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Genotype X Environment Interaction and Stability Analysis in Cauliflower Genotypes Under Tarai Region of Uttarakhand (*Brassica oleracea var. botrytis L.)*

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ABSTRACT

Sixty genotypes of cauliflower were evaluated in augmented block design (ABD) with three replications under four environments to study the stability behavior of genotypes under the four environmental condition created with different spacing and boron *viz*., 60 x 50 cm without spacing (E_1), 60 x 50 cm with boron (E_2), 40 x 50 cm without boron (E_3) and 40 x 50 cm with boron (E_4). Pooled analysis of variance exhibited significant mean squares due to genotypes for all the traits. There was enough variability due to environments for all the traits. The genotypes PCF202, PCF203, PCF205, PCF206, PCF207, PCF218, PCF232, PCF233, PCF236, PCF251, PCF252, PCF240, PCF248 and PCF255 were found to be only desirable stable genotypes for Tarai region of Uttarakhand. They can be used as parents in hybridization programme or could be suggested for planting under varying type of environments as specified in the present investigation.

Key words : *Brassica oleracea var. botrytis L,* Cauliflower, Environment, Genotypes and Stability

The major objective of any plant breeding and selection programme is to develop genotypes, which could perform consistently superior in many variables environments. Phenotypically suitable genotypes are usually sought after for the commercial production of crop plants. However, one of the main constrains to the fulfillment of this objective is the genotype-environment interactions (G x E interaction) which make it difficult to correctly identify genotypes that could exhibit stable performance over different environments and are widely adopted so that these may be commercially grown in larger area. Therefore, one of the significant steps in identifying stable genotypes is to subjects the population of potential genotypes to multi-environments testing and thereby to generate basic information with respect to likely magnitude of G x E interactions. Such breeding objective requires the basic information on the nature and extends of G x E interaction in respect of yield and its components characters. It was, therefore, felt necessary to study the stability behavior of newly developed cauliflower genotypes and their performance under varying environment spacing (60 x 50 cm and 40 x 50 cm) and boron (0.5% with boron and without boron).

MATERIAL AND METHODS

The present investigation was conducted during winter season, at the Vegetable Research Centre (VRC), Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. The experimental material comprised of sixty promising midseason cauliflower genotypes from diverse source being maintained at V.R.C of the university. The experiment was conducted in augmented block design (ABD) with four environments as given below. Environments *viz*., E_1 (60 x 50 cm without boron), E_2 (60 x 50 cm with boron), E_3 (40 x 50 cm without boron) and E_4 (40 x 50 cm with boron). Sixty genotypes of cauliflower were evaluated with including three checks *viz*., PCF201, PCF202, PCF203, PCF204, PCF205, PCF206, PCF207, PCF208, PCF209, PCF210, PCF211, PCF212, PCF213, PCF214, PCF215, PCF21 6, PCF217, PCF218, PCF219, PCF220, PCF221, PCF222, PCF223, PCF224, PCF225, PCF226, PCF227, PCF228, PCF229, PCF230, PES3, PCF231, PCF232, PCF233, PCF234, PCF235, PCF236, PCF237, PCF238, PCF239, PCF240, PCF241, PCF242, PCF243, PCF244, PCF245, PCF246, PCF247, PCF248, PCF249, PCF250, PCF251, PCF252, PCF253, PCF254, PCF255, PCF256, PG-3, PG-5 and PG-6. Each environment consisted of

sixty genotypes every ten genotypes three checks were repeated PG3, PG5 and PG6. The seedlings were planted at a spacing of 60 x 50 cm normal and 40 x 50 cm, high density spacing were planted and environments E_1, E_3 without boron and E_2 and E_4 were 0.5% boron were applied. Each genotypes were average five plant taken the observations, quantitative Characters whole plant weight (g), leaf length (cm), leaf breath (cm), curd weight (g), curd length (cm), curd diameter (cm), plant height (cm), plant diameter (cm), number of leaves per plant, petiole length (cm), days to first curd formation, days to 50% maturity and qualitative characters *viz.,* curd compactness, curd shape, leaf angle, leaf apex shape, seedling leaf color, seedling leaf, juvenile development, leaf blade thickness, leaf tip attitude, leaf color, leaf bloom, curd formation. Data was analyzed statistically as per techniques proposed by Eberhart and Russel (1969) to estimate the stability parameters and G x E interactions with respect to different characters.

