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Agro-Morphological Characterization of Oat Genotypes Under Climatic Conditions of Tandojam

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Abstract

The current study was conducted at Agronomy Section, Agriculture Research Institute, Tandojam during the growing season of 2019-20, to assess new oat genotypes for their growth performance under the environmental conditions of Tandojam. For this study, a total of eleven new oat genotypes along with one check genotype were grown for their evaluation. A total of seven characters consisting crop stand (m^{-2}), plant height (cm), leaves plant^{-1}, number of tillers plant^{-1}, leaf area (cm^{-2}), green fodder and dry mater yield (t ha^{-1}) were investigated. The mean squares values for the investigated traits of all the genotypes were found significantly different ($P \leq 0.05$) among the genotypes, which shows that these genotypes possess valuable genetic combinations for further improvements. Under the agro-climatic conditions of Tandojam, the maximum crop stand (96.66 m^{-2}), greater green fodder (86.00 t ha^{-1}) and also maximum dry matter yield (43.00 t ha^{-1}) was produced by Entry-D; the Entry-H produced the tallest plants (96.66 cm) and maximum number of leaves plant^{-1} (68.00). Whereas Entry-F produced maximum number of tillers plant^{-1} (17.66). Hence, these oat genotypes may be preferred for commercial cultivation in the tested climatic conditions. Regarding correlation results, the traits crop stand ($r=0.93^{**}$), tillers plant^{-1} ($r=0.39^{*}$) and leaf area ($r=0.38^{*}$) showed significant and positive associations with green fodder yield, hence these characters may be given priority in high yielding oat cultivar development.

Keywords: Correlation, green fodder yield, growth traits, Oat, Pakistan

Introduction

Oat (*Avena sativa* L.) is regarded as one of the important cereal crops, which is mainly cultivated for food and feed. In comparison with other cereal crops, oat is tagged as the most useful for marginal conditions, such as cool-wet areas and less fertile arid soils (Buerstmayr *et al.*, 2007). The oat is ranked 5th in the globe and is proper and adequate feed for livestock (Shaker *et al.*, 2016). According to Welch (2012), the oat crop is primarily used as grain feed for livestock, showing an average about 74% of the world's total use and may also be used as green forage or silage, and overcoming the dearth period of the fodder of year. Oat genotypes are also great source for food protein, fibre, vitamins, carbohydrates and mineral elements, which show great beneficial to health. In Pakistan, the livestock are normally deficient in protein (60%) and energy (40%). So, running the livestock industry more efficiently, the superior quality of forage is the prerequisite (Sial and Aalam, 1988). Recently, Kaziu *et al.* (2018) reported that oat landraces are well adapted in our climatic conditions, however, these genotypes do not show good response to improved management practices hence low production is resulted. Thus, the evolving of new high yielding oat genotypes is quite important. The advancement in modern practices, improvement in natural resources, and superior genotype selection with desirable characteristics tended to increase the yield in recent times. The inaccessibility of fodder crops is a main problem, which decrease the livestock productivity, and consequently, there will be dropping in number of livestock animals to rear. Therefore, the diversification of fodder production is necessary to assist the animal production (Shaker *et al.,* 2016). In winter, the farmers face fodder shortage except having only dry stalks of previous season's grasses. The advanced oat genotypes can produce multifold green fodder, which is almost 70 to 80 tons per hectare and double number of animals can feed per unit area against the oat landraces (Haqqani *et al.*, 2003). Several oat varieties tend to possess greater feed values, while cutting at flowering stage or soon after this growth phase and it can meet the demand that is required by fast increasing Pakistan's livestock industry. Ideal cultivars are those, which retain wider adaptation with higher potential in yield (Khan *et al.,* 2014). The production of fodder and fodder species heavy rely on the climatic cues, such as temperature, frost, water availability, winter duration, length of growth period and rainfall distribution, whereas soil factors including texture and structure also play a key role (Bruzon, 2007). Oat being the winter catch crop, is preferred to feed all kind of animals, while possessing soft straw and grain, which are feed to dairy cows, young animals, horses, and poultry (Khan *et al.,* 2014). Correlation analysis is a useful method for determining the association between various traits in a genetically diverse population in order to maximize crop improvement (Kandel *et al.,* 2018; Dhami *et al.,* 2018). In plant breeding, the correlations are very important because of its reflection in dependence degree between two or more traits. Correlation analysis shows the intensity of dependence (correlation) between studied traits. In crop breeding, the breeders mostly elucidate the relationship between agronomic and morphological traits by using simple correlation (Kharel *et al.,* 2018). Hence, a field investigation with eleven oat entries was carried out for evaluating and identifying the suitable oat varieties and also to find out the characters for selection criteria of evolving high yielding oat cultivars.

