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CONTENTS

Evaluation of seed quality parameters in forage oat (*Avena sativa* l.) germplasm

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ABSTRACT: Oat (*Avena sativa* L.) is used throughout the world for human food and animal feed, and it is frequently grown as a dual-purpose crop (grain harvest after grazing or forage cutting). To examine the seed quality of an oat germplasm an experiment was conducted in seed Testing Laboratory of BSPC, GBPUAandT, Pantnagar, Uttarakhand with 57 oat germplasm (54 germplasm+3 check) in three replication using completely randomized block design (CRBD). The observation was recorded for fifteen quantitative traits. The present findings revealed that there are significant differences among all genotype under study for different seed quality parameters. seedling shoot length showed maximum value for genotype EC-2660 (16.55cm), followed by M-27(16.4cm). Similarly genotypes EC-2660 (34.73cm) also showed maximum value for seedling length followed by M-27(33.17cm). Whereas germplasm D-1394(2.85g) and EC-43555 (2.34g) showing high value for the trait seedling fresh weight. These findings revealed that EC-2660, M-27, D-1394 and EC-43555 are superior for fodder purpose as they are showing high biomass and weight. Whereas, OX-503, EC-35199, M-72, EC-2660, M-27, D-1394, EC-43555, OX-559, OX-1090 and EC-2874 were identified as superior in overall performance with respect to all quality parameters. Hence, they can be utilized in further breeding program for developing high fodder yielding varieties.

Key words: Fodder, germplasm, oat, seed quality parameter

Oat (*Avena sativa* L.) is an important annual crop that belongs to the Poaceae family. It is one of the most utilized winter forage crops and is widely grown by marginal farmers across the world. The crop has been adopted well because of its multipurpose nature, i.e., crop for pasture, forage, and grain which is considered to be one of the best dual-purpose cereal crops that fit well into the platter of human and cattle as well. FAO (2021) stated that oat ranked seventh in world cereal production after wheat, rice, maize, barley, sorghum, and millets but it was neglected for a long time despite its high nutritious values. Concerning most staple cereals, oat grains are rich in lipids, quality proteins, dietary fiber, phenolic as well as have high antioxidant properties (±-tocotrienol, ±- tocopherol, and avenanthramides) (Vilmane *et al.*, 2015; Chen *et al.*, 2017). In recent years, with the dawn of exaggerated dairy industry over the globe, the oat has fascinated the attention of breeders for its improvement due to its nutritionally enriched fodder for livestock and its grains as an animal feed with high net energy gains (Ruwali *et al.,* 2013; Jaipal and Shekhawat, 2016). seed plays a vital role in sustainable growth of agriculture because it is basic and primary material for propagation. seed has many qualities and on the basis of these qualities seed should be characterized or evaluated in laboratory conditions before their sowing. The ultimate aim of testing seeds for germination and vigour is to gain information with respect to planting value of seed under field condition and obtained results can be used for comparison among different germplasm. A germination test determines the percentage of seeds that are alive in any seed lot. By knowing the germination rate, farmers can adjust their planting rates to attain the desired plant population in the field.

MATERIALS AND METHODS

The present investigation was carried out at the seed testing laboratory of G.B. Pant University of Agriculture and Technology, Pantnagar (Udham Singh Nagar), Uttarakhand. The completely randomized design was used for evaluating 57 oat germplasm. Germination test was conducted in three replication each containing 100 seeds taken randomly from each germplasm. seeds were kept in between paper (B.P.) media. Then the samples were placed at 20^0C in germinator. Only normal seedlings were counted on the 5^{th} day and 10^{th} day of test.

Observation was taken for days to first count (%), standard germination (%), seedling root length(cm), seedling shoot length(cm), seedling length(cm), seedling fresh weight(g) and seedling dry weight(g). After that other seed quality parameters were calculated –

seedling vigour index

The seedling vigour index was calculated by two different methods (Abdul Baki and Anderson, 1973).

