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RESEARCH ARTICLE

Study of morphological and genetical variabilities for improving forage production in oat

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SUMMARY

Oat (*Avena sativa* L.), one of the important dual purpose crops of the world is grown for food and forage purpose. In India it is exclusively grown as fodder. Sixteen genotypes of oat grown at the Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, W. Bengal In the *Rabi* season of 2010-11 to estimate the direct and indirect effect of the component characters on the dry matter production. Considering the mean values for time taken for germination and other twenty five different forage yield characters, the genotypes OL-1709, JHO-2010-2, Kent, NDO- 729, OS-6 and JO-03-97 were found to produce significantly higher total dry weight per tiller at 50 per cent flowering (time of harvest). A close proximity between GCV and PCV were obtained for the characters like, plant height at 20 and 40 days age of the crop and also at 50 per cent flowering, fresh weight of leaf, dry weight of leaf, fresh weight of stem, dry weight of stem per tiller at 40 days, total dry weight of stem per tiller at 40 days, fresh weight of stem, dry weight of stem per tiller at 50 per cent flowering, fresh weight of flag leaf, dry weight of flag leaf, flag leaf area, Ch 'a', Ch 'b' and total chlorophyll content and crude protein percentage revealed the characters were not much influenced by environment. These characters had very high values for broad sense heritability. Some of these characters like dry weight and fresh weight of stem per tiller at 40 days, fresh and dry weight of stem per tiller at 50 per cent flowering, chlorophyll 'b' content; fresh and dry weight of flag leaf produced high magnitude of GA in terms of percentage of mean. All these characters indicated to be controlled by additive gene action. Therefore, direct selection in desired direction may be practiced for improvement of the characters on the basis of phenotype can be done.

Key Words : Morphological, Genetical variabilities, Forage production

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Inadequate feed during the dry winter (December-April) is one of the biggest constraints to livestock development. Livestock get the most of the green matter from June to September and the quality of forage available during this period could be regarded as more or less adequate, it is different in winter, when rice straw, maize stover and other fibrous crop by-products are

important foods because crop residues are of very poor quality. Oat (*Avena sativa* L.), one of the important dual purpose crops of the world is grown for food and forage purpose. In India it is exclusively grown as fodder. The nutritive value of oat forage is high and showed to have dry matter digestibility in excess of 75 per cent when fed to dairy cattle (Burgess *et al*., 1972). Cereal straws have similar chemical compositions but oat straw has higher digestibility organic matter content (Cuddeford, 1995). Thus, the present study was undertaken to estimate the variability in germplasm and other standard varieties of *Avena sativa* sp. for different fodder characters. However, to obtain a clear picture of the inheritance pattern of different dry matter yielding attributes, the experiment was under taken to study the genetic variability in forage oat and Identification of dry matter yield contributing characters of forage oat (*Avena sativa* L.).

MATERIAL AND METHODS

The field experiment was conducted at the Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal. Geographically the farm is situated 9.7 m above sea level at 23.50N latitude and 810E longitude. The farm had mostly well drained upland soil of new alluvial type with low to medium fertility level. The present experiment was conducted in a plot with medium fertility.

The list of 16 different genotypes of oat used in this experiment were; NDO-712, NDO-729, JHO-2010-1, JHO-2010-2, UPO-10-1, UPO-10-2, SKO-188, SKO-170, JO-03-97, JO-03-99, ANDO-3, OS-377, OL-1709, KENT, OS-6 and JHO-99-2.

The field lay out was in a Randomized Block Design. There were 16 genotypes grown in 3 replications. The plot size for each genotype in each replication was 3.0 m×3.0 m. Each plot accommodated 12 rows of 3m length at a distance of 25 cm between rows. The seed rate was 120g/plot. The gap between plots and replications was 0.5m and 1.0m, respectively. The experiment was conducted with fodder oat (*Avena sativa* L.), data were recorded with respect to different morphological and biochemical characters only.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Variability studies :

Time taken to germinate (*days*) :

As revealed from the mean values presented in the Table 1, four genotypes among the sixteen under study had taken significantly lower number of days to germinate and another four had taken significantly more number of days to germinate. The lowest number of days taken to germinate was 3.3 days by the genotype JHO-99-2 followed by OL-1709, UPO-10-1, and UPO-10-2. However, the highest number of days taken to germinate was 7.0 days by the two genotypes NDO-729 and OS-377 followed by JHO-2010-2 and NDO-712. Such intervarietal difference with respect to time taken for germination may be attributed to differential genetic makeup of the different varieties.

Plant height (*cm*) :

The range of plant height varied from 31.70 cm to 39.76 cm at 20 days age of the crop. Only three genotypes JO-03-97, UPO-10-1 and JO-03-99 produced significantly higher mean plant height with compared to grand mean as revealed by C.D. value at this age of the crop (Table 1). However, among these three genotypes there was no significant difference in mean plant height. Significantly lower mean was observed in the genotypes NDO-729 followed by JHO-2010-2 and SKO-170. At 40 days of the crop, however, the range of plant height varied from 64.63cm to 82.70cm. The mean plant height of the genotypes JO-03-99, OL-1709 and JO-03-97 were found significantly higher with compared to grand mean as revealed by C.D. value. The former genotype produced the highest mean of 82.70cm at this age. It may be mentioned here that the former and the latter genotypes produced significantly higher mean at 20 days also. Significantly lower mean was observed in genotypes SKO-170 followed by NDO-729 and NDO-712. Considering the same character the mean values at 50 per cent flowering, the range was from 141.70cm to 188.30 cm. The mean plant height of as many as 8 genotypes out of sixteen *viz.*, UPO-10-2, OL-1709, UPO-10-1, JHO-99-2, OS-6, OS-377, JHO-2010-1 and JHO-2010-2 were found significantly higher with compared to grand mean as revealed by C.D. value. The former genotype produced the highest mean of 188.3cm. Significantly lower mean was observed in genotype NDO-712 followed by SKO-170, NDO-729, SKO-188 and ANDO-3.

The mean values, therefore, indicate the variation in growth pattern of the genotypes. The results further indicate that different genotypes pick up growth at