Materials and Methods

This study was conducted at Agronomy, ARI, Tandojam in the growing season of 2019-20 to evaluate new oat genotypes in the Tandojam environment in terms of their growth. The oat genotypes were provided by National Agriculture Research Center, Islamabad, Pakistan. In randomized complete block design, the experiment was conducted with three replications of 1.8 m x 6.0 m plot size and with 6 rows per plot. A seed rate of 80 kg ha^{-1} was used, whereas NPK nutrition was applied at the rate of 75-50-00 Kg ha^{-1} by using DAP, respectively. The plant to plant and row to row distance was maintained as 15 and 30cm, respectively. Five plants were selected as index plants per replication per genotype for recording morphological data at the time of maturity. A total of twelve new oat genotypes were used and as tagged from Entry-A to Entry-L. The soil was categorized as silty clay loam with 7.9 pH. The analysis of various, least significant test and correlation analysis was carried out though the computer software of Statistix Ver. 8.1.

Results and Discussion

The mean squares of all the genotypes were significantly different ($P \leq 0.05$) with respect to all investigated characters including crop stand, plant height, leaves $plant^{-1}$, tillers $plant^{-1}$, leaf area, green fodder and dry matter yield, showing that these oat genotypes possess valuable genetic combinations for further improvements. Similarly, other research workers (Mut *et al.*, 2015; Ali *et al.*, 2016; Shaker *et al.*, 2016) also noticed significant differences for different morphological characters between various oat genotypes. The crop stand differed from 66.00 to 96.66 m^{-2}; however, the maximum crop stand was produced by Entry-H (96.66 m^{-2}), while the minimum crop stand of 66.00 m^{-2} was found in Entry-J and an average of 81.00 m^{-2} was noted (Table 2). The plant height ranged from 68.00 to 96.66 cm. The tallest plants were noted in Entry-D (96.66 cm), followed by Entry-J (96.66 cm) and Entry-B (92.53). The shortest plants measuring plant height of 66.00, 72.66 and 73.66 cm in the Entries of G, H and F, respectively. On an average plant height of 82.65 cm was noted (Table 2). High yielding oat varieties show more plant height (Zaman *et al.,* 2006; Ayub *et al.*, 2011; Khan *et al.*, 2014). The main reason for such variations in plant height is the difference in genetic constitution of oat genotypes. The character number of leaves tiller^{-1} is having great worth in growth and productive stages of crop plants. The incline or decline in leaves tiller^{-1} shows a straight effect on the fodder yield of crops. The leaves plant^{-1} ranged between 33.33 and 68.00 (Table 2). Taking mean values of leaves plant^{-1}, the maximum leaves plant^{-1} counted in Entry-D (68.00), Entry-J (68.00) and Entry-I (56.33), whilst minimum number of leaves plant^{-1} such as 33.33, 35.33, 41.00 and 43.33 were noted in Entries H, F, K, and E, respectively, with an average of 49.02 leaves plant^{-1}. The results obtained are in consistent with the findings of Naeem *et al.* (2002) and Khan *et al.* (2014). Green fodder yield profoundly depends on number of tillers plant^{-1}, which certainly acts as key foundation for it. The number of tillers plant^{-1} differed from 10 to17.66; however, the maximum number of tillers plant^{-1} was produced by Entry-F (17.66), while the minimum number of tillers plant^{-1} of 10.00 was found in Entry-H and an average of 14.27 was noted (Table 2). Bibi *et al.* (2012) and Ali *et al.* (2016) observed substantial variations in the number of tillers, which matched the findings of the current research. Leaf area is considered as dimensionless trait and demarcated as the total one-sided area, having photosynthetic tissue per unit ground surface area that indicates the potential of photosynthetic of a crop at its growth stage. The leaf area (cm^{-2}) was measured between 49.66 and 85.66 and is given in Table 1. On an average, the leaf area of 85.66 cm^{-2} was found in all oat genotypes. The greatest leaf area was noted in Entry-F (85.66 cm^{-2}), followed by Entry-J (79.33 cm^{-2}), Entry-H (74.68 cm^{-2}) and Entry-B (74.00 cm^{-2}); nevertheless, the lowest values of 49.66, 51.66, 54.33, and 55.33 cm^{-2} were recorded for Entry-D, Entry-G, Entry-A and Entry-K D, G, A and K Entries, respectively. The present study results were significant, however contrasting results were found by Khan *et al.