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Genetic Analysis for Forage Yield and Morphological Traits of Seed in Oat (*Avena sativa* L.)

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A B S T R A C T

Present investigation was carried out at the Students Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *Rabi*-2017-18. Analysis of variance revealed significant variation exists among the stains for all characters studied except stem girth, leaf width, nodes per plant, leaves per plant and seedlings dry weight. Heritability estimates varied from 6.65 percent for leaves per plant to 98.33 percent for days to maturity. Seed vigour index showed high GCV. Moderately high variability for GCV coupled with high estimates of heritability were observed for seedlings dry weight, green fresh weight of total tillers and green leaves weight per plant. Green fresh weight of total tillers exhibited comparatively higher estimates of genotypic coefficient variance, heritability and genetic advance as percent of mean which is indicative of predominance of additive gene action in expression of this trait therefore, for this character selection appears to be effective. The genetic advancement as percent mean was found to be highest for green fresh weight of total tillers (61.00) and moderately observed for plant height. This study will provide opportunity to identify best genotypes to be used in breeding. Besides it helps in understanding the diversity available in the genotypes selected and helps in selection and improvement of desirable traits to be used or transferred during crossing programme.

Introduction

Oats (*Avena sativa L.)* is the most important cereal annual crop of belongs to family gramineae grown in *rabi* season in several states of country including north western, central and extending up to the states of eastern India. Oat has sixth ranks in cereal production globally following wheat, maize, rice, barley and sorghum. It is considered to be one of the best dual purpose cereal crop that fit well into the society of human and population cattle as well. In respect to consumption by human and cattle feeding

purposes, high nutrients contents of protein, carbohydrates, lipids, silicon, manganese, zinc, calcium, phosphorus and vitamin A, B1, B2, E and lower fiber contents are required. Oats taxonomic patters are similar to that of wheat and consists of polyploidy series with seven (n=7) chromosome numbers i.e. diploid (2n = 2x= 14), tetraploid (2n= 4x=28) and hexaploid (2n= 6x= 42) The common oat (Avena sativa L.) is grown in India as dual purpose crop with the total area of about 500,000 hectares is covered under oat cultivation in the country. The crop occupies maximum area in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%) and Madhya Pradesh (6%). Rest of the area is shared by other states i.e. Gujarat, Maharashtra, Odessa, Uttrakhand etc. (Annonymous,2015).Presently India faces a net deficit of 63 % green fodder, 24 % dry fodder residues and 64 % feeds due to increasing population of cattle's and as point of view of better production by animals. This crop gives heavy yield and the average yield of seed and green fodder ranges from 1.5 to 2.5 and 45 to 55 tons per hectare respectively. Yield of any crop is a complex and quantitatively inherited character, contributed by the various characters and influenced by environmental variation and thus considering the importance of effecting improvement in the seed and fodder yield characters and its contributing traits primarily depends on nature and magnitude of the heritable traits.

Materials and Methods

An experiment was conducted at Students Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *Rabi*-2017-18. The research materials comprised twenty five number of genotypes of diverse nature namely, CSOFSC-12-2, CSOFSC-11-5, Kent, CSOFSC-11-4, CSOFSC-11-1, CSOFSC-12-1, CSOFSC-12-1, UPO-212, ANDO-1, JHO-03-91, CSAOSC-12-1, ANDO-2, OS-403, OS-344, OS-1, SKO-105, NDO-25, JHO-2007-2, CSAOSC-14-6, SKO-105, JHO-2007-2, JHO-03-93, NDO-612, OS-6, JHO-851 and JHO-99-2 were evaluated in RBD with three replications with row to row spacing of 30 cm under late sown condition and In order to test the validity of performance of each varieties statistical analysis was done in accordance to Randomized Completely Block Design (RCBD) for all the field and laboratory observations. Observations were recorded on five randomly selected plants in each replication for green fresh weight at 50 days (g),days to 50% flowering, green plant weight (g), green leaves weight per plant (g) stem girth (cm), total numbers of tillers per plant, leaf length(cm), leaf width (cm), number of nodes per plant, number of leaves per plant, plant height (cm.), days to maturity, panicle length (cm),biological yield per plant (g) seeds per plant,100 seed weight (g), dry weight per plant (g), Harvest index (%), seed germination in percent, seedling length (cm) seedling dry weight (g), seed vigour index and seed yield per plant (g).The data for quantitative characters were subjected to analysis of variance (ANOVA) for randomized completely block design statistically analyzed The differences between treatments means were compared using 'F' value at 1% and 5% probability levels.

