SORGHUM BREEDING RESEARCH REPORT

1982-83

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ICRISAT
OAU / STRC JP 31 SAFGRAD
IAR / ABU SAMARU

SORGHUM BREEDING

C O N T E N T S

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I. INTRODUCTION AND OBJECTIVES

This is the second year of the ICRISAT-OAU/STRC JP-31-SAFGRAD project for sorghum improvement.

Research efforts continued with the primary objective of breeding suitable cultivars of sorghum that could lead towards development of production systems of higher levels of yield performance and stability across a range of West African environments.

During the previous year (1981), approximately a thousand lines of tropical origin were introduced and critically evaluated for various attributes of adaptational significance - insect and disease reaction, suitability for planting across a range of environments, standability and yield (mostly visually and quantitatively in a few cases). About 50 lines were selected for detailed evaluation and several for the breeding nursery.

During the 1982 rainy season, the selected lines were further evaluated for yield and other attributes across a range of environments and planting dates. Particular emphasis was on grain yield and mould resistance, which could not be studied during the previous year since rains ceased prematurely. Thus, the 1982 effort is essentially a continuation of the adaptational exercise leading to the identification of potential cultivars of agronomic worth for sole as well inter-, relay- and sequential cropping systems.

A Nigerian collection was critically evaluated during the current year at Samaru.

The results are presented in this report.

II. RAINFALL AND GROWING CONDITIONS

Rainfall, particularly in Northern Nigeria, was not high but well distributed. The 1982 season is, therefore, considered favourable for crop growth and yield.

For our study, Kano (Northern Nigeria) and Maroua (Northern Cameroon) both in the Sudanian zone, represent dry areas. Samaru in the Northern Guinea savanah represents moderately high rainfall area. Mokwa and Yandev in the Southern Guinea savanah represent heavy rainfall areas with a prolonged growing season. Rainfall data over 10-day periods at these locations are presented in Table-1 and in Figs. 1-5.

(1) The drier areas

Maroua in Cameroon received only a total rainfall of only 490.7 mm over 37 rainy days during the period June-September. Yet the yields of some short season sorghums are spectacularly high. The soils had somewhat high clay content.

Kano received a total rainfall of 637.6 mm of rain over 38 rainy days mostly between June and September. The soils were sandy. The fields allotted for our experimental work are reported to be problematic where sorghum never grew successfully. It is likely the soils are acidic and the pH is very low. Data are so variable and erratic that no statistical treatment is feasible.

(2) Moderately high rainfall areas

Samaru, in this zone, received a total rainfall of 768.5 mm over 65 rainy days. Total rainfall is below normal, but well distributed.

October rains enabled development of moulds on early sorghums and enabled screening for mould resistance.

(3) Heavy rainfall areas

Mokwa and Yandev received total rainfall of 958.6 and 1341.9 mm respectively. The crop management was poor at both locations. Besides, at Yandev the soil was problematic. Compared to Mokwa, the growing season at Yandev was longer.

No plant protection measures were taken at any of the stages, at all locations and the crops were grown totally under unprotected conditions.

Table-1. Rainfall (mm) over ten-day periods and number of rainy days (1982 rainy season)

		MAROUA	KANO	SAMARU	MOKWA	YANDEV
FEB	20-28	-	-	-	-	40.7 (1)
	Total	-	-	-	-	40.7 (1)
MARCH	1-10	-	-	-	-	21.3 (1)
	11-20	-	-	-	-	41.2 (1)
	21-31	-	-	-	64.2 (1)	10.0 (1)
	Total	-	-	-	64.2 (1)	72.5 (3)
APRIL	1-10	-	-	2.3 (1)	-	- (0)
	11-20	-	-	26.8 (5)	16.1 (3)	36.0 (1)
	21-30	-	4.2 (1)	30.6 (4)	15.2 (3)	28.2 (2)
	Total	-	4.2 (1)	59.7(10)	31.3 (6)	64.2 (3)
MAY	1-10	-	1.0 (1)	16.7 (2)	91.9 (5)	27.7 (2)
	11-20	-	-	22.1 (2)	9.7 (2)	39.4 (4)
	21-31	-	94.0 (3)	33.3 (3)	28.3 (1)	52.6 (3)
	Total	-	95.0 (4)	72.1 (7)	129.9 (8)	119.7 (9)
JUNE	1-10	35.3 (2)	7.7 (2)	8.1 (2)	28.2 (3)	104.1 (6)
	11-20	7.5 (1)	19.7 (2)	69.7 (3)	18.1 (2)	21.6 (1)
	21-30	17.9 (3)	62.4 (2)	36.1 (3)	36.7 (3)	147.5 (6)
	Total	60.7 (6)	89.8 (6)	113.9 (8)	83.0 (8)	273.2(13)
JULY	1-10	45.5 (4)	82.5 (4)	51.3 (4)	75.4 (4)	101.5 (4)
	11-20	21.5 (3)	19.6 (3)	76.5 (3)	64.9 (5)	20.0 (3)
	21-31	42.0 (3)	20.2 (2)	40.9 (3)	39.6 (4)	64.9 (4)
	Total	109.0(10)	122.3 (9)	168.7(10)	179.9(13)	186.4(11)
AUGUST	1-10	69.9 (5)	105.6 (6)	33.9 (4)	8.0 (2)	18.4 (3)
	11-20	46.2 (4)	55.7 (3)	45.5 (5)	15.8 (2)	5.8 (2)
	21-31	63.2 (3)	105.7 (4)	111.3 (8)	140.5 (8)	80.3 (4)
	Total	179.3(12)	267.0(13)	190.7(17)	164.3(12)	104.5 (9)

		MAROUA	KANO	SAMARU	MOKWA	YANDEV
SEPT	1-10	42.9 (3)	45.1 (2)	75.8 (7)	16.4 (3)	104.9 (6)
	11-20	72.9 (3)	3.2 (1)	33.0 (4)	107.9 (4)	68.9 (6)
	21-30	6.5 (1)	6.8 (1)	8.8 (1)	16.3 (3)	68.8 (4)
	Total	122.3 (7)	55.1 (4)	117.6(12)	140.6(10)	242.6(16)
OCT	1-10	19.4 (2)	4.2 (1)	45.8 (2)	82.6 (3)	93.8 (7)
	11-20	-	-	-	82.8 (4)	89.1 (4)
	21-31	-	-	-	-	63.2 (5)
	Total	19.4 (2)	4.2 (1)	45.8 (2)	165.4 (7)	246.1(16)
TOTAL FOR THE YEAR		490.7(37)	637.6(38)	768.5(66)	958.6(65)	1349.9(81)

- Figures in parantheses represent the number of rainy days during the period.

FIG. 1. RAINFALL (mm) AND RAINY DAYS AT 10 DAYS PERIOD (MAROUA, 1982)

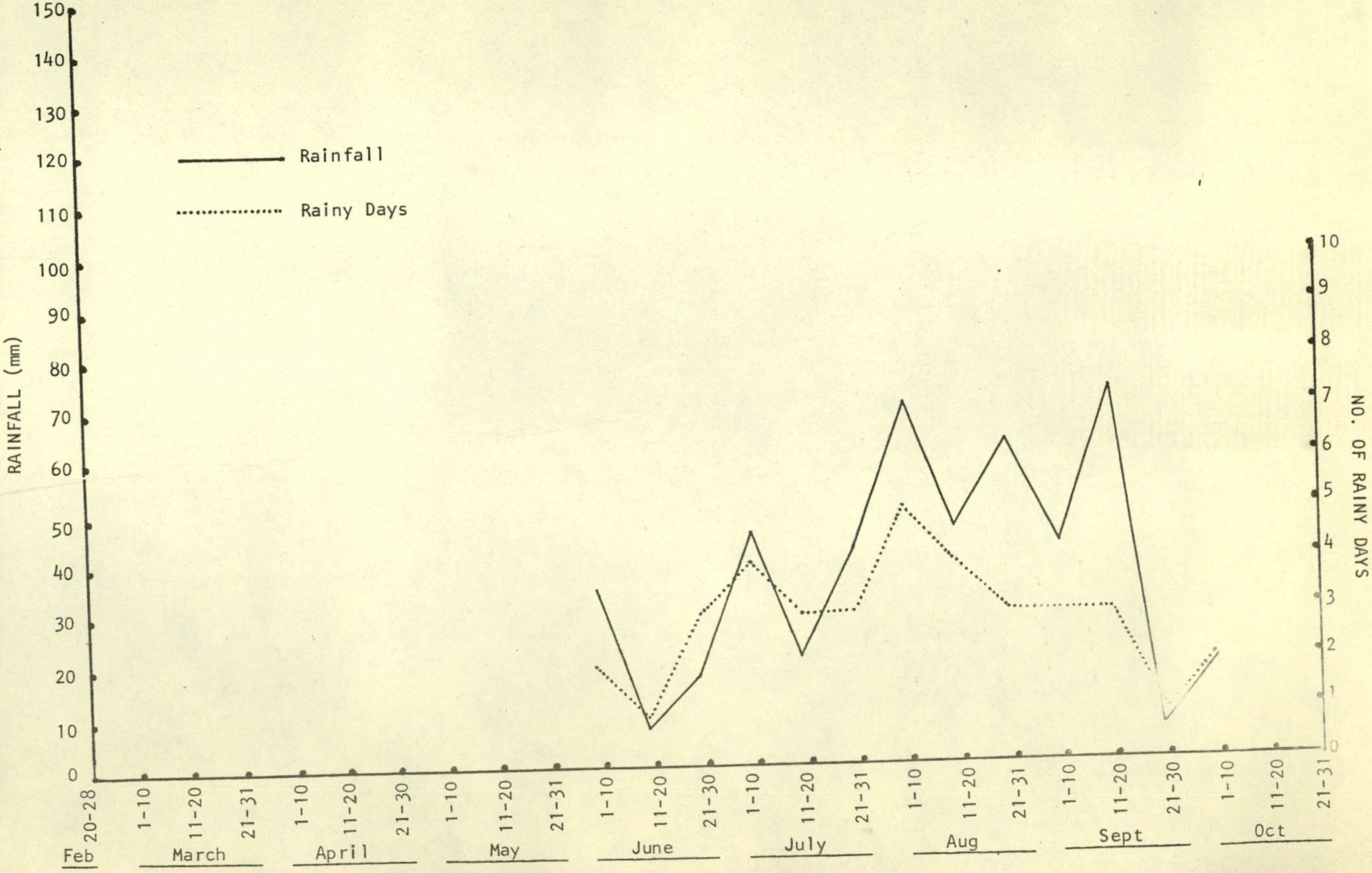


FIG. 2. RAINFALL (mm) AND RAINY DAYS AT 10 DAYS PERIOD (KANO, 1982).

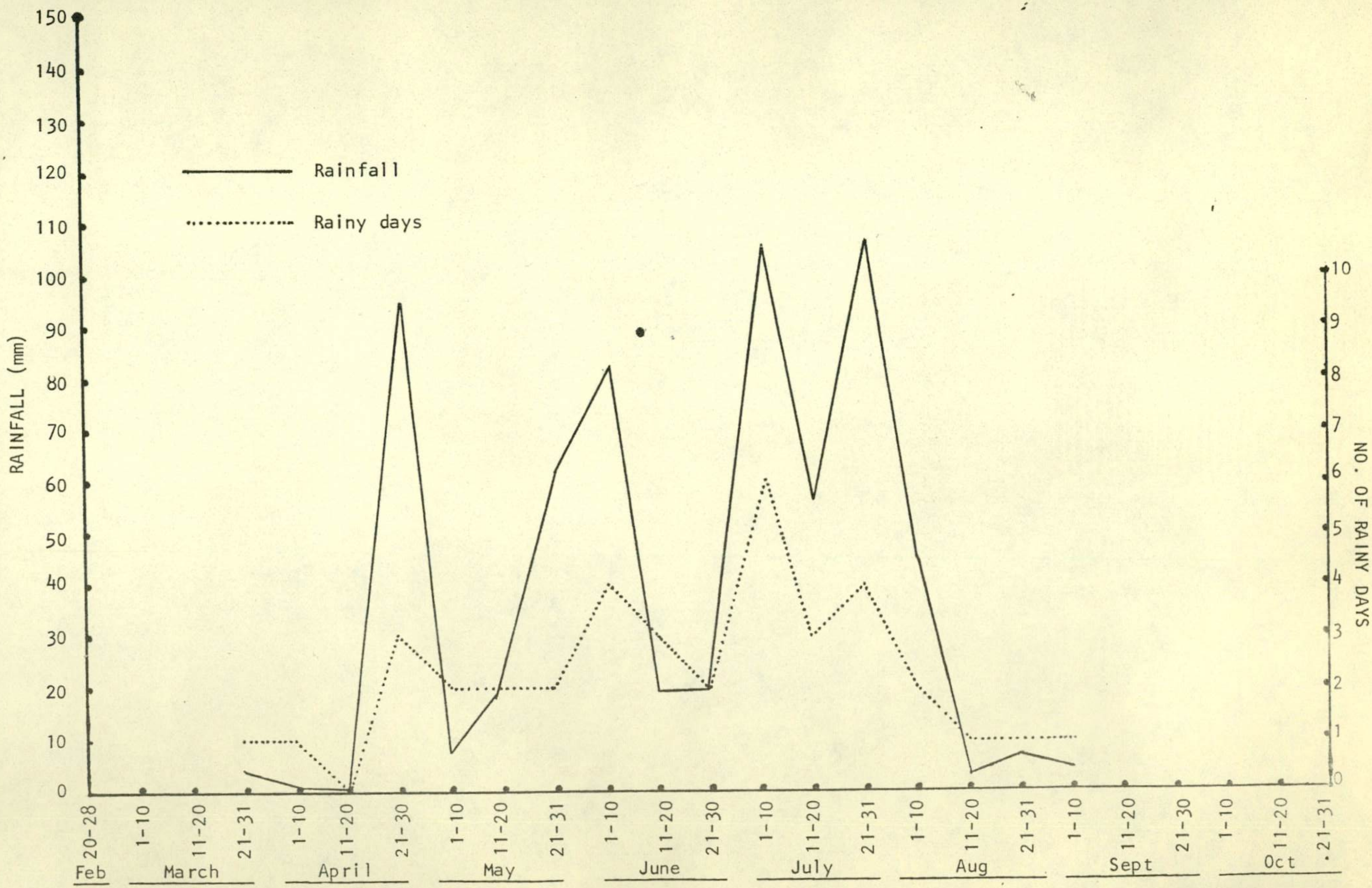


FIG. 3. RAINFALL (mm) AND RAINY DAYS AT 10 DAYS PERIOD (SAMARU, 1982)

