Differentiation in sorghum varieties caused by tropical and temperate environments

It is well known from a large number of studies so far reported that many characters of varieties or hybrid populations vary depending on natural environments under which they grow[2]. These changes occur primarily due to differences in the response of their genotypes to different environments. In 1958, Akemine and Kikuchi[1] tried to cultivate F_2 to F_6 hybrid populations, derived from crosses between early and late varieties of japonica rice, at 13 locations without carrying out any selection, and they reported conspicuous changes occurred in the genetic constitution of these populations in response to environmental conditions.

In the present paper, changes in the genetic constitution with respect to heading time and culm length will be demonstrated with sorghum varieties grown under diverse environments: tropical and temperate regions. The work has been carried out by the authors at the University of the Philippines at Los Banõs from 1976 to 1978.

Of the world collection of sorghum varieties by the All-India Coordinated Sorghum Improvement Programme (AICSIP), 20 varieties which were first introduced to Thailand and subsequently to the Philippines (hereafter referred to CS group), and 18 varieties which were introduced to Japan and later to the Philippines (IS group) were used as the experimental material. These varieties were grown in experimental fields of the University during the 1976 wet season (July 19 to October 28), the 1977 dry season (January 19 to April 20), and the 1977 wet season (April 20 to August 8) for a ratoon crop.

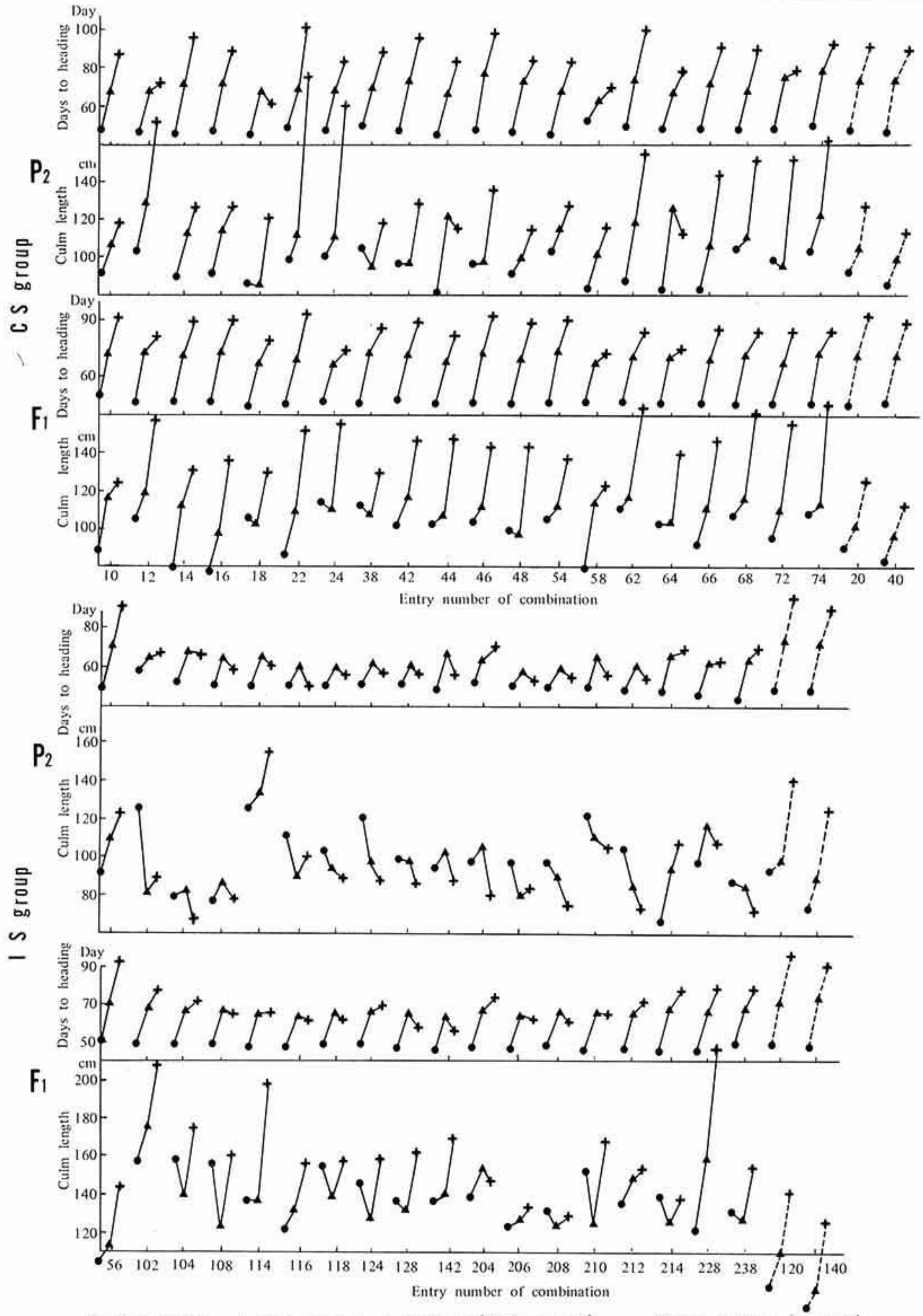
Each plot was composed of 4 rows: 2 for a parent (P_2) and 2 for a hybrid (F_1) between P_2 and a male sterile line. Each row was 4 m long and 75 cm wide. No replication was made. A check variety, cosor-1, was inserted every 36 rows so as to estimate the uniformity of the field conditions.