Estimation of Variability: Different parameters such as mean, range coefficient of variation etc. were used to estimate to the diversity present among the genotypes for different quantitative traits and genotypic variances and coefficients of variation using formula as suggested by Burton and de Vane (1953) as:

Genotypic variance ($\sigma^2 g$)

$$= \frac{MSg - MSe}{r}$$

Where, r is numbers of replications, MSg is mean square due to genotypes, MSe is mean square of error (Environmental variance), Environmental variance (σ^2 e) is error mean square, Phenotypic variance (σ^2p) is σ^2g + MSe where, σ^2g is genotypic variance and phenotypic coefficient variation (PCV) estimated as the following formula:

$$PCV = \frac{\sqrt{\sigma^2 p}}{GM} \times 100$$

Where, GM is an overall mean of character and σ^2p is σ^2g + MSe

$$GCV = \frac{\sqrt{\sigma^2 g}}{GM} \times 100$$

Where, GM is an overall mean of character and σ^2g is MSg + MSe/ Replications

Estimation of Heritability: Heritability is the ratio of the genotypic variance to the total variance *i.e.* phenotypic variance (genotypic and environmental), and it denotes the proportion of phenotypic variance that is due to genotypes *i.e.*, heritable and calculated as per the formula given by (Hasan *et al.*, 1956).

$$H \text{ (board sense)} = \frac{\sigma^2 g}{\sigma^2_p} \times 100$$

Where

σ^2 g = Genotypic variance

σ^2_p = phonotypic variation (Variance genotypic + variance environmental)

Estimation of Genetic Advance: It is the improvements in the mean genotypic value of the selected families over the base population.

Genetic advance was calculated in percents of mean according to Johnson *et al.*,(1955a). as given here under:

$$GA \text{ (\% of mean)} = \frac{\sigma^2 g \times (K)}{(\sigma^2 \rho) \times \text{mean}} \times 100$$

Where

K, Selection differential at 5% selection intensity (K = 2.06)

σ^2g = Genotypic variance

$\sigma^2\rho$ = Phenotypic stand and deviation of the character

Results and Discussion

Variability analysis

The analysis of variance revealed a significant variation (Table 1) among the genotypes for all traits green fresh weight (392.85**), days to flowering(63.97**), number of total tillers per plant (26.53**), green plant weight (77.39**), green leaves weight per plant(5.90**), leaf length (39.59**), days to maturity (16.63**), plant height (147.03**), panicle length (30.13**), biological yield per plant(2.77**), seeds per plant (70.69**),100-seed weight(1.20*), dry weight per plant (2.47**), harvest index (33.05**) seed germination in percent (69.25**), seedling length (36.62**), seed vigour index (1.288) and seed yield per plant (0.51*), except stem girth (0.22), leaf width (0.02), number of nodes per plant (0.02), number of leaves per plant (0.03) and seedlings dry weight per plant (0.2) under investigation, there by indicating the existence of a considerable magnitude to genetic variability among the genotypes. (Khan *et al.*,(2002), Wani *et el.* (2013), Krishana *et al.*, (2013), Bajpai *et al.*, (2014) and Singh *et al.*, (2018). The mean values of traits, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, and genetic advance as percent of mean at 5 % are mentioned in Table 2 and 3 respectively. Estimation of range of mean for all the characters studied where, a wide range for

