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The barley mutant's genetic variability of some important quantitative characters

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Abstract

Barley (*Hordeum vulgare* L.) is an important cereal crop of rabi season in the country. It has got the special significance being cultivated in almost all parts of the world. It is a major source of food for a large number of people living in the cooler and semi-arid area of the world where other cereal is poorly adapted. Barley has been known for a long time for food and it has been under cultivation since ancient time. Barley originated in Abyssinia which is the principal centre of its origin because of wide diversity is present there in different wild form of barley. According to some other investigators South Eastern Asia, particularly China, Tibet and Nepal is the centre of origin of barley. A field experiment was undertaken during wet seasons of 2008 to evaluate the response of Important Quantitative Characters in Mutant Barley. The experimental was laid out on a sandy loam soil of Post graduate College Ghazipur on farm, to applied fertilizer for rationalizing the use of Nitrogen (N), Phosphorus (P) and Potassium (K) fertilizers by Basal application and real time management respectively for making them more suitable for Barley Crops. The experiment involved twenty newly developed barley mutants and two mother cultivars, were the materials of the present research work. The mutation research work using chemical (Ethyl methanesulfonate (EMS) and Hydroxylamine (HA) and physical (Gamma rays) mutagens on barley cultivars. In progress in the Dept. of Genetic and plant Breeding, P.G. College Ghazipur. The EMS is a colorless liquid, alkylating agent. It's commonly used of a chemical mutagen in experimental genetics to change the various organisms of plant cell. The maximum days to 50% flowering was observed in mutant K-551 and minimum was in Mutant K-925 had the minimum days to maturity and G-30-5 and K-50-50 had the maximum days to maturity. Number of tiller was the maximum K-40-72 and the minimum K-226. The plant height was observed maximum in mutant KH3-63 and minumum in mutant K-882. The maximum number of seed per spike was found in mutant Gitanjali and minimum in mutant K-925. Ear length was the maxi-mum in mutant K-40-35 and the minimum in mutant K-882. The maximum 100 seed weight was observed in mutant KE-3-75 and the minimum in mutant K-551. Biological yield per plant was the maximum in mutant K30-88 and the minimum in mutant K50-50. Harvest index was maximum in mutant K-50-35 and minimum in mutant K-55. Seed yield per plant was the maximum in K-50-50 and the minimum in K-55. Genotypic coefficient of variability GCV was the highest for the biological yield/plant, followed by harvest index, seed yield/plant, plant hight, 100 seed weight, number of seed/spike, days to 50% flowering, number of tillers, Ear length, days to maturity.

Keywords: Quantitative characters in mutant, change plant cell, barley crops

Introduction

Barley (*Hordeum vulgare* L.) is a crucial cereal crops, ranking fourth globally after Wheat, maize and rice. It's a versatile plant use for human food, animal feed and malting in the brewing industry. Barley thrives in cooler, semi-arid region and can also be grown in divers environments, including the high altitudes. Barley has been known for a long time for food and it has been under cultivation since ancient time. Barley originated in Abyssinia which is the principal centre of its origin because of wide diversity is present there in different wild form of barley. According to some other investigators South Eastern Asia, particularly China, Tibet and Nepal is the centre of origin of barley. Barley was introduced in India soon after the arrival of Aryans. In Sanskrit it is called "Yava". It is cultivated in various agro climatic conditions. The prime barley growing countries of world are USSR, France, Canada, UK, USA, Germany, Spain, Denmark, Turkey and China. The total

world area under barley cultivation is about 84818 thousand hectares and the total world production is about 167627 thousand tons. In India it is cultivated on about 880,000 hectares from where an annual production of about 1700000 MT grain are obtained (Chandola, 1999) [5]. It is cultivated mainly in U.P., Rajsthan, M.P., Bihar and Haryana. It is more tolerant to alkali soils than other cereals. Barley grains constitute about 74% carbohydrates, 11.5% albuminoides, 3.9% crude fibers, 1.5% minerals and 1.3% lipids. The barley grains are used as animal concentrate, human food and malt. It supplies carbohydrates and proteins in animal ration. Barley by products of malting industries are also utilized for cattle, poultry and swine feeding. Barley green plants are used as hay and green fodder. Barley straw known as "Bhusa" is used for animal feeding and bedding. Barley grains are used as flour for making breads and "Sattu". Baby food is also prepared from barley. Barley grains are used for malting purposes. Germinating seeds of barley produce two important enzymes; alpha-amylase and beta-amylase which hydrolyze carbohydrates to dextrin and fermentable sugars.

