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ELEVENTH ANNUAL REPORT

of the

AID-ARS Project

Major Cereals in West Africa

1974

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GENERAL RESUMÉ

K. R. Stockinger
USDA-USAID-PASA Team Leader
Samaru, Nigeria

Population improvement was continued in NCA, NCB, and S123, and started in Biu Yellow with full-sib selection for increased yield and reduced lodging. The Biu Yellow test had entries which yielded over 100 q/ha.

The first cycle of a recurrent selection program for increasing high quality protein in SC123 was completed this year. A similar program was started with NCA and NCB. The high protein recombinations of these two populations had 11.7 and 11.9 percent protein, respectively, the highest protein level of any population tested.

Seed increases of three millet varieties, five sorghum varieties, and five maize varieties were made by the Foundation Seed Unit. The seed from these increases were processed, and 22 quintals were delivered to 25 different organizations for research experiments and trials, and 272 quintals were sold to various states and other organizations for multiplication.

To check a reported breakdown of resistance of NCArb and NCBrb to Helminthosporium maydis on the Benue Plateau, three trials were planted in warm and cool locations of the Plateau. The susceptible varieties became infected with Helminthosporium turcicum and a trace of H. maydis and the resistant varieties with only H. turcicum at the cool location. At the warm location the susceptible varieties were infected with H. maydis with a trace of H. turcicum while the resistant varieties had only a few lesions of H. turcicum. The results indicate that there was no breakdown in the resistance of the rb gene to H. maydis.

Tests of seed mold-resistant lines of sorghum were continued in 1974. Trials were planted in mid-June and July 1-2, and showed that the earlier plantings which were exposed to more rain had more seed-mold damage than the same lines planted 2-3 weeks later; but lines that were superior in grain mold remained relatively superior, whether planted early or late.

In the advanced Striga screening trial of sorghum, nine lines completely suppressed the emergence of Striga plants, although they showed some foliar symptoms due to Striga infection. Nineteen Striga-suppressing or Striga-resistant lines were selected for agronomic characters and will be increased under irrigation for further testing in larger plots in 1975.

A Fusarium disease complex, known as Pokkah boeng or twisted top in sugarcane, was observed in Nigeria in 1975 on maize, millet, and sorghum. It is characterized by deformed or discolored leaves at the top of the plant, and in extreme cases may move from the leaves and sheath into the stalks, causing death. It is more prevalent during periods of wet weather; and when the high humidity subsides, the fingus dries up and the plant resumes normal growth.

The maize streak disease present in Nigeria was shown to be the same as that present in East Africa by use of an antiserium developed by the maize streak research program EAAFRO in Kenya, and resistant material found can be used in both East and West Africa to develop resistant varieties. The disease has become more prevalent in West Africa in recent years, especially in the second growing season in the south.

Five trials for shoot fly primary resistance were carried out on resistant varieties from India and from crosses with these varieties and local material. Over half of the crosses were resistant, and the resistant varieties remained resistant. Other varieties and crosses are being screened for recovery resistance (recovery after the main shoot has been killed). Two trials with 120 varieties and 174 selections of sorghum from 16 crosses showed over 200 lines with good resistance to the maize stem borer.

A long-term crop residue experiment showed that removing crop residues reduced the soil organic matter, reduced the exchangeable magnesium and potassium level of the soil, and reduced yields. Burning the residues and returning the ash resulted in a smaller decrease in pH than incorporating or removing the residue. Returning the residues resulted in a higher soil organic matter content than burning or returning residues. Burning the residues or incorporating them results in better soil conditions for crop growth and, after three years, resulted in 250 kg/ha more grain yield than when the residue was removed.

After 25 years of continuous cropping at Kano, adequate yields of millet can still be maintained by use of chemical fertilizers. The principle effect of farmyard manure on millet yields was as a source of N and P and also to reduce the acidifying effect of the nitrogen fertilizer. The plots which received nitrogen fertilizer have become very acid especially in the 15 to 30 cm depths and need to be limed.

A mixture of rock phosphate with sulfur was shown to be as efficient as superphosphate. The tests were performed on a virgin soil at Samaru, and the equivalent of 150 kg/ha of P_2O_5 of superphosphate or rock phosphate with sulfur was required for maximum yields. Rock phosphate alone gave increases in yield, but at a lower rate.

Soil tests at the Kano Agricultural Research Station showed that the soil was acid down to 45 to 90 cm. in two fields with poor growth of sorghum and groundnuts. This illustrates the problem which will result from the continued use of nitrogen fertilizer, especially ammonium sulfate.

A conference was held under the auspices of the Scientific and Technical Research Committee, Organization of African Unity at the International Institute for Tropical Agriculture, Ibadan, on Cereal Pathology and Entomology. The conference was attended by representatives of 16 African countries, CIMMYT, ICRISAT, IITA, IRAT, the Inter-Asian Corn Program, USAID, and USDA. The conference resulted in the exchange of information and discussion of problems of cereal pests and diseases in West Africa, and also in other similar areas of the world. A list of diseases and pests of sorghum, millet, and maize was compiled. A uniform scoring system is needed to measure host reaction, and it was requested that JP-26 prepare proper methods and distribute them to the various laboratories in the region. Regional trials were discussed, and it was recommended that a workshop be held each year to discuss entries in the tests and location for the tests. The regional trials should be continued after JP-26 is phased out.

The following table gives a staff list of people involved in the administration and technical aspects of the project in Africa:

Scientific and Technical Research Commission, Organization of African Unity, Lagos, Nigeria

A. O. Odelola	Executive Secretary
Papa Diouf	Project Coordinator (resigned July 1974)

Regional AID--Niamey, Niger

A. Baron	ADO
Victor Lateef (stationed in Lagos)	Project Manager

At the end of July, the project management was transferred to AID--Nigeria.

AID Nigeria, Lagos

William Ford	Mission Director
R. O. Olson	Food and Agriculture Officer and Project Manager

USDA/PASA Staff at Institute for Agricultural Research, Samaru, Nigeria

		Date of Arrival
D. B. Barry	Entomologist Departed July 2, 1974	June 24, 1972
J. H. Clifton	Seedsman Agronomist	October 15, 1972
C. L. Goodrich	Plant Breeder	September 18, 1973
S. B. King	Plant Pathologist Departed February, 1974	April 24, 1967

K. R. Stockinger	Team Leader--Soil Scientist	June 17, 1966
L. E. Wallace	Entomologist	December 6, 1974
N. Zummo	Plant Pathologist	February 14, 1974

At Federal Research Station, Moor Plantation, Ibadan, Nigeria

		Date of Arrival
G. E. Cook	Plant Pathologist	October 15, 1973

Field Trials Officer

A. Bouchitté	Marawa, Cameroon
F. Léger	Dakar, Senegal
M. Pomfret	Kumasi, Ghana
R. Taylor	Kano, Nigeria

Cooperators

M. El Rouby	Cereal Breeder--Inst. for Agr. Res., Samaru, Nigeria
F. Khadr	Cereal Breeder--Inst. for Agr. Res., Samaru, Nigeria
A. Mokwunye	Soil Scientist--Inst. for Agr. Res., Samaru, Nigeria
L. Nnadi	Soil Scientist--Inst. for Agr. Res., Samaru, Nigeria
S. Monzo	Plant Pathologist--Inst. for Agr. Res., Samaru, Nigeria
J. M. Fajamisin	Plant Pathologist--Federal Research Station, Moor Plantation, Ibadan, Nigeria

SOILS AND AGRONOMY

K. R. Stockinger

The rainfall was slightly above average for 1974, for the first time in five years at Samaru. The rains were slow in starting, and maize planting was delayed until mid-June; but the rains were well-distributed and plentiful until early October, resulting in excellent yields. The drought appears to be over, and good yields were reported throughout West Africa in 1974.

Several official trips were taken in 1974 to coordinate project activities with other agencies, to increase cooperation, and to become acquainted with the research of workers in related fields. Dr. Barry and I attended the East African Cereals Conference in Malawi in March. We each presented a paper and toured the various experimental sites. This was the end of the wet season, and the crops looked very good. Maize was especially good, including farmers' fields. The presence of a commercial seed company in East Africa has enabled them to produce and distribute improved varieties and hybrids to the farmers of the region. I also attended the OAU-STRC sponsored Major Cereals Conference held at Ibadan in early July. The meeting was devoted to the plant pathological and entomological aspects of cereal production in Africa. I presented a progress report for the project for the last 10 years.

Other trips involved a visit to Washington, D.C., during my R&R to consult with USDA and AID officials about extending the project for another year to allow for an overlap with the International Crop Research Institute for the Semi-Arid Tropics, who will take over and expand our work on millet and sorghum. In August I visited Senegal and Gambia with Mr. Léger, the Field Trials Officer (FTO) for that area. We stopped at Bambey, Gambia, Casamance, and Senegal River Valley. The average annual rainfall varies from 300 mm in the Senegal River Valley to 1600 in Casamance in Southern Senegal. Since most of Senegal is very dry, millet is the dominant crop. The millet research program is very strong and they have developed high yielding, short stalk millets which look very good. Unfortunately, they are adapted only in Senegal because of lack of disease resistance to the strains of powdery mildew prevalent elsewhere. Gambia was visited en route to Southern Senegal. Conditions were similar to Senegal except there was much less fertilizer available and yields were lower as a result. In general, crops looked very good in Gambia and Senegal, and the drought appeared to be over. No special problems were encountered that were not being handled locally. There is a strong research cereal program in Senegal which is directed to the development of varieties and practices for increased food production.

In October, Dr. Zummo and I went to Cameroon to observe the cereal production practices, problems, and on-going research. We had also planned to visit Chad and Central African Republic with Mr. Alec Bouchitté,

but the trip had to be cancelled when I developed a very bad cold. We stayed two days in Cameroon and then returned. We visited the IRAT station and field experiments. They had a good sorghum breeding program underway. We also met Dr. Jacques Eckbiel who had recently returned from Nebraska where he had just received his Ph.D. degree, under the sponsorship of JP-26. His training was in sorghum plant breeding, but it looked as if he was going to be put in charge of food production research for all of Cameroon.

Crop Residue Management

The purpose of this long-term experiment, started in 1971, is to compare the effect of three crop-residue management treatments (remove, burn, incorporate) in a continuous millet-maize rotation on soil properties, crop growth, and yield. Sub-plot treatments, comprising factorial combinations of nitrogen and phosphorus, each at two levels, are also included in the experiment.

The 3-year changes in soil chemical properties and on the yield of maize are summarized below.

(a) Soil pH: All treatments resulted in decrease in pH of the topsoil (0-15 cm). Greatest acidification occurred where the higher level of N (135 kg/ha of N) was used in conjunction with unburned residue incorporation. The decline in pH was minimized by return of crop residue ash.

N (kg/ha)	Residue trt.			
	Burn	Incorporate	Remove	Mean
45	-0.12	-0.16	-0.25	-0.17
135	-0.21	-0.50	-0.38	-0.36
Mean	-0.17	-0.33	-0.32	- .027

Application of single superphosphate also minimized the decrease in pH of topsoil and subsoil. This effect of phosphorus on soil pH is probably due in part to the calcium in the superphosphate fertilizer.

P (kg/ha)	Soil layer	
	0 - 15 cm	15 - 30 cm
0	-0.33	+0.07
36	-0.20	+0.18

It would also appear as if some bases (particularly Mg and K) are leached down to the sobsoil where they raise the subsoil pH while the topsoil remains acid. This aspect of cation and anoin movement requires a closer look, and some comprehensive work on the nutrient movement has been planned for the coming seasons.

(b) Organic matter and nitrogen: Changes in organic carbon content of the topsoil were significantly related to nitrogen and residue management treatments. The incorporation of crop residues led to a significantly higher content of soil carbon relative to "burn" and "remove" treatments, but only where the higher rate of N was used. This may reflect both the greater production of crop dry matter on high nitrogen plots and the greater percentage transformation of highly carbonaceous material into humified organic matter where nitrogen was less limiting.

Changes in total nitrogen of soil were not significantly related to residue treatments.

(c) Exchangeable bases: (i) Calcium status was improved in both topsoil and subsoil by single superphosphate, but neither residue management nor nitrogen treatments had any significant effect on calcium level. (ii) Magnesium status of the topsoil was severly reduced by the higher rate of nitrogen, by single superphosphate, and by the removal of crop residues. The last two factors showed a positive interaction. (iii) Potassium level in the topsoil was very seriously lowered (44%) by residue removal, but was otherwise little affected by treatments.

(d) Yield of maize grain: The yield of maize was affected by residue, nitrogen, and phosphorus treatments. There was no significant difference between "burn" and "incorporate" treatments; but each of these treatments gave a significantly higher yield than the "remove" treatments.

Residue mgt.	Grain yield (kg/ha)
Burn	2764
Incorporate	2704
Remove	2482

Where no phosphate fertilizer had been applied for the last three years, growth of the maize plots was slow and maturity was delayed by as much as three weeks. Maturity of maize was most delayed on sub-plots with the combination of zero phosphorus and the higher level of nitrogen. The lowest grain yield was obtained on the "remove" plots with no phosphorus application.

Leaching Losses of Nitrogen

The loss of nitrogen by leaching plays a major role in the cation balance and the acidification of the soil.

The extent of nitrogen losses by leaching was investigated using lysimeters measuring 1.83 x 1.83 x 0.91 meters in length, width, and depth. Different sources of nitrogen fertilizer at the rate of 240 kg/ha of N were applied to the lysimeter plots. The cumulative losses of N (NH_4 + NO_3) and drainage in the presence of early seeded maize were:

Source of N	Loss of N kg/ha	Drainage mm	Yield quintals
None	8.0	177	32.1
CAN	9.9	110	51.5
SCU	19.9	178	45.8
Urea	36.3	175	42.5

Variability among replicates was high, especially in the urea treatment in which the high N rate affected early and uniform establishment of the maize plants. Generally the loss of N by leaching was low in the presence of a maize crop.

Long Term DNPK Experiments

The DNPK experiment at Samaru was carried out for the 25th year and confirmed previous results which showed that good yields can be obtained with commercial fertilizers and that the principle benefits of manure are due to the nitrogen and phosphorus which it provides. Soil analysis shows that the high rate of manure provides almost as much phosphorus as the low rate (60 kg/ha of P_2O_5) of superphosphate.

The DNPK experiment at Kano was carried out this year with millet as the test crop. The most important factors for yield were manure, nitrogen, and phosphorus. The average yields over all plots for the main affects at the three levels of application are given in the following table:

	Dung	Nitrogen	Phosphorus	Potassium
0	1730	1380	1930	2220
1	2230	2390	2250	2140
2	2381	2580	2170	1980

The levels of dung were 0, 2.5, and 5T/ha, of nitrogen and phosphorus were 0, 60, and 120 kg/ha of N and P_2O_5, respectively, and 0, 50, and 100 kg/ha of K_2O for the potassium treatment. The results show a good response to the first increment of nitrogen and a small response to the second increment, indicating the lower yield potential of the millet variety used. Soil tests indicate that all of the nitrogen plots have become acidified. The effect is more pronounced in the 15 and 30 cm depth and deeper and reaching a pH as low as 3.5 in 0.01 M CaCl2. Only ½ to 3T/ha of lime are required to correct the acidity of the surface 15 cm. Manure reduces the acidifying effects of nitrogen fertilizer. Ammonium sulphate was used as the nitrogen source for 20 years and is undoubtedly the principle cause of the acidification. The plots will be treated with lime to neutralize their acidity in 1976.

Phosphorus Studies

Laboratory studies are underway to determine the phosphorus fixing capacity of various soils in northern Nigeria. In conjunction with this study, the efficiency of three phosphate fertilizers was studied at Samaru on a virgin soil. The yields of maize are given below:

Rate kg P_2O_5/ha	Super phosphate	Rock phosphate kg/ha	Rock phosphate with sulfur
0	650	561	600
50	3030	1910	2200
100	3470	1830	3140
150	4230	2580	4330
200	3780	3270	3380

The results show that 150 kg/ha of P_2O_5 as superphosphate or rock phosphate with sulfur give maximum yields. Rock phosphate also gives increasing yields, but at a slower rate. The experiment will be continued for two years more, with additional phosphate added this year and the residual effects to be measured next year. The results also show that 150 kg/ha of P_2O_5 are needed in the virgin soil to overcome the fixing capacity of the soil before sufficient phosphorus is available for maximum yields. This was the quantity predicted by the laboratory tests.

Soil Acidity

Recently complaints were received about the poor growth of sorghum and groundnuts in two fields at Kano ARS. Soil samples showed that the pH of the soils was acid, down to 45 and 90 cm. The pH of three profiles are given below:

Depth (cm)	pH		
	1	2	3
0 - 7.5	4.81	4.58	4.05
7.5 - 15	4.48	4.40	3.92
15 - 22.5	4.13	4.10	4.06
22.5 - 30	4.05	4.00	4.10
30 - 45	4.05	4.25	4.40
45 - 60	4.28	4.56	4.60
60 - 75	4.45	4.58	4.82
75 - 90	4.45	4.90	4.80

Liming trials and general liming will be carried out on these fields. The problem is complicated by the depth of the acidity in the profile and how to get lime down to lower depths to counteract it. The best solution is to prevent it from happening by avoiding the use of ammonium sulfate and applying the nitrogen in such a way that the plants absorb all of it.

CEREALS PATHOLOGY

Natale Zummo

Maize

Because of reports at the Cropping Scheme Meeting in February 1974 that resistance to Helminthosporium maydis had broken down on the Benue Plateau, an experiment was planted to determine if this was so. Approximately 1/10-acre plots of each of the varieties NCA and NCB, which are susceptible to Helminthosporium maydis (Southern leaf blight), and H. turcicum (Northern leaf blight); and to Puccinia sorghi, Puccinia polysora, NCArb, and NCBrb, which are resistant to H. maydis and P. polysora but susceptible to H. turcicum and P. sorghi, were planted on the Benue Plateau at Riyom and Pankshin where the cool temperatures would favor the development of H. turcicum and P. sorghi, and at Gangnum on the lowland where the warmer temperature would favor the development of H. maydis and P. polysora.

Disease inspection (Table 1) showed that the NCA and NCB at Riyom and Pankshin became infected with H. turcicum and P. sorghi along with a trace of H. maydis. The NCArb and NCBrb became infected with H. turcicum and P. sorghi at these locations but not with H. maydis. At Gangnum, the NCA and NCB became infected with H. maydis and P. polysora along with a trace of H. turcicum. The NCArb and NCBrb remained free of H. maydis and P. polysora but had a few lesions of H. turcicum.

These results indicated that there was no breakdown in the resistance of the rb gene to H. maydis and P. polysora. Observations in some fields of NCArb and NCBrb, near Samaru, that were infected with P. polysora were found to have been crossed with other varieties due to open pollination. The use of open-pollinated seed which was crossed with susceptible germplasm could account for the suspicion that there is a breakdown in the resistance of the rb gene.

