 | 72.90 | 13.30 | 109.40 | 150.00 | 56.00 |
| BL x $BS_3$ | 3775.1 | 93.20 | 72.80 | 18.50 | 84.70 | 155.00 | 53.00 |
| Local (Bomo Local) | 3190.4 | 97.40 | 62.50 | 23.10 | 74.20 | 155.00 | 51.00 |
| Means | 5690.31 | 93.80 | 57.64 | 12.27 | 109.47 | 160.19 | 55.58 |
| L.S.D. (05) | 950.55 | 18.15 | 24.08 | 5.73 | 22.43 | 13.76 | - |
| C.V. (%) | 11.81 | 8.65 | 29.54 | 33.04 | 14.49 | 6.07 | - |

Table 15. Yields and other agronomic characters from E.A.M.V.T., Samaru, 1973 (Expt. 73013) planted June 13, 1973.

| 73013 Entry | Source | Yield | Stand | Lodg-ing | B. tip | U. ear | E. ht. | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|---|
| | | kg/ha | % | % | % | % | cm | dy |
| Local (SC 123) | Nigeria | 6138 | 82.3 | 65.3 | 11.7 | 117 | 186 | 56 |
| MAS | Tanzania | 6115 | 86.5 | 72.7 | 14.2 | 110 | 201 | 60 |
| Local (NCB) | Nigeria | 5813 | 86.5 | 80.4 | 16.3 | 118 | 181 | 63 |
| H5011 | Kenya | 5696 | 83.3 | 90.5 | 13.4 | 145 | 170 | 62 |
| Ilonga Composite | Tanzania | 5580 | 72.9 | 66.0 | 25.7 | 124 | 200 | 62 |
| Ukiriguru Comp. A(F)C5 | Tanzania | 4278 | 86.5 | 78.3 | 26.8 | 89 | 201 | 61 |
| Ukir Comp. A(F) 5 x Ukir Comp. B-Fw | Tanzania | 4069 | 80.2 | 88.1 | 30.1 | 101 | 186 | 67 |
| H5033 | Kenya | 4069 | 71.9 | 73.8 | 22.3 | 125 | 181 | 60 |
| Kawanda Comp. A(S)CL ex Makerere | Uganda | 3976 | 74.0 | 67.9 | 31.6 | 87 | 195 | 60 |
| Kawanda Comp. A(m) C1 ex Kampala | Uganda | 3813 | 83.3 | 80.9 | 28.1 | 78 | 196 | 64 |
| H632 | Kenya | 3673 | 85.4 | 83.3 | 27.6 | 89 | 173 | 61 |
| SR 52 | Zambia | 3580 | 83.3 | 89.5 | 33.2 | 67 | 163 | 60 |
| Chitdze Comp. A | Malawi | 3464 | 76.0 | 87.8 | 28.5 | 98 | 183 | 65 |
| MC1 x KW CA | Uganda | 3441 | 74.0 | 84.1 | 51.8 | 74 | 186 | 62 |
| Katumani Comp. B | Kenya | 3325 | 85.4 | 69.4 | 21.9 | 76 | 145 | 59 |
| H512 | Kenya | 3162 | 82.3 | 89.9 | 41.3 | 73 | 173 | 63 |
| Ukir Comp. A(F)C4 x Ukir Comp. B(F) C3 | Tanzania | 3162 | 78.1 | 81.6 | 33.0 | 70 | 190 | 64 |
| H 622 | Kenya | 3092 | 83.3 | 78.5 | 43.3 | 68 | 171 | 59 |
| H 613 (R) C3 | Kenya | 3092 | 85.4 | 87.8 | 21.4 | 79 | 220 | 62 |
| Zambian Composite A | Zambia | 2813 | 72.9 | 89.8 | 42.9 | 85 | 168 | 61 |
| Embu 1 x Embu II | Kenya | 2441 | 86.5 | 85.7 | 23.5 | 49 | 200 | 57 |
| H 611 (R) C3 | Kenya | 2348 | 77.1 | 93.1 | 18.1 | 97 | 205 | 61 |
| H 5022 | Kenya | 2325 | 86.5 | 82.0 | 36.4 | 68 | 195 | 62 |
| H 613C | Kenya | 2302 | 81.2 | 83.5 | 27.2 | 74 | 173 | 63 |
| H 511 | Kenya | 2255 | 76.0 | 90.8 | 54.6 | 64 | 153 | 56 |
| KIII x EC573(R12) C3 | Kenya | 2185 | 78.1 | 84.0 | 26.6 | 81 | 216 | 63 |
| Kitale Comp. B(S) C2 x Kitale Comp. E(S) C2 | Kenya | 2046 | 78.1 | 85.7 | 52.3 | 56 | 205 | 62 |
| H611C | Kenya | 1976 | 91.7 | 82.7 | 27.8 | 62 | 210 | 67 |
| Bambu | Rwanda | 1720 | 58.3 | 95.0 | 33.7 | 74 | 168 | 59 |
| H611 | Kenya | 465 | 82.3 | 82.3 | 47.2 | 22 | 188 | 67 |
| Means | | 3414.27 | 80.31 | 82.35 | 30.42 | 84.50 | 186.39 | 61.43 |
| L.S.D. (05) | | 1377.29 | 17.61 | 19.39 | 31.57 | 43.05 | 32.75 | - |
| C.V. (%) | | 24.70 | 13.43 | 14.42 | 63.54 | 31.20 | 10.76 | - |

