ISSN: 2617 – 8338 (Online)
: 2617 – 832X (Print)

EBAUB Journal
An Academic Journal of
EXIM Bank Agricultural University Bangladesh

Significant Role of Environment on Different Vegetative Characteristics of Some Maize Varieties Available in Bangladesh in Respect of Variance, Heritability and Genetic Advance

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ARTICLE INFO

Received date: April 21, 2021
Accepted date: Dec. 02, 2021

ABSTRACT

The experiment was conducted for screening superior variety in respect of vegetative characteristics. In this experiment 50 maize varieties were used. The experiment conducted was laid out in randomized complete block design with three replications. For screening superior maize varieties, the analysis of variance was done. Analysis of variance revealed significant differences among the genotypes for all the characters studied. In respect of cob height, the phenotypic variance (63.19) was higher than the genotypic variance (51.86) and the phenotypic coefficient of variation (10.70%) was higher than the genotypic coefficient of variation (9.69%). Phenotypic variance (553.46) was higher than the genotypic variance (271.15) in case of plant height and genotypic (7.83%) co-efficient of variation. The differences between phenotypic variances (1.11) and genotypic variances (0.60) were relatively low for leaves per plant. Leaves per plant showed moderate heritability (53.79%) along with low genetic advance in percentage of mean (9.12%) revealed the possibility of predominance of both additive and non additive gene action in the inheritance of this trait. In case of leaf length, the phenotypic variance and genotypic variance were 54.07 and 33.05, respectively and high heritability (61.12) coupled with moderate genetic advance in percent of mean (10.64) attributed to both additive and non-additive gene actions. Phenotypic and genotypic variance for leaf breadth was observed 0.79 and 0.51, respectively. High heritability (64.54) coupled with moderate genetic advance in percent of mean (13.45) attributed to both additive and non-additive gene actions. The phenotypic coefficient of variation (10.12%) was higher than the genotypic coefficient of variation (8.13%), which suggested that environment has a significant role on the expression of this trait.

Keywords: Advance genetics, Heritability, Maize**,** Variance, Vegetative characteristics

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1. INTRODUCTION

Maize (*Zea mays* L.) belongs to the family Poaceae, one of the most important plants in the order Poales. Maize is known as the queen of cereals' due to its' demand and wider adaptability. It is the second most important cereal crop in the world in terms of acreage and production. Global production of Maize was about 1040 million metric ton in

To Cite: Hossain, M. D., Bhuiyan, M. S. R., Mahmud, F., Zeba, N. & Islam, M. R. (2022). Significant role of environment on different vegetative characteristics of some maize varieties available in Bangladesh in respect of variance, heritability and genetic advance. *EBAUB J.*, 4, 105-110.

the year 2016–2017, where in USA and China contributed about 38 and 23%, respectively (Jaidka et al., 2019). The centre of origin of maize is the Mesoamerican region, probably in the Maxican highlands from where it spreads rapidly.

Maize exploration has been high from its point of origin in Central American tropics and Mexico (Adiaha & Agba, 2016) to all parts of the globe, with its uses/utilization doubling as the day counts, and as science attention has been on the crop for ages. Maize is the third important cereal crop globally after wheat and rice. Now maize is widely cultivated throughout the world.

Top corn producing countries include the United States, China, Brazil, Mexico, Indonesia, India, France and Argentina. Maize is cultivated in several Asian countries including the Philippines, Thailand, China, India, Pakistan and most recently in Bangladesh. The Portuguese pioneers first to introduce maize to the Indian subcontinent in the sixteenth century. Centuries later, around mid-1900s, research and development (R & D) on maize emerged in Bangladesh which was then considered to be East Pakistan, before the 1971 Liberation War (Alam et al., 2013).

In Bangladesh, maize production gained momentum from the 1990s. Prior to that, open pollinated varieties of maize were generally cultivated in the Chittagong Hill Tract areas as a component crop of Jhum or shifting cultivation practiced by the tribal people. After the establishment of the Bangladesh Agricultural Research Institute (BARI, 1993), the potentials of developing the maize sector were emphasized, and maize was recognized as a high yielding cereal crop. Bandarban, Rangamati, Dinajpur, Gaibandha and Rajshahi districts are the major maize producing areas. But maize is cultivated in almost all the districts of Bangladesh except in Narail District (Akhter & Mittra, 1990). Maize is one of Bangladesh's few cash crops which have the potential to pull farmers out of poverty. Maize is a multipurpose crop.

It plays a significant role in human and livestock nutrition worldwide (Bantte & Prasanna, 2004). The suitable soil conditions, topography, and climate mean that Bangladesh has the opportunity to increase its maize cultivation area and yield per acre significantly.