green fresh weight of total tillers was observed 82.60 to 201.80. with lowest in variety CSOFSC-11-1 and highest in SKO -105 with an overall mean value (151.85), coefficient of variation (9.71), standard error (12.04) and critical distance (24.21). Days to flowering had a range of 83.93 to 101.80 with lowest in variety JHO-03-91 and highest in NDO- 25 with an overall mean value(93.85),coefficient of variation (0.53), standard error (0.29) and critical difference (0.82). Total number of tillers per plant having a range of 8.53 to 20.13 with lowest in genotype CSOFSC-11-1 and highest in SKO105 with an overall mean value (14.40), coefficient of variation (7.82), standard error (0.65) and critical distance (1.85). Green weight of per plant was showed a range of 16.33 to 36.00 with lowest in variety OS344 and highest in CSAOSC-14-6 with an overall mean value (28.08), coefficient of variation (12.74), standard error (2.07) and critical distance (5.87). The green leaves weight per plant was exhibited a range of 2.27 to 8.52, with minimum value of mean in variety OS-344 and maximum in OS-6 as compared to mean value (5.99), coefficient of variation (16.64), standard error (0.57) and critical difference (1.63). The character stem girth was showed a range of 1.70 to 2.90 with lowest in variety OS-344 and highest in CSAOSC-14-6 with an overall mean value (2.24), coefficient of variation (7.00), standard error (0.09) and critical distance (0.26). Leaf length exhibited a range of 35.87 to 50.07; with lower value of mean in genotype CSOFSC12-2 and higher in ANDO-2 with an overall mean value (44.43), coefficient of variation (3.17), standard error (0.81) and critical difference (2.31). The character leaf width displayed a range of 1.48 to 1.81 with lowest mean value in an accession CSAOSC12-1 and highest in Kent with an overall mean value (1.66), coefficient of variation (2.37), standard error (0.02) and critical distance (0.06). Number of nodes per plant displayed a range of 5.20 to 5.47 with lowest in variety JHO03-93 and highest in CSOFSC11-4 with an overall mean value (5.35), coefficient of variation (3.45), standard error (0.11) and critical distance (0.80). The range of 5.20 to 5.47 with lowest in variety JHO-03-93 and highest in CSOFSC11-1 with an overall mean value (5.34), coefficient of variation (3.70), standard error (0.11) and critical distance (0.33) were recorded for leaves per plant. Days to maturity had a range of 123.67 to 131.07with lowest in variety CSOFSC12-2 and highest in ANDO-1with an overall mean value (127.51), coefficient of variation (0.24), standard error (0.18) and critical distance (0.50). The plant height expressed a mean values of 154.67 to 177.93 with lowest in variety SKO105 and highest in CSOFSC11-5 with an overall mean value (167.74), coefficient of variation (1.78), standard error (1.72) and critical distance (4.89). Panicle length had a range of 17.13 to 29.05 with lowest in variety JHO851 and highest in Kent with an overall mean value (25.68), coefficient of variation (2.79), standard error (0.01) and critical distance (1.17). The range of 12.53 to 16.33, with lowest in variety Kent and highest in UPO212 with an overall mean value (14.22), coefficient of variation (1.34), standard error (0.11) and critical distance (0.31) were observed for this character. For seeds per plant were recorded estimations of variations *viz.,* range from 88.27 to 106.27 with lowest in genotype OS6 highest in UPO-212 with an overall mean value (96.02), coefficient of variation (1.10), standard error (0.61) and critical distance (1.74). The character 100 - seeds weight showed a range from 3.21to 5.19 with lowest in variety OS-1 highest in NDO-612 with an overall mean value (4.25), coefficient of variation (6.77), standard error (0.17) and critical distance (0.47). Dry weight per plant was showed a range of 8.68 to 11.72 with lowest in variety CSAOSC-14-6 and highest in CSAOSC12-1 with an overall mean value (10.09), coefficient of variation (2.37),

standard error (0.14) and critical distance (0.39). Harvest index displayed a range of 25.75 to 37.22(%) with lowest in variety JHO-03-93 and highest for JHO-2007-2 with an overall mean value (29.70), coefficient of variation (2.46), standard error (0.42) and critical distance (1.20). The variability estimations namely; range of 65.40 to 90.77 with lowest in variety CSOFSC12-2 and highest in SKO-105 with an overall mean value (84.47), coefficient of variation (8.15), standard error (3.98) and critical distance (11.31) were observed for seed germination in percent. The character seedling length per plant showed a wide range of 18.43 to 28.47 with lowest in genotype CSOFSC11-1 and highest in SKO-105 with an overall mean value (23.05), coefficient of variation (5.32), standard error (0.71) and critical distance (2.01). The single seedling dry weight displayed a range of 0.02 to 0.04, with lowest in JHO-03-93 and highest in CSOFSC-12-1 with an overall mean value (0.03), coefficient of variation (13.51), standard error (0.0) and critical distance (0.0). For seed vigour index a range of 1.49 to 4.02 with lowest in variety JHO99-2 and highest in JHO03-91 with an overall mean value (2.37), coefficient of variation (13.87), standard error (0.27) and critical distance (0.54) were observed. Seed yield per plant exhibited a range of 3.68 to 5.28 with lowest in variety JHO03-93 and highest in JHO-2007-2 with an overall mean value (4.20), coefficient of variation (2.16), standard error (0.05) and critical distance (0.15). A crossing between genotypes exhibiting significant variance and higher value of mean for the desired characters will help in development of variety with increase in seed and green, dry fodder yield. Khan *et al.,* (2002), Bibi *et al.,* (2012), Krishana *et al.*,(2013), Dubey *et al.,* (2014), Bajpai *et al.,* (2014), Kumar *et al.,* (2017) and Singh *et al.,* (2018).