Table 16. Yields and other agronomic characters from FAO Nursery, Samaru, 1973 (Expt. 73104) planted June 14, 1973.

| 73014 Entry | Source | Yield | Stand | Lodg-ing | B. tip | ear | E. ht. | Days-50% anthesis |
|---|---|---|---|---|---|---|---|---|
| | | kg/ha | % | % | % | % | cm | dy |
| Ghana | India | 7058 | 94.8 | 74.6 | 13.1 | 147 | 165 | 59 |
| Ghana | India | 6628 | 100.0 | 74.2 | 27.7 | 107 | 168 | 59 |
| Gh 355 | Egypt | 5827 | 95.8 | 82.2 | 13.8 | 119 | 155 | 55 |
| Gh 359 | Egypt | 5089 | 97.9 | 77.2 | 15.7 | 108 | 156 | 56 |
| Ghana Safed-2 | India | 5027 | 93.8 | 72.9 | 14.9 | 136 | 168 | 57 |
| Local Check | Nigeria | 4883 | 87.5 | 75.9 | 20.5 | 113 | 168 | 56 |
| Vijay | India | 4719 | 93.8 | 75.7 | 16.3 | 109 | 163 | 57 |
| Neelum | Pakistan | 4658 | 100.0 | 78.7 | 19.6 | 85 | 150 | 50 |
| HIM 123 | India | 4576 | 101.0 | 74.9 | 26.4 | 89 | 160 | 50 |
| Comp. C Var. | Egypt | 4329 | 97.9 | 80.2 | 21.6 | 83 | 153 | 52 |
| Cross 69 Kat. | Egypt | 4227 | 100.0 | 89.6 | 26.2 | 80 | 183 | 58 |
| Comp. B | Kenya | 4083 | 88.5 | 84.5 | 29.3 | 98 | 175 | 57 |
| Comp. A | Egypt | 3837 | 95.8 | 77.1 | 20.0 | 88 | 146 | 53 |
| GH 175 | Egypt | 3693 | 92.7 | 90.7 | 26.1 | 86 | 151 | 51 |
| Comp. Y | Egypt | 3632 | 95.8 | 79.3 | 22.0 | 85 | 165 | 54 |
| Hyb. 632 | Kenya | 3139 | 93.8 | 78.4 | 25.7 | 84 | 178 | 60 |
| American Early | Egypt | 3119 | 92.7 | 83.1 | 16.0 | 82 | 171 | 57 |
| Comp. B | Egypt | 3098 | 91.7 | 75.9 | 28.9 | 67 | 153 | 54 |
| GH 186 | Egypt | 2831 | 102.1 | 83.9 | 17.6 | 88 | 148 | 53 |
| Ghana 5 | India | 1764 | 42.7 | 77.5 | 33.9 | 88 | 153 | 56 |
| Means | | 4311.25 | 92.92 | 79.33 | 21.46 | 97.56 | 161.75 | 55.5 |
| L.S.D. (05) | | 1287.13 | 13.94 | 20.84 | 12.88 | 29.44 | 24.50 | - |
| C.V. (%) | | 18.28 | 9.19 | 16.09 | 36.77 | 18.48 | 9.27 | - |

## Breeding

Each full-sib family from the NCA, NCB, SC 123, and 096 full-sib yield trials was planted in two 20-plant rows in the 1973 breeding nursery. The six best appearing plants in each plot were self-pollinated. The three best ears were saved from each plot, and the best ear of these three was saved to represent the selected lines in the 1973-74 recombination nursery. The purpose of this procedure is to provide for selection of agronomic characters within selected lines and to provide adequate seed for making recombinations.

Due to a lack of space in the 1972-73 irrigated nursery, the selected full-sib lines from the 1972 Biu Yellow yield trial were held for the 1973 main season nursery. These selected lines were recombined in 1973, and the resulting crosses will be tested in 1974.

One hundred twelve varieties and several outstanding lines selected from the 1972 yield trials were maintained by sib pollination in 1973. Also 363 lines in various stages of inbreeding were planted for further inbreeding and selection or maintenance.

Table 17. Yields and other agronomic characters from FAO Observation Nursery (Expt. 73015), Samaru, 1973. Planted June 25, 1973.

