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Research Article

YIELD AND FORAGE QUALITY TRAITS OF FODDER OAT (*Avena sativa* L.) VARIETIES UNDER INTEGRATED MANAGEMENT TECHNIQUES IN IRRIGATED SUB-TROPICS OF JAMMU REGION

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Abstract: The A field experimental was conducted at Research Farm of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, during winter season of 2016-17 to study the yield and forage quality traits of fodder oat (*Avena sativa* L.) varieties under integrated management techniques. The experimental soil of the field was texturaly sandy clay loam, slightly alkaline in reaction (7.60), low in organic carbon (0.47 per cent) and available nitrogen (210.80 kg/ha) but medium in available phosphorus (13.25 kg/ha) and potassium (110.5 kg/ha) with electrical conductivity in the safer range. The experiment consisting of three varieties *viz*. Kent (V1) JHO-851 (V2) and Palampur-1 (V3) and five integrated nutrient management treatments on soil test basis were recommended dose of fertilizers (T1), RDF +25% RDN through FYM (T2), 75% RDF + 25% RDN through FYM (T3), 50% RDF +50% RDN through FYM (T4) and 25% RDF + 75% RDN through FYM (T5) in three replications was laid out in Factorial Randomized Block Design. Among integrated nutrient management, the treatment where RDF was incorporated with 25% RDN through FYM proved superior in terms of yield, green (239.50 kg/ha/day) and dry fodder efficiency (61.34 kg/ha/day). As regard to quality characters significantly lowest ADF and NDF was recorded with RDF + 25% RDN through FYM which was found to be statistically at par with 100% RDF whereas, significantly highest crude protein at second and third cut and crude protein yield (1.19 t/ha) as well as total digestible crude protein yield (0.49 t/ha) was also recorded in RDF + 25% RDN through FYM.

Among the varieties, Variety Kent out yielded other varieties to the tune of 21.17 and 5.09 t/ha at first and third cut, respectively with maximum green fodder (233.73kg/ha/day) and dry fodder (58.54 kg/ha/day) production efficiency. As regard to quality traits ADF and NDF were recorded significantly lowest in Kent and Palampur-1 varieties, at first cut, respectively. Also, Kent recorded the numerically highest crude protein (12.44 and 11.63 per cent in second and third cut, respectively) and crude protein yield (1.08 t/ha) as well as total digestible crude protein yield (0.38 t/ha).

Keywords: *Fodder production efficiency, Crude protein yield, Total digestible crude protein yield, Quality traits, ADF*

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Introduction

Forage and livestock are the vital part of the Indian agricultural system [1]. As the agriculture and livestock sector provides employment to 52 per cent of the work force. Whereas, especially in rural areas nearly 70 per cent of Indian population is engaged in livestock production and management and thus the livestock sector alone creates large self-employment opportunities in these regions [2]. Further, its contribution to the Gross Domestic Product and Agricultural Gross Domestic Product is to the tune of 4.11 per cent and 25.6 per cent, respectively [3]. Also, the share of Indian animal husbandry sector to the Gross Value Output of the country agriculture has been increasing continuously at faster rate than the crop sector. This suggests that livestock is likely to emerge as an engine of agricultural growth in the coming decades but animal productivity in our country is lower than other developed countries. To compensate for the low productivity of the livestock, availability of green forage to animals is the key to success of dairy enterprises as it is difficult to maintain the health and milk production of the livestock without supply of green fodder. Among fodder crops the oat is fast growing and it produces a considerable amount of quality fresh fodder within short period ranging from 60 to 70 days with adequate nutritional facts [4]. Different oat varieties have their specific characteristics, phenology, growth habits which further affects its yield and quality traits. Thus, selection of high yielding local specific oat varieties is also very important criteria for bridging the gap between demand and supply of fodder [5].

Further the fodder crops are grown in poor and marginal areas having low nutrient supply. The integration of organic and inorganic sources of nutrients to fodder crops not only increase productivity of fodder oat but also enhance its qualitative traits. Keeping this in view an experimental trial was laid to evaluate yield and quality traits of fodder oat (*Avena sativa* L.) varieties under integrated management techniques in irrigated sub- tropics of Jammu region.

Materials and Methods

A field experimental trial was conducted during *rabi* season of 2016-17 at Research Farm of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The Geographical location of experimental site is located at 32◦39' N latitude and 74◦53' E longitude at an elevation of 332 meter above mean sea level. The climate of the site is subtropical with hot and dry early summers followed by hot and humid summers and cold winters. The average annual rainfall is nearly 1174 mm, which is mainly received in the months of June to September. The initial soil sample analysis revealed that soil was texturaly sandy clay loam, slightly alkaline (7.60), low in organic carbon (0.47 per cent) and available nitrogen (210.80 kg/ha) but medium in available phosphorus (13.25 kg/ha) and potassium (110.5 kg/ha) with electrical conductivity of 0.21ds/m. The experiment consisted of fifteen treatment combinations with five integrated nutrient management techniques on soil test basis *viz*. Recommended dose of fertilizers,

Table-1 *Fodder yield, efficiency and dry matter (%) of fodder oat varieties at different harvesting intervals under varying INM treatments*

