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Seed Germination in Pearl Millet Hybrids and Parents Under Extreme Temperature Conditions

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ABSTRACT

Germination behaviour and seedling growth of two pearl millet (*Pennisetum glaucum* (L) R, Br, emend, stuntz) F1 hybrids - GHB-15 and GHB-235 and two parents MS 5054-A and J-108 (parents of GHB-15)) were studied in a range of temperatures from 10 to 50°C under laboratory conditions. The optimum temperature for germination was found to be 30-35°C, while there was no germination at 10°C and 50°C. The seeds kept at 10°C for a week, when transferred to the optimum temperature resumed normal germination, thus exhibiting the chilling resistance. The hybrids performed better than the parents with respect to per cent germination, germination index and seedling growth in terms of length and dry weight at most of the temperatures studied. The hybrid GHB-15 exhibited better parental heterosis at all the temperatures and the magnitude of mid parental heterosis was more adverse temperatures than that at the optimum.

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INTRODUCTION

Heterosis in seedling growth and vigour in pearl millet has already been established (Joshi *et al.* 1986 a, b). The study of heterotic behaviour under extreme environmental conditions is a matter of interest and utility. A relationship of base germination temperature and germination parameters with adaptability and yield in sorghum has been shown (Mann and Miller 1983, Mann *et al.* 1983). Seed germination and seedling establishment in pearl millet under extremely low temperature conditions have been studied (see Pearson 1984). The high soil temperatures have also been found to be one of the principle causes of poor seedling emergence and establishment (see Rai and Anandkumar 1994). The present paper deals with the study and comparision of germination behaviour and seedling growth of pearl millet hybrids and parents in a range of temperatures under laboratory conditions.

MATERIALS AND METHODS

The seeds of two F1 hybrids GHB-15 and GHB-235, and two parents of the hybrid GHB-15 viz., MS 5054-A and J-108, harvested at Millet Research Station, Gujarat Agricultural University, Jamnagar, India in summer 1993 and stored for two months in paper bags kept at room temperature (mean daily temperature : 30°C; mean R.H.: 72%)

were surface sterilized with 0.1% solution of mercuric chloride for 10 min. and thoroughly washed. The petri dishes, each containing 50 seeds on Whatman No. 1 filter paper moistened with DW were transferred to the incubators maintained at 10, 15, 20, 25, 30, 35, 40, 42, 45 and 50 (± 2°C) in continuous dark. Each treatment had three replicates.

The germination percentage was recorded at suitable intervals till the plateau was achieved. Further, the petri dishes kept for germination under the extreme temperatures viz., 10 ± 2°C and 50 ± 2°C were transferred after a week to 35 ± 2°C and the observations on the per cent germination were recorded. The germination index for each treatment was calculated using following formula-

$$GI = \frac{GP(t1)-GP(t0)}{t1} + \frac{GP(t2)-GP(t1)}{t2} + \frac{GP(tn)-GP(tn-1)}{tn}$$

where,

GI = Germination index

GP (t0), GP (t1) GP (tn) = Germination percentage after the time periods t0, t1.....tn

t0, t1....tn = Time in days.

Seedling dry weight, root and shoot lengths after 48 hours of germination were recorded. Ten seedlings were used for the measurement and mean values are presented for each replicate. As there was no germination at 10°C and 50°C and very slow germination at 15, 42 and 45°C, the length and dry weight measurements could not be taken at these temperatures.

Per cent germination over time was subjected to standard deviation analysis and seedling growth parameters to ANOVA as per factorial CRD and critical differences were indicated in the graphical representations. Mid parental heterosis was calculated for the hybrid GHB-15 using

Turner's (1953) formula -

$$\text{per cent heterosis over mid parent} = \frac{F1-MP}{MP} \times 100$$

and is represented in the graphical form.

RESULTS AND DISCUSSION

The first count of germination percentage, germination index and seedling growth in terms of root length, shoot length and seedling dry weight (Figs. 1 & 2) indicated that the optimum temperature for germination in pearl millet was 30-35°C, the minimum 10 ± 2°C and the maximum 50 ± 2°C. This observation is in agreement with the earlier data (Garcia-Huidobro *et al.* (1982) indicating that the base temperature for germination in pearl millet (under constant temperature condition on a thermal gradient plate) is around 12°C, the optimum 33-35°C and the maximum for germination 48°C. The temperature below 30-35°C delayed the germination, while that above 30-35°C not only delayed the germination but resulted in a marked decline in the germination percentage due to high temperature injury. High temperature effects on seedling emergence and stand establishment have been indicated (Soman and Peacock 1985, Ougham *et al.* 1988, Lynch 1993 and Rai and Anand Kumar 1994).