| 73015 Entry | Source | Yield | Stand | Lodging | B. tip | U. ear | E. ht. | Days to 50% anthesis |
|---|---|---|---|---|---|---|---|---|
| | | kg/ha | % | % | % | % | cm | dy |
| Exp. HYB. 4362 | India | 4740.1 | 95.3 | 6.4 | 29.9 | 127.4 | 125.0 | 50.0 |
| Exp. HYB. 4116 | India | 4555.4 | 95.3 | 27.6 | 39.2 | 113.3 | 115.0 | 53.0 |
| Neelum | Pakistan | 4278.4 | 96.9 | 20.5 | 48.1 | 107.0 | 117.0 | 50.0 |
| Exp. HYB. 4587 | India | 4247.6 | 95.3 | 12.9 | 14.6 | 144.5 | 125.0 | 53.0 |
| YUZP SC-3 | Yugoslavia | 3970.6 | 71.9 | 8.7 | 25.0 | 97.5 | 107.5 | 50.5 |
| Local | Nigeria | 3878.3 | 98.4 | 41.2 | 36.6 | 94.7 | 135.0 | 56.5 |
| JI (W) | India | 3847.3 | 98.4 | 25.5 | 19.3 | 115.9 | 145.0 | 57.5 |
| Syn. 513 | Pakistan | 3785.9 | 92.2 | 35.5 | 39.4 | 98.7 | 115.0 | 50.5 |
| YUZP-58C | Yugoslavia | 3785.9 | 98.4 | 9.2 | 47.7 | 98.7 | 115.0 | 50.5 |
| D.C. 406 | Pakistan | 3724.4 | 96.9 | 29.2 | 53.1 | 110.0 | 120.0 | 48.0 |
| Exp. HYB. 4207 | India | 3693.6 | 95.3 | 21.3 | 33.7 | 116.4 | 127.5 | 53.0 |
| YUZP-SC-3 | Yugoslavia | 3632.0 | 100.0 | 23.4 | 30.4 | 93.8 | 102.5 | 50.5 |
| YUZP-SC-48A | Yugoslavia | 3632.0 | 96.9 | 19.6 | 21.4 | 96.7 | 145.0 | 43.5 |
| Var. Cross 69 | Egypt | 3601.3 | 81.2 | 44.7 | 8.4 | 116.6 | 130.0 | 56.5 |
| YUZP-SC-806 | Yugoslavia | 3447.4 | 95.3 | 38.8 | 43.5 | 98.3 | 125.0 | 50.5 |
| D1 | India | 3416.6 | 90.6 | 39.6 | 13.6 | 217.6 | 142.5 | 57.0 |
| Exp. HYB. 4034 | India | 3385.8 | 100.0 | 14.1 | 12.0 | 104.7 | 142.5 | 56.0 |
| Comp. H1 | India | 3355.0 | 96.9 | 35.9 | 23.8 | 119.2 | 130.0 | 54.5 |
| D.C. 456 | Pakistan | 3293.5 | 98.4 | 14.3 | 43.7 | 85.6 | 90.0 | 47.5 |
| Exp. HYB. 4204 | India | 3231.9 | 92.2 | 41.9 | 32.8 | 118.0 | 132.5 | 56.0 |
| Comp. H3 | India | 3170.3 | 93.8 | 11.3 | 23.3 | 100.1 | 125.0 | 50.5 |
| Syn. 532 | Pakistan | 3078.0 | 93.8 | 38.3 | 38.8 | 98.3 | 132.5 | 52.0 |
| D.C. 435 | Pakistan | 3078.0 | 98.4 | 39.9 | 55.6 | 80.9 | 120.0 | 51.5 |
| YUZP SC-46A | Yugoslavia | 2893.3 | 100.0 | 29.7 | 34.8 | 75.0 | 125.0 | 43.5 |
| YUZP DC-370 | Yugoslavia | 2801.0 | 82.8 | 7.6 | 11.7 | 91.6 | 95.0 | 43.0 |
| YUZP SC-6 | Yugoslavia | 2770.2 | 85.9 | 20.6 | 15.8 | 94.7 | 147.5 | 50.0 |
| Syn. 509 | Pakistan | 2739.0 | 92.2 | 38.5 | 40.3 | 91.9 | 122.5 | 51.0 |
| YUZP DC-551 | Yugoslavia | 2708.6 | 100.0 | 20.3 | 35.3 | 82.8 | 97.5 | 46.0 |
| YUZP SC-71C | Yugoslavia | 2585.5 | 71.9 | 9.7 | 34.6 | 95.2 | 100.0 | 53.0 |
| Syn. 501 | Pakistan | 2554.7 | 92.2 | 28.5 | 38.7 | 88.7 | 112.5 | 44.5 |
| Ganga safed 2 | India | 2524.0 | 90.6 | 43.4 | 35.4 | 106.5 | 127.5 | 56.0 |
| Syn.200 | Pakistan | 2462.4 | 89.1 | 62.9 | 41.2 | 99.9 | 105.0 | 50.5 |
| S.C. 287 | Pakistan | 2185.4 | 79.7 | 62.1 | 39.3 | 91.7 | 115.0 | 53.5 |
| KCB (S)CIxKCE(S)C1 | Kenya | 1508.2 | 95.3 | 58.1 | 15.2 | 56.6 | 137.5 | 55.5 |
| H613 C | Kenya | 1046.5 | 85.9 | 67.2 | 30.6 | 59.3 | 147.5 | 55.0 |
| Means | | 3259.26 | 92.62 | 29.93 | 31.86 | 99.79 | 122.85 | 51.42 |
| L.S.D. (05) | | 1270.49 | 18.70 | 30.53 | 23.21 | 30.48 | 41.97 | - |
| C.V. (%) | | 19.49 | 10.09 | 51.00 | 36.42 | 15.27 | 16.97 | - |

In general, the lines in the fifth or sixth generation of inbreeding were sib-pollinated, and the earlier inbreeding generations were advanced by selfing.

Several advanced generation inbreds and several promising varieties were topcrossed to Tuxpeno Planta Baja (TPB). The tester variety, TPB, is low-eared, white-seeded, and has a strong root and stalk. It is hoped that these topcrosses, with promising varieties from the Samaru breeding program, will produce hybrids. The topcrosses to TPB will be included in the 1974 trial with the best looking variety hybrids from 1973 trials.

