SORGHUM BREEDING RESEARCH REPORT

1982-83
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ICRISAT


SORGHUM BREEDING
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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 att ributes 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.

## 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 (Northem Nigeria) and Maroua (Northem Cameroon) both in the Sudanian zone, represent dry areas. Samaru in the Northem Guinea savanah represents moderately high rainfall area. Mokwa and Yandev in the Southern Guinea savenah 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 $Y_{\text {andev }}$ 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 (m) over ten-day periods and number of rainy days (1982 rainy season)

| 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) |  |  |
|  | $11-20$ |  |  | 26.8 (5) | 16.1 (3) | 36.0 (1) |
|  |  |  | 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 | - | $1.0(1)$ |  |  |  |
|  | 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 |  |  |  | 75.4 (4) | 101.5 (4) |
|  | $11-20$ | $21.5 \text { (3) }$ | $19.6(3)$ | 76.5 (3) | 64.9 (5) | 20.0 (3) |
|  |  | 42.0 (3) | 20.2 (2) | 40.9 (3) | 39.6 (4) | 64.9 (4) |
|  | Total | $\overline{109.0}(\overline{10})$ | 122. $\overline{3}$ (9) | - $\overline{68} . \overline{7}(\overline{10})$ | 179.9(13) | $1 \overline{86}$-4(1I) |
| AUGUST | 1-10 | $69.9(5)$ | 105.6 (6) | 33.9 (4) | 8.0 (2) | $18.4(3)$ |
|  | $11-20$ $21-31$ | $46.2(4)$ 63.2 (3) | 55.7 (3) 105.7 (4) | $45.5(5)$ $111.3(8)$ | 15.8 140.5 (2) | 5.8 (2) 80.3 (4) |
|  | Total | 179.3(12) | 267.0(13) | 190.7(17) | 164.3(12) | 104.5 ( ${ }^{-1}$ |

$\begin{array}{rrrrrrr}\text { SEPT } & 1-10 & 42.9(3) & 45.1(2) & 75.8(7) & 16.4(3) & 104.9(6) \\ & 11-20 & 72.9(3) & 3.2(1) & 33.0(4) & 107.9(4) & 68.0(6) \\ & 21-30 & 6.5(1) & 6.8(1) & 8.8(1) & 16.3(3) & 68.8(4)\end{array}$


TOTAL FOR
THE YEAR ) $490.7(37) \quad 637.6(38) \quad 768.5(66) \quad 958.6(65) \quad 1349.9(81)$

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

RAINFALL (mm)



## RAINFALL (mm)




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


RAINFALL (mm)

III. PROBLEMS IN ADAPTATION - INSECT AND DI SEASE REST STANCE

When cultivars, particularly those bred-el sewhere are int roduced, their reaction to the insect pest and disease complex is of consi derable 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 val ues 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 bo rers.