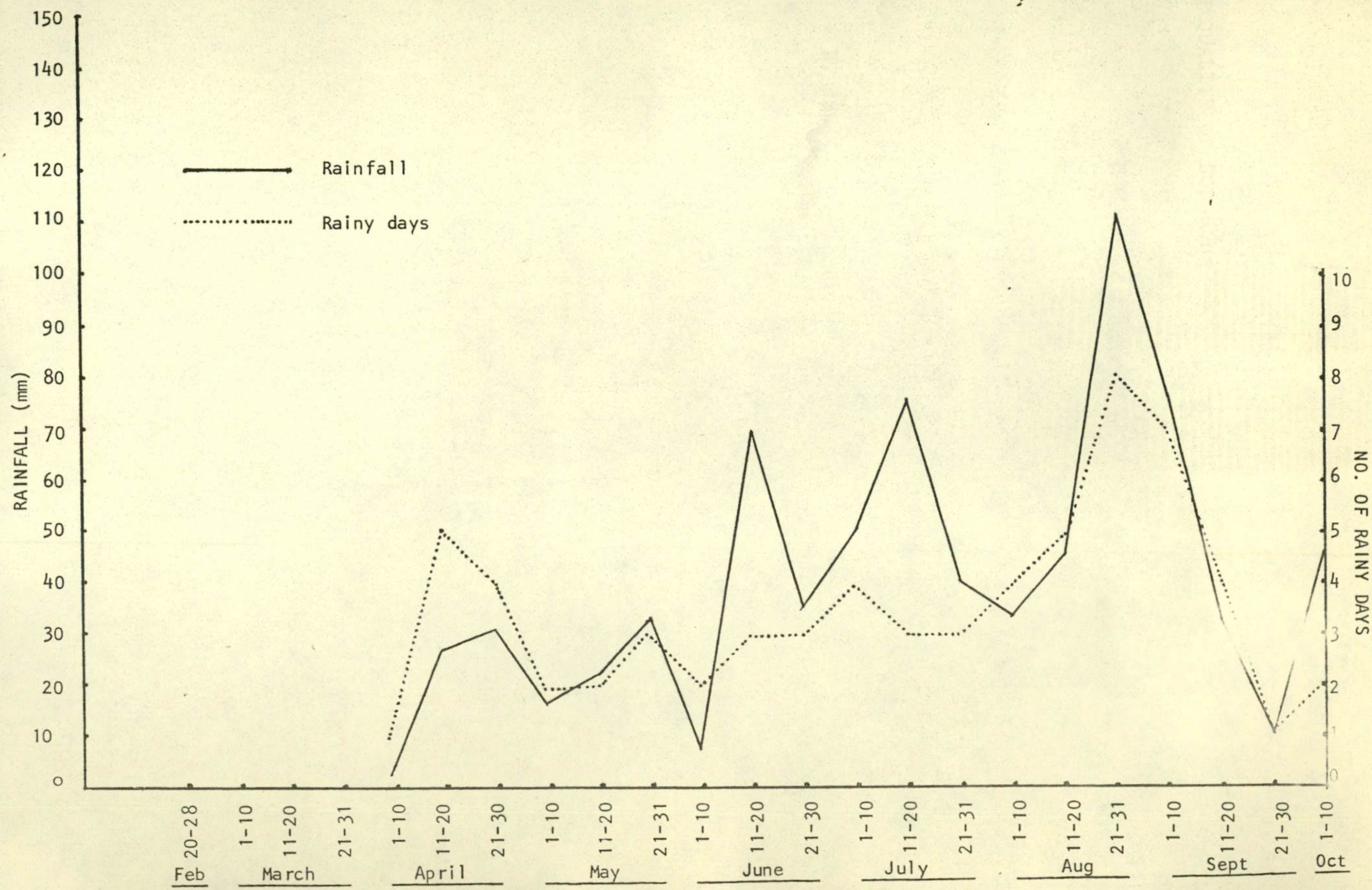


FIG. 4. RAINFALL (mm) AND RAINY DAYS AT 10 DAYS PERIOD (MOKWA, 1982).

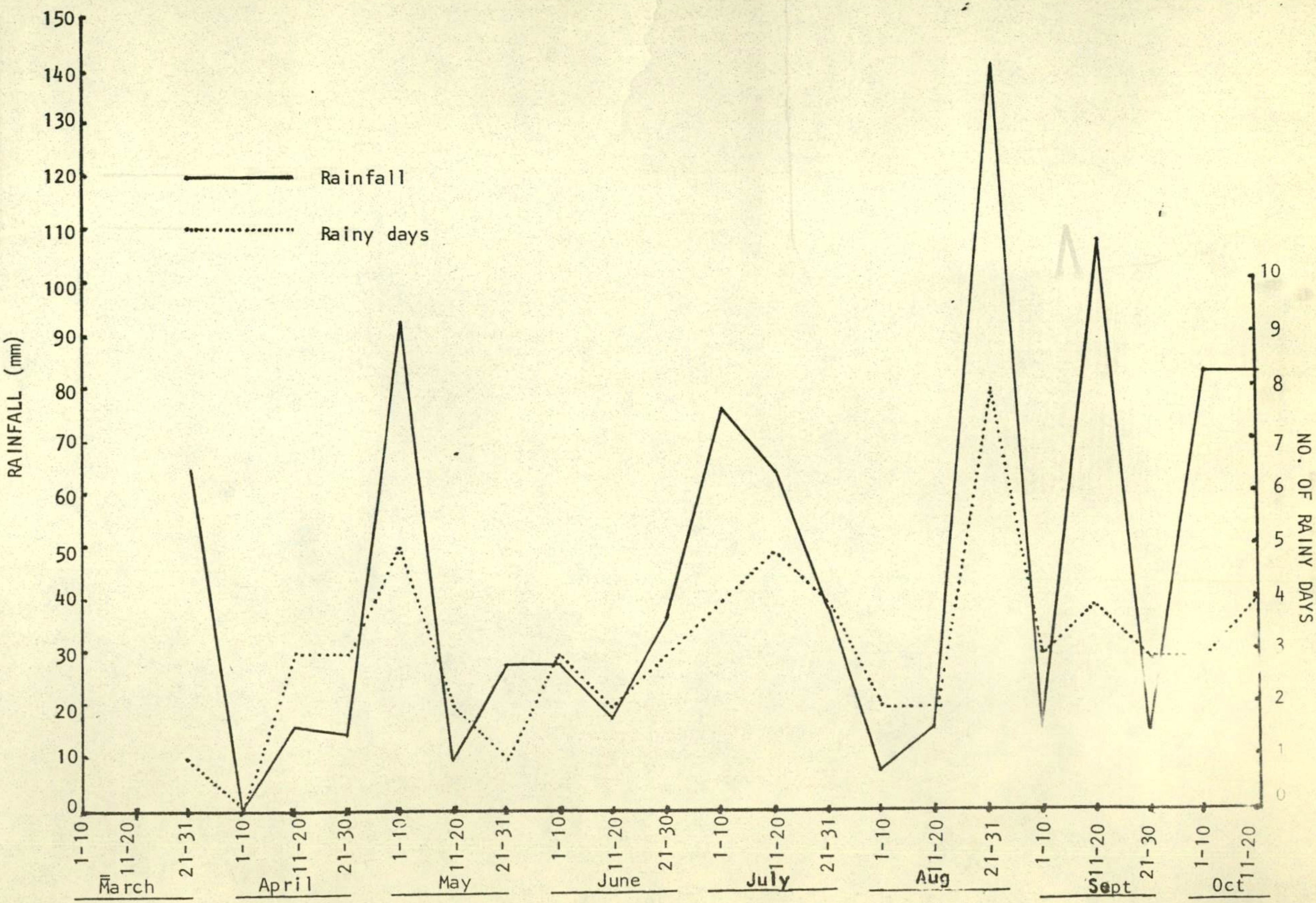
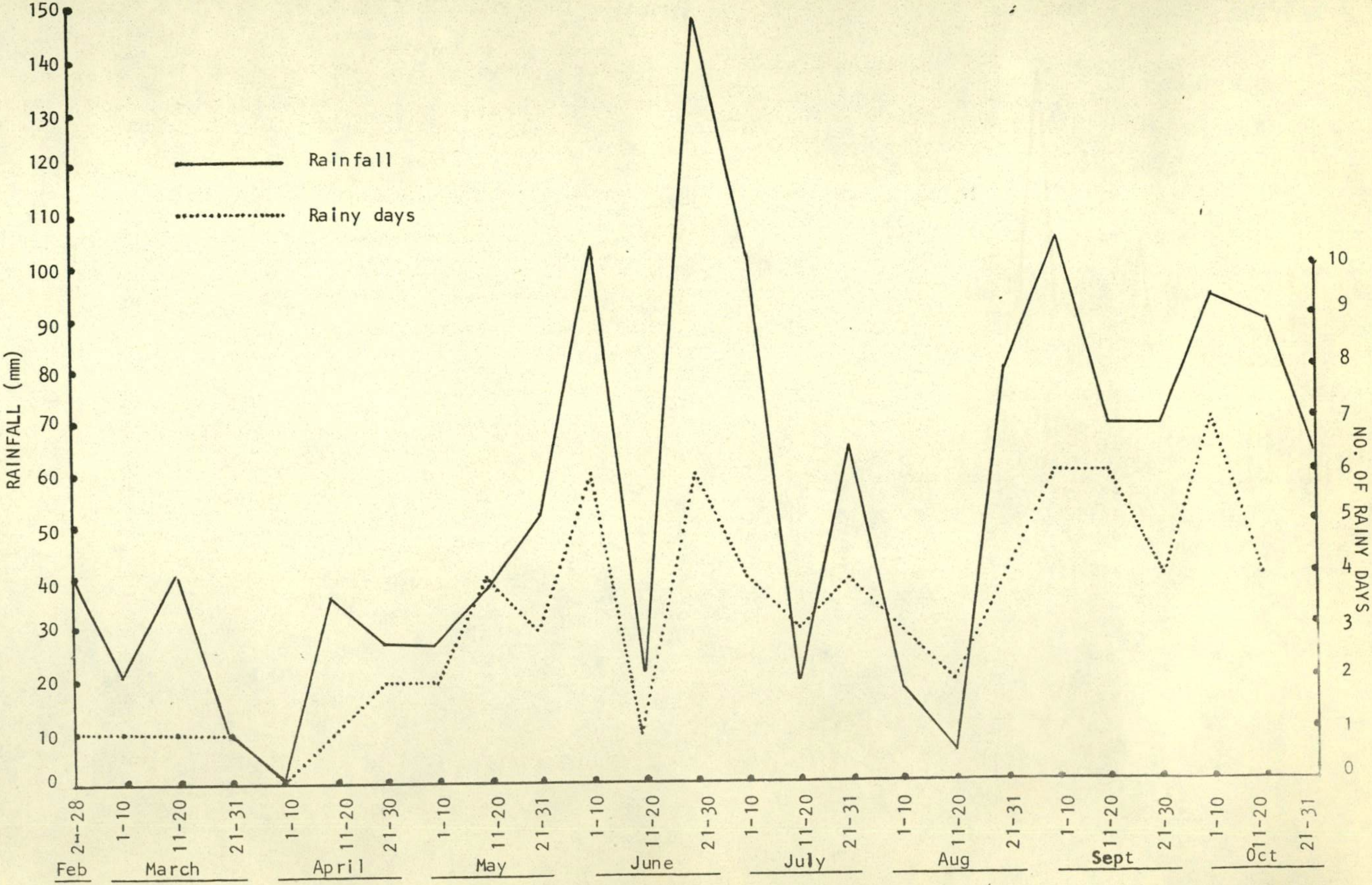


FIG. 5. RAINFALL (mm) AND RAINY DAYS AT 10 DAYS PERIOD (YANDEV, 1982).



III. PROBLEMS IN ADAPTATION - INSECT AND DISEASE RESISTANCE

When cultivars, particularly those bred-elsewhere are introduced, their reaction to the insect pest and disease complex is of considerable significance.