Nine early maturing varieties were topcrosses to Bomo Local in 1973. These crosses will be evaluated at several locations in northern Nigeria in 1974.

For each of the populations NCA, NCB, SC 123, and 096, a bulk of seed from 1972 selections was grown in isolation in 1973. The resulting open-pollinated seed will be used in future trials to represent that particular cycle of selection for each variety.

## Protein Selection

Selection for high protein was begun in 1971 by selfing in a bulk planting of composite SC3. A total of 840 ears was sent to Beltsville for N determination. On the basis of these results, 200 S1 lines were selected for a yield trial in 1972. These were grown in two replications in Samaru. Protein determinations on composite samples from each of the entries were made in Dr. Stockinger's laboratory. The 20 highest yielding S1 lines were selected for recombination in 1972-73. Unfortunately, these lines were misplaced, and efforts to locate them have been unsuccessful. The study did show that selecting for high yield among the 200 S1 lines did not negate the initial difference for high protein.

With these results in mind, a similar study was initiated in the 1973-74 irrigation nursery by bulk planting the composite variety SC 123. Selfing will be done in this planting to obtain 1,000 ears for analysis in Dr. Stockinger's laboratory prior to the 1974 growing season. The 200 ears with the highest protein values will be grown in an S1 yield trial at Samaru in 1974.

Selfed ears from full-sib families in the 1973 NCA and NCB full-sib yield trials were analyzed for protein content in Dr. Stockinger's laboratory utilizing the Udy method. A total of 120 ears were analyzed for each population. Based on the results of the protein determination, 11 lines from NCA and 13 lines from NCB were selected for diallel recombination in the 1973-74 irrigation nursery. Due to a lack of space in the Samaru irrigated nursery, these lines are being recombined at Mokwa. The protein content of the selected lines and the yield of the corresponding full-sib families are listed in Tables 18 and 19 for NCA and NCB, respectively. There is not much difference in the selection differential for protein between the two populations. However, in the NCA population the mean yield of the protein-selected lines is less than the overall mean, while for NCB the protein-selected lines had a higher mean yield than the average of all lines.

Several populations from the breeding program were analyzed for protein content in Dr. Stockinger's laboratory utilizing both the Kjeldahl and Udy methods. These same samples were run on the amino acid analyzer in the Chemistry Department of ABU by Dr. Brian Isbelle. The results are listed in Table 20.

Table 18. Protein values and yield of selected high-protein lines from 1973 NCA full-sib yield trial. (Average of 8 replications)

| Line | Protein | Yield |
|---|---|---|
| | % | kg/ha |
| 15 | 11.64 | 4839 |
| 18 | 13.17 | 4675 |
| 22 | 11.64 | 4582 |
| 40 | 11.98 | 4710 |
| 49 | 12.81 | 5187 |
| 81 | 12.34 | 5170 |
| 83 | 12.26 | 5662 |
| 84 | 12.34 | 5439 |
| 86 | 11.78 | 5206 |
| 106 | 12.02 | 4529 |
| 108 | 12.26 | 4688 |
| Mean of selected lines | 12.20 | 4981 |
| Mean of 120 entries | 9.96 | 5177 |

Table 19. Protein values and yield of selected high-protein lines from 1973 NCB full-sib yield trial. (Average of 8 replications)

| Line | Protein | Yield |
|---|---|---|
| | % | kg/ha |
| 15 | 12.86 | 4417 |
| 19 | 12.11 | 5593 |
| 21 | 11.68 | 6954 |
| 26 | 11.44 | 6231 |
| 50 | 12.52 | 6705 |
| 51 | 11.60 | 6460 |
| 71 | 11.95 | 6980 |
| 78 | 12.81 | 5398 |
| 79 | 11.25 | 5606 |
| 86 | 11.23 | 7446 |
| 88 | 12.19 | 6181 |
| 93 | 11.85 | 5834 |
| 107 | 11.73 | 6573 |
| Mean of selected lines | 11.92 | 6175 |
| Mean of 120 entries | 9.69 | 5909 |

Table 20. Protein values for Kjeldahl and Udy methods of analysis and basic amino acid content of several populations from the Samaru maize breeding program.

| Variety | Protein | | Basic Amino Acid[1] | | | |
|---|---|---|---|---|---|---|
| | Kjeldahl | Udy | Lysine | Arginine | Histidine | Total |
| 096 | 8.88 | 8.91 | 0.113 | 0.126 | 0.105 | 0.344 |
| $OP_2$-1972 | 9.04 | 12.57 | 0.228 | 0.291 | 0.182 | 0.701 |
| NCB | 9.25 | 11.49 | 0.132 | 0.129 | 0.100 | 0.361 |
| BS 3 | 10.59 | 11.54 | 0.110 | 0.115 | 0.107 | 0.332 |
| Early flint Syn. | 10.70 | 10.60 | 0.133 | 0.112 | 0.088 | 0.333 |
| Line 7 | 11.32 | 11.20 | 0.180 | 0.251 | 0.190 | 0.621 |
| Tuxpeno PL-B | 11.09 | 11.68 | 0.142 | 0.142 | 0.109 | 0.393 |
| C 10 | 9.57 | 8.76 | 0.128 | 0.153 | 0.140 | 0.421 |
| Bomo Local | 9.95 | 8.64 | 0.151 | 0.158 | 0.153 | 0.462 |
| Biu Yellow | 11.35 | 11.42 | 0.161 | 0.151 | 0.134 | 0.446 |
| BS3 x Bomo Local | 10.64 | 10.10 | 0.161 | 0.228 | 0.172 | 0.561 |
| SC 123 | 10.54 | 10.22 | 0.148 | 0.214 | 0.184 | 0.543 |
| SC 3 | 10.71 | 15.96 | 0.344 | 0.404 | 0.239 | 0.982 |
| NCA | 10.69 | 10.73 | 0.146 | 0.222 | 0.182 | 0.550 |

[1]Expressed as micromoles per 100 mg. of sample.

