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Effect of oat + sarson mixture on the productivity and quality of fodder mixture and seed yield of oat under different cutting management

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Abstract
A field experiment was carried out during *rabi* 2007-08 to 2010-11 at Punjab Agricultural University, Ludhiana to study the effect of cutting management and oat + sarson mixtures on the yield and quality of fodder and seed yield of oat. The harvest at 65 days after sowing (DAS) produced significantly higher fodder yield than harvest at 55 DAS. The cutting management did not influence the seed yield of oat and fodder equivalent yield significantly. The quality parameters such as crude protein, *In-vitro* dry matter digestibility (IVDMD) and ash were higher in first cut at 55 DAS than harvested at 65 DAS, whereas, crude fibre content was not influenced by cutting management. The higher net returns were obtained at 65 DAS (Rs. 15,666) than at 50 DAS (Rs. 13,635). Oat (62.5 kg/ha) + sarson 2.5 kg/ha mixture recorded 57.9, 26.1 and 9.9 percent higher green fodder and; 60.5, 25.2 and 10.2 percent higher dry matter yield in first cutting over oat (pure), oat + 1.25 kg sarson/ha and oat + 1.88 kg sarson/ha, respectively. In second cutting, the trend was reverse. The total green fodder yield in oat + 2.5 kg/ha sarson was 7.7 percent higher than pure oat. The seed yield of second cut of oat was significantly higher in oat (pure) over oat + 2.5 and 3.18 kg/ha sarson mixture but was at par with oat + 1.25 and 1.88 kg/ha sarson mixtures. The fodder equivalent yield was highest in oat + 2.5 kg sarson/ha mixture than pure oat by a margin of 9.2 to 11.5 percent. The crude protein, IVDMD and ash contents in the first cut increased with increase in seed rates of sarson up to 3.13 kg/ha sarson. In crude fibre content, the trend was reverse. Oat + 2.5 kg/ha sarson gave additional income of Rs. 4463 to 5077/ha than oat (pure).

Key words: Cutting management, Dry matter, Fodder quality, Green fodder, Oat + sarson mixture, Seed rate

Introduction

Oat (*Avena sativa*) is an important *rabi* fodder crop and is next to berseem in nutritive value. It is rich in energy, protein, vitamin B, phosphorus and iron (Gupta *et al*., 2002). It is grown in almost all parts of Punjab in 0.91 lakh ha area as an irrigated crop. Most of the farmers grow oat as a multicut or dual purpose (for fodder and seed) crop. First cut supplies green fodder during the scarcity period of December-January but the fodder yield of the first cut is very low due to less tillering, small height and more succulence. To enhance the productivity of the first cut, the alternative is to grow some short duration crop in mixture with oat. Puri *et al*. (2010) observed higher fodder yield of the ryegrass + oat/sarson over pure crop of ryegrass in the first cutting. Similarly, Kumar *et al*. (2010) reported 29.9 percent crude protein content in berseem + 1.88 kg sarson/ha as compared to 27.9 percent in pure berseem. Therefore, different seed rates of sarson were mixed in the recommended seed rate of oat because sarson gives only one cut and the second cut of oat can either be taken for fodder or for seed.

Materials and Methods

The experiment was conducted during *rabi* seasons of 2007-08 to 2010-11 at Punjab Agricultural University, Ludhiana. The treatments consisted of two cutting management (first cut at 55 and 65 days after sowing (DAS) and second cut at 50 percent flowering) and five mixtures of oat + sarson (pure oat + 1.25, 1.88, 2.50 and 3.13 kg sarson/ha) were evaluated in randomized block design in three replications. The soil of the experimental field was loamy sand, low in organic carbon (0.32 %) and available nitrogen (188.6 kg/ha) and medium in available phosphorus (19.3 kg/ha) and high in available potassium (343.7 kg/ha). The values of pH and electrical conductivity of the experimental field were 7.8 and 0.20 (dmm^{-1}) respectively. In oat + sarson mixture, oat was sown by *kera* method at a row spacing of 20 cm with 62.5 kg seed/ha in plot size of 5 x 4 m. Sarson seed was sown by broadcast followed by planking. A dose of 37.5 kg N/ha + 20 kg P_2O_5/ha was drilled at sowing and 37.5 kg N/ha was top-dressed at 30 days after sowing in all the plots in first cutting. In second cut, 75 kg N/ha was applied after sprouting the crop *i.e*., after 7 days of first cut. The first cut was taken