* (2014) and Siloriya *et al.* (2014), who also reported that oats varieties did not show mark differences for leaf area. The results with respect to green fodder yield (t ha^{-1}) are presented in Table 2. The yield of green fodder (t ha^{-1}) differed from 41.33 to 86.00; however, the maximum yield for green fodder (t ha^{-1}) was obtained in Entry-H (86.00 t ha^{-1}), while the lowest yield for green fodder (t ha^{-1}) of 41.33 was found in Entry-K, on average of 64.16 (t ha^{-1}) was noted. Nawaz *et al.* (2004) have found major differences in green forage yield among oat cultivars. According to Amanullah *et al.* (2004), higher fodder yields in oat genotypes can be attributed to their larger leaf area, which results in higher photosynthetic activities and a high capacity to store assimilative photosynthesis products. The available variations in the yield of green fodder of the exploited oat genotypes may be associated to their diverse genetic makeup and response to environmental conditions (Ali *et al.,* 2016). These findings are in similar directions as obtained by Naeem *et al.* (2004), Lodhi *et al.* (2009), Ayub *et al.* (2011), Khan *et* *al.* (2014), Kaziu *et al.* (2018) and Singh *et al.* (2018). The results of dry matter yield (t ha^{-1}) were ranged between 12.33 and 27.33. The greatest yield of dry matter (t ha^{-1}) was obtained in Entry-I (27.33 t ha^{-1}), followed by Entry-L (20.33 t ha^{-1}), Entry-D (17.66 t ha^{-1}) and Entry-F (17.00 t ha^{-1}), whereas lowest dry matter yield was equally shown by Entries-K and Entry-G (12.33 t ha^{-1}), respectively. Habib *et al.* (2003), Amanullah *et al.* (2004), and Khan *et al.* (2014) all registered significant differences in oat variety dry matter. Regarding correlation results of crop stand, the character crop stand manifested significantly positive associations with tillers $plant^{-1}$ (0.29^{*}) and green fodder yield (0.93^{**}), nevertheless positive but non-significant association of crop stand with leaf area (0.21) and plant height (0.09^{*}) was reported. The crop stand displayed negative non-significant associations with leaves $plant^{-1}$ (-0.01) and dry matter yield (-0.07). Plant height manifested significantly positive associations with leaf area (0.71^{**}) and dry matter yield (0.58^{**}), while negative but non-significant association of plant height with the character of leaf area (0. 02) and green fodder yield (0.05). The character leaves $plant^{-1}$ reported positively significant relationship with tillers $plant^{-1}$ (0.32^{*}) and dry matter yield, whilst negative but non-significant association with leaf area (0.18) and green fodder yield (0. 14). Tillers $plant^{-1}$ revealed positive and significant associations with green fodder yield (0. 39^{*}), however, non-significant association of tillers plant with leaf area (0. 25) and dry matter yield (0.05), while leaf area demonstrated significant and positive associations with green fodder yield (0.38^{*}), nonetheless, negative and non-significant association of leaf area with dry matter yield (0.19) was also observed. Ahmad *et al.* (2013) noted that plant height established significant positive association with culm diameter, leaf stem ratio, and number of tillers m^{-1}. Spikelets $panicle^{-1}$, 1000 seed weight, and seed length and width both had strong and favorable association coefficients with grain yield $plant^{-1}$. Except for the number of leaves and stem girth, Krishna *et al.* (2014) found that green fodder yield was positively associated with most of the traits studied. Plant height and leaf length had the greatest amount of favorable correlations with the various traits investigated.