The problem of host plant resistance to stem borers, particularly *Busseola fusca*, has been studied in some detail during 1981, the results of which were presented in that report. Stem borers in West Africa cause both seedling deadhearts, stem tunnelling, damage to the peduncle and sometimes at the base as well.

(1) Seedling deadhearts

Seedling deadhearts result due to the attack of both stem borers and shootfly. During the normal season plantings deadhearts are primarily due to the stem borers and late plantings might occasionally result in heavy shootfly attack.

Seedling deadhearts at 4 locations - Samaru, Kadawa, Mokwa and Yandev were studied 40 days after planting. At Samaru, the studies were made under a normal June planting and a late July planting. At Kano, virtually, there were no deadhearts.

The studies were all replicated. Transformation of deadheart percentages into angles reduced coefficients of variability. The means (transformed values) for the five environments are presented in Table-2.

The values for Samaru normal plantings, Kadawa, Mokwa and Yandev represent deadhearts primarily due to stem borers. At Kadawa, the field was low lying and close to paddy fields and the insect activity could be diverse. The deadhearts were always more at the field borders where grass growth was profuse. The Samaru late planting was followed by a heavy rain and prolonged drought. This resulted in encrustation, poor germination and poor seedling growth. The shootfly attack was fairly severe and the deadhearts were due to shootfly and stem borers.

Table-2 presents mean values over all the five environments and also for the four environments which represented primarily stem borer attack. In all cases, varietal differences are statistically significant. There is also correspondence between the 5-location and 4-location means. This may be due to the weightage conferred by the 4 locations and may not necessarily be interpreted as correspondence between stem borer and shootfly damage.

The top entries which showed the least percentages are S2, S36 and S40. Several of the entries show moderate resistance and they could be considered along with yield and other attributes. Such entries include K4, S17, S19, S20, S35, S37 and SPV-245.

Based upon the values from the five environments, the stability of shootfly resistance has been analysed. The stability parameters are presented in Table-3 and figures 6 and 7. The most stable varieties are again S40, S36, S35 and S2. The stability of resistance of some of the agronomically desirable varieties is presented in Fig. 7. The entries K4, S17, S19, S32, S34, S35 and S37 are moderately stable.

Two regional trials from ICRISAT centre were received late and planted during late July. The seedling deadheart percentages are presented in Table-4. They could not be evaluated for yield. However, single plant selections have been made in the varietal trial.

Table-2. Seedling deadhearts (% transformed) at five locations, 1982.

Variety	Kadawa	Mokwa	Yandev	Samaru Normal planting	Samaru Late planting	Mean	Mean excl. late planting
K1	24.9	26.6	15.3	24.3	48.3	27.9	22.8
K2	42.9	41.2	21.8	33.7	59.9	39.9	34.9
K3	29.1	20.1	13.7	20.3	47.3	26.1	20.8
K4	29.9	26.0	19.3	13.4	49.6	27.7	22.2
K5	23.4	25.2	17.9	22.1	45.2	26.8	22.1
K6	24.6	25.6	14.2	23.2	54.3	28.4	21.9
S1	27.1	27.0	19.0	31.7	59.7	32.9	26.2
S2	17.8	19.8	11.5	16.2	47.4	22.5	16.3
S3	26.9	33.5	20.6	27.0	60.8	33.7	27.0
S4	25.2	26.7	25.2	33.9	57.1	33.6	27.7
S5	33.4	38.3	17.2	23.1	56.3	33.7	28.0
S6	48.6	42.0	23.5	33.5	69.0	43.3	36.9
S7	28.7	28.0	17.3	20.4	56.0	30.1	23.6
S8	31.2	35.6	15.4	19.0	52.4	30.7	25.3
S9	26.2	34.5	19.3	16.7	49.8	29.3	24.2
S10	26.6	36.5	12.2	20.4	48.1	28.8	23.9
S12	30.1	30.0	10.2	26.6	65.8	32.5	24.2
S13	36.7	25.5	8.3	21.7	46.9	27.8	23.0
S14	37.8	28.2	15.0	27.6	60.6	33.8	27.1
S15	39.1	18.8	16.7	25.9	56.8	31.4	25.1
S16	26.3	36.5	19.8	19.8	47.7	30.0	25.6
S17	23.8	29.0	13.0	15.3	54.4	27.1	20.3

Variety	Kadawa	Mokwa	Yandev	Samaru		Mean	Mean excl. late planting
				Normal planting	Late planting		
S18	31.1	21.5	13.9	18.4	53.7	27.7	21.2
S19	28.4	20.6	13.9	15.9	5.20	26.1	19.7
S20	29.8	23.5	13.5	14.7	54.0	27.1	20.4
S21	23.2	24.8	14.4	17.8	55.4	27.1	20.1
S22	19.9	23.0	11.7	22.1	45.9	24.5	19.2
S23	22.8	23.9	12.0	23.4	48.6	26.2	20.5
S25	22.6	27.7	23.4	23.0	55.7	30.5	24.2
S26	30.5	32.3	18.0	23.8	57.2	32.4	26.1
S27	19.9	27.7	33.0	23.8	55.9	32.1	26.1
S30	29.9	29.9	17.7	16.6	56.0	30.0	23.5
S31	35.0	38.3	30.9	29.9	57.5	38.3	33.5
S32	47.6	43.1	18.9	17.6	67.9	39.0	31.8
S34	38.3	29.0	18.3	21.0	48.7	31.1	26.7
S35	27.0	23.3	17.0	16.0	47.5	26.2	20.8
S36	20.6	14.7	16.3	14.0	43.6	21.8	16.4
S37	24.7	26.8	22.9	14.9	58.7	29.6	22.3
S39	50.2	55.9	24.4	32.5	77.7	48.1	40.7
S40	15.5	17.1	12.9	0.0	32.3	15.6	11.4
S41	40.2	36.5	22.1	22.5	45.8	33.4	30.3
S42	40.3	32.7	27.3	18.6	65.3	36.8	29.7
S43	41.4	43.5	33.3	24.8	75.3	43.7	35.8
S44	26.6	31.3	24.9	21.6	60.5	33.0	26.1
SPV-245	23.6	25.9	20.3	19.9	45.2	27.0	22.4
BES	28.7	38.6	27.9	25.1	49.9	34.0	30.1

Variety	Kadawa	Mokwa	Yandev	Samaru Normal planting	Samaru Late planting	Mean	Mean excl. late planting
SK	40.5	42.6	34.2	34.0	62.5	42.8	37.9
Local farafara	18.1	27.1	35.7	38.0	58.3	35.4	29.7
Mean	29.9	29.9	19.3	22.2	54.7	31.2	25.3
SEm	5.5	3.7	3.6	3.3	4.5	2.4	2.7
CD 5%	15.8	10.7	10.4	9.2	12.8	6.7	7.7
CV %	26.1	17.6	26.6	25.5	11.6	17.1	21.7

Table-3. Stability analysis for seedling deadhearts (% transformed)

Variety	a	byx	SE(b)	Reg.M.S.	Deviation mean squares
K1	27.9	0.86	0.11	569.5*	8.8
K2	39.9	0.95	0.19	697.3*	26.7
K3	26.1	0.90	0.14	633.2*	16.2
K4	27.7	0.96	0.15	709.7*	17.8
K5	26.8	0.75	0.07	442.2*	3.7
K6	28.4	1.07	0.11	890.0*	10.0
S1	32.9	1.06	0.22	866.2*	38.4
S2	22.5	1.01	0.10	786.6*	7.9
S3	33.7	1.11	0.13	955.0*	14.1
S4	33.6	0.86	0.27	575.4*	55.8
S5	33.7	1.05	0.16	859.4*	19.6
S6	43.3	1.19	0.19	1093.1*	28.1
S7	30.1	1.10	0.02	933.2*	0.2
S8	30.7	1.02	0.16	805.2*	21.0
S9	29.3	0.91	0.17	648.4*	22.2
S10	28.8	0.93	0.22	666.5*	39.1
S12	32.5	1.42	0.18	1578.1*	25.7
S13	27.8	0.94	0.28	681.5*	62.3
S14	33.8	1.17	0.20	1068.4*	29.6
S15	31.4	1.06	0.31	880.9*	76.1
S16	30.0	0.80	0.18	503.0*	24.8
S17	27.1	1.18	0.09	1083.5*	5.6
S18	27.7	1.11	0.14	955.4*	15.5
S19	26.1	1.09	0.12	926.8*	10.5

Variety	a	byx	SE(b)	Reg.M.S.	Deviation mean squares
S20	27.1	1.16	0.11	1055.4*	8.6
S21	27.1	1.17	0.07	1060.2*	3.4
S22	24.5	0.88	0.14	604.0*	16.3
S23	26.2	0.94	0.14	681.9*	15.7
S25	30.5	0.97	0.18	737.9*	24.7
S26	32.4	1.07	0.05	896.9*	1.9
S27	32.1	0.83	0.34	530.7	90.4
S30	30.0	1.13	0.08	989.7*	5.2
S31	38.3	0.80	0.07	493.6*	4.1
S32	39.0	1.41	0.33	1537.9*	82.6
S34	31.1	0.83	0.19	541.2*	29.5
S35	26.2	0.90	0.08	635.4*	4.5
S36	21.8	0.85	0.16	558.0*	20.5
S37	29.6	1.16	0.19	1054.0*	28.8
S39	48.1	1.42	0.27	1572.8*	57.9
S40	15.6	0.72	0.23	407.7	41.3
S41	33.4	0.66	0.23	335.8	39.7
S42	36.8	1.22	0.22	1156.0*	36.9
S43	43.7	1.33	0.19	1385.3*	27.0
S44	33.0	1.10	0.15	940.8*	18.4
SPV-245	27.0	0.74	0.07	429.0*	3.9
SK	34.0	0.83	0.05	538.3*	1.9
BES	42.8	0.68	0.16	357.3*	20.4
Local farafara	35.4	0.70	0.47	381.1	173.7

* Significant at 5%.

FIG. 6. STABILITY OF SEEDLING DEADHEART (%).

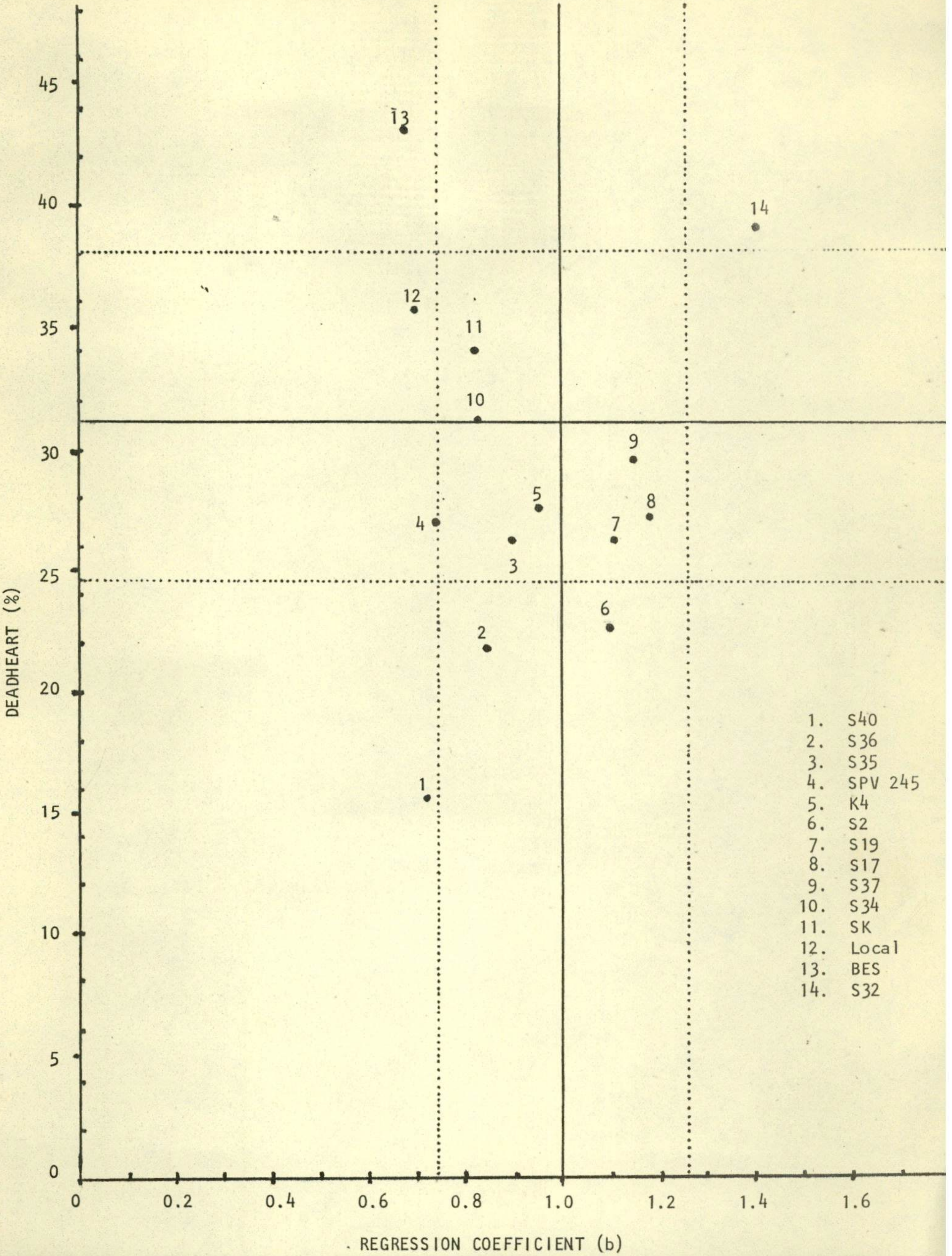


FIG. 7. STABILITY OF SEEDLING DEADHEART (%)