Table 1 : Mean values and critical difference (CD) of sixteen genotypes of oat

Variable	D GER	PH 20	PH 40	PH 50%	FW/P 20	DW/P 20	TFW/T 40	FWL/T 40	DWL/T40	FWS/T 40	DWS/T40	TDW/T40
OL-1709	3.66*	38.00	81.93*	179.20*	1.44	0.19	6.00	5.63	0.63*	0.38*	0.03*	0.67*
JHO-2010-2	6.66*	33.53*	76.66	171.20*	1.43	0.19	5.15	4.97	0.48*	0.16*	0.01*	0.50*
NDO-712	6.66*	34.83	64.63*	141.70*	1.51	0.22	4.34*	4.19*	0.39*	0.16*	0.02	0.41*
Kent	5.33	35.33	75.66	163.90	2.52*	0.27*	4.57*	4.43*	0.43*	0.14*	0.01*	0.44*
UPO-10-2	4.66*	39.00	75.46	188.30*	1.67	0.24	6.08	5.96	0.60	0.12*	0.01*	0.61
JO-03-99	5.66	39.26	82.70*	166.20	1.59	0.21	5.83	5.72	0.57	0.12*	0.01*	0.58
NDO-729	7.00*	31.70*	64.86*	148.30*	2.23*	0.25	3.70*	3.65*	0.34*	0.05*	0.01*	0.35*
SKO-170	6.00	33.96*	65.93*	147.00*	1.53	0.21	5.33	5.12	0.50	0.21	0.02	0.52*
OS-6	6.00	35.96	77.10	175.30*	1.48	0.24	5.65	5.51	0.62*	0.14*	0.02	0.60
JHO-2010-1	5.00	39.10	78.00	172.00*	1.53	0.20	6.14	5.86	0.65*	0.28*	0.03*	0.68*
SKO-188	6.00	36.83	73.93	152.40*	1.70	0.21	6.41	5.94	0.66*	0.46*	0.05*	0.73*
ANDO-3	5.33	37.76	76.80	158.70*	1.59	0.20	6.14	5.89	0.63*	0.23	0.05*	0.68*
UPO-10-1	4.00*	39.63*	76.03	177.60*	1.54	0.20	5.94	5.73	0.65*	0.21	0.02	0.65*
JO-03-97	5.66	39.76*	80.90*	164.80	2.06*	0.26*	6.17	5.31	0.52	0.19	0.02	0.53
OS-377	7.00*	35.86	76.50	172.90*	2.30*	0.26*	5.57	5.37	0.56	0.21	0.02	0.57
JHO-99-2	3.33*	38.73	78.16	175.40*	1.69	0.22	6.81*	6.33*	0.60	0.48*	0.04*	0.65*
Mean	5.50	36.83	75.33	165.90	1.74	0.22	5.62	5.35	0.55	0.22	0.02	0.58
CD	0.77	2.38	4.15	4.99	0.39	0.04	0.82	0.62	0.06	0.04	0.01	0.06

D GER= Days required for germination, PH 20 = Plant height at 20 days (cm), PH 40 = Plant height at 40 days (cm), PH 50% = Plant height at 50 % Flowering (cm), FW/P 20 = Fresh weight per plant at 20 days (g), DW/P 20 = Dry weight per plant at 20 days (g), TFW/T 40 = Total fresh weight /tiller at 40 days (g), FWL/T40 = Fresh weight of leaf/tiller at 40 days (g), DWL/T40 = Dry weight of leaf/tiller at 40 days(g), FWS/T 40 = Fresh weight stem/tiller at 40 days(g), DWS/T40 = Dry weight of stem/tiller at 40 days(g), TDW/T40 =Total dry weight/tiller at 40 days(g),

* indicate significance of value at P=0.05

Table 1 : Contd.……..

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Variable	TFW/T 50%	FWL/T 50%	DWL/T 50%	FWS/T 50%	DWS/T 50%	FWFL	DWFL	FLA	Ch 'a'	Ch 'b'	TCh	CP %	TDW/T 50%
OL-1709	19.17*	14.00	1.78*	4.12*	0.44*	1.17	0.16*	48.63*	1.21*	0.24*	1.45*	8.97*	2.22*
JHO-2010-2	15.98	12.82	1.19	1.80*	0.16*	1.23*	0.17*	41.76	0.84*	0.16*	1.01*	5.93*	1.39*
NDO-712	15.40	12.60	1.28	2.14	0.25*	1.03*	0.13*	33.83*	1.28*	0.26	1.54*	9.93*	1.53
Kent	14.11*	11.41	1.21	1.81*	0.26*	1.38*	0.19*	37.01*	0.72*	0.12*	0.85*	6.32*	1.46*
UPO-10-2	17.51	15.05*	1.52	2.81	0.36	0.81*	0.10*	33.53*	0.55*	0.27	1.13*	7.14*	1.88
JO-03-99	18.06	15.80*	1.58	3.07	0.31	0.91*	0.11*	34.89*	1.09	0.34*	1.44*	7.50*	1.83
NDO-729	12.72*	10.70*	1.29	1.55*	0.18*	1.03*	0.13*	32.76*	1.01	0.28	1.29	9.08*	1.46*
SKO-170	15.02	12.10	1.28	2.03*	0.22*	0.94*	0.12*	34.63*	0.96	0.37*	1.34	9.27*	1.51
OS-6	17.94	13.04	1.76*	4.33*	0.57*	1.08*	0.15	36.38*	1.27*	0.24*	1.51*	7.69	2.34*
JHO-2010-1	17.43	14.29	1.47	2.19	0.22*	1.31*	0.18*	42.57*	1.11*	0.21*	1.33	6.72*	1.69
SKO-188	16.48	13.89	1.51	2.48	0.26*	1.29*	0.17*	52.67*	0.95*	0.43*	1.42*	8.63*	1.72
ANDO-3	18.52	12.65	1.19	5.65*	0.58*	0.94*	0.12*	37.03*	0.62*	0.21*	1.14*	7.37*	1.76
UPO-10-1	15.35	11.55	1.41	2.94	0.35	1.16	0.15	41.71	1.09	0.32*	1.41*	9.82*	1.75
JO-03-97	17.27	12.10	1.54	4.03*	0.54*	1.00*	0.13*	34.62*	1.16*	0.24*	1.36	7.18*	2.08*
OS-377	16.72	12.94	1.53	3.22	0.41*	1.27*	0.18*	44.45*	0.89*	0.42*	1.35	6.06*	1.94
JHO-99-2	17.27	12.59	1.36	4.13*	0.52*	1.83*	0.22*	47.61*	1.04	0.22*	1.26	7.87	1.88
Mean	16.56	12.97	1.43	3.02	0.35	1.15	0.15	39.63	1.03	0.27	1.30	7.84	1.78
CD	2.13	1.98	0.25	0.86	0.06	0.03	0.01	2.16	0.08	0.03	0.08	0.29	0.29

TFW/T50% = Total Fresh weight/tiller at 50% flowering(g), FWL/T50%= Fresh weight of leaf/tiller at 50% flowering(g), DWL/T50% = Dry weight of leaf/tiller at 50% flowering(g), FWS/T50%= Fresh weight of stem/tiller at 50% flowering(g), DWS/T50%= Dry weight of stem/tiller at 50% flowering(g), FWFL =Fresh weight of flag leaf(g), DWFL = Dry weight of flag leaf (g), FLA = Flag leaf area(cm^2), Ch 'a'= Chlorophyll'a' (mg/g fresh tissue), Ch 'b' = Chlorophyll 'b' (mg/g fresh tissue), TCh = Total chlorophyll (mg/g fresh tissue), CP% = Crude protein%, TDW/T 50% = Total dry weight/tiller at 50% flowering(g). * indicate significance of value at P=0.05

different ages. Though some genotype that exhibited faster growth at 20 days age could also do so at 40 days age but exceptions were there. The genotype UPO-10-1 that produced significantly higher mean at 20 days could not do so at 40 days. On the other hand OL-1709 that produced non-significant increase of plant height at 20 days had significantly higher mean at 40 days. At 50 per cent flowering stage, as many as 8 genotypes produced significantly higher mean yet none of such genotypes produced significantly higher mean at both the earlier two ages. However, among the genotypes that produced significantly higher mean at 50 per cent flowering, some produced significantly higher mean either at 20 days age or at 40 days. Thus, no consistant linear relation could be established for this character. This was further clear in case of the genotype UPO-10-2 that produced the highest mean at 50 per cent flowering could neither produce significantly higher mean at 20 days age nor at 40 days. This indicates differential behaviour of different genotypes. It may be assumed that the grand growth period of different oat genotypes is different. Sharma and Verma (2005) found that lower values of plant height when maximum temperature was below 25.80 ^{0}C in oat. Effects of weather condition were reported in oat by Coffman and Frey (1961). They found shorter days or reduced light intensity results in taller plants and delay in flowering and maturity. Therefore, may have appeared due to differential genetic makeup of different genotypes and their differential response to weather condition particularly temperature. Raj Bahadur *et al.* (2007) from fodder yield traits in oat under normal and late sown conditions found significant differences for plant height, stem diameter, number of leaves/plant, leaf length, leaf breadth and dry fodder yield.