In our country barley breeding and improvement is not so extensive as wheat, rice, maize and other crops. Many old and new varieties in this crop are under cultivation in India but they are not so popular as wheat and rice varieties. Still there is a large of scope to modify this plant species for improved yield and quality. Mostly the yield contributing traits are poly genetically inherited each trait contributes a little and show continuous variation. Knowledge regarding the nature and magnitude of genetic variation is necessary for different breeding programmed.

Therefore, the present study described the mutant of barley and highlighted the recent progresses of Important Quantitative Characters in Barley.

Materials and Methods

Experimental site description

A field experiment was conducted during wet seasons of 2008 at Post Graduate College Ghazipur Uttar Pradesh, India. The crop received a total rainfall of 862.1 mm and 1101.6 mm during *kharif* 2008, respectively. The weekly weather condition of the experimental site during the crop growth period of the 2008. The daily maximum and minimum temperature during the crop growth period varied from 29.2- 36.4 °C and 11.8 - 26.3 °C, respectively during the crop growth period of the year 2008. whereas, in the year 2008 the maximum and minimum temperatures ranged from 29.2- 37.4 °C and 12.6- 26.8 °C, respectively. The crop received a total rainfall of 862.1 mm and 1101.6 mm during the year 2008, respectively. The relative humidity at 07:00 AM and 02:00 PM during 2008 ranged from 81.9% to 94%, 44.7% to 81.9%, 80.2% to 91.7% and 45.1% to 81.2% in the same order.

The soil is Typic Haplustept (US Soil Taxonomy, Soil Survey Staff 2003) and clay loam in texture average (39.5% sand, 34.8% silt, and 21.2% clay) with general initial properties ranged from: pH 7.38, electrical conductivity 0.12 dsm^{-1}, and organic carbon 0.43, available N 218 kg ha^{-1}, available P_2O_5 28 kg ha^{-1} and available K_2O 220 kg ha^{-1}. This data presented in table 1.

Table 1: Physicochemical properties of experimental soil before planting

Parameter	2008	Methods
Sand (%)	39.5	Bouyoucos
Silt (%)	34.8	
Clay (%)	21.2	
Textural Class	Loam	
Bulk density (Mg M^{-3})	1.51	Jackson
pH (1:2.5 soil: water suspension)	7.38	
EC (dS m-1)	0.12	
Oxidizable organic carbon (%)	0.43	Walkley and Black
Available nitrogen (kg ha^{-1})	218	Subbiah and Asija
Available phosphorus (kg ha^{-1})	28	Olsen *et al*.
Available potassium (kg ha^{-1})	220	Jackson

Table 2: Mutants of present research work.

1. K-226	2. K-882	3. K-508	4. K-551
5. K-925	6. G-30-5	7. K-40-12	8. K-50-50
9. K-50-66	10. K-30-88	11. K-40-72	12. K-40-35
13. K-50-35	14. Gitanjali.	15. KHA-3-53	16. KH-3-63
17. KH-40	18. G.50-11	19. KE-553	20. KE-3-75

The experimental material was grown in Randomized Block Design (RBD) using three replications of each during Rabi 2008 at Crop Research Farm, P.G. College Ghazipur. Each mutant was grown in 3 rows of 3 m length of beds. The row to row distances 45 cm and plant to plant distance 15 cm was maintained. All necessary cultural practices were provided to raise the commercial crop.

Recording Observations

Data were recorded on 5 randomly selected plants treatment. The followings observations were recorded- Days to 50% flowering, It was recorded as the number of days taken from the date of sowing to the appearance of 50% flowering in a plot. Days to maturity Days were counted from the date of sowing to physi-ological maturity of plant. Number of tillers per plant Number of fertile tillers bearing heads were counted. Those tillers bearing no heads were rejected. Plant height (cm) the height of first tiller was measured in cm from the base of the plant, including the length of awns. Number of seeds per spikes fertile spikelets after maturity were counted from the main spike of plant and the empty spikelets were rejected. Ear length (cm) Ear lenth are measured in cm. 100 seed weight (g) 100 seed were counted and the weight was taken using electronic balance. Biological Yield per plant. The plants were harvested separately and dried in sun. The yield of whole plant was taken using electronic balance. Harvest index. The ratio of

economic yield to the biological yield gives harvest index and the value is expressed in percentage (Donald 1962) [7]. The seed yield was divided by biological yield of plants and after multi-plying by 100 it was measured as

$$H_I(\%) = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Statistical Analysis
The following statistical procedures were followed in the present investigation.