By growing more maize it may be possible to meet up the national demand and also can be exported to the other countries which ultimately influence in our national economy. There are a lot of maize varieties available in Bangladesh. Among the varieties maximum are hybrids and some are open pollinated varieties.

The yield of hybrid maize is about 20-30% higher than that of open pollination composite ones, which encouraged the farmers to prefer hybrid maize (Islam et al., 2014). Exploitation of heterosis or hybrid vigor and selection of superior hybrid is an important breeding approach in crop improvement. Breeder's objectives are to select hybrids on the basis of expected level of heterosis. Maize is considered as a major source of protein ranking only behind meat, fish and legumes in terms of yearly protein production (Dasbak et al., 2008). The grain is similarly rich in vitamins and fats and makes the crop match suitably, as an energy source, with root and tuber crops per unit measure (Dasbak et al., 2008; Kling, 1991). The major chemical constituent of the maize kernel is carbohydrate which accounts for 72-73% of the Kernel (Wilson, 1987). Maize is the major source of energy and protein in the diet of many people. Its grain contains 11.2% protein, 66.2% carbohydrate, 3.6% fat, 1.5% minerals and 2.7% fiber (Gopalan et al., 1981). Maize is fairly rich in vitamin B and the yellow kernel is also good source of the pro-vitamin A, β carotene, which can prevent human blindness.

Considering the above mentioned aspects the main objectives of the study was for screening superior maize variety through evaluating variance, co-efficient of variation, heritability and genetic advance of different maize varieties available in Bangladesh in respect of vegetative characteristics.

2. MATERIALS AND METHODS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka. There are fifty maize varieties were used in this study (Table 1). The methodology of the study was described in different heads as follows:

2.1. Land Preparation

The experimental plot was opened in the first week of March 2017 with a power tiller and was exposed to the sun for a weak. After a week, the land was prepared by several ploughing and cross ploughing followed by laddering and harrowing with power tiller and country plough to bring about good tilth. This was carried out to manage weeds, provide good soil aeration and to obtain good seedling emergence and root penetration. Weeds and other stubbles were removed carefully from the experimental plot and leveled properly. The final land preparation was done on 20th March 2017. Special care was taken to remove the rhizomes of mutha grass.

2.2. Manure and Fertilizer Application

Generally, cow dung, Urea, TSP and MP fertilizers are required for maize cultivation. The field was fertilized with 10 ton cow dung per ha. The field was also fertilized with 185, 276, 276, 185, 17, 12 kg per hectare N, P, K, S, Zn and B, respectively. The entire amount of cow dung was applied seven days before sowing. P, K, S, Zn and B were applied during final land preparation and incorporated into the soil. The total amount of urea was divided by two phases. Half of the urea was applied after 40 - 45 days of seed germination and the rest of the urea was applied after 70 -75 days of seed germination (before flowering) of the plants. The 1st and 2nd weeding was applied respectively after 20 and 40 days of sowing. Flood irrigation was given when it is necessary. Generally, irrigation was given 25-30 days interval. Pesticide, insecticide and intercultural operations like irrigation, weeding were applied when it is necessary.

Table 1 List of different varieties of maize used in the experiment

Sl. no.	Varieties	Sources	Sl. no.	Varieties	Sources
01	BHM-3	BARI	26	AS-999	ACI
02	BHM-5	BARI	27	Kaberi-369	ACI
03	BHM-6	BARI	28	NZ-001	ACI
04	BHM-7	BARI	29	NZ-003	ACI
05	BHM-9	BARI	30	NZ-510	ACI
06	Shuvra	BARI	31	25KSS	ACI
07	BM-5	BARI	32	Pioneer-3056	Petrocem Co.
08	BM-6	BARI	33	AgroG-8255	Energypac Ltd.
09	Khaibhutta	BARI	34	GP-50	Getco
10	BHM-8	BARI	35	Auto-987	Auto Crop Care Ltd.
11	NK-40	Syngenta	36	GP-901	Getco
12	Pacific-11	BRAC	37	Krishibid -550	Krisibid Group
13	PAC-399	BRAC	38	PAC-984	BRAC
14	BARI Mistri-1	BARI	39	PAC-555	BRAC
15	PAC-984	BRAC	40	Elite	
16	Dekalb S. Gold	Monsanto	41	Krishibid -102	Krisibid Group
17	Dekalb-962	Monsanto	42	GP-838	Getco
18	Khaibhutta	BRAC	43	Pioneer-07	Petrocem Co.
19	Barnali	BRAC	44	ACI-3110	ACI
20	VB-100		45	Krishibid -222	Krisibid Group
21	Pacific-98	BRAC	46	Progreen-1000	AR Malik
22	PAC-740	BRAC	47	GP-100	Getco
23	Dekalb-9120	Monsanto	48	PAC-999	BRAC
24	VA-786		49	Bioseed-707	Getco
25	Profit	ACI	50	Badsha	Getco
18	Khaibhutta	BRAC	43	Pioneer-07	Petrocem Co.
19	Barnali	BRAC	44	ACI-3110	ACI
20	VB-100		45	Krishibid -222	Krisibid Group
21	Pacific-98	BRAC	46	Progreen-1000	AR Malik
22	PAC-740	BRAC	47	GP-100	Getco
23	Dekalb-9120	Monsanto	48	PAC-999	BRAC
24	VA-786		49	Bioseed-707	Getco
25	Profit	ACI	50	Badsha	Getco

