VARIABILITY IN FODDER PRODUCTION POTENTIAL OF EXOTIC OATS (*AVENA SATIVA*) GENOTYPES UNDER IRRIGATED CONDITIONS

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ABSTRACT

Nine exotic cultivars of oats collected from Renewable Natural Resources Research Centre, Bajo, Wangdue-Bhutan were evaluated at National Agricultural Research Centre, Islamabad, Pakistan during 2004-05 and 2005-06. These cultivars alognwith 2 local check entries were planted during winters of 2004-05 and 2005-06 under irrigated conditions. New exotic oats cultivar NZ-0034 with medium plant height (149.8 cm), more number of leaves (5.17), number of tillers per plant (6.45) and medium leaf area (125.7 cm^2) produced higher green fodder and dry matter yields (94.68 and 25.51 t/ha). Higher fodder yields of NZ-0034 might be attributed to more stiffness of plants than other varieties. So this cultivar could be planted for high fodder yields and be used in breeding programmes to improve low yielding out-moded stock and develop high fodder yielding varieties of oats.

KEYWORDS: ***Avena sativa;*** **cultivers; performance; irrigated farming; agronomic characters; Pakistan.**

INTRODUCTION

Fodder oats (*Avena sativa* L.) is an important winter season cereal fodder crop which can be successfully grown throughout Pakistan under both irrigated and rainfed conditions with a rainfall of 400 mm and an optimum temperature range of 16-32°C. It is an important forage/grain crop grown as a pasture, hay, silage and poultry feed in the world. It requires temperate and cool sub-tropical conditions for its growth (2). The use of oats as forage or grain crop is a common practice the world over. Recently tendency to use oats for forage and seed has increased in irrigated as well as high rainfall areas of Pakistan.

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The oat fodder being nutritious is especially suitable for horses and milch animals. Moreover, oat produces an abundance of excellent fodder at the time when other succulent better quality fodders are scarce and cannot be cut/grazed as a green feed, hay or silage crop. It is a quick growing, palatable, succulent and nutritious crop. It forms an excellent combination when fed alongwith other cold season legumes, like berseem or Egyptian clover (*Trifolium alexandrinum),* Lucerne or alfalfa (*Medicago sativa)*, senji or Indian clover (*Melilotus indica)*, shaftal or Persian clover (*Trifolium resupinatum),* pea (*Pisum arvense)* and vetch (*Vicia sativa).* It provides green fodder during the fodder lean period (December, January and May) when there is green fodder shortage and animals are fed with dry fodder.

No systematic research work appears to have been conducted on oats for its utility as a fodder crop in Pakistan. Dhumale and Mishra (5) observed that fresh fodder yields were positively correlated with plant height, flag leaf and tillers per plant. Plant height has a direct effect on yield and all morphological characters except tillers per plant. Hussain *et al.* (10) reported that out of 15 oats cultivars variety No. 725 produced taller plants, greater number of tillers per plant, more leaves and leaf area, higher green fodder and dry matter yields. Hussain *et al.* (8) also found that oat variety Fatua harvested at 50 percent flowering stage produced higher green fodder and dry matter yields. Hussain and Khan (7) concluded that if seed is not required from oats crop and farmer is only interested in maximum green forage and dry matter yields, then crop harvesting only for fodder at 50 percent flowering would be the most productive option but forage quality will be inferior. To increase fodder quality, mixing of any winter legume would solve the problem. Hussain *et al.* (6) reported that oats genotype Super Late having maximum plant height is superior in number of green leaves per tiller, leaf area, green fodder and dry matter yield. Ali *et al.* (1) investigated that oats variety Jasper produced significantly more plant height and number of tillers per plant, reasonable number of green leaves per tiller and leaf area and ultimately higher green fodder and dry matter yields. Bhatti *et al*. (2) reported significant differences in oats cultivars for plant height, tillers per plant, stem thickness, leaves per tiller and leaf area. Other researchers like Hussain *et al.* (9), Chaudhary (3) and Chaudhary *et al*. (4) have evaluated the suitability of oats as a forage crop under different agro-climatic conditions.

In present study, new exotic varieties of oats were evaluated in comparison with local varieties for enhancing fodder production in Pakistan.

MATERIALS AND METHODS

The experimental material comprised nine exotic cultivars of oats (Carville, Canadian, Taiko, Bhutan Oat, NZ-9217604, NZ-0034, NZ-1001, NZ-Stampede, Cuscade) introduced from Renewable Natural Resources Research Centre, Bajo, Wangdue-Bhutan during 2002. These cultivars alongwith two checks (PD2-LV65 and S-2000) were evaluated at National Agricultural Research Centre, Islamabad, Pakistan during 2004-05 and 2005-06. These were sown in the month of October during both years under irrigated conditions. Layout system was RCBD with three replications. The gross plot size sown was 6m x 3m and net plot of 6m x 1.2 m was harvested at 50 percent flowering stage for estimation of green fodder yield. A seed rate of 80 kg per hectare was hand drilled by keeping 30 cm row to row spacing. Fertilizer @ 50-50-:0 kg NPK per hectare was applied at sowing and 25 kg nitrogen per hectare after 70 days of sowing with irrigation. Two irrigations were applied for obtaining good fodder yields during 2005-06. First irrigation was applied 22 days after sowing on November 10, 2005 and second in third week of December 2005. As good rains were received during 2004-05, no irrigation was given to the experiment. Meteorological data recorded during crop growth period are given below:-

Maximum/minimum temperature and rainfall observations for growing period of oats at NARC, Islamabad during 2004-05 and 2005-06.