Mean
Mean was calculated by usual procedure:

$$\bar{x} = \frac{\varepsilon}{n}$$

Where, $\bar{x}$ Mean value
x = Total value of character
n = Number of observation

Range
Range was calculated with the help of treatments mean.

Analysis of variance
The mean values of genotypes in each replication were used for statistical analysis. The data were analysed from randomized block design (RBD) to test the significance of differences between the genotypes for various characters. The data were subjected to simple analysis of variance in the following manner.

Anova

Source of variation	Degree of freedom	S.S.	M.S.S.	Expected M.S.S.	F value
Replication	r-1	SSr	MSr	σ^2e+tσ^2rg	
Treatment	t-1	SSt	MSt	σ^2e+rσ^2g	MSt/MSe
Error	(r-1) (t-1)	SSe	MSe	σ^2e	

Where,
r= Number of replications
t = Number of treatment
σ^2e =Error variance
σ^2g = Genotypic variance

The steps involved in the analysis of the Randomized Block Design were as described by Panse and Sukhatme (1967) [28]. The significance of differences among treatment means were tasted by 'F' test, whenever, the 'F' test was found to be significant, critical difference (C.D.) was calculated.

CD = SEd 'x 't'

Where,
t= Table value of 't' error degree of freedom
SEd = Satandard error of differences between two treatment means.

$$SEd = \frac{\sqrt{2\ MSe}}{r}$$

Where,
MSe = Error mean square
t = Number of replications.

Variability, heritability and genetic advance

$$\sigma^2 g = \frac{MSt - MSe}{r}$$

Where,
MSt= Mean squares due to treatment
MSe= Mean squares due to error
r= number of replications
and σ^2p = σ^2g + σ^2e

Where
σ^2p= estimates of phenotypic variance
σ^2g = estimates of genotypic variance.
σ^2e = estimates of error variance.

Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were calculated using the formula as suggested by Burton (1952) [2].

$$PCV = \frac{\sqrt{\sigma^2 p}}{\bar{x}}$$

$$GCV = \frac{\sqrt{\sigma^2 g}}{\bar{x}}$$

Where
$\bar{x}$= is the means of the character,

Heritability (h2) in broad sense was calculated according to Burton (1952) [2].

$$\hat{h}^2 = \frac{\sigma^2 g}{\sigma^2 p}$$

The expected genetic advance at 5% intensity of selection differential was calculated for each character following the formula suggested by Johnson *et al*. (1955) [16].

GA =K. σ^2p. h^2

Where, k =constant i.e. value of selection intensity e.g. 2.06 at 5% selection intensity. The genetic advance as percent of mean to facilitate comparison between different characters was elimated as suggested by Johnson (1955) [16], Robinson and Comstock (1955).

$$\text{GA Genetic advance as\% of mean} = \frac{GA}{\bar{x}} \times 100$$

Correlation coefficient analysis
Genotypic and phenotypic correlation among all characters under were estimated as given by Searle (1961).

i) Genotypic correlation between X and Y characters,

$$r\,xy(g) = \frac{Cov.\,XY(g)}{\sqrt{S^2 x_{(g)} \times S^2 y_{(g)}}}$$

ii) Phenotypic correlation between characters X and Y,

$$r\,xy(p) = \frac{Cov.\,XY(p)}{\sqrt{S^2 x_{(p)} \times S^2 y_{(p)}}}$$

Cov. XY(g) and Cov.XY(p) denote genotypic and phenotypic covariance for character "X" and "Y" respectively. S2 x(g) and S2 x(p) denote the genotypic and phenotypic variances for character "X" and S2 Y(g) and S^2 Y(p) denote the genotypic and phenotypic variances respectively for character "Y".