The seeds kept for a week at 10 and 50°C when transferred to 35 ± 2°C, the former resumed the normal germination showing chilling resistance and no low

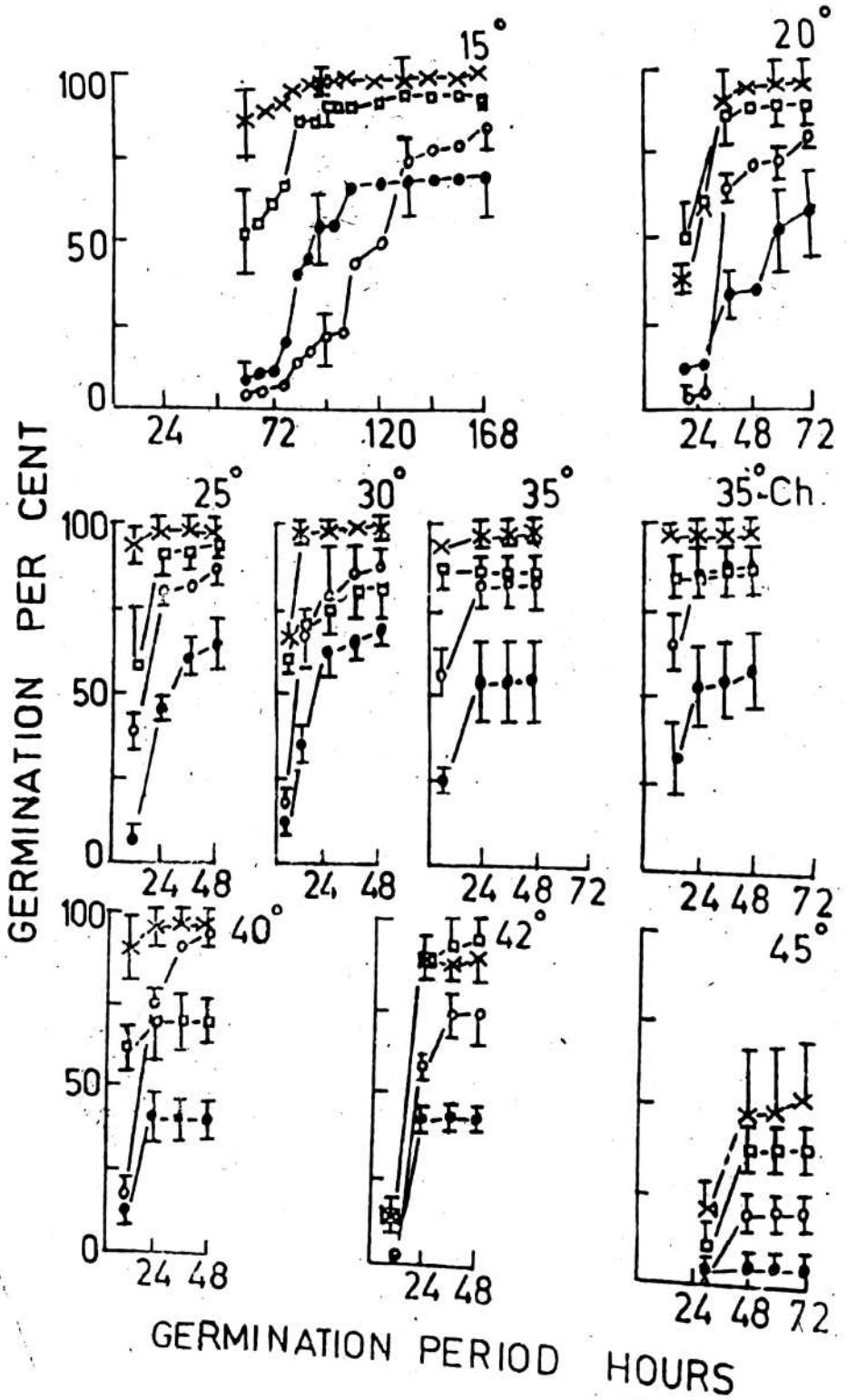


Fig.1. : Effect of temperature on seed germination per cent in pearl millet hybrids GHB-235 (❑ —❑) and GHB-15 (x – x), and female parent MS 5054–A (0 – 0) and male parent J-108 (● – ●) of the hybrid GHB-15. The vertical bars represent the standard deviation. 35°–Ch indicates germination percentage at 35°C after chilling (10 ± 2°C) the seeds for a week.