Table 1. Infection of NCA, NCB, NCArb, and NCBrb with *H. maydis*, *H. turcicum*, *P. polysora*, and *P. sorghi* at Riyom, Pankshin, and Gangnum in 1974*

Location and Disease	Variety			
	NCA	NCB	NCArb	NCBrb
Riyom				
H. maydis	+	+	-	-
H. turcicum	+	+	+	+
P. polysora	-	-	-	-
P. sorghi	+	+	+	+
Pankshin				
H. maydis	+	+	-	-
H. turcicum	+	+	+	+
P. polysora	-	-	-	-
P. sorghi	+	+	+	+
Gangnum				
H. maydis	+	+	-	-
H. turcicum	+	+	+	+
P. polysora	+	+	-	-
P. sorghi	-	-	-	-

* + = infection from natural spread
- = no infection from natural spread

Sorghum

Grain Mold Resistance

Because of the advantage of a short-season sorghum that can mature grain before the end of the rainy season and still produce an acceptable grain that could store well, 37 selected dark- and 37 light-colored sorghum lines were further tested for resistance to seed mold in 1974. There was considerably more rain in Samaru in 1974, compared to each of the three previous years. These lines were planted on July 1-2, allowed to mature, and remain in the field until November 21 when they were harvested. Bagged and unbagged seed of each line were compared (Table 2). In addition, seed of these lines were compared with similar lines planted by Dr. El Rouby, sorghum breeder, approximately 2-3 weeks earlier (Table 3). Because the nature of resistance to grain molds is variable and not clearly defined, no attempt was made to determine the type of seed mold resistance encountered but to select sorghum lines that could produce good quality grain under conditions of high humidity without losing quality. The seed of these lines were examined for the purpose of molds under 20X magnification and rated on a scale of 1 to 10 with 1 being completely free of molds and 10 being completely covered.

Date of planting played an important part in the amount of seed mold on each line. These lines, planted earlier and exposed to the rains, had a higher seed mold rating than the same lines planted 2-3 weeks later (Tables 2, 3). However, those lines that were superior in grain mold resistance remained relatively superior whether planted early or late.

Table 2. Relative grain mold and Striga resistance of 37 light- and 37 dark-colored sorghum lines at Samaru in 1974.

Seed Mold Resistant			Trial--Light-colored seed		
			Seed Mold Rating*		Avg. No.
Entry No.	SRN	ISN	Not Bagged	Bagged	Striga plants per 35' plot
1	373	452	2.0		3.8
2	374	453	2.7	2.0	3.8
3	401	455	4.0	2.0	10.2
4	412	466	2.7	2.0	4.4
5	414	468	2.0	3.0	8.8
6	415	469	3.3	3.0	3.6
7	416	470	2.7	2.0	2.4
8	418	472	4.0	2.0	2.4
9	419	473	3.3	2.0	4.0
10	420	474	4.0	2.0	8.2
11	462	519	4.3	3.0	8.8
12	503	577	5.0	3.0	9.2
13	1901	2209	3.3	2.0	13.0
14	1902	2210	3.0	3.0	7.2
15	1905	2213	3.7	3.0	20.4
16	1911	2219	5.7	3.0	34.0
17	1918	2227	5.7	3.0	17.2
18	1923	2232	3.3	2.0	12.0
19	2265	2430	4.7	3.0	26.6
20	2657	2722	2.7	2.0	54.6
21	2658	2723	2.0	1	70.6
22	3465	3421	1.3	1.0	45.0
23	3667	3555	2.0	2.0	20.4
24	4208	3955	1.0	1.0	30.4
25	4209	3956	1.0	1.0	14.2
26	4211	3958	1.3	1.0	3.0
27	4212	3959	1.7	1.0	2.8
28	4250	8160	2.3	2.0	3.2
29	4698	8574	2.7	1.0	1.0
30	5374	4707	2.0	1.0	2.8
31	5695	9225	2.3	1.0	0.6
32	6389	9607	2.0	3.0	1.6
33	6494	9672	2.0	1.0	3.0
34	6498	9676	2.3	2.0	2.0
35	6639	9747	2.0	2.0	0.2
36	6865	10398	4.3	1.0	0.0
37	CE-90-132-Senegal		3.5	2.0	0.0

Table 2 (continued). Relative grain mold and *Striga* resistance of 37 light- and 37 dark-colored sorghum lines at Samaru in 1974.

Seed Mold Resistant			Trial--Dark-colored seed		
			Seed Mold Rating*		
Entry No.	SRN	ISN	Not Bagged	Bagged	Average No. *Striga* plants per 35' plot
1	612	660	2.0	1.0	5.0
2	922	931	4.0	3.0	2.2
3	1956	2240	3.0	2.0	0.8
4	2019	2283	4.0	3.0	2.6
5	2111	2334	4.0	4.0	1.4
6	2146	6953	5.5	4.0	2.2
7	2152	2361	2.5	3.0	5.4
8	2155	2365	3.0	3.0	7.8
9	2230	6992	4.5	5.0	8.6
10	2272	2438	5.5	2.0	3.8
11	2303	2444	2.5	3.0	1.2
12	2310	2451	3.0	3.0	0.8
13	2515	2596	2.0		0.8
14	2586	7202	2.5	3.0	2.6
15	2745	7294	3.5	2.0	5.2
16	2775	2832	3.5	2.0	1.1
17	2816	2849	7.5	3.0	2.2
18	2876	7353	3.0	3.0	0.4
19	2859	2867	4.0	3.0	3.8
20	3017	3029	4.0	2.0	2.4
21	3175	3171	3.0	2.0	1.6
22	3344	7618	6.5	3.0	1.6
23	3604	3504	3.0	4.0	1.6
24	3629	7775	7.5	5.0	2.0
25	3660	3547	2.5	3.0	0.4
26	3964	3821	2.5	3.0	2.2
27	3983	7975	3.0	2.0	1.0
28	4100	8064	2.0	2.0	2.0
29	4234	8143	3.0	3.0	3.2
30	4327	8191	5.5	2.0	1.2
31	4329	8193	4.0	2.0	2.0
32	5282	8966	3.0	3.0	1.2
33	5849	9326	2.0	2.0	4.4
34	5982	9388	3.0	3.0	1.0
35	6075	5100	3.0	2.0	3.4
36	Damouguri 55		4.0	4.0	0.2
37	12567 C		7.0	5.0	5.8

* 1 : completely free from molds
10 : completely covered with molds

Table 3. Relative grain mold resistance of 25 selected sorghum lines grown by Dr. El Rouby, sorghum breeder, at Samaru in 1974. These lines were planted 2-3 weeks earlier than those in Table 2.

Entry No.	Variety	Seed Mold Rating*	Class
18	IS 3555	3.2	a
2	IS 477	4.8	b
3	IS 473	4.8	b
15	IS 453	5.0	b
7	IS 2210	6.0	c
20	Nagawhite	6.0	c
23	137/62-L6	6.0	c
4	IS 474	6.2	c
10	2232	6.2	c
17	IS 12610 C	6.2	c
24	R 960	6.3	c
5	IS 577	6.5	c
8	IS 2219	6.7	c
9	IS 2227	6.7	c
11	5782 (IS 9281)	6.7	c
16	AND - 195	6.7	c
1	IS 466	6.8	c
6	IS 2209	6.8	c
19	CE 90	6.8	c
13	IS 517	7.0	c
22	137/62-L8	7.0	c
12	C4 (125969c)	7.3	c
21	Pickett 147	7.7	d
14	IS 2573	8.5	d
25	KN 1227	9.2	e

LSD.05 1.2

* Average of 6 replications

* 1 : completely free from molds
10 : completely covered with molds

Striga Resistance

Stage V Screening: Eighty-one selected lines from stage IV screening in 1973 were planted in a 9 x 9 lattice, replicated nine times in heavily Striga-infested soil at University Farm. Striga infection was good in the field on susceptible lines. Nine varieties (Table 4) completely suppressed the emergence of Striga plants even though in some instances there were foliar symptoms due to Striga infection on these plants. It was reasoned that a sorghum line that can completely suppress the emergence of Striga plants will prevent Striga seed production and will eventually lead to the exhaustion of Striga seed with the subsequent elimination of Striga from that land over a period of years. Therefore, a priority was given to the selection of those lines which completely suppressed Striga emergence. A total of 19 Striga-suppressing or Striga-resistant lines were selected in cooperation with the sorghum breeder, Dr. El Rouby, for agronomic characters such as plant type, seed quality and disease resistance, and time to maturity, etc. Seed of these 19 lines will be increased under irrigation, and these lines will be further tested in large plots in 1975.

Stage IV Screening: One hundred and sixty-nine selected tall sorghum varieties from stage III in 1973 were planted in a 13 x 13 lattice in 1974 at University Farm in the Striga plots. Striga infection was very heavy. None of these lines completely suppressed Striga emergence (Table 5). Many of these lines, however, possess enough Striga tolerance or resistance so that they can be grown in areas where Striga is a problem.

Screening of Grain mold-resistant sorghum lines for Striga resistance: Each of the selected light- and dark-seed grain mold-resistant sorghum varieties (Tables 2 and 3) were planted in plots 35 feet long (replicated five times) in the Striga trial at University Farm. Most of them had acceptable levels of Striga tolerance and resistance so that they could be grown in areas where Striga is a problem.

Variability in Striga infection:

Variability in Striga infection was observed on maize, millet, and sorghum in West Africa. In Nigeria and Cameroon, where millet and sorghum were interplanted, Striga, basically, attacked only the sorghum. In Senegal, on the other hand, when sorghum and millet were interplanted, Striga attacked only the millet. This generalization was not absolute as one millet plant intercropped with sorghum was observed to be infected with Striga in Nigeria. At University Farm, where numerous varieties of maize and sorghum were planted at the same time on adjacent rows in the same field (approximately 1 acre maize and 1½ acres sorghum), there were only four Striga plants emerged in the maize, whereas there were thousands emerged in the sorghum. On the sorghum row bordering the maize, there were over 50 emerged Striga plants. In an adjacent field where rows of maize

were interplanted among sorghum varieties, the maize generally remained free from emerged Striga plants, whereas there were hundreds of emerged Striga plants per row of sorghum.

A striga virulence trial was planted at three locations in Nigeria and Senegal, Ghana, Upper Volta, and Cameroon using four sorghum varieties, two millet varieties, and two maize varieties to determine if these observed differences in Striga infection are real or only apparent.

Table 4. Striga infection and effect of Striga on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average no. of Striga plants/ sorghum plant	Effect on * sorghum plant
SRN 324	1.5	2
SRN 1317	1.0	2
SRN 2339	1.0	3
SRN 2342	0.2	3
SRN 2359	0.1	2
SRN 3192	2.4	3
SRN 4044	0.2	2
SRN 4057	0.5	3
SRN 4081	1.0	2
SRN 4089	1.0	3
SRN 4099	1.0	3
SRN 4112	0.6	3
SRN 4127	0.0	2
SRN 4144	0.3	2
SRN 4150	0.5	2
SRN 4171	1.0	2
SRN 4231	1.3	3
SRN 4280	1.3	1
SRN 4284	-	2
SRN 4310	0.4	2
SRN 4361	1.0	1
SRN 4373	-	-
SRN 4416	0.0	2
SRN 4423	0.0	1
SRN 4481	0.5	2
SRN 4506	0.4	1
SRN 4594	1.0	2
SRN 4611	0.3	2
SRN 4627	0.3	2
SRN 4694	1.0	2
SRN 4841	0.0	2
SRN 4879	1.5	3
SRN 4882	0.0	1
SRN 4887	0.0	2
SRN 4893	0.5	3
SRN 4928	1.3	2
SRN 4991	0.6	2
SRN 5134	0.2	2
SRN 5162	1.4	1
SRN 5246	1.4	2
SRN 5336	0.4	2
SRN 5347	3.0	2
SRN 5381	0.5	1
SRN 5399	0.6	2

Table 4 (continued). Striga infection and effect of Striga on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average no. of Striga plants/ sorghum plant	Effect on * sorghum plant
SRN 5400	1.5	2
SRN 5425	2.0	1
SRN 5531	0.5	2
SRN 5633	2.0	2
SRN 5755	0.4	2
SRN 5790	0.2	2
SRN 6174	0.1	2
SRN 6483	0.6	3
SRN 6496	0.0	2
SRN 6527	3.0	2
SRN 6544	0.8	2
SRN 6580	0.0	2
SRN 6641	0.0	2
SRN 6788	0.0	2
SRN 6836	0.9	3
SRN 6838	0.2	1
SRN 6892	1.0	3
SRN 6899	1.6	2
SRN 6939	1.6	3
SRN 6951	1.0	3
SRN 6984	0.5	3
SRN 7033	1.3	4
SRN 7072	0.3	2
SRN 7122	0.5	2
SRN 7141	0.2	2
SRN 7183	0.3	2
SRN 7252	0.8	2
SRN 7254	0.0	1
SRN 7266	2.0	2
SRN 5912	0.3	3
Var 2123	2.0	1
BC-9	1.4	2
SRN 1352	0.5	1
SRN 2072	0.4	1
SRN 3172	1.2	3
SRN 2417	0.0	0

* 0 = no symptoms or effect on growth
1 = very slight chlorotic spotting on the leaves, possibly not noticeable to the untrained observer.
2 = distinct chlorotic spotting, readily apparent but not doing any obvious damage to the plant.
3 = numerous large, conspicuous chlorotic to necrotic areas on leaves not exceeding 25% of leaf area and doing some apparent injury to the plant.
4 = very severe necrotic spotting on over 25% of leaf area, some leaves killed, or entire plant stunted or killed.

Table 5. *Striga* infection and effect of *Striga* on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average No. of *Striga* plants/ sorghum plant	Effect on * sorghum plant
SRN 7329	1.2	0
SRN 7334	4.0	4
SRN 7335	2.0	1
SRN 7336	3.2	3
SRN 7350	3.0	3
SRN 7352	2.0	1
SRN 7375	3.5	1
SRN 7387	2.1	2
SRN 7404	2.8	2
SRN 7417	4.7	2
SRN 7419	6.0	3
SRN 7431	4.3	3
SRN 7437	4.1	2
SRN 7441	1.3	0
SRN 7468	1.4	0
SRN 7470	2.1	3
SRN 7471	4.0	1
SRN 7473	1.9	3
SRN 7501	3.2	2
SRN 7503	1.8	2
SRN 7507	3.6	1
SRN 7508	5.5	-
SRN 7516	3.4	1
SRN 7524	5.4	2
SRN 7526	5.3	1
SRN 7531	5.2	-
SRN 7532	3.3	4
SRN 7533	4.4	0
SRN 7553	2.6	1
SRN 7562	3.4	4
SRN 7563	3.3	3
SRN 7564	2.5	2
SRN 7566	1.3	2
SRN 7567	1.9	3
SRN 7575	3.6	2
SRN 7585	3.0	2
SRN 7597	5.0	3
SRN 7610	3.1	3
SRN 7611	1.7	2
SRN 7612	1.4	1
SRN 7614	2.5	1
SRN 7618	3.0	3
SRN 7620	4.6	-

Table 5 (continued). Striga infection and effect of Striga on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average No. of Striga plants/ sorghum plant	Effect on * sorghum plant
SRN 7621	3.9	3
SRN 7638	3.4	2
SRN 7639	4.8	3
SRN 7642	3.6	2
SRN 7633	3.2	2
SRN 7644	6.3	2
SRN 7650	2.9	1
SRN 7656	4.0	2
SRN 7664	4.4	1
SRN 7667	1.8	4
SRN 7671	2.9	3
SRN 7672	4.6	3
SRN 7674	2.6	1
SRN 7675	4.2	3
SRN 7679	6.5	3
SRN 7687	5.0	2
SRN 7690	3.7	2
SRN 7693	1.7	1
SRN 7701	3.6	2
SRN 7705	4.7	3
SRN 7715	4.3	1
SRN 7720	3.4	3
SRN 7734	4.3	3
SRN 7735	5.7	4
SRN 7752	4.4	2
SRN 7753	3.8	3
SRN 7755	6.6	3
SRN 7757	3.8	3
SRN 7759	4.4	0
SRN 7760	5.2	2
SRN 7767	7.2	2
SRN 7778	6.5	1
SRN 7785	5.3	0
SRN 7795	5.1	3
SRN 7799	3.9	0
SRN 7810	7.4	2
SRN 7822	2.6	0
SRN 7826	1.4	4
SRN 7830	3.1	0
SRN 7831	4.8	2
SRN 7832	5.1	3
SRN 7835	8.4	4
SRN 7837	8.6	3

Table 5 (continued). Striga infection and effect of Striga on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average No. of Striga plants/ sorghum plant	Effect on * sorghum plant
SRN 7839	7.9	3
SRN 7842	2.9	3
SRN 7843	3.0	2
SRN 7846	3.1	2
SRN 7848	5.3	3
SRN 7850	3.4	3
SRN 7856	3.3	2
SRN 7865	1.8	2
SRN 7866	3.5	2
SRN 7868	2.8	0
SRN 7870	7.4	3
SRN 7876	5.3	2
SRN 7877	7.0	0
SRN 7881	4.6	2
SRN 7882	5.4	3
SRN 7921	3.0	2
SRN 7926	3.0	2
SRN 7928	5.4	2
SRN 7938	0.9	1
SRN 7941	3.1	2
SRN 7942	2.5	2
SRN 7945	2.4	4
SRN 7946	2.2	3
SRN 7949	3.3	1
SRN 7972	3.9	4
SRN 7977	5.0	2
SRN 7981	7.4	3
SRN 7984	5.1	3
SRN 7987	3.5	3
SRN 7989	3.3	2
SRN 7992	1.7	2
SRN 7993	2.2	1
SRN 7994	3.4	2
SRN 7995	2.3	2
SRN 7998	3.4	3
SRN 8011	3.0	3
SRN 8014	5.7	4
SRN 8015	1.8	3
SRN 8016	4.5	3
SRN 8018	5.4	3
SRN 8020	9.4	0
SRN 8021	5.0	2
SRN 8022	4.6	4

Table 5 (continued). *Striga* infection and effect of *Striga* on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average No. of *Striga* plants/ sorghum plant	Effect on * sorghum plant
SRN 8023	3.1	1
SRN 8024	1.5	2
SRN 8025	1.8	2
SRN 8029	1.8	0
SRN 8033	3.1	3
SRN 8034	3.3	3
SRN 8035	3.4	1
SRN 8044	2.1	4
SRN 8053	6.3	2
SRN 8069	3.8	1
SRN 8070	6.1	3
SRN 8073	4.9	2
SRN 8076	4.4	2
SRN 8077	5.5	2
SRN 8079	3.6	2
SRN 8091	2.8	1
SRN 8106	2.9	3
SRN 8115	4.0	0
SRN 8119	5.5	3
SRN 8129	6.3	2
SRN 8146	3.0	3
SRN 8149	5.5	1
SRN 8150	3.6	2
SRN 8151	7.3	3
SRN 8160	2.4	3
SRN 8168	2.3	1
SRN 8173	2.0	2
SRN 8174	1.3	2
SRN 8175	4.8	2
SRN 8177	1.6	2
SRN 8191	2.4	3
SRN 8192	1.6	2
SRN 8193	2.5	2
SRN 8194	8.2	0
SRN 8195	5.3	3
SRN 8212	5.7	3

Table 5 (continued). Striga infection and effect of Striga on individual sorghum plants of selected lines of sorghum at Samaru in 1974.

Variety	Average No. of Striga plants/ sorghum plant	Effect on * sorghum plant
SRN 7408	5.1	3
SRN 7706	7.8	3
SRN 2123	3.3	2
BC-9	2.6	2

* 0 = no symptoms or effect on growth
1 = very slight chlorotic spotting on the leaves, possibly not noticeable to the untrained observer.
2 = distinct chlorotic spotting, readily apparent but not doing any obvious damage to the plant.
3 = numerous large, conspicuous chlorotic to necrotic areas on leaves not exceeding 25% of leaf area and doing some apparent injury to the plant.
4 = very severe necrotic spotting on over 25% of leaf area, some leaves killed or entire plant stunted or killed.

