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 (m²), plant height (cm), leaves plant⁻¹, number of tillers plant⁻¹, leaf area (cm²), 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≤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 m²), 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≤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 m²; however, the maximum crop stand was produced by Entry-H (96.66 m²), while the minimum crop stand of 66.00 m² was found in Entry-J and an average of 81.00 m² 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 to 17.66; 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 (cm²) was measured between 49.66 and 85.66 and is given in Table 1. On an average, the leaf area of 85.66 cm² was found in all oat genotypes. The greatest leaf area was noted in Entry-F (85.66 cm²), followed by Entry-J (79.33 cm²), Entry-H (74.68 cm²) and Entry-B (74.00 cm²); nevertheless, the lowest values of 49.66, 51.66, 54.33, and 55.33 cm² 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 (0.09⁹) 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

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>D.F.</th>
<th>Crop stand</th>
<th>Plant height</th>
<th>Number of leaves plant⁻¹</th>
<th>Number of tillers plant⁻¹</th>
<th>Leaf area (cm²)</th>
<th>Green fodder yield (t ha⁻¹)</th>
<th>Dry matter yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replications</td>
<td>2</td>
<td>4.17</td>
<td>9.02</td>
<td>94.36</td>
<td>3.69</td>
<td>56.58</td>
<td>50.08</td>
<td>44.11</td>
</tr>
<tr>
<td>Entries</td>
<td>11</td>
<td>4402.00⁺⁺</td>
<td>281.66⁺⁺</td>
<td>382.75⁺⁺</td>
<td>14.23⁺⁺</td>
<td>392.18⁺⁺</td>
<td>736.93⁺⁺</td>
<td>290.21⁺⁺</td>
</tr>
<tr>
<td>Error</td>
<td>22</td>
<td>183.83</td>
<td>4.51</td>
<td>34.51</td>
<td>0.69</td>
<td>0.40</td>
<td>6.38</td>
<td>0.80</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>320.39</td>
<td>14.18</td>
<td>12.46</td>
<td>0.39</td>
<td>1.46</td>
<td>1.34</td>
<td>1.00</td>
</tr>
</tbody>
</table>

** indicates significance at 1% probability level

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

<table>
<thead>
<tr>
<th>Entries</th>
<th>Crop stand (m²)</th>
<th>Plant height (cm)</th>
<th>Number of leaves plant⁻¹</th>
<th>Number of tillers plant⁻¹</th>
<th>Leaf area (cm²)</th>
<th>Green fodder yield (t ha⁻¹)</th>
<th>Dry matter yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry-A</td>
<td>75.000D</td>
<td>87.33C</td>
<td>44.00DEF</td>
<td>14.66CD</td>
<td>54.33G</td>
<td>56.00G</td>
<td>33.00B</td>
</tr>
<tr>
<td>Entry-B</td>
<td>89.667B</td>
<td>92.53B</td>
<td>55.33BC</td>
<td>13.00EF</td>
<td>74.00C</td>
<td>81.33B</td>
<td>33.00B</td>
</tr>
<tr>
<td>Entry-C</td>
<td>77.667CD</td>
<td>82.66D</td>
<td>45.00DEF</td>
<td>16.66AB</td>
<td>64.00E</td>
<td>60.33F</td>
<td>15.00F</td>
</tr>
<tr>
<td>Entry-D</td>
<td>94.667A</td>
<td>96.66A</td>
<td>68.00A</td>
<td>14.00DE</td>
<td>49.66I</td>
<td>71.33D</td>
<td>17.66E</td>
</tr>
<tr>
<td>Entry-E</td>
<td>81.667C</td>
<td>88.66E</td>
<td>43.33DEF</td>
<td>10.00G</td>
<td>65.66D</td>
<td>62.00E</td>
<td>12.33G</td>
</tr>
</tbody>
</table>
Table 3. Correlation analyses among agro-morphological traits of different oat genotypes

<table>
<thead>
<tr>
<th>Traits</th>
<th>Crop stand</th>
<th>Plant height</th>
<th>Leaves plant</th>
<th>Tillers plant</th>
<th>Leaf area</th>
<th>Green fodder yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height</td>
<td>0.09</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Leaves plant</td>
<td>-0.01</td>
<td>0.71**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tillers plant</td>
<td>0.29*</td>
<td>-0.11</td>
<td>0.25*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Leaf area</td>
<td>0.21</td>
<td>0.02</td>
<td>0.18</td>
<td>0.25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Green fodder yield</td>
<td>0.93**</td>
<td>0.05</td>
<td>0.14</td>
<td>0.39*</td>
<td>0.38*</td>
<td>-</td>
</tr>
<tr>
<td>Dry matter yield</td>
<td>-0.07</td>
<td>0.58**</td>
<td>0.27*</td>
<td>0.05</td>
<td>0.19</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*, ** 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.

References