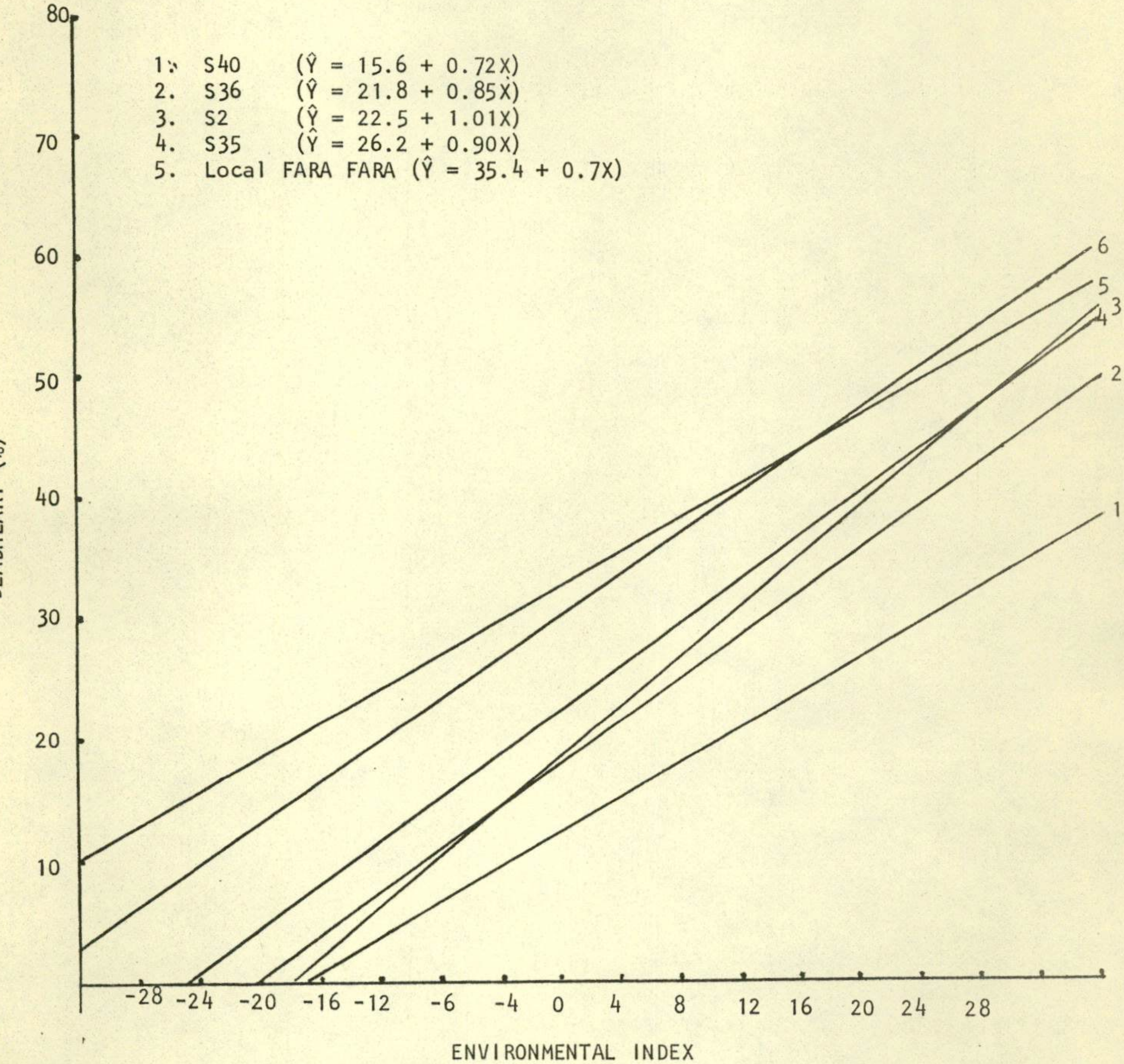


Table-4. Seedling deadhearts in International Sorghum Variety (ISVAT) and Hybrid trials (ISHAT).

1982 SAMARU LATE PLANTING

ISVAT			ISHAT		
Entry	% dead-hearts	Angles	Entry	% dead-hearts	Angles
A 13113	69.6	58.5	2219A x MR 702	54.9	47.8
A 13108	66.4	54.7	" x MR 801	67.3	55.4
A 13120	67.7	55.5	" x MR 802	60.0	50.9
A 13134	59.0	50.2	" x MR 806	60.5	51.1
A 13144	64.6	53.7	" x MR 819	62.6	52.5
A 13214	73.8	59.5	296A x MR 839	51.5	45.8
M 60252	53.9	47.3	" x MR 841	48.9	44.3
M 60256	65.5	54.1	" x MR 858	67.2	55.4
M 60263	39.4	38.9	" x MR 844	58.2	49.8
M 60264	68.2	55.8	" x MR 836	72.6	58.6
M 60272	43.3	41.1	2077A x MR 823	62.9	52.7
M 60297	54.0	47.3	" x MR 824	52.4	46.4
SAR-5	58.1	49.8	" x A 16051	56.1	48.6
SAR-9	52.1	46.2	" x A 16052	62.5	53.5
SAR-16	49.0	44.3	2219A x A 16001	60.5	51.5
D 71396	66.4	54.9	2219A x A 16003	55.7	48.5
D 71383	53.3	47.0	296A x A 16101	62.8	52.8
D 71390	49.9	45.0	" x A 16102	54.1	47.5
SPV-245	52.6	46.5	" x A 16103	59.8	51.0
SPV-346	48.4	44.1	" x A 16104	58.3	49.8
SPV-138	52.7	46.6	ICSV 107 (M 60252)	54.3	47.6
CSH-1	83.0	65.7	CSH-1	66.2	54.9
CSH-5	53.3	46.9	CSH-5	59.4	50.5
Local farafara	53.8	47.2	Local check (S.K)	60.9	51.3
GM	58.3	50.0		59.6	50.8
S.Em	6.6	4.1		8.5	5.2
C.D.(5%)	18.8	11.8		24.2	14.8
C.V. (%)	19.6	14.2		24.7	17.7

(2) Mature plant resistance to stem borers

The borer attack was heavier during the previous year when the very susceptibles were eliminated.

During the current year, stem borer damage at maturity of various entries has been evaluated by my colleague, Dr. MacFarlan, and will be reported by him.

A stage has now been reached that in entries selected for agronomic worth, there may be some tunnelling, but this does not apparently affect grain yield.

(3) Head bugs

Headbugs of various kinds have been observed, but compared to the Calocoris damage in India, the damage caused was not serious.

(4) Disease resistance

Compared to 1981, leaf diseases were low during 1982. The leaf disease reactions were reported during 1981 and they were maintained during 1982. All selected entries are superior to the locals and are near free or less susceptible to leaf diseases.

October rains enabled mould development and all the entries were scored for mould incidence and grain deterioration. Only those that combined yield with mould tolerance have been retained and a mention of them will be made later.

(5) Durable resistance

Screening of the same breeding material from dry to wet location under different planting times enabled identification of lines resistant to prevalent and potential pests and elimination of susceptible ones. This process led to the consideration of durable resistance. Selected material, limited in numbers, could now be studied in greater detail in the coming years.

IV. SELECTION AND ADAPTATION OF TROPICAL CULTIVARS

(1) Evaluation of selected lines

Based on the evaluation during the rainy season and offseason performance in the past, about 50 lines were selected for yield evaluation. These varieties were studied in two yield trials (Trials 1 and 2).

(a) Drier areas : The two trials with selected lines were conducted at Kano in Nigeria and at Maroua in Northern Cameroon by Dr. O.P. Dangi, Sorghum Breeder. The Maroua data will be reported by Dr. Dangi and should be viewed in conjunction with Samaru data. The Maroua trials also had a much higher population levels.

The Kano trials which were planted on June 30, 1982 ran into soil problems. The stands were excellent and there was drought after July 10. The plants started recovering towards the beginning of August and it looked as though it was an excellent opportunity to evaluate for seedling drought. The soils were very heterogeneous and we were later told that they had the history of sorghum failures. They were probably of low pH. Data from replication to replication were very variable and not amenable for analysis.

In trial 1, the entries K1, K4, S2, S13, S14, S16, S17, S20 and CSH-5 looked promising and were superior to Yargunki, the local check.

Trial 2 was more heterogeneous and in several cases, the plants collapsed. One interesting feature of this trial is, the entry S38 yielded reasonably well in all the three replications. If soil acidity is the real problem, then the utility of S38 for such soils needs to be further assessed.

(b) Moderately wet areas : The two trials were conducted at Samaru and plantings were done on June 21, 1982. For trial-1, the plot size was 4 rows, 3 m long spaced 75 cm apart. For trial-2, the plot size was 4 rows, 5 m long. Detailed data on initial stand, seedling dead-hearts, plant height, days to flower, number of earheads per hectare and grain yield are presented in tables 4 and 5.

In trial-1, the local Farafara yielded the maximum, but not so in trial-2. This descrepancy may, perhaps, be due to a possible mix up, which could not be rectified, or due to enhanced border effects in short row plots. common with talls; compared to trial-1 this trial was in a relatively low lying area and the moisture stress may also be less on the late locals. The recorded yield level is slightly over 5,000 kg/ha while in trial-2, it is 2,733 kg/ha which is more realistic and comparable to those obtained in several University experiments as well. Amongst earlies BES is the best available improved variety.

Trial-1 : In trial-1, the entries K4, K5, S2, S10, S13, S17, S20, SPV-245 and CSH-5 are promising. In case of CSH-6, the germination was poor and the stands were low. While CSH-5 has yielded well, the hybrid did not exhibit superiority over the best varieties (Table-5).

Trial-2 : In trial-2, the entries, S32, S33, S34, S35, S36, S37, S38 and S40 are promising for yield (Table-6).

(c) Wet areas

Forty nine entries from the two trials-1 and 2 were grown in a single trial with two replications at Mokwa and Yandev. The trial at Mokwa was planted on August 19, 1982 and at Yandev on August 16, 1982. Management at both locations was poor; besides at Yandev, the plot allotted had the history of not being suitable for sorghum.

The yields of promising entries at Mokwa are as follows :

K4	-	2367	kg/ha
S21	-	2733	"
S35	-	2733	"
S40	-	2467	"
BES	-	1567	"

The above entries also looked promising at Yandev.

Table-5. Selection and adaptation of tropical cultivars (Trial-1) - Samaru 1982 rainy season

S.No.	Selection	Pedigree	Initial stand/ha	Normal planting deadhearts at 40 days		Deadhearts in late planting at 40 days		Plant height (cm)	Days to flower	Plant aspect score	No. of heads/ha.	Grain yield (kg/ha)
				%	Angles	%	Angles					
1.	K1	SPV-315	52,222	17.1	24.3	55.7	48.3	153	76	3.8	44,111	3744
2.	K2	SPV-301	50,000	31.0	33.7	74.9	59.9	120	71	1.5	47,777	1922
3.	K3	M 36411	57,777	12.2	20.3	54.0	47.3	170	71	2.7	51,444	3744
4.	K4	M 36037	67,110	6.4	13.4	58.1	49.6	177	70	3.8	61,111	4778
5.	K5	M 39281	51,444	14.9	22.1	50.3	45.2	210	76	3.3	50,000	4111
6.	K6	D 82066	46,666	15.7	23.2	65.9	54.3	133	77	2.0	44,111	1967
7.	S1	SPV-126	60,777	27.9	31.7	74.6	59.7	167	70	2.5	56,333	3589
8.	S2	Eth.12089	56,666	7.8	16.2	54.2	47.4	213	78	3.7	46,333	4589
9.	S3	SPV-220	51,444	20.7	27.0	75.3	60.8	110	74	1.2	39,666	2556
10.	S4	SPV-221	39,666	31.2	33.9	70.1	57.1	120	75	1.5	39,666	1967
11.	S10	SPV-301	54,777	12.1	20.4	55.2	48.1	150	71	3.2	58,888	4078
12.	S12	SPV-312	58,882	20.2	26.6	83.2	65.8	133	75	3.7	53,333	3367
13.	S13	SPV-313	56,666	14.5	21.7	53.3	46.9	140	71	3.2	61,444	3811
14.	S14	SPV-314	57,444	22.2	27.6	75.6	60.6	137	70	3.7	45,555	3367
15.	S15	SPV-314	52,999	19.5	25.9	70.0	56.8	133	74	3.2	43,666	3256
16.	S16	SPV-314	59,999	12.0	19.8	54.6	47.7	197	80	4.3	49,222	3367
17.	S17	SPV-314	56,333	7.1	15.3	65.9	54.4	150	70	3.8	56,666	4589
18.	S18	SPV-315	52,999	12.3	18.4	64.9	53.7	143	75	3.8	48,555	4189
19.	S19	SPV-315	53,330	7.8	15.9	61.9	52.0	143	74	4.0	50,333	4144
20.	S20	SPV-315	59,666	6.7	14.7	65.4	54.0	150	73	4.0	58,111	4411
21.	S21	SPV-315	54,444	10.0	17.8	67.7	55.4	150	75	3.8	48,888	3967
22.	S22	SPV-315	52,222	15.4	22.1	51.6	45.9	147	75	3.7	41,888	3444
23.	S23	SPV-315	46,666	15.8	23.4	56.2	48.6	157	75	4.0	39,222	3633
24.	SPV-245	SPV-245	54,111	11.7	19.9	50.4	45.2	150	76	3.3	48,888	4300
25.	CSH-5	(2077A x CS3541)	57,444	17.6	24.7	70.8	57.3	160	70	3.7	55,555	4478
26.	CSH-6	(2219A x CS3541)	23,000	27.7	31.2	74.3	59.6	140	66	3.3	31,888	1778
27.	L 187	Imp.variety	44,444	35.3	36.3	43.7	41.3	200	109	1.2	23,666	1633
28.	S.K	Short Kaura	46,333	31.4	34.0	77.6	62.5	260	111	2.5	37,444	2778
29.	L 1499	Imp.variety	58,555	26.2	30.7	75.0	60.0	227	108	2.5	50,777	2778
30.	Local	Farafara	55,555	38.0	38.0	72.5	58.3	440	109	2.5	54,444	5000
	G.M.		52,999	18.3	24.3	64.1	53.5				48,111	3440
	S.Em			4.2	3.2	7.0	4.3					233.3
	C.D.(5%)			12.1	9.3	20.1	12.4					677.8
	C.V.(%)			39.6	23.0	15.4	11.3					11.7

