Forage Res., **43** (2) : pp. 110-115 (2017) **http://forageresearch.in**

ESTIMATES OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN OATS (*AVENA* SP.) FOR SEED AND FODDER YIELD TRAITS

TANVI KUMARI, Y. JINDAL* AND SATPAL

Department of Genetics & Plant Breeding
CCS Haryana Agricultural University,
Hisar-125 004 (Haryana), India
(e-mail : yjindalhau@gmail.com)
(Received : 25 April 2017; Accepted : 30 June 2017)

SUMMARY

Fifty diverse genotypes of oats were evaluated for different qualitative and quantitative traits to assess the genetic diversity during **rabi** 2015-16. These genotypes were evaluated for 22 yield and its component traits to assess the genetic diversity. The genotypic and phenotypic coefficient of variations in terms of unit of their expression were observed highest for seed yield per plant, seed width and 100-seed weight. Low estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for days to 50 per cent flowering, days to maturity, leaves per plant, culm diameter, flag leaf length, tillers per plant, plant height at maturity and green fodder yield per plant. The estimates of high heritability (broad sense) were noticed in almost all the characters like plant height, days to 50 per cent flowering, leaves per plant, flag leaf width, flag leaf length, leaf length, leaf width, culm diameter, number of nodes on the main tiller, days to maturity, tillers per plant, peduncle length, axis length, axis node number, green fodder yield per plant, dry fodder yield per plant, dry matter per cent, seed yield, 100-seed weight, seed length and seed width. The high estimates of genetic advance as per cent of mean were recorded for number of flag leaf length, flag leaf width, leaf length, leaf width, tillers per plant, peduncle length, axis length, green fodder yield per plant, dry matter per cent, seed yield, 100-seed weight and seed width. High heritability coupled with high genetic advance for traits viz., flag leaf length, flag leaf width, leaf length, leaf width, tillers per plant, peduncle length, axis length, green fodder yield per plant, dry matter per cent, seed yield, 100-seed weight and seed width.

Key words : Oats, genetic diversity, genetic variability parameters, heritability, genetic advance

Oat is dual purpose crop and is used as both forage and grain. It is good source of protein, vitamin B, phosphorus and iron. It is used for human consumption as well as for poultry, dairy cattle and other animals. It has more proteins per kg than corn and its crude protein content varies from 10.9 to 14.6 per cent at different stages of growth. It is mainly grown in North-western, Central and Hilly parts of India due to congenial climate. Oat has adequate soluble carbohydrates and fibres. It provides one of the richest sources of the dietary soluble fibre beta-glucan. Nutrition experts believe that beta-glucan inhibit cholesterol built up and hence help in the prevention of heart disease (Whitehead *et al*., 2014). In India, the oat is used as baby food, oat meal, oat granola and as breakfast cereal particularly because of demonstrated dietary benefits of oat whole grain products.

Oat is basically a European and North American crop. It is best grown in temperate and sub-tropical regions of the world as they are winter hardy in nature. Oat requires cool and moist climate. The total area, production and productivity during 2015 were about 9.58 million hectares, 22.60 million metric tonnes and 2.36 metric tonnes per hectare, respectively, in the world (USDA, FAS, 2016). European Union is the largest producer of oat followed by Russian Federation, Canada, USA and Australia. Europe accounts for 64.2 per cent of total oat produced in the world (FAOSTAT, 2015). In India, oat is grown on 1,00,000 hectares of area with productivity of 35-40 tonnes of green fodder per hectare (Anonymous, 2014).

MATERIALS AND METHODS

The present investigation was conducted at Forage Research Area, Department of Genetics & Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana), India during

rabi 2015-16. The experiment was conducted in randomized block design with three replications and two row plot of three metre each. Standard recommended agronomical package of practices were followed.

The climate of Hisar is semi-arid and sub-tropical with hot and dry winds during summer months. Warm humid in monsoon and cold dry weather in winter are the general features of this region. Both, winter and summer are usually harsh to bear upon. The mean minimum and maximum temperatures exhibit wide variations. A maximum temperature zooming 44 to 48ºC during summer and temperature dipping as low as to freezing point accompanied with chill frost in winter is of common occurrence.

The experimental material comprised 50 oat genotypes, belonging to eight different *Avena* species, from oat germplasm. These genotypes included released varieties, advanced breeding lines and genetic stocks, etc. (Table 1).

