TARC Note

Heterosis of sorghum F_1 plants in different growing seasons

In the tropics, sorghum can be grown at any season of the year. However, it is not known yet how is the heterosis of F_1 plants expressed in different seasons with different daylength and precipitation. The present study was carried out in cooperation with the Plant Breeding Section, College of Agriculture, the University of the Philippines, with an aim of knowing effects of seasons on the expression of F_1 heterosis.

A male-sterile line (MS 143-234-123-99-61, hereafter referred to MS) which showed high and stable fertility in both dry and wet season of 1975 was used as female parent. A total of 128 crossings were made in 1975 dry season, and F_1 seeds obtained were used for the experiments. However, several combinations in which pollen parents with extremely low disease-resistance were used, or those which showed abnormally early heading or very low fertility of F_1 plants were discarded from the study. As a result a total of 110 crosses, including 29 varieties of CS group, 34 of IS group and other 47 varieties, was studied. Growing seasons and cultural conditions are shown in Table 1.

Agronomic characters examined are as follows:

1. Seedling height: length from soil surface to top of the longest leaf at 3 weeks after germination.
2. No. of days to heading: days from germination to heading of 80% of plants in a plot.
3. Culm length: length from soil surface to panicle neck at the time of maturity.
4. Panicle length: length from panicle neck to top of panicle.
5. No. of primary rachis branches: those bearing secondary rachis branches were counted.
6. 1,000 grain weight: measured with perfect grains.
7. Grain yield: weight of perfect grains harvested, excluding two plants each at the both ends of a planted row.

Each plot was composed of 2 rows. Each F_1 plant plot and its pollen parent plot were placed side by side as a pair. Cosor 1 was planted every 10 pairs as a check variety to estimate environmental variations, because no repetition of plots was made.

Figure 1 shows distribution of selected agronomic characters of F_1 plants as against pollen parents in three seasons. The ordinates denote characters of pollen parents (P_2), and abscissae those of F_1 plants of MS$\times P_2$. Solid line circles show the range of variation observed with the check variety, and the broken line circles show the distribution range of characters of F_1 plants as against those of P_2. Small circles outside the broken line circles are regarded as exceptional cases showing peculiar distribution.

It can be theoretically understood that crosses distributed along the line, b=1, show

Table 1. Growing seasons and conditions of the experiments

Type of experiment	Experiment	No. of combniations studies	Planting date	Harvesting date	Day-length	Season
Combining ability test	1st	110	July 19, 1976	Oct. 28, 1976	long day	Wet
	2nd	110	Jan. 19, 1977	April 20, 1977	Short day	Dry
	3rd	110	April 21, 1977	Aug. 8, 1977	Short → long*	Dry → wet*

* During the growth period, dry season with short day ended, followed by wet season with long day.