Table.1 Analysis of variance for different traits in genotypes of oat (*Avena sativa L.*)

S.V.	d. f.	GFWTT (g)	DF	TTPP	GWPP (g)	GLWPP (g)	SG (cm)	LL(cm)	LW(cm)	NPP	LPP	DM	PH(cm)
Treatment	24	392.85**	63.97**	26.53**	77.39**	5.90**	0.22	39.59**	0.02	0.02	0.03	16.63**	147.03**
Replication	2	198.41	4.98	0.19	22.23	0.92	0.26	120.07	0.02	0.13	0.18	8.65	1169.73
Error	48	217.51	0.25	1.27	12.81	0.99	0.02	1.98	0.00	0.03	0.04	0.09	8.89

S.V.	d. f.	PL(cm)	BYPP(g)	SPP	HSW	DWPP(g)	HI (%)	SG (%)	SLL(cm)	SLDW(g)	SVI	SYPP(g)
Treatment	24	30.13**	2.77**	70.69**	1.20*	2.47**	33.05**	69.25**	36.62**	0.2	1.28*	0.51**
Replication	2	17.83	7.43	21.87	0.07	3.86	14.89	44.70	1.11	0.3	0.19	0.05
Error	48	0.51	0.04	1.12	0.08	0.06	0.53	47.45	1.50	0.1	0.11	0.01

*,** significant at 5% and !% levels, respectively.

Table.2 Mean, coefficient of variation, standard error and critical distance for various, seed and fodder yield and related traits in oat (*Avena sativa* L.)

Traits/parameters	GFWTT(g)	DF	TTPP	GWPP(g)	GLWPP(g)	SG (cm)	LL (cm)	LW (cm)	NPP	LPP	DM	PH (cm)
Mean	151.85	93.85	14.40	28.08	5.99	2.24	44.43	1.66	5.35	5.34	127.51	167.74
C.V.	9.71	0.53	7.82	12.74	16.64	7.00	3.17	2.37	3.45	3.70	0.24	1.78
F.Ratio	15.60	257.74	20.90	6.04	5.94	8.85	20.00	15.93	0.56	0.81	177.71	16.54
S.E.(m)	8.51	0.29	0.65	2.07	0.57	0.09	0.81	0.02	0.11	0.11	0.18	1.72
C.D.5%	24.21	0.82	1.85	5.87	1.63	0.26	2.31	0.06	0.30	0.33	0.50	4.89

Traits/parameters	PL(cm)	BYPP(g)	SPP	HSW	DWPP (g)	HI (%)	SG (%)	SLL(cm)	SSLDW(g)	SVI	SYPP(g)
Mean	25.68	14.22	96.02	4.25	10..09	29.70	84.47	23.05	0.03	2.37	4.20
C.V.	2.79	1.34	1.10	6.77	2.37	2.46	8.15	5.32	13.51	13.87	2.16
F.Ratio	58.83	75.90	62.88	14.44	43.34	61.83	1.46	24.37	20.00	11.86	61.55
S.E.(m)	0.41	0.11	0.61	0.17	0.14	0.42	3.98	0.71	0.00	0.19	0.05
C.D.5%	1.17	0.31	1.74	0.47	0.39	1.20	11.31	2.01	0.00	0.54	0.15