In general, the agreement between the Kjeldahl and Udy methods is good. Since the Udy method essentially determines the amount of the basic amino acids including lysine, the calculated protein tends to be higher when the protein is high in lysine.

The proportion of the total basic amino acid and lysine was relatively constant ($r = 0.95$ and total = 0.0433 + 2.83 lysine). The Udy values were highly correlated with the lysine content ($r = 0.82$) with a relation, Udy value = 6.865 + 25.345 lysine. The correlation of the Udy value with total basic amino acids was 0.70 with a relation, Udy value = 7.32 + 7.275 total.

## Field Trials Officers (FTO)

A full complement of FTO's is now on duty, but the changes interrupted the continuity of some of the programs. M. Dumont, FTO, Dakar, completed his tour in June and did not return. M. Leger was transferred to Dakar from Maroua, Camerouns, after completing his tour and returning from home leave on December 15, 1973. M. Bouchitte replaced M. Leger on January 25, 1974, at Maroua. Mr. Pomfret arrived in Kumasi, Ghana, on September 18, 1973, to fill the last of the FTO positions. Mr. Taylor at Kano, Nigeria, will be going on home leave in March 1974, and returning, maintaining continuity at this post.

Because of the long interruption at Dakar, there are no experimental results to report. Also, the Ghana FTO has just arrived, so there were no experiments to report. In Maroua, Mr. Bouchitte informs me that he has not received the results from the trials which Mr. Leger started. Mr. Taylor's report follows.

### Trial Results from FTO Nigeria

Richard Taylor

Yields of cereal demonstration/multiplication plots reported by the end of 1972 are given below:

| Site | Crop | Variety | Plot size ha | Grain yield kg/ha |
|---|---|---|---|---|
| Dan Gora | Maize | 096 | 0.05 | 867 |
| | | 096 | " | 955 |
| | | 096 | " | 788 |
| | Sorghum | SK 5912 | " | 661 |
| | | SK 5912 | " | 1214 |
| | | SK 5912 | " | 2070 |
| Minna | Maize | NCA | 0.012 | 4008 |
| | | NCB | " | 3164 |
| Jakarde | Maize | NCA | " | 7234 |
| | | NCB | " | 7596 |
| | | SC3 | " | 5787 |
| | | SC123 | " | 4341 |

The site at Jakarde, north of Kano, received supplementary irrigation. Yields were poor at Dan Gora, in spite of good management and crop establishment, due to poor rainfall distribution.

### Work in Hand

The Maize Variety x Soil Productivity Trials are to be organized from Kano in 1974. Other trials will be as 1973 with the possible addition of five short-season hybrid sorghum agronomy trials in the Sudan Savannah Zone and the West African Regional Sorghum and Millet Trials. Entries for the Regional Sorghum trials have been received from outside Nigeria, but the millet trials are very short of material.

It is hoped to multiply sorghum (variety 137-62) and maize at the Kadawa irrigation site for distribution in 1974.

## Maize Package Trials

The trials were designed to determine the important inputs in a cereal package. Treatments were: the complete package (A), the complete package less one input (B to H). Treatment A consisted of variety Bulk 3, 220 lb 15-10-10 fertilizer/acre, seedbed herbicide, striga control, stem borer control, 20,000 plants/acre, early planting. The results of the three trials reported by January 1974, are as follows:

| Treatment | Grain Yield % A | | |
|---|---|---|---|
| | Osara | Daudawa | Kano |
| A Complete Package | 25.8 q/ha | 31.3 q/ha | 18.9 q/ha |
| B Local Variety | 41.2*% | 50.2*% | 54.2*% |
| C ½ Fertilizer | 72.8% | 67.7*% | 68.1% |
| D No seedbed herbicide | 78.8% | 78.4% | 94.6% |
| E No striga control | 119.8% | 87.0% | 79.0% |
| F No stem borer control | 73.3% | 72.6*% | 71.7% |
| G 10,000 plants/acre | 65.1% | 92.2% | 79.9% |
| H Late planted | 112.7% | 69.8*% | 26.7*% |

* Treatment differs significantly from A

Stand counts were reduced at Osara due to lack of rain after the early planting (A to G), whereas the late-planted plots (H) were not affected and yielded well. At the other sites, late planting significantly reduced grain yield. The recommended variety (Bulk 3) appeared to be the most important input.