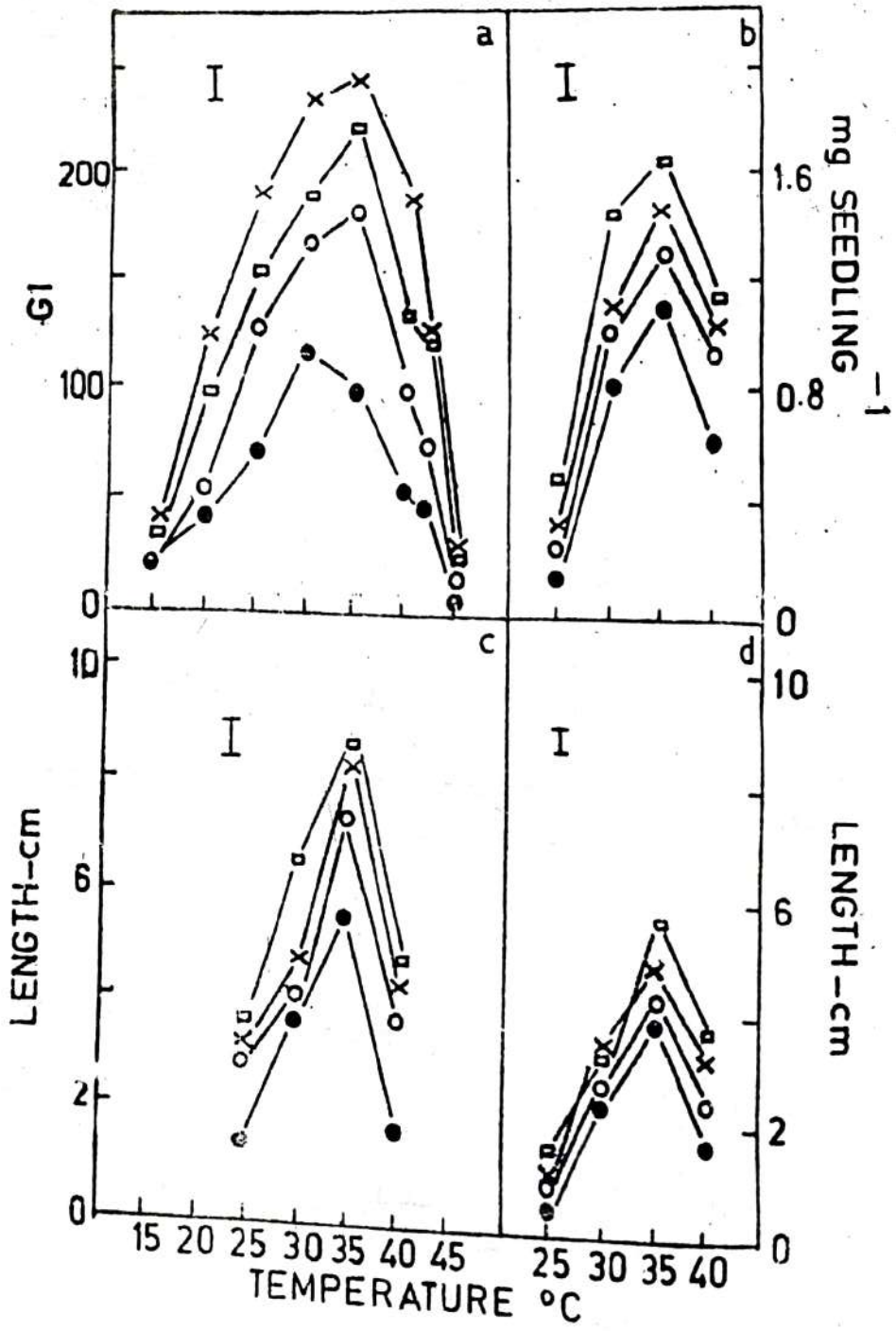


Fig. 2.: Effect of temperature on a) GI, b) dry weight, c) root length and d) shoot length after 48 hours of incubation in pearl millet hybrids and parents. The vertical bar (I) represents LSD. Other details as in Fig. 1.