2.3. Experimental Design

The trial was laid out in a Randomized Complete Block Design (RCBD) with three replications.

2.4. Experimental Materials

Fifty varieties were used for conduction the experiment for screening the superior genotypes of maize. The list of maize genotypes is listed in Table 1.

2.5. Bed Preparation

Accordingly, 3.5 m × 2.0 m sized plots were prepared for seed sowing. Seeds of fifty different hybrids maize varieties were accommodated in this plot.

2.6. Seed Sowing

Two seeds per hill for each set of variety were sown at the spacing 75 cm × 25 cm with seed rate 20 kg ha^{-1}.

2.7. Gap Filling

Necessary gap filling was made by re-sowing within 8 days after sowing.

2.8. Thinning

The field was thinned to one plant per hill two weeks after emergence of plant (Fig.1).

2.9. Intercultural Operations

Inter cultural operations viz. weeding, irrigation, earthing up was done when necessary. Weeding and mulching were done properly. Weeding was done in the soil whenever it was necessary to keep the soil free from weeds. The soil was mulched frequently after irrigation by breaking the crust for better aeration and conservation of soil moisture. Generally, the 1st and 2nd weeding were applied after 30 and 60 DAS respectively. The experimental plots were irrigated when necessary, during the crop period. Generally, the crop was irrigated 6 times at 15 days interval starting from 15 DAE. Further irrigation was made at 30, 45, 60, 75 and 90 DAS. Earthing up was done two times during the growing period. The first earthing up was done at 45 DAS and the second earthing up was done after 65 DAS. Stacking was done during the silking stage of plants. For staking bamboo stick was placed and spike was tied with the stick. Each plant was supported by 100 cm long bamboo sticks to facilitate the plant to keep erect. The plant was fastened loosely with the bamboo stick by jute string to prevent the plant from lodging.

2.10. Plant Protection

Adult and larva of many insects were found in the crop during the vegetative and flowering stage of the plant. To control such insects Malathion-57 EC @ 2ml/litre and Diazinon 60 EC @ 2 ml/litre of water were sprayed at 70 and 90 DAS respectively. The insecticide was applied in the afternoon. Ridomil 2g/litre of water was sprayed thrice the plants as protective measures against fungal disease.

2.11. Data Collection

Data on yield and yield components were taken properly. Data were collected from the selected plants at random from each unit plot. Data were collected in respect of the following parameters (Fig.2).

2.12. Cob Height

The heights (cm) of ten randomly selected plants were measured from each unit plot in centimeters with a graduated measuring stick. Ear height was taken from the soil surface (ground level) to the node bearing the uppermost ear node. Ear heights were measured from the same plant from which plant heights were recorded.

2.13. Plant Height

Plant height (cm) refers to the length of the plant from ground level up to the last node (base of the tassel/flag leaf node) of the plant. Height of 10 randomly selected plants of each unit plot was measured at an interval of seven days starting from 30 DAS till 90 DAS and the mean was calculated. It was measured in cm with a graduated measuring stick.

2.14. Leaves per Plant

All the leaves of selected plants were counted at an interval of 7 days starting from 30 DAS till 90 DAS. Number of leaves per plant was recorded by counting all the leaves from the selected plants of each unit plot and the mean was calculated.

2.15. Leaf Length

The length (cm) of leaves of randomly selected plants was recorded at an interval of seven days starting from 30 DAS till 90 DAS. The length of leaves from randomly selected plants was measured by a measuring scale from leaf base (ligules) to the tip and was expressed in cm.

2.16. Leaf Breadth

The width (cm) of leaves of randomly selected plants was recorded at an interval of seven days starting from 30 DAS till 90 DAS. The width of leaves of randomly selected plants was measured by a measuring scale from one side of the middle and was expressed in cm.