TABLE 1
List of oat genotypes used in the study

S. No.	Genotype	Species	S. No.	Genotype	Species
1.	HFO 33	*A. sativa*	26.	HFO 503	*A. sativa*
2.	HFO 41	*A. sativa*	27.	HFO 512	*A. sativa*
3.	HFO 47	*A. sativa*	28.	HFO 513	*A. sativa*
4.	HFO 49	*A. sativa*	29.	HFO 681	*A. sativa*
5.	HFO 50	*A. sativa*	30.	HFO 682	*A. sativa*
6.	HFO 52	*A. sativa*	31.	HFO 684	*A. sativa*
7.	HFO 53	*A. sativa*	32.	HFO 685	*A. sativa*
8.	HFO 55	*A. sativa*	33.	HFO 716	*A. sativa*
9.	HFO 56	*A. sativa*	34.	HFO 833	*A. sativa*
10.	HFO 58	*A. barbata*	35.	HFO 834	*A. sativa*
11.	HFO 59	*A. sativa*	36.	HFO 864	*A. brevis*
12.	HFO 60	*A. byzantina*	37.	HFO 867	*A. maroccana*
13.	HFO 103	*A. orientalis*	38.	HFO 868	*A. sativa*
14.	HFO 114	*A. sativa*	39.	HFO 870	*A. vaviloviana*
15.	HFO 233	*A. sativa*	40.	ALGERIAN	*A. sativa*
16.	HFO 239	*A. sativa*	41.	JHO 851	*A. sativa*
17.	HFO 305	*A. nuda*	42.	JO 1	*A. sativa*
18.	HFO 306	*A. sativa*	43.	PLP 1	*A. sativa*
19.	HFO 307	*A. sativa*	44.	UPO 212	*A. sativa*
20.	HFO 346	*A. sativa*	45.	KENT	*A. sativa*
21.	HFO 476	*A. sativa*	46.	OS 6	*A. sativa*
22.	HFO 488	*A. sativa*	47.	OS 7	*A. sativa*
23.	HFO 489	*A. sativa*	48.	OS 377	*A. sativa*
24.	HFO 490	*A. sativa*	49.	OS 403	*A. sativa*
25.	HFO 502	*A. sativa*	50.	HJ 8	*A. sativa*

The observations were recorded on five randomly selected plants in each genotype for the following 22 quantitative traits viz., plant height at fodder stage (PHF) in cm, number of days to 50 per cent flowering (DF), number of leaves per plant (LPP), flag leaf width (FLW) in cm, flag leaf length (FLL) in cm, leaf length (LL) in cm, leaf width (LW) in cm, culm diameter/stem girth (CD) in mm, number of nodes on the main culm (NODES), number of days to maturity (DM), plant height at maturity (PHM) in cm, number of tillers per plant (TPP), peduncle length (PL) in cm, axis length (AL) in cm, axis node number (ANN), green fodder yield per plant (GFY/P) in g, dry fodder yield per plant (DFY/P) in g, dry matter (%) (DrM%), seed yield per plant (SY) in g, 100-seed weight (HSW) in g, seed length (SL) in mm and seed width (SW) in mm.

RESULTS AND DISCUSSION

The analysis of variance investigated during the study indicated significant differences among the genotypes for all the characters studied (Table 2). These results indicated that there was a plenty of scope for the improvement of germplasm through selection and heterosis breeding. The results clearly indicated that all the studied oat genotypes showed high variability for grain and fodder yield and its component traits. The earlier workers Shehzad *et al*. (2011), Bibi *et al*. (2012), Hisir *et al*. (2012) and Bind *et al*. (2016) also suggested a large and exploitable variation in different oat germplasm, it could be stated that there was ample scope of variation in these traits that could be utilized for improvement through selection for the traits investigated in the present material.