SB-27

Table-6. Selection and adaptation of tropical cultivars (Trial-2) - Samaru 1982 rainy season

S.No.	Selection	Pedigree	Initial stand/ha	Normal planting deadhearts at 40 days		Late planting deadhearts at 40 days		Plant height (cm)	Days to flower	Plant aspect score	No. of heads/ ha.	Grain yield (kg/ha)
				%	Angles	%	Angles					
1.	S5	SPV-255	55,336	16.1	23.1	68.8	56.3	173	66	1.7	53,336	2489
2.	S6	SPV-265	56,003	31.7	33.5	87.1	69.0	173	73	2.3	53,336	2800
3.	S7	SPV-266	54,003	12.8	20.4	67.7	56.0	177	77	1.7	58,003	2644
4.	S8	SPV-290	61,336	12.1	19.0	62.9	52.4	143	61	2.5	59,336	3111
5.	S9	SPV-298	56,670	8.2	16.7	58.3	49.8	163	73	2.2	58,003	3311
6.	S24	SPV-321	57,336	20.8	25.8	69.6	56.5	107	61	1.7	65,336	3556
7.	S25	SPV-338	49,336	15.7	23.0	66.8	55.7	140	67	2.5	54,669	3067
8.	S26	SPV-342	58,003	16.7	23.8	70.7	57.2	133	64	1.8	66,670	3445
9.	S27	SPV-388	52,669	16.6	23.8	68.5	55.9	120	78	1.5	50,669	2111
10.	S28	SPV-104xCS3541	57,336	6.9	14.5	75.0	60.1	193	76	1.7	61,336	3511
11.	S29	"	54,669	9.8	18.0	74.4	59.6	170	76	1.7	54,003	3467
12.	S30	SPV-104x148/168	52,003	10.1	16.6	68.6	56.0	183	74	1.7	49,336	2467
13.	S31	A 6291	47,336	24.9	29.9	71.1	57.5	150	76	3.0	43,336	3467
14.	S32	A 6213	57,336	9.3	17.6	85.8	67.9	173	76	3.5	53,336	4622
15.	S33	A 6286	56,669	18.4	25.3	76.3	60.9	200	76	2.8	52,003	4089
16.	S34	Sepon 103('80 nur.)	57,336	13.7	21.0	56.4	48.7	183	76	4.3	55,336	4733
17.	S35	M 91019	58,003	7.7	16.0	54.3	47.5	190	62	3.8	52,003	4489
18.	S36	M 90411	58,670	6.1	14.0	47.6	43.6	157	71	3.8	56,003	4045
19.	S37	M 36170	60,003	7.7	14.9	73.0	58.7	207	81	4.5	54,669	4111
20.	S38	H 166	59,336	20.6	24.9	74.0	59.5	190	69	3.5	61,336	4156
21.	S39	SF 62	56,003	28.9	32.5	95.4	77.7	147	71	1.5	52,003	2000
22.	S40	Eth. 12089	57,336	0.0	0.0	28.6	32.3	230	77	4.3	51,336	5089
23.	S41	GSA 766	57,336	15.7	22.5	51.4	45.8	157	73	3.8	48,002	3333
24.	S42	GSA 932	54,669	10.6	18.6	82.6	65.3	160	68	2.2	48,669	3111
25.	S43	470	56,003	18.0	24.8	91.6	75.3	163	71	2.7	65,336	4245
26.	S44	SPV-104xCS3541	52,669	13.7	21.6	74.9	60.5	163	77	2.5	53,336	3533
27.	BES	Imp.variety	52,669	18.5	25.1	58.5	49.9	170	66	3.3	59,336	4333
28.	YG	Imp.variety	55,336	13.9	18.1	74.2	59.5	380	93	2.5	38,668	3267
29.	L 187	Imp.variety	49,336	29.9	29.9	81.4	64.6	217	107	1.5	27,335	1245
30.	S.K.	Imp.variety	48,669	15.4	22.5	84.4	66.7	257	110	2.5	31,335	2067
31.	L 1499	Imp.variety	62,670	11.7	19.1	56.4	48.7	233	106	2.5	50,003	2622
32.	Local	Farafara	56,003	31.2	33.9	93.3	75.0	427	108	2.5	54,003	2733
	GM		55,336	15.4	21.6	70.3	57.8				52,669	3352
	S.Em			4.5	3.7	5.9	4.0					238.1
	C.D.(5%)			12.8	10.6	16.9	11.5					673.5
	C.V.(%)			50.9	30.1	11.9	9.8					12.3

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(2) West African Regional Trial

Data from a West African regional trial conducted at Samaru on 4 row plots with 3 replications are presented in Table-7. This trial-3 was sown on 22.6.1982.

The highest yielding entry in this trial was SRN-4841, followed by K5 and S18. SRN-4841 is highly susceptible to leaf diseases, but known to be resistant to striga. The seeds are brown. K5 and S18 have very little leaf disease and white pearly grain. K5 has a tendency to lodge. SRN-4841 is a good base for further improvement.

Table-7. Selection and adaptation of tropical cultivars (Trial 3) - Samaru 1982 rainy season

S.No.	Entry	Initial stand/ha	Deadhearts at 40 days %	Deadhearts at 40 days Angles	Plant height (cm)	Days to flower	Plant aspect score	No. of heads/ha	Grain yield (kg/ha)
1.	M 61006	53,334	12.2	20.2	137	61	2.8	48,467	3089
2.	TNI-20	47,134	22.1	27.8	160	70	1.5	58,000	3445
3.	M 62641	51,134	3.7	9.0	170	65	3.2	50,200	3600
4.	SUCR : 35 : 5	50,200	34.8	36.0	153	76	2.8	72,867	3733
5.	TNI-16	51,800	34.4	35.6	147	71	1.7	61,800	3533
6.	M 90950	56,467	16.0	23.2	163	74	3.3	52,200	3200
7.	SUCR:36:80/70	35,534	17.7	24.7	127	76	1.5	54,000	2378
8.	123-2	43,134	23.4	28.6	163	70	2.7	42,867	3333
9.	SRN-4841	53,134	10.8	19.1	197	64	2.5	65,800	5467
10.	212-10	42,000	8.8	17.1	163	69	1.7	40,867	3467
11.	Dabr 1-1-1-1	52,467	11.0	19.3	163	74	1.8	56,200	4067
12.	K5	57,534	3.5	10.6	207	71	3.2	49,334	4600
13.	S16	59,134	10.9	19.2	200	80	4.2	48,000	3422
14.	S18	58,467	6.9	14.3	160	74	4.0	56,000	4200
15.	S30	46,200	21.9	27.8	173	77	2.3	37,334	1845
16.	S31	46,667	17.0	24.2	143	75	3.0	43,800	3333
17.	S44	50,667	12.0	19.6	170	77	2.8	48,200	3133
18.	Short Kaura (local check)	52,867	14.6	22.2	253	111		41,334	2867
	G.M.	50,437	15.6	22.1				51,515	3484
	S.Em		3.7	3.0					325.1
	C.D. (5%)		10.7	8.5					993.4
	C.V. (%)		41.3	23.1					16.2

SB-30

(3) Promising selections

Based on the studies at Samaru and observations at Kano, Mokwa and Yandev, the following selections may be considered promising (Table-8). Their performance at Maroua will be compared, but visual observations indicated their promise at Maroua (Camaroon) as well.

The trials clearly separate the high yielding from the low yielding. Their insect and disease reactions and behaviour of yield at a range of planting dates and locations is available.

The yields reported are at constant populations of 50-55 thousand plants per hectare which is known to be optimum for the local farafara and other local improved varieties. The short and early duration varieties can take populations upto 150,000 plants per hectare. To optimize their yields, it is necessary to work out the production technology.

Out of the 14 lines listed, some of them like S40, S35, S19/S20/S21, K4, etc., are promising under August plantings as well and could stand a range of planting dates. Such varieties will provide the basis for studies for new cropping systems - inter-, relay- and sequence.

The striga resistant SRN-4841 could provide the basis for improving West African sorghums. Based on present data on yield, insect and disease resistance, a useful crossing programme could be developed.

Table 1 Some promising sorghum selections identified by ICRISAT/SAFGRAD Sorghum Breeding program.

Table-8. Some promising selections

S. No.	Selection/ Entry	Pedigree	Initial stand	No. of heads at harvest	Mean dead-hearts (% transformed)	Plant height (cm)	Days to flower	Plant aspect score	Average Grain yield (kg/ha)
1.	S10	SPV-301	54,777	58,888	28.8	150	71	3.2	4078
2.	S13	SPV-313	56,666	61,444	27.8	140	71	3.2	3811
3.	S17	SPV-314	56,333	56,666	27.1	150	70	3.8	4589
4.	S 19/20	SPV-315	59,666	58,111	27.1	150	73	4.0	4411
5.	S32	A 6213	57,336	53,336	39.0	170	76	3.5	4622
6.	S34	Sepon 103 (1980 nursery)	57,336	55,336	31.1	180	76	4.3	4733
7.	S35	M 91019	58,003	52,003	26.2	190	62	3.8	4489
8.	S36	M 90411	58,670	56,003	21.8	160	71	3.8	4045
9.	S37	M 36170	60,003	54,669	29.6	210	81	4.5	4111
10.	S38	H 166	59,336	61,336	-	190	69	3.5	4156
11.	S40	Eth. 12089	57,336	51,336	15.6	230	77	4.3	5089
12.	K4	M 36037	67,110	61,111	27.7	180	70	3.8	4778
13.	SRN-4841		53,134	65,800		200	64	2.5	5467
14.	SPV-245		54,111	48,888	27.0	150	76	3.3	4300

SB-32

(4) Other Regional Trials

During 1981, a regional trial of direct introductions was conducted in Mauritania. Plantings were done on July 20, 1981. The yield data are presented in Table-9. SPV-35, CSH-1 and SPV-161 exhibited some promise.

Of the early entries tested in non-replicated blocks, CE-151 recorded a grain yield of 3460 kg/ha followed by CE-145 with 3000 kg/ha.

At D'ina (Benin), six improved varieties of Nigerian origin were grown. Of them, L-1499 was the highest yielder. At Saria (Upper Volta), the Nigerian entry 38-3 was the highest yielder with 3057 kg/ha. In Camaroon, CE-151, CE-145, and BES, all of which are early exhibited some progress. The regional trial was erratic.

None of these experiments may be considered valid since these stray studies lack consistence.

Table-9. Yield data of direct introductions in Mauritania

1981 RAINY SEASON

Varieties	grain yield (kg/ha)
CSH-6	2590
CSH-1	3295
CSH-5	2960
SPV-220	1850
SPV-316	1700
SPV-313	2590
SPV-138	815
SPV-221	445
SPV-314	2700
SPV-224	1850
SPV-260	1035
SPV-35	4135
SPV-161	3550
CSH-9	2405
SPV-245	2150
SPH-200	1295
SPV-99	1185
CSV-4	2000
SPV-315	2665
SPV-92	1260
CSM	2000
Temoin Fella	-

V. EVALUATION OF NIGERIAN SORGHUM COLLECTION

The genetic resources unit of ICRISAT made available small quantities of seed of 203 collection of sorghum, made primarily in Northern Nigeria during the 1981 rainy season.

These collections were grown in single rows (3m long, 75 m apart) during the 1982 rainy season at Samaru. The plantings were done on 22.6.1981 at the lowest end of the field. Observations were recorded on, (1) number of plants in a row after final thinning, (2) number of deadhearts at 40 days, (3) number of ear bearing plants at harvest, (4) plant height (cm), (5) days to flower, (6) earhead weight, (7) grain weight, and (8) threshing %. Plant height and days to flower were based on a single observation while earhead weight, grain weight and threshing % were based on 3 individual plant observations per line. The data are appended in Table-10.