Fresh weight (*g*) :

The range of fresh weight per plant at 20 days varied from (1.43g to 2.52 g). Three genotypes *viz.*, Kent, OS-377 and NDO-729 exhibited significantly higher mean for this character (Table 1). None of the genotypes produced significantly lower mean for this character. No relationship could be established between this character and plant height at this age due to profuse growth of the plants, individual plant could not be identified, therefore, data on per tiller basis was considered for this character from this stage onward. The range of fresh weight per tiller at 40 days varied from 3.70g to 6.81g.

Conspicuously, only one genotype *i.e.* JHO-99-2 recorded significantly higher mean with compared to grand mean (5.62g). However, significantly lower mean was observed in the genotypes NDO-729, followed by NDO-712, Kent. Since in case of forage crop, leaf is more important for its protein content, palatability and digestibility, the leaves were separated from the stem and data on fresh weight of leaf and stem were collected separately from this stage. The range of fresh weight of leaves per tiller at 40 days was varied from 3.65g to 6.33g. The mean value for fresh weight of leaves was recorded significantly higher only in the genotype JHO-99-2 with compared to grand mean (5.35). Significantly lower mean was observed in the genotypes NDO-729, followed by NDO-712 and Kent. It may be mentioned here that the former two genotypes produced significantly lower mean for plant height at this stage. The range for fresh weight of stem per tiller at 40 days varied from 0.05 g to 0.48g. The mean value of fresh weight of stem was recorded significantly higher in genotype JHO-99-2 followed by SKO-188, OL-1709 and JHO-2010-1. Significantly lower mean was observed in the genotypes NDO-729, JHO-2010-2, NDO-712, UPO-10-2, JO-03-99, Kent and OS-6. The range of fresh weight per tiller at 50 per cent flowering varied from 12.72g to19.17g. Significantly higher mean of 19.17g for this character was recorded in the genotype OL-1709. This genotype produced significantly higher mean for plant height at this age also. Significantly lower mean was observed in the genotypes NDO-729, followed by Kent. Considering the fresh weight of leaf at 50 per cent flowering, it varied from 10.70g to 15.80g. The mean value for fresh weight of leaves was recorded significantly higher in genotype JO-03-99 followed by UPO-10-2. There was no significant difference between these two genotypes for this character. Significantly lower mean was observed in the genotypes NDO-729. The range of fresh weight of stem per tiller at 50 per cent flowering was varied from 1.55g to5.65g. The mean value of fresh weight of stem was recorded significantly higher in genotype ANDO-3 followed by OS-6, JHO-99-2, OL-1709 and JO-03-97. Significantly lower mean was observed in the genotypes NDO-729, followed by NDO-712, JHO-2010-2, Kent and SKO-170. Bagul *et al.* (2008) found inter varietal difference with respect to green fodder yield and dry matter yield and crude protein. Basavaraju and Gururaja Rao (1993) found that the maximum forage yield was obtained when the plants were harvested at a cutting height of 75 or 100 cm at an interval of 60 days.

Dry weight (*g*) :

The range of dry matter yield per plant at 20 days varied from 0.19g to 0.27g. In the present experiment only three genotypes could produce significantly higher dry matter yield at 20 days with compared to the grand mean (0.22g) (Table 1). They were, Kent, JO-03-97 and OS-377. Among these genotypes only JO-03-97 had significantly higher plant height at this age. However, none of the genotypes produced significantly lower mean for this character. At 40 days age of the crop however, the range of dry matter yield of leaf per tiller varied from 0.34g to 0.66g. The mean value for dry matter yield of leaf per tiller was recorded significantly higher in genotypes SKO-188 followed by JHO-2010-1, UPO-10-1, OL-1709, ANDO-3 and OS-6. No relation between plant height, fresh weight of leaf and dry weight of leaf could be discerned at this age. However, significantly lower dry matter yield was found in the genotype NDO-729, followed by NDO-712, Kent and JHO-2010-2. The range of dry matter yield of stem per tiller at 40 days varied from 0.01g to 0.05g and the mean value of dry matter yield of stem per tiller was recorded significantly higher in genotype SKO-188, ANDO-3, JHO-99-2, OL-1709 and JHO-2010-1. Significantly lower dry matter yield was found in the genotype JH0-2010-2, Kent, UPO-10-2, JO-03-99 and NDO-729. Interestingly, upto this stage of growth the amount of leaf production was more than stem.

Considering total dry matter yield per tiller at 40 days it varied from 0.35g to 0.73g There were six genotypes exhibiting significantly higher mean value for total dry matter yield per tiller. The genotypes were SKO-188 followed by JHO-2010-1, ANDO-3, OL-1709, UPO-10-1 and JHO-99-2. Generally, the genotypes that produced significantly higher mean for dry weight of leaf could produce significantly higher mean for total dry matter also. However, significantly lower dry matter yield was found in the genotype NDO-729 followed by NDO-712, Kent, JH0-2010-2 and SKO-170. At 50 per cent flowering stage, the range of dry matter yield of leaf per tiller varied from 1.28g to 1.78g. Only two genotypes, OL-1709 and OS-6 produced significantly higher mean for this character. None of the genotypes produced significantly lower mean. No relation between fresh weight of leaf and dry weight of leaf could be established indicating differential accumulation of photosynthate in unit quantity of fresh tissue by different genotypes. The range of dry matter yield of stem per tiller at 50 per cent flowering varied from 0.16g to 0.58g. There were as many as six genotypes that produced significantly higher mean for this character. The highest mean was produced by ANDO-3, followed by OS-6, JO-03-97, JHO-99-2, OL-1709 and OS-377. Generally, these genotypes produced significantly higher mean for plant height at 50 per cent flowering stage as well. However, significantly lower dry matter yield of stem was found in the genotype JH0-2010-2 followed by NDO-729, SKO-170, JHO-2010-1, NDO-712, Kent and SKO-188. Considering the total dry matter yield per tiller including stem and leaf at 50 per cent flowering stage it varied from 1.39g to 2.34g. Only three genotypes *viz.*, OS-6, OL-1709 and UPO-10-1 produced significantly higher mean for this character, the former produced the highest mean. Necessarily the genotypes that produced significantly higher mean for this character had significantly higher dry weight of stem. Significantly lower dry matter yield was found in the genotype JH0-2010-2 followed by Kent and NDO-729. In this respect also the genotypes that produced significantly lower mean for this character had necessarily significantly lower mean for stem dry weight.

Therefore, considering the fresh weight and dry weight of leaf and stem it may be presumed that besides differential accumulation of photosynthate by unit quantity of fresh weight of leaf, the rate of translocation also varied as a result of which no relation between fresh weight and dry weight of leaf could be discerned but it was there in case of tiller. Raj Bahadur *et al.* (2007) from fodder yield traits in oat under normal and late sown conditions also found significant differences for dry fodder yield.