## Sorghum Supplementary Nitrogen Trials

Trials were carried out at Kano and Daura in 1972 and 1973 to determine the effect of time of application of supplementary nitrogen to long- and short-season sorghum. Nitrogen (40 lbs N/acre or 80 lbs N/acre) was applied shortly after planting (P) or at times corresponding with flower primordia initiation (F) or grain filling (A). A fourth treatment (B) combined A and F. 1972 was usually dry, and time of application was not significant. In 1973, the trial at Kano was abandoned due to root rot, and the long-season variety at Daura failed as a result of drought. Grain yields were as follows:

| Treatment | Dry Grain Yields q/ha Kano 1972 | | Daura 1972 | | Daura 1973 |
|---|---|---|---|---|---|
| Growing Period | Short | Long | Short | Long | Short |
| Application Time | | | | | |
| P | 20.8 | 17.1 | 29.5 | 15.4 | 3.3 |
| F | 20.9 | 18.4 | 23.5 | 18.5 | 4.7 |
| A | 22.4 | 19.8 | 25.4 | 14.0 | 4.9 |
| B | 18.2 | 20.0 | 20.5 | 19.6 | 3.2 |
| SE | 2.10 | 2.10 | 2.57 | 2.57 | 0.6 |
| Rate | | | | | |
| 40 N | 21.4 | 19.4 | 23.3 | 17.8 | 4.1 |
| 80 N | 19.7 | 18.3 | 26.2 | 15.9 | 4.0 |
| SE | 1.48 | 1.48 | 1.82 | 1.82 | 0.4 |

## Maize Variety x Soil Productivity Trials

These trials were started in 1972, and were intended for the same site for three years. Because the original site proved unsuitable, or for other reasons, many of the trials were relocated in 1973. Eight locations, including the irrigated site at Kadawa, were reported by December 1973, but the yields from two of these were too variable to be of use. Six sites are reported below.

| Site & Year | | Grain Yield kg/ha Productivity Level L | M | H | Variety Bulk-3 | SC123 | NCA | LWxXB101 | NCB |
|---|---|---|---|---|---|---|---|---|---|
| Kadawa | 72 | 773 | 1375 | 2081 | | | | | |
| | 73 | 1661 | 2217 | 3168 | 2569 | 2180 | 2531 | 2007 | 2456 |
| Ajasse | 72 | 2042 | 3439 | 4311 | | | | | |
| | * 73 | 3135 | 4776 | 4770 | 4266 | 4065 | 4052 | 4376 | 4376 |
| Orara | 72 | 962 | 913 | 870 | | | | | |
| | 73 | 1851 | 2525 | 2687 | 1891 | 2043 | 2451 | 3487 | 1901 |
| Ochaja | 72 | 715 | 1114 | 881 | | | | | |
| | 73 | 1154 | 1299 | 1931 | 1530 | 1518 | 1256 | 1617 | 1386 |
| Daudawa | 72 | 4099 | 6390 | 6661 | | | | | |
| | 73 | 1959 | 3074 | 2547 | 2210 | 2386 | 2763 | 2411 | 2864 |
| Biu | 73 | 4169 | 3721 | 3625 | 3564 | 3645 | 4337 | 3827 | 3808 |
| Variety Mean | | | | | 2672 | 2640 | 2898 | 2954 | 2799 |

* Same site 1972/73

Only the varieties Bulk 3 and NCB were common to the trials in 1972 and 1973. The hybrid Lagos White x XB101 showed the highest mean yield and was the highest yielding entry at three of the six sites. Poorly distributed rainfall after planting resulted in variable stands and yields at Osara and Ochaja in 1972. In 1973, there was a response to the highest level of fertilizer (800 lb/acre 21-14-14) at only three of the six sites. The Biu trial was planted on a newly cleared site where a negative response to fertilizer was obtained.

Table 1. 1973 West African Uniform Maize Trials. Five locations reported by December 1973. Grain yields in quintals/ha. at 12% moisture content.

| Entry | Origin | IITA Ibadan Nigeria | Mokwa Nigeria | Samaru Nigeria | Farako-Ba Upper Volta | Njala Sierra Leone | Mean |
|---|---|---|---|---|---|---|---|
| TZA(C1) x TZB(C2) | Nigeria | 40.4 | 18.8 | 75.0 | 42.3 | 70.3 | 49.4 |
| Pioneer XB101A | Jamaica | 35.6 | | 68.8 | 36.3 | 69.3 | 46.5* |
| TZB(C2) | Nigeria | 44.1 | 16.2 | 68.3 | 30.8 | 66.8 | 45.2 |
| Western Yellow 1 | Nigeria | 33.5 | 16.6 | 66.0 | 30.7 | 70.9[x] | 43.5 |
| Pioneer 515 | Jamaica | 30.2 | | 68.0 | 35.4 | 63.0 | 43.1* |
| NCA Rb | Nigeria | 36.4 | 16.5 | 63.6 | 31.6 | 55.8 | 40.8 |
| Tuxpeno P.B. | Mexico | 36.8 | 14.1 | 65.1 | 22.9 | 60.8 | 39.9 |
| NCA(C2) | Nigeria | 23.7 | 14.7 | 56.8 | 34.3 | 65.3 | 39.0 |
| Naiouli 7 x ATC | Dahomey | 24.5 | 15.2 | 50.9 | 28.9 | 60.4 | 36.0 |
| C.P.J. | Iv. Coast | 20.2 | 10.1 | 44.8 | 25.3 | 68.2 | 33.7 |
| Bomo Local x BS3 | Nigeria | 6.9 | 11.4 | 38.8 | 22.3 | 38.4 | 23.6 |
| Local Variety | | 20.0 | 12.3 | 32.6 | 21.8 | 36.2 | |
| Improved Variety | | 38.9 | 14.7 | 55.7 | 25.5 | 43.7 | |
| Mean | | 30.1 | 14.6 | 58.0 | 29.9 | 59.2 | 40.1 |
| LSD | | 5.5 | 5.5 | 9.8 | 10.1 | 17.9(19.4)[x] | 7.3(7.8)* |
| CV % | | 12.8 | 26.1 | 11.7 | 23.5 | 21.0 | 14.2 |

* Mean yields for XB101A and 515 contain values estimated for Mokwa by the missing plot technique. Use LSD (7.8) to compare these entries with other.