Table-2 presents mean val ues 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 percent ages are S , 536 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, S29, 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, 535 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 ICFI SAT centre were received late and planted during late July. The seedling deadheart percentages are presented in Table-4. They could not be evaluated for yiel d. 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 |  |  | Mean excl. late planting |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Normal planting | Late planting |  |  |
| KI | 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 |
| St | 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 |
| 53 | 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 |
| 57 | 28.7 | 28.0 | 17.3 | 20.4 | 56.0 | 30.1 | 23.6 |
| 58 | 31.2 | 35.6 | 15.4 | 19.0 | 52.4 | 30.7 | 25.3 |
| 59 | 26.2 | 34.5 | 19.3 | 16.7 | 49.8 | 29.3 | 24.2 |
| Slo | 26.6 | 36.5 | 12.2 | 20.4 | 48.1 | 28.8 | 23.9 |
| 522 | 30.1 | 30.0 | 10.2 | 26.6 | 65.8 | 32.5 | 24.2 |
| 513 | 36.7 | 25.5 | 8.3 | 21.7 | 46.9 | 27.8 | 23.0 |
| 514 | 37.8 | 28.2 | 15.0 | 27.6 | 60.6 | 33.8 | 27.1 |
| 515 | 39.1 | 18.8 | 16.7 | 25.9 | 56.8 | 31.4 | 25.1 |
| S1. 6 | 26.3 | 36.5 | 19.8 | 19.8 | 47.7 | 30.0 | 25.6 |
| S17 7 | 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 | $\begin{aligned} & \text { Late } \\ & \text { planting } \end{aligned}$ |  |  |
| 518 | 31.1 | 21.5 | 13.9 | 18.4 | 53.7 | 27.7 | 27.2 |
| Sl7 9 | 28.4 | 20.6 | 13.9 | 15.9 | 5.20 | 26.1 | 19.7 |
| 520 | 29.8 | 23.5 | 13.5 | 14.7 | 54.0 | 27.1 | 20.4 |
| 521 | 23.2 | 24.8 | 14.4 | 17.8 | 55.4 | 27.1 | 20.1 |
| 522 | 19.9 | 23.0 | 11.7 | 22.1 | 45.9 | 24.5 | 19.2 |
| 523 | 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 |
| 527 | 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 |
| 534 | 38.3 | 29.0 | 18.3 | 21.0 | 48.7 | 31.1 | 26.7 |
| 535 | 27.0 | 23.3 | 17.0 | 16.0 | 47.5 | 26.2 | 20.8 |
| 536 | 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 |
| 540 | 15.5 | 17.1 | 12.9 | 0.0 | 32.3 | 15.6 | 11.4 |
| 541 | 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 |
| 543 | 41.4 | 43.5 | 33.3 | 24.8 | 75.3 | 43.7 | 35.8 |
| 544 | 26.6 | 31.3 | 24.9 | 2.6 | 60.5 | 33.0 | 26.1 |
| SPV-245 | 23.6 | 25.9 | 20.3 | 19.9 | 45. 2 | 27.0 | 22.4 |
| 3ES | 28.7 | 38.6 | 27.9 | 25.1 | 49.9 | 34.0 | 30.1 |


| Variety | Kadawa | Mokwa | Yandev | Samaru |  | Mean | Mean excl. late planting |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | No rmal planting | 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 |



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


FIG. 7. STABILITY OF SEEDLI NG DEADHEART (\%)


Table-4. Seedling deadhearts in International sorghum Variety (ISVAT) and Hybrid trials (ISFA T). 1982 SAMAFU LATE PLANTING

| Entry | \% deadhearts | Angles | Entry | \% deadhearts | Angles |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A 13113 | 69.6 | 58.5 | 2219A x MR 702 | 54.9 | 47.8 |
| A 13108 | 66.4 | 54.7 | " $\times$ 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 | " $\quad$ M MR 806 | 60.5 | 51.1 |
| A 13144 | 64.6 | 53.7 | " x MR 819 | 62.6 | 52.5 |
| A 15214 | 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 | " xMR 858 | 67.2 | 55.4 |
| M 60263 | 39.4 | 38.9 | " x MR 844 | 58.2 | 49.8 |
| M 60264 | 68.2 | 55.8 | " 1 x MR 836 | 72.6 | 58.6 |
| M 60272 | 43.3 | 41.1 | 2077 A x MR 823 | 62.9 | 52.7 |
| M 60297 | 54.0 | 47.3 | " $\quad$ M MR 824 | 52.4 | 46.4 |
| SAR-5 | 58.1 | 49.8 | " xA 16051 | 56.1 | 48.6 |
| SAR-9 | 52.1 | 46.2 | " $\quad$ ¢ A 16052 | 62.5 | 53.5 |
| SAR-16 | 49.0 | 44.3 | $2219 \mathrm{~A} \times \mathrm{A} 16001$ | 60.5 | 51.5 |
| D 71396 | 66.4 | 54.9 | 2219 ¢ 416003 | 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 I6103 | 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 tinnelling, 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 wore 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. Sel ected material, limited in numbers, could now be studied in greater detail in the coming years.