(a) seedling vigour index-I=
Standard germination (%) × seedling length (cm)

(b) seedling vigour index- II =
Standard germination (%)× seedling dry weight (mg)

Speed of germination

In this test, three replications of 100- seeds were taken from each treatment and placed in between paper (B.P.) media and then kept at 20^0 C in germinator. After the seed start to germinate, they were examined daily at approximately the same time each day. Normal seedlings were removed from the test when they reached a predetermined size. This procedure was continued until all seed that were capable of producing a normal seedling had germinated. An index was computed for each treatment by dividing the number of normal seedlings removed each day by the corresponding day of counting.

Relative growth index (RGI)

Relative growth index was calculated according to the evaluation of Brown and Mayer (1986) as under:

$$RGI=\frac{\text{No. of seed germinated at I count}}{\text{No. of seed germinated at Final count}}\times 100$$

Germination index (GI)

Germination index (GI) was computed as described in the association of official seed Analysts (1983) using the following formula:

$$GI=\frac{\text{No. of germinated seeds}}{\text{Days of first count}}+....+\frac{\text{No. of germinated seed}}{\text{Days of final count}}$$

(MGT)

Mean germination time (MGT) was calculated by the formula given by Ellis and Roberts (1981) as under:

$$MGT = \frac{\Sigma Dn}{\Sigma n}$$

Where, n is the number of seeds which were germinated on day D, and D is the number of days counted from the start of germination.

Mean daily germination

To estimate the mean daily germination the following formula was used:

$$MDG=\frac{\text{Final Germination \%}}{\text{Total no. of days}}$$

Time to 50% germination (T_{50})

The time to 50% germination (T) was calculated according to the following formula of Coolbear *et al.* (1984) modified by Farooq *et al.* (2005) as under:

$$(T_{50})=ti+\frac{\left[\frac{N}{Z}-ni\right](tj-ti)}{nj-ni}$$

Where, N is the final number of germination and n_i, n_j cumulative number of seeds germinated by adjacent counts at time t_i and t_j when $n_i<N/2<n_j$.

Statistical analysis was done following Completely Randomized Design (CRD) for all laboratory tests. OPStat Excel version software package was used for statistical analysis and performed using a one-way analysis of variance (ANOVA) of individual characters/traits (Sheoran *et al.*, 1998) and results were considered statistically significant at p<0.01.

RESULTS AND DISCUSSION

Analysis of variation revealed highly significant variation among the germplasm for all the parameter studied. The analysis of variation for Complete Block Design for all the seed quality parameter in different germplasm of oat is presented in Table 1.

The germination at first count for different genotypes and check varieties varied significantly and ranged from 43.33% to 92.33%. The significantly highest value was recorded for OX-559 and the lowest value for this character was noted for EC-2818 with overall mean 72.70 (Table 2).

The ultimate count of germination varied from 53.33% to 100%. With an aggregate mean of 88.17, EC-2874 had the substantially highest value (100%) and EC-2818 had the lowest value (53.33%) for this character. The value ranged from 12.07 cm to 19.67 cm with a mean of 16.17 cm for seedling root length. OX-503 had the highest value for this character, and EC-9655 had the lowest value (12.07). The length of the seedling shoot varied from 10.60 cm to 16.55 cm, with a mean of 13.60 cm. The highest recorded value for this character was EC-2660 (16.55), while the lowest recorded value was EC-131240.The value for seedling length ranged from 25.17 cm to 34.73 cm, with a mean value of 29.77. The character's maximum value was recorded at EC-2660 (34.73 cm), and its shortest value was at OL-1325 (25.17 cm). From 0.97 g to 2.85 g, seedling fresh weight varied substantially. The highest value, which was significantly greater than all other germplasm, was recorded in D-1394 (2.85g), while the lowest value, which was recorded in OX-882 (0.97g), was noticed. The character's overall mean was 1.83g. Dry seedling weight ranged widely from 0.08 g to 0.30 g. While OL-125 had the lowest value (0.08g), EC-117406 had the highest value (0.30g), which was much greater than any other germplasm. The character's overall mean was 0.179 g. The vigour index I value ranged widely between 1409.53 to 3220.23. While EC-6269 (3216.23) had the highest value, which was much greater than all other germplasm, EC-2818 (1400.53) had the lowest value. The character's total mean was 2626.15. The vigour index II ranged widely in value from 7.49 to 26.89. The maximum value, which was significantly greater than all other germplasm, was found in EC-107022 (26.89), while the lowest value, which was found in OL-125 (7.49), was noted. The character's total mean was 15.78. Values for the relative growth index ranged widely, from 63.95 to 93.65. Algerion had the lowest value (63.95), whereas EC-96583 had the highest (93.65), which was much higher than all other germplasm. The character's total mean was 82.18. Values for the germination index ranged widely from 10.10 to 19.50. The maximum value, which was significantly greater than all other germplasm, was found in OX-559 (19.50), while the lowest value, which was found in EC-2818 (10.10), was recorded. The character's total mean was 16.79.