Fresh weight of flag leaf (*g*) :

Flag leaf of oat plays an important role in the production of dry matter. The mean values for this character ranged from 0.81g to 1.83 g (Table 1). There were six genotypes *viz.*, JHO-99-2, Kent, JHO-2010-1, SKO-188, OS-377 and JHO-2010-2 produced significantly higher fresh weight of flag leaf. Generally the genotypes that produced significantly higher mean for plant height at 50 per cent flowering could produce significantly higher mean for this character also. The genotypes UPO-10-2 produced lowest fresh weight of flag leaves followed by JO-03-99, SKO-170, ANDO-3, JO-03-97, NDO-712 and OS-6.

Dry weight of flag leaf (*g*) :

There was a close correspondence between the genotypes exhibiting significantly higher mean for fresh weight of flag leaf and this character (Table 1). The range for dry weight of flag leaf in the present experiment

varied from 0.10g to 0.22 g. There were seven genotypes *viz.*, JHO-99-2, Kent, JHO-2010-1, OS-377, JHO-2010-2, SKO-188 and OL-1709 that produced significantly higher dry weight of flag leaf with compared to grand mean (0.15g). The genotypes UPO-10-2 produced lowest dry weight of flag leaf followed by JO-03-99, SKO-170, ANDO-3, JO-03-97, ND0-712, NDO-729 and JO-03-97.

Flag leaf area (*cm*^{2}) :

The range of flag leaf area varied from 32.76 cm^2-52.67 cm^2. In case of area of flag leaf, five genotypes out of sixteen produced significantly higher mean with compared to grand mean (39.63) as revealed by C.D. value (Table 1). Such genotypes were SKO-188, OL-1709, JHO-99-2, OS-377 and JHO-2010-1. Eight genotypes produced significantly lower mean. Such genotypes were NDO-729, UPO-10-2, NDO-712, JO-03-97, SKO-170, JO-03-99, OS-6 and Kent. Simon *et al*. (2004) reported that an increase in leaf area will increase the total dry matter production.

Chlorophyll content (*mg/g*) :

Chlorophyll 'a' and chlorophyll 'b' are the two main photosynthetic pigments that play important role in absorbing light energy which is ultimately converted in to chemical energy and subsequently to photosynthate responsible for accumulation of dry matter. In the present experiment, chlorophyll content in the flag leaf was measured. The amount of chlorophyll 'a' chlorophyll 'b' and total chlorophyll content were estimated per unit quantity of fresh tissue. The results obtained are presented in the Table 1. Perusal of the table reveals that the content of chlorophyll 'a', 'b' and total chlorophyll varied from 0.55mg to 1.28mg, 0.12mg to 0.43mg and 0.85mg to 1.54 mg/g of fresh tissue, respectively. Comparing the mean values as revealed by C.D. value

Table 2 : Genotypic and phenotypic variances (Vg and Vp), genotypic co-efficient of variation (GCV), phenotypic phenotypic co-efficient of variation (PCV), heritability in broad sense (h^2%), genetic advance (GA) and genetic advance over mean (GA%) of different forage characters of oat

Variable	Mean	Vg	Vp	GCV	PCV	h^2%	GA	GA (%)
D GER	5.50	1.21	1.43	20.06	21.74	85	2.09	38.14
PH 20	36.83	5.41	7.46	6.32	7.41	73	4.08	11.08
PH 40	75.33	29.08	35.28	7.16	7.89	82	10.08	13.39
PH 50%	165.90	170.40	179.40	7.87	8.07	95	26.19	15.79
FW/P 20	1.74	0.10	0.15	18.13	22.58	64	0.52	29.93
TFW/T 40	5.62	0.59	0.84	13.71	16.28	71	1.33	23.77
FWL/T40	5.35	0.48	0.62	12.95	14.72	77	1.26	23.47
FWS/T 40	0.22	0.02	0.02	55.14	56.08	97	0.25	111.60
TFW/T50%	16.56	2.38	4.00	9.31	12.07	59	2.45	14.77
FWL/T50%	12.97	1.36	2.77	9.00	12.83	49	1.69	13.00
FWS/T50%	3.02	1.25	1.51	36.97	40.73	82	2.09	69.13
FWFL	1.15	0.06	0.06	21.35	21.42	99	0.50	43.87
DW/P 20	0.22	0.01	0.02	10.45	15.34	46	0.03	14.65
DWL/T40	0.55	0.01	0.01	17.27	18.46	88	0.18	33.29
DWS/T40	0.02	0.01	0.02	57.12	59.58	92	0.03	112.70
TDW/T40	0.58	0.01	0.01	18.26	19.45	88	0.20	35.33
DWL/T50%	1.43	0.03	0.05	11.57	15.71	54	0.25	17.57
DWS/T50%	0.35	0.02	0.02	40.02	41.21	94	0.28	80.08
DWFL	0.15	0.001	0.001	21.51	21.73	97	0.06	43.86
FLA	39.63	37.45	39.13	15.44	15.78	96	12.33	31.12
Ch 'a'	1.03	0.03	0.03	15.46	16.10	92	0.31	30.56
Ch 'b'	0.27	0.01	0.01	31.51	32.07	97	0.17	63.78
TCh	1.30	0.03	0.04	14.19	14.68	94	0.37	28.27
CP%	7.84	1.68	1.71	16.54	16.69	98	2.65	33.77
TDW/T50%	1.78	0.07	0.10	14.52	17.55	69	0.44	24.77

obtained for this character from different genotypes it was observed that content of chlorophyll 'a' was always higher in all genotypes than the chlorophyll 'b'. However, five genotypes *viz.*, NDO-712, OS-6, OL-1709, JHO-2010-1 and JO-03-97 produced significantly higher mean for chlorophyll 'a'. None of the genotypes that produced significantly higher mean for chlorophyll 'a' could produce significantly higher mean for chlorophyll 'b'. There were five genotypes *viz.*, SKO-188, OS-377, SKO-170, JO-03-99 and UPO-10-1 that produced significantly higher mean for chlorophyll 'b'. In case of total chlorophyll content, the six genotypes, NDO-712, OS-6, OL-1709, JO-03-99, SKO-188 and UPO-10-1, exhibited significantly higher mean while the lowest value observed by the genotype Kent, JHO-2010-2, UPO-10-2, ANDO-3 for total chlorophyll content. It may be mentioned here that OS-6, OL-1709 and UPO-10-1 produced significantly higher mean for total dry matter per tiller. Generally, the genotypes that produced significantly higher mean for total chlorophyll content had either significantly higher mean for chlorophyll 'a' content or chlorophyll 'b' content or both. Ghosh and Kashyap (2003) found that photosynthetic productivity depends on chlorophyll content in rice leaves.