Fusarium diseases:

A Fusarium disease complex was observed in 1975 in Nigeria and West Africa on maize, millet, and sorghum. The disease, long known as Pokkah boeng or twisted top on sugarcane, is characterized by deformed or discolored leaves near the top of the plant. In some cases, the leaves become so wrinkled that they are unable to unfold properly, resulting in a ladderlike appearance. In extreme cases infection may move from the leaves and sheath into the stalks, causing death of the tops. In mild cases of Pokkah boeng, symptoms often superficially resemble those of maize streak caused by a virus. Pokkah boeng can be differentiated from streak by its characteristically wrinkled leaf bases and numerous transverse cuts in the leaf margins. Sometimes the disease causes stalks to bend, and sometimes the stalks display "knifecut" symptoms (narrow, uniform, transverse cuts in the rind that give the impression that tissue has been removed with a sharp knife). Because they are covered by the leaf sheaths, these lesions may not be apparent when Pokkah boeng leaf symptoms are present.

During periods of wet weather, the fungus grows upwards on the outside of sorghum stalks, and the fungus temporarily may become established behind the leaf sheath or in the whorl; metabolites produced by the fungus incite distortions in the plants. Later, when the high humidity subsides, the fungus dries up and the plant resumes normal growth.

There is evidence that this disease can be seed transmitted, especially in millet. When seed of three millet lines (planted under irrigation, germinated well, and then began to die as young seedlings) was surface sterilized and plated on sterile agar, Fusarium was consistently isolated (Table 6). There were two Fusaria most commonly isolated: Fusarium moniliforme and F. gramineanum. Further studies are required to determine more precisely the role of each of these two fungi in the disease complex.

Table 6. Percent *Fusarium* sp. isolated from three varieties of millet at Samaru, Nigeria

Variety	% of seed yielding Fusarium	
	Fusarium sp.	Other organisms
Nigerian Composite (S4) C1	73	27
Samaru Dwarf synthetic x Nigerian Composite	66	33
Souna Dry x K5 Bulked	65	35

Millet

Plants of 23 millet lines of 97 lines planted in the downy mildew trial showed some degree of resistance to Green Ear and were advanced for further testing. Some of these varieties (SDN 482 and 587) also possess sufficient resistance to other diseases, and they will be grown in larger plots in order to select superior clones from among them (Table 7). The most prevalent diseases of millet in 1974 were Ergot, Smut, and Phyllosticta leaf spot.

Table 7. Disease rating of the 23 lines showing most resistance to downy mildew at Samaru in 1974.

	DISEASE RATING				
Variety	Smut*	Ergot*	Phyllosticta**	Piricularia**	Rust**
SDN 228	0	0	3	0	0
SDN 293	0	1	0	0	0
SDN 319	2	2	2	2	0
SDN 342	1	2	0	0	0
SDN 347	0	1	3	0	0
SDN 366	0	2	4	0	0
SDN 395	0	2	0	0	0
SDN 462	1	1	4	0	0
SDN 476	1	2	0	0	2
SDN 482	0	0	3	0	0
SDN 483	1	0	2	0	0
SDN 496	2	2	4	0	0
SDN 503	1	0	2	0	0
SDN 511	1	2	2	0	0
SDN 515	0	0	0	0	0
SDN 528	2	1	4	0	0
SDN 550	2	2	4	0	0
SDN 604	0	1	4	0	0
SDN 617	1	1	4	0	0
SDN 621	4	1	0	0	0
SDN 714	2	1	2	0	0
SDN 735	0	0	2	0	0
SDN 587	1	2	0	0	0

* 0 = no disease
1 = only a few seed per head diseased
2 = 1-2% of seed per head diseased
3 = 2-10% of seed per head diseased
4 = 10% or more of seed per head diseased

** 0 = no disease
1 = disease present on variety but not apparent without searching.
2 = disease quite noticeable on a variety but too slight to be considered of economic importance.
3 = disease abundant enough to cause some reduction in quality or yield but not covering over 25% of leaf area.
4 = disease obviously responsible for some reduction in yield with over 25% of leaf area affected.

CEREAL ENTOMOLOGY

Lew E. Wallace

During 1974, sorghum resistance studies to Contarinia sorghicola (Coquillett), sorghum midge; Atherigona varia soccato Rond., sorghum shoot fly; and Busseola fusca Fuller, maize stem borer were continued. Hybrid selections, varieties, and composite populations of sorghum have been tested for resistance. Some breeding exercises to combine resistance in desirable susceptible varieties were also conducted.

Midge Resistance Tests

Eight converted midge-resistant lines (converted from tall photosensitive plants to shorter stalks and photoinsensitivity) from the U.S. were grown for seed increase and will be evaluated for midge resistance in 1975. Forty-five varieties of the world collection of sorghums from Dr. King's tests, selected as midge-resistant, were tested again in 1974. Most showed resistance and only five were discarded. Four of these (I.S. 8902, 8910, 1916, 8905) were the closed-head type, and the fifth (I.S. 2943) was a lax open-head type. The head types and seed color of these varieties are described in Dr. Barry's 1973 report. These varieties are also very tall sorghums, and the possibility of conversion in the U.S. has been explored.

Shoot Fly Resistance Tests

Resistance to the shoot fly is of two types "primary" (resistance to oviposition and possibly establishment) and "recovery" (production of tillers by the damaged plant). The primary resistance has been screened in India from the world collection of sorghums.

This material has been crossed to Nigerian varieties and to a group of selections termed the "West African Base Composite" (WABC). The recovery resistance has been drawn from East African selections by Dr. Barry and Dr. Doggett.

Three tests involved the primary resistance from India and were grown in replicated plots. These were: twelve resistant varieties (I.S. numbers) from the Indian screening program, crosses of these varieties to Nigerian varieties, and to the WABC. All three tests were evaluated on the basis of dead hearts; and when the entry (variety or selection) sustained less than 30 percent, it was considered resistant. The percentage of plant recovery was also recorded in these tests.

The Indian material remained resistant (Table 1). Eight selections were susceptible in the 26 tested from the Nigerian crosses. Two of these showed good recovery and will be retested as well as the resistant selections (Table 2). The 52 selections of the WABC crosses had 32 susceptible and, again, 15 of these showed good recovery and will be retested along with the resistant selections (Table 3). Head characteristics and grain color are also recorded for the latter in Dr. Barry's 1973 report.

The other two primary resistance tests were Nigerian varieties and selections from the Samaru breeding program. These were screening tests for resistance. The 52 entries from the breeding program all had more than 30 percent dead hearts (Table 4), but 5 of them showed some recovery and will be retested. The Nigerian varieties faired a little better, 17 of the 32 entries were susceptible, but 9 of these showed good recovery (Table 5). Eight of the entries will be discarded and the rest retested.

The two recovery resistant tests were rated in relation to the variety U-10 which is deemed to have fair recovery resistance. The rating is an index figure which is arrived at from two percentage dead-heart readings and a percentage recovery reading. This gives a fluctuating figure which varies with the conditions and allows a comparison with U-10. In the East African selections, only 4 of the 53 entries had index figures more than 10 points lower than U-10 (Table 6). Most of this material will be retested. There was a significant difference in the yield figures recorded this year. Yield will be considered in selecting material for future tests. The 319 selections from the Samaru breeding program only had 5 selections which were 10 points below U-10. However, the high index figures were due to high percentages of dead hearts, and only 25 had recovery percentages of 75 percent or better. I feel that the index may be misleading because of the high percentages of dead hearts. This material should be reevaluated and a better measure of the resistance devised.

Maize Stem Borer Resistance

Resistance of sorghum to the maize stem borer was embodied in two tests this year. Percentage of dead hearts and infestation were recorded. A rating was also made on the basis of larval penetration in the stem. Tunneling of 1 mm or less was rated resistant, 1-10 mm intermediate, and 10 mm or more susceptible.

In the first test of 120 varieties selected from Dr. King's screening of the world collection of sorghums for disease resistance, 20 were susceptible, 20 in the questionable category, and the remainder were either intermediate or resistant (Table 7). The second test of 174 selections from 46 crosses of the Samaru breeding program had 23 susceptible, 20 intermediate, and 121 resistant (Table 8).

Some of the infestation percentages are high and yet the rating is resistant (Tables 7 and 8). In these, there is an indication of antibiosis or, at least, resistance to feeding. Sometimes the reverse is true, indicating undesirable oviposition sites or resistance to feeding before entrance into the stem. The nature of resistance should be clarified if possible.

Selecting Hybrid and Composite Populations Under Shoot Fly Pressure

A composite population was planted and uninfested plants removed, leaving 100 percent infestation. The plants were then selected for recovery resistance. The selections will either be reselected on the same basis or tested in randomized plots for resistance.

Using male-sterile WABC material, a cross was made with the primary shoot fly-resistant I.S. 5622. This material has been planted under irrigation for selfing and segregation. Individual heads will be selected from this material for further testing of primary shoot fly resistance.

There is good resistance to the three insects (midge, shoot fly, and maize stem borer) in the varieties and selections grown in these tests. The best material will be carried forward and retested in 1975. Some of the varieties carry resistance to more than one insect. A closer assessment of this multiple resistance will be made and an effort made to combine resistance to the three insects in an agronomically acceptable variety. This variety can then be increased and released to the sorghum growers of Nigeria.

Biology

Different dates of planting of six varieties of sorghum and six varieties of maize were sown again this year. Time from planting to 50 percent bloom, percentage dead hearts, and yield data were recorded. Again it was shown that early planting escapes shoot fly infestation while late planted receives heavy infestation of shoot fly. The later plantings also produce less grain. The last three planting dates of sorghum produced no grain (Table 9). The maize faired better with only the last planting giving no yield (Table 10). It is assumed this loss of yield is partly due to shoot fly damage but part must also be due to late seeding. To sort out and attribute the loss more precisely to the different sources, a more detailed test will be designed. Damage from the maize stem borer and sorghum midge will also be assessed, if possible.

Rearing the Maize Stem Borer

A maize stem borer colony has been maintained in a rearing room with temperature and humidity controlled. At the present time the larvae are fed on sorghum stems, but the use of an artificial diet would be more productive and less work. Several diets have been tried but with little success. We are assessing these tests and will attempt to design a better diet and different mixing methods. A test, using at least three diets, will be made when Buseola eggs are available.

Table 1. Average (2 replications) percentage dead hearts, percentage recovery, and index rating of shoot fly-resistant varieties from India.

Entry I.S. No.	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index
1054	5.2	10.8	73.7	-10.3
1082	10.7	15.4	67.9	- 6.0
2123	5.2	18.4	75.7	- 2.7
3962	2.5	8.1	71.8	-17.6
4646	0	10.8	64.9	-24.3
5072	5.4	8.3	78.4	- 7.9
5383	6.8	17.9	82.8	7.5
5566	7.1	9.8	71.4	-11.7
5604	2.5	2.5	61.5	-33.5
5622	5.4	24.3	75.7	5.4
5642	5.0	28.2	77.5	10.7
8315	6.0	21.9	78.8	6.7

Table 2. Average (6 replications) percentage dead hearts, percentage recovery, and index ratings for crosses of shoot fly-resistant varieties crossed with Nigerian varieties.

Entry I.S. No.	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index
1054 x 23/2	7.0	28.8	59.0	- 5.2
1054 x 453	6.6	19.9	73.3	- 0.2
1054 x R960	8.8	30.8	61.9	1.5
1082 x 453	18.3	40	80.9	39.2
1082 x R960	20	42	44.3	6.3
3962 x 453	11.9	48.6	45.2	3.7
3962 x R960	8.3	9.33	55.0	11.5
3962 x R960	4.4	14.5	71.6	- 9.5
4646 x 23/2	12.3	41.6	68.8	22.7
4646 x 453	5.7	17.2	74.6	- 2.5
4646 x R960	6.4	15.2	77.4	- 1.0
5072 x 23/2	6.3	22.3	65.6	- 5.8
5072 x 453	6.4	22.7	72.3	1.4
5383 x 453	11.2	35.4	64.6	11.2
5383 x R960	41.9	42.7	52.3	36.9
5383 x SK5912	15.3	37.4	56.4	9.1
5604 x 23/2	4.2	20	70.1	- 5.8
5604 x 453	4	4.4	73.1	-18.5
5622 x 23/2	17.7	26.5	71.8	16.0
5622 x 453	11.5	28.1	69.6	9.2
5622 x R960	20.6	49.5	51.6	21.7
5622 x SK5912	35.6	35.3	54.4	25.3
5642 x 23/2	5.8	15.6	66.6	-12.0
5642 x R960	36.5	38	53	27.5
8315 x 453	14	27.6	69.3	10.9
8315 x SK5912	14.2	24.4	64.9	3.5

Table 3. Average (6 replications) percentage dead hearts, percentage recovery, and index ratings for crosses of shoot fly-resistant varieties and selections of the WABC.

Entry I.S. No.	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index
$5383\text{-}211_2\text{-}8$	24.4	56.8	59.5	40.7
$5383\text{-}303_1\text{-}2$	11.5	34.3	64.6	10.4
$5383\text{-}402_1\text{-}4$	13.6	33.2	80.7	27.5
$5566\text{x}202_1\text{-}5$	16.1	48.7	69.2	34.0
$5604\text{x}106_1\text{-}1$	29.6	61.5	61.8	52.9
$5604\text{x}311_1\text{-}1$	11.4	29.8	64.4	5.6
$5604\text{x}403_1\text{-}8$	9.5	32.2	63.3	5.0
$5622\text{-}112_1\text{-}10$	12.5	38.4	72.5	23.4
$5622\text{-}204_1\text{-}1$	33.3	57.1	67.4	57.8
$5622\text{-}309_1\text{-}4$	24.4	56.7	68.5	49.6
$5622\text{-}401_1\text{-}2$	24	56.7	68.5	49.6
$5642\text{-}111_1\text{-}5$	11.6	37.2	67.5	16.3
$5642\text{-}111_2\text{-}5$	13.7	41.9	66.8	22.4
$5642\text{-}215_2\text{-}10$	30	65.6	48	43.6
$5642\text{-}410_2\text{-}1$	8.8	20.7	61.1	--
$8315\text{x}105_1\text{-}5$	21.6	43.4	65.3	30.3
$8315\text{x}206_1\text{-}1$	14.2	3.3	53.4	--
$8315\text{x}302_1\text{-}9$	28	54.2	69.6	51.8
$8315\text{x}302_2\text{-}6$	25.2	55.8	42	23.0
$8315\text{x}407_2\text{-}6$	13.5	32.3	75.3	21.1
$1082\text{x}310_1\text{-}5$	7.0	21.4	57.2	--
3962-412-6	16.6	45.4	65.9	27.9
$1054\text{x}108_1\text{-}9$	21.7	61.9	55.8	39.5
$1054\text{x}203_2\text{-}2$	20.8	47.9	63.1	31.8
$1054\text{x}305_1\text{-}9$	24.6	45	62.3	31.9
$1054\text{x}305_2\text{-}1$	19.2	56.3	58.4	33.9
$1054\text{x}414_2\text{-}1$	17.1	40.4	71.8	29.3
1082x109-8	8.9	31.5	58.9	31.6
$1082\text{x}109_2\text{-}1$	10.9	34.8	61.2	6.9
$1082\text{x}109_3\text{-}6$	13.4	57.4	58.2	29.0
$1082\text{x}207_1\text{-}6$	10.4	29.5	69.6	9.5
$1082\text{x}406_1\text{-}5$	17.5	38.5	64.5	20.5
$1082\text{x}406_2\text{-}1$	13.4	28.3	59.1	8.6
$2123\text{x}103_2\text{-}4$	4.1	16.5	65.9	--
$2123\text{x}312_1\text{-}5$	37.1	45.8	66.5	49.4

Table 3 (continued) Average (6 replications) percentage dead hearts, percentage recovery, and index ratings for crosses of shoot fly-resistant varieties and selections of the WABC.

Entry I.S. No.	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index
$2123x312_2$-2	18.9	44.3	69.8	33.0
$2123x408_1$-4	11.9	43.6	65.4	20.9
$2123x408_2$-10	8.4	30.2	63.2	1.8
$3962-102_3$-4	17.2	37.7	69.6	24.5
$3962-102_2$-8	21	41.6	68.4	14.7
$3962-102_1$-4	20.8	49.2	55.7	25.7
$3962-209_1$-9	14.2	35.8	61.4	11.4
$3962-307_1$-2	12.3	44.6	62	18.9
$3962-307_2$-2	15.3	38.2	36.4	--
$4646x214_1$-1	39.1	64.9	64.7	68.7
$4646x214_1$-1	4.5	23.5	73.0	1.0
$4646x308_1$-2	20.5	40	55.9	16.4
$5072x101_1$-6	26.8	43	83.1	52.9
$5072-101_2$-5	33.1	45.8	80.3	59.2
$5072-314_2$-3	22.3	41	57	19.3
$5072-404_1$-4	17	34.5	80.5	32.0
$5383-110_2$-3	14.5	22.5	86.2	23.2

Table 4. Average (2 replications) percentage dead hearts, percentage recovery, and index in selections from the Samaru breeding program screened for primary shoot fly resistance.

Entry I.S. No.	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index
1064	36.6	57.5	61	55.1
1085	37.2	67.5	60.5	65.2
569	38.1	73.8	69.1	81.1
961	28.6	80.5	50	59.1
902	33.3	57.6	44.4	35.3
1119	16.3	51.2	58.1	25.6
1015	44.4	58.3	63.9	66.5
986	75.0	59.0	70.0	104.0
1093	68.4	64.9	73.7	107.0
1003	7.5	12.5	71.4	66.6
992	45.2	66.7	32.3	44.2
579	52.8	75	47.2	75.0
988	34.2	70.3	47.4	51.9
836	28.6	66.7	25.0	20.3
971	17.5	66.7	42.5	26.7
717	25.6	57.9	43.6	27.1
1111	22	55	53.7	30.7
1099	25	60.5	47.2	32.7
1185	4	66.7	67.5	38.2
499	25.6	46.2	76.9	48.7
950	26.8	47.4	61.0	35.2
1065	21.2	30.3	70.0	21.5
972	32.4	48.6	51.4	32.4
975	4.0	48.7	55.0	7.7
1078	35.9	57.9	61.5	55.3
732	19.0	43.2	64.9	27.1
1108	37.2	61.9	53.5	52.6
1012	72.5	65.0	67.5	105.0
851	28.2	61.5	66.7	56.4
1070	37.8	54.1	46.0	37.9
1136	39	65.9	53.7	58.6
608	42.1	60.5	40.0	42.6
987	18.6	52.5	70.0	41.1
744	44.7	62.8	66.0	73.5
503	30.8	48.0	65.4	44.2
985	37.9	55.2	69.0	62.1
537	33.3	66.7	59.0	59.0
1002	46.2	72.2	48.7	67.1
1107	17.8	72.7	42.2	32.7
484	29.3	57.9	56.1	43.3
745	38.6	72.1	56.8	67.5
1126	18.2	65.0	52.3	35.5
993	28.6	56.3	42.9	27.8
1079	38.5	64.1	48.7	51.3
493	48.9	69.6	44.7	63.2
1112	51.2	61.9	69.8	82.9
CK 60	18.4	50.0	33.2	1.6
CK 60	33.3	35.0	40.5	28.8

Table 5. Average (2 replications) percentage dead hearts, percentage recovery, and index ratings in Nigerian varieties screened for shoot fly resistance.