Year	Month	Temperature (^{o}C)		Rainfall
		Maximum	Minimum	(mm)
2004-05	October 2004	26.2	12.6	82.2
	November 2004	24.8	7.6	23.1
	December 2004	18.3	4.8	30.1
	January 2005	15.0	2.6	59.2
	February 2005	19.9	5.1	184.4
	March 2005	22.9	10.2	75.4
	April 2005	29.4	12.2	13.9
	May 2005	33.4	16.8	20.3
2005-06	October 2005	29.3	13.2	66.6
	November 2005	24.5	6.6	3.94
	December 2005	20.7	0.9	9.0
	January 2006	17.0	3.0	53.79
	February 2006	24.0	8.0	22.9
	March 2006	24.1	9.4	51.8
	April 2006	31.4	12.7	20.5
	May 2006	38.5	21.2	41.2

All other cultural practices such as weeding, inter-culturing, etc. were kept normal and uniform for each variety/replication. Five plants were selected at

random in each plot at the time of 50 percent flowering for recording morphological observations. Parameters studied include plant height, number of tillers per plant, green leaves per tiller, leaf area (length x breadth), green fodder and dry matter yields. Green fodder samples (200-500 g) at the time of harvest from each plot and replication were randomly collected. These samples were weighed and dried in an oven at 60°C for 48 hours. These were again weighed to calculate the dry matter yield for each cultivar.

The data were statistically analyzed using analysis of variance and LSD test at 5 percent probability level to compare the differences among varietal means (11).

RESULTS AND DISCUSSION

Analysis of variance combined over two years (Table 1) revealed significant differences among varieties and between years for all traits except for number of leaves per tiller. Regarding variety x year interaction, also

Table 1 Source of variation (SOV), degree of freedom (DF) and mean squares of different traits of oats as affected by various varieties .

SOV	DF	Mean squares					
		Plant height (cm)	Number of leaves/tiller	Number of tillers/plant	Leaf area (cm^2)	Green fodder yield (t/ha)	Dry matter yield (t/ha)
Replications	2	88.164	0.097	2.059	476.123	78.929	4.072
Varieties (V)	10	691.810**	1.383*	2.000 NS	4092.439**	258.332**	17.628**
Years (Y)	1	829.565**	0.219 NS	18.034**	1858.713**	2550.422**	165.268**
V x Y	10	318.423**	0.471 NS	2.769*	759.517 NS	210.342**	13.161**
Error	42	104.841	0.607	1.183	291.670	48.216	3.060

*Significant at 5% level of probability,** Significant at 1% level of probability, NS = Non-significant

significant differences were observed for all traits except number of leaves per tiller and leaf area. Average results of fodder yield components, green fodder yield and dry matter yield are discussed below:-

Fodder yield components

Differences among various oat varieties for plant height were significant. Oats variety Cuscade produced significantly the tallest plants (173.9 cm). (Table 2). Variety Taiko recorded significantly different plant height (160.4 cm) but was at par with those of NZ-9217604 and NZ-0034 (152.9 and 149.8 cm). Varieties NZ-9217604 and NZ-0034 gave plant height similar to PD_2-LV_{65}, Carville, NZ-Stampede, S-2000, Bhutan Oats, and Canadian (146.3, 145.7, 142.2, 141.6, 141.4 and 141.1 cm). NZ-1001 produced the lowest plant

height (136.8 cm). Statistically significant differences among various oat varieties were also observed for number of leaves per tiller (Table 2).

Table 2. Average yield components, green fodder yield, dry matter yield and % increase (+) or decrease (-) over check for various oats varieties

Varieties	Plant height (cm)	Green leaves/ tiller	Tillers/ plant	Leaf area (cm^2)	Fodder yields (t/ha)		% increase (+) or decrease (-) over check	
					Green fodder	Dry matter	Green fodder	Dry matter
S-2000 (Check)	141.6 cd	4.72 abc	6.40	115.5 bc	76.30 cd	20.56 de	-	-
Carville	145.7 cd	3.77 d	5.78	107.2 bc	72.73 d	19.65 e	- 4.68	- 4.42
Canadian	141.1 cd	4.68 abc	5.77	155.2 a	85.69 b	22.94 bc	+ 12.31	+ 11.57
Taiko	160.4 b	4.15 cd	6.12	124.3 bc	76.02 cd	20.61 de	- 0.36	- 0.24
Bhutan Oat	141.4 cd	4.75 abc	6.32	105.5 c	75.69 cd	20.43 de	- 0.80	- 0.63
NZ-9217604	152.9 bc	4.12 cd	6.05	112.5 bc	86.02 b	23.01 b	+ 12.74	+ 11.91
NZ-0034	149.8 bc	5.17 ab	6.45	125.7 b	94.68 a	25.51 a	+ 24.09	+ 24.07
NZ-1001	136.8 d	5.23 a	7.63	70.45 d	81.02 bc	21.97 bcd	+ 6.18	+ 6.86
NZ-Stampede	142.2 cd	4.32 bcd	5.98	111.7 bc	77.45 cd	20.89 de	+ 1.51	+ 1.60
Cuscade	173.9 a	4.70 abc	5.93	157.9 a	77.55 cd	20.92 cde	+ 1.64	+ 1.75
PD_2-LV_{65}	146.3 cd	5.17 ab	6.38	154.0 a	86.34 b	23.12 b	+ 13.16	+ 12.45
LSD (0.05)	11.93	0.91	NS	19.90	8.090	2.038		