Crude protein (*%*) :

In case of forage crops crude protein content is an important character. Therefore, crude protein content in the dried samples of finally harvested plants was estimated. The percentage of crude protein content in the different genotypes has been presented in the Table 1. The results reveal that the range of crude protein (%) varied from 5.93 per cent to 9.82 per cent. The mean values in six genotypes for this character was observed to be significantly high. The genotypes were UPO-10-1, NDO-712, SKO-170, NDO-729, OL-1709 and SKO-188. Significantly lower mean for this character was observed in the genotypes JHO-2010-2, OS-377, Kent, JHO-2010-1, UPO-10-2, JO-03-97, ANDO-3 and JO-03-99. Generally, the genotypes that produced significantly higher mean for this character had significantly higher chlorophyll content. The above results presented in details indicate that among 16 genotypes, 6 genotypes *viz.*, OL-1709, JHO-2010-2, Kent,

Table 3 : Genotypic correlation among 25 characters of oat

Character	DGER	PH 20	PH 40	PH 50%	FW/P 20	DW/P 20	TFW/T 40	FWL/T 40	DWL/T 40	FWS/T 40	DWS/T 40	TDW/T 40	TFW/T 50%
D GER		-0.793**	-0.552*	-0.621*	0.305	0.388	-0.727**	-0.702**	-0.614*	-0.561*	-0.405	-0.628**	-0.514*
PH 20			0.752**	0.617*	-0.299	-0.227	0.901**	0.865**	0.768**	0.379	0.350	0.739**	0.784**
PH 40				0.755**	-0.155	-0.242	0.738**	0.711**	0.679**	0.300	0.201	0.642**	0.826**
PH 50%					-0.173	-0.095	0.567*	0.621*	0.580*	0.118	-0.085	0.516*	0.573*
FW/P 20						0.885**	-0.478	0.545*	-0.538*	-0.273	-0.207	-0.536	-0.691**
DW/P 20							-0.441	0.527*	-0.581*	-0.492	-0.462	-0.614	-0.562*
TFW/T 40								0.993**	0.934**	0.730**	0.638**	0.941**	0.892**
FWL/T 40									0.963**	0.642**	0.582*	0.957**	0.874**
DWL/T40										0.594*	0.578*	0.994**	0.871**
FWS/T 40											0.807**	0.676**	0.444
DWS/T40												0.666**	0.484
TDW/T40													0.851**
TFW/T50%													
FWL/T50%													
DWL/T50%													
FWS/T50%													
DWS/T50%													
FWFL													
DWFL													
FLA													
Ch 'a'													
Ch 'b'													
TCh													
CP%													

Table 3 : Contd.……..

Table 3 : Contd……..

Character	FWL/ T50%	DWL/ T50%	FWS/ T50%	DWS/ T50%	FWFL	DWFL	FLA	Ch 'a'	Ch 'b'	TCh	CP %	TDW/T50 %
D GER	-0.233	-0.310	-0.450	-0.429	-0.373	-0.262	-0.380	0.146	0.269	0.024	-0.156	-0.434
PH 20	0.613*	0.544*	0.594*	0.567*	0.059	-0.033	0.242	0.247	0.014	0.197	-0.100	0.620*
PH 40	0.564*	0.660**	0.603*	0.555*	0.213	0.241	0.382	0.059	-0.219	0.066	-0.536*	0.707**
PH 50%	0.449	0.546*	0.347	0.405	0.196	0.214	0.272	-0.072	-0.225	0.169	-0.435	0.590*
FW/P 20	-0.642**	0.286	-0.274	-0.078	0.176	0.250	-0.153	-0.537*	-0.029	0.472	-0.375	-0.235
DW/P 20	-0.522*	0.026	-0.194	0.108	-0.050	0.001	-0.505*	-0.252	-0.049	0.269	-0.321	0.073
TFW/T 40	0.600*	0.492	0.697**	0.638**	0.273	0.176	0.586*	0.095	0.181	0.180	-0.180	0.639**
FWL/T 40	0.681**	0.480	0.648**	0.570*	0.226	0.138	0.547*	0.044	0.190	0.137	-0.187	0.591*
DWL/T40	0.680**	0.624**	0.606*	0.505*	0.140	0.126	0.596*	0.146	0.234	0.255	-0.103	0.650**
FWS/T 40	0.209	0.216	0.330	0.262	0.664**	0.580*	0.883**	0.109	0.172	0.189	0.143	0.262
DWS/T40	0.042	0.053	0.617*	0.465	0.384	0.320	0.636**	0.066	0.143	0.145	0.160	0.201
TDW/T40	0.632**	0.560*	0.618*	0.498*	0.202	0.179	0.655**	0.134	0.220	0.239	-0.067	0.604*
TFW/T50%	0.711**	0.674**	0.801**	0.708**	-0.052	-0.077	0.350	0.365	-0.031	0.303	-0.261	0.799**
FWL/T50%		0.622*	0.158	0.055	-0.233	-0.252	0.220	0.155	0.231	0.280	-0.268	0.392
DWL/T50%			0.363	0.453*	-0.123	-0.085	0.300	0.594*	0.337	0.679**	0.062	0.863**
FWS/T50%				0.963**	-0.006	-0.052	0.151	0.306	-0.084	0.206	-0.069	0.757**
DWS/T50%					0.063	0.012	0.084	0.317	-0.101	0.199	-0.104	0.842**
FWFL						0.967**	0.688**	-0.124	-0.223	0.190	-0.197	-0.038
DWFL							0.712**	-0.176	-0.244	-0.236	-0.294	-0.037
FLA								-0.046	0.223	0.113	-0.033	0.227
Ch 'a'									0.068	0.861**	0.547*	0.546*
Ch 'b'										0.571*	0.341	0.111
TCh											0.624**	0.511*
Cp%												-0.039

* and ** indicate significance of values at P=0.05 and 0.01, respectively

NDO-729, OS-6 and JO-03-97 produced significantly higher mean for total dry weight per tiller at 50 per cent flowering. Again among these 6 genotypes, it was observed that all of them had significantly higher mean for total dry weight per tiller at 40 days, fresh weight of stem per tiller at 50 per cent flowering, dry weight of stem per tiller at 50 per cent flowering and dry weight of flag leaf. Besides, they had generally significantly higher mean for dry weight of leaf per tiller at 40 days, fresh weight of stem per tiller at 40 days, fresh weight of flag leaf, dry weight of flag leaf, flag leaf area, chlorophyll 'b' content and crude protein percentage. Considering the number of characters for which their genotypes produced significantly higher mean were conspicuously high. The genotype NDU-729 had significantly higher mean for 19 different characters out of 24 characters studied; Kent had significantly higher mean for 18 different characters while OL-1709, JHO 2010-2, OS-6 and JO-03-97 had significantly higher mean for 17, 14, 12 and 13 different characters, respectively.

Estimation of genetic parameters :

Vegetative yield and its attributing characters :

The mean, genotypic and phenotypic variance, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), heritability (h^2 % BS), genetic advance and genetic advance as per cent of mean of 16 genotypes of oat grown during winter season, 2010-11 are presented in Table 2. A wide range of variability was found among the genotypes for plant height at 50 per cent flowering, flag leaf area, plant height at 40 days, respectively. This indicates a good scope of selection for these characters. The highest estimates of genotypic and phenotypic variances were observed for plant height at 50 per cent flowering (170.40, 179.40, respectively), followed by flag leaf area (37.45, 39.13, respectively) and plant height at 40 days (29.08, 35.28, respectively).