The range of the mean germination time, from 3.81 to 5.17, was quite wide. OX-481 had the highest value (5.17), which was significantly greater than all other germplasm, and M-27 had the lowest value

Table 1: Analysis of variance for different seed quality parameters of oat germplasm

Character	Mean sum of square	
	Treatments	Error
Degree of freedom	56	114
Shoot length	6.19225**	0.44
Root length	8.68952**	1.21
seedling length	16.46261**	1.73
seedling fresh weight	0.426818**	0.76
seedling dry weight	0.953297**	0.29
First count	498.5960**	28.82
Standard germination	412.2761**	18.60
seedling Vigour index-I	504742.1**	34245.98
seedling vigour index-II	82.80792**	27.86
Relative growth index	172.3043**	25.73
Germination index	16.67071**	0.68
Mean germination time	0.32790**	0.57
Mean daily germination	4.11296**	0.19
Speed of germination	35.1229**	1.78
T_{50} value	0.2411339**	0.22

**Significant at P= 0.01

Table 2: Range and mean performance of seed quality parameters

Character	Range	Mean
First count (%)	43.33-92.33	72.70
Standard germination (%)	53.33-100	88.17
Root length(cm)	12.07-19.67	16.17
Shoot length(cm)	10.60-16.55	13.60
seedling length(cm)	25.17-34.73	29.77
Fresh weight(g)	0.97-2.85	1.83
Dry weight(g)	0.08-0.30	0.179
seedling Vigour index-I	1409.53-3220.23	2626.15
seedling vigour index-II	7.49-26.89	15.78
Relative growth index	63.95-93.65	82.18
Germination index	10.10-19.5	16.79
Mean germination time	3.81-5.17	4.50
T 50 value	3.3-4.8	3.9
Mean daily germination	5.30-10	8.79
Speed of germination	12-26.2	20.6

Table 3: Mean performance of oat germplasm for Standard germination (%), Vigour index-I, Vigour index-II, R.G.I , G.I. Mean germination time, Mean daily germination, Speed of germination and T50 value