## IV. SEIECTION 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 yiel d eval uation. These varieties werestudied 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 Northem 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 al so 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, SL3, Sl 4, SI6, Si7, 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 538 yiel ded reasonably well in all the three replications. If soil acidity is the real problem, then the utility of 538 for such soils needs to be further assessed.
(b) Moderately wet areas : The two trials were conducted at Samaru and pl antings were done on June 21, 1982. For trial-1, $t$ he 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 deadhearts, 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. comon 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 $5,000 \mathrm{~kg} / \mathrm{ha}$ while in trial-2, it is $2,733 \mathrm{~kg} / \mathrm{ha}$ which is mo re 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, SlO, SI3, S17, S2O, 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 yiel ded well, the hybrid did not exhibit superiority over the best varieties (Table-5).

Trial-2 : In trial-2, the entries, $532,533,534,535,536$, S37, S38 and S40 are promising for yield (Table-6).
(c) Wet areas

Forty nine entries from the $t$ wo trials-1 and 2 were grown in a single trial with two replications at Mokwa and Yandev. Thetrial 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 sorghu.

The yields of promising entries at Mokwa are as follows :

| K4 | - | 2367 | $\mathrm{~kg} / \mathrm{ha}$ |
| :--- | :--- | :--- | :--- |
| S21 | - | 2733 | $"$ |
| S35 | - | 2733 | $"$ |
| S4O | - | 2467 | $"$ |
| BES |  | 1567 | $"$ |

The above entries al so looked promising at Yandev.

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


Table-6. Selection and adaptation of tropical cultivars (Trial-2) - Samaru 1982 rainy season
 stand/ha deadhearts at deadhearts at height to aspect heads/ yield

## (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 $K 5$ and Sl8. SRN-484I is highly susceptible to leaf diseases, but known to be resistant to striga. The seeds are brown. K5 and 518 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


## (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 yiel ding. 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 yiel ds, it is necessary to work out the production technology.

Out of the 14 lines listed, some of them like S40, S35, $519 / \mathrm{S} 20 / \mathrm{S} 21, \mathrm{~K} 4$, 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 programe could be developed.


## (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 $3460 \mathrm{~kg} / \mathrm{ha}$ followed by CE-145 with $3000 \mathrm{~kg} / \mathrm{ha}$.

At $D^{\prime}$ ina (Benin), six improved varieties of Nigerian origin were grown. Of them, I-l 499 was the highest yielder. At Saria (Upper Volta), the Nigerian entry $38-3$ was the highest yielder with $3057 \mathrm{~kg} / \mathrm{ha}$. In Camaroon, CE-151, CE-145, and EES, all of which are early exhibited some progress. The regional trial was erratic.

None of these experiment's may be considered valid since these stray studies lack consistence.

Table-9. Yield data of direct int roductions in Mauritania 1981 RAINY SEASON

## Varieties

grain yield ( $\mathrm{kg} / \mathrm{ha}$ )

2590
CSH-1 3295

CSH-5 2960

SPV-220 1850
SPV-316 ..... 1700
SPV-313 ..... 2590
SFV-138 ..... 815
SPV-2RI ..... 445
SPV-314 ..... 2700
SPV-224 ..... 1850
SPV-260 ..... 1035
SPV-35 ..... 4135
SPV-161 ..... 3550
C SH-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 ( 3 m 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) thr $\in$ shing \%. 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.
(a)

The collection was st udied with $t$ he following objectives :
Whether there is adequate variability among collections (mostly late and tall) so as to warrant selection and isolation of superior types.

Whether the hybrid races established under natural selection have advantages of yield or other att ributes so as to warrant the ir further exploitation. The following are the saliant 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 southem 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 di sease resistance in that all of them are susceptible for leaf spots, primarily the grey leaf spot.

## (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 hich 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 ( $\overline{\mathrm{X}})$ of 98.1 g and S.D. 35.7 . There is adequate variability for yield in the collections.

The analy sis of variance for grain yield is as follows :

Table-1l. ANOVA for grain yield


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 |  |
| $0-36 \mathrm{~g}$ | 11 |
| $37-72 \mathrm{~g}$ | 30 |
| $73-108 \mathrm{~g}$ | 70 |
| $109-144 \mathrm{~g}$ | 60 |
| $145-180 \mathrm{~g}$ | 15 |

The frequency diyliluntion fox giciu yint 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 yiel ding.