The magnitudes of PCV were higher than the GCV for all the characters. This revealed the influence of environment on the expression of the characters. However, a close proximity between GCV and PCV

indicated less influence of environmental effects on the expression of most of the characters. In case of the characters like fresh weight per tiller at 50 per cent flowering (FW/T50%), fresh weight of leaf per tiller at 50 per cent flowering (FWL/T50%) and dry weight per plant at 20 days age (DW/P 20) there was wide difference between GCV and PCV. There, the value of PCV was substantially more than GCV indicating significant influence of environment on the expression of these characters. Although moderate, but in case of some of the characters like fresh weight per plant at 20 days (FW/P20), total fresh weight per tiller at 40 days (FW/T40), fresh weight of stem per tiller at 50 per cent flowering (FW/T50%) and dry weight of leaf per tiller at 50 per cent flowering (DWL/T50%) the PCV was higher than GCV indicating the importance of environment in the expression of these characters. High estimates of GCV and PCV were obtained for the characters like, dry weight of stem per tiller at 40 days (57.12, 59.58), fresh weight of stem per tiller at 40 days (55.14, 56.08), dry weight of stem per tiller at 50 per cent flowering (40.02, 41.21), fresh weight of stem per tiller at 50 per cent flowering (36.97, 40.73) and chlorophyll 'b' content (31.51, 32.07). Among these characters fresh weight of stem per tiller at 50 per cent flowering (36.97, 40.73) exhibited relatively more PCV than GCV. Shankar *et al*. (2002) reported high estimates of genotypic and phenotypic co-efficient of variation (GCV and PCV) in grain yield, plant height, leaf length, leaf width, green forage yield and dry matter yield in oat. Close proximity between genotypic co-efficient of variation and phenotypic co-efficient of variation

Table 4 : Phenotypic correlation among 25 characters of oat

Character	D GER	PH 20	PH 40	PH 50 %	FW/ P 20	DW/ P 20	TFW/ T 40	FWL/ T 40	DWL/ T 40	FWS/ T 40	DWS/ T 40	TDW/ T 40	TFW/ T 50 %
D GER		-0.565*	-0.434	-0.536*	0.286	0.260	-0.502*	-0.538*	-0.478	-0.513*	-0.359	-0.496	-0.353
PH 20			0.704**	0.522*	-0.170	-0.125	0.692**	0.674**	0.650**	0.339	0.275	0.624**	0.556*
PH 40				0.671**	-0.031	-0.050	0.614*	0.599*	0.582*	0.260	0.122	0.560*	0.645**
PH 50%					-0.081	-0.053	0.512*	0.567*	0.547*	0.118	-0.078	0.488	0.491
FW/P 20						0.812**	-0.268	0.320	-0.404	-0.232	-0.228	-0.412	-0.269
DW/P 20							-0.291	0.329	-0.382	-0.332	-0.355	-0.415	-0.195
TFW/T 40								0.947**	0.843**	0.594*	0.513*	0.848**	0.610*
FWL/T 40									0.893**	0.556*	0.485	0.889**	0.648**
DWL/T40										0.574*	0.550*	0.987**	0.653**
FWS/T 40											0.788**	0.650**	0.310
DWS/T40												0.629**	0.333
TDW/T40													0.626**
TFW/T 50%													
FWL/T 50%													
DWL/T50%													
FWS/T50%													
DWS/T50%													
FWFL													
DWFL													
FLA													
Ch 'a'													
Ch 'b'													
TCh													
CP%													

Abbreviations as per Table 1

Table 4 : Contd.……

Table 4 : Contd….

Character	FWL/T50%	DWL/T50%	FWS/T50%	DWS/T50%	FWFL	DWFL	FLA	Ch 'a'	Ch 'b'	TCh	CP%	TDW/T50%
D GER	-0.169	-0.186	-0.367	-0.382	-0.335	-0.217	-0.355	-0.110	0.248	0.035	-0.148	-0.295
PH 20	0.398	0.347	0.452	0.475	0.052	-0.017	0.212	0.228	0.028	0.175	-0.081	0.457
PH 40	0.545*	0.353	0.466	0.475	0.190	0.215	0.335	0.038	-0.174	0.065	-0.479	0.472
PH 50%	0.353	0.449	0.323	0.395	0.190	0.208	0.252	-0.050	-0.210	0.147	-0.420	0.523*
FW/P 20	-0.252	0.131	-0.155	-0.048	0.146	0.198	-0.162	-0.400	-0.014	0.345	-0.301	-0.101
DW/P 20	-0.167	0.018	-0.101	0.084	-0.037	-0.030	-0.337	-0.159	-0.040	0.153	-0.241	0.052
TFW/T 40	0.421	0.358	0.495	0.480	0.230	0.152	0.465	0.102	0.150	0.124	-0.155	0.468
FWL/T 40	0.495	0.357	0.497*	0.462	0.195	0.130	0.451	0.048	0.176	0.127	-0.173	0.456
DWL/T40	0.461	0.454	0.521*	0.462	0.132	0.128	0.537*	0.138	0.214	0.236z	-0.117	0.522*
FWS/T 40	0.115	0.171	0.285	0.258	0.651**	0.569*	0.849**	0.096	0.167	0.188	0.134	0.229
DWS/T40	0.010	0.027	0.547*	0.450	0.369	0.312	0.600*	0.051	0.122	0.123	0.148	0.210
TDW/T40	0.425	0.410	0.514*	0.455	0.187	0.172	0.592*	0.118	0.201	0.215	-0.079	0.486
TFW/T 50%	0.714**	0.539*	0.709**	0.612*	-0.039	-0.053	0.254	0.285	0.013	0.231	-0.217	0.672**
FWL/T 50%		0.456	0.180	0.080	-0.161	-0.191	0.153	0.087	0.195	0.157	-0.197	0.329
DWL/T50%			0.372	0.396	-0.087	-0.064	0.219	0.489	0.239	0.517*	0.022	0.891**
FWS/T50%				0.929**	-0.006	-0.044	0.139	0.297	-0.064	0.212	-0.074	0.694**
DWS/T50%					0.057	0.012	0.083	0.299	-0.088	0.197	-0.110	0.752**
FWFL						0.961**	0.665**	-0.122	-0.219	0.188	-0.193	-0.029
DWFL							0.678**	-0.173	-0.232	-0.226	-0.228	-0.026
FLA								-0.025	0.216	0.117	-0.034	0.179
Ch 'a'									0.057	0.850**	0.513*	0.484
Ch 'b'										0.548*	0.333	0.095
TCh											0.590*	0.441
CP%												-0.054

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Abbreviations as per Table 1

estimates in combination with high heritability values have been reported by Singh (1999) in oats for plant height, number of leaves per plant, green forage yield, dry forage yield and leaf stem ratio. High estimates of GCV and PCV for number of leaves, number of tiller, green fodder yield and dry matter yield was reported by Arunkumar *et al.* (2004) and Shankar *et al*. (2002) obtained moderate GA for plant height in oat. Therefore, the present findings corroborate the earlier reports. Prasad *et al*. (2002) in sorghum reported high heritability and moderate genetic advance for plant height. But Bahl *et al*. (1989) reported high heritability accompanied by high genetic advance for plant height in fodder oats.

Among the 25 different characters studied in the present experiment, the heritability was very high in sixteen different characters. The characters like, fresh weight of flag leaf (99%), crude protein per cent (98%), fresh weight of stem per tiller at 40 days (97%), dry weight of flag leaf (97%), chlorophyll 'b'(97%), flag leaf area (96%), plant height at 50 per cent flowering (95%), dry weight of stem per tiller at 50 per cent flowering (94%), total chlorophyll content (94%), dry weight of stem per tiller at 40 days (92%), chlorophyll 'a'(92%), dry weight of leaves per tiller at 40 days (88%), total dry weight per tiller at 40 days (88%), date of germination (85%), plant height at 40 days (82%), fresh weight of stem per tiller at 50 per cent flowering (82%) exhibited very high heritability. Therefore, the above characters may be expected to be governed mainly by the genotype of plants. Heritability was moderate for all remaining character like, dry weight per plant at 20 days (46%), fresh weight of leaves per tiller at 50 per cent flowering