Test of Significant

$$t = \frac{r_{xy(p)}}{\sqrt{1-(r_{xy(p)})^2}} \times \sqrt{n-2}$$

n = number of genotypes
rxy(p) = Phenotype correlation

Results and Discussion

Analysis of variance for ten quantitative characters in barley

In this experiment, twenty newly induced barley mutants were grown to Genetic variability of some important quantitative characters in mutant Barley (*Hordeum vulgare* L.). Ten characters were taken for study presented in (Table 3) such as days to 50% flowering, days to maturity, number of tillers, plant height, number of seed per spike, ear length, 100 seed weight, biological yield/plant, harvest index and seed yield per plant. The results of the experiment are discussed in this chapter. The mutants and other varieties differed considerably for the different characters under study. Which is evident from analysis of variance? Spontaneous and induced genetic variations barley has been found to be extensive. Induced mutants now comprise a large portion of the variation available in barley than in any other flowering plant. Extensive collections of induced mutants are being maintained in different countries. Several workers have studied the differences in different cultivars/mutants in barley (Bansel 1974, Kim *et al*. 1994, Srivastava *et al*. 1992, Ullrich *et al*. 1982, Harr and Wettstein 1976, Abdalla *et al*. 1979). Variability studies have been done by several worker in barley (Bhatnagar *et al*. 1977, Chaudhary 1977, Dixit 1973, Ekman *et al*. 1975, Ibrahim *et al*. 1974, Rasmussen and Glass 1967, Rutger *et al*. 1966, Tikka 1978, Trehan *et al*. 1970a, 1970b, Verma and Nagi 1974).

The maximum days to 50% flowering was observed in mutant K-551 and minimum was in Mutant K-925. Mutant G-30-5 had the minimum days to maturity and K-50-5 had the maximum days to maturity. Number of tiller was the maximum K-40-72 and the minimum K-226. The plant height was observed maximum in mutant KH3-63 and minumum in mutant K-882.The maximum number of seed per spike were found in mutant Gitanjali and minimum in mutant K-925. Ear length was the maximum in mutant K-40-35 and the minimum in mutant K-882. The maximum 100 seed weight was observed in mutant KE3-75 and the minimum is mutant K-55. Biological yield per plant was the maximum in mutant K-30-88 and the minimum in mutant K-50-50. Harvest index was maximum in mutant K-50-35 and minimum in mutant K-551. Seed yield per plant was the maximum in K-50-50 and the minimum in K-551.

Variability and heritability of barley

Estimates of genotypic and phenotypic variance were different, for different characters presented in (Table 4). GCV was the maximum for biological yield and it was the minimum for days to maturity. While PCV was the maximum for biological yield and it was the minimum for days to maturity. The estimates of GCV and PCV showed wide range. The GCV and PCV respectively varied from 3.37 and 3.82 (for days to maturity) to biological yield 14.44 and 14.77 (for biological yield). The maximum ECV was recorded for characters 100-seed weight. It indicates the presence of considerable amount of variability among the mutants. The minimum ECV was recorded for the characters days to maturity. Variability has been studied by several workers in barley (Bhatnager *et al*. 1977). Chaudhary 1977, Dixit 1973, Verma and Negi (1974). Kaw (1960), Murty and Sethi (1961) and Masood *et al*. (1986) have reported high GCV and PCV for different characters in barley. Heritability was the highest (97%) for plant height while the genetic advance was the highest for harvest index (9.24). High heritability (more than 50%) was estimated for plant hieght, days to 50% flowering, biological yield, days to maturity, ear length. It indicated the effect of additive genes. Moderates BSH was seen for 100 seed weight and number of tiller. There may be dominance and epistatic gene action for these characters. Summarizing a large number of references Hockett and Nilan (1985) have reported average BSH 44% for grain yield, 49% for number of spike, 64% for seeds/spike, 63% for seed weight, 74% for heading date, 66% for plant height and spike length in barley. Variation in heritability estimates as reported by different workers may be due to methods of estimation, generation of sample employed and environment (Hanson, 1963). Panse *et al*. (1957) [28] reported that high heritability and high genetic advance were mostly attributed to additive genetic effects and high heritability and low genetic advance may be due to non additive gene action such as dominance and epistasis. In present experiment high genetic advance and high heritability observed for harvest index and number of seeds per spike. The low genetic advance with low heritability for many traits indicated that the non allelic gene action played important role in controlling these traits. Similar results have been reported by several workers, (Johnson *et al*. 1955, Trehan *et al*. 1970, Sethi *et al*. 1972, Khan *et al*. 1972, Mall and Singh 1980, Kumar *et al*. 1984, Lu *et al*. 1995) [16, 73, 36, 22, 23]. Hockett and Nilan (1985) reviewed a number of references and reported average genetic advance 23% for grain yield, 28% for seed/spike,

12% for seed weight and 20% for spike length.