Parameters/ Traits	Range		σ^2e	σ^2g	GCV	σ^2p	PCV	H^2(bs)	Gen.Adv. as% of mean 5%
	Min	Max							
GFWTT(g)	82.60	201.80	217.51	1058.44	21.43	1275.96	23.52	82.95	61.00
DF	83.93	101.80	0.25	21.24	4.91	21.49	4.94	98.84	9.40
TTPP	8.53	20.13	1.27	8.42	20.15	9.69	21.61	86.90	5.6
GPW(g)	16.33	36.00	12.81	21.53	16.52	34.33	20.87	62.70	7.6
GLWPP(g)	2.27	8.52	0.99	1.63	21.36	2.63	22.24	62.24	2.1
SG (cm)	1.70	2.90	0.02	0.06	11.33	0.09	13.32	73.35	0.40
LL(cm)	35.87	50.07	1.98	12.54	7.97	14.52	8.58	86.36	6.8
LW(cm)	1.48	1.81	0.01	0.01	5.29	0.01	5.80	83.27	0.2
NPP	5.2	5.47	0.03	0.01	0.01	0.03	3.18	17.41	0.1
LPP	5.2	5.6	0.04	0.01	0.01	0.04	3.59	6.65	0.01
DM	123.67	131.07	0.09	5.51	1.84	5.61	1.86	98.33	4.8
PH(cm)	154.67	177.93	8.89	46.05	4.05	54.94	4.42	83.82	12.8
PL(cm)	17.13	29.05	0.51	9.87	12.23	10.39	12.55	95.07	6.3
BYPP(g)	12.53	16.33	0.04	0.91	6.71	0.95	6.84	96.15	1.9
SPP	88.27	106.27	1.12	23.19	5.01	24.31	5.14	95.38	9.7
HSW	3.21	5.19	0.08	0.37	14.34	0.45	15.86	8.75	1.1
DWPP(g)	8.68	11.72	0.06	0.81	8.89	0.86	9.20	93.38	1.8
HI(%)	25.75	37.22	0.53	10.84	11.09	11.37	11.37	95.30	6.6
SG (%)	65.40	90.77	47.45	7.27	3.19	54.71	8.76	13.29	2.0
SLL(cm)	18.43	28.47	1.5	11.71	14.84	13.21	15.77	88.62	6.6
SLDW(g)	0.02	0.04	0.00	0.00	24.29	0.00	27.79	76.37	0.0
SVI	1.49	4.02	0.11	0.39	26.38	0.50	29.81	78.36	1.1
SYPP(g)	3.68	5.28	0.01	0.17	9.72	0.18	9.96	95.28	0.8

Table.3 estimates of different genetic parameters for various traits in oat (*Avena sativa* L.)

1-GFWTT(g)= Green fresh weight of Total Tillers (g)	**6-SG (cm)=Stem Girth (cm)**	**11-DM = Days to maturity**	**16-HSW= 100-Seeds weight (g)**	**21-SLDW(g) = Seedling dry weight (g)**
2-DF = Days to flowering	7-LL(cm) =Leaf Length (cm)	12-PH(cm) = Plant Height (cm)	17-DWPP(g)= Dry weight per Plant (g)	22-SVI= Seed Vigour Index
3-TTPP= Total Tillers per Plant	8-LW(cm)=Leaf width(cm)	13-PL(cm) Panicle Length (cm)	18-HI(%) = Harvest Index (%)	23-SYPP(g)= Seed yield per plant (g)
4-GPW(g) = Green Plant Weight (g)	9-NPP =Nodes per PLANT	14-BYPP(g)= Biological yield per Plant (g)	19-SG (%)= Seed Germination (%)	
5-GLWPP(g) Green leaves weight per Plant(g)	10-LPP = Leaves per Plant	15-SPP = Seeds per Plant	20-SLL(cm)= Seedling Length (cm)	

σ^2e =Variance Environmental, σ^2g = Variance Genotypic and σ^2p = Variance Phenotypic

Table.4 Appendix -Mean *per se* performance for various character in genotypes of Oat (*Avena sativa l.)*

Variety	GFW	DF	TTPP	GPW	SG	GLW	LL	LW	NPP	LPP	DM	PH
CSOFSC12-2	168.07	86.13	16.00	29.17	2.13	6.24	35.87	1.75	5.33	5.33	123.67	176.80
CSOFSC11-5	221.60	95.47	13.27	32.67	2.17	4.57	40.27	1.68	5.33	5.27	129.53	177.93
Kent	181.40	94.20	16.27	28.50	2.45	6.57	43.67	1.81	5.33	5.27	128.13	172.87
CSOFSC11-4	118.13	96.60	17.33	19.67	2.47	6.29	36.07	1.72	5.47	5.20	128.00	177.47
CSOFSC11-1	82.60	95.67	8.53	21.00	2.53	3.25	38.27	1.64	5.33	5.47	129.80	177.60
CSOFSC12-1	199.00	95.13	19.53	28.00	2.73	4.48	44.60	1.60	5.33	5.33	128.07	167.60
UPO212	126.47	95.73	11.60	25.00	1.97	7.40	43.27	1.53	5.33	5.40	129.93	167.93
ANDO1	148.87	101.80	13.60	23.33	2.00	5.32	42.33	1.73	5.33	5.33	131.07	176.47
JHo03-91	159.67	83.93	15.13	32.33	2.10	7.92	46.07	1.61	5.27	5.33	124.87	166.73
CSAOSC12-1	99.40	93.80	9.87	25.00	2.00	5.63	45.53	1.48	5.47	5.33	129.07	176.40
ANDO2	114.07	95.00	10.20	28.00	2.40	5.41	50.07	1.60	5.47	5.27	129.60	163.27
OS403	136.47	94.20	12.93	32.67	2.23	5.57	49.87	1.69	5.33	5.53	131.00	164.67
OS344	150.20	93.73	12.73	16.33	2.03	2.27	45.80	1.53	5.40	5.53	130.13	167.80
OS1	148.33	100.13	13.80	24.33	2.13	6.98	44.40	1.73	5.40	5.40	128.07	168.33
SKO105	185.73	93.93	18.00	23.67	2.03	5.17	47.73	1.78	5.47	5.27	124.53	154.67
NDO25	119.47	101.07	11.87	32.33	2.40	6.21	44.60	1.78	5.47	5.40	129.13	167.73
JHO2007-2	119.80	94.07	11.60	31.00	2.10	6.75	47.27	1.79	5.20	5.60	125.80	162.73
CSAOSC14-6	165.27	93.80	15.93	36.00	2.90	7.12	47.40	1.59	5.40	5.20	123.80	156.67