Entry I.S. No.	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index
97	39.0	70.7	41.5	51.2
22	11.8	37.9	70.6	20.3
CK 60	40.5	70.7	52.4	63.6
54	25.5	30.4	93.6	49.5
18	6.4	17.8	53.2	--
68	9.5	28.6	83.3	21.4
6	0	5.0	75.0	--
64	31.8	28.6	81.8	42.2
19	8.1	13.9	78.4	0.4
24	9.8	25.6	85.4	20.8
8	2.6	15.4	97.3	15.3
144	30.1	30.6	81.6	42.8
143	42.6	33.3	87.3	63.2
16	14.3	23.0	71.4	8.7
2	9.6	23.3	90.3	23.2
146	38.1	54.8	76.2	69.1
20	9.5	29.3	72.1	10.9
101	44.4	47.8	64.4	56.6
25	20.0	25.0	48.0	- 7.0
112	38.9	52.8	58.3	50.0
17	10.0	28.2	62.5	.7
11	15.4	30.8	53.8	0.0
26	22.2	48.9	46.7	17.8
CK 60	47.8	78.3	69.5	95.6
7	3.8	11.5	80.8	- 3.9

Table 6. Average (4 replications) percentage dead hearts, percentage recovery, index ratings, and yield for selection of West African material screened for recovery resistance to the shoot fly.

Entry	Dead Hearts % 1	Dead Hearts % 2	Recovery %	Index	Yield kg/plot
39-P-4-21	11.0	21.1	64.4	- 3.5	1.45
45-P-2-1-1	2.4	27.5	61.0	- 9.4	1.47
45-P-2-21	2.5	38.0	69.9	10.2	2.02
48-P-1-1-1	5.8	23.5	63.8	- 6.9	1.62
50-P-2-1-1	9.8	25.3	70.7	5.8	2.73
71-P-1-2-1	5.1	36.1	60.8	2.0	1.69
78-P-2-2-1	4.1	27.9	60.8	- 7.2	1.51
135-P-5-1-1	10.1	32.9	68.4	11.4	1.58
135-P-5-2-1	3.8	33.8	58.2	- 4.2	1.72
143-P-2-2-1	4.7	27.5	67.4	- 0.4	1.70
156-P-5-2-1	13.8	34.2	68.8	16.8	2.42
157-P-3-1-1	9.3	22.0	67.4	-13.0	1.79
71-P-2-2-1	3.9	28.4	53.9	-13.8	1.78
165-P-6-2-1	1.2	20.0	70.2	- 7.6	1.26
107-P-6-1-1	7.5	27.6	60.0	- 4.9	1.97
102-P-4-1-1	2.7	25.7	58.1	-13.5	1.28
210-P-4-1-1	21.0	37.7	66.7	25.4	2.24
210-P-5-2-1	9.1	24.7	59.7	- 6.5	1.42
211-P-3-1-1	13.1	32.5	53.6	-10.8	1.55
217-P-1-2-1	2.6	22.7	35.5	-39.2	1.24
218-P-3-2-1	6.3	20.6	48.1	-25.0	1.14
228-P-1-2-1	9.9	42.5	61.7	14.1	1.03
234-P-5-2-1	2.5	36.1	49.4	-12.0	1.01
221-P-3-1-1	3.5	26.4	54.7	-15.4	1.60
CK 60	5.2	52.7	51.4	9.3	0.88
U-10	12.2	30.1	56.8	- 0.9	1.40
V-2-1-1-1	6.3	28.4	57.5	- 7.8	1.71
V-U-1-1	13.9	26	57	- 3.1	1.14
V-30-1-1	5.8	21.4	72.1	- 0.7	1.78
V-63-1	13.4	49.2	50.1	12.3	1.22
V-100-1-1-1	7.4	32.9	43.2	16.5	1.40
1-P-4-1-1	8.4	36.6	76.0	150	2.00
2-P-3-1-1	10.3	43.1	64.4	17.8	1.98
2-P-1-21	2.7	36.0	58.1	- 3.2	1.74
3-P-5-1-1	7	3.5	66.3	8.3	1.79
7-P-1-1-1	5.8	36.6	70.1	8	1.96
12-P-1-2-1	6	33.8	66.3	6.1	1.17
14-P-3-2-1	2.9	23.1	58	-160	1.09
14-P-4-2-1	4.9	43.4	72.0	10.5	2.10
14-P-6-1-1	2.4	2.7	50.6	-44.3	1.71
15-P-1-1-1	5.3	24.6	58.7	-11.4	1.82
25-P-3-1-1	8.5	20.6	56.3	-146	1.42
26-P-2-1-1	1.3	17.6	64.9	-16.2	1.06

Table 6 (continued) Average (4 replications) percentage dead hearts, percentage recovery, index ratings, and yield for selection of West African material screened for recovery resistance to the shoot fly.

Entry	Dead Hearts %		Recovery %	Index	Yield kg/plot
	1	2			
28-P-1-1-1	4.1	18.6	60.3	-170.0	1.13
28-P-1-1-1	8.5	51.3	58.5	18.3	1.39
29-P-1-1-1-1	4.6	43.3	73.9	22.0	1.56
31-P-1-2-1	0	26.8	59.2	-140	1.45
31-P-4-1-1	3.8	12.5	46.3	-37.4	1.15
35-P-2-1-1	1.3	27.0	52.5	-29.7	1.56
35-P-5-2-1	2.5	29.5	61.7	-63.0	1.80
33-P-3-2-1	1.3	29.2	71.1	1.6	1.54
37-P-1-1-1	5.0	34.6	65	4.6	1.52
37-P-3-2-1	10.1	35.1	64.6	9.8	1.35

Table 7. Average (4 replications) percentage dead hearts, percentage infestation, and resistance rating of varieties from the world sorghum collection tested for maize stem borer resistance.

Entry	Dead hearts %	Infst. %[1]	Rating	Entry	Dead hearts %	Inf. %[1]	Rating	Entry	Dead hearts %	Inf. %[1]	Rating
6449	15	0 a	R	5707	34.7	25 a-f	I	11823	58.3	40 c-i	I
13258	26.6	0 a	R	6747	38.4	25 a-f	R	3959	42.3	40 c-i	I
6441	18.1	5 ab	R	12038	55.8	25 a-f	I	10742	56.6	40 c-i	S
2330	40	5 ab	R	11615	31.1	25 a-f	I	8187	20	45 d-j	S
11833	36.6	5 ab	R	11617	33.7	25 a-f	R	10852	78.1	45 d-j	I
11441	62.1	5 ab	R	11620	22.8	25 a-f	I	6959	31.3	45 d-j	S
10008	53.6	5 ab	R	9183	44.7	30 b-g	I	3482	53.5	45 d-j	I
10325	31.9	10 abc	R	4969	16.9	30 b-g	S	4820	11.1	45 d-j	I
455	25.6	10 abc	R	10861	75.3	30 b-g	I	8881	25.3	50 e-k	S
SK				7369	47.7	30 b-g	I	2536	39.4	50 e-k	I
5912	39.5	10 abc	R	5572	29.3	30 b-g	I	2756	20.9	50 e-k	S
CK				6388	40	30 b-g	I	6082	29.9	50 e-k	S
1216-9	40.7	10 abc	R	2514	38.8	30 b-g	I	2433	60.9	50 e-k	I
11333	20	10 abc	R	2765	17.2	30 b-g	I	2579	38.1	50 e-k	I
11453	41.5	10 abc	R	3076	36.7	30 b-g	I	12224	48.3	50 e-k	I
11662	35.7	10 abc	R	2125	14.3	30 b-g	I	9061	18.3	50 e-k	I
10500	27.6	15 a-d	I	2141	50.8	30 b-g	I	8164	20	55 f-l	S
5674	33.3	15 a-d	R	12019	72.3	30 b-g	I	9278	12.4	55 f-l	S
7339	29.4	15 a-d	R	11642	24.4	30 b-g	I	9317	52.4	55 f-l	I
CK				96/12				2762	21.7	55 f-l	S
2991c	50	15 a-d	R	7a Mal.	71.6	30 b-g	I	6103	18.1	55 f-l	I
11174	53	15 a-d	R	10747	7.5	35 c-h	I	6965	38.8	55 f-l	S
11616	35.6	15 a-d	R	8910	12.4	35 c-h	S	6194	37.9	55 f-l	S
13253	16.9	15 a-d	R	9854	40.2	35 c-h	I	4368	22.4	60 g-m	S
10650	33.8	15 a-d	R	6390	31.7	35 c-h	I	6774	66.7	60 g-m	S
10746	38	15 a-d	R	6917	51.9	35 c-h	I	2265	8.3	60 g-m	S
10491	38.3	20 a-e	R	5818	18.1	35 c-h	I	4215	11.3	60 g-m	S
4960	19	20 a-e	I	6819	78.2	35 c-h	I	3422	15.9	60 g-m	S
7302	27	20 a-e	I	7122	53.8	35 c-h	I	8168	20.3	65 h-n	S
6426	34.9	20 a-e	R	8144	55.6	40 d-i	I	8746	13.3	65 h-n	S
2166	6.9	20 a-e	R	8163	25.9	40 e-i	S	2530	71.9	65 h-n	S
10956	43.9	20 a-e	I	8976	14.8	40 e-i	I	5550	30.6	65 h-n	S
11269	47.2	20 a-e	I	9479	40.9	40 e-i	I	5699	28.4	65 h-n	S
11032	30.7	20 a-e	R	10036	39.7	40 e-i	I	7027	42.5	65 h-n	S
11562	71.2	20 a-e	I	10954	50.6	40 e-i	I	7032	37.5	65 h-n	S
13246	41.2	20 a-e	I	1041	7.8	40 e-i	I	6086	24	70 i-o	S
11639	52.6	20 a-e	I	1580	27.6	40 e-i	I	6123	33.8	70 i-o	S
11666	60.3	20 a-e	I	7382	55.4	40 e-i	I	1107	47	70 i-o	S
9270	21.2	20 a-e	R	7476	22.7	40 e-i	I	7669	18.4	75 j-p	S
8910	25.6	20 a-e	.	7566	10.5	40 e-i	S	6149	29.7	80 k-q	S
10746	25.9	20 a-e	R	3485	51.3	40 e-i	I				
8088	17.2	25 a-f	I								
9845	15.4	25 a-f	I								

[1] Infestation percentages followed by the same letters are not significantly different (LSD.05).

Table 8. Average (4 replications) percentage dead hearts, percentage infestation, and resistance ratings of selections from Samaru breeding program screened for maize stem borer resistance.

Selection	Dead hearts %	Infestation %	Rating	Selection	Dead hearts %	Infestation %	Rating
11 x SK	25.4	25 cdef	S	43 x 2347	16.6	5 ab	R
	25.6	35 efg	I		30.0	30 defg	I
	52.6	45 ghi	S	94 x SK	31.7	0 a	R
11 x 2123	52.8	15 abcd	R				
33 x SK	18.1	10 abc	R		24.7	10 abc	R
(CK-Kuv)	24.1	10 abc	R		34.3	15 abcd	R
	16.1	15 abcd	R		35.5	15 abcd	R
	17.3	15 abcd	I		35.9	20 bcde	R
	25.3	20 bcde	I		23.6	20 bcde	I
	23.2	20 bcde	I		34.5	20 bcde	I
	38.6	35 efg	I		38.3	30 defg	I
	34.8	40 fgh	S	94 x 2347	25.7	40 fgh	S
	17.3	40 fgh	S	94 x 2337	34.7	10 abc	R
	42.6	45 ghi	S	94 x 2123	24.6	25 ab	R
33 x 2347	32.1	35 efg	I		18.4	20 bcde	I
33 x SK	28.6	15 abcd	I		22.2	30 defg	I
43 x 2123	38.0	20 bcde	R	104 x 22	30.0	5 ab	R
	19.0	25 cdef	I		26.8	55 gh	S
	47.7	25 cdef	I	99 x 1879	31.6	5 ab	R
43 x 2337	19.5	20 bcde	I		22.2	5 ab	R
56 x W x 383	25.0	20 bcde	I		43.3	10 abc	R
	17.6	35 efg	I		46.3	55 gh	S
43 x 2347/1	5.6	25 cdef	R	93 x 1879	4.25	0 a	R
92 x 2123	23.3	0 a	R		8.2	0 a	R
	24.3	5 ab	R		2.0	0 a	R
	41.8	5 ab	R		22.5	0 a	R
	33.8	10 abc	R		18.6	5 ab	R
	41.8	20 bcde	R		4.35	10 abc	I
	17.3	20 bcde	I		4.6	10 abc	R
	21.9	35 efg	S		29.0	10 abc	R
	35.5	45 ghi	S		27.8	15 abcd	I
92 x 5912/1	26.2	20 bcde	R		30.4	15 abcd	R
	47.5	25 cdef	R		30.6	15 abcd	R
	26.1	40 fgh	I		17.2	15 abcd	R
93 x SK (CK-	13.9	10 abc	R		25.7	20 bcde	I
Kuv)	37.5	10 abc	R		19.4	25 cdef	I
	29.6	15 abcd	I		30.0	25 cdef	I
	25.0	25 cdef	I		32.9	25 cdef	I
	56.6	30 defg	I	146 x SK	56.6	5 ab	R
93 x 2123	29.7	5 ab	R	(CK-Juv)	45.5	15 abcd	R
	9.4	10 abc	R		25.3	20 bcde	I
	21.8	10 abc	R		31.3	25 cdef	I
	25.4	15 abcd	R		48.4	30 defg	S
	18.2	15 abcd	I		29.9	35 efg	I
	30.8	25 cdef	R		43.6	60 i	S
	25.6	25 cdef	R		51.3	60 i	S
	33.8	40 fgh	I	99 x CK (CK-Kuv)	25.0	25 ab	R

Table 8 (continued)

Selection	Dead hearts %	Infestation %	Rating	Selection	Dead hearts %	Infestation %	Rating
146 x 1879	11.5	10 abc	R	023 x 2123	30.3	15 abcd	I
	19.6	15 abcd	I		20.6	30 defg	I
	17.4	15 abcd	I	MSB x SK 3	25.4	30 defg	I
	21.3	20 bcde	I		21.9	30 defg	I
	22.1	20 bcde	I		20.9	35 efg	I
	9.1	30 defg	I		25.6	45 ghi	I
	9.0	30 defg	I	MSB x 268/1	51.4	20 bcde	I
	39.4	30 defg	I		44.3	35 efg	S
	15.5	40 fgh	S		31.9	40 fgh	S
46 x 2123	22.4	10 abc	R		40.0	45 ghi	S
	26.8	10 abc	R	MSB x 268/3	18.5	30 defg	I
	25.3	15 abcd	R	1021 x 33	17.2	15 abcd	R
	30.9	15 abcd	R		7.5	25 cdef	I
	14.0	15 abcd	R		36.5	25 cdef	I
	14.4	20 bcde	I	MSB x 284/1	49.3	60 i	S
	20.8	20 bcde	R	MSB x 284/2	13.2	10 abc	R
	35.0	25 cdef	I		21.9	10 abc	R
	31.9	35 efg	I		25.0	10 abc	R
	24.0	40 fgh	S		23.5	15 abcd	I
229 x CK					8.25	15 abcd	I
(CK-Kuv)	23.5	15 abcd	R		30.1	20 bcde	I
228 x 2123	30.0	10 abc	R		28.8	20 bcde	I
	26.6	35 efg	I		22.7	25 cdef	I
237 x W x 383	22.5	20 bcde	I		20.3	25 cdef	I
237 x 1879	43.0	5 ab	R		28.1	25 cdef	I
1011 x 336	33.3	30 defg	I		18.5	30 defg	I
228 x SK	22.6	10 abc	R		25.4	30 defg	I
	22.5	20 bcde	R		27.0	35 efg	I
1013 x 57	0.0	0 a	R		42.0	35 deg	S
	11.5	5 ab	R		38.5	40 fgh	I
	12.12	10 abc	I		50.0	45 ghi	S
	18.8	30 defg	I	F 4's ex			
	16.2	30 defg	I	Kano 11 x			
	28.8	30 defg	I	2123	41.6	0 a	R
	40.5	40 fgh	S				
	31.2	55 hi	S				
978 x 242	28.4	10 abc	R				
335 x W x 383	31.3	20 bcde	R				
978 x 243	34.2	40 fgh	I				
2123 x 9289	11.8	10 abc	R				
	25.5	40 fgh	I				
2123 x 22 F6's	15.1	0 a	R				
	18.9	10 abc	R				
	14.7	15 abcd	R				
	36.4	15 abcd	R				
	13.1	15 abcd	R				
	17.1	20 ncde	I				
	44.3	25 cdef	I				
	47.6	60 i	S				
2364 x 22	28.8	15 abcd	R				

Table 9. Number of days to flowering, shoot fly infestation, and yield for the sorghum date of planting studies.

Date of planting	VARIETY					
	R 960	2123	U-10	SK 5912	453	CK 60
	Average Days to Flower (50%)					
13/6	81	118	89	122	122	66
27/6	108	112	93	109	111	87
12/7	81	104	100	108	108	95
	Average Number of Shoot Fly-Infested Plants (%)					
13/6	4.4	4.4	2.0	.8	5.3	0.0
27/6	28.2	20.1	8.5	18.2	16.2	12.9
12/7	49.7	39.9	28.7	61.1	54.7	40.9
26/7	49.7	39.9	28.7	61.1	54.7	40.9
9/8	70.7	75.8	50.8	71.7	64.8	66.4
24/8	94.8	99.1	86.8	97.3	95.6	92.7
	Average Relative Yield (kg/plot)					
13/6	2.79[1/] cd	3.21 bc	3.49 bc	6.29 a	4.25[1/] b	1.68 d
27/6	1.19 ef	2.68 cd	2.70 cd	4.61 b	2.16 cde	.53 f
12/7	0.77 f	.95 ef	1.13 ef	1.54 def	.88 ef	.45 f

[1/] Yields followed by the same letters are not significantly different. (LSD at .05).

Table 10. Number of days to tasseling, shoot fly infestation, yield, and moisture content for the maize date of planting studies.

Date of planting	VARIETY					
	096	By x C10	NCB	S123	NCA	SC 3
	Average Days to Tasseling (50%)					
13/6	60	56	57	55	57	56
27/6	62	60	61	56	59	60
12/7	64	60	61	62	61	61
26/7	63	62	62	62	62	62
9/8	69	68	68	68	68	68
	Average Number of Shoot Fly-Infested Plants (%)					
13/6	0.0	1.2	6.4	0.4	1.3	1.89
27/6	8.3	4.6	3.9	8.7	5.0	2.8
12/7	14.2	16.2	7.3	11.9	18.8	6.3
26/7	24.9	31.0	23.3	28.0	27.3	16.7
9/8	49.6	43.7	38.0	48.5	61.0	41.0
24/8	83.7	85.5	69.4	85.7	81.8	57.1
	Average Relative Yield (kg/plot dry weight)					
13/6	6.52 1/ a-c	7.13 1/ a	7.13 1/ a	6.93 1/ ab	6.07 1/ a-e	6.6 1/ ab
27/6	4.58 f-h	5.33 c-g	6.43 a-c	6.39 a-d	5.14 d-g	5.78 b-f
12/7	3.15 i-k	4.35 g-i	5.01 e-g	3.69 h-j	4.65 f-h	3.08 jk
26/7	2.72 jk	3.71 h-j	3.58 h-j	2.11 k	2.13 k	2.26 k
	Average Moisture Content at Harvest (kg/plot)					
13/6	1.29	2.03	1.73	1.77	1.72	1.99
27/6	1.96	1.59	1.76	1.78	1.55	1.84
12/7	1.19	1.33	1.51	1.16	1.15	1.17
26/7	1.22	1.35	1.29	0.8	0.83	1.04

1/ Yields followed by the same letters are not significantly different (LSD at .05).