RESULT AND DISCUSSION

The pooled analysis of variance of difference characters presented in (Table 1). The mean squares due to genotype were significant for all the chanters *viz*. whole plant weight (g), leaf length (cm), leaf breath (cm), curd weight (g), curd length (cm), curd diameter (cm), plant height (cm), plant diameter (cm), number of leaves per plant, petiole length (cm), days to first curd formation, days to 50% maturity (Table 1 & 2) and Plate (1, 2 and 3). The significant Variations, df, Plant weight (g), Leaf length (cm), Leaf breadth (cm), Curd weight (g), Curd length (cm),Curd breadth (cm) variation due to environments was noticed for all the characters. The presence of environmental variability is a pre requested to any useful regression response analysis (Pfahler and Linskens, 1979). Among the four environments, comprising different spacing & boron, the environments.

Among the four environments comprising different spacing and boron concluded that E_1 60 x 50cm with boron gave early curd formation & early 50% curd maturity while E_2 60 x 50 cm without boron gave best performance compare to other environments in curd weight, curd length and curd breadth but other two environments high density spacing 40 x 50 cm with boron & 40 x 50cm without boron only favorable for vegetative characters. Significant mean squares due to G x E interaction were observed for all traits indicating differential response of the genotypes to four different spacing & boron concentrations. This suggested that cauliflower genotypes must be evaluated over different density and micronutrient concentration (boron) regimes to obtain the precise estimates for different traits. The linear component of G x E interaction was significant for all the characters mainly for economic characters viz., curd weight (g), curd length (cm), curd diameter (cm), days to first curd formation and days to 50% maturity. The non linear responses of genotypes as measured from linear regression were significant for all the characters. These result suggested that Eberhart and Russells model (1966) could be used to identify stable genotypes.

Finally, it is usually considered necessary to identify genotypes promising consistently good under Tarai region of Uttarakhand environments. For getting such information so vital to the breeding programmes Eberhart and Russel (1966) suggested that an ideally adaptable genotypes would be one having high mean, unit regression coefficient (bi=1.0) and a deviation from regression as small as possible ($s^2di=0$). Based on the Eberhart and Russells model (1966), the genotype could be categorized as suitable for favourable for the curd weight (g), curd length (cm), curd diameter (cm), days to first curd formation and days to 50% maturity in our study.

It was found that, the most desirable and desirable genotypes of vegetative characters for plant weight PCF 206, leaf length PCF 235, leaf breadth PCF 218 and PCF 228, number of leaves PCF251, PCF221, PCF237, PCF241, PCF240, PCF215 and PCF225. Plant height PCF248 and PCF201, plant diameter PCF 253, PCF255, PCF 203, PCF240 and PCF 227. Also genotypes suitable for significant environments in plant weight PCF 217, PCF245, PCF233, PCF238, PCF206, PCF210, PCF204 and PG6. Leaf length PCF251, PCF221, PCF249 and PCF210. Similar result also supported by (Shukla, 1994) and (Kallo and Pandey, 1979).

The most desirable and desirable genotypes of economic characters curd weight showed most stable and genotypes for curd weight PCF 203, PCF232, PCF218, curd length PCF 250, PCF202

Table 1. Pooled analysis of variance (mean squares) for different characters of cauliflower.

Variations	df	Plant weight (g)	Leaf length (cm)	Leaf breadth (cm)	Curd weight (g)	Curd length (cm)	Curd breadth (cm)
Genotype (G)	59	58879.63**	61.53**	99.34**	46116.0**	006.97**	002.20**
Environment (E)	3	298561.62**	284.78**	72.41**	27140.93**	006.46**	006.21**
G x E	177	36656.29**	63.03**	73.99**	39448.91**	007.82**	002.52**
E+ G x E	180	40507.84**	66.29**	73.96**	39267.91**	007.80**	2.5782**
E (Linear)	1	895684.81**	854.36**	217.23**	81422.80**	019.39**	18.63**
G x E (Linear)	59	51931.56**	52.48**	79.54**	40366.10**	006.13**	002.35**
Pooled deviation	118	28591.91**	67.29**	70.16**	38416.92**	008.54**	002.57**
Pooled error	348	22967.31**	89.21**	108.10**	35165.16**	24.41**	19.24**

Table 2. Pooled analysis of variance (mean squares) for different characters of cauliflower.