SKO105	201.80		95.20	20.13	30.00	2.20	6.39	46.67	1.77	5.33	5.33	128.87	167.73
JHO2007-2	182.67		94.00	17.87	24.33	2.10	5.85	46.67	1.60	5.27	5.33	128.00	158.73
JHO03-93	143.67		84.93	13.67	34.33	2.57	7.67	44.67	1.63	5.33	5.20	124.93	169.13
NDO612	141.40		94.73	13.87	26.67	2.10	5.60	46.73	1.59	5.27	5.33	126.47	157.73
OS6	172.93		84.07	16.80	35.67	2.40	8.52	45.27	1.67	5.33	5.33	124.67	165.80
JHO851	141.20		94.73	13.80	31.67	1.70	6.96	43.80	1.63	5.27	5.33	125.27	159.33
JHO99-2	167.93		94.27	15.67	30.33	2.10	5.52	43.83	1.65	5.20	5.27	125.60	171.47
Range	Min	82.60	83.93	8.53	16.33	1.70	2.27	35.87	1.53	5.20	5.20	123.67	154.67
	Max	221.60	100.13	20.13	35.67	2.90	8.52	50.07	1.81	5.47	5.53	131.07	177.93
Range of Variation	**139***		**16.2**	**11.6**	**19.32**	**1.2**	**6.25**	**14.20**	**0.28**	**0.27**	**0.33**	**7.4**	**23.26**

Contd…….

Variety	PL	BYPP	SSP	HSW	DWPP	HI	SG	SLL	SLDW	SVI
CSOFSC12-2	26.37	14.13	93.60	4.83	10.81	26.96	65.40	25.27	0.03	2.30
CSOFSC11-5	26.50	13.93	95.07	3.43	10.68	26.93	83.27	19.23	0.02	1.82
Kent	29.05	12.53	96.27	4.24	9.28	29.00	85.43	22.73	0.03	2.54
CSOFSC11-4	27.44	14.47	97.07	4.29	10.98	27.22	83.07	21.37	0.02	2.08
CSOFSC11-1	25.80	14.33	100.53	3.90	11.07	27.49	84.07	18.43	0.03	3.11
CSOFSC12-1	27.87	14.73	97.87	4.64	11.37	25.78	83.53	21.80	0.04	3.46
UPO212	27.53	16.33	106.20	3.72	11.10	25.97	84.20	28.47	0.02	1.78
ANDO1	24.93	14.27	102.27	4.45	10.23	29.61	86.67	18.60	0.03	2.10
JHO03-91	26.07	15.00	98.00	5.05	10.49	27.94	87.77	29.57	0.04	4.02
CSAOSC12-1	27.60	16.13	100.40	3.89	11.72	27.58	77.67	21.13	0.02	1.82
ANDO2	28.00	14.53	98.73	3.83	10.32	29.27	86.37	21.93	0.02	1.95
OS403	27.07	14.07	99.00	3.32	9.87	30.43	83.47	26.50	0.02	1.49
OS344	26.60	13.73	92.67	3.93	9.95	28.59	87.20	19.60	0.02	2.02