CEREALS SEED PROJECT

Foundation Seed Unit

J. H. Clifton

The remainder of the dry season of spring 1974 was a continuation of activities begun before the first of the year in 1973. Due to drought in 1973, it had been decided by the Institute for Agricultural Research (IAR) of Ahmadu Bello University (ABU) late in the year to produce as much early-maturing sorghum seed as possible during the 1973-74 dry season. It was stated in the last West African Major Cereals Crop Report that four widely spaced irrigation sites were located for plantings.

The seed production realized from this effort by the Seed Unit of IAR was 11,652 kilograms and was harvested in time for rainy season plantings in the drought areas. This seed was processed, treated, packaged, and combined with rainy season production and amounted to 37,493 total kilograms of seed. Seed delivered was 29,470 kilograms after a loss of 1919 kilos as clean out, trash and broken seeds, and 5593 kilos unaccounted warehouse losses. The 2239 kilos of seed were supplied at no charge to 25 different organizations, departments, and schools for various research experiments and trials. The remainder (27,231 kilos) of the delivered seed was sold to States, individuals, and organizations for multiplication. Through tours and personal contacts, the Seed Unit found that at least 265 acres of three sorghum varieties were being increased for seed. Feedback as to what generally happens to the Foundation Seed and other seeds has been limited so far; however plans have been made with Extension, Research, and Liaison Service to more formally survey the cereals seed situation next season.

While seed deliveries were being made, plans for production during the rainy season were also underway. The millet breeder had two promising millet composites ready for increase. The maize breeder supplied about 30 kilos each of the current selection cycle of three maize composites.

Two purposes are served in the seed production program:

1) to produce enough seed of the more promising lines or varieties to facilitate a more extensive testing program, and

2) to supply foundation seed of proved varieties for multiplication by others.

Plantings of two sorghum varieties, one millet variety and two millet composites, and four maize composites were made on IAR farm at Samaru. One additional maize composite and two sorghum varieties were planted on University Farm. Following the end of the rainy season production, plantings were made at Kadawa irrigation farm near Kano of one sorghum variety, the A and B lines for male sterile increase for a sorghum hybrid, and one

maize composite. The names or numbers of varieties in production are:

Millet	Sorghum	Maize
Nigerian Composite C_1, S_4	SA.7706	Nigerian Composite A
Nigerian Composite A C_1	R 960	Nigerian Composite B
Ex Ghana	SK 5912	Samaru 1,2,3
	CK-60 A&B	Upper Volta Early
	Naga white	096

The Foundation Seed Unit is within the Plant Breeding Section of IAR administratively, and the Seed Unit has enjoyed excellent support from all sections of IAR. Agriculture Ministry personnel and individuals outside IAR seem well pleased that there is a source of high quality seed available and especially that it is cleaned, treated, and packaged. Sorghum and millet seed is packaged in 1-kilo plastic bags and maize in 5-kilo bags. Because there are some large acreages planted to a single variety, some seed was packaged in 25-kilo bags. The Seed Unit has only a history of 1973 and 1974 for experience to draw from; therefore it is still guesswork as to how much seed of each variety to produce and the amount of seed to put into each package for distribution.

Early in the year a request was placed for a Seed Technology Laboratory consultant from Mississippi State University. This would allow for plans to be made for the processing plant design, processing equipment, and storage buildings needed for presentation to the Development Committee in 1975. Approximately one-half of the approved capital funds (₦ 60,000) is to be available in 1975 for the Foundation Seed Unit building program.

Problems encountered in production, processing, storage and marketing:

There were no insurmountable problems encountered, even though there were a large number of problems that occurred. Fortunately, the Seed Unit was operating on a small scale or some of the problems could have proven disastrous. For example, the Seed Unit found it necessary to make several plantings much later than optimum planting time in order to isolate a variety by time. Because herbicides were not permitted to be used, the young seedlings had to compete with weed growth during the intensive rainy period. Hand weeding was necessary to the point of carrying the weeds from the field to stop their growing again. Many plants were lost by careless weeding or by too much moisture resulting in high labor costs and low yields. There were many other similar problems important to a producer, so that the experience gained by the Seed Unit could be of real value to commercial seed producers.

It became apparent at the end of the growing season that labor costs for hand weeding, some harvesting, and threshing were not too different for sorghum, millet, or maize. The small fields of sorghum required bird watchers at daybreak and dusk, but it was necessary to have guards on the maize fields 24 hours per day from the soft dough stage until the crop was harvested (about 2 to 2½ months). This, of course, increased labor costs tremendously but did illustrate the crops' acceptance as roasting ears or as dry grain.

Plans for 1975:

1. Early plantings of varieties if head mold is not a problem. Maize, millet, and some sorghums may be planted early. Some of the very early-maturing sorghum will be planted at Kadawa during the rainy season or the dry season.

2. Isolation difficulties at IAR farm makes it seem prudent to produce the bulk of the lines at University Farm or Shika Livestock Farm.

3. Apply herbicides on all varieties that are tolerant to the available atrazene.

4. Produce larger acreage per variety so that planting, cultivating, topdressing, and harvesting may be carried out mechanically. Unit cost of the seed should then be lowered to an acceptable figure; whereas 1974 labor costs alone varied from a low of 29 naira* per acre to a high of 202 naira per acre. Some of the above costs are, of course, unacceptable so that next season's efforts will be oriented to the economics of seed production, but with no loss of agronomic standards. The past 2 years have demonstrated that the rainfall pattern is such that one can seldom enter the fields at Samaru with tractors after July 15, which means top-dressing and ridging up, the last operation, should be finished by that time.

5. Obtain data from the breeders so a fact sheet on characteristics of each variety may be printed.

6. Enlarge the number of varieties offered for sale. For example, produce TZA and TZB maize which was developed for areas south of Samaru. There are also some very promising sorghum varieties that should be tested over a larger area. The number of varieties will probably be seven sorghum, three millets, and seven maize varieties and composites.

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*Naira - Dollar approximate exchange rate $1.65 to one naira.

MAIZE BREEDING INVESTIGATIONS

OAU/STRC-26
USDA/USAID

Chester L. Goodrich

Introduction

Since the introduction of high yielding composite maize varieties at IAR, the major emphasis of the breeding program has been recurrent selection for improved yield in these composites. In 1974, the composites undergoing selection were NCA; NCB; Samaru 1,2,3; and Biu Yellow. Yield trials for all of these populations were conducted at Samaru and Mokwa with NCA, also being grown at IITA in Ibadan.

As of the date of this report, no data has been received from the IAR computing center. All analyses have been done with an electronic desk calculator and not as many characters are reported as in past years.

An important development in the past two years is the addition of high protein selection in populations NCA; NCB; and Samaru 1,2,3. Selection is based on Udy analysis which is done in Dr. Stockinger's laboratory. Currently NCB is undergoing the second recombination, S1,2,3 the first recombination, and NCA has undergone one recombination.

Cooperative yield trials in 1974 included the National Zonal Trial, West African Uniform Maize Trial, FAO Regional Cooperative Yield Nursery, and FAO Regional Cooperative Maize Observation Nursery.

There are no counterparts to the maize breeder at the present time. Mr. G. I. Adeniyi transferred to the ERLS section of IAR in March 1974. Also in March 1974, Mr. D. Adezwa left for the U.S. for a 2-year period to complete course work leading to the Ph.D. degree in plant breeding.

Rainfall Data

The monthly rainfall totals for Samaru in 1974 are presented in Table 1.

Table 1. Monthly rainfall, Samaru, Nigeria, for 1974, and 50-year average.

	Rainfall (mm)	
Month	1974	1924-1973
January	0.0	0.2
February	0.0	1.1
March	11.2	7.6
April	30.0	35.2
May	33.8	121.8
June	144.4	162.4
July	251.9	224.8
August	328.9	284.2
September	247.0	226.9
October	67.6	35.7
November	0.0	1.2
December	0.0	0.1
Total	1114.8	1101.2

The rains started in March but did not become steady enough for planting until mid-June. The rains in 1974 extended into October, and all trials had sufficient moisture to reach maturity.

List of 1974 Performance Trials

The following is a list of the 1974 performance trials conducted by the maize breeding project at IAR.

Expt. No.	Title	No. of Entries	Locations	Planting date
01	National Zonal Maize Trial	18	Samaru	June 14
02	West African Uniform Maize Trial	24	Samaru	June 14
03	Topcross Trial	33	Samaru	June 17
04	FAO Cooperative Yield Nursery	36	Samaru	July 1
05	Population Diallel Crosses	20	Samaru, Mokwa	June 15 May 5
06	Tuxpeno Pl. B. Topcrosses	169	Samaru	June 17
07	Outside Hybrids	26	Samaru	June 17
08	FAO Cooperative Observation Nursery	32	Samaru	July 1
09	Early Maize Variety Trial	24	Samaru	June 18
10	Biu Yellow Full-Sib Recurrent Selection	144	Samaru Mokwa	June 14 May 5
11	NCA Full-Sib Recurrent Selection	169	Samaru Mokwa Ibadan	June 15 July 15 Sept.24
12	NCB Full-Sib Recurrent Selection	196	Samaru Mokwa	June 17 July 15
13	Samaru 1,2,3 Full-Sib Recurrent Selection	100	Samaru Mokwa	June 17 July 13
14	S1,2,3 Protein Selection S1 Yield Trial	115	Samaru	July 5
15	*Striga* Resistance Trial		Samaru	June 29

Experimental Procedures

The maize yield and breeding nurseries were located on fields X-1 through X-4 in 1974. The land was plowed in May, and 400 lbs per acre of compound fertilizer 20-10-10 was broadcast prior to seedbed preparation. As soon as there was sufficient moisture, the land was disced and marked into 28-inch rows. For yield trials, plants were spaced 1-foot apart within rows. All planting was done on the flat with 'hand-jobber' planters. Approximately six weeks after planting a sidedress application of Nitrochalk at the rate of 80 lbs N per acre was applied. Two mechanical cultivations were done with some supplemental hand weeding.

The date of pollen shed for each plot was recorded as the days from planting to the time that 50 percent of the plants in a plot were shedding pollen from 50 percent of the tassel. Ear height was measured as the distance from the ground to the uppermost ear-bearing node, expressed in cm.

Stand counts were taken shortly after pollination. Standard plot size was 32 plants per plot with the cooperative trials having 45 or 60 plants per plot. At maturity the number of plants lodged in each plot was recorded. All ears were hand harvested; the usable ears were counted and weighed in the field. Each plot was then shelled and shelled weight recorded. Moisture for each plot was determined using a portable Dickey-John Moisture Meter. Yield of shelled grain was adjusted to 12 percent moisture and converted to quintal/ha (1 quintal = 100 kg).

Trial Results

1. National Zonal Maize Variety Trial

This trial is coordinated by the Federal Department of Agricultural Research at Moor Plantation, Ibadan. The trial is grown at 17 different locations throughout Nigeria. Historically, Samaru consistently produces the top yield of all 17 locations. Data for 1974 at the other locations will be reported by FDAR at a later date. The performance data for this trial in 1974 at Samaru are presented in Table 2. There were four replications.

The top yielding entry was C10 x Biu Yellow from IAR, followed very closely by NCA from IAR, TZA(S1)C2 x TZB(S1)C3 from IITA, and NCD from FDAR.

2. West African Uniform Maize Trial

This trial is coordinated by Mr. B. R. Taylor, JP-26 Field Trials Officer stationed at Kano, Nigeria. The purpose of the trial is to test genotypes from different breeding programs over a wide range of conditions.

The data for this trial at Samaru in 1974 are presented in Table 3. The top yielding entry was TZA(S1)C2 x TZB(S1)C3 from IITA, followed closely by three of the Pioneer hybrids. Golden crystal from Ghana was the only other entry over 80 quintals/ha.

The varieties BS3 and BS3 x Bomo Local were included in the trial primarily to test their performance in drier areas, but they both had relatively good yield at Samaru.

Table 2. National Zonal Maize Trial, Samaru, 1974 (4 replications)

Entry	Source	Yield Q/ha	Days to pollen shed	Ear height (cm)	Lodging %
NCA	IAR	69.2	54.0	156	50
NCB	IAR	59.9	53.3	150	45
NCC	FDAR	59.1	52.0	154	55
NCD	FDAR	68.3	57.8	164	53
NCARb	FDAR	57.4	54.3	148	58
NCBRb	FDAR	58.6	53.0	145	60
Samaru 1,2,3	IAR	61.1	52.6	133	50
Bulk 3		59.8	55.8	166	56
XB101 x Lagos White	IAR	53.9	56.3	116	54
NS-1		58.2	58.5	195	57
NS-5		59.0	53.8	159	60
NCBRb O_2 (m2)	FDAR	52.3	54.8	153	61
NCBRb O_2 (m2)	FDAR	55.4	51.8	139	51
TZA(S1)C2 x TZB(S1)C3	IITA	68.6	54.8	149	47
TZPB(PR)C2	IITA	57.8	58.0	138	56
096 EP6	FDAR	65.4	57.5	158	58
C10 x Biu Yellow	IAR	73.8	52.5	126	54
Mean		61.1	54.8	150	54
LSD .05		10.5			

Table 3. West African Uniform Maize Trial, Samaru, 1974 (4 replications)

Entry	Source	Yield (Q/ha)	Ear height (cm)	Days to pollen shed
Bomo Local	Samaru, Nigeria	52.1	110	53
096	Samaru, Nigeria	74.1	150	56
NCA	IAR, Nigeria	69.2	150	55
TZB(S1)C3	IITA, Nigeria	75.1	155	59
NCARb x NCBRb	FDAR, Nigeria	76.3	160	56
TZA(S1)c2 x TZB(S1)C3	IITA, Nigeria	89.4	155	57
Western Yellow 1	Nigeria	67.9	160	58
TZPB(ER)C2	Mexico	70.4	120	57
Bomo Local x BS3	IAR, Nigeria	58.6	100	50
DHI Naiouli 7XATC	Dahomey	68.7	130	54
C10 x Biu Yellow	IAR, Nigeria	67.2	110	57
Samaru 123	IAR, Nigeria	72.8	125	57
C J B	Ivory Coast	63.0	160	59
Farako-Ba Syn Jaune C1	Upper Volta	66.0	190	56
Pioneer Hybrid x 101A	Jamaica	83.0	145	57
Pioneer Hybrid x 515	Jamaica	81.7	125	55
Pioneer Hybrid x 306B	Jamaica	72.8	145	58
Pioneer Hybrid x 105A	Jamaica	85.6	140	57
Ghana Composite 4	Ghana	73.7	205	61
Golden Crystal	Ghana	80.3	165	59
La Posta	Mexico	79.8	180	60
Composite W	Ghana	73.3	170	59
Coast Composite	Kenya	70.6	165	58
B S-3	IAR, Nigeria	57.5	100	48
Mean		72.1		
LSD 05		11.3		

3. Topcrosses to XB101, Biu Yellow, and NCA

The results of this trial are presented in Table 4. This trial in 1974 was a consolidation of selected entries from three separate trials in 1973. The object was to confirm the performance of various hybrid combinations and to confirm the combining ability of a group of selected inbred lines. The XB101 crosses all performed reasonably well but will not be tested again as better hybrids are available.

The cross of 096 x Biu Yellow was outstanding; it is recommended that this hybrid be tested more widely for general adaptation. None of the remaining Biu Yellow crosses will be tested in 1975.

All of the inbreds crossed to NCA performed well. All of these inbreds will be retained in the breeding program.

4. FAO Regional Cooperative Maize Yield Nursery

The results of this trial are presented in Table 5. The trial was planted later than desirable (July 1), and yields were not very high. The highest yielding entries were NCA from Nigeria and X105A from Kenya. None of the other outside entries are of interest to the breeding program.

5. Population Diallel Crosses

The object of this trial was to identify superior combinations of the varieties in the breeding programs at Samaru and Mokwa. Unfortunately, in 1974 old seed was planted and stands were so poor at Samaru and Mokwa that the trial was a failure. New seed was made in 1974, and the trial will be repeated in 1975 at both locations.

6. Topcrosses to Tuxpeno Planta Baja

Tuxpeno Planta (TPB) is a Mexican variety with good general combining ability and has low ears with a strong root and stalk. The purpose of this trial was to see if Tuxpeno could transmit its desirable characteristics into hybrids with Samaru inbreds. The trial consisted of 153 inbred lines crossed to TPB along with 14 checks. A total of 21 of the inbred-TPB hybrids were selected, based on yield, and the results are presented in Table 6. The 21 inbred lines will be saved for further evaluation and the rest discarded. Although the TPB crosses were in general high yielding, the ear height was not particularly low, and lodging was only slightly better than the checks. It is doubtful if any of these crosses are superior to the best variety crosses from the Samaru breeding program.

Table 4. Top crosses to XB101, Biu Yellow and NCA, Samaru, 1974 (3 replications)

Entry		Yield (q/ha)	Ear height (cm)	Days to Pollen shed
Mexican Comp. x XB101		60.4	150	61
C-33 x XB101		65.6	140	59
H501 x XB101		78.7	145	62
H507 x Biu Yellow		68.7	130	58
096 x Biu Yellow		86.1	140	56
C33 x Biu Yellow		17.9	110	61
C12 x Biu Yellow		66.3	125	54
NCB x Biu Yellow		54.7	130	56
NCA x Biu Yellow		64.7	130	57
S123 x Biu Yellow		64.3	120	55
69-1-1-1-1 x NCA	164(1972 Source)	76.1	140	61
67-1-1-1-1 x NCA	166	81.1	150	62
67-1-1-1-1-2-1 x NCA	120	79.1	145	62
67-1-1-1-1-2 x NCA	119	73.7	155	61
97-1-2-2-2-1 x NCA	122	73.4	160	62
NCA(S1) x NCA	67	82.2	130	54
NCB(S1) x NCA	32	77.8	150	55
19-2-1-1-1-1 x NCA	113	70.6	145	56
475-2-2-1-1-3 x NCA	157	76.5	135	56
NCA(S1) x NCA	88	79.3	130	57
NCA(S1) x NCA	70	77.6	155	57
NCA(S1) x NCA	51	65.6	130	56
NCA(S1) x NCA	50	73.9	150	56
19-2-1-1-2-1 x NCA	114	67.8	150	59
NCA(S1) x NCA	57	66.3	140	57
SC1(S1) x NCA	7	72.8	140	56
SC1(S1) x NCA	1	74.5	140	59
Checks				
C10 x Biu Yellow		77.2	115	55
Line 7 x C10		80.9	110	54
NCA		65.4	125	55
NCB		66.5	135	57
S123		69.7	130	54
096		73.0	145	60
mean		70.6		
LSD 05		25.2		

Table 5. FAO Regional Cooperative Maize Yield Nursery, Samaru, 1974 (3 replications).