at 55 and 65 days after sowing. Each plot was divided into 2 equal parts – one for green fodder and the second for seed. The second cut of fodder was harvested at 50% flowering for fodder in one plot and at full maturity for seed in the second plot. All cultural practices were uniformly applied to all the treatments. The samples of oat + sarson mixtures were taken for dry matter at the time of harvesting at each cut from all the treatments and were sun dried. Then these were dried in the oven at 60^0C for a constant weight. The dried samples were grinded and analyzed for crude protein, crude fibre, mineral matter and *IVDMD* contents (A.O.A.C., 1970).

Results and Discussion

Fodder yield

The cutting management significantly influenced the fodder yield of mixture (Table 1). The mixtures harvested at 65 DAS produced significantly higher green fodder (236.0 q/ha) and dry matter (360.q/ha) yield than harvested at 55 DAS. The magnitude of increase was 17.6 percent in green fodder and 36.9 percent in dry matter yield. In second cutting, the green fodder (359.6 q/ha) and dry matter (88.6 q/ha) yield decreased when first cut was taken at 65 DAS than at 55 DAS (317.3 q/ha green fodder and 93.5 q/ha dry matter yield) but the differences were non significant. Total green fodder and dry matter yields were slightly higher in first cut at 65 DAS and second cut at 50 percent flowering. The higher fodder yield in crop harvested at 65 DAS was obtained due to taller plants of oat and sarson and more plant population than the crop harvested at 55 DAS (Table 4). Tiwana *et al*. (2002) also observed that oat harvested at 90 DAS gave 15.8 percent higher green fodder and 14.3 percent higher dry matter yield over the crop harvested at 70 DAS.

The green fodder and dry matter yields were significantly increased in oat + sarson mixture than pure oat during all the years of experimentation. In first cutting, the green fodder and dry matter yields of oat + sarson mixture increased significantly than pure oat (158.2 q/ha green fodder and 22.3 q/ha dry matter yield). Among the oat + sarson mixtures, fodder yield increased with increase in seed rates of sarson but the significant differences were observed up to 2.5 kg/ha. Crop mixture of oat (62.5 kg/ha) + sarson 2.5 kg/ha recorded 57.9, 26.1, 9.9 percent higher green fodder and; 60.5, 25.2 and 10.2 percent higher dry matter yield over oat pure, oat + 1.25 kg sarson/ha and oat + 1.88 kg sarson/ha, respectively. The taller plants and more plants per unit area might have helped in increasing the fodder yield of oat + 2.5 kg/ha sarson mixture (Table 4). Puri *et al.* (2010) also observed higher fodder yield of the ryegrass + oat/sarson over pure crop of ryegrass in the first cutting. In second cut, the fodder yield decreased significantly in oat + sarson mixtures as compared to pure crop of oat. The reduction was more pronounced as the seed rates of sarson increased from 1.25 to 3.18 kg/ha. This reduction in fodder yield might be due to adverse effect of sarson on the fodder crop of oat resulting in delayed sprouting, less number of tillers and less plant height. Puri *et al*. (2010) also reported reduction in fodder yield in subsequent cuttings of ryegrass + oats/sarson mixtures, higher seed rates of oats and sarson as compared to ryegrass alone. The total green fodder and dry matter yields of both the cuts increased with increase in seed rates of sarson but the differences were non-significant. The highest total green fodder (599.5 q/ha) and dry matter (124.1 q/ha) yields were obtained with oat + 2.5 kg sarson/ha mixture which was 7.7 and 5.1 percent higher than pure oat, respectively.

Seed and fodder equivalent yield

Cutting management influenced the seed yield of oat but the differences were non-significant (Table 1). The seed yield was highest in crop harvested at 55 DAS (8.95 q/ha) than the crop harvested at 65 DAS (8.40 q/ha). The cutting management did not influence the fodder equivalent yield significantly. Tiwana *et al.* (1987) reported 250 q/ha green fodder of oats in first cut and 15 q/ha of seed yield of second cut as compared to 20 q/ha seed yield from single cut oat. The seed yield of second cut of oats was influenced significantly with oat + sarson mixtures (Table 1). The seed yield of second cut of oat was highest in pure oat and decreased significantly with increase in seed rates of sarson from 1.25 to 3.18 kg/ha. The seed yield in pure oat was significantly higher over oat + 2.50 and 3.18 kg/ha sarson mixtures but was at par with oat + 1.25 and 1.88 kg/ha sarson mixtures. The fodder equivalent yield (green fodder yield of first cut and seed yield of second cut) was significantly higher in oat + sarson mixtures over pure oat. The fodder equivalent yield was highest in oat + 2.5 kg sarson/ha mixture by a margin of 9.2 to 11.5 percent than pure oat. The similar results have also been reported by Tiwana *et al*. (2007).