OS1		23.60	14.73	88.73	3.21	10.12	28.69	84.27	19.40	0.02	1.89
SKO105		27.33	13.27	92.35	3.48	9.23	31.92	87.07	21.97	0.03	2.64
NDO25		25.93	13.53	90.60	3.95	9.12	34.09	81.17	22.53	0.03	2.46
JHO2007-2		25.33	16.07	90.07	3.98	11.44	27.53	85.40	23.47	0.02	1.78
CSAOSC14-6		26.00	12.67	91.93	4.84	8.68	30.75	88.23	24.47	0.03	2.48
SKO105		27.13	13.00	95.00	4.63	8.94	33.84	90.77	29.97	0.03	2.76
JHO2007-2		28.33	14.13	104.73	5.48	8.84	37.72	89.17	22.27	0.04	3.64
JHO03-93		27.60	14.33	98.13	4.28	10.56	25.75	83.57	18.60	0.02	2.01
NDO612		26.27	14.33	99.67	5.19	8.95	36.66	86.67	26.73	0.02	2.05
OS6		19.33	13.53	88.27	4.97	9.38	33.90	84.20	21.03	0.03	2.54
JHO851		17.13	13.67	92.40	4.99	9.47	30.91	87.57	23.20	0.03	2.83
JHO99-2		17.27	14.07	91.07	3.73	9.78	27.88	85.53	28.00	0.02	1.59
Range	Min	**17.13**	**12.53**	**88.27**	**3.21**	**8.68**	**25.75**	**65.40**	**18.43**	**0.02**	**1.59**
Range	Max	**29.05**	**16.33**	**106.20**	**5.19**	**11.72**	**37.72**	**90.77**	**29.97**	**0.04**	**4.02**
Range of Variation		**11.92**	**3.80**	**16.46**	**1.98**	**3.04**	**10.91**	**25.37**	**11.54**	**0.02**	**2.43**

Analysis of GCV, PCV, ECV, heritability and genetic advance as percent of mean was observed for green fresh weight of total tiller GCV (21.43), PCV (23.52), ECV (217.51), heritability (82.95) and genetic advance as percent increase over mean (61.00). Days to 50% flowering was showed the values of GCV (4.91), PCV (4.94), ECV (0.25), heritability (98.84) and genetic advance as percent increase over mean (9.40).Total numbers of tillers per plant was exhibited value of GCV (20.15), PCV (21.61), ECV(1.27), heritability (86.90) and genetic advance as percent increase over mean (5.6). The GCV (16.52), PCV (20.87), ECV (12.81), heritability (62.70) and genetic advance as percent increase over mean (7.6) were observed for green plant weight. Green leaves weight per plant had the value of GCV(21.36), PCV(22.24), ECV (0.99), heritability (62.24) and genetic advance as percent increase over mean (2.1).The character stem girth, having the values of GCV(11.33), PCV (13.32), ECV (0.02), heritability(73.35) and genetic advance as percent increase over mean (0.40).The estimations of GCV (7.97), PCV (8.58), ECV(1.98), heritability (86.36) and genetic advance as percent increase over mean (6.8) were exhibited by leaf length of plant. The variability parameters *viz;* GCV (5.29), PCV (5.8), ECV (0.01), heritability (83.27) and genetic advance as percent increase over mean (0.2) were recorded from the Leaf width of plant. Nodes per plant were displayed an estimates for GCV (0.01), PCV (3.18), ECV (0.03), heritability (17.41) and genetic advancement percent increase over mean (0.1). Leaves per plant having the values of GCV (0.01), PCV (3.59), ECV (0.04), heritability (6.65) and genetic advancement percent increase over mean (0.01). Days to maturity had estimates for GCV (1.84), PCV (1.86), ECV (0.09), heritability (98.33) and genetic advance as percent increase over mean (4.8). The GCV (4.05), PCV (4.42), ECV (8.89), heritability (83.82) and genetic advance as percent increase over mean (12.80) were estimates for plant height.

Panicle length was showed the values for GCV (12.23), PCV (12.55), ECV (0.51), heritability (95.07) and genetic advance as percent increase over mean (6.3). Biological yield per plant was displayed an estimates of GCV (6.71), PCV (6.84), ECV (0.04), heritability (96.15) and genetic advance as percent increase over mean (1.9). For seeds per plant GCV (5.01), PCV (5.14), ECV (1.12), heritability (95.38) and genetic advance as percent increase over mean (9.7) variability components were estimated. The 100-seeds weight was exhibited the estimates of GCV (14.34), PCV (15.86), ECV (0.08), heritability (8.75) and genetic advance as percent increase over mean (1.10). Dry weight per plant was showed with values of GCV (8.89), PCV (9.20), ECV (0.06), heritability (93.38) and genetic advance as percent increase over mean (1.8). An estimation of GCV (11.09), PCV (11.37), ECV (0.53), heritability (95.30) and genetic advance as percent increase over mean (6.6) was observed for harvest index in percent.The seed germination in percent was expressed with values of GCV (7.27), PCV(8.76), ECV(47.45), heritability (13.29) and genetic advance as percent increase over mean (2.0). The estimates of GCV (14.84), PCV (15.77), ECV (1.5), heritability (88.62) and genetic advance as percent increase over mean (6.6) were recorded for seedling length. The single seedling dry weight was expressed the values for GCV (24.29) PCV(27.79), ECV(0.00), heritability (76.37) and genetic advance as percent increase over mean (0.0). Seed vigour index had the values of GCV (26.38), PCV (29.81), ECV (0.11), heritability (78.3) and genetic advance as percent increase over mean (1.1) in present investigation. The seed yield per plant was displayed an estimations for GCV (9.72), PCV (9.96), ECV (0.01), heritability (95.28) and genetic advance as