Among grain and fodder yield and its component characters, plant height at fodder stage varied from 65.2-124.2 cm (OS 377) with a mean of 103.9 cm. Flag leaf length varied from 29.5-46.8 cm. The genotype HFO 476 with highest flag leaf length indicated better photosynthesis that resulted in high biomass accumulation. Plant height at maturity also varied between 86.2-138.3 cm with a mean height of 120.6 cm (Table 2). Green fodder yield per plant possessed the highest range of 140.2-223.3 with a mean yield of 177.1 g and maximum yield in the genotype HJ 8. Seed yield per plant gave a range of 40.3-241.0 g (HFO 490) with a mean of 102.0 g. Another character 100-seed weight also varied between 2.2-4.5 g. HFO 476 with highest value indicated a bold seed (Table 3). This shows that these characters were responsible for wide variation in grain and fodder yield of various genotypes. Wide range of variability was observed for green fodder yield by Arora (2013). For plant height, Bibi *et al.* (2012) and Siloriya *et al*. (2014) also reported similar results. However, there was less variation in other characters.

TABLE 2
Mean performance of oat genotypes for yield and its component traits

S. No.	Genotypes	PHF	DF	LPP	FLW	FLL	LL	LW	CD	NODES	DM	PHM
1.	HFO 33	122.2	92.3	41.4	2.2	38.7	48.0	2.3	6.7	5.7	120.0	127.7
2.	HFO 41	118.6	96.3	35.5	2.2	33.8	45.7	2.0	6.7	5.3	122.3	138.3
3.	HFO 47	116.4	91.0	40.4	1.8	38.3	48.3	2.3	6.5	5.0	113.3	121.7
4.	HFO 49	111.4	94.3	35.5	2.2	31.5	49.7	2.4	6.6	5.3	121.7	126.7
5.	HFO 50	107.3	91.3	41.2	2.2	38.7	54.3	2.4	6.5	5.7	116.7	122.7
6.	HFO 52	111.0	96.3	45.2	1.4	33.4	38.0	2.4	5.8	5.3	120.7	122.3
7.	HFO 53	90.9	95.0	35.4	1.8	34.7	36.3	1.9	6.0	6.0	121.7	103.2
8.	HFO 55	117.3	91.3	35.3	2.3	33.7	48.3	2.3	6.5	5.7	122.0	125.3
9.	HFO 56	111.8	96.0	36.5	1.7	35.3	44.3	1.9	5.8	5.0	120.0	132.3
10.	HFO 58	109.9	95.7	36.4	1.7	34.7	45.7	2.8	6.3	5.3	121.7	125.3
11.	HFO 59	111.1	91.3	41.4	2.3	39.4	49.0	2.1	6.3	6.3	118.7	127.3
12.	HFO 60	102.0	96.7	41.5	2.0	34.3	45.0	1.8	6.6	6.0	121.7	125.7
13.	HFO 103	114.2	96.0	45.4	2.1	29.4	34.3	1.8	5.7	5.3	121.3	130.4
14.	HFO 114	119.3	96.3	35.4	2.6	38.5	50.0	2.5	5.8	6.4	118.7	128.7
15.	HFO 233	111.8	94.0	40.4	2.2	38.6	52.0	2.0	5.9	5.3	116.7	124.8
16.	HFO 239	105.2	96.0	40.1	1.9	33.4	53.0	2.5	6.3	5.9	122.0	137.7
17.	HFO 305	99.7	91.0	40.3	2.0	36.4	48.7	2.4	6.2	6.4	117.0	117.7
18.	HFO 306	102.8	92.0	39.4	2.3	44.7	50.3	2.1	6.2	4.9	118.0	114.3
19.	HFO 307	106.5	91.0	38.5	1.8	35.5	47.3	2.5	5.6	6.0	118.7	123.7
20.	HFO 346	113.1	94.0	43.5	2.7	41.7	48.3	2.3	6.4	6.8	118.0	124.3
21.	HFO 476	94.7	91.7	40.4	2.0	46.8	53.0	2.1	5.4	5.7	117.3	115.7
