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Assessing Yield and Yield Associated Traits of Oat Genotypes Grown under the Semi-Arid Conditions of Pakistan

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Abstract: Limited and scarce feed and fodder availability has been considered as the major problem in harnessing the potential of the livestock sector in Pakistan. With the objective to find out the suitable oat genotypes for providing higher fresh fodder yield, a field experiment was conducted during rabi season of 2014-15 at Agriculture Research Institute Tarnab, Peshawar Pakistan. The treatments consisted of thirteen genotypes of oat (NARC Oat(check), F-411, Kalash, Sargoda-1, Domount, Sargoda Oat-2011, No-632, Nz-0034, No-663, Canadian, Ck-1, 07-Cot-008 and Apsi-1). The results showed that the genotype "Kalash" produced the highest number of tillers (523 m^2), fodder yield (75.6 t ha^{-1}) followed by No-663 (61.5 t ha^{-1}). The dry matter yield was higher for genotype "No-663" and "Kalash" (12.8, 12.3 t ha^{-1} respectively) compared to other genotypes. Check variety NARC Oat recorded highest Dry matter percentage (23). Growth parameters such as leaf area, leaf area index were superior for variety "Canadian" and "No-663," respectively. It can be concluded that genotypes "Kalash" and N0-663 due to its higher yield are recommended and should be adopted by the farmers that will provide them with higher fodder yield which will lead to meet the need of their livestock.

Key words: Oat genotypes · Green fodder yield · Dry matter · Tillers m^{-2} · Leaf area · Leaf area index

INTRODUCTION

Agricultural sector contributes 21% to GDP of Pakistan not only act as a driven wheel of economy but provides most of the jobs. Livestock as an important sub-sector of agriculture dominates all other sector by contributing 11.4% to total gross demostic product (GDP) that is 53.2% of agriculture's share to GDP [1]. Fodder and fodders act as central cohesive source of support for livestock and their survival is not possible without fodder. Compared to concentrates fodder can provides 2 to 3 times cheaper feed to livestock.

Oats (*Avena sativa* L.) belong to the family Poaceae and locally known as javi, jai, or jodar is originated from Mediterranean region. As a cereal crop, oats ranks 5th in cereal production in the world, but mostly used as a grazing crop or harvested as green fodder, hay or silage. Animals love Oats when provided as green fodder. Oat crop as green fodder is succulent and highly nutritive for animals. Atmosphere of temperate and cool sub-tropical areas is favorable for high yield and progressive growth oats crop. Temperature range from 16-32 °C with a well distributed rainfall of 400 mm for five month duration are enough to match the requirements of oats as fodder crop [2].

Climate (temperature, frost, duration of winter, availability of water, distribution of rainfall, growth period length) and soil (structure, texture) is the main domination feature of fodder species and fodder production in a particular area [3]. Sustainable livestock production

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is depended upon regular availability of fodder. Production of fodder in Pakistan is three times less than the genuine requirements of animals. This under fed and under nourished livestock results in their poor performance. In these conditions the only way to reduce the gap between fodder production and needs of animals is evolution of high yielding genotypes of fodder crops [4].

The present oat genotypes are very low in fodder yield as they are very old genotypes and their capacity is very lost to produce high yield more over they are sensitive towards attack of insect pest and diseases. There is frightful need to develop a high yielding, more nutritive, disease and insect tolerant genotypes of oats. There is shortage of agricultural land, so more fodder and fodder supply is only possible by increasing yield per unit of land. Ideal variety is always one, which is best suited to the general environment with higher yield potential [5].

The improved genotypes of oats have the ability to produce three-fold green fodder i.e. 60-80 tons ha^{-1}. It has the potential to fulfill the requirement of double number of animals per unit area as compared to traditional fodder crops of rabi season [6].

Keeping in view the scarcity of green fodder and necessity of new improved genotypes of fodder crop the present study was conducted to assess and identify appropriate, high yielding oat genotypes for agro-ecological conditions of Peshawar valley.