S. No.	Germplasm	Standard germination (%)	Vigour index-I	Vigour index-II	Relative growth index	Germination index	Mean germination time	Mean daily germination	Speed of germination	T50 value
1	EC6269	98.33	3220.23	16.23	74.38	18.35	4.68	9.80	22.5	4.0
2	EC-9655	93.33	2381.33	14.10	88.26	17.80	4.38	9.30	22.8	3.5
3	EC-9884	97.33	2849.13	16.16	79.36	18.42	4.56	9.70	22.9	3.8
4	EC-16195	96.33	2860.77	18.83	71.79	17.89	4.87	9.60	20.9	4.2
5	EC-22023	91.33	2634.03	21.64	77.08	16.76	4.74	9.10	20.7	4.0
6	EC-24900	98.33	3066.33	19.32	82.75	18.72	4.48	9.80	23.4	3.7
7	EC-35199	96.33	3029.93	19.82	83.45	18.36	4.51	9.60	22.7	3.7
8	EC-43555	65.33	2037.80	15.36	91.03	12.73	4.26	6.50	15.8	3.8
9	EC-57651	59.33	1869.90	8.56	75.33	11.07	4.76	5.90	13.9	3.9
10	EC-57662	91.33	2796.67	12.06	84.69	17.46	4.60	9.10	20.6	3.9
11	EC-61704	95.33	3012.80	25.31	86.47	18.35	4.35	9.50	23.2	3.7
12	EC-62355	88.33	2611.70	8.48	87.50	17.11	4.15	8.80	22.4	3.5
13	EC-79813	88.33	2787.87	12.08	84.19	16.79	4.62	8.80	20.2	4.3
14	EC-87444	95.33	3061.30	23.70	88.50	18.58	4.14	9.50	24.1	3.5
15	EC-96583	96.33	3017.83	16.41	93.65	18.83	3.96	9.60	25.4	3.4
16	EC-107022	94.33	2880.37	26.89	90.35	18.44	4.29	9.40	22.9	3.7
17	EC-108451	85.33	2548.27	7.81	86.68	16.51	4.47	8.50	20.1	3.8
18	EC-108636	96.33	2844.93	8.81	95.83	18.98	3.98	9.60	25.1	3.5
19	EC-108656	89.33	2520.53	8.76	71.13	17.04	4.90	8.90	19.8	4.1
20	EC-117406	79.33	2487.53	24.03	83.76	14.97	4.35	7.90	18.7	3.9
21	EC-130643	97.33	3008.60	16.51	79.36	18.42	4.44	9.70	23.9	3.9
22	EC-131240	72.33	1838.60	11.71	76.41	13.50	4.92	7.20	15.4	4.2
23	EC-131306	92.33	2677.77	15.37	90.21	18.03	4.08	9.20	23.8	3.4
24	EC-131313	95.33	3004.67	20.07	89.40	18.44	4.12	9.50	24.5	3.6
25	EC-605833	93.33	2550.50	12.15	87.09	17.94	4.31	9.30	22.9	3.7
26	EC-155073	71.33	2339.60	15.49	84.66	13.67	4.42	7.10	17.0	3.9
27	EC-159606	94.33	2867.70	16.51	84.04	18.06	4.33	9.40	23.2	3.9
28	EC-196071	91.33	2872.97	21.76	88.00	17.63	4.22	9.10	22.8	3.9
29	EC-2660	85.33	2974.00	21.58	86.37	16.46	4.42	8.50	20.7	3.6
30	EC-4830	68.33	2102.50	8.51	72.94	12.71	4.86	6.80	15.7	3.6
31	EC-2818	53.33	1409.53	12.40	80.91	10.10	4.58	5.30	12.0	3.8
32	EC-2874	100.00	2660.00	21.10	78.00	18.89	4.53	10.00	23.9	4.2
33	EC-KENT	91.33	3001.27	21.84	75.44	17.08	4.89	9.10	19.3	4.4
34	D-1394	71.33	2033.47	13.92	81.95	13.46	4.70	7.10	15.9	3.9
35	Fulgham	99.00	2840.77	19.85	86.94	19.16	4.43	9.90	23.7	3.9
36	M-72	96.33	3049.33	18.21	70.69	17.88	4.92	9.60	20.6	4.3
37	Algerion	86.33	2490.53	23.27	63.95	15.80	5.16	8.60	17.3	4.8
38	OX-481	68.33	1978.30	10.83	66.22	12.36	5.17	6.80	13.8	4.4
39	OX-503	99.00	2563.83	24.74	76.46	18.54	4.75	9.90	21.6	4.2
40	EC-159602	97.33	3217.93	21.17	73.13	18.13	4.79	9.70	21.8	4.0
41	OX-435	97.33	2542.53	15.53	82.55	18.61	4.43	9.70	23.1	3.8
42	OX-559	99.00	3067.07	10.90	92.98	19.50	4.24	9.90	24.2	3.8
43	OX-882	92.33	2954.57	8.08	86.96	18.40	3.95	9.20	18.4	4.1
44	OX-1275	94.33	2768.60	17.36	90.42	18.45	4.41	9.40	22.2	4.0
45	OX-1165	96.33	2573.57	14.74	87.50	18.58	4.11	9.60	24.5	3.6
46	OX-1090	99.00	2854.97	17.32	90.88	19.24	3.94	9.90	26.2	3.3
47	M-27	95.33	3162.40	8.32	89.59	18.46	3.81	9.50	21.2	3.5
48	NO 982	79.33	2188.53	8.72	78.53	14.56	4.73	8.30	17.8	4.0
49	NO1310	80.33	2393.87	17.23	81.25	15.14	4.65	8.00	18.1	4.0
50	NO-1003	88.67	2662.47	13.49	76.14	16.47	5.03	8.80	18.3	4.1
51	OL-125	93.33	2436.53	7.49	75.48	17.37	4.84	9.30	20.1	4.2
52	OL-1325	98.33	2474.80	9.34	86.73	18.89	4.19	9.80	24.7	3.8
53	UPO-276	90.33	2595.77	12.54	66.70	16.60	5.07	9.00	19.7	3.9
54	EC605838	69.33	2056.60	16.41	72.60	12.92	4.89	6.90	14.6	4.0
55	upo-94	94.33	3058.83	21.73	90.35	18.08	4.45	9.40	22.2	3.8
56	kent	74.33	1848.20	15.92	90.37	14.36	4.22	7.40	18.1	3.7
57	UPO-212	64.33	2050.23	13.00	77.12	11.94	4.61	6.40	14.8	4.1
	GM	88.17	2626.15	15.78	82.18	16.79	4.50	8.79	20.6	3.9
	SEM(±)	2.49	106.84	1.00	2.93	0.48	0.14	0.25	0.8	0.9
	CD(0.05)	6.98	299.33	2.79	8.20	1.34	0.39	0.70	2.2	0.2
	CD(0.01)	9.23	395.85	3.69	10.85	1.77	0.51	0.93	2.8	0.3