22.	HFO 488	88.7	91.7	40.4	1.7	36.7	51.0	1.9	6.1	5.0	117.0	105.3
23.	HFO 489	83.1	93.0	35.6	1.3	35.7	46.7	2.5	5.4	5.1	122.3	125.3
24.	HFO 490	98.3	93.3	38.3	1.5	38.4	37.7	2.4	5.5	4.8	119.7	113.2
25.	HFO 502	91.2	91.0	37.4	1.8	37.4	46.7	1.8	5.7	5.2	117.0	108.4
26.	HFO 503	95.2	92.0	34.5	1.8	36.4	47.0	2.5	5.9	5.6	118.3	112.3
27.	HFO 512	92.7	92.0	42.7	2.0	38.7	50.7	2.8	6.4	5.2	118.7	112.7
28.	HFO 513	77.4	92.0	36.7	1.8	33.4	38.0	2.0	6.1	4.3	123.3	115.7
29.	HFO 681	89.0	92.0	40.4	1.7	38.8	50.3	2.3	5.8	4.0	118.3	112.3
30.	HFO 682	86.6	92.0	40.3	1.7	38.5	45.0	2.4	6.1	5.7	119.3	95.6
31.	HFO 684	95.1	92.0	40.4	2.2	39.5	54.3	2.1	6.7	6.0	122.3	127.3
32.	HFO 685	96.6	91.7	38.4	2.0	38.3	52.0	2.2	6.1	5.6	121.3	117.3
33.	HFO 716	65.2	92.3	40.4	2.0	36.8	49.3	2.4	6.0	5.3	123.3	86.3
34.	HFO 833	98.7	92.0	40.4	1.9	37.7	54.0	2.3	6.9	6.0	120.0	116.6
35.	HFO 834	112.1	91.7	41.5	1.9	37.4	51.0	2.6	6.4	5.7	119.0	129.6
36.	HFO 864	109.3	95.3	38.4	2.1	37.8	34.0	2.5	6.0	6.2	122.0	130.3
37.	HFO 867	102.9	103.0	39.5	1.4	38.3	51.7	3.0	5.0	5.8	121.0	116.3
38.	HFO 868	115.6	90.3	44.3	2.0	37.4	50.0	2.5	5.9	6.1	121.0	125.3
39.	HFO 870	112.3	91.3	38.4	2.9	38.7	54.3	2.6	6.2	5.8	121.3	125.7
40.	ALGERIAN	102.9	92.0	37.5	2.2	38.5	50.3	2.5	6.3	5.9	121.0	117.7
41.	JHO 851	109.1	98.0	36.4	2.5	38.8	51.3	2.4	6.5	6.6	120.0	121.7
42.	JO 1	106.0	96.3	36.4	2.3	36.5	32.0	1.4	6.5	5.7	121.3	125.3
43.	PLP 1	84.2	95.0	38.4	2.4	35.7	33.7	1.6	6.2	6.6	121.7	100.7
44.	UPO 212	109.4	91.3	40.2	2.1	38.4	51.7	2.2	6.7	5.7	121.0	123.3
45.	KENT	103.1	92.0	38.5	2.1	37.4	50.7	2.0	6.9	5.4	122.0	118.3
46.	OS 6	107.2	94.7	38.4	1.8	35.4	48.7	1.9	6.2	5.8	122.3	126.7
47.	OS 7	116.3	95.0	38.4	2.3	35.3	45.0	2.3	6.2	6.1	122.0	128.3
48.	OS 377	124.2	92.0	40.5	3.0	39.4	49.3	2.3	6.8	6.4	120.0	130.3
49.	OS 403	111.6	92.7	34.2	2.2	40.5	51.0	2.2	6.9	6.0	120.0	125.3
50.	HJ 8	114.2	91.3	45.4	2.3	39.5	52.0	2.4	6.8	6.7	120.0	122.7
	Mean	103.9	93.4	39.2	2.0	37.3	47.4	2.3	6.2	5.7	120.1	120.6
	SE(m)	4.2	0.9	1.6	0.1	1.2	1.8	0.2	0.2	0.1	1.1	3.2
	CV	7.0	1.8	7.3	7.3	5.8	6.6	13.1	5.2	3.1	1.5	4.6

PHF: plant height at fodder stage, DF: days to 50% flowering, LPP: leaves per plant, FLW: flag leaf width, FLL: flag leaf length, LL: leaf length, LW: leaf width, CD: culm diameter, NODES: number of nodes on the main tiller, DM: days to maturity, PHM: plant height at maturity, TPP: tiller per plant, PL: peduncle length, AL: axis length, ANN: axis node number, GFY/P: green fodder yield per plant, DFY/P: dry fodder yield per plant, DrM%:dry matter per cent, SY: seed yield, HSW: hundred seed weight, SL: seed length, SW: seed width.

