Indian J. Genet., **59**(1): 105-108 (1999)

Short communication

GENOTYPIC DIFFERENCES IN RELATION TO CLIMATIC ADAPTATION OF TWO CULTIVATED BARNYARD MILLET SPECIES AT GARHWAL HILLS

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(Received : February 2, 1998; accepted: December 17, 1998)

ABSTRACT

Genotypic differences in climatic adaptation were examined between two cultivated species of barnyard millet viz. *Echinochloa frumentacea* (Roxb.) Link and *E. crusgalli* ssp. utilis (L.) P. Beauv on four characters (1) days to emergence of seedling from soil, (2) optimum thermal time for seedling emergence, (3) seedling root length and (4) grain yield under field condition at high altitude (2100m MSL) of Garhwal hills in the Himalayas on three different temperature regimes of sowing date in April, May and June, respectively. Climatic condition in April remained cool. Early emergence of seedling, requirement of low thermal time, normal development of root and high grain yield in April sowing provide greater acclimation to low atmospheric temperature at high hills to the cultivars of *E. crusgalli* ssp. utilis (L) P. Beauv.

Key words : Barnyard millet, high altitude, seedling emergence, grain yield, cold acclimation

Echinochloa frumentacea (Roxb.) Link is the most popular barnyard millet species cultivated in India. The crop, however, fails to produce satisfactory grain yield at higher elevation of hills in the Himalayas due to exposure to low atmospheric temperature. Genotypes suitable for cold climatic conditions of high hills have not been identified so far due to the lack of effective selection criteria, narrow genetic base and complex genetic control of cold acclimation [1-3]. On the contrary, another species of cultivated barnyard millet *E. crusgalli* ssp. utilis (L.) P. Beauv., exhibits better adaptation to cold climatic condition at high hills. Climatic adaptation at non freezing cold stress depends upon the maintenance of normal growth and development of cultivar [4]. Hence, in this investigation genotypic differences in climatic adaptation were examined on seedling characters and grain yield of two cultivated species of barnyard millet.

Seeds of seven genotypes of *E. crusgalli* ssp. utilis (L.) P. Beauv. and four genotypes of *E. frumentacea* (Roxb.) Link, were sown in a randomized block design at high altitude (2100 m MSL) of Garhwal hills in the Himalayas on three dates in April (9-4-1997), May (15-5-97) and June (10-6-97) respectively at an uniform depth (1.5 cm) of soil. Moisture content of soil remained favourable for germination of seeds in April and June as adequate rainfall was received during post sowing period; while a dry weather prevailed in May. Observations were recorded on average value of atmospheric temperature on each day from date of sowing to date of 80% seedling emergence from soil [5, 6], number of days required for emergence of seedling from soil at respective sowing dates [7], seedling root length [8] at 45 days after sowing and grain yield. Analysis of variance on individual sowing dates and on pooled data over three sowing dates were computed. Correlation coefficient among six different pairs of characters were calculated on pooled data over three sowing dates.

Table 1. Range and means of atmospheric temperature and the performance of barnyard millet genotypes on three sowing dates

Entries	Days to emergence of seedling from soil			Accumulated temperature for seedling emergence from soil (degree days)			Seedling root length (cm) at 45 days after sowing			Grain yield (q/ha)		
	April	May	June	April	May	June	April	May	June	April	May	June
PRB 9401	17.3	34.3	16.6	248.98	647.88	332.06	5.3	3.3	8.3	13.1	10.0	8.5
PRB 9402	16.6	34.0	15.3	236.96	641.95	305.78	6.3	3.3	7.3	17.6	14.5	12.0
PRB 9403	14.6	34.6	15.3	201.35	655.31	305.78	7.6	3.6	9.3	27.7	25.0	19.0
PRB 9404	13.3	33.6	14.6	178.63	621.15	292.31	8.6	3.6	8.0	29.0	22.2	18.0
PRB 9501	22.6	33.6	16.6	339.26	634.51	332.06	4.3	2.6	8.3	20.3	16.3	11.0
PRB 9601	23.3	34.0	16.6	350.28	641.95	331.41	6.3	3.0	8.0	23.1	16.0	12.5
PRB 9602	24.6	34.6	15.3	371.36	655.31	305.78	6.0	2.3	8.3	27.7	17.5	14.0
VL 21	36.3	35.3	16.6	555.53	667.51	332.06	1.5	3.0	7.6	6.8	5.3	1.8
VL 29	37.0	36.0	17.3	566.55	680.88	344.88	2.6	3.3	8.6	3.8	4.6	2.0
Local 1	30.0	36.6	17.3	462.65	693.08	355.88	1.3	3.6	8.0	4.2	4.4	2.4
Local 2	32.6	36.6	16.6	493.83	693.25	332.06	2.0	3.0	8.3	6.2	5.7	3.9
CD	2.7	ns	ns	45.10	ns	ns	2.3	ns	ns	2.8	3.3	2.7