Entry	Origin	Yield Q/ha	Ear height (cm)	Days to Pollen shed
Comp. 108	Egypt	14.0	115	57
Comp. 113	Egypt	29.0	110	57
VC 69	Egypt	30.2	120	65
VC 80	Egypt	38.9	150	61
DC 186	Egypt	26.2	110	56
American Early	Egypt	18.4	125	65
Alemaya C41	Ethiopia	28.6	145	66
Awassa A511	Ethiopia	36.3	135	59
Comp. 4	Ghana	26.0	90	66
Golden Crystal	Ghana	39.4	140	60
La Pasta	Ghana	47.6	135	66
Comp. W	Ghana	48.4	120	65
X105A	Kenya	58.7	130	60
H512	Kenya	25.4	120	59
Katumani Comp. B	Kenya	36.6	105	49
NCA	Nigeria	59.1	130	60
NCB	Nigeria	35.8	105	65
C10 x By	Nigeria	48.7	120	61
S 1,2,3	Nigeria	44.4	110	59
Neelum	Pakistan	42.8	115	54
Akba	Pakistan	27.5	95	54
Agaiti-2	Pakistan	37.7	70	51
BDS	Senegal	40.1	115	56
Comp. A1	Turkey	47.9	115	57
Sakarya 66	Turkey	28.2	70	57
YU ZP SC6	Yugoslavia	36.3	55	51
YU ZP SC580	Yugoslavia	38.0	60	53
YU ZP SC4	Yugoslavia	40.0	95	56
YU ZP SC65A	Yugoslavia	29.6	60	49
YU ZP SC48A	Yugoslavia	37.1	65	49
YU ZP 3	Yugoslavia	36.6	80	57
YU ZP 46A	Yugoslavia	40.6	50	47
YU ZP DC498	Yugoslavia	38.2	80	49
YU ZP TC73	Yugoslavia	29.2	115	55
YU ZP 73	Yugoslavia	45.7	85	55
096	Nigeria	37.0	135	64
Mean		36.8		
LSD .05		12.3		

Table 6. Topcrosses to Tuxpeno Planta Baja, Samaru, 1974 (3 replications).

Source		Yield (Q/ha)	Ear height (cm)	Days to Pollen shed
SC1 72:7001-1-1	x Tuxpeno	74.8	130	60
SC1 72:7001-3-1	x Tuxpeno	85.2	140	69
SC2 72:7001-18-1	x Tuxpeno	82.8	140	63
SC2 72:7001-21-1	x Tuxpeno	78.3	125	58
SC2 72:7001-33-1	x Tuxpeno	78.5	130	59
SC3 72:7001-53-1	x Tuxpeno	75.2	120	58
NCB 72:7001-67-1	x Tuxpeno	75.0	140	61
NCB 72:7001-85-1	x Tuxpeno	75.6	130	62
NCA 72:7001-89-1	x Tuxpeno	78.5	125	58
NCA 72:7001-91-1	x Tuxpeno	75.0	140	60
NCA 72:7001-115-1	x Tuxpeno	75.4	135	60
NCA 72:7001-117-1	x Tuxpeno	81.8	135	61
NCA 72:7001-123-1	x Tuxpeno	80.2	145	59
NCA 72:7001-127-1	x Tuxpeno	75.4	135	59
NCA 72:7001-132-1	x Tuxpeno	76.5	125	59
NCA 72:7001-135-1	x Tuxpeno	75.6	125	58
NCA 72:7001-138-1	x Tuxpeno	76.5	135	60
NCA 72:7001-145-1	x Tuxpeno	75.0	130	60
66-2-2-1-2-2-3-1 72:7001-212-1	Tuxpeno	74.6	135	60
271-1-1-1-2-2-1-1 72:7001-238-1	Tuxpeno	84.4	170	67
NCA 72:7001-288-1	Tuxpeno	74.8	160	62
CHECKS				
NCA	x Tuxpeno	65.8	135	59
NCB	x Tuxpeno	68.0	135	59
096	x Tuxpeno	76.7	150	62
S 1,2,3	x Tuxpeno	67.4	130	59
Line 7	x Tuxpeno	69.1	130	60
C10	x Tuxpeno	60.0	135	61
Biu Yellow	x Tuxpeno	70.6	120	59
C10 x BY		52.3	125	58
Line 7 x BY		64.7	110	57
NCA		60.6	130	59
NCB		54.6	125	58
S 1,2,3		62.7	130	58
Columbia Comp.		59.3	135	62
Trial mean		64.8		
Mean of Selected Topcrosses		77.6		
Mean of Topcrossed Checks		68.2		
Mean of checks		59.0		
LSD 05		18.0		

7. Outside Hybrids

Twelve U.S. maize hybrids were received from Dekalb Agrisearch, Inc. for testing at Samaru in 1974. The performance data for these hybrids and checks are presented in Table 7. Most of these hybrids were very early maturing and did not yield well. All of the hybrids, except XL99 and B660, were heavily damaged by maize rust (*P. polysora*). Hybrid B660 would probably be acceptable under Samaru conditions.

8. FAO Regional Cooperative Maize Observation Nursery

The results of this trial are presented in Table 8. This trial was planted late (July 1) and yields were rather poor. Most entries were very early, susceptible to rust (*P. polysora*), and lodged badly. None of these entries are of further interest to the Samaru breeding program.

9. Early Maize Variety Trial

The drought conditions which existed in Northern Nigeria in 1973 created a great deal of interest in a short-season maize variety for that area. A total of 24 early varieties and variety crosses were included in a trial at Samaru in 1974. The performance data for this trial are presented in Table 9. The most promising varieties in terms of yield are the crosses with Bomo Local. Also, BS3 x ETO looks promising. This trial will be repeated in 1975.

Table 7. Yield of U.S. commercial hybrids, Samaru, 1974 (4 replications)

Entry	Yield (q/ha)	Ear height (cm)	Days to Pollen shed
Dekalb x L99	57.8	105	61
Dekalb x L64	49.3	60	51
Dekalb x L43	45.6	55	50
Dekalb x L43A	45.1	75	53
Dekalb x L321	50.6	70	51
Dekalb x L380	53.3	80	53
Dekalb x L310	40.1	65	50
Dekalb 007	30.6	55	45
Dekalb B660	67.9	115	63
Dekalb XL78	62.4	100	52
Dekalb x L68	42.6	90	57
Dekalb x L322	39.1	75	51
NCA	70.4	145	61
NCA C2	57.6	130	63
NCA C3	70.0	135	62
NCB	65.8	130	56
NCB C3	66.5	130	60
S1,2,3	57.8	95	61
S1,2,3 C2	53.9	135	63
096	67.6	160	61
096 C1	62.2	145	63
C10 x Biu Yellow	70.6	130	61
BS 3	49.4	100	53
BS 3 x ETO	63.9	115	53
Afgan Early x NCA	43.0	95	51
Afgan Early x S1,2,3	38.6	90	46
Mean	54.7		
LSD 05	9.3		

Table 8. FAO Regional Cooperative Maize Observation Nursery, Samaru, 1974. (2 replications)

Entry	Source	Yield (q/ha)	Ear height (cm)	Days to Pollen shed
EMBU Comp. 1	Kenya	13.9	110	55
EMBU Comp. 2	Kenya	18.5	110	55
SADAF	Pakistan	41.6	100	56
N.C. 72	Pakistan	37.8	110	55
HIMALA	Pakistan	35.7	90	54
SYN 551	Pakistan	27.0	95	49
INIA 347	Spain	29.7	40	47
INIA 548	Spain	12.9	55	51
ZUBIETA 30	Spain	31.0	45	46
INIA 302	Spain	24.7	70	51
MV-SC 405	Hungary	37.7	50	48
MV-SC 370	Hungary	30.4	50	49
MV-TC 596	Hungary	40.8	60	50
MV-SC 580	Hungary	43.3	70	49
MV-DC 520	Hungary	42.4	65	48
MV-TC 540	Hungary	40.6	60	49
YU-ZP 306/2	Yugoslavia	32.9	45	43
YU-ZP 790	Yugoslavia	38.9	60	53
YU-ZP-SC 58C	Yugoslavia	40.2	70	51
YU-ZP-SC 48A	Yugoslavia	40.2	80	45
YU-ZP-SC 46A	Yugoslavia	36.0	65	51
YU-ZP 448	Yugoslavia	40.2	60	45
YU-ZP-SC 65A	Yugoslavia	37.5	65	49
YU-ZP 399/2	Yugoslavia	31.8	60	43
YU-ZP-TC 75	Yugoslavia	40.1	75	53
SK 330	Romania	41.7	45	49
SK 310	Romania	22.6	65	47
SK 410	Romania	43.0	60	49
SK 405	Romania	41.5	70	47
SK 230A	Romania	19.9	35	51
SK 225	Romania	29.3	50	46
096 (Check)	Nigeria	37.2	130	54
Mean		33.8		
LSD 05		16.9		

Table 9. Early Maize Variety Trial, Samaru, 1974 (4 replications).

Entry	Yield (q/ha)	Ear height (cm)	Days to Pollen shed
Bomo Local	33.2	95	54.0
BS3	28.0	68	52.0
Early Flint Syn.	23.6	50	44.7
BS5	22.9	72	43.7
BS4	19.3	83	51.0
Danwata	42.4	63	49.3
Fara	27.2	87	50.7
Badankama	33.4	75	50.3
Early Flint x Bomo Local	29.2	73	50.3
Eto(m)C6 x Bomo Local	32.1	95	54.7
BS3 x Bomo Local	35.5	95	58.0
BS4 x Bomo Local	38.4	88	53.7
BS5 x Bomo Local	28.7	68	48.0
BS3 x Eto (m)C6	39.3	82	53.3
Eto(m) C6	41.5	92	54.0
$BSSS_2$	26.0	72	56.7
$BSSS_{13}$	34.3	78	58.0
Iowa Rootworm Syn.	31.4	73	56.0
BSL (S) C5	15.9	70	53.0
(OH43 Sm202 x B37 Sm)F2	24.5	72	54.0
(W64ASm 2 0_2 x 103Sm^{20}2)F2	24.9	78	57.3
BSL(S)C5 x Bomo Local	28.9	103	54.0
BSSS13 x Bomo Local	42.7	88	55.3
Purple (A632 x B70)	11.0	67	53.0
Mean	29.0		
LSD 05	12.4		

10. Biu Yellow Full-Sib Recurrent Selection Trial

In 1974, Biu Yellow underwent the first cycle of full-sib testing following four cycles of S1 recurrent selection. Yield trials of the 144 full-sib families were grown in two replications at Samaru and Mokwa. The performance data for the 14 selected full-sib families are presented in Table 10. The yields at Samaru were very good, averaging approximately twice those at Mokwa. The combined location analysis of variance for yield (q/ha) is as follows:

Source	d.f.	ms	f
Locations	1	244085	2709**
families	143	267	2.97**
families x location	143	104	1.16*
error (pooled)	286	90	

Not unexpectedly, the location variation was highly significant. The variation among full-sib families was highly significant; but the families x location interaction was barely significant at the 5 percent level of probability. Using the appropriate combination of variance components, the calculated heritability estimate is 0.734. Multiplying heritability by the selection differential results in an expected gain of 10.9 q/ha for this population.

The 14 selected lines are being recombined in the 1974/75 irrigated nursery for a second cycle of full-sib testing in 1975.

11. NCA Full-Sib Recurrent Selection Trial

NCA underwent the third cycle of full-sib family recurrent selection in 1974, following one cycle of S1 testing. Yield trials of the 169 full-sib families were grown in two replications at three locations: Samaru, Mokwa, and Ibadan (IITA). The performance data for the 18 selected full-sib families are presented in Table 11. Yields at Samaru were approximately double those at Mokwa and Ibadan. The combined location analysis of variance for yield (q/ha) is as follows:

Source	d.f.	ms	f
Locations	2	165685	2043**
families	168	215	2.61**
families x location	336	81	0.98NS
error (pooled)	504	83	

Table 10. Yield, ear height, and days to pollen shed for Biu Yellow full-sib trial, Samaru and Mokwa, 1974.

	Yield (q/ha)			Ear height (cm)			Days to pollen shed		
Entry	Samaru	Mokwa	Ave.	Samaru	Mokwa	Ave.	Samaru	Mokwa	Ave.
2	90.3	58.7	74.5	105	78	92	53	58	55.5
4	91.0	38.4	64.7	100	59	80	53	53.5	53.3
8	92.1	35.6	63.9	125	61	93	56	57.5	56.8
24	93.6	37.5	65.6	110	58	84	53.5	56.5	55.0
25	90.6	37.0	63.8	113	63	88	54.5	55.5	55.0
28	100.3	50.4	75.4	115	66	91	55	55	55.0
29	101.8	46.3	74.0	118	75	97	54.5	55.5	55.0
52	78.8	48.6	63.7	108	73	91	54.5	56.5	55.5
54	77.6	48.6	63.1	113	62	88	55	57.5	56.3
60	92.5	41.6	67.1	125	60	93	54.5	56.5	55.5
80	87.3	42.1	64.7	98	58	78	53.5	57	55.3
81	88.4	41.2	64.8	95	56	76	53	57	55.0
83	92.9	45.3	69.1	113	71	92	54.5	56	55.3
86	92.1	43.0	67.1	100	48	74	54	55.5	54.8
Mean of selections	90.7	43.9	67.3						
LSD 05	20.2	17.3	13.3						
overall mean	73.0	31.8	52.4						
selection differential			14.9						

heritability = 0.734

expected gain = 10.9 q/ha
expected gain is 20.9% of overall mean

Table 11. Yield, ear height, and days to pollen shed for NCA full-sib trial, Samaru, Mokwa, and Ibadan, 1974.

Entry	Samaru			Mokwa			Ibadan			Average		
	Yield	E.Ht.	Days	Yield	E.Ht.	Days	Yield	E.Ht.	Days	Yield	E.Ht.	Days
	(q/ha)											
18	78.5	140	56	39.9	94	57	39.0	130	55	52.5	121	56
19	77.2	150	57	43.1	106	59	31.0	120	56	50.4	125	57
46	70.9	135	59	50.5	89	60	22.8	105	57	48.1	110	59
61	76.2	140	58	47.2	94	57	35.7	125	54	53.0	120	56
63	83.7	160	59	47.2	101	59	29.5	122	56	53.5	128	58
64	91.5	160	59	51.3	102	59	28.2	132	56	57.0	131	58
65	92.5	140	57	35.0	87	59	32.4	125	56	53.3	117	57
66	79.8	135	57	38.3	79	56	25.7	125	56	47.9	113	56
67	97.1	135	57	45.6	101	59	52.3	127	55	65.0	121	57
68	90.9	120	59	48.0	97	60	36.9	125	55	58.6	114	58
79	75.2	140	55	42.3	92	55	22.8	127	53	46.8	120	54
91	76.8	130	59	42.3	118	57	45.7	125	55	54.9	124	57
112	78.5	125	55	38.3	106	56	29.9	125	54	48.9	119	55
113	81.1	135	57	41.5	105	58	36.5	127	55	53.0	122	57
114	87.0	135	59	40.7	99	60	29.1	122	57	52.3	119	57
124	81.1	160	60	35.8	110	59	40.7	140	56	52.5	137	58
128	81.7	150	58	51.3	95	58	49.4	130	56	60.8	125	57
130	82.1	140	56	40.7	95	56	45.7	120	55	56.2	118	56
Mean of selections	82.3			43.3			35.2			53.6		
overall mean	68.5			30.7			29.7			43.0		
LSD 05	18.2			19.2			16.4			10.4		
selection differential										10.6		
heritability										0.619		
expected gain										6.4		

expected gain is 15.0% of overall mean

Both locations and families sources of variation were highly significant. Surprisingly, the families x location interaction was nonsignificant even though the locations are greatly different. Calculated heritability was 0.619, resulting in an expected gain of 6.4 q/ha.

Unfortunately, the Ibadan data was not received in time to include in making selections for recombination in the 1974/75 irrigated nursery. If the data from Ibadan had been included, the selection differential would have been 11.2 instead of 10.6 which is not a very serious reduction.

12. NCB Full-Sib Recurrent Selection Trial

In 1974, NCB underwent the second cycle of full-sib testing following two cycles of S1 testing. The 196 entries were grown in two replications at Samaru and Mokwa. The performance data for the 20 selected full-sib families are listed in Table 12. The trial mean yield was not quite twice as great at Samaru as at Mokwa. The combined location analysis of variance for yield (q/ha) is as follows:

Source	d.f.	ms	f
Locations	1	124692	1342**
families	195	173	1.86**
families x locations	195	113	1.21*
error (pooled)	390	93	

The source of variation due to locations was, as expected, highly significant as was the families source of variation; however, the interaction variation was only significant at the 5 percent level of probability. Calculated heritability was low compared to the Biu Yellow and NCA full-sib trials and was calculated to be 0.348. The expected gain from selection was 3.8 q/ha or only 6.8 percent of the population mean.

The 20 selected lines are being recombined in the 1974/75 irrigated nursery at Samaru.

Table 12. Yield, ear height, and days to pollen shed for NCB full-sib trial, Samaru and Mokwa, 1974.

Entry	Yield (g/ha)			Ear height (cm)			D.P.		
	Samaru	Mokwa	Mean	Samaru	Mokwa	Mean	Samaru	Mokwa	Mean
11	73.2	40.7	57.0	140	83	112	60	60	60
25	81.4	33.4	57.4	135	93	114	59	58	59
33	70.6	41.1	55.9	140	92	116	58	60	59
36	71.6	37.9	54.8	140	108	124	61	61	61
61	83.7	32.6	58.2	125	89	107	57	60	59
71	70.6	39.1	54.9	140	97	119	59	60	60
79	77.2	37.9	57.6	135	110	123	56	58	57
84	71.6	35.0	53.3	130	100	115	59	59	59
91	74.5	39.1	56.8	145	115	130	57	56	57
104	61.5	45.2	53.4	140	100	120	61	58	60
118	70.0	41.5	55.8	145	108	127	61	59	60
128	65.1	41.9	53.5	140	90	115	56	58	57
132	65.1	41.9	53.8	150	114	132	62	60	61
139	82.4	29.3	55.9	140	96	118	58	58	58
142	66.7	45.2	56.0	130	100	115	58	59	59
146	66.4	40.7	53.6	125	96	111	58	58	58
156	77.8	33.0	55.4	140	110	125	63	63	63
165	69.0	41.9	55.5	125	94	110	58	58	58
166	69.0	43.1	56.1	135	106	121	61	57	59
167	69.6	44.0	56.8	125	101	113	57	57	57
Mean of selections	71.9	39.2	55.6						
overall mean	57.3	32.1	44.7						
LSD 05	22.9	14.3	13.5						
selection differential			10.9						
heritability			0.348						
expected gain			3.8						

expected gain is 6.8% of overall mean

13. Samaru 1,2,3 Full-Sib Recurrent Selection Trial

Samaru 1,2,3 underwent the third cycle of recurrent selection in 1974. This population was formed in 1971 from the best selections from Samaru Composites 1, 2, and 3. There were only 100 full-sib families available for testing in 1974, and these were grown in two replications at Samaru and Mokwa. The performance data for the 10 selected full-sib families are presented in Table 13. As in the other full-sib trials, the mean yield at Samaru was approximately double that at Mokwa. The combined location analysis of variance for yield (q/ha) is as follows:

Source	d.f.	ms	f
locations	1	105057	540**
families	99	186	0.95 NS
families x locations	99	102	0.52 NS
error (pooled)	198	195	

Unfortunately there was no significant variation due to families or families x locations interaction. This is attributed to the high error mean square from the individual location analysis of variance for Mokwa. The Mokwa error mean square was 314, and Samaru 79. This produced a highly significant difference for families at Samaru and nonsignificant difference at Mokwa. The calculated heritability was 0.301, resulting in an expected gain of 3.3 q/ha, or only 6.7 percent of the population mean.