Fig. 1Showing the field views at vegetative stage.

Fig. 2 Showing quantitative data collection in different stage.

2.17. Statistical Analysis

Mean data of the characters were used to statistical analyze like analysis of mean, range were calculated by using MSTATC software program. Genotypic and phenotypic variance was estimated by the formula used by Johnson et al., (1955). Heritability and genetic advance were measured using the formula given by Allard (1960). Genotypic and phenotypic coefficient of variation was calculated by the formula of Burton (1952).

3. RESULTS

Genotypic and phenotypic variance, heritability and genetic advance in percentage of mean were estimated for five vegetative traits in 50 genotypes of maize that presented in Table 2.

3.1. Cob Height

In respect of cob height (cm), the phenotypic variance (63.19) was higher than the genotypic variance (51.86) indicating that highly environmental influence for expression of this character (Table 2). The phenotypic coefficient of variation (10.70 %) was higher than the genotypic coefficient of variation (9.69 %), which suggested that environment has a significant role on the expression of this trait. High heritability (82.06%) coupled with moderate genetic advance as percent of mean (18.09) was observed for this trait. These traits are most probably controlled by both additive and non additive gene action.

3.2. Plant Height

Phenotypic variance (553.46) was higher than the genotypic variance (271.15) in case of plant height (cm) indicating that highly environmental influence for expression of this character which was supported by high difference between phenotypic (11.18%) and genotypic (7.83%) co-efficient of variation (Table 2).

Moderate heritability (48.99%) along with moderate genetic advance in percentage of mean (11.29) revealed the possibility of predominance of both additive and non additive gene action in the inheritance of this trait. The analysis of variance revealed significant difference ($p<0.05$) among genotypes for plant height in his study.

Table 2 Genetic parameters for yield attributes of different maize genotypes

Characters	Genotypic variance (σ2g)	Phenotypic variance (σ2P)	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (%)	Genetic advance (GA)	Genetic advance (%)
Cob height (cm)	51.86	63.19	9.69	10.70	82.06	13.44	18.09
Plant height (cm)	271.15	553.46	7.83	11.18	48.99	23.74	11.29
Leaf per plant	0.60	1.11	6.04	8.23	53.79	1.17	9.12
Leaf length (cm)	33.05	54.07	6.60	8.45	61.12	9.26	10.64
Leaf breadth (cm)	0.51	0.79	8.13	10.12	64.54	1.19	13.45

3.3. Leaf per Plant

The differences between phenotypic variances (1.11) and genotypic variances (0.60) were relatively low for leaves per plant indicating low environmental influence on these characters (Table 2). The value of PCV and GCV were 8.23 % and 6.04 % respectively for this trait which indicating that less variation exists among different genotypes. Leaves per plant showed moderate heritability (53.79%) along with low genetic advance in percentage of mean (9.12%) revealed the possibility of predominance of both additive and non additive gene action in the inheritance of this trait. Gungula et al. (2005) observed in their study that there were significant differences among the varieties for total number of leaves per plant.

3.4. Leaf Length

In case of leaf length (cm), the phenotypic variance and genotypic variance were 54.07 and 33.05, respectively with relatively large differences indicating large environmental influences on expression of this character as well as PCV (8.45 %) and GCV (6.60 %) indicating the presence of considerable variability among the genotypes (Table-2). High heritability (61.12) coupled with moderate genetic advance in percent of mean (10.64) attributed to both additive and non-additive gene actions. Song et al. (2016) stated in their study that extension of leaf length responded to increase plant density as soon as onset of mild interplant competition.

3.5. Leaf Breadth

Phenotypic and genotypic variance for leaf breadth (cm) was observed 0.79 and 0.51, respectively with moderate differences between them, suggested moderate influence of environment on the expression of the genes controlling this trait. The phenotypic coefficient of variation (10.12%) was higher than the genotypic coefficient of variation (8.13%) (Table 2), which suggested that environment, has a significant role on the expression of this trait. High heritability (64.54) coupled with moderate genetic advance in percent of mean (13.45) attributed to both additive and non-additive gene actions. Song et al. (2016) observed in their study that the leaf breadth reduced due to a smaller growth rate in response to increase plant density.

4. CONCLUSION

Data on different vegetative characters were recorded time to time and analyzed statistically. In respect of selection of the suitable maize varieties, the analysis of variance showed highly significant differences among the genotypes for all the characters. Significant variation was observed in different yield and yield contributing characteristics among the varieties under study. All the parameters under studied suggested that environment has a significant role on the expression of these traits. High heritability coupled with moderate genetic advance in percent of mean attributed to both additive and non-additive gene actions.

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