Fodder quality

Fodder quality of oat (pure) and oat + sarson mixtures was significantly influenced with cutting management (Table 2). The values of crude protein, IVDMD and ash contents were higher in first cut at 55 DAS than harvested at 65 DAS. In crude fibre content, the trend was reverse.

At 55 DAS, the crude protein, crude fibre, IVDMD and ashcontents were 12.2, 27.4, 62.4 and 10.1 percent, respectively as compared to 11.6, 28.8, 61.1 and 9.8 percent at 65 DAS. In second cutting at 50 percent flowering, the quality of oat was almost the same in both the cutting management. Tiwana *et al*. (2007) also reported higher crude protein in oat + sarson mixtures than pure oat.

Oat + sarson mixtures improved the quality of first cut fodder mixture than pure oat (Table 2). There was increase in crude protein, ash and IVDMD contents and decrease in crude fibre content with the increase in seed rates of sarson up to 3.13 kg sarson/ha. The crude protein content increased from 10.9 to 13.6, ash content from 9.5 to 10.1 and IVDMD from 60.6 to 62.4 percent in oat + 3.13 kg sarson/ha at 55 DAS. Similar trend was observed at 65 days after sowing. Kumar *et al*. (2010) reported 29.9 percent crude protein content in berseem + 1.88 kg sarson/ha as compared to 27.9 percent in pure berseem.

Economics

The net returns were influenced slightly with cutting management (Table 3). Higher net returns were obtained in first cutting at 65 DAS (Rs. 12865 – 17308 / ha in different treatments) than at first cutting at 55 DAS (Rs. 10273 – 15477/ha). The higher net return at 65 DAS was might be due to more fodder yield of mixtures in first cutting.

Oat + sarson mixtures increased the net returns appreciably than pure oat (Table 3). Net returns increased with in seed rates of sarson. Among the mixtures, oat + 2.5 kg sarson gave additional income of Rs. 4463/ha with first cut at 55 DAS and Rs. 5077/ha with first cut at 65 DAS than oat pure. The magnitude of increase was 34.8 and 49.4 percent, respectively. The higher fodder yield of mixture might have helped in increasing the net returns.

Conclusion

From the present study, it may be concluded that oat + 2.5 kg sarson/ha mixture recorded 57.9 percent higher green fodder and 60.5 percent higher dry matter yield in the first cutting; and 7.7 percent higher total fodder yield of both the cuts over oat (pure). The crude protein, ash and IVDMD contents were higher in oat + sarson mixtures than pure oat. Seed yield decreased with increase in seed rates of sarson but fodder equivalent yield was highest with oat + 2.5 kg sarson/ha mixture.

Table 1. Effect of cutting management and seed rates of sarson on the fodder mixture and seed yield of oat (pooled data 2007-08 to 2010-11)

Treatments	Green fodder yield (q/ha)			Dry matter yield (q/ha)			Fodder equivalent yield (q/ha)	Seed yield (q/ha)
	Cut I	Cut II	Total	Cut I	Cut II	Total	Cut II	
Cutting management								
1st cut at 55 DAS	200.7	371.3	572.0	26.3	93.5	119.8	8.95	388.9
1st cut at 65 DAS	236.0	359.6	595.6	36.0	88.6	124.6	8.40	398.1
C D (P=0.05)	11.8	NS	NS	1.58	NS	NS	NS	NS
Oat + sarson mixtures (kg/ha)								
T_1	158.2	398.5	556.7	22.3	95.8	118.1	10.70	382.1
T_2	198.1	383.0	581.1	28.6	93.7	122.3	9.96	407.2
T_3	227.3	363.6	590.9	32.5	91.0	123.5	8.84	416.0
T_4	249.8	349.7	599.5	35.8	88.3	124.1	7.99	421.6
T_5	258.7	332.5	591.2	36.4	84.1	120.5	5.91	386.8
C D (P=0.05)	18.6	NS	NS	2.49	8.26	NS	1.59	NS