TABLE 3
Mean performance of oat genotypes for yield and its component traits

S. No.	Genotypes	TPP	PL	AL	ANN	GFY/P	DFY/P	DrM (%)	SY	HSW	SL	SW
1.	HFO 33	6.4	33.9	29.8	7.0	178.6	30.0	16.5	103.0	2.6	13.0	2.0
2.	HFO 41	5.4	25.0	32.3	6.9	173.8	28.7	15.5	157.7	3.2	12.0	2.1
3.	HFO 47	5.8	41.3	34.9	7.0	197.9	31.9	16.2	99.0	3.2	14.3	2.3
4.	HFO 49	6.2	32.7	23.8	6.3	183.8	30.4	16.6	124.0	3.3	14.0	2.4
5.	HFO 50	7.4	29.1	35.0	7.2	187.8	32.3	17.3	132.0	3.2	19.0	2.7
6.	HFO 52	6.5	25.7	33.1	6.4	174.7	29.7	15.7	56.7	2.2	16.0	3.0
7.	HFO 53	5.8	26.7	25.6	5.9	167.4	26.6	15.7	70.0	3.2	17.0	3.1
8.	HFO 55	5.8	29.3	32.3	7.7	176.8	30.4	17.1	48.0	3.3	15.0	2.3
9.	HFO 56	6.6	31.2	29.3	7.8	176.8	28.4	15.0	45.0	2.4	13.3	1.0
10.	HFO 58	5.3	29.4	36.8	7.1	168.8	29.7	18.6	65.3	3.5	15.0	1.0
11.	HFO 59	6.5	29.2	30.1	5.3	182.4	31.4	21.1	152.3	2.7	16.0	2.5
12.	HFO 60	5.4	23.4	31.7	7.1	167.5	28.4	16.2	131.7	3.4	12.3	3.0
13.	HFO 103	5.8	35.9	32.1	7.2	166.4	29.2	16.5	88.0	2.4	14.3	3.1
14.	HFO 114	6.2	28.0	28.1	5.0	175.5	30.5	20.2	62.7	3.5	18.0	3.0
15.	HFO 233	5.4	29.2	35.1	8.1	175.8	30.7	21.6	72.7	4.2	17.0	3.0
16.	HFO 239	6.5	26.4	30.0	6.8	149.6	28.7	20.4	56.0	2.3	16.0	2.0
17.	HFO 305	5.8	26.4	27.0	6.2	176.4	31.3	17.8	71.7	3.2	13.0	2.9
18.	HFO 306	5.1	34.7	26.6	6.4	191.4	31.7	16.6	42.3	3.4	14.3	1.1
19.	HFO 307	5.8	23.7	25.8	6.4	174.7	30.7	18.1	132.0	3.2	18.0	2.1
20.	HFO 346	5.5	28.0	34.6	7.4	202.3	30.7	15.3	87.7	4.3	15.0	2.0
21.	HFO 476	7.4	25.4	31.3	7.6	180.7	31.4	27.6	81.3	2.7	16.3	2.0
22.	HFO 488	5.4	27.2	38.4	8.0	179.7	32.7	21.1	152.0	4.4	17.0	3.1
23.	HFO 489	5.5	24.9	30.3	7.2	173.5	28.5	18.3	61.7	4.3	15.0	2.2
24.	HFO 490	5.4	34.3	30.4	6.4	171.6	30.7	18.3	241.0	2.7	16.3	2.0
25.	HFO 502	6.8	25.7	32.1	6.9	176.3	31.6	18.8	164.3	3.6	15.0	2.7
26.	HFO 503	7.4	29.9	29.8	7.4	178.3	31.3	22.6	174.0	3.4	14.0	2.3
27.	HFO 512	6.8	21.0	25.2	5.8	186.7	34.5	24.7	123.0	3.3	15.0	2.2
28.	HFO 513	6.4	20.6	30.2	6.9	146.6	26.4	21.6	66.0	3.2	14.0	2.3
29.	HFO 681	7.7	37.0	31.8	6.2	178.6	32.4	18.2	106.0	3.3	16.0	3.3
30.	HFO 682	5.7	40.4	25.8	8.1	182.8	33.1	19.8	134.7	3.4	14.0	2.7
31.	HFO 684	6.5	30.3	36.1	6.4	151.7	29.7	20.6	103.0	3.5	17.0	2.7
32.	HFO 685	5.5	28.6	27.1	5.9	155.6	28.7	19.5	163.7	4.0	17.0	3.1
33.	HFO 716	6.5	19.6	22.4	6.1	140.2	27.4	21.8	133.3	3.4	14.0	2.9
34.	HFO 833	6.5	32.0	32.6	6.9	182.7	31.7	22.5	106.7	3.3	19.0	3.0
35.	HFO 834	7.2	26.6	33.0	7.6	183.5	33.3	16.5	100.0	3.6	12.3	1.0
36.	HFO 864	5.8	30.6	30.0	5.9	155.9	29.7	20.0	74.7	3.2	17.0	2.0
37.	HFO 867	7.8	18.6	23.8	5.2	195.4	32.4	18.2	151.7	4.5	15.0	2.8
38.	HFO 868	5.8	29.8	30.7	7.0	180.4	33.7	20.7	119.0	2.2	14.0	2.2
39.	HFO 870	5.7	23.4	29.8	7.2	181.5	33.4	21.3	159.7	3.2	16.0	2.8
40.	ALGERIAN	6.5	15.3	33.3	6.8	182.5	32.2	19.8	68.0	3.2	13.0	2.3
41.	JHO 851	5.7	29.7	33.3	7.2	180.6	31.4	18.4	111.0	3.3	15.0	2.7
42.	JO 1	5.7	30.9	35.1	6.9	175.7	27.3	14.5	87.3	3.7	15.3	2.2
43.	PLP 1	5.2	23.7	21.3	5.0	166.0	26.7	15.5	40.3	2.2	14.3	2.1
44.	UPO 212	7.4	27.7	33.2	6.9	187.7	31.7	17.3	124.7	3.3	16.3	2.7
45.	KENT	7.5	30.1	37.4	7.3	181.7	31.3	17.6	123.0	3.3	16.3	2.0
46.	OS 6	6.6	33.2	29.8	6.9	176.4	28.1	15.0	104.0	3.5	17.0	1.8
47.	OS 7	5.4	28.3	34.3	6.9	184.7	30.1	16.4	45.3	3.3	16.3	2.7
48.	OS 377	6.5	25.1	21.2	4.8	185.7	32.3	21.5	71.7	3.2	18.0	4.0
49.	OS 403	6.8	27.4	38.0	7.4	182.4	31.3	17.2	53.3	3.3	12.3	1.7
50.	HJ 8	5.4	31.9	32.4	7.4	223.3	32.2	14.4	56.3	4.4	15.0	2.3
	Mean	6.2	28.4	30.7	6.8	177.1	30.6	18.5	102.0	3.3	15.3	2.4
	SE(m)	0.4	0.9	0.6	0.2	5.0	1.2	0.8	1.3	0.1	0.6	0.2
	CV	11.9	5.3	3.4	7.6	4.9	7.0	7.6	2.2	2.7	6.2	14.0