[x] Use LSD (19.4) to compare Western Yellow 1 with other entries at Njala.

Table 2. 1973 West African Uniform Maize Trials. Five locations reported by December 1973. Means of field characteristics.

| Entry | Grain Color | Days to Anthesis | Ear Height cm | Ears/** Plant |
|---|---|---|---|---|
| TZA(C1) x TZB(C2) | White | 57 | 143 | 0.88 |
| Pioneer x B101A* | White | 55 | 133 | 0.92 |
| TZB(C2) | White | 57 | 147 | 0.81 |
| Pioneer 515* | White | 52 | 117 | 0.84 |
| Western Yellow 1 | Yellow | 58 | 151 | 0.82 |
| NCA Rb | Mixed | 56 | 135 | 0.80 |
| NCA(C2) | Mixed | 54 | 130 | 0.74 |
| Tuxpeno P.B. | White | 58 | 124 | 0.79 |
| Naiouli 7 x ATC | White | 51 | 123 | 0.95 |
| C.P.J. | Yellow | 55 | 121 | 0.72 |
| Bomo Local x BS3 | Mixed | 52 | 124 | 0.57 |
| Mean | | 55 | 132 | 0.80 |
| LSD | | 1 | 11(12) | 0.16(0.17) |
| CV % | | 1.6 | 6.6 | 13.4 |

* Figures for XB101A and 515 contain values estimated for Mokwa by the missing plot technique. Use (LSD) to compare these entries with others.

** Numbers of ears/plant not available from Njala.

# Major Cereals Seed Project

J. H. Clifton

## Dry Season Early 1973

During the 1972-73 dry season, several dates of plantings were made using nine restorer lines and male sterile lines of sorghum varieties at three locations: Mokwa, Bacita, and Samaru. Hand pollinations were made for 38 different crosses. Sixteen had poor seed set and were discarded. Five male sterile varieties were increased also at Mokwa. They were locally developed male sterile RCF, RCS, and ISNI-A. The U.S. lines were Combine Kafir - 60 and Four Dwarf Kafir.

Several hybrids showed excellent yield potential on subsequent grow outs. Two problems arose that delayed immediate use of more of these lines: (1) the locally developed ms lines needed to be stabilized further, and (2) the wide spread in blooming dates of CK-60 or four dwarf Kafir and the local restorer lines is too great for rainy season production. Irrigated land is very limited, so dry-season production would be limited. Local hybrid seed was shelved for the present, and a hybrid, CK-60 x SA 7706, that is easily produced will receive the greatest attention.

The local ms lines are photoperiod sensitive, and yields were so low that it appears that costs for dry-season seed production of the photosensitive lines would be prohibitive. To assure their blooming together, the split in planting dates between the sterile and the restorer will make many of these crosses impracticable on a field production basis. The nonsensitive U.S. lines produced near normal of what their yields are during the rainy season. However, some of the locally developed lines show good yield potential as hybrids and, following more work on them by the breeder, they will again be evaluated as to production problems and production costs.

Seed of male sterile CK-60, four dwarf Kafir, and RCF was harvested in February and in March at Mokwa which is 350 miles south of Samaru. Arrangements were made to try for two crossing blocks north of Samaru to determine if two seed crops could be produced during the dry season and if seed could be harvested prior to the rainy season. One location was at Bakura, 185 miles north and the other at Maradi in Niger. The three steriles were planted in the same field, and SA 7706 was used as the pollinator. For the year 1973, which was abnormal, the two crops during the dry season were possible. It appears probable that two seed crops may be produced during the dry season in most years. By utilizing head mold-resistant lines developed by Dr. S. King, JP-26 pathologist, and lines requiring shorter maturity time, three seed crops are feasible within a five- to six-hundred mile area with Samaru at the center.

A yield of 5100 kilograms of grain per hectare was reported at Tarna station, Maradi, Niger, in 1972, using the hybrid CK-60 x SA 7706. This yield was made on 450 mm of moisture and 90 pounds of nitrogen. This hybrid is relatively easy to produce and is the most promising available sorghum that can somewhat compete with maize yields in the Guinea, Savannah and southern Sudan zones. So far, improved local sorghum varieties that are available do not yield enough to compete with maize.

## Rainy Season Production

It was anticipated that seed of early maturing sterile sorghum would encounter many problems when produced during the rainy season. Head mold and sprouting in the head were the primary problems expected. The 1973 rains were abnormal, so the fact that no problems were encountered with the four dwarf Kafir A and B lines production is not conclusive. One of the Kafir steriles will be increased during the rainy season in 1974.