Variations	df	Plantheight (cm)	Leaves perplant	Petiole length (cm)	Days to first curd formation	Days to 50% maturity	Plant diameter (cm)
Genotype (G)	59	206.08**	20.76**	7.03**	197.06**	165.07**	195.12**
Environment (E)	3	472.87**	39.06**	42.01**	294.68**	825.36**	323.92**
G x E	177	150.75**	16.33**	8.58**	137.58**	125.71**	114.72**
E+ G x E	180	155.48**	16.66**	9.07**	139.89**	136.00**	117.80**
E (Linear)	1	1418.62**	117.19**	126.05**	884.05**	2476.10**	971.78**
G x E (Linear)	59	162.79**	14.96**	8.65**	132.33**	164.88**	131.61**
Pooled deviation	118	142.60**	16.76**	8.42**	138.15**	104.56**	104.71**
Pooled error	348	1724.55**	215.00**	76.50**	768.30**	642.16**	445.35**

and PCF246. Curd breadths were PCF 251, PCF252, PCF233, PCF248, PCF202 and PCF240. Curd weight showed significant variation in PCF254, PCF222, PCF227 and PCF228. Curd length showed suitable for rich environments were PCF253, PCF251, PCF212, PCF255, PCF246, PCF256, PCF220, and PCF204 and PCF227. curd breadth are PCF 243, PCF253, PCF217, PCF221, PCF208, PCF214, PCF236, PCF234, days to first curd formation showed suitable for rich environments in PCF254, PCF212, PCF232, PCF211, PCF230, PCF209, PCF215, PCF250, PCF225, PCF204 and PCF218. Days to 50% maturity suitable for rich environment PCF233, PCF221, PCF246, PCF237, PCF232, PCF222, PCF204 and 218. Similar result also supported by (Peter and Rai,1979).

PCF 201, PCF 202, PCF 203, PCF 206, PCF 215, PCF225, PCF207, PCF 221, PCF237, PCF 227, PCF224, PCF 205, PCF 235, PCF 232, PCF 236, PCF 218, PCF 228, PCF233, PCF 248, PCF241, PCF244, PCF253, PCF250, PCF251, PCF252, PCF255, PCF246 and PCF240 exhibited significantly higher mean than the general mean (Xi) having regression coefficient close to one and s^2di values approaching zero indicated that they fulfilled the criteria of desirable and stable genotypes as per the requirements of Eberhart and Russels (1966).

Conclusion

Result of the present study revealed that genotypes PCF202, PCF203, PCF205, PCF206, PCF207, PCF218, PCF232, PCF233, PCF236, PCF251, PCF252, PCF240, PCF248 and PCF255 were found to be only desirable stable genotypes for Tarai region of Uttarakhand. The information about stability and contribution of different characters of interest will be useful in selecting parents for hybridization. Hybridization may be initiated to generate wide spectrum of variability so that breeder can manipulate the material. At the same time, the promising genotype can be evaluated in larger plots and recommended for release.

Plate 1. Pooled analysis of variance for plant weight (g) and curd weight (g).