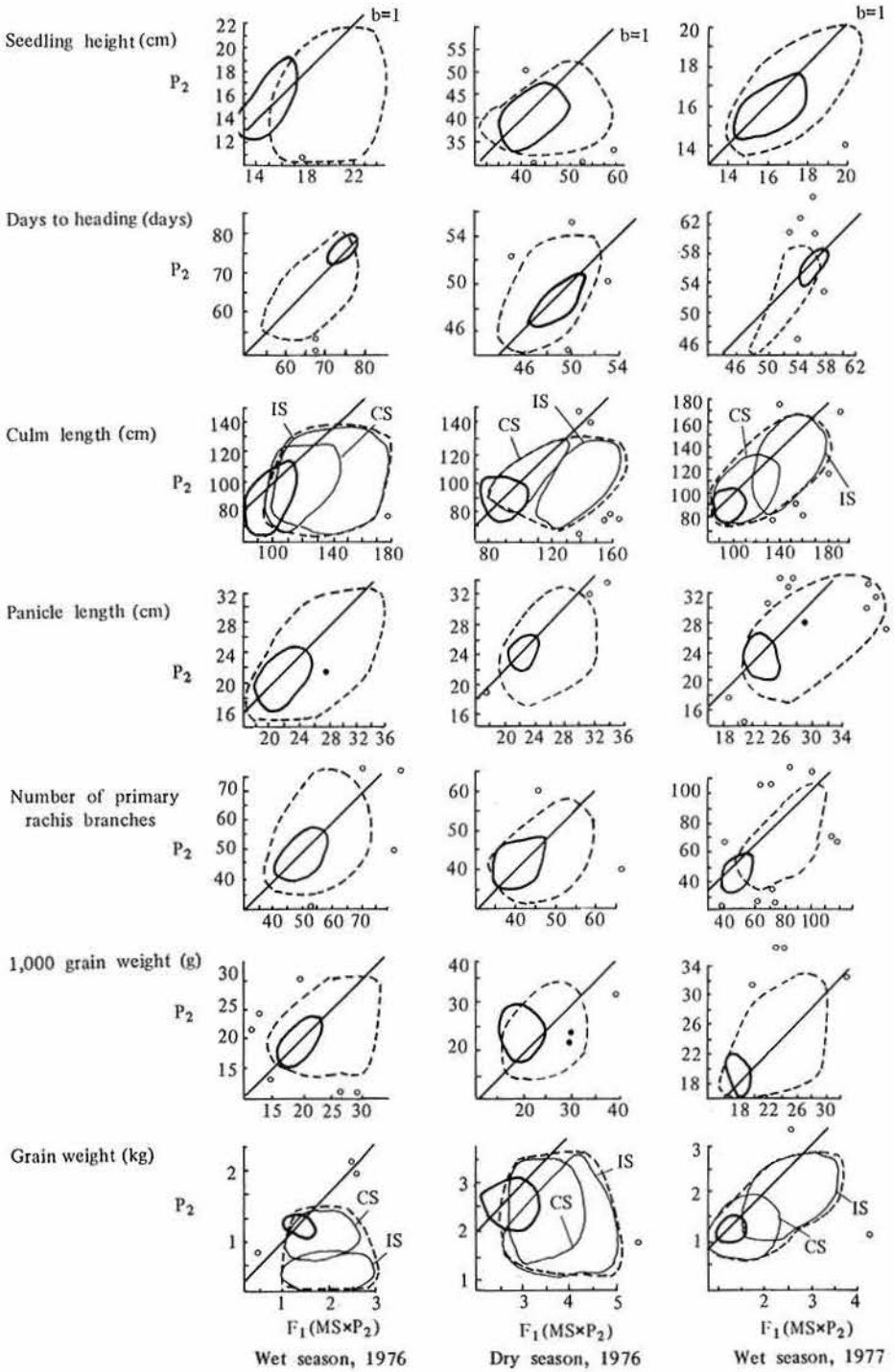


Fig. 1. Distribution of selected agronomic characters of F_1 plants as against those of P_2
Legend: see text

no heterosis, while those distributed to the right side of the line show heterosis. The farther away to the right, the greater is the heterosis. Thus, the results shown in Fig. 1 can be summarized as follows:

1. As to the effect of seasons on heterosis, the degree of heterosis was found to be similar in both wet and dry seasons of 1976 but it was less in 1977 wet season (ratoon crop), particularly with seedling height, culm length and grain yield.

2. Heterosis in culm length was very great in 1976 wet season. Greater culm length is not desirable as it cause lodging and hence difficulty for mechanical harvesting.

3. For no. of days to heading, heterosis was hardly observed, and its variation in different seasons was also very small. Thus, it is desirable that the prolongation of growth duration due to heterosis does not occur.

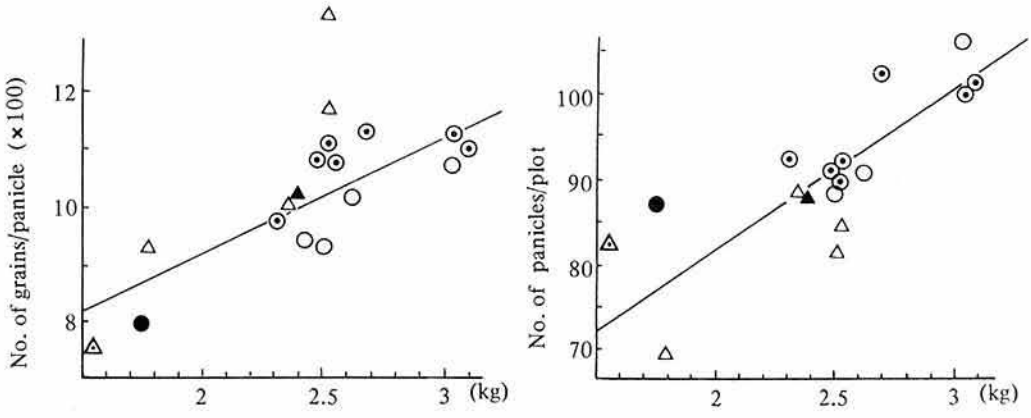
4. As to the yield components, panicle length, no. of primary rachis branches and 1,000 grain weight expressed quite small degree of heterosis, and not so effected by different season.

5. In spite of this fact, grain yield expressed very large heterosis, particularly in the dry season. Grain yield in 1976 dry season reached 5 kg/plot, as compared to 3–3.5 kg/plot in the wet season of 1976 and 1977.

The reason why the grain yield expressed very large heterosis, in spite of the very small heterosis occurred with panicle length, no. of primary rachis branches, and 1.000 grain weight was analyzed in the productivity tests carried out from Oct. 6, 1977 to Jan. 12, 1978, using F_1 plants of 18 promising crosses selected from the above 110 crosses. The result showed that grain yield was closely correlated with culm length, no. of grains/panicle and no. of panicles/plot, as shown in Fig. 2. Sorghum varieties used in the present study produce one panicle/plant, so that the no. of panicles/plot is determined by the rate of plant survival in the field. Thus, it was made clear that the higher grain yield of F_1 plants was derived from larger no. of panicles/plot which was related to higher rate of plant survival probably due to the heterosis and larger no. of grains produced/panicle.

Differences in F_1 heterosis between CS group and IS group are shown for culm length and grain yield in Fig. 1. In both cases, IS group shows greater heterosis than CS group. The MS used as P_1 was developed by backcrossing of Cosor 1 to a male-sterile line introduced to the Philippines from U.S.A., and hence genetically close to the CS group, while IS group is remote from the MS, showing quite different response from CS group to environmental conditions.

From the practical point of view, F_1 plants



Note: ⊙: IS group, △: CS group, ○: other group, ●: Cosor-1, △: Cosor-3 and ▲: SG-5

Fig. 2. Correlation between grain yield and no. of grains/panicle or no. of panicles/plot

of MS×IS group may have a risk of lodging due to their larger culm length, although their yield is quite high. However, as they recover more quickly from lodging than CS group, their lodging loss may be relatively less. From these results, it seems to be desirable to conduct further experiment with F_1 of MS×IS group under the condition where early growth stage is in the wet season and late stage comes to the dry season.

1) Imai, T. & Gomez, A.A.: Differentiation in sorghum varieties caused by tropical and temperate environments. *JARQ*, **13**, 149–151 (1979).

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