On pooled data over three sowing dates

	Days to emergence	Accumulated temperature	Seedling root length	Grain yield
E. crusgalli ssp. utilis (L) P. Beauv.				
Range	14-36	**157-682**	2-10	8.5-29.0
Mean	22.91	**426.95**	5.88	**17.35**
E. frumentacea (Roxb.) Link				
Range	16-39	**422-719**	1-10	**1.8-6.8**
Mean	29.01	**514.93**	4.40	**4.25**

Atmospheric temperature (°C)

	April	May	June	Pooled
Range	10.3-18.4	**14.3-21.7**	17.8-21.7	**10.3-21.7**
Mean	15.4	**18.9**	19.8	**18.03**

The results (Table 1) revealed that the atmospheric temperature during post sowing period in April remained cool in comparison to that of environments in May and June sowing dates. Days to emergence of seedling from soil, accumulated temperature (degree days) for seedling emergence and seedling root length showed significant genotypic variation for April sowing, while non significant variation was registered in May and June sowings. This indicated that this non uniformity in expression of characters related to seedling emergence, appeared due to exposure to low atmospheric temperature during sowing condition in April and was a conspicuous difference in expression of all characters between two species. Relatively higher values of accumulated temperature i.e. thermal time and more number of days for seedling emergence were recorded in May sowing. It was assumed that an influence of moisture stress condition soil after sowing perhaps constituted this anamoly [9]. Grain yield exhibited significant genotypic variation on individual sowing dates. Maximum yield was, however, obtained at an environmental conditions prevailed sowing during in April irrespective of genotypes. An influence of atmospheric temperature on genotype was revealed on pooled analysis of variance over three sowing dates (Table 2).

Table 2. Pooled Analysis of variance over three sowing dates for 4 characters of barnyard millet (involving two species)

Source	d.f.	Days to seedling emergence	Accumulated temperature for seedling emergence	Seedling root length	Grain yield
Replication (in environments)	6	0.83	**331.63**	0.41	2.05
Environments	2	2858.75	**1105570.10****	212.84**	324.01**
Genotypes	10	105.73	**28427.42**	7.06	529.98**
G × E	20	61.55**	**14611.56****	6.59**	10.55**
Pooled error	60	2.59	**1098.67**	1.70	3.39

*,**Significant at 5 and 1 per cent level.

The negative significant association of accumulated temperature with seedling root length and grain yield and positive significant association with days to seedling emergence (Table 3) indicated that an acclimation to low atmospheric temperature was perhaps associated with the requirement of low thermal times, early emergence of seedling, high grain yield and normal development of seedling root length. Correlation coefficient values for other characters revealed that relative advantage of

Table 3. Estimates of correlation coefficients among four characters of barnyard millet on data pooled over three sowing dates

Character	Seedling root length	Grain yield	Accumulated temperature for seedling emergence
Days to seedling emergence	–0.88**	–0.86**	0.99**
Seedling root length		0.89**	–0.89**
Grain yield			–0.87**

climatic adaptation, as indicated by the physiological production capacity of cultivars, was inversely related with days to emergence of seedling from soil and directly associated with seedling root length. A comparative assessment on mean performance of genotypes between two species of barnyard millet on pooled data over three sowing date (Table 1) indicated that the cultivars of *E. crusgalli* ssp. utilis (L.) P. Beauv. were superior to *E. frumentacea* (Roxb.) Link in respect to all desire characters and exhibited better climatic adaptation to cold stress at high hills in the Himalaya.

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