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Genetic variability, heritability and genetic advance studies in oat (*Avena sativa* L.)

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Abstract
Eight genotypes *viz*., Kent, OS 6, JHO-99-2, JHO 851, OS 403, OL 125, UPO 212 and NDO 612 were studied for genetic variability, heritability and genetic advance for green fodder yield, days to 50% flowering, number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pod per spike, length of spike and leaf stem ratio. Analysis of variance showed highly significant differences among the parents and F_1s for all the attributes. The parent's *vs* hybrids revealed highly significant differences for all the traits. The F test indicated that the variance due to treatments were highly significant for all the characters which indicated that the presence of substantial genetic variability in the present set of material. The highest values of genotypic and phenotypic coefficient of variation (more than 25%) were observed for number of leaves per plant, number of tillers per plant, leaf stem ratio and green fodder yield per plant, suggested that there was a possibility of improvement of fodder yield through direct selection. High heritability coupled with high genetic advance as percent of mean was recorded for number of leaves per plant, leaf area, plant height, Number of tillers per plant, stem girth, number of green pods per spike, length of spike and green fodder yield per plant, indicating that these characters are governed by additive gene action. Direct selection of these attributes will be effective and profitably for yield improvement.

Keywords: *Avena sativa*, variability, heritability, genetic advance

Introduction
Oat has been used as fodder and grain as it's a good source of protein, fibre and minerals. It is used as green crop, hay and silage for animal feed alone or in mixture feed to dairy cattle, horses, mules and turkeys, with lesser quantities feed to hogs, beef cattle and sheep. India is increasing on a fast scale as oat meal, oat granola, baby food and breakfast cereal. Oats have adequate soluble carbohydrates to make good silage. Oat straw is good, palatable roughage and also excellent bedding. Oat in small bags is very popular in hilly areas. High forage yield is a complex character and an interactive effect/contribution of different traits. Therefore, for any crop improvement programme through selection, the study of genetic variability and heritability together with genetic advance is necessary. So the development of high yielding varieties of oats for forage, fodder and grain yield requires the implication of crop improvement to stable the superior genotype or initiating a breeding programme based on the yield components. Yield component concept in breeding has got much importance in improving yield potentiality. Beside grain yield, some traits are more contributing in increasing the fodder yield directly or indirectly such as number of plants per square meter, plant height, number of leaves per plant, spike length, number of spikelets per spike, green fodder yield per plant, stem thickness and grain filling period etc. From the plant breeder's view point, genetic variation for yield and its components is important but evaluation of traits relationships are necessary for better understanding and developing of breeding programme. Assessment of the genetic variability can be achieved by using morphological measurements and phenotypic characterization. The characterization of forage and fodder crops requires the availability of the variable genetic material for the component characters that is a major assets for initiating a fruitful crop improvement programme. Initiation of breeding programme for forage crop improvement has developed only a few varieties of oats those are available for commercial forage cultivation and their grain yield. The distribution of different wild and weedy species is confined mainly to the temperate Northern hemisphere. The countries bordering the Mediterranean Sea, Turkey, Iran, Iraq and parts of the former USSR are rich in the diversity of species.

Oat is chiefly a crop of European and North American content having cool and moist climate to which it is well adopted. It is one of the highly nutrious and fast growing *rabi* forage crops capable of tolerating biotic and abiotic stresses (Prakas, 2012) [6].

Material and Methods

The experimental material for the present investigation was comprised of eight promising diverse parents namely Kent, OS6, JHO-99-2, JHO851, OS403, OL125, UPO212 and NDO612 and their all possible 28 F_1's, developed through crossing eight parental lines in diallel mating design (excluding reciprocals). All genotypes were evaluated in a complete randomized block design with three replications at Crop Research Center (Chirodi) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, during *rabi* season 2015-16 and 2016-2017. The observations were recorded on ten characters *viz*., days to 50% flowering, number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pods per plant, length of spike, leaf stem ratio and green fodder yield per plant. The data recorded on all these traits were subjected to various statistical and biometrical analyses *viz*., to work out analysis of variance, genotypic and phenotypic coefficient of variation, heritability and genetic advance. The experiment for raising parents and F_1's was conducted in a complete randomized block design with three replications. Seeds of eight parents and F_1's were sown by hand dibbling method and the length of each row was kept 3m with inter and intra row distances of 30cm and 10cm, respectively. The coefficients of variation, heritability in broad sense and expected genetic advance were calculated by the formula given by Burton (1952) [2] and Johnson *et al.* (1955) [5], Crumpacker and Allard (1962) [3] and Robinson *et al.* (1949) [7].