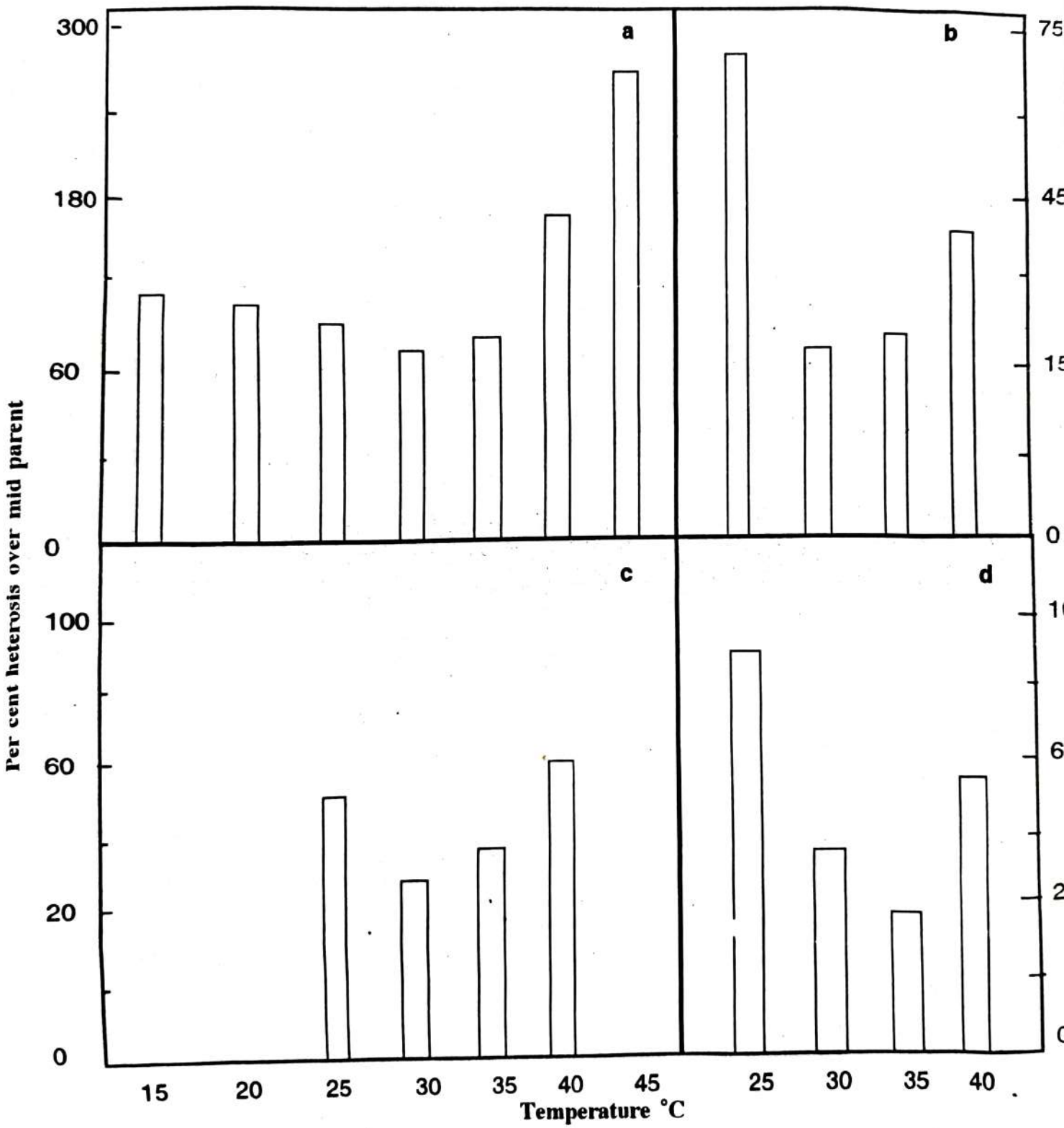


Fig. 3. : Effect of temperature on mid parental heterosis for a) GI, b) seedling dry weight, c) root length and d) shoot length in the pearl millet hybrid GHB-15 (MS 5054-A x J-108).

temperature injury was observed (Fig. 1, 35°–Ch.) while the later could not germinate at all due to high temperature injury. The high temperature effects on germination have also been reported by Garcia-Huidobro *et al.* (1985).

The hybrid GHB-15, which was superior in germination index as compared to the hybrid GHB-235, was trailing behind it with respect to seedling growth characters (root length, shoot length and seedling dry weight). Hence, besides germination rate, the influence of mean shoot length on vigour index has also been stressed (Parvathamma *et al.* 1988).

The hybrids performed better than the parents with respect to GI and seedling growth at almost all the temperatures especially the adverse ones. Hybrid vigour in pearl millet seedling growth under normal conditions (Joshi *et al.* 1986 a, b) and heterosis effects on cold tolerance in sorghum (Matthews 1983) have already been reported. Evidently the magnitude of mid parental heterosis in GHB-15 for GI and seedling growth was much higher at adverse temperatures than the optimum (Fig. 3). According to Pearson (1975) an unfavourable climate has a progressive and cumulative effect on seedling performance where as all genotypes may germinate, differences become apparent at emergence and get progressively larger.

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List of abbreviations used :

ANOVA	**= Analysis of variance**	**CRD**	**= Complete randomised design**
DW	**= Distilled water**	**GI**	**= Germination Index**
GP	**= Germination percentage**	**LSD**	**= Least Significant Difference**
		MP	**= Mid parent**