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


Table-13. Particulars of high yielding collections.


## (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 component s. - 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 yiel ds could be obtained in the backgrounds of farafara (Guinea), caudatum or hybrid combination sof CG, GC and even against a broom 00 m background.

## (6) Natural hybridization and selection

Hybridization and natural sel ection 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 wich 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 seen 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 superio $r$ to the best parentel 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 $2000-5000 \mathrm{~kg} / \mathrm{ha}$ are feasible depending upon the seasonal conditions and inputs applied. The $200-2500 \mathrm{~kg} / \mathrm{ha}$ 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 yieids of $150-200 \mathrm{~g}$ and this may be feasible through controlled recombination breeding.


## VT. ANALYSIS, SLMMARY AND CONCLUSIONS

(I) 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 al so 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 margina?. improvements in cultivar yields and management practices. Their impact todate has been marginal.

Altemative production systems for sole and mixed crops based on altered cultivars, if concoived 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 ueeful 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 aro known for better harvest indices and better responses to increased population and fertility level.s. 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 altemative 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 - tine, space and inputs.
(2) The mechanism

To answer the cultivar needs of such situations, particularly in the immediate context, the mechanism we cho se comprised of :
(a) Initial eval uation of a few comercial 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, AIC SIP, 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 eval uation 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) The results

The problem of stem borers has been analysed fairly critically and it has been possible to isolate lines with low deadheart percent ages 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 al so 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 yiel ding 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 del ay 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 onable development of suit able parents for a hybrid programe in West Africa.

Observational studies have been made on new cropping systems, particulariy gromanut-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 st udies.

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 we st 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 st udy of germplasm collections of Northern Nigeria provides an insight into the late maturing so rghums. The farafaras (Guinea types) and the caudatums (yellow en dosperm) 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 discemible. 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 accomplist ed, 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.

| $\begin{gathered} \mathrm{S} . \\ \mathrm{No} \end{gathered}$ | Nursery No. | Collection No. | Total plants | No. of deadhearts | No. of earheads | PI. ht. (cm) | $\begin{aligned} & \text { Days } \\ & \text { to } \\ & \text { flower } \end{aligned}$ | Head wt./ r plant (g) | Grain wt./ plant (g) | Threshing (\%) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |  | 9 |  |  |
| 1. | 67\% | St | 12 | 9 | 7 | 460 | 110 | 207.3 | 152.3 | 37.5 |
| 2. | 675 | 52 | 11 | 5 | 6 | 570 | 110 | 133.0 | 100.3 | 75.4 |
| 3. | 676 | S3 |  | 2 | 7 | 450 | 102 | 156.0 | 122.7 | 78.6 |
| 4. | 677 | 54 | 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 | 59 | 9 | 2 | 0 | - | 110 | - | - | - |
| 8. | 681 | 510 | 10 | 2 | 7 | 370 | 97 | 191.0 | 135.3 | 70.8 |
| 9. | 682 | 511 | 11 | 3 | 7 | 390 | 97 | 139.3 | 99.0 | 71.1 |
| 10. | 683 | ST5 | 12 | 2 | 10 | 450 | 94 | 184.3 | 137.0 | 74.3 |
| 11. | 684 | SI 6 | 14 | 2 | 8 | 380 | 97 | 140.3 | 110.0 | 78.4 |
| 12. | 685 | SL7 | 12 | 2 | 6 | 370 | 100 | 116.3 | 86.7 | 74.5 |
|  |  |  |  |  |  |  |  | win see |  |  |
| 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 | 522 | 9 | 2 | 8 | 450 | 95 | 130.7 | 76.7 | 58.7 |
| 18. | 691 | 523 | 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 |
| 23. | 694 | 526 | 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. | 536 | 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 | 545 | 11 | 0 | 11 | 100 | 97 | 160.7 | 114.3 | 71.1 |
| 36. | 799 | 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 | 548 | 8 | 5 | 4 | 420 | 100 | 192.0 | 134.0 | 69.8 |
| 39. | 72 | 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 |
| 47. | 714 | 551 | 11 | 0 | 9 | 420 | 105 | 189.7 | 144.0 | 75.9 |
| 42. | 75 | S52 | 15 | 5 | 13 | 440 | 108 | 121.3 | 86.0 | 70.9 |
| 43. | 76 | S53 | 10 | 3 | 5 | 380 | 102 | 244.0 | 172.7 | 70.8 |
| 44. | 77 | 554 | 11 | 4 | 5 | g10 | 95 | 182.0 | 115.3 | 63.3 |
| 45. | 78 | S55 | 9 | 2 | 7 | 200 | 95 | 143.3 | 84.3 | 58.8 |