Character details are given in Table 2.

The estimation of heritable and non-heritable components in the total variability observed was crucial for the adoption of suitable breeding programmes. The heritable component could be assessed by studying phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and predicted genetic advance. The magnitude of phenotypic coefficient of variance was higher than genotypic coefficient of variance for all the characters studied indicating the importance of environment on the expression of these characters. Similar results were found by Kumar *et al*. (2016). The highest estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for seed yield per plant, seed width, flag leaf width, peduncle length, 100-seed weight and dry matter per cent (Table 4). So, selection for these characters would be effective for the improvement of yield in oat.

Moderate estimates of GCV and PCV were observed for traits like plant height at fodder stage, leaf length, leaf length, number of nodes on the main tiller, axis length, axis node number, dry matter per cent and seed length. Low GCV and PCV were estimated for days to 50 per cent flowering, days to maturity, leaves per plant, culm diameter, flag leaf length, tillers per plant, plant height at maturity and green fodder yield per plant (Table 4). Similar findings were reported by Bibi *et al*. (2012), Chakraborty *et al*. (2014) and Surje and De (2014) for one or more characters. Bind *et al*. (2016) found low GCV and PCV for days to flowering and days to maturity which supported the present findings. Dubey *et al*. (2014) recorded low GCV and PCV for traits like leaves per plant, tillers per plant and axis length, while moderate GCV and PCV for dry matter yield per day. PCV and GCV relatively showed very small difference. A close proximity between GCV and PCV indicated very less influence of environment on the expression of the characters. This was supported by the findings of Surje and De (2014). GCV together with heritability and genetic advance was considered as good estimates of genetic gain to be expected from selection on phenotypic basis.