Similar letters in a column indicate non-significant differences at 5 percent level of probability.

Varieties NZ-1001, NZ-0034, PD_2-LV_{65}, Bhutan Oat, S-2000, Cuscade and Canadian produced higher and similar number of leaves per tiller (5.23, 5.17, 5.17, 4.75, 4.72, 4.70, and 4.68). Minimum number of leaves were recorded in variety NZ-9217604 (4.12). Regarding number of tillers per plant, non-significant differences were observed among different oats varieties. However, maximum number of tillers per plant (7.63) were recorded in variety NZ-1001 followed by NZ-0034 (6.45) against minimum (5.77) in variety Canadian (Table 2). The data indicate further statistically significant. differences among various oats varieties for leaf area. Maximum and significantly similar leaf area was recorded in varieties Cuscade (157.9 cm^2), Canadian (155.2 cm^2**)** and PD_2-LV_{65} (154 cm^2**)**. Oats variety NZ-0034 recorded leaf area of 125.7 cm^2 which was statistically different from varieties Cuscade, Canadian and PD_2-$LV_{65,}$ but similar to varieties Taiko, S-2000, NZ-9217604, NZ-Stampede and Carville (124.3, 115.5, 112.5, 111.7 and 107.2 cm^2). Minimum leaf area was noted in variety NZ-1001 (70.45 cm^2).

Green fodder yield

The differences among various oats varieties for green fodder yield were found statistically highly significant. Maximum and significantly different green fodder (94.68 t/ha) was recorded in oats variety NZ-0034 (Table 2). Varieties PD_2-LV_{65}, NZ-9217604, Canadian and NZ-1001 produced similar green fodder yields (86.34, 86.02, 85.69 and 81.02 t/ha) but differed from variety NZ-0034

(94.68 t/ha). Oats varieties Cuscade, NZ-Stampede, S-2000, Taiko, Bhutan Oat and Carville yielded similar and minimum green fodder yields (77.55, 77.45, 76.30, 76.02, 75.69 and 72.73 t/ha). Higher green fodder yield in new exotic oats variety NZ-0034 might be due to medium height, more number of leaves and stiffness of stem. It was further assessed that new exotic oats variety NZ-0034 recorded 24.09 percent more green fodder yield than check S-2000. These results are in accordance with those of Ali *et al.* (1), Bhatti *et al.* (2), Hussain *et al.* (6, 8, 10) and Hussain and Khan (7). These workers recorded green fodder yields ranging from 41 to 82 tons per hectare in different studies.

Dry matter yield

Significant differences were observed among various oats varieties for dry matter yield. Similar pattern of dry matter yield was similar to green fodder yield. Variety NZ-0034 recorded highest dry matter yield (25.51 t/ha) followed by variety PD_2-LV_{65} and NZ-9217604 (23.01 t). These two varieties were also at par with that of Canadian (27.94 t) and NZ-1001 (21.97 t). Variety Carville recorded the lowest dry matter (19.65 t/ha) and was similar to Taiko, Bhutan Oat, NZ-Stampede, Cuscade and S-2000 (20.61, 20.43, 20.89, 20.92 and 20.56 t/ha). It was also observed that new high fodder yielding exotic oats variety NZ-0034 recorded 24.07 percent more dry matter yield than check variety S-2000. Bhatti *et al.* (2), Hussain *et al* (6, 9, 10) reported similar findings and noted 8-21 tons per hectare dry matter yield in oats varieties.

CONCLUSION

The study concludes that oats exotic genotype NZ-0034 with medium plant height, more number of leaves, tillers and medium leaf area recorded the highest green fodder yield (94.68) and dry matter yield (25.51 t/ha). So this variety yielded 24 percent higher green fodder and dry matter yields than standard variety S-2000. It was also assessed that higher fodder yields in NZ-0034 might be due to its more stiff plant structure high fertilizer response and more resistance to lodging than other varieties tested in this study. NZ-0034 was also found disease tolerant and being late, it can provide green fodder to the livestock during fodder scarcity period. Further this genotype could be utilized in oats breeding programme to improve outmoded local oats material for obtaining higher fodder yields. There is a need to test fodder production potential of genotype NZ-0034 in different ecologies of the country to see the genotype x environment interaction effect on its performance.

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