MATERIALS AND METHODS

Site Description: The experiment was conducted at Agricultural Research Institute Tarnab Peshawar. The site is located about 14 km east of Peshawar city, the capital of Khyber Pakhtunkhwa. Peshawar is located about 1600 km of north Indian Ocean and thus has a continental climate. The Research Institute is located at 34° N and 71.3° E having altitude of 450 m above sea level. The soil of Research Institute is silty loam (clay and silt 27 and 50% respectively) with pH value of soil is 7.7-8.0,and contained 1.06% organic matter with 0.053%, 22.1 and 186.0 mg kg^{-1} N, P and K, respectively.

Experimental Procedure: Thirteen oats genotypes were tested at Agricultural Research Institute Tarnab during rabi season 2014-15. The trial was planted on 3rd November 2014. The site was planted with sorghum during kharif season 2014. The layout of the experiment was according to the randomized complete block design (RCBD) with three replications. Each plot of a genotype occupied 10.8 square meters. The total numbers of plots was thirty nine with gross plot size of 1.8m x 6m. The rows were spaced 30 cm apart with seeding rate of 80 kg ha^{-1}. Fertilizers at the rate of 75-50-00 NPK Kg ha^{-1} were applied. Whole phosphorus and half nitrogen were applied at the time of seed bed preparation in the form of di-ammonium phosphate (DAP) and urea, respectively. Whereas, remaining half of nitrogen was applied with first irrigation. All other agronomic practices were maintained normal and uniform for all genotypes.

Data Recording Procedure: Numbers of tillers m^{-2} was recorded by counting the number of tillers of one meter length in three central rows of each plot and then converted to tiller m^{-2} by using the following formula.

$$\text{Tiller } m^{-2} = \frac{\text{Total number of tillers counted}}{\text{No of rows (R-R distance) x (Row Length)}}$$

Leaf area $plant^{-1}$ was calculated by measuring the length and width of top three leaves of ten representative plants from the plot of each treatment at the time of harvest. The mean single leaf area $plant^{-1}$ was calculated by computing the following formula.

Leaf area = Leaf length x Leaf width x 0.75

Leaf area index was calculated as leaf area $plant^{-1}$ ha^{-1} divided by ground area covered $plant^{-1}$ ha^{-1}.

At 50 % flowering stage, all treatments of each replications was harvested and weighed to get fresh fodder yield (FFY). The fresh fodder yields were then bounded in form of bundles. The fresh fodder yields obtained from each treatment was converted into ton ha^{-1}.

Sample of green fodders was dried at 60-70°C in the oven. The dry matter % of the samples was calculated by weighing these samples before and after drying to a constant weight in an oven at 103-105°C. After cooling the samples to room temperature in the desiccator the final weight of all the samples was recorded. The dry matter contents were calculated by computing the following formula:

$$\text{Dry Matter (\%)} = \frac{\text{wt. of oven dry sample}}{\text{wt. of sample before drying}} \times 100$$

Dry fodder yield (DMY) was calculated by applying this formula. FFY (t ha^{-1}) x DM (%)