A trait having high heritability and high genetic advance highlighted the usefulness of plant

TABLE 4

Mean, range, coefficient of variation (phenotypic and genotypic), heritability, and genetic advance as per cent of mean for various traits in oat

Characters	Mean	Range		Coefficient of variation (%)		Heritability % (Broad sense)	Genetic advance as per cent of mean
		Min.	Max.	Genotypic	Phenotypic		
PHF	103.90	65.19	124.25	11.10	13.09	71.81	19.37
DF	93.37	90.33	103.00	2.41	2.98	95.36	4.02
LPP	39.22	34.20	45.42	5.87	9.33	89.58	7.61
FLW	2.04	1.27	3.01	16.32	17.87	83.41	30.70
FLL	37.25	29.49	46.81	7.17	9.23	80.40	21.15
LL	47.38	32.00	54.33	11.78	13.53	75.87	24.02
LW	2.25	1.43	3.03	11.51	17.44	83.54	25.64
CD	6.19	4.99	6.94	6.48	8.29	81.09	10.43
NODES	5.67	4.00	6.78	10.05	10.51	91.47	19.81
DM	120.09	113.33	123.00	1.49	2.13	98.88	2.14
PHM	120.63	86.23	138.30	7.93	9.15	75.10	14.16
TPP	6.18	5.12	7.76	9.56	15.29	90.00	42.33
PL	28.36	15.33	41.33	17.16	18.51	91.97	35.08
AL	30.68	21.22	38.44	13.67	14.10	94.04	27.34
ANN	6.75	4.78	8.11	11.03	13.41	87.77	18.71
GFY/P	177.12	140.18	223.32	7.41	8.89	69.50	28.92
DFY/P	30.57	26.41	34.45	6.96	12.80	56.50	7.78
DrM%	18.54	14.42	27.64	14.39	16.29	77.97	26.19
SY	101.96	40.33	241.00	27.46	28.80	77.60	40.90
HSW	3.28	2.20	4.50	17.33	17.53	97.69	35.28
SL	15.31	12.00	19.00	10.79	12.49	74.62	19.02
SW	2.41	1.00	4.03	24.11	28.05	75.11	43.04

Characters details are given in Table 2.

selection based on phenotypic performance. The high estimates of heritability (broad sense) were recorded for almost all the characters studied. The findings are in accordance with earlier findings of Chakraborty *et al*. (2014), Dubey *et al*. (2014) and Bind *et al*. (2016). Also, genetic advance as per cent of mean was high for characters like flag leaf width, flag leaf length, leaf length, leaf width, tillers per plant, peduncle length, axis length, green fodder yield per plant, dry matter per cent, seed yield, 100-seed weight and seed width, while the estimates of genetic advance as per cent of mean were moderate for plant height, number of nodes on the main tiller, axis node number and seed length (Table 4) indicating that the improvement of these through selection as well as their exploitation through combination breeding. However, the estimates of high heritability coupled with high genetic advance were observed for the characters viz., flag leaf width, flag leaf length, leaf length, leaf width, tillers per plant, peduncle length, axis length, green fodder yield per plant, dry matter per cent, seed yield, 100-seed weight and seed width suggesting that simple selection could be done for the improvement of these traits in the existing material. Sangwan *et al.* (2012) observed high heritability with high genetic advance for tillers per plant and green fodder yield. Chakraborty *et al*. (2014) observed high heritability along with high genetic advance for characters like green fodder yield, 100-seed weight and seed yield per plant. These results indicated the scope for selection in these characters.

Based on the results of this study, it was suggested that the genotypes HFO 47, HFO 50, HFO 306, HFO 346, HFO 512, HFO 834, HFO 867, HJ 8, OS 7 and OS 377 were selected as promising genotypes for green fodder yield, whereas HFO 47, HFO 50, HFO 306, HFO 346, HFO 488, HFO 512, HFO 834, HFO 867, HFO 868, HFO 870, HJ 8 and OS 377 had high dry fodder yield. So, these genotypes can be selected for further breeding programmes to enhance the fodder yield.

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