Table 1. Mean squares obtained from analysis of variances for different agronomical traits

Source of variance	D.F.	Crop stand	Plant height	Number of leaves $plant^{-1}$	Number of tillers $plant^{-1}$	Leaf area	Green fodder yield	Dry mater yield
Replications	2	4.17	9.02	94.36	3.69	56.58	50.08	44.11
Entries	11	4402.00^{**}	281.66^{**}	382.75^{**}	14.23^{**}	392.18^{**}	736.93^{**}	290.21^{**}
Error	22	183.83	4.51	34.54	0.69	0.40	6.38	0.80
Total	35							

** indicates significance at 1% probability level

Table 2. Mean values of agro-morphological traits of different oat genotypes

Entries	Crop stand (m^{-2})	Plant height (cm)	Number of leaves $plant^{-1}$	Number of tillers $plant^{-1}$	Leaf area (cm^2)	Green fodder yield (t ha^{-1})	Dry mater yield (t ha^{-1})
Entry-A	75.000D	87.33C	44.00DEF	14.66CD	54.33G	56.00G	33.00B
Entry-B	89.667B	92.53B	55.33BC	13.00EF	74.00C	81.33B	33.00B
Entry-C	77.667CD	82.66D	45.00DEF	16.66AB	64.00E	60.33F	15.00F
Entry-D	94.667A	96.66A	68.00A	14.00DE	49.66I	71.33D	17.66E
Entry-E	81.667C	88.66E	43.33DEF	10.00G	65.66D	62.00E	12.33G

Entry-F	87.667B	73.66F	35.33FG	17.66A	85.66A	75.66C	17.00E
Entry-G	67.333E	66.00G	46.33CDE	12.00F	51.66G	46.33H	12.00G
Entry-H	96.667A	72.66F	33.33G	15.66BC	74.68C	86.00A	20.00D
Entry-I	73.000D	85.66CD	56.33BC	15.66BC	62.66F	59.66F	27.33C
Entry-J	66.000E	96.66A	68.00A	12.33F	79.33B	45.00I	33.33B
Entry-K	67.333E	75.33E	41.00EFG	14.00EFG	55.33G	41.33J	12.33G
Entry-L	95.333A	82.66DE	52.33BCD	15.66BC	63.00EF	85.00A	42.33A
Range	66-96	66.00-82.66	33.33-68.00	10.00-17.66	49.66-85.66	41.33-86.00	12.33-27.33
Average	81.00	82.69444	49.02778	14.27778	65	64.16667	21.86111
LSD (5%)	2.4474	3.51	1.0730	1.4111	1.0730	1.0525	1.5150

Table 3. Correlation analyses among agro-morphological traits of different oat genotypes

Traits	**Crop stand**	**Plant height**	**Leaves plant^{-1}**	**Tillers plant^{-1}**	**Leaf area**	**Green fodder yield**
Plant height	0.09	-				
Leaves plant^{-1}	-0.01	0.71**	-			
Tillers plant^{-1}	0.29*	-0.11	0.25*	-		
Leaf area	0.21	0.02	0.18	0.25	-	
Green fodder yield	0.93**	0.05	0.14	0.39*	0.38*	-
Dry matter yield	-0.07	0.58**	0.27*	0.05	0.19	0.05

*, ** indicates significance at 5% and 1% probability level, respectively.

Conclusions

It is found that the maximum crop stand (96.66 m^{-2}), greater green fodder (86.00 t ha^{-1}) and maximum dry matter yield (43.00 t ha^{-1}) was produced by Entry-D; the Entry-H produced the tallest plants (96.66 cm) and maximum number of leaves plant^{-1} (68.00). Whereas Entry-F produced maximum number of tillers plant^{-1} (17.66). Hence, these two oat genotypes may be preferred for commercial cultivation in the tested climatic conditions of Tandojam, Pakistan. Regarding correlation results, the traits crop stand (r=0. 93**), tillers plant^{-1} (r=0. 39*) and leaf area (r=0. 38*) showed significant and positive associations with green fodder yield, hence these characters may have the potential to be used in future breeding programs for the development of high yielding oat cultivars.

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