Correlation

Seed yield/plant showed positive and significant correlation with plant height (cm) and harvest index. Days to maturity exhibited positive and significant correlation with number of tiller per plant, showed significant and positive correlation with seed field number seeds/spike exhibited significant and positive correlation with 100 seed weight and harvest index. 100-seed weight. Shows significant and positive correlation with biological yield/ plant and harvest index. Alveri (1963) reported that correlation between grain yield and plant height was large and positive. Sirajuddin and Malik (1967) [37] using simple, potion and multiple correlations reported that plant height highly significant positive correlation with yield, number of ears and 1000-grain weight. Jha and Ram (1968) [18] showed high positive association number of kernel per spike and grain yield per plant and between spike length and number of spike bearing tillers per plant. Virk and Anand (1970) [44] reported a positive correlation between grain yield and plant height, number of spike per plant and 100-kernel weight. The association of grain yield with number of grains per panicle and 1000 grain weight were observed to be positive and number of ear bearing tillers with number of grains per panicle and 1000 grain weight were negative. Singh and Randhwa (1971) [39] found significant and positive association between grain yield and number of tillers per plant, number of spikelet's per spike, number of grain per spike and kernel weight per spike. Sharma *et al*. (1971) [38] observed that sixteen varieties of barley representing a cross section of strong as well as week genotypes from India, Mexican germplasm and a set of fifty one segregating lines derived from crosses made between these in different conditions were studied. Correlation studies revealed that thousand kernel weight was in general negatively correlated with all the characters but flower recovery with which it was positively and significantly correlated the DBC value and the sedimentation value were positively correlated. However, various quality characters were not correlated with morpho-logical characters such as leaf width, ear length and their number.

Bhatt (1973) [4] showed a positive relationship between kernel weight and plant height, while a negative relationship with heading date. Singh *et al*. observed a positive and significant association of grain yield with number of fertile spikelets and number of effective tillers per plant. Jaimini *et al*. (1974) [19] reported that yield was significantly and positively corrrelated with number of spike per plant, number of spikelets per spike and 1000-grain weight. Days to maturity showed a significant negative association with kernel weight. Das (1976) [8] studied phenotpic and genotypic correlation and path coefficient analysis. He observed that ear number per plant grain number per ear and 250-grain weight had high positive direct effect on grain yield in 6 varieties when shown on two dates. Rachana (1978) [32] reported that, among the easily identifiable Characters, productive tillers, 1000 grains weight and spikelets per spike were positively associated with grain yield per plant in barley. Rao *et al*. (1981) [33] observed that grain yield was positively associated with number of grains per panicle, grain weight per productive shoot except 1000-grain weight, which was negatively correlated. Sambasiva *et al*. (1982) [42] observed that grain yield positively correlated with number of productive tillers, number of grains per ear and weight of ear except 1000-grain weight, which was negatively correlated during 1978-79. It was also noted that the plant height dry matter. Producing ear length, number of spiklets per ear, fertility ratio of spikelets and harvest index was positively correlated with grains yield. Negative and significant correlation between number of grains per ear and 1000 kernel weight was observed.

Table 3: Analysis of variance for ten quantitative characters in barley at PG College Ghazipur

Source of variation	D.F.	Days of 50% Flowering	Days to maturity	No. of tillers/plant	Plant height (cm)	No. of seeds per spike	Ear length (cm)	100 seeds weight (g)	biological yield/ plant	Harvest Index (%)	Seed yield per plant (g)
Replication	2	6.2907	9.7702	0.6720	5.5056	14.6379	2.6483	0.0153	21.7925	0.6416	2.1812
Treament	19	42.0049**	55.8215**	4.0261**	140.9399**	139.3933**	40.2421**	0.7452**	301.7512**	66.8074**	45.0609**
Error	38	1.7456	4.9058	0.2736	29117	2.7468	0.8557	0.3726	4.5302	1.6866	1.8241

* Significant at 5% level of significances
**Significant at 1% level of significance.

Table 4: Genetic parameters for different characters in barley mutants.

Characters	Gegeral Mean	Range	Coefficient of variation (CV)			Heritability (h2) (%)	Genetic advance	Genetic advance as percent of mean
			GCV	PCV	ECV			
Days to 50% flowering	70.56	64.17-75.00	5.19	5.51	1.87	0.884	7.09	10.04
Days to maturity	122.18	107.33-126.20	3.34	3.82	1.81	0.775	7.47	6.11
Number of tillers/ plant	7.26	5.43-11.07	15.39	16.99	7.19	0.820	2.08	28.65
Plant height (cm)	82.31	66.30-90.37	8.24	8.49	2.07	0.940	13.55	16.46
Number of seeds/spike	46.00	34.98-56.73	14.66	15.10	3.60	0.943	13.50	29.34
Ear length (cm)	21.47	9.80.24.57	16.87	17.41	4.30	0.938	7.23	33.67
100 seeds weight	3.29	2.71-4.66	10.81	21.43	18.50	0.254	0.37	11.45
Biological Yield/plant (g)	68.89	45.87-85.63	14.44	14.77	3.08	0.956	20.05	29.10
Harvest Index (%)	10.47	2.96-20.83	44.47	46.17	12.39	0.927	9.24	88.25
Seed yield/plant (g)	11.36	5.13-17.70	33.38	35.45	11.91	0.887	7.36	64.78