$$DMY\ (t\ ha^{-1}) = \frac{FFY\ (t\ ha^{-1}) \times DM\ (\%)}{100}$$

Statistical Analysis: The data was statistically analyzed according to Steel *et al.* [7] for randomized complete block design and means among different treatment were composed using least significant differences (LSD) test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Number of Tillers m^{-2}: Data concerning number of tillers m^{-2} are shown in Table 1. Analysis of variance depicted substantial differences among genotypes for number of tillers m^{-2}. Average values of different oats genotypes for number of tillers m^{-2} ranged from 297 "F-411"to 523 "Kalash". The maximum plant population of 523 tillers m^{-2} was recorded for genotype "Kalash" follow by (No-663 and Ck-1) obtained 424.3 and 406.6, tillers m^{-2} in decreasing sequence. "Kalash" showed 26.4 percent more tillers m^{-2} compared to check variety NARC Oat. Check variety NARC Oat reported 346 tillers m^{-2} followed by genotypes (07-Cot-008 and Domount) with 345.3 and 342.6 tillers m^{-2}, respectively and were found to be statistically at par for numbers of tillers m^{-2}. The lowest number of tillers m^{-2} was observed for "Apsi-1" followed by "Sargoda-1" which recorded 325.3 and 325.6 tillers m^{-2}, respectively. Number of tillers m^{-2} act as key foundation to green fodder yield it is therefore genotype "Kalash" obtained the top position in fresh fodder yield (75.6 t ha^{-1}) followed by "No-663" having 61.5 t ha^{-1} and dry matter yield (12.3 and 12.8 t ha^{-1}, respectively) among other genotypes. Similar results are reported earlier by Bibi *et al.* [8] and Hussain *et al.* [9] found significant differences for number of tillers which agreed with present study.

Leaf Area $plant^{-1}$: Leaf area $plant^{-1}$ is the measure of size of assimilatory system of plant and is product of leaf length and breadth. The data obtained on leaf area $plant^{-1}$ revealed that oat genotypes have visible differences ($P<0.05$). The data depicted in Table 1 revealed that the maximum leaf area $plant^{-1}$ was recorded in genotype Canadian (218.17 cm^2) followed by "Sargoda-1" (215.71 cm^2) and were recorded to be statistically identical. Check variety "NARC Oat", recorded leaf area of 206.82 cm^2 $plant^{-1}$closely followed by "Nz-0034"obtained a leaf area of 204.36 cm^2 $plant^{-1}$, while the minimum leaf area $plant^{-1}$ was noted in "Kalash" (144.49 cm^2) follow by "Ck-1" produced leaf area of 177.42 cm^2 $plant^{-1}$. These results are in accordance with the findings of Hussain *et al.* [10], Zaman [11] and Naeem *et al.* [12] their findings explained that the variation in leaf area and other parameters in different genotypes may be attributed to varying genetic make-up, soil and environmental adaptability.

Leaf Area Index: It is a dimensionless variable and was first defined as the total one-sided area of photosynthetic tissue per unit ground surface area which expresses the

Table 1: Number of tillers m^{-2} and leaf area $plant^{-1}$ of various oat genotypes grown under agro-ecological conditions of Peshawar Valley.

Genotypes Name	Number of tillers m^{-2}	Increase over check (%) forNumber of tillers m^{-2}	Leaf area $plant^{-1}$	Increase over check (%) for Leaf area $plant^{-1}$
NARC Oat (Check)	346 cde	----	206.82 abc	----
F-411	297 f	-7.31	189.13 abc	- 8.90
Kalash	523 a	+26.4	144.49 d	- 31.9
Sargoda-1	325.6 ef	-3.03	215.71 ab	+ 4.30
Domount	342.6 de	-0.49	184.07 bc	- 10.99
Sargoda Oat-2011	371.6 cd	+3.83	186.13 abc	- 10.00
No-632	334.6 e	-1.69	175.14 cd	- 15.31
Nz-0034	348.6 cde	+0.39	204.36 abc	- 1.185
No-663	424.3 b	+11.69	178.95 c	- 13.47
Canadian	374 c	+4.18	218.17 a	+ 5.49
Ck-1	406.6 b	+9.06	177.42 c	- 14.21
07-Cot-008	345.3 cde	-0.1	198.6 abc	- 3.97
Apsi-1	325.3 ef	-3.08	195.32 abc	- 5.56
LSD	160.47		32.754	
CV	13.42		10.21	

Table 2: Leaf area index and green fodder yield t ha^{-1} of various oat genotypes grown under agro-ecological conditions of Peshawar Valley