(49%), dry weight of leaves per tiller at 50 per cent flowering (54%), fresh weight of leaves per tiller at 50 per cent flowering (59%), fresh weight per plant 20 days (64%), total dry weight per tiller at 50 per cent flowering (69%), total fresh weight per tiller at 40 days (71%), plant height at 20 days (73%), fresh weight of leaves per tiller at 40 days (77%). Pundir *et al.* (2003) reported high estimates of heritability accompanied by high genetic advance for green fodder yield, dry fodder yield, number of leaves per plant, leaf length, leaf breadth, green leaf weight, dry leaf weight indicating the effectiveness of simple selection for the improvement of these traits. Therefore, the present findings corroborate the findings of the above authors. In case of cowpea, Bhandari *et al.* (2008) studied co-efficient of variation, heritability and genetic advance estimation. Analysis of variance revealed adequate genetic variability among genotypes of most of the characters studied over the year. Heritability estimates were found by them to be high and they were coupled with high to moderate genetic advance for plant height, days to 50 per cent flowering, number of leaves per plant, crude protein content and green forage yield indicating predominance of additive gene action effects of these characters. It has been suggested that when heritability estimates are used in conjunction with selection differential *i.e.* the amount of which the mean of selected groups exceeds the mean of entire group, the utility of heritability estimates is increased. Further the broad sense heritability estimates reflects both additive and epistatic gene effects, it would be reliable only if accompanied by high genetic advance. Burton and Devane (1953) suggested that GCV in combination with high heritability in broad sense will give realistic indication of the expected amount of improvement by selection. According to Johnson *et al.* (1995) heritability in broad sense indicates only the effectiveness with which selection of genotypes be based on the phenotypic performance but fails to show the

Table 5 : Direct and indirect effects of component characters on total dry matter yield per tiller at 50 per cent flowering

Effect of Character	D GER	PH 20	PH 40	PH 50%	FW/P 20	DW/P 20	TFW/T 40	FWL/T 40	DWL/T 40	FWS/T 40	DWS/T 40	TDW/T 40	TFW/T 50%
D GER	-0.0383	0.1371	-0.0381	-0.2452	-0.0231	0.0457	0.1913	-0.1376	0.0542	-0.2534	-0.1140	0.0412	-0.0756
PH 20	0.0304	-0.1728	0.0520	0.2437	0.0227	-0.0268	-0.2372	0.1692	-0.0678	0.1711	0.0985	-0.0485	0.1154
PH 40	0.0211	-0.1300	0.0691	0.2983	0.0117	-0.0285	-0.1942	0.1394	-0.0599	0.1354	0.0564	-0.0421	0.1215
PH 50%	0.0238	-0.1066	0.0521	0.3951	0.0131	-0.0112	-0.1491	0.1218	-0.0512	0.0535	-0.0239	-0.0339	0.0843
FW/P 20	-0.0116	0.0516	-0.0106	-0.0683	-0.0760	0.1043	0.1258	-0.1067	0.0475	-0.1235	-0.0583	0.0352	-0.1016
DW/P 20	-0.0148	0.0393	-0.0167	-0.0375	-0.0673	0.1178	0.1162	-0.1032	0.0512	-0.2223	-0.1301	0.0403	-0.0827
TFW/T 40	0.0278	-0.1557	0.0509	0.2239	0.0363	-0.0520	-0.2632	0.1946	-0.0824	0.3298	0.1796	-0.0618	0.1314
FWL/T 40	0.0269	-0.1496	0.0491	0.2455	0.0414	-0.0620	-0.2614	0.1960	-0.0850	0.2903	0.1638	-0.0629	0.1287
DWL/T40	0.0235	-0.1327	0.0469	0.2293	0.0409	-0.0684	-0.2458	0.1886	-0.0883	0.2685	0.1626	-0.0653	0.1282
FWS/T 40	0.0215	-0.0654	0.0207	0.0468	0.0208	-0.0579	-0.1921	0.1259	-0.0524	0.4519	0.2271	-0.0444	0.0653
DWS/T40	0.0155	-0.0605	0.0138	-0.0335	0.0157	-0.0545	-0.1680	0.1140	-0.0510	0.3646	0.2814	-0.0437	0.0712
TDW/T40	0.0240	-0.1276	0.0443	0.2040	0.0407	-0.0724	-0.2476	0.1876	-0.0878	0.3052	0.1875	-0.0657	0.1253
TFW/T50%	0.0196	-0.1355	0.0570	0.2263	0.0525	-0.0662	-0.2349	0.1714	-0.0769	0.2005	0.1362	-0.0559	0.1472
FWL/T50%	0.0089	-0.1060	0.0389	0.1775	0.0488	-0.0615	-0.1579	0.1334	-0.0600	0.0944	0.0118	-0.0415	0.1046
DWL/T50%	0.0119	-0.0940	0.0456	0.2158	0.0217	0.0030	-0.1294	0.0941	-0.0550	0.0976	-0.0148	-0.0367	0.0992
FWS/T50%	0.0172	-0.1026	0.0416	0.1371	0.0208	-0.0228	-0.1835	0.1270	-0.0535	0.1493	0.1735	-0.0406	0.1179
WS/T50%	0.0164	-0.0980	0.0383	0.1601	0.0059	0.0127	-0.1680	0.1117	-0.0445	0.1186	0.1308	-0.0327	0.1042
FWFL	0.0142	-0.0101	0.0147	0.0773	-0.0133	-0.0059	-0.0718	0.0442	-0.0124	0.3000	0.1079	-0.0133	-0.0077
DWFL	0.0100	0.0057	0.0166	0.0843	-0.0190	0.0001	-0.0462	0.0269	-0.0111	0.2618	0.0900	-0.0117	-0.0114
FLA	0.0145	-0.0417	0.0264	0.1073	0.0116	-0.0595	-0.1543	0.1072	-0.0526	0.3992	0.1790	-0.0430	0.0515
Ch 'a'	0.0056	-0.0427	0.0040	-0.0285	0.0408	-0.0297	-0.0250	0.0086	-0.0129	0.0491	0.0185	-0.0087	0.0536
Ch 'b'	-0.0103	-0.0023	-0.0151	-0.0887	0.0022	-0.0057	-0.0476	0.0371	-0.0206	0.0775	0.0402	-0.0144	-0.0046
TCh	-0.0009	-0.0340	-0.0045	-0.0666	0.0359	-0.0317	-0.0472	0.0269	-0.0225	0.0855	0.0407	-0.0157	0.0446
CP%	0.0059	0.0173	-0.0370	-0.1719	0.0285	-0.0378	0.0474	-0.0365	0.0090	0.0647	0.0449	0.0043	-0.0383

Table 5 : Contd.…….