(3.81). The character's total mean was 4.50. Between 3.3 and 4.8, T50 values showed a significant range. Algerion had the highest value (4.8), which was noticeably greater than all other germplasm, while OX-1090 had the lowest value (3.3). The character's total mean was 3.9. Between 5.30 and 10, there were considerable variations in the mean daily germination levels. While EC-2818 (5.30) had the lowest value, EC-2874 (10), which had the maximum value, had significantly higher values than any other germplasm. The character's total mean was 8.79. The range for the speed of germination was a wide 12 to 26.2. While EC-2818 had the lowest value, the highest value was found in OX-1090 (26.2), which was much greater than all other germplasm. The character's total mean was 20.6.

The present findings revealed that there are significant differences among all genotype under study for different seed quality parameters. Germination at first count and Standard germination (%) showed maximum variation for different oat germplasm under study. This differential behavior of different germplasm seed indicated that the germination at first count of seed and standard germination (%) was affected by diversity in genetic constitution of different line. Kanta *et al.* (2002) results for first count (%) and standard germination are in agreement to the results under study. seedling shoot length showed maximum value for genotype EC-2660 (16.55cm), followed by M-27(16.4cm) indicate that these genotypes will be good for fodder purpose if they will grow in field. Differential bio-membrane metabolism of different genotypes leading to germinate differently and trend in variation observed. Simmilar findings have also been given by Arivazhagen and Kadarmohideen (2006) in French bean, Patil *et al.* (1999) while working on finger millet, Willenborg *et al.* (2005) in oat, Mao *et al.* (2013) in oat and Kumar *et al.* (2016) in oat germplasm.

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CONCLUSION

Various seed quality parameters were assessed and analysis of variance revealed significant difference among genotype for all the trait studied. The mean performance and range of variation for different seed quality characters of genotypes showed a higher extent of variability. Germination at first count and Standard germination (%) varied significantly for different oat germplasm under study. This differential behavior of different germplasm seed indicated that the germination at first count and germination at final count of seed was affected by diversity in genetic constitution of different line. Similarly, seedling shoot length, root length, seedling length, fresh weight, dry weight, vigour index, relative growth index, germination index, mean germination time, mean daily germination, speed of germination and T50 value also varied significantly for different oat germplasm line. EC-2660, M-27, D-1394 and EC-43555 are superior for fodder purpose as they are showing high biomass and weight. Whereas OX-503, EC-35199, M-72, EC-2660, M-27, D-1394, EC-43555, OX-559, OX-1090 and EC-2874 were identified as superior in overall performance with respect to most of the seed quality parameters. Hence these lines may be utilized in further breeding program for developing greater biomass yielding and earliness varieties. Genotypes EC-2660, OX-503, EC-35199, M-72, D-1394, OX-559, OX-1090, EC-2874, M-27, EC- 43555 were identified as superior in overall performance with respect to quality parameters. Hence, they can be utilized in further breeding program for developing high yielding and high-quality fodder varieties.

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