The collection was studied with the following objectives :

(a) Whether there is adequate variability among collections (mostly late and tall) so as to warrant selection and isolation of superior types.

(b) Whether the hybrid races established under natural selection have advantages of yield or other attributes so as to warrant their further exploitation.

The following are the salient features of the study :

(1) The collection

Both according to the tentative classification of K.E.Prasada Rao's on the spot, and our assessment, several of the collections represent hybrid races. A better classification may be :

(a) Original land races

(b) Recombinants as a result of natural hybridization and selection

(c) Mutant forms

The Kano-Samaru belt across the Northern latitudes of Nigeria is a mleting pot in the sense that there has been considerable hybridization between farafaras (Guinea types), Caudatums, durras, broom corns, conspicums and other forms.

The Southern latitudes represent a near monolith of the farafara (Guinea) types with occasional fields of caudatums or other groups.

(2) Disease resistance

The collection does not provide any variability for disease resistance in that all of them are susceptible for leaf spots, primarily the grey leafspot.

(3) Incidence of borers

The incidence of stem borers is also common in all collections. The initial stand count, the deadhearts and the number of ear-bearing plants do appear to provide some variability. Selected lines need assessment in replicated trials. Those that offer promise in this respect are : S.Nos. 15, 45, 51, 59, 65, 69, 72, 78, 82, 85, 91, 92, 94, 126, 128, 138, 144, 145, 160, 162, 180 and 183.

The mature plant resistance to stem borers has been evaluated by Dr. MacFarlan.

(4) Grain yield

Yield data for which individual plant observations were available on 186 collections were critically analysed.

The range for grain yield was from 13.7 to 172.7 g per plant with a mean ($\bar{X}$) of 98.1 g and S.D. 35.7. There is adequate variability for yield in the collections.

The analysis of variance for grain yield is as follows :

Table-11. ANOVA for grain yield

Source	D.F.	M.S.	F.
Between varieties	185	3824.2**	6.95
Within varieties	372	550.4	

S.Em = 19.16
C.D.(5%) = 37.54
C.V.(%) = 23.91

Using one standard deviation as the class interval, the yield classes were divided into 5 groups as follows :

Table-12. Frequency distribution for grain yield

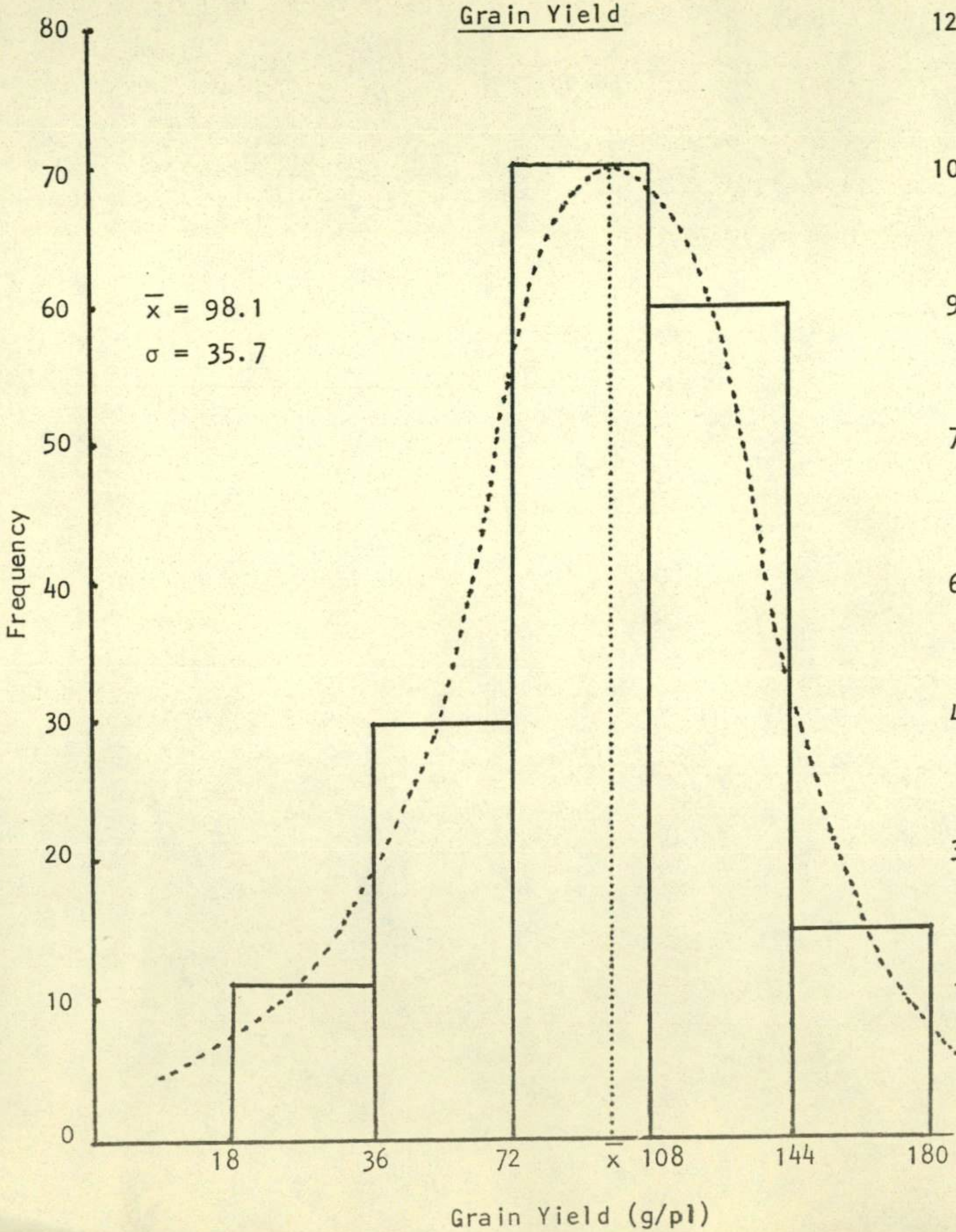
Yield group	No. of collections in the group
0 - 36 g	11
37 - 72 g	30
73 - 108 g	70
109 - 144 g	60
145 - 180 g	15

The frequency distribution for grain yield is near normal (Fig. 8).

Varieties with an average single plant yield level of more than 135 g per plant represent the highest yielding class. They are presented in Table-13. Out of these, S.Nos. 51, 59, 65, 69, 72, 78, 82, 92, 126, 128, 138, 144, 162 and 183 combine insect tolerance with yield.

Threshing % ranged from 39.1 to 89.5 with a mean of 70.9. The extreme cases were both low yielding.

FIG.8. FREQUENCY DISTRIBUTION IN NIGERIAN COLLECTION (SAMARU, 1982)



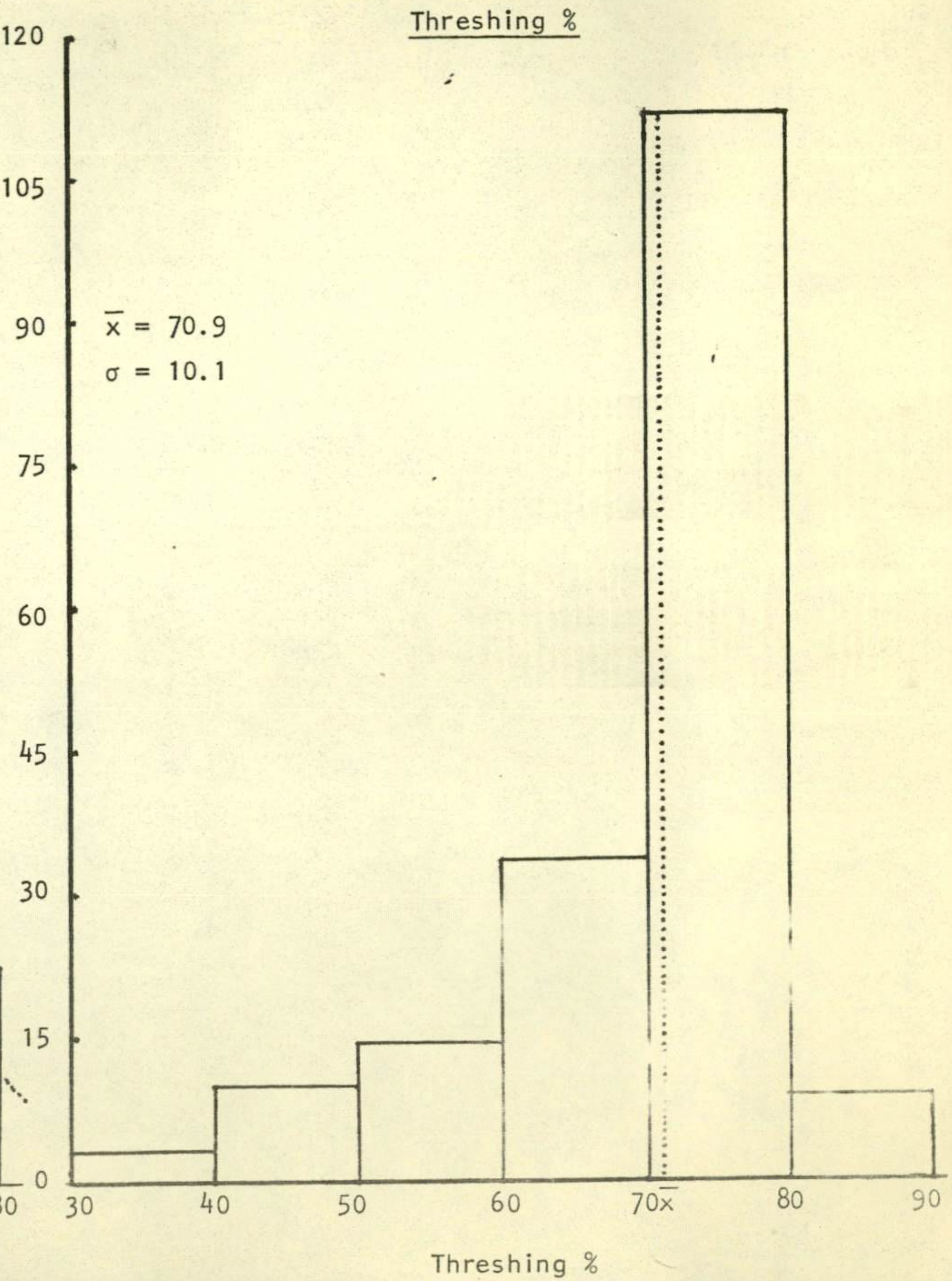


Table-13. Particulars of high yielding collections.

Nursery No.	Collection No.	Origin		Local name
674	S1	Kaduna	(Giwa)	Farafara
681	S10	Kaduna	(Gora)	Kaura
683	S15	Kano	(Garo)	Kaura
686	S18	"	"	Kaura
692	S24	"	"	Kaura
694	S26	"	"	Farafara
701	S33	"	(Utai)	Farafara
704	S36	"	"	Kaura
713	S50	"	(Wudil)	Kaura
714	S51	"	"	Kaura
716	S53	"	"	Kaura
721	S58	"	"	Farafara
722	S59	"	"	Farafara
726	S63	"	"	Farafara-yala
727	S65	Bauchi	Zindi	Farafara
728	S66	"	"	Kaura
729	S67	"	"	Kaura
731	S69	"	Kari	Kaura white
732	S70	"	"	Farafara
734	S72	"	"	Kaura
737	S76	"	"	Farafara
739	S78	"	"	Farafara
742	S82	Borno	Potiskun	Kaura
752	S92	"	Bama	Chakkalani-Fari
784	S126	Gangola	Mubi	
786	S128	"	"	
794	S138	Borno	Biu	
800	S144	Bauchi	Biu	
818	S162	"	Badarumo	Kaura
829	S173	"	Nailo	Kaura
838	S183	"	Bauchi	

Total 31 (16.7%)

(5) Panicle components

The collections were arbitrarily grouped on the basis of the panicle types and a few representatives for each group were studied in detail for the panicle components. The entire data is not presented here.

Out of them, the panicle components of only the high yielding collections are presented in table-14. The primary purpose is to see whether the high yielding types conformed to any specific group.

An examination of the panicle morphology reveals that high yields could be obtained in the backgrounds of farafara (Guinea), caudatum or hybrid combinations of CG, GC and even against a broom corn background.

(6) Natural hybridization and selection

Hybridization and natural selection does lead to high yield types but the hybrid forms are at best as superior as a guinea or caudatum. This results in several inferior types which continue to occur in natural populations and tend to reduce population yields. At this stage, it is rather difficult to state that such natural hybridization and selection has led to isolation of forms that are superior to the best available farafaras or caudatums. There is no doubt considerable recombination occurred between panicle components, but under natural selection they do seem to compensate and the high yield forms are obtained against all hybrid combinations.

This being the case, the question is whether controlled hybridization and selection under carefully planned mating systems could result in hybrid derivatives superior to the best parental forms. To me, this appears feasible and if we are to breed for late maturing types, only such carefully planned approach might yield results of some significance. Presently, for farafara and other late types at optimal population levels of 50,000 plants per hectare yield levels of 2000-5000 kg/ha are feasible depending upon the seasonal conditions and inputs applied. The 200-2500 kg/ha yield level is more common under optimal management. Of course, there is the inherent danager of crop failure of lates, particularly, when late rains fail.