Genotypes Name	Leaf area index	Increase over check (%) forleaf area index	Green fodder yield (t ha^{-1})	Increase over check (%)for Green fodder Yield (t ha^{-1})
NARC Oat (Check)	7.1 abc	----	51.6 cd	----
F-411	5.6 d	-5.7	47.3 cd	-8.33
Kalash	7.6 ab	+1.9	75.6 a	46.51
Sargoda-1	7 abcd	-0.3	53.7 bc	4.06
Domount	6.3 bcd	-3	50.9 cd	-1.3
Sargoda Oat-2011	6.9 abcd	-0.7	54.2 bc	5.03
No-632	5.9 cd	-4.5	42.4 d	-17.8
Nz-0034	7.1 abc	-3.8	52 bcd	0.77
No-663	7.6 ab	+1.9	61.5 b	19.18
Canadian	8.1 a	+3.8	47.7 cd	-7.55
Ck-1	7.2 abc	-0.3	55.2 bc	6.97
07-Cot-008	6.9 abcd	-0.7	54.1 bc	4.84
Apsi-1	6.3 bcd	-3	56.2 bc	8.91
LSD	1.41		9.8148	
CV	12.15		10.77	

photosynthetic potential of a crop at its particular growth stage. Data pertaining leaf area index did not indicate marked variations among genotypes. More ground area was covered by genotype "Canadian" with leaf area index of 8.1followed by "Kalash and No-663" with leaf area index of 7.6 (Table 2). Leaf area index of check variety "NARC Oat"and "Nz-0034" was observed as 7.1 very closely followed by "Sargoda-1" with leaf area index of 7 and were statistically identical. Genotype "F-411" was observed with minimum leaf area index5.6followed by "Domount and Apsi-1" with leaf area index of 6.3 and was found statistically similar. This result is in line with that obtained by Siloriya *et al.* [13], who also reported that oats varieties does not show mark differences for leaf area index.

Green Fodder Yield (t ha^{-1}): Data regarding green fodder yields of oats considerably ($P<0.05$) different due to genotypes ranged from 42.4 to 75.6 ton ha^{-1} as illustrated in Table 2. Their exist superiority of "Kalash" on all other genotypes. Mean values showed that maximum green fodder yield of 75.6 ton ha^{-1} was obtained from "Kalash" followed by genotypes (No-663 and Apsi-1) that produced yield of 61.5 and 56.2 ton ha^{-1} and were statistically same. The "Kalash" possessed the potential to produce 46.5 percent more fodder yield than check "variety NARC oat". Check variety "NARC Oat" produced green yield of 51.6 ton ha^{-1}. The minimum fodder yield of 42.2 ton ha^{-1} was observed in "No 632" and was different from all other genotypes. The variation in green fodder yield of the mention genotypes may be attributed to their varied genetic makeup and response to environmental condition. These results are in accordance with those reported by Syed *et al.*[14], Lodhi *et al.* [15] and Ali *et al.* [16]. They recorded green fodder yield of different oats varieties ranging from 41 to 82 tons ha^{-1} in different studies.

Dry Matter Content (%): Dry matter content of oat genotypes showed highly significant differences and its varied 23 to 15% among oat genotypes. Check variety "NARC Oat" showed superiority over all genotypes and was different from other genotypes in dry matter %. Check variety "NARC Oat" obtained maximum dry matter % (23), followed by 07-Cot-008 with dry matter of 22.3% (Table 3) and were statistically similar. Dry matter content of genotypes (Kalash and F-411) shows very small variation among each other having 16.4 and 16% respectively and was statistically identical. The minimum dry matter content (15%) was recorded for "Ck-1" and was statistically different from all other genotypes. The variation in percent dry matter may be attributed to variation in the genetic make-up and adaptability of these varieties to different environmental conditions. Wang *et al.* [17] also reported variation in dry matter % among oat varieties with different fertilizers levels.