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Effect of Character	FWL/T 50%	DWL/T 50%	FWS/T 50%	DWS/T 50%	FWFL	DWFL	FLA	Ch 'a'	Ch 'b'	TCh	CP%	TDW/T50% (genotypic correlation)
D GER	0.0341	-0.9421	-0.0702	-0.0371	0.1788	-0.1302	0.2448	-0.1067	0.1447	-0.0175	0.0150	-0.434
PH 20	-0.0896	0.3404	0.0927	0.0491	-0.0282	-0.0166	-0.1300	0.1802	0.0072	-0.1418	0.0096	0.620*
PH 40	-0.0824	0.4131	0.0941	0.0480	-0.1023	0.1200	-0.2057	0.0427	-0.1181	0.0473	0.0515	0.707**
PH 50%	-0.0656	0.3419	0.0542	0.0351	-0.0938	0.1063	-0.1462	-0.0526	-0.1209	0.1217	0.0419	0.590*
FW/P 20	0.0938	-0.1791	-0.0427	-0.0067	-0.0842	0.1246	0.0825	-0.3914	-0.0158	0.3406	0.0360	-0.235
DW/P 20	0.0764	0.0162	-0.0302	0.0093	0.0241	0.0004	0.2717	-0.1838	-0.0264	0.1943	0.0309	0.073
TFW/T 40	-0.0877	0.3077	0.1089	0.0553	-0.1310	0.0874	-0.3157	0.0693	0.0975	-0.1295	0.0173	0.639**
FWL/T 40	-0.0995	0.3005	0.1012	0.0493	-0.1082	0.0685	-0.2945	0.0322	0.1021	-0.0991	0.0179	0.591*
DWL/T40	-0.0993	0.3903	0.0947	0.0437	-0.0674	0.0629	-0.3210	0.1063	0.1258	-0.1842	0.0098	0.650**
FWS/T 40	-0.0305	0.1351	0.0516	0.0227	-0.3186	0.2885	-0.4756	0.0791	0.0924	-0.1366	-0.0138	0.262
DWS/T40	-0.0061	-0.0331	0.0963	0.0402	-0.1841	0.1592	-0.3424	0.0480	0.0770	-0.1043	-0.0153	0.201
TDW/T40	-0.0924	0.3502	0.0966	0.0431	-0.0971	0.0889	-0.3526	0.0974	0.1183	-0.1724	0.0064	0.604*
TFW/T50%	-0.1039	0.4218	0.1251	0.0613	0.0251	-0.0385	-0.1886	0.2656	-0.0168	-0.2185	0.0250	0.799**
FWL/T50%	-0.1462	0.3890	0.0246	0.0047	0.1117	-0.1255	-0.1182	0.1126	0.1243	-0.2022	0.0258	0.392
DWL/T50%	-0.0909	0.6258	0.0567	0.0392	0.0591	-0.0423	-0.1615	0.4329	0.1813	-0.4900	-0.0059	0.863**
FWS/T50%	-0.0230	0.2272	0.1562	0.0834	0.0026	-0.0259	-0.0813	0.2230	-0.0452	-0.1484	0.0066	0.757**
DWS/T50%	-0.0080	0.2834	0.1504	0.0866	-0.0300	0.0061	-0.0452	0.2311	-0.0545	-0.1436	0.0100	0.842**
FWFL	0.0340	-0.0771	-0.0008	0.0054	-0.4799	0.4813	-0.3703	-0.0906	-0.1201	0.1373	0.0189	-0.038
DWFL	0.0368	-0.0532	-0.0081	0.0010	-0.4640	0.4978	-0.3831	-0.1279	-0.1314	0.1705	0.0283	-0.037
FLA	-0.0321	0.1878	0.0236	0.0072	-0.3301	0.3542	-0.5384	-0.0332	0.1201	-0.0812	0.0031	0.227
Ch 'a'	-0.0226	0.3717	0.0478	0.0274	0.0597	-0.0874	0.0245	0.7287	0.0367	-0.6209	-0.0527	0.546*
Ch 'b'	-0.0337	0.2107	-0.0131	-0.0087	0.1071	-0.1214	-0.1201	0.0497	0.5385	-0.4121	.-0.0328	0.111
TCh	-0.0410	0.4251	0.0321	0.0172	0.0914	-0.1176	-0.0606	0.6273	0.3077	-0.7212	-0.0600	0.511*
CP%	0.0392	0.0387	-0.0108	-0.090	0.0944	-0.1464	0.0178	0.3989	0.1838	-0.4497	-0.0962	-0.039

Residual effect =0.074 Abbreviations as per Table 1 * and ** indicate significant of values at P=0.05 and 0.01, respectively

genetic progress. Panse (1957) concluded that a character with high heritability in association with high genetic advance (in % mean) is an indication of expression of additive gene action. Characters without such combination appear generally because of non-additive gene action (Liang and Walter, 1968). In guinea grass, high heritability combined with high genetic advance as a percentage of the mean was observed for number of leaves per plant, stem weight, leaf weight, green fodder yield per plant and dry matter content Philomina *et al.* (1999) and Bendale *et al.* (2004) reported in lablab bean that leaf area had high estimates of heritability associated with higher magnitude of genetic advance as percentage of mean.

In the present experiment, the magnitude of GA in terms of percentage of mean was very high for fresh weight of stem per tiller at 40 days (111.60), dry weight of stem per tiller at 40 days (112.70), fresh weight of stem per tiller at 50 per cent flowering (69.13), dry weight of stem per tiller at 50 per cent flowering (80.08), chlorophyll 'b'(63.78) content, fresh weight of flag leaf (43.87), dry weight of flag leaf (43.86) while moderate for days for germination (38.14), total dry weight per tiller at 40 days (35.33), crude protein per cent (33.77), dry weight of leaves per tiller at 40 days (33.29). All these characters had very high heritability and close proximity between GCV and PCV indicating the characters to be controlled mainly by additive gene action. Therefore, direct selection in desired direction may be practiced for improvement of the character on the basis of phenotype. Low genetic advance was recorded for all the remaining characters *viz.*, plant height at 20 days (11.08), plant height at 40 days (13.39), plant height at 50 per cent flowering (15.79), dry weight per plant at 20 days (14.65), total fresh weight per tiller at 50 per cent flowering (14.77), fresh weight of leaves per tiller at 50 per cent flowering (13.00), dry weight of leaves per tiller at 50 per cent flowering (17.57), fresh

weight of leaves per tiller at 40 days (23.47) and total fresh weight per tiller at 40 days (23.77). These characters indicated predominance of non-additive gene action and moderate heritability due to favourable influence of environmental factors rather than genotype and selection for these characters may not be rewarding.

Conclusion :

The results with respect to mean values of the above characters indicated that among 16 genotypes, 6 genotypes *viz*., OL-1709, JHO-2010-2, Kent, NDO-729, OS-6 and JO-03-97 produced significantly higher mean for total dry weight per tiller at 50 per cent flowering. Again among these 6 genotypes, it was observed that all of them had significantly higher mean for total dry weight per tiller at 40 days, fresh weight of stem per tiller at 50 per cent flowering, dry weight of stem per tiller at 50 per cent flowering and dry weight of flag leaf. Besides, they had generally significantly higher mean for dry weight of leaf per tiller and fresh weight of stem per tiller at 40 days, fresh weight of flag leaf, dry weight of flag leaf, flag leaf area, chlorophyll 'b' content and crude protein percentage. Considering the number of characters for which the above genotypes produced significantly higher mean were conspicuously high. The genotype NDO-729 had significantly higher mean for 19 different characters out of 24 characters studied; Kent had significantly higher mean for 18 different characters while OL-1709, JHO 2010-2, OS-6 and JO-03-97 had significantly higher mean for 17, 14, 12 and 13 different characters, respectively. In the present experiment, the characters like dry weight and fresh weight of stem per tiller at 40 days; fresh and dry weight of stem per tiller at 50 per cent flowering; chlorophyll 'b' content; fresh and dry weight of flag leaf, all these characters had very high heritability and close proximity between GCV and PCV indicating the characters to be under genetic controlled. The magnitude of GA in terms of percentage of mean was also very high indicating the characters to be controlled by additive gene action. Therefore, direct selection in desired direction may be practiced for improvement of the characters on the basis of phenotype. It was noted that generally these characters exhibited significantly higher mean for 12 to 19 different characters out of 24 characters studied.

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