Table 5: Phenotypic -correlation co-efficient among the ten characters in Barley at PG College Ghazipur.

Character	Days to 50% flowering	Days to maturity	No. of tillers/plant	Plant height (cm)	No. of seeds per spike	Ear length (cm)	100-seeds weight (g)	Biological Yield/plant (g)	Harvest index	Seed yield per plant (g)
Days to 50% flowering		0.541	0.042	0.041	0.096	0.305	0.291	-0.046	0.325	0.149
Days to maturity			-0.114	0.259	-0.186	0.065	0.155	0.366*	0.012	0.260
Number of tillers/ plant				0.041	0.583	0.116	0.265	-0.113	0.113	0.003
Plant height (cm)					0.031	-0.076	0.516**	-0.690	0.010	0.445
Number of seeds/spike						0.148	0.161	0.588	0.115	-0.296
Ear length (cm)							0.258	0.188	0.306	0.351
100 seeds weight								0.154	0.238	0.561**
Biological Yield/plant (g)									0.029	-0.368
Harvest Index (%)										0.491
Seed yield/plant (g)										

* Significant at 5% level of significance
** Significant at 1% level of significance.

Conclusion

An experiment was conducted to "Genetic variability of some important quantitative characters in mutant Barley (*Hordeum vulgare* L.)." at Crop Research Farm, Post Graduate College, Ghazipur during rabi crop season (2008). Twenty newly developed mutants and two mother cultivars were grown in RBD using three replications. The seed yield/plant and nine other yield contributing characters such as days to 50% flowering, days to maturity, number of tillers, plant height, Ear length, number of seed per spike, 100 seed weight, biological yield/plant, harvest index were studied. The maximum days to 50% flowering was observed in mutant K-551 and minimum was in Mutant K-925 had the minimum days to maturity and G-30-5 and K-50-50 had the maximum days to maturity. Number of tiller was the maximum K-40-72 and the minimum K-226. The plant height was observed maximum in mutant KH3-63 and minumum in mutant K-882. The maximum number of seed per spike was found in mutant Gitanjali and minimum in mutant K-925. Ear length was the maxi-mum in mutant K-40-35 and the minimum in mutant K-882. The maximum 100 seed weight was observed in mutant KE-3-75 and the minimum in mutant K-551. Biological yield per plant was the maximum in mutant K30-88 and the minimum in mutant K50-50. Harvest index was maximum in mutant K-50-35 and minimum in mutant K-55. Seed yield per plant was the maximum in K-50-50 and the minimum in K-55. Genotypic coefficient of variability GCV was the highest for the biological yield/plant, followed by harvest index, seed yield/plant, plant hight, 100 seed weight, number of seed/spike, days to 50% flowering, number of tillers, Ear length, days to maturity. Phenotypic coefficient of variability (PCV) was the highest for the biological yield, followed by harvest index, seed yield/plant, 100-seed weight, plant height, number of tiller followed by 100 seed weight, days to 50% flowering and seed yield per plant. Heritability (BSH) was the maximum for number of seed per spike followed by biological yield per plant, plant height and days to maturity. The minimum heritability was estimated for number of tillers followed by 100-seed weight, days to 50% flowering and seed yield per plant. Genetic advance as percentage of mean was the maximum for biological yield followed by seed yield per plant, Plant height and number of seed per spike. It was the minimum for ear length followed by days to maturity, number of tiller and 100-seed weight. Seed yield/plant showed positive and significant correlation with plant height (cm) and harvest index. Days to maturity exhibited positive and significant correlation with number of tiller per plant, 100-seed weight, biological yield per plant showed significant and positive correlation with harvest Harvest Index. Plant height exhibited positive correlation with seed yield per plant, number seed of seeds/spike exhibited significant and positive correlation with 100 seed weight and harvest index. 100-seed weight showed significant and positive correlation with biological yield/plant and harvest index.

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