The 10 selected full-sib lines are being recombined in the 1974/75 irrigated nursery.

14. Samaru 1,2,3 High Protein S1 Yield Trial

Selection for high protein in Samaru 1,2,3 was initiated in the 1973/74 irrigated nursery. Selfing was done in a bulk planting of Samaru 1,2,3. The resulting 444 ears were analyzed by the Udy procedure in Dr. Stockinger's laboratory. Seed from the highest 115 ears, based on Udy Reading, were planted in an S1 yield trial in 1974 with two replications at Samaru. Yield data was taken and a Udy analysis performed on a bulked sample from each plot. Yield was multiplied by the Udy reading, and the highest 20 lines were selected for recombination in the 1974/75 irrigated nursery. The S1 yield performance and Udy readings for the selected 20 lines are presented in Table 14.

The yield level of the selected lines was very good, resulting in a selection differential for yield of 19.2 q/ha. However, the calculated correlation of yield with Udy was -0.22. This resulted in only a 1.6 expected gain in Udy reading.

Table 13. Yield, ear height, and days to pollination for Samaru 1,2,3 full-sib trial, Samaru and Mokwa 1974

Entry	Yield (q/ha)			Ear height (cm)			D.P.		
	Samaru	Mokwa	Mean	Samaru	Mokwa	Mean	Samaru	Mokwa	Mean
4	79.4	43.5	61.5	125	93	109	56	56	56
9	82.1	40.7	61.4	135	100	118	57	56	57
11	83.0	33.8	58.4	120	85	103	53	53	53
27	78.8	45.6	62.2	130	71	101	60	60	60
31	79.8	40.3	60.0	130	63	97	61	63	62
36	81.1	46.4	63.7	105	83	94	55	59	57
60	82.7	39.5	61.1	120	64	92	52	53	53
67	70.0	48.0	59.0	110	80	95	58	60	59
72	78.1	37.9	58.0	115	74	95	53	58	56
78	76.2	40.3	58.2	120	82	101	55	56	55
mean of selections	79.1	41.6	60.4						
overall mean	65.4	33.0	49.2						
LSD 05	17.8	35.5	19.7						
selection differential			11.2						
heritability			0.301						
expected gain			3.3 q/ha						
expected gain is 6.7% of overall mean									

Table 14. Samaru 1,2,3 Protein Selection S1 Yield Trial, Samaru, 1974.

Entry	Yield (q/ha)	Udy Reading
4	64.0	54.7
11	53.3	57.3
15	78.8	51.4
31	70.2	47.8
32	43.4	66.3
39	59.5	48.8
43	64.6	46.1
54	57.9	58.1
66	55.7	51.0
68	65.0	48.0
71	77.8	51.7
72	59.4	62.0
75	44.2	64.5
81	52.8	60.4
93	51.3	63.9
102	51.7	55.0
104	50.2	60.8
108	55.4	52.1
111	47.6	62.2
115	53.8	53.1
mean of selections	57.8	55.8
overall mean	38.6	54.2
selection differential	19.2	1.6

gross correlation yield with Udy = -0.22

In future selection work in this population, some kind of weighted index could be used to increase Udy selection differential at the expense of yield increase.

15. *Striga* Resistance Screening Trial

A cooperative trial with Dr. Zummo was grown on the University farm in 1974. The trial consisted of 50 full-sib families each from Biu Yellow; NCA, NCB; and Samaru 1,2,3. Also included were 50 entries from the variety maintenance of the maize breeding program. The material was replicated twice. The planting date was June 29. Unfortunately no *Striga* appeared in this trial and no selection for *Striga* tolerance was possible.

Alongside of the screening trial a small breeding plot was established. The material consisted of bulked remnant seed of the best 50 percent of entries for *Striga* tolerance of an experiment conducted by Dr. Stan King in 1973. The purpose was to make paired plant crosses and select the pairs with best *Striga* resistance for a full-sib trial in 1975. Unfortunately, no *Striga* appeared in this area either. However, seed of 169 full-sib families was selected from the crossing plot and will be planted at three locations in 1975. The three locations will be two *Striga*-infested areas and one *Striga*-free area. Hopefully, planting can take place earlier and *Striga* infection will occur.

Breeding Nursery

Much of the breeding nursery work each year is devoted to increasing seed of, and selecting within, the full-sib families from the recurrent selection trials. A 25-plant row from each of the full-sib families in populations NCA; NCB; S1,2,3; and Biu Yellow was planted. The best 10 plants in each row were self-pollinated, and the ears from the best three plants were saved to represent the selected families in the recombination nursery. Characters selected for are primarily ear height, disease resistance, and lodging resistance.

Another major nursery program in 1974 was the production of seed for the diallel population cross trial planned for 1975.

Approximately 200 inbred lines in various stages of inbreeding were advanced by selfing in 1974. Many of these lines have been discarded, based on visual observation and on the results of the Tuxpeno Planta Baja topcross trial described in the trial results section of this report. New material for selfing each year includes the full-sib families selected from the previous year's recurrent selection yield trials.

There has been no extensive testing of the different cycles of any of the populations undergoing recurrent selection. In 1974, seed was planted in the breeding nursery for each cycle of each population undergoing recurrent selection. Sibbing was done, taking care to maintain a large population size. This seed will be used for an evaluation trial of progress from selection in populations NCA; NCB; and Samaru 1,2,3. A total of 17 locations in the Northern States of Nigeria have been secured for this trial in 1975.

Isolated small-plot increases of C10 x BY (C4), Bomo local, and NCA (c3) x NCB (C3) were grown in 1974. The NCA(C3) x NCB(C3) cross has been entered in the 1975 National Zonal and West African Uniform Maize trials.

Seed of C10 x BY(C4), NCA(Co) x NCB(CO), and NCA(C3) x NCB(C3) has been planted for sibbing in the 1974/75 irrigated nursery. The resulting F2 seed will be grown in a trial in 1975 to determine the amount of heterosis retained in the advanced generations of the variety crosses.

Seed of NCA(C3); NCB(C3); and Samaru 1,2,3(C2) was turned over to Mr. Clifton for multiplication by the IAR Foundation Seed Unit.

Protein Selection

Selection for high protein was begun in 1971 by selfing in a bulk planting of Samaru Composite 3. The 840 resulting ears were analyzed for protein and 200 selected for an S1 yield trial in 1972. The 20 highest yielding S1 lines were selected for recombination but were unfortunately lost and never recovered. However, the 1972 S1 yield trial showed that selecting for high yield among the 200 S1 lines did not negate the original difference for high protein. This was the basis of starting a similar selection program in Samaru 1,2,3 in the 1973/74 irrigated nursery. For Samaru 1,2,3 a total of 444 ears were analyzed in Dr. Stockinger's laboratory utilizing

In future selection work in this population, some kind of weighted index could be used to increase Udy selection differential at the expense of yield increase.

15. *Striga* Resistance Screening Trial

A cooperative trial with Dr. Zummo was grown on the University farm in 1974. The trial consisted of 50 full-sib families each from Biu Yellow; NCA, NCB; and Samaru 1,2,3. Also included were 50 entries from the variety maintenance of the maize breeding program. The material was replicated twice. The planting date was June 29. Unfortunately no *Striga* appeared in this trial and no selection for *Striga* tolerance was possible.

Alongside of the screening trial a small breeding plot was established. The material consisted of bulked remnant seed of the best 50 percent of entries for *Striga* tolerance of an experiment conducted by Dr. Stan King in 1973. The purpose was to make paired plant crosses and select the pairs with best *Striga* resistance for a full-sib trial in 1975. Unfortunately, no *Striga* appeared in this area either. However, seed of 169 full-sib families was selected from the crossing plot and will be planted at three locations in 1975. The three locations will be two *Striga*-infested areas and one *Striga*-free area. Hopefully, planting can take place earlier and *Striga* infection will occur.

Breeding Nursery

Much of the breeding nursery work each year is devoted to increasing seed of, and selecting within, the full-sib families from the recurrent selection trials. A 25-plant row from each of the full-sib families in populations NCA; NCB; S1,2,3; and Biu Yellow was planted. The best 10 plants in each row were self-pollinated, and the ears from the best three plants were saved to represent the selected families in the recombination nursery. Characters selected for are primarily ear height, disease resistance, and lodging resistance.

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the Udy method. Of these lines, 115 were selected for an S1 yield trial at Samaru in 1974. The results of this trial have been reported in the trial results section of this report (Table 14). As in the first experiment, the selection for yield did not result in an expected decrease in protein. However, the selection criteria in 1974 was a product of yield and Udy readings. The recombined lines will be selfed in 1975 for a second cycle of selection.

Selfed ears from full-sib families in the 1973 NCA and NCB full-sib yield trials were analyzed by the Udy method. Based on the sampling of 120 ears from each population, 11 ears from NCA and 13 ears from NCB were selected for recombination in the 1973/74 irrigated nursery. Because of a lack of space in the Samaru nursery, the lines were sent to Mokwa for recombination. The seedset in each population recombination was very poor. The NCA recombinations were bulked and planted at Samaru in 1974. Approximately 500 sib pollinations were made in this population. These ears can be used for a second cycle of selection in 1975. Enough seed was obtained from the NCB recombination to plant 200 full-sib families in 10-plant rows replicated three times in the breeding nursery. One selfed ear was saved from each row and analyzed by the Udy method. The 20 full-sib families with the highest Udy readings (readings averaged over three replications) were selected for recombination in the 1974/75 irrigated nursery. The overall mean of Udy readings was 47.2, and the mean of the selections was 57.3 resulting in a selection differential of 10.1 The analysis of variance of the Udy readings is as follows:

Source	d.f.	ms	f
Replications	2	27539	370**
Entries	199	81	1.08NS
Error	385	75	

Unfortunately, a nonsignificant entries variation was observed with a highly significant replications variation. This may indicate more extensive testing is needed to identify genetic differences for protein content.

A representative sample from 17 populations in the breeding program were analyzed for protein using the Kjaldahl and Udy methods. The results are as follows:

Entry	Kjeldahl % Protein	Udy Reading
NCA Co	11.08	36.0
NCA C1	11.02	33.3
NCA C2	10.38	33.5
NCA C3	9.22	27.5
NCA High Protein C1	11.74	37.0
NCB CO	9.35	27.5
NCB C1	9.78	29.5
NCB C2	10.47	33.3
NCB C3	10.56	32.1
NCB High Protein C1	11.90	36.9
Samaru 1,2,3 CO	9.00	30.6
Samaru 1,2,3 C1	10.94	38.3
Samaru 1,2,3 C2	10.18	34.3
C10 x Biu Yellow	9.96	31.1
Biu Yellow	9.16	30.2
NCA (C3) x NCB (C3)	9.62	30.0
096	10.94	34.7

Correlation Kjeldahl with Udy = ± 0.88

It is interesting that for NCA the percent protein declines with cycles of recurrent selection but for NCB protein increases over the cycles of selection. For both populations the high protein recombinations showed the highest protein percentage of any of the populations tested. All populations, except the variety crosses, were grown in the same area of the breeding nursery.

It appears from the data that progress in improving protein content has been made from one cycle of selection in NCA and NCB.

An analysis of variance and covariance was performed on the data from the S1,2,3 protein selection S1 yield trial for yield and Udy reading. The results are as follows:

Source	d.f.	Variance Yield (lbs/plot)	Variance Udy	Covariance Yield, Udy
reps	1	3.56**	318.20**	30.09
entries	90	1.83**	51.82**	-1.68
error	90	0.74	21.99	-1.88

** indicates significance at the 1 percent level of probability.

Highly significant sources of variation, due to replications and entries, were observed for both yield and Udy readings. Utilizing the appropriate components of variance and covariance the phenotypic correlation of yield and Udy was calculated to be -0.17 and the genetic correlation ±0.04, neither of which is significant. This, however, does indicate that no expected reduction in Udy value will occur when selecting for higher yield or no reduction in yield is expected in this population when selecting for higher Udy readings.

Regression of the Udy reading of the original selfed ears was calculated on the average Udy reading for two replications for each entry in the S1 yield trial. The calculated value was b = ±0.22. This value seems quite low. Possibly more extensive testing is needed to identify true genetic differences. The original selection differential for the lines in the S1 yield trial was 11.0 Udy units.

MAIZE PATHOLOGY

OAU/STRC JP-26
USDA/USAID

G. E. Cook

The following objectives were established for the maize pathology program; however, not all of these were continued:

1. to select for multigenic resistance to Helminthosporium maydis in the composite NCB;

2. to determine if resistance to H. maydis in NCBRb had broken down in the Jos area or if H. turcicum was the causal organism;

3. to determine the stalk rotting organisms at locations throughout Nigeria;

4. to identify the vector of maize streak virus and multiply it and use it to establish a maize screening program;

5. to nominate outstanding research workers for further training under the OAU/STRC JP .-26 program;

6. to select maize plants with double ears and stalk-rot tolerance from the composite NCB and NCC;

7. to assist other members of the OAU/STRC JP -26 program whenever possible.

The selection for multigenic resistance to Helminthosporium maydis in composite NCB was done by the Nigerian workers of FDAR at Moor Plantation.

Because the second objective, determining if NCBRb had lost its resistance to H. maydis in the Jos area required field work at Jos, it was given to Dr. Zummo. This problem was of great concern to agricultural officials in the North and could be handled better through IAR.

Many stalk rotting organisms were isolated from maize grown at Ibadan, Ilora, NIFOR, Umudike, Uyo, Badeggi, Riyom, and Zaria during the first rainy season and at Ibadan, NIFOR, and Uyo during the second season. The main stalk rotting organism at all locations was Fusarium moniliforme, although other Fusarium sp., Cephalosporium sp., Pythium sp., Rhizoctonia sp., a bacterium, and Macrophomina phaseoli were also isolated. During the second season, M. phaseoli was nearly as prevalent as F. moniliforme (Table 1). None of the other organisms occurred frequently enough to be considered as a serious problem in 1974. These trials will be continued in 1975.

The vector of maize streak virus in Nigeria has not been identified. The leafhopper vector in East Africa, Cicadulina mbila, has been identified in northern Nigeria and is probably present in the rest of Nigeria. Dr. John Medler, USAID-Wisconsin at the University of Ife, spent some time helping my assistant and me learn to identify Cicadulina sp. We finished building our cages and a screenhouse to confine the insects in late June. The screenhouse does not have a water supply, although it was promised in June; and this has hindered the usage of it. Most of my early insect populations died within a few days after they were placed in the cages. Dr. Zummo first suggested and Dr. Starks, a USDA entomologist, later confirmed that the plastic I had used in constructing my cages was toxic to leafhoppers. New cages were constructed and the work was started again. There was a very low incidence of maize streak in the Ibadan area in 1974, and no infective leafhoppers were obtained. This work was halted in late November by labor problems.

Dr. John Guthrie, Head of the EAAFRO Maize Streak Research Program in Kenya, sent antiserum for maize streak virus and two other viruses. He visited us in October and gave me many constructive suggestions. Dr. Okusanya, Virologist at FDAR, confirmed that the strain of maize streak present in Nigeria was similar to the strain in East Africa by obtaining positive results with Dr. Guthrie's antiserum. We agreed to cooperate with Dr. Guthrie and try to identify some of the grass hosts of maize streak virus in Nigeria and West Africa. Because of the low incidence of streak, no alternate hosts have been found this year. More detail is given in the report by Fajemisin, Cook, and Okusanya following this section.

Mr. Obilana has shown himself to be a good scientist and, with Dr. Eberhart's support, I nominated him for further training. With the assistance of Mr. Odelola, Executive Secretary of the OAU/STRC, and Dr. Olson, our Project Manager, Mr. Obilana was accepted for advanced training.

The stalk rot selection trial is a joint project with Mr. Obilana and is in its third generation. The first two generations were selfs, and extensive notes were taken on agronomic characters and disease reaction during the second season. The third generation was planted at IITA because of the labor problems at FDAR. Dr. Albrecht, the Director General of IITA, went out of his way to assist me in getting my maize planted. There are 430 single line selfs of NCC and 371 single line selfs of NCB. These will be called MSC and MSB, respectively (multiple ear stalk rot selection C and B).

I assisted Mr. Odelola and Mr. Harrison, the maize breeder at IITA, in planning and coordinating the OAU/STRC JP-26 meetings in July. These meetings were successful and the people at IITA were very accommodating. I presented a paper entitled "Is Maize Streak Virus Present in Nigeria?" It is being printed in African Soils. I edited all of the papers presented at the July meeting for African Soils.

I traveled with Dr. Zummo to Senegal in April. We met with Mr. Girard, a Plant Pathologist with IRAT, and discussed the disease of grain crops in West Africa.

In June Dr. Zummo, Dr. Goodrich, and I visited the Ejura Farms in Ghana to determine if the ear rotting organism found in 1973 was present in 1974. We did not find any trace at that time. Dr. Zummo and I returned in August and did find some but did not consider it serious. Mr. Pomfret, OAU/STRC Field Trial Officer in Ghana, and Mr. Akpose and Mr. Addison of the Crops Research Institute in Kumasi; Mr. Jim Ford of USAID; and the staff at the Ejura Farms all assisted us with our work.

Table 1. The type of stalk rot and the intensity of Fusarium in Maize grown at eight locations in Nigeria during 1974.

Location	Growing Season	Percentage of plants infected by fungus				Infection types of Fusarium
		Cechlasporium	Pythium	Macrophonina	Fusarium	
Uyo*	1		1	2	97	5**
Uyo	2	5	2	1	92	5
Riyom		4	1		95	3
Badeggi			1		99	2
Ilora		3	1	2	94	4
N.I.F.O.R.	1		5	5	90	5
N.I.F.O.R.	2			8	92	2
Ibadan A8	1	7		1	91	4
Ibadan A8	2	1		47	52	4
Ibadan C3	1	14		1	80	4
Ibadan C3	2	1		53	46	4
Zaria		2		1	97	4
Umudike				1	99	3

* Percentages based on approximately 100 plants.

** Rating scale: 1 = trace of discoloration in internode; 2 = discoloration 50% or more of internode; 3 = 1 internode totally discolored and 1 or 2 more partially discolored; 4 = more than 1 internode totally discolored partial senescence; 5 = premature death.

MAIZE STREAK EPIPHYTOTIC

J. M. Fajemisin, G. E. Cook, and Funnso Okusanya

Introduction

Maize streak virus disease of maize (MSV) is prevalent in many parts of Africa and, until recently, had not been found on any other continent. It has been described frequently in East (1,3,10) and South (6,8,9) Africa and recently in West Africa (5) and India (7).