Dry Matter Yield (t ha^{-1}): Genotypes recorded the highest green fodder yields and produced the maximum dry matter yields. Total dry matter yield tons ha^{-1} is shown in Table 3 illustrated significant differences among oats genotypes. The maximum dry matter yield (12.8 tons ha^{-1}) was obtained in "No-663" followed by the "Kalash" (12.3 t ha^{-1}) and was statistically at par with

Table 3: Dry matter percentage and dry matter yield t ha^{-1} of various oat genotypes grown under agro-ecological conditions of Peshawar Valley

Genotypes Name	Dry matter %	Increase over check (%) for Dry matter %	Dry matter yield t ha^{-1}	Increase over check (%) for Dry matter yield t ha^{-1}
NARC Oat $_{(Check)}$	23 a	----	11.9 ab	----
F-411	16 fg	-30.43	7.5 e	-3.69
Kalash	16.4 fg	-28.69	12.3 a	0.33
Sargoda-1	19.3 cde	-16.08	10.3 bc	-1.3
Domount	19.1 cde	-16.95	9.6 cd	-1.9
Sargoda Oat-2011	17 efg	-26.08	9.2 cde	-2.2
No-632	19.8 bcd	-13.9	8.4 de	-2.9
Nz-0034	21.1 abc	-8.26	10.9 abc	0.84
No-663	21 abc	-8.695	12.8 a	0.75
Canadian	20 bcd	-13.04	9.5 cd	-2.0
Ck-1	15 g	-34.78	8.3 de	-3.0
07-Cot-008	22.3 ab	-3.043	12 ab	0.08
Apsi-1	17.7 def	-23.04	9.9 cd	-1.6
LSD	2.6228		1.8945	
CV	8.15		10.98	

Table 4: Correlation coefficients of some yield traits of oat as affected by different Genotypes

Variables	Green fodder	Leaf area	Tillerm^{-2}	Dry matter %	Dry Matter Yield
Leaf Area	-0.2782				
P-VALUE $_{(0.05)}$	0.0864				
Tillers m^{-2}	0.6489	-0.4625			
P-VALUE $_{(0.05)}$	0.0000	0.0030			
Dry matter %	-0.3222	0.1701	0.1783		
P-VALUE $_{(0.05)}$	0.0455	0.3005	0.2775		
Dry matter t ha^{-1}	0.6593	-0.0898	0.4232	0.4909	
P-VALUE $_{(0.05)}$	0.0000	0.5866	0.0073	0.0015	
Leaf area index	0.3331	0.4952	0.5332	0.0198	0.3226
P-VALUE $_{(0.05)}$	0.0383	0.0013	0.0005	0.9049	0.0451

each other. Check variety "NARC Oat" and genotype "Nz-0034" recorded dry matter yield of 11.9 and 10.9 t ha^{-1} and were statistically identical, while the minimum dry matter yield of 7.5 t ha^{-1} was recorded for "F-144", followed by genotype"Ck-1" and "No 632" with dry matter of 8.3 and 8.4 t ha^{-1}. Conspicuous difference was observed for "F-144" compares to all other genotypes. This may be due to the genetic make-up and the abilities to use the present resources. These results are inconformity with Hussain *et al.* [18] and Amanullah *et al.* [19], who found significant variations among different genotypes regarding dry weight per plant and total dry matter yield.

Correlation Analysis: Correlation analysis determined the characters which are associated with green fodder yield and dry matter yield. A negative and non-significant association of leaf area was observed with green fodder yield and dry matter yield,that is in agreement with the study of Ghulam *et al.* [5]. Tillers m^{-2} was positively and significantly correlates with green fodder yield and dry matter yield which is in line with the observation of Gibinski [20]. Results presented in Table 4 reveled a positive more significant association of dry matter percentage with dry matter yield and negative significant correlation with green fodder yield. A significant positive association was obtained for leaf area index with green fodder yield and dry matter yield. Significant positive association was recorded among the green fodder yield and dry matter yield that is accordingly with study of Adeel *et al.* [21].

CONCLUSION

The genetic variations in genotypes induced significant changes in yield traits. The data suggested that new genotypes have potential to assist the fodder resolves. Based on the findings of the present investigation, the genotypes "Kalash"and "No-663" are recommended for general cultivation as it has performed better for fresh and dry matter yield under the agro-climatic conditions of Peshawar region.

Future research should consider the growth period and optimum time of sowing of individual genotype to ensure the green fodder material during the entire winter season.

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