percent increase over mean (0.8) in this study. A crossing between genotypes having higher values for the useful traits will helps an improvement of characters and in development of new genotypes with increase in grain and fodder yield. (Khan *et al.,* (2002), Pundir *et al.,* (2008), Hossein *et al.,* (2011), Bibi *et al.,* (2012), Krishana *et al.,* (2013), Wani *et al.,* (2013) Dubey *et al.,* (2014), Bajpai *et al.,* (2014), Kumar *et al.,* (2017) and Singh *et al.,* (2018). A close resemblance between the corresponding estimates of phenotypic coefficient Variance and genotypic coefficient variance suggested little role of environment in the expression of different traits.

It is evident from the table 3 that phenotypic variances ranging between leaf width (0.001) and green fresh weight (1275.96) and genotypic variances ranging between leaf width (0.001) and green fresh weight (1058.44) for these traits whereas, phenotypic coefficients of variation (PCV) ranged from 1.86 for days to maturity to 29.81 for seed vigour index, considered in this study. Deshmukh *et al.*,(1986) classified PCV and GCV values as high (>20%), medium (10 - 20%) and low (<10%). Seed vigour Index (29.81) showed high value of PCV followed by single seedling dry weight (27.79), green fresh weight of total tillers (23.52), green leaves weight per plant (22.24), total tillers per plant (21.61) and green plant weight (20.87),comparatively higher phenotypic variance value of 1275.96 for green fresh weight of total tillers was recorded in this study, similarly, the genotypic variances for this character almost as high, indicating that the genotype could be reflected by the phenotype and the effectiveness of selection based on the phenotypic performance for these characters. Bhal *et al.,* (1988), Dubey *et al.,* (1995), Choubey and Gupta (1986) and Choubey *et al.,* (1986). However, medium PCV and GCV were displayed in medium was displayed in 100- seed weight (15.86), single seedling length (15.77), stem girth (13.32), panicle length (12.55), harvest index (11.37). Bhal *et al.,* (1988), Dubey *et al.,* (1995), Choubey and Gupta (1986) and Choubey *et al.,* (1986). Furthermore, low PCV and GCV, were observed for seed yield per plant (9.96), followed by dry weight per plant (9.20), seed germination in percent (8.76), leaf length (8.58), biological yield per plant(6.84), leaf width (5.80), seeds per plant (5.14), days to flowering (4.94), plant height (4.42), leaves per plant (3.59), nodes per plant (3.18) and days to maturity (1.86), indicating minute scope of selection as they are under the influence of environment. Wide differences between PCV and GCV values were observed in nodes per plant, leaves per plant, which may be indicate significant influence of environmental factors on these characters, thus, it would be appropriate to consider the above characters depending on the objective of crop improvement program.

Pramoda and Prasad (2007) divided heritability estimates as low (<40%), medium (40- 59%), moderately high (60- 78%) and very high (>80%) whereas, genetic advance was grouped by Johansson *et.al.*,(1955a) as >20% high, 10-20% moderate and <10% low. Heritability estimates varied from 6.65% for leaves per plant to 98.84% for days to maturity.

High to moderately high variability for PCV and GCV coupled with high estimates of heritability were recorded for total numbers of tillers per plant (86.90) followed by green fresh weight of total tillers (82.95), green plant weight (62.70), green leaves weight per plant (62.24), stem girth (73.35), panicle length (95.07), harvest index (95.30) and single seedling length (88.62) present in Table 3, which indicate an advantage through simple selection. Khan *et al.,* (2002), Pundir *et al.,* (2008), Hossein *et al.,* (2011), Krishana *et al.,* (2013), Wani *et al.,* (2013) Dubey *et al.,*

(2014), Bajpai *et al.*, (2014), Kumar *et al.*, (2017), Kumar *et al.*, (2017) Sarojini *et al.*, (2017) and Singh *et al.*, (2018).

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