Table 1: Analysis of variance for green fodder yield and its components in oat (*Avena sativa* L.)

Source of variance	d.f.	Days to 50% flowering	No. of leaves per plant	Leaf area (cm^2)	Plant height (cm)	No. of tillers per plant	Stem girth (mm)	No. of green pods per spike	Length of spike (cm)	Leaf stem ratio (w/w)	Green fodder yield per plant (g)
Replication	2	6.08	0.48	0.24	0.17	0.09	0.12	0.37	0.24	0.01	4.11
Treatment	35	73.12**	2469.36**	562.56**	777.07**	110.69**	2.07**	801.09**	89.32**	0.35**	678.13**
Parents	7	76.90**	4667.69**	744.14**	1332.72**	115.19**	2.94**	702.71**	90.21**	0.42**	816.00**
Crosses	27	79.83**	3505.41**	692.32**	987.13**	93.94**	2.88**	687.98**	94.73**	0.46**	734.71**
Parents vs crosses	1	54.89**	8036.28**	345.93**	698.08**	125.03**	0.88**	4.41**	62.83**	0.95**	10.85**
Error	70	3.77	0.80	0.44	5.16	0.12	0.02	1.09	0.37	0.05	15.71

* Significant at 5%, ** Significant at 1% level, respectively

Table 2: Mean performance and parameters of variability for various traits studied in oats (*Avena sativa* L.)

Characters	Heritability (%)	Genetic Advance	Genetic Advance (as % of mean)	GCV (%)	PCV (%)
Days to 50% flowering	85.57	9.01	8.18	4.30	4.64
No. of leaves per plant	99.92	66.14	73.44	35.66	35.68
Leaf area (cm^2)	99.76	27.56	41.08	19.97	19.99
Plant height (cm)	98.42	36.67	22.74	11.13	11.22
No. of tillers per plant	99.57	10.85	72.49	35.27	35.34
Stem girth (mm)	96.80	1.67	23.31	11.50	11.69
No. of green pods per spike	99.37	26.93	36.55	17.80	17.86
Length of spike (cm)	98.81	11.37	32.85	16.04	16.14
Leaf stem ratio (w/w)	98.03	0.21	4.79	27.06	27.23
Green fodder yield per plant (g)	92.47	27.51	20.57	25.34	25.65

Results and Discussion

A thorough screening of the material studied (table-1) under present investigation exhibited sufficient variability for all the ten characters *i.e. viz*., days to 50% flowering, number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pods per plant, length of spike, leaf stem ratio and green fodder yield per plant which indicated that sufficient variability existed in the present set of material and further genetic analysis and study would be meaningful. Highest percentage of genotypic and phenotypic coefficient of variation (more than 25%) were recorded for number of leaves per plant, number of tillers per plant, leaf stem ratio and green fodder yield per plant (table-2). Estimates of phenotypic coefficient of variation were generally higher than their corresponding genotypic coefficient of variation for all the attributes. Similar views have been reported by earlier workers **S**hinde *et al.* (2015) [8] and Bind *et al.* (2016) [1]. The high values of genotypic and phenotypic coefficient of variation for these characters, suggested that there was a possibility of improvement of fodder yield through direct selection. High (>60%) heritability was observed for days to 50% flowering, number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pods per spike, length of spike, leaf stem ratio and green fodder yield per plant. The high or moderate degree of heritability estimates for these characters suggested that the attributes were under genotypic control. This result is in agreement with finding of Bind *et al.* (2016) [1] and Jaipal and Shekhawat (2016) [4]. High (>20%) estimates of genetic advance expressed as percent of mean have been observed for number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pods per spike, length of spike and green fodder yield per plant, suggesting good response for selection based on *per se* performance. Earlier research have reported similar finding with respect to genetic advance, Shinde *et al.* (2015) [8] and Bind *et al.* (2016) [1]. High heritability coupled with high genetic advance as percent of mean was noted for number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pods per spike, length of spike and green fodder yield per plant, which indicated that these characters are controlled by additive gene action. Direct

selection of these attributes will be effective and profitably for yield improvement. The above finding are in agreement with those of Bind *et al.* (2016) [1] and Jaipal and Shekhawat (2016) [4]. Therefore, on the basis of study of all the variability parameters, it may be interpreted that maximum improvement through direct selection can be brought for number of leaves per plant, leaf area, plant height, number of tillers per plant, stem girth, number of green pods per spike, length of spike, leaf stem ratio and green fodder yield per plant.

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