Interaction between cutting management and sarson mixtures were non-significant

T_1- Oat pure (62.5 kg/ha) T_2- Oat + sarson (1.25 kg/ha) T_3- Oat + sarson (1.88 kg/ha) T_4- Oat + sarson (2.50 kg/ha) T_5- Oat + sarson (3.18 kg/ha)

Table 2. Effect of seed rates of sarson on the quality of first cut of oat + sarson fodder mixture (mean of 2007-08 to 2010-11)

Treatments (kg/ha)	Crude protein (%)		Crude fibre (%)		IVDMD (%)		Ash (%)	
	55 DAS	65 DAS	55 DAS	65 DAS	55 DAS	65 DAS	55 DAS	65 DAS
T_1	10.9	10.6	28.8	30.4	60.6	59.7	9.5	9.3
T_2	11.3	10.9	28.2	29.5	61.8	60.3	9.8	9.5
T_3	12.2	11.4	27.5	28.9	62.3	61.0	10.0	9.8
T_4	13.0	12.1	26.7	28.0	62.9	61.9	10.3	10.0
T_5	13.6	12.8	26.0	27.4	64.3	62.5	10.7	10.2
Mean	12.2	11.6	27.4	28.8	62.4	61.1	10.1	9.8

Table 3. Effect of seed rates of sarson on the economics (Rs./ha) of oat + sarson fodder mixture (2007-08 to 2010-11)

Treatments	Cost of cultivation	Gross returns	Net returns	Increase over oat pure	
				Rs./ha	(%)
First cut at 55 DAS and second cut at 50 % flowering					
T_1	15,943	26,216	10,273	-	-
T_2	16,024	28,873	12,849	2,576	25.1
T_3	16,049	30,274	14,225	3,952	38.5
T_4	16,074	31,424	15,350	5,077	49.4
T_5	16,099	31,576	15,477	5,204	50.7
Mean	16,038	29,673	13,635	4,202	40.9
First cut at 65 DAS and second cut at 50 % flowering					
T_1	15,943	28,788	12,845	-	-
T_2	16,024	30,756	14,732	1,887	14.7
T_3	16,049	32,246	16,197	3,552	26.1
T_4	16,074	33,383	17,308	4,463	34.8
T_5	16,099	33,348	17,249	4,404	34.3
Mean	16,038	31,704	15,666	3,577	27.5

Table 4. Effect of seed rates of sarson on the growth characteristics of oat and sorson in oat + sarson mixture

Treatments (kg/ha)	1st cut 55 DAS		1st cut 65 DAS		1st cut 55 DAS		1st cut 65 DAS	
	Cut I	Cut II	Cut I	Cut II	Cut I	Cut II	Cut I	Cut II
	Plant height of oat (cm)				Tillers/m of oat			
T_1	34.2	123.6	43.4	116.8	63.5	59.3	69.7	54.9
T_2	37.2	121.4	46.0	115.3	61.7	56.7	65.5	52.3
T_3	39.6	118.8	48.4	112.7	60.5	54.9	64.8	50.7
T_4	41.9	117.0	49.5	110.1	59.1	52.8	32.2	48.6
T_5	43.2	115.7	51.2	109.3	57.6	51.0	62.1	45.4
Mean	39.2	119.3	47.7	112.8	60.4	54.9	65.1	50.4
	Plant height of sarson (cm)				Plant population of sarson			
T_2	91.8	-	109.2	-	26.1	-	25.4	-
T_3	96.1	-	112.1	-	34.1	-	34.1	-
T_4	97.2	-	114.3	-	39.8	-	38.8	-
T_5	99.7	-	116.5	-	42.3	-	42.7	-
Mean	96.2	-	113.0	-	35.6	-	35.3	-

CD 5% Oat Cutting management (55 DAS) Cut I-3.00 Cut II-7.76 Cutting mgt. (65 DAS) Cut-I: 4.07 Cut- II: 3.10
Mixtures 4.75 12.27 Mixtures 6.44 4.99
Sarson Cutting mgt: 5.43 Mixtures: NS Cutting mgt: NS Mixtures: 3.84

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