If a late variety is to be bred, one has to concentrate on average per plant yields of 150-200 g and this may be feasible through controlled recombination breeding.

Table-14. Panicle components of some high yielding collections

Nursery No.	Collection No.	Panicle length (cm)	Primary axis length (cm)	Width of panicle branches (cm) Base	Middle	Top	No. of panicle branches	No. of panicle whorls	Ear-head weight (g)	Grain weight (g)	Remarks
829	S.123	33	30	9	8	4	120	13	191.0	151.7	C Light yellow seed; elongate
731	S.69	29	26	7	6	4	143	Cont.	186.0	149.7	CG White pearly; elongate & compact
734	S.72	39	37	10	9	3	103	12	213.3	163.7	CG YE; elongate & compact
742	S.82	31	30	7	6	3	102	12	175.3	136.0	CG YE; elongate & compact
721	S.58	33	25	9	14	9	65	Cont.	193.0	157.3	GC Wh.chalky; elongate & compact
786	S.128	30	28	7	5	2	89	11	-	139.7	GC Wh.pearly; elongate & compact
784	S.126	37	32	8	8	4	95	9	171.7	138.3	GC Reddish plant & Reddish seed
794	S.138	38	35	6	8	5	114	11	172.0	136.7	GC Reddish plant & Reddish seed
726	S.63	54	47	19	16	11	69	10	221.0	172.7	G Farafara type
800	S.144	53	49	17	13	6	94	13	180.0	140.7	G Farafara type
704	S.36	42	25	14	18	20	92	6	172.7	136.3	BC YE; long & lore, close to broom corn type
713	S.50	36	14	13	14	22	77	4	207.7	152.3	BC "
692	S.24	64	8	47	-	58	40	2	185.7	128.7	BC Very lore head, broom corn like.

VI. ANALYSIS, SUMMARY AND CONCLUSIONS

(1) The basis

The duration of traditional cultivars has generally been much longer than the duration of the rainy season; the periods of flowering coincided with cessation of rains. Consequently, productivity risks have been there with greater probabilities in years when late rains ceased prematurely. Rainfall at the start of the season, when farmers start planting, is also uncertain and rains get established only as the season progresses. The cultivars are tall, vegetative with low harvest indices and respond only to low population and fertility levels. Improvement efforts in the past have generally been oriented towards the traditional agroclimatic zones and traditional maturities with marginal improvements in cultivar yields and management practices. Their impact todate has been marginal.

Alternative production systems for sole and mixed crops based on altered cultivars, if conceived and implemented properly, could result in the much needed improvements in productivity and stability. Suitable short season cultivars with built-in resistances and flexibilities for planting across a range of environments and planting dates could be useful in the drier areas of the North; as an assured high yield crop grown during the period when rainfall is most stable in the moderately heavy rainfall North guinean zone and as a late sown crop in the long season heavy rainfall South guinean zone. Superior short season cultivars are known for better harvest indices and better responses to increased population and fertility levels. They are also likely to be less competitive and amenable for greater manipulations in the development of stable and productive cropping systems in place of the traditional ones. Such cultivars could be of immediate use and also provide the basis for future improvement. In other words, the need is for an alternative base with wide adaptation as has happened in wheat and rice on a global basis and with sorghum to a limited scale. The use of short season sorghums in place of 6-8 month cultivars could lead towards better resource utilization - time, space and inputs.

(2) The mechanism

To answer the cultivar needs of such situations, particularly in the immediate context, the mechanism we chose comprised of :

(a) Initial evaluation of a few commercial hybrids and varieties of India in $\frac{1}{2}$-1 hectare diagnostic blocks in a range of situations primarily to assess the scope and problems of adaptation.

(b) Screening of a large number of improved tropical types available from various sources - ICRISAT centre, AICSIP, Ethiopia, Sudan, Upper Volta, Mali, etc., in different agroclimatic zones in a multi-location set up for their insect and disease reactions and adaptation *per se* during 1981. Further evaluation of a common set of selected lines during 1982 for yield and other attributes in such a diverse multi-location set up across a range of planting dates.

In the implementation of this procedure, there were limitations of management, particularly under out-station conditions. The elimination of breeding lines was drastic. Yet, 1982 data from Maroua in Cameroon (dry zone), Samaru (moderately wet) and Mokwa (heavy rainfall, long season) supplemented by visual observations at Kano, Kadawa and Yandev do lead us to useful conclusions. The mechanism takes care, to a reasonable extent, the problems of adaptation and results in incorporation of durable resistances against high yielding backgrounds of wide adaptation.

(3) <u>The results</u>

The problem of stem borers has been analysed fairly critically and it has been possible to isolate lines with low deadheart percentages and good levels of mature plant resistance/tolerance that would not affect yield levels. The shootfly problem is limited and could be avoided. Tolerance levels to shootfly have also been identified.

Selected lines exhibit high level of resistance to prevalent leaf diseases in West Africa and good tolerance to grain moulds and grain deterioration.

It has been possible to separate the high yielding lines from low yielding. Among the high yielding, lines that have wide adaptation to dry, moderately wet and wet areas across a range of planting dates are discernible. That high yields and wide adaptation could go together has also been established.

When cultivars bred in India are introduced into West Africa, there is slight delay in maturity and a reduction in plant height. This needs explanation. Limited studies with hybrids do not reflect their superiority over the selected varieties. This needs critical analysis so as to enable development of suitable parents for a hybrid programme in West Africa.

Observational studies have been made on new cropping systems, particularly groundnut-sorghum and soybean-sorghum. Based on modified cultivars, the potentialities for studies on new cropping systems have been pointed out.

(4) Immediate future

The first priority has to be for studies on production technology of new sorghums - particularly population and fertilizer studies.

The next priority should be on development of stable and productive cropping systems using modified sorghum cultivars in place of the traditional ones. Inter-, relay-, and sequence studies have place in different situations.

Long smut in drier areas and acid and problematic soils in northern portions of West Africa need special attention.

It is now possible to develop a planned hybridization programme involving local and exotic germplasm.

(5) The long season sorghums

A reasonably critical study of germplasm collections of Northern Nigeria provides an insight into the late maturing sorghums. The farafaras (Guinea types) and the caudatums (yellow endosperm) are by far the best cultivars in the region. A part of the Sudanian zone (latitudes between Samaru and Kano) is virtually a melting pot in that there has been considerable natural hybridization between farafaras, caudatums, durras and broom-corns and a large number of hybrid forms are discernible. The areas south of Samaru generally represent a near monolith of farafaras (guinea types). Some of the best hybrid forms selected in nature seem to be as good as the best caudatums or farafaras. At best there may be marginal advantages. Even though there is considerable recombination, the panicle components seem to compensate in such a way that for final yield, the recombinants are as good as the best parental progenitors. This observation may need further analysis.

Planned hybridization between diverse high yield types from germplasm collections and selection under carefully planned mating systems should lead to late maturing types with per plant yield potential of 150-200 g of grain. If this could be accomplished, the yield levels of such cultivars at 50,000-55,000 population level could touch a new high if there is no resource limitation. But then, the inherent risk due to failure of late rains is there and the resource utilization with late and tall sorghums is not certainly going to be efficient.

Table-10. Attributes of Nigerian collection grown at Samaru - 1982 rainy season.

S. No.	Nursery No.	Collection No.	Total plants	No. of dead-hearts	No. of ear-heads	Pl. ht. (cm)	Days to flower	Head wt./ plant (g)	Grain wt./ plant (g)	Threshing (%)
1	2	3	4	5	6	7	8	9	10	11
1.	674	S1	12	9	7	460	110	207.3	152.3	73.5
2.	675	S2	11	5	6	570	110	133.0	100.3	75.4
3.	676	S3	9	2	7	450	102	156.0	122.7	78.6
4.	677	S4	11	4	3	410	110	150.3	107.7	71.6
5.	678	S6	11	2	3	470	110	182.7	133.3	72.9
6.	679	S7	6	3	3	330	97	158.0	88.0	55.7
7.	680	S9	9	2	0	-	110	-	-	-
8.	681	S10	10	2	7	370	97	191.0	135.3	70.8
9.	682	S11	11	3	7	390	97	139.3	99.0	71.1
10.	683	S15	12	2	10	450	94	184.3	137.0	74.3
11.	684	S16	14	2	8	380	97	140.3	110.0	78.4
12.	685	S17	12	2	6	370	100	116.3	86.7	74.5
								(twin seed)		
13.	686	S18	13	4	6	420	97	169.7	142.3	83.8
14.	687	S19	8	4	2	500	97	-	-	-
15.	688	S20	11	3	6	430	93	121.7	52.0	42.7
16.	689	S21	11	3	8	510	95	152.0	104.0	68.4
17.	690	S22	9	2	8	450	95	130.7	76.7	58.7
18.	691	S23	7	4	5	360	97	179.3	140.3	78.2
19.	692	S24	12	4	5	400	100	185.7	128.7	69.3
20.	693	S25	12	5	10	400	85	124.3	65.3	52.5
21.	694	S26	13	8	5	350	97	215.3	167.3	77.7
22.	695	S27	13	10	4	400	93	136.0	84.0	61.7
23.	696	S28	11	5	6	420	95	185.0	119.3	64.4
24.	697	S29	2	2	0	-	-	-	-	-
25.	698	S30	7	3	5	300	100	155.3	110.0	70.8
26.	699	S31	9	3	4	370	93	120.3	80.0	66.5
27.	700	S32	14	8	10	350	93	185.0	130.3	70.4
28.	701	S33	12	2	9	340	97	186.3	138.7	74.4
29.	702	S34	11	5	4	180	85	92.3	39.7	43.0
30.	703	S35	8	2	5	200	95	134.0	77.0	57.5
31.	704.	S36	13	4	4	430	97	172.7	136.3	78.9
32.	705	S37	9	5	4	410	97	156.7	114.0	72.7
33.	706	S39	12	7	3	400	85	75.3	48.0	63.7
34.	707	S44	11	3	6	350	95	105.0	64.0	60.9
35.	708	S45	11	0	11	400	97	160.7	114.3	71.1
36.	709	S46	15	3	9	350	95	168.7	110.7	65.6
37.	710	S47	10	0	6	430	100	148.0	78.3	52.9
38.	711	S48	8	5	4	420	100	192.0	134.0	69.8
39.	712	S49	11	1	8	450	97	192.0	125.0	65.1
40.	713	S50	10	2	5	430	100	207.7	152.3	73.3
41.	714	S51	11	0	9	420	105	189.7	144.0	75.9
42.	715	S52	15	5	13	440	108	121.3	86.0	70.9
43.	716	S53	10	3	5	380	102	244.0	172.7	70.8
44.	717	S54	11	4	5	210	95	182.0	115.3	63.3
45.	718	S55	9	2	7	200	95	143.3	84.3	58.8