In East Africa, MSV has long been recognized as one of the most serious diseases of maize. The disease is characterized by broken, almost continuous, narrow chlorotic streaks centered on secondary and tertiary leaf veins and distributed uniformly over the leaf surface. The parallel chlorotic streaks may partially or almost completely fuse, leaving irregular green lines or islands centered between veinlets. The green stripes vary from a few millimeters to several centimeters in length and from 0.5 to 1 mm in width. The virus is spread from plant to plant by some species of the genus Cicadulina (8,9). It is not mechanically transmitted and is not seedborne.

Historical Record in Nigeria

In Nigeria, MSV has been present for many years. The importance of this disease was described in 1966 (2), and symptoms identical to those of MSV have been found on herbarium specimens in the Federal Department of Agriculture Library that were collected in 1958. Prior to 1971, the disease was usually confined to off-season irrigated experimental plots. Maize planted in either the first (March-April planting) or the second (August planting) season was usually free of the disease. After 1971, MSV was observed on the second-season maize crop in both experimental and local farmer plots.

Observations

Distribution

Symptom expression and serological tests of samples from different parts of Nigeria have confirmed that MSV is present in the following areas: Ibadan, Oyo, Ogbomosho, Oshogho, Ilesha, Ilorin, Jebba, Bida, Mokwa, Zaria, Jos, Benin, Umudike, Uyo, Ikenne, and Epe.

Prevalence of MSV on Maize in 1973 and 1974

In the 1973 first-season planting (March-April), there was an average incidence of about five percent in the experimental plots at the Federal Department of Agricultural Research, Ibadan, and local farms. Even though this appeared to be low, it is significant in that maize planted during this season in the past has been known to be free of streak disease.

On the second-season crop (August-September), the disease was prevalent in most areas where the crop was grown in Nigeria. A survey of local farms in the central Western State of Nigeria showed varying degrees of streak incidence depending on the time of planting (Table 1). None of the sampled maize fields was free of streak. Most of the fields planted later than August 16 had a substantial amount of infection with those planted in September being the most severely affected. Thus 100 percent streak infection, or nearly so, was recorded for fields with plants not yet at the green-cob stage at the time of scoring. The high severity of the disease made some farmers abandon their plots. All the farmers interviewed described this as the first time for such an epiphytotic and, in fact, most of them had never observed streak disease on their farms.

In 1974, during the first growing season, the incidence of MSV was lower than in recent years. An incidence of MSV from 0-0.5% was recorded in the Southern States and from 0-16% in the Northern States. During the second season in the south, very little streak appeared. The incidence of MSV during the off-season was less than 30%.

Reaction of Nigerian local Maize Varieties and Elite Breeding Stocks

Ninety-five maize varieties, including local open-pollinated varieties, and most of the best breeding stocks in the country were planted for observations on the natural incidence of streak. They were planted at two different dates viz: August 31 and November 7, 1973; and streak counts were made at three different dates for each planting. There was a greater streak development in the November planting (Table 2). At the final scoring date there were 32 and 93 percent plant infections for the August and November plantings, respectively.

Figure 1 illustrates the distribution of the maize cultivars tested as to their reactions to natural infection of streak. Data used are those obtained from the November planting. About 73 percent of the cultivars had a streak incidence of over 90 percent.

Symptoms of MSV in Nigeria were similar to those described by Storey. Plants not showing streak symptoms at tasseling did not develop symptoms. This disease effected maize by reducing plant height, vigor, grain, and ear size and caused barrenness and premature death.

Transmission Studies

Seed Transmission

Seeds from a susceptible plant were planted in 6-inch pots at six seeds per pot. The pots were kept in cages to prevent any possible insect vectors from contacting the plants. None of the plants showed any streak symptoms after six weeks of caging. This suggests that the disease is not seedborne; however, this experiment will be repeated.

Mechanical Transmission

All attempts to transmit the virus mechanically have not been successful.

Insect Transmission

Establishment of a viruliferous insect-vector population has not been achieved. This has been due to the difficulty being encountered in capturing, identifying, and culturing on the Cicadulina sp. which is the reported insect vector. As a result, no successful insect transmission of the virus disease from maize to maize has been achieved.

Serology

Maize streak virus is immunogenic. Crude sap from maize leaves showing symptoms of maize streak gave a positive reaction with MSV antiserum at an optimum titre of 1:64 in gel diffusion plates. This reaction was obtained with samples collected from various regions of Nigeria.

Serological reactions in agar-gel diffusion tests have shown that the Nigerian isolate of the maize streak virus (MSV) is serologically related to the East African isolate. (Antisera to MSV East African isolate was kindly supplied by E. J. Guthrie and K. R. Bock, Overseas Development Agency, Crop Virology Research Project, EAAFRO, Kenya.)

Conclusions

Observations on the incidence and pattern of disease development of the maize streak virus disease are identical with the maize streak as found in East Africa (3,4,5). That the maize streak virus is not seedborne also is in agreement with Storey's findings (3).

The 1973 maize streak epiphytotic in Nigeria reveals that the maize streak virus (MSV) infection is no longer confined to experimental plots and that the second season maize is more vulnerable to streak infection than in past years.

The higher incidence of MSV during the second growing season and the irrigated season may be due to an increase in the numbers or in the activity of the vector. Another possibility is that most of the vectors' natural hosts may be dormant during the irrigated season and the only available hosts would be maize grown under irrigation. This would tend to concentrate the vectors on a limited number of plants, thus increasing the chance for a viruliferous vector to transmit the disease to a susceptible host. It may be a combination of these factors or something else.

Vigorous and urgent efforts should therefore be made to study the disease, especially with regards to the positive identification of the vector in Nigeria, its distribution in relation to the seasonal occurrence of the disease, and the development of effective control measures. Presently, the only feasible way of reducing infection is to plant early during the

second growing season. This would help to prevent early infection of the crop and thereby reduce the effects of the virus infection on the yield of the crop.

Le Conte (5) has reported that a maize variety from Reunion has a high degree of tolerance/resistance to MSV in Dahomey. Harrison at the International Institute of Tropical Agriculture and Fajemisin at the Federal Department of Agricultural Research have also observed this in other maize lines. If this tolerance/resistance does not break down, it may be possible to develop maize with a high degree of tolerance/resistance to MSV.

Table 1. Incidence of Maize Streak in the Central Western State of Nigeria. (1973 late season)

Zone surveyed	Growth stage of sampled field	Percent plants with streak
Iwo Road	Between Green* and Harvest	9
	1 week after mid-silk	99
	Mid-silk	97
	Mid-tasseling	98
	Near harvest	12
Ife Road	Just past Green	17
	Green	24
	1 week after mid-silk	100
	Near harvest	19
Oyo Road	Near harvest	6
	Green	100
	Mid-silk	97
	Between Green and Harvest	55
	Harvest	5
Abeokuta Road	Near harvest	27
	Almost Green	96
	Between Green and Harvest	17
	1 week after mid-silk	96
	Between Green and Harvest	25
Ijebu Road	Just past Green	20
	Almost Green	100
	Green	35
	Almost Green	80
	Almost Green	100

* Green = green-cob stage

Table 2. Streak disease development. Percent plants with streak at three different dates for each of two dates of planting (Plant population--approx. 3000).

August 31, 1973 Planting			November 7, 1973 Planting		
Percent plants with infection on:			Percent plants with infection on:		
8/10	26/10	21/11	29/11	19/12	10/1
7	30	32	14	76	93

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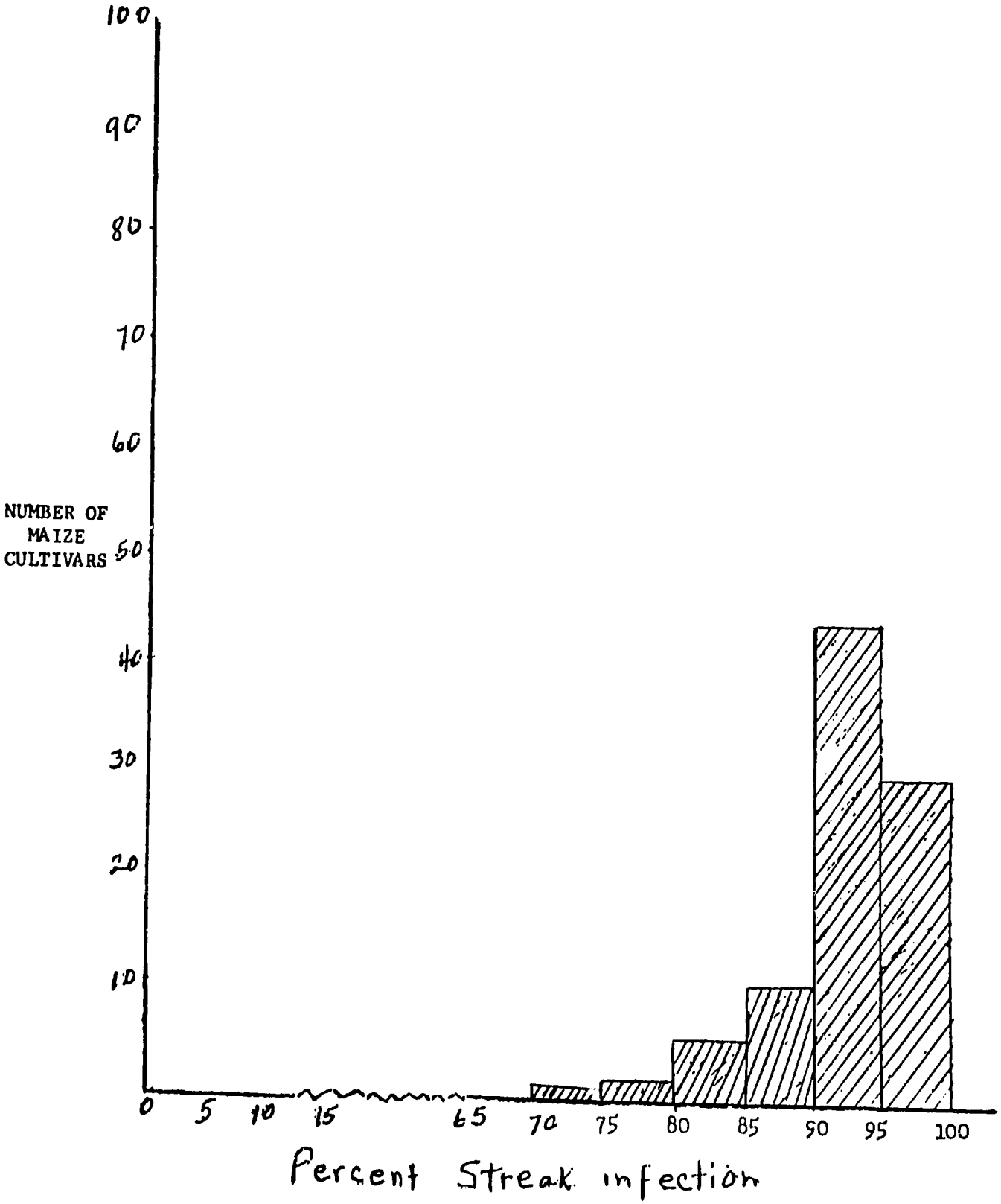
Fig. 1. Distribution of the incidence of maize streak infection among 95 maize cultivars (Planted November 7, 1973).



UNIFORM MAIZE TRIAL

B. R. Taylor

The highest yielding sites were Samaru, Nigeria (trial mean yield 7207 kg/ha); Matuga, Kenya (5504 kg/ha); and Amoutchou, Togo (5339 kg/ha). The overall mean of all trials was 3911 kg/ha, and this reflects the high levels of management in these trials. TZA x TZB was the overall highest yielding entry, and outyielded all other entries in 9 out of 22 trials. This entry was the second highest yielder in 1973. The Pioneer Hybrid 515, which did well in 1973, was the second highest yielding entry in 1974.

The early entry, Bomo Local x BS3, showed susceptibility to rust and blight and only performed well at the drier sites. Good resistance to lodging was shown by the entries with a low-ear height, notably Nialuli 7 x ATC, TZPB, and 515. The tall, late entries, such as Western Yellow 1 and the Ghana entries, performed better at the wetter sites for which they were intended and not as well in drier regions. As in 1973, good ear prolificacy was shown by Niaouli 7 x ATC, although this hybrid ranked only 20th overall.

Table 1. West African Uniform Maize Trial Yields

Entry	Origin	Sefa, Senegal	Kaedi-Rindiao, Mauritania	Yundum, The Gambia	Giroba-Kunda, The Gambia	Njala, Sierra Leone	Sotuba, Mali	Ferkessedougou, Ivory Coast	Farako-Ba, Upper Volta	Kwadaso, Ghana	Nyankpala, Ghana	Amoutchou, Togo
		quintals/ha										
1. NCA(C3)	Nigeria	38.3	25.8	16.9	40.2	16.1	38.4	40.3	49.2	42.4	39.4	46.7
2. TZB(C3)	Nigeria	49.6	23.2	23.2	48.8	8.7	32.9	42.1	54.6	51.3	42.0	53.2
3. NCARb x NCBRb	Nigeria	51.2	27.7	20.7	42.5	19.3	38.4	46.5	59.7	52.6	39.1	61.0
4. TZA(C2) x TZB(C3)	Nigeria	54.6	19.9	19.7	47.4	20.8	42.7	41.2	55.3	55.0	48.9	68.1
5. WY1	Nigeria	36.2	21.0	15.1	39.5	11.9	30.1	33.8	50.0	33.4	39.5	49.7
6. TZB(C2)	Nigeria	39.4	28.9	24.4	41.1	19.8	23.9	42.6	49.1	50.3	41.1	60.9
7. BL x BS3	Nigeria	40.9	34.5	23.0	38.9	12.3	33.7	26.9	36.7	24.7	29.4	39.2
8. N7 x ATC	Dahomey	41.3	26.1	24.4	35.6	11.6	38.2	31.3	35.7	38.2	30.3	38.6
9. C10 x BY	Nigeria	40.2	27.8	13.3	45.6	19.0	34.1	41.8	52.1	37.6	35.0	53.8
10. Samaru 123	Nigeria	37.5	24.8	15.3	44.4	16.0	35.5	35.4	44.6	35.1	36.9	57.6
11. CJB	Ivory Coast	42.6	20.1	16.2	42.8	10.6	35.6	37.7	47.5	37.0	38.9	49.2
12. FB SJ	Upper Volta	41.0	12.5	14.7	40.9	12.5	32.7	41.5	34.9	31.7	33.9	50.2
13. X101	U.S.A.	44.1	-	23.7	48.9	-	40.8	50.5	56.6	48.4	39.7	52.9
14. 515	U.S.A.	50.6	21.6	23.6	55.0	-	50.2	44.4	63.0	33.7	42.0	59.8
15. X306B	U.S.A.	42.8	-	17.9	42.4	-	30.9	49.6	55.1	39.1	31.7	50.7
16. X105A	U.S.A.	45.9	17.4	16.6	45.6	14.3	36.0	38.3	55.5	48.9	42.9	59.4
17. GCH	Ghana	40.0	15.6	19.7	41.8	11.4	29.2	40.5	56.1	50.2	41.8	60.5
18. Golden Crystal	Ghana	39.6	12.9	22.5	40.1	11.9	26.7	42.7	46.2	39.4	29.2	52.2
19. La Posta	Ghana	39.8	14.1	16.0	41.8	8.8	31.7	43.6	48.3	54.7	18.3	63.0
20. Comp W	Ghana	38.7	17.0	17.0	41.8	19.0	28.6	39.7	46.7	43.0	42.7	56.6
21. Coast Comp.	Kenya	39.9	-	19.6	40.5	-	31.8	38.3	52.2	37.8	41.9	59.0
22. BS3	Nigeria	31.8	30.0	16.8	36.7	-	24.0	22.4	28.5	25.8	22.3	-

Table 1 (continued).

Entry	Origin	Kolo, Niger	Ibadan, IITA (1st Season)	Ibadan, IITA (2nd Season)	Ilora, Nigeria	Mokwa, Nigeria	Samaru, Nigeria	Maroua, Cameroon	Deli, Chad	Bekamba, Chad	Grimari, C.A.R.	Matuga, Kenya	Mean
		quintals/ha											
1. NCA(C3)	Nigeria	23.1	23.9	33.3	41.0	30.6	69.2	56.0	29.0	24.3	36.9	54.6	38.8
2. TZB(C3)	Nigeria	32.8	34.3	41.9	44.8	27.5	75.1	53.6	29.4	28.0	47.3	51.5	40.7
3. NCARb x NCBRb	Nigeria	34.7	29.8	38.0	44.5	35.1	76.3	56.3	29.8	26.1	48.3	64.9	42.8
4. TZA(C2) x TZB(C3)	Nigeria	43.4	29.4	42.8	44.3	32.0	89.4	55.5	36.9	17.2	58.2	63.8	44.8
5. WY1	Nigeria	19.6	34.6	35.0	41.6	26.7	67.9	45.8	25.2	21.1	37.9	60.8	35.3
6. TZB(C2)	Nigeria	21.6	38.4	36.1	40.0	28.2	70.4	52.4	22.0	16.9	48.3	64.9	39.1
7. BL x BS3	Nigeria	29.5	23.6	16.9	15.6	17.7	58.6	63.6	27.8	25.6	16.3	35.0	30.5
8. N7 x ATC	Dahomey	28.0	22.7	25.9	31.6	23.5	68.7	49.2	30.2	32.2	32.0	40.2	33.4
9. C10 x BY	Nigeria	29.4	32.9	31.1	38.0	28.5	67.2	60.9	38.5	27.1	41.4	51.5	38.5
10. Samaru 123	Nigeria	34.1	25.6	27.2	32.7	26.8	72.8	67.9	30.9	24.0	34.1	47.4	36.7
11. CJB	Ivory Coast	26.7	24.8	34.9	33.1	25.9	63.0	47.3	32.1	25.7	39.1	51.5	35.6
12. FB SJ	Upper Volta	23.5	17.2	28.6	36.7	25.2	66.0	51.5	34.1	31.7	39.5	55.6	34.4
13. X101	U.S.A.	28.9	33.6	39.1	33.6	33.0	83.0	-	30.9	32.0	52.3	-	42.9
14. 515	U.S.A.	34.0	35.0	37.2	42.6	23.7	81.7	63.0	29.0	27.6	43.6	62.8	44.0
15. X306B	U.S.A.	26.2	27.4	39.0	39.0	30.2	72.8	48.2	34.5	24.3	53.2	59.7	40.7
16. X105A	U.S.A.	24.4	33.7	37.9	34.6	31.6	85.6	52.2	33.3	23.6	51.5	69.0	40.8
17. GCH	Ghana	23.1	31.7	37.8	38.9	37.7	73.7	49.6	26.2	17.7	30.1	-	36.8
18. Golden Crystal	Ghana	19.6	23.3	32.7	31.3	31.0	80.3	43.0	27.8	24.5	37.7	-	34.0
19. La Posta	Ghana	22.3	38.1	37.4	39.1	28.2	79.8	47.6	18.4	21.5	34.2	-	35.6
20. Comp W	Ghana	18.5	33.5	39.1	39.1	41.6	73.3	41.3	19.8	21.2	49.4	62.8	37.8
21. Coast Comp.	Kenya	33.2	23.0	33.9	36.3	30.4	70.6	47.5	26.4	31.4	40.4	-	38.6
22. BS3	Nigeria	24.0	-	-	-	-	57.5	52.3	23.4	22.8	16.8	-	29.0