为








| 148. | 821 | 5265 | 6 | 2 | 3 | 410 | 112 | 148.3 | 108.0 | 72.8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 149. | 822 | ST66 | 8 | 2 | 4 | 450 | 110 | 123.3 | 78.3 | 63.5 |
| 150. | 823 | 5267 | 7 | 3 | 3 | 370 | 106 | 152.0 | 110.0 | 72.3 |
| 151. | 824 | 5268 | 9 | 2 | 3 | 450 | 106 | - | - | - |
| 152. | 825 | ST69 | 8 | 2 | 5 | 410 | 110 | 7 40.7 | 109.0 | 77.5 |
| 153. | 326 | S2. 70 | 10 | 2 | 7 | 460 | 106 | 154.3 | 126.3 | 81.8 |
| 154. | 827 | SLI 71 | 7 | 1 | 2 | 400 | 106 | 126.0 | 92.0 | 73.0 |
| 155. | 828 | 5272 | 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. | 839 | SL78 | 8 | 2 | 7 | 410 | 110 | 147.0 | 109.6 | 74.6 |
| 16. | 834 | 5179 | 9 | 3 | 2 | 370 | 106 | - | - | - |
| 162. | 835 | 5180 | 11 | 2 | 9 | 430 | 110 | 166.7 | 128.3 | 77.0 |
| 163. | 836 | 5181 | 9 | 3 | 3 | 400 | 115 | 119.3 | 93.7 | 78.5 |
| 164. | 837 | 5182 | 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. | 84 | 5196 | 16 | 6 | 7 | 330 | 117 | 126.3 | 81.7 | 64.7 |
| 169. | 842 | 5187 | 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 | 5189 | 13 | 6 | 15 | 450 | 115 | 122.7 | 95.7 | 78.0 |
| 172. | 845 | 5181 | 9 | 5 | 6 | 410 | 115 | 109.0 | 75.0 | 68.8 |
| 173. | 846 | 5193 | - | - | - | - | - | - | - | - |
| 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 | 5197 | 9 | 2 | 7 | 420 | 120 | 63.0 | 29.0 | 46.0 |
| 177. | 850 | 5198 | 8 | 3 | 4 | 450 | 120 | 78.7 | 50.0 | 63.5 |
| 178. | 851 | 5199 | 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 | 5802 | 10 | 0 | 7 | 440 | 115 | 69.7 | 42.3 | 60.8 |
| 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 | 5213 | 13 | 5 | 7 | 500 | 113 | 67.0 | 49.3 | 73.6 |
| 189. | 862 | S21 4 | 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 | S2]. 6 | 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 |
| 198. | 869 | S221 | 7 | 8 | 3 | 500 | 123 | 70.3 | 29.0 | 41.3 |
| 197. | 870 | 5223 | 4 | 1 | 5 | 500 | 125 | 62.7 | 27.0 | 43.1 |
| 198. | 871 | 5224 | 7 | 2 | 4 | 500 | 125 | 71.3 | 28.3 | 39.7 |
| 199. | 872 | S22 5 | 7 | 2 | 5 | 480 | 130 | 85.7 | 48.0 | 56.0 |
| 200. | 873 | 5226 | 6 | 3 | 2 | 460 | 130 | 81.0 | 42.0 | 51.8 |
| 201. | 874 | 5228 | 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 (AR stations (open triangle) and other fowns (closed triangles) in Nigeria and neighboring countries (closed circles).

## SORGHUM BREEDING RESEARCH REPORT

Rao, N. G. P.

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