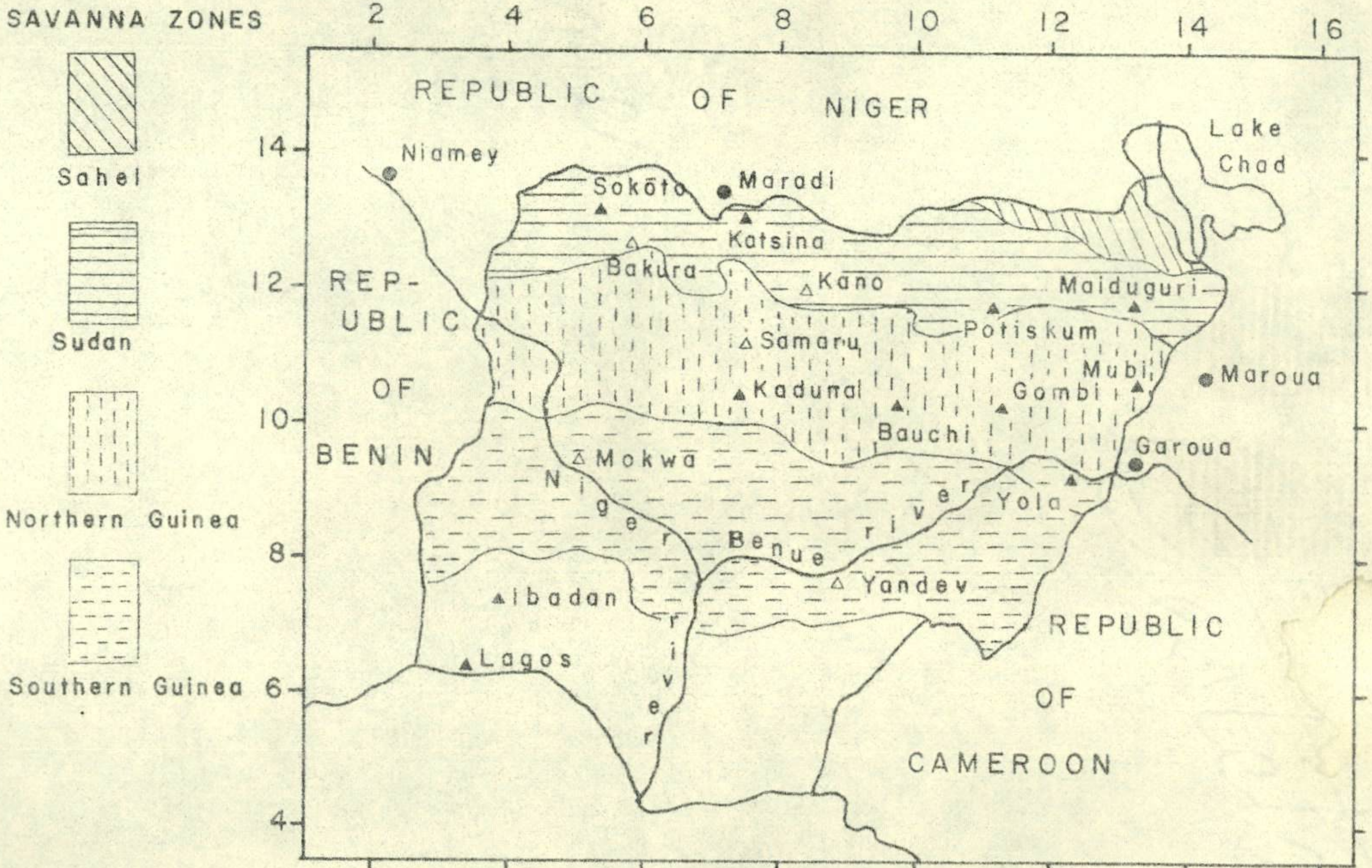
1	2	3	4	5	6	7	8	9	10	11
46.	719	S56	10	3	5	200	95	149.0	84.0	56.4
47.	720	S57	14	6	8	370	105	172.2	134.7	78.2
48.	721	S58	13	5	8	390	105	193.0	157.3	81.5
49.	722	S59	13	5	10	380	105	187.0	149.0	79.7
50.	723	S60	11	8	6	360	105	136.7	117.0	85.6
51.	724	S61	13	7	8	380	97	185.7	132.0	71.1
52.	725	S62	11	6	1	450	110	-	-	-
53.	726	S63	14	6	3	460	105	221.0	172.7	78.1
54.	727	S65	15	5	10	380	100	205.7	160.3	77.9
55.	728	S66	11	6	4	380	100	209.3	161.0	76.9
56.	729	S67	13	9	6	320	97	210.7	154.7	73.4
57.	730	S68	13	5	5	370	105	167.0	130.3	78.0
58.	731	S69	12	3	9	400	105	186.0	149.7	80.5
59.	732	S70	13	3	6	400	97	175.3	136.3	77.7
60.	733	S71	8	5	4	430	97	189.3	133.3	70.4
61.	734	S72	9	6	8	410	105	213.3	163.7	76.7
62.	735	S74	9	4	7	410	110	131.3	96.3	73.3
63.	736	S75	14	4	10	320	105	158.7	124.3	78.7
64.	737	S76	11	5	5	350	100	190.7	146.7	77.2
65.	738	S77	11	2	13	420	105	112.0	92.7	73.8
66.	739	S78	12	4	8	350	105	176.6	140.3	79.4
67.	740	S80	11	4	8	410	102	174.7	129.3	74.0
68.	741	S81	12	4	5	380	95	117.3	80.3	68.4
69.	742	S82	13	1	10	420	105	175.3	136.0	77.6
70.	743	S83	10	3	7	340	95	165.3	131.7	79.7
						(goose-neck)				
71.	744	S84	14	3	8	330	100	156.7	117.7	75.1
72.	745	S85	10	0	10	330	85	104.3	71.0	68.1
73.	746	S86	11	4	8	440	85	83.0	63.0	75.9
74.	747	S87	9	3	7	270	85	161.7	116.3	71.9
75.	748	S88	12	3	10	250	80	138.7	104.3	75.2
76.	749	S89	12	4	4	380	108	87.0	59.0	67.8
77.	750	S90	10	2	10	480	108	150.3	115.7	76.9
78.	751	S91	9	3	9	520	110	169.0	131.0	77.5
79.	752	S92	9	0	9	450	110	196.0	154.7	78.9
80.	753	S93	9	1	7	500	112	141.3	110.7	78.3
81.	754	S94	4	1	6	420	108	182.7	134.7	73.7
82.	755	S95	5	1	5	420	108	135.0	105.0	77.8
83.	756	S96	6	2	6	500	115	180.0	132.0	73.3
84.	757	S98	11	7	5	440	108	126.3	98.7	78.1
85.	758	S99	10	2	8	420	115	105.3	80.3	76.3
86.	759	S100	10	6	7	450	115	104.7	81.7	78.0
87.	760	S101	8	3	10	450	115	72.3	51.7	71.5
88.	761	S102	8	1	5	400	110	138.0	110.0	79.7
89.	762	S103	9	6	5	480	115	149.7	106.3	71.0
90.	763	S104	8	5	5	400	110	118.3	89.3	75.5
91.	764	S105	8	4	7	500	110	109.3	85.7	78.4
92.	765	S106	7	3	5	480	112	137.7	98.7	71.6
93.	766	S107	12	3	7	470	115.	161.7	116.6	72.1
94.	767	S108	11	3	6	480	110	156.3	127.0	81.3
95.	768	S109	10	8	1	410	110	-	-	-

1	2	3	4	5	6	7	8	9	10	11
96.	769	S110	13	7	14	420	110	117.0	89.3	76.3
97.	770	S111	5	3	0	-	115	-	-	-
98.	771	S112	7	3	4	430	108	-	-	-
99.	772	S113	11	2	12	470	110	92.0	63.0	68.5
100.	773	S114	10	3	7	500	110	131.0	103.3	78.8
101.	774	S115	13	1	15	480	110	123.3	96.0	77.9
102.	775	S116	7	1	3	-	117	-	-	-
103.	776	S117	7	2	4	460	117	-	-	-
104.	777	S118	10	2	6	490	117	92.0	72.0	78.3
105.	778	S119	8	0	5	500	115	98.0	73.0	74.4
106.	779	S120	9	0	7	510	115	117.0	94.3	80.6
107.	780	S122	8	1	7	500	115	117.0	87.7	74.9
108.	781	S123	11	0	9	410	117	70.7	57.7	81.6
109.	782	S124	12	4	6	500	115	-	81.0	-
110.	783	S125	9	2	8	480	115	136.3	104.0	76.3
111.	784	S126	9	6	6	490	110	171.7	138.3	80.5
112.	785	S127	8	5	4	360	110	117.0	84.0	71.8
113.	786	S128	10	1	8	470	124	-	139.7	-
114.	787	S129	6	3	4	450	124	111.7	92.7	83.0
115.	788	S130	9	1	1	500	124	66.7	28.0	42.0
116.	789	S131	9	1	3	410	117	91.7	59.7	65.1
117.	790	S132	10	1	7	400	110	131.7	103.0	78.2
118.	791	S133	6	1	9	340	124	-	108.3	-
119.	792	S135	12	2	10	410	108	131.7	104.0	78.9
120.	793	S136	10	2	6	440	108	135.7	98.0	72.2
121.	794	S138	10	2	11	500	106	172.0	136.7	79.5
122.	795	S139	14	1	9	470	106	95.0	73.0	76.8
123.	796	S140	11	1	10	500	106	126.0	98.0	77.8
124.	797	S141	11	2	11	510	108	153.3	108.7	70.9
125.	798	S142	7	3	7	520	106	143.0	102.3	71.5
126.	799	S143	10	1	6	510	106	97.7	78.7	80.6
127.	800	S144	10	1	8	510	106	180.0	140.7	78.2
128.	801	S145	10	1	9	500	110	166.0	125.0	75.3
129.	802	S146	9	3	5	480	110	110.0	86.0	78.2
130.	803	S147	6	3	5	480	110	147.0	115.0	78.2
131.	804	S148	10	5	4	430	122	-	-	-
132.	805	S149	10	3	5	500	115	116.0	86.3	74.4
133.	806	S150	11	5	7	440	115	130.7	100.3	76.7
134.	807	S151	9	5	4	460	115	39.3	17.7	45.0
135.	808	S152	9	3	5	460	110	104.3	80.0	76.7
136.	809	S153	10	7	3	460	110	98.0	73.0	74.5
137.	810	S154	10	4	5	430	110	81.7	59.3	72.5
138.	811	S155	9	5	6	510	110	148.0	114.0	77.0
139.	812	S156	3	0	3	480	110	132.3	102.3	77.3
140.	813	S157	12	3	5	500	115	127.0	100.7	79.2
141.	814	S158	11	2	8	450	97	114.3	88.7	77.6
142.	815	S159	6	5	0	-	-	-	-	-
143.	816	S160	11	3	12	500	106	168.0	131.7	78.4
144.	817	S161	3	1	1	-	113	-	-	-
145.	818	S162	7	5.	4	500	108	172.7	137.7	79.7
146.	819	S163	13	3	6	410	110	136.3	103.3	75.8
147.	820	S164	13	3	5	440	110	132.3	94.7	75.6

1	2	3	4	5	6	7	8	9	10	11
148.	821	S165	6	2	3	410	112	148.3	108.0	72.8
149.	822	S166	8	2	4	450	110	123.3	78.3	63.5
150.	823	S167	7	3	3	370	106	152.0	110.0	72.3
151.	824	S168	9	2	3	450	106	-	-	-
152.	825	S169	8	2	5	440	110	140.7	109.0	77.5
153.	826	S170	10	2	7	460	106	154.3	126.3	81.8
154.	827	S171	7	1	2	400	106	126.0	92.0	73.0
155.	828	S172	15	5	8	440	106	168.0	130.3	77.6
156.	829	S173	14	5	5	430	106	191.0	151.7	79.4
157.	830	S174	9	1	4	500	110	147.3	112.3	76.2
158.	831	S175	12	4	7	470	106	134.7	100.0	74.2
159.	832	S176	9	3	5	510	110	155.0	117.0	75.5
160.	833	S178	8	2	7	440	110	147.0	109.6	74.6
161.	834	S179	9	3	2	370	106	-	-	-
162.	835	S180	11	2	9	430	110	166.7	128.3	77.0
163.	836	S181	9	3	3	400	115	119.3	93.7	78.5
164.	837	S182	9	2	7	410	106	100.3	78.3	78.1
165.	838	S183	12	3	7	420	110	166.3	137.0	82.3
166.	839	S184	14	4	8	420	117	109.7	75.3	68.6
167.	840	S185	10	3	5	400	117	122.0	85.3	69.9
168.	841	S196	16	6	7	330	117	126.3	81.7	64.7
169.	842	S187	14	1	10	450	112	162.0	124.3	76.7
170.	843	S188	8	2	3	400	116	94.0	66.0	70.2
171.	844	S189	13	6	15	450	115	122.7	95.7	78.0
172.	845	S191	9	5	6	440	115	109.0	75.0	68.8
173.	846	S193	-	-	-	-	-	-	-	-
174.	847	S194	10	3	2	470	120	35.0	13.7	39.1
175.	848	S195	5	1	4	500	120	77.0	49.3	64.0
176.	849	S197	9	2	7	420	120	63.0	29.0	46.0
177.	850	S198	8	3	4	450	120	78.7	50.0	63.5
178.	851	S199	10	3	5	500	122	62.3	35.7	57.3
179.	852	S200	10	5	4	430	117	94.3	42.0	44.5
180.	853	S201	9	2	5	420	115	118.0	88.0	74.6
181.	854	S202	10	0	7	440	115	69.7	42.3	60.7
182.	855	S203	7	3	2	410	115	107.0	74.0	69.2
183.	856	S207	12	4	7	500	117	79.3	61.7	77.8
184.	857	S208	12	2	-	-	117	-	-	-
185.	858	S209	13	1	3	440	106	78.0	49.3	63.2
186.	859	S210	11	4	4	480	106	80.0	62.0	68.9
187.	860	S211	7	5	5	410	106	72.0	50.0	69.4
188.	861	S213	13	5	7	500	113	67.0	49.3	73.6
189.	862	S214	10	6	2	490	116	67.0	39.0	58.2
190.	863	S215	12	7	6	440	116	59.7	35.0	58.6
191.	864	S216	7	4	4	280	115	87.0	61.0	70.1
192.	865	S217	9	4	3	260	115	63.7	57.0	89.5
193.	866	S218	5	4	1	300	116	-	-	-
194.	867	S219	6	1	4	300	113	163.3	107.7	65.9
195.	868	S220	6	2	6	310	120	63.0	27.3	43.3
196.	869	S221	7	4	3	500	123	70.3	29.0	41.3
197.	870	S223	4	1	5	500	125	62.7	27.0	43.1
198.	871	S224	7	2	4	500	125	71.3	28.3	39.7
199.	872	S225	7	2	5	480	130	85.7	48.0	56.0
200.	873	S226	6	3	2	460	130	81.0	42.0	51.8
201.	874	S228	6	0	8	450	130	73.3	28.7	39.1
202.	875	S229	11	5	9	460	130	81.3	38.3	47.1
203.	876	S230	9	2	6	440	126	-	-	-

VII. PERSONNEL

Dr. N. G. P. Rao	-	Regional Sorghum Breeder and Hon. Visiting Research Professor IAR/ABU
Mr. V. O. A. Ameh	-	Technician
Mr. Mores Tondo	-	Technician
Mr. Augustine Chabba	-	Technician
Miss Patience N. Onyebinachi	-	Typist



Frontispiece: Map showing IAR stations (open triangle) and other towns (closed triangles) in Nigeria and neighboring countries (closed circles).

1983-06

SORGHUM BREEDING RESEARCH REPORT

Rao, N. G. P.