The characters studied were heading time (days to heading), culm length and internode length. Variations of each character observed in the parents, the crosses, and the variety groups in response to different growing seasons are shown in Fig. 1. Remarkable variations are recognized in the response of the P_2 and F_1 of each variety and that between variety groups. Variations of heading time and culm length in response to different growing seasons were more apparent in the CS group than in the IS one. The response to different growing seasons was compared between P_2 and F_1 with all combinations, and it was found that the response of F_1 reflected the genetic characteristic of P_2 used as pollen parents.

The difference in the response of heading time and culm length as observed between the CS and IS populations suggests the possibility that such a difference might have resulted from different environments of the countries of transit of these two groups, namely Thailand and Japan. For sorghum cultivation, important environmental differences between tropical and temperate regions are related to day-length and temperature. Therefore, some analysis of the above result will be made from this point of view.

Heading time In Japan, sorghum is grown during the warm season from May (planting time) to September (harvesting). With early varieties, their vegetative growth period is not sufficiently long, while with late varieties their ripening occurs at low temperature after the end of the warm season. Therefore, intermediate varieties between early and late ones are selected for the purpose of breeding. Therefore, when the varieties which became adapted to the condition of Japan are brought back to the tropics, they must show a reduced genetic variability for heading time as compared to the original varieties. It is interesting to note that such varieties showed a stable pattern of variations of heading time among different planting seasons in the Philippines.

On the other hand, it can be assumed that the purpose of introducing varieties from

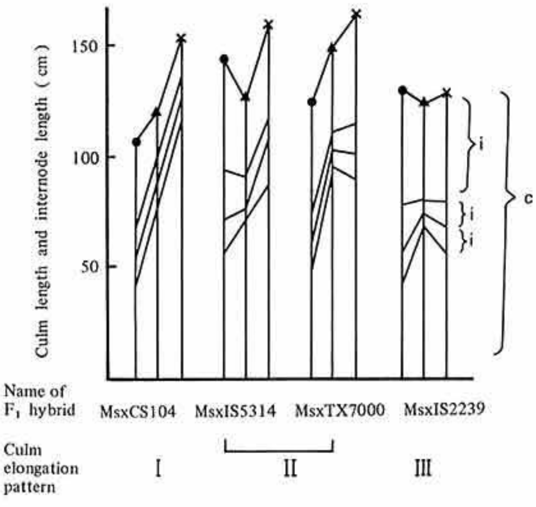


● Dry season, ▲ Wet season, + Ratoon (Wet season), --- Check variety (cosor-1)

Fig. 1. Histograms showing responses of heading time (days to heading) and culm length of 2 groups of varieties to different planting seasons

India to Thailand was to search for resistances to lodging and diseases, rather than earliness or lateness under the tropical condition of short day and high temperature all the year round. Selection for heading time such as that in Japan might not have occurred. To prove such a hypothesis, it would be necessary to examine the heading response in Japan of varieties showing different heading times in the Philippines.

Culm length Although plant growth increases generally in proportion to growth durations, no such relation was clearly shown in the present experiment. To elucidate the reason for this phenomenon, culm length and internode length were measured at each season of the experiment. As shown in Fig. 2, it was found that the culm elongation could be classified into 3 types. In the first type, the culm elongation takes place through the internode differentiation (increase in number of internodes), and in the third type, it occurs through the increase in length of each internode, while in the second type both mechanisms are involved. Existence of such different patterns of culm elongation is considered to have disturbed the relationship to be shown between heading time and culm length among different planting seasons.



Note: ●: Dry season, ▲: Wet season, ×: Ratoon (Wet), i: Internode, C: Culm length
Only 3 upper internodes are shown as an example for each hybrid.

Fig. 2. Histograms showing different patterns of culm elongation of F_1 hybrids grown in different planting seasons.

Moreover, it was recognized that the CS group followed the first pattern, while the IS group showed the third one. Based on this finding, it is suggested that the IS group had been exposed to the selection for heading time under the condition of Japan where photoperiod is longer than in the tropics, resulting in the differentiation of the internode elongation pattern.

As a result of varietal differentiation caused by natural selection under different environments, both groups, CS and IS, showed not only different responses to the cultivation in different seasons, but also different levels of F_1 heterosis, when used as pollen parents for male sterile lines. Namely, the IS varieties manifested a higher level of heterosis than the CS varieties. To elucidate the cause of such difference, it is necessary to enlarge the genetic base of the material to be used or to carry out investigations on the inter-action between variety and environment from the standpoint of ecological genetics.

1) Akemine, H. & Kikuchi, F.: In "Studies on the bulk method of plant breeding" (Sakai, K., Takahashi, T. & Akemine, H. ed.), 89–105 Yokendo, Tokyo (1958) [In Japanese].
2) Allard, R. W. & Hansche, P. E.: Some parameters of population variability and their implications in plant breeding. *Advan. Agron.*, 16, 281–325 (1964).

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