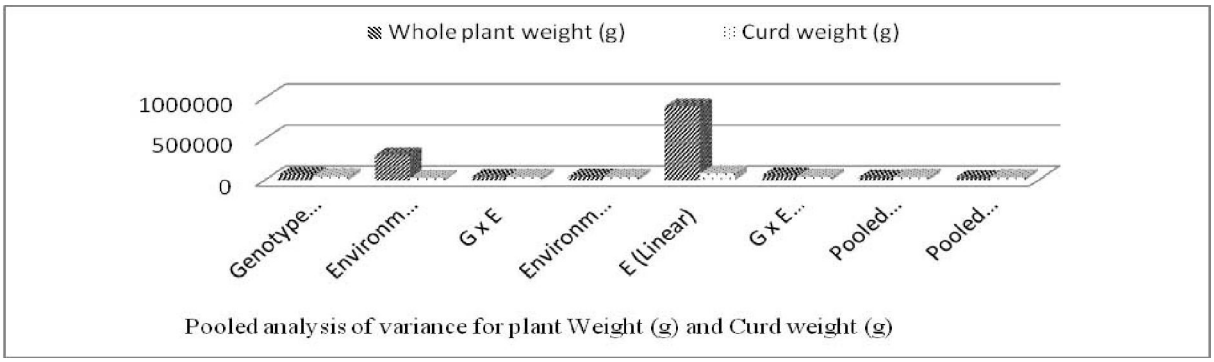


Plate 2. Pooled analysis of variance for curd length (cm) and curd breadth (g).

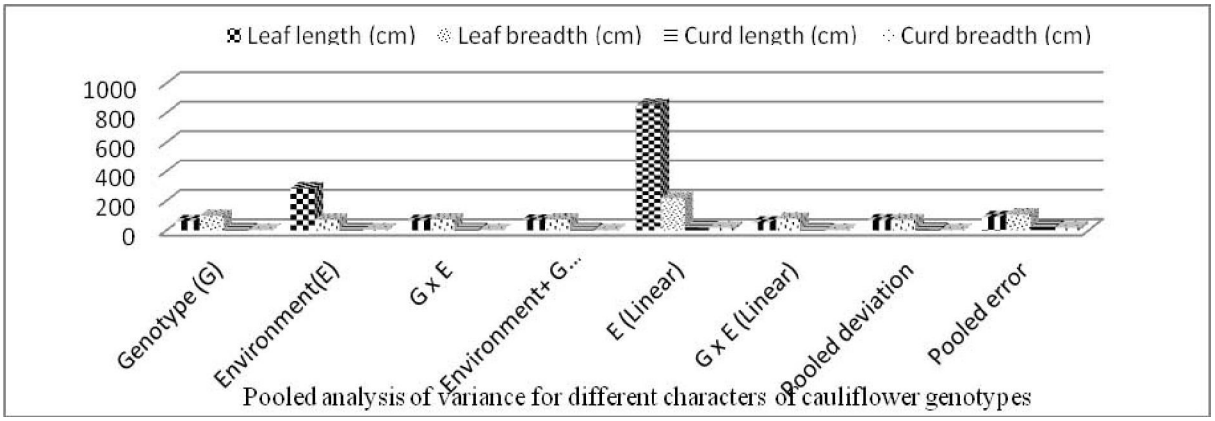
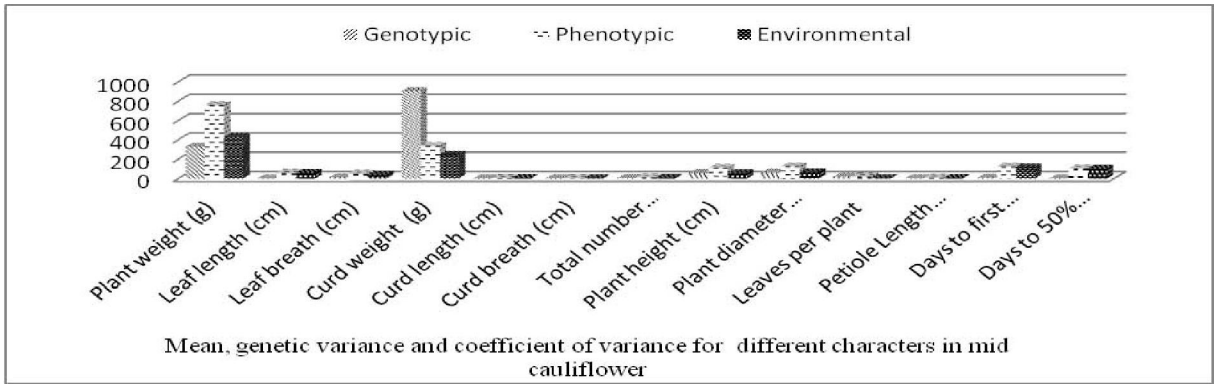


Plate 3. Pooled analysis of variance for Phenotypic, Genotypic and Environment.



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