A small acreage of SA 7706, R-960, and SK 5912 was produced. Planting of SA 7706 was delayed until July 16. Even with the delayed planting, extensive head mold (*Fusarium moniliforim*) occurred on the seed.

Seed yields were satisfactory; however, more effort will be made in the future to boost seed yield per unit of land. Following is the rainy season production on seed of Sorghum and Maize that will be available for sale:

| Sorghum | kilogram |
|---|---|
| SA 7706 | 2123 |
| R-960 | 4175 |
| SK 5912 | 1106 |
| **Maize** | |
| Samaru Comp. 1,2,3 | 12,160 |
| Nigerian Comp. A | 930 |
| Nigerian " B | 1,180 |
| 096 | 420 |
| C-10 x Biu Yellow | 264 |
| Total = | 22,358 |

## Seed Production Climate

Northern Nigeria and southern Niger have an excellent climate for seed production during the dry season and also during the rainy season. Rains usually end at a predictable time, so plantings may be planned according to maturity ranges. Rainy season poses some problems for the extremely short-season type sorghums because late plantings run a risk of being attacked by shoot fly or midge. Breeding for short-season sorghum and millet will be intensified; however, because (1) they are more drought escaping and may be utilized nearer the desert areas, and (2) maize has proved to give very high yields up through the 600 to 700 mm rainfall area. It should be noted again that, so far, only hybrid sorghums can compete in yields with maize composites. Hybrid sorghums have, so far, only been produced during the dry season. Rainy season production will be made in 1974 to determine some of the production problems. Isolation will likely prove very difficult. However, in order to produce a large quantity of hybrid seed, the rainy season will necessarily be the season because of lack of irrigated land.

During the latter half of calendar year 1973, the Board of Governors approved a proposal for a Foundation Seed Unit to be established at the Institute for Agricultural Research, Ahmadu Bello University. Funding, staff development, and capital outlays were scheduled over the five-year period from 1975 through 1980.

Funds approved for the period amounted to ₦120,000, approximately $200,000.00. The plan has provision for four key people: (1) a position of Senior Research Fellow to head the Unit, (2) three research fellow positions as assistant general manager, production manager, and warehouse-processing manager. Tentative plans were quickly made to recruit staff, and a site was chosen for a flat storage building and seed processing facility when funds become available. Small bulk storage units are also planned. Seed handling and processing equipment will probably cause the longest delays in bringing the Seed Unit to full capability. However, training in production, records, processing, and packaging was started in late 1973, utilizing the very limited equipment and facilities available.

In late November 1973, ₦30,000 for drought relief became available to IAR. It was decided that seed, especially seed of early maturing varieties, would be the one greatest contribution to drought relief that IAR could do that probably no others would or could accomplish.[1/]

IAR's Foundation Seed Unit existed only on paper and the hopes of a few individuals. With the ₦30,000 drought relief fund available, some seed unit activities could begin before fiscal 1975.

Individuals from Extension-Research-Liaison Service, Botany Section, IAR, Kansas State University contract team, Joint Project 26, and Director Dagg began planning a dry-season production program. December was obviously late to start a program, but a need existed so the attempt must be made to produce all the seed possible. Dry-season production must have irrigation water which limited the choice of areas and increased competition for use of the land. An appeal for land was sent out by letter by the Director, and personal visits were made by other volunteers to the operators of the irrigation sites. Possible production sites were at Bacita, Dep, Zaria, and Kadawa near Kano. JP-26 had sufficient seed of SA 7706, a white-grained sorghum that matures in about 90 days, to plant approximately 280 hectares. A normal yield of something over two tons per hectare would make a significant contribution to the drought areas. However, lacking an organized seed unit or buildings and seed handling facilities, a normal yield would prove very difficult to manage. Logistics in supervising the production and transporting the harvested seed will point up some of the problems to be addressed first in future operations.

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1/ It has been estimated that upwards of 15 million people have been severely affected by drought in northern Nigeria. The region has also had a large influx of drought victims from the Sahel zones to the north that compounds the problem in the food grain short area.

Problems in Providing High Quality Seed for Farmers' Use

A functioning seed industry is composed of (1) seed production, (2) handling, processing, and storage, (3) infrastructure for distribution and temporary storage dispensed widely to be near the farmers, and (4) marketing.

Of the four listed above, marketing is by far the most difficult:

(1) There is no known market, therefore, few will take the chance of producing seed. Several potential private seed producers have stated their interest and willingness to produce seed but state they would need help in selling it;

(2) The general assumption is that the farmers can't afford to buy seed, especially at a price sufficient to allow the seed producer to grow seed year after year. This assumption has been proven incorrect many times for other agricultural inputs where the farmer was convinced of the items' value to him;

(3) Probably the greatest problem in marketing seed is that other people and other production inputs become involved so that crop performance is dependent on many outside agencies. For example, maize yields of 4500 kg per hectare were obtained in a very dry area north of Samaru in 1973. Fertilizer is believed to be the key for the improved composite to produce so well. Credit, availability of other inputs, and grain markets all influence seed marketing and are outside the seedsman's control. Therefore, the development of the seed industry is essentially dependent upon availability of crop production inputs for increased yields and the increased yields to have been demonstrated to the farmer.

When IAR's Foundation Seed Unit is fully established, its staff will be in an excellent position to assist and advise commercial seed producers. The growing demand for grain for both human and livestock feed helps create a good climate for seed marketing.