Treatments	Green fodder yield (t/ha)			Dry fodder yield (t/ha)			Dry matter (%)			Green fodder production efficiency (kg/ha/day)	Dry fodder production efficiency (kg/ha/day)
Integrated nutrient management	Ist Cut	IInd Cut	IIIrd Cut	Ist Cut	IInd Cut	IIIrd Cut	Ist Cut	IInd Cut	IIIrd Cut		
T_1: (Recommended dose of fertilizers (RDF)	18.73	11.28	5.27	3.74	2.71	2.53	19.05	23.82	46.00	225.57	57.40
T_2: (RDF +25% RDN through FYM)	19.62	12.23	5.80	3.92	2.94	2.78	18.46	21.80	53.14	239.50	61.34
T_3: (75% RDF + 25% RDN through FYM)	15.03	11.03	4.73	3.00	2.65	2.27	20.96	24.31	48.14	195.37	50.26
T_4: (50% RDF +50% RDN through FYM)	14.03	10.36	4.09	2.8	2.49	1.97	19.23	24.08	51.03	180.48	45.99
T_5: (25% RDF + 75% RDN through FYM	11.95	8.7	3.59	2.39	2.09	1.72	19.13	25.19	45.47	153.13	39.17
Sem(±)	0.63	0.66	0.34	0.07	0.09	0.07	0.70	0.11	0.24	-	-
CD (5%)	1.83	1.92	1.00	0.21	0.27	0.22	1.90	0.31	0.74	-	-
Varieties											
V_1: (Kent)	21.17	9.51	5.09	4.23	2.29	2.44	17.18	26.43	48.44	233.73	58.54
V_2: (JH0-851)	10.42	12.91	4.00	2.08	3.10	1.92	25.44	21.62	50.74	164.97	42.85
V_3: (Palampur-1)	16.02	9.75	5.00	3.21	2.40	2.40	19.25	23.48	47.10	200.07	51.66
Sem(±)	0.49	0.51	0.25	0.06	0.07	0.06	0.61	0.08	0.20	-	-
CD (5%)	1.42	1.49	0.71	0.16	0.22	0.17	1.81	0.25	0.72	-	-

Table-2 *ADF(%), NDF (%) and crude protein (%) of fodder oat varieties at different harvesting intervals under varying INM treatments*

Treatments	ADF (%) Harvesting intervals			NDF (%) Harvesting intervals			Crude protein (%) Harvesting intervals			Crude protein yield	Total digestible crude protein yield
Integrated nutrient management	Ist Cut	IInd Cut	IIIrd Cut	Ist Cut	IInd Cut	IIIrd Cut	Ist Cut	IInd Cut	IIIrd Cut		
T_1: (Recommended dose of fertilizers(RDF)	30.91	32.47	32.84	52.95	52.77	53.44	12.37	12.42	11.66	1.09	0.39
T_2: (RDF +25% RDN through FYM)	30.21	31.94	31.82	51.96	51.33	52.00	12.45	12.91	11.80	1.19	0.49
T_3: (75% RDF + 25% RDN through FYM)	31.75	32.91	33.25	53.58	54.11	54.33	12.18	12.22	11.54	0.94	0.25
T_4: (50% RDF +50% RDN through FYM)	33.08	33.31	33.89	54.15	56.77	56.77	12.16	12.16	11.45	0.86	0.17
T_5: (25% RDF + 75% RDN through FYM	33.50	33.74	34.29	55.23	58.11	58.33	12.08	12.06	11.35	0.73	0.04
Sem(±)	0.63	0.56	0.49	0.58	0.73	0.74	0.09	0.15	0.09	-	-
CD (5%)	1.84	N.S	1.42	1.69	2.11	2.14	N.S	0.45	0.26	-	-
Varieties											
V_1: (Kent)	31.31	32.25	33.83	54.73	54.26	54.06	12.16	12.44	11.63	1.08	0.38
V_2: (JH0-851)	31.40	33.67	32.95	53.97	54.20	56.06	12.37	12.34	11.55	0.85	0.16
V_3: (Palampur-1)	32.96	32.71	32.87	52.02	55.40	54.80	12.21	12.28	11.50	0.95	0.26
Sem(±)	0.49	0.44	0.38	0.45	0.56	0.57	0.07	0.12	0.07	-	-
CD (5%)	1.43	N.S	N.S	1.31	N.S	N.S	N.S	N.S	N.S	-	-

RDF +25% RDN through FYM, 75% RDF + 25% RDN through FYM, 50% RDF +50% RDN through FYM and 25% RDF + 75% RDN through FYM and three varieties *viz*. Kent, JHO-851 and Palampur-1 with three replications and laid out in Factorial Randomized Block Design. The sowing was done with kera method on 3rd November by using 100 kg seed rate for all varieties by maintaining row to row spacing of 20 cm. The fertiliser dose was given as per soil test basis and then accordingly there was increase on RDF. On soil test basis the dose calculated for variety kent and palampur-1 was 100:40:40 and for JHO-851 was 150:40:40.

In all the treatments, at the time of sowing half dose of nitrogen and full dose of phosphorous and potassium was applied. The remaining half dose of nitrogen was top dressed in two equal splits one each at after first and second cut, respectively. The application of FYM was two weeks earlier as per technical programme. Crop was irrigated thrice through flooding method at pre-sowing (07 before sowing) followed by two irrigations (5 cm depth) at 71 and 116 days after sowing. Three cuts were taken for all varieties. First cut was done at first nodal appearance in all the treatments followed by second cut at 45 days after the first cut and third cut 45 days preceding to second cut. The plants were cut at 10 cm above the ground surface to allow good regeneration for the crop. The observations were recorded on forage yield and forage quality. Green as well as dry fodder production efficiency day-1 was calculated by dividing respective green and dry fodder yield by number of days for cutting and expressed in kg ha day-1. The forage quality was determined after the samples were dried and crushed to a fine powder to find crude protein content, neutral detergent fibre and acid detergent fibre

Percent crude protein = [(Vol.of N/10 H2SO4 x 250 x 0.0014 x 6.25)/ (Aliquot taken x Weight of sample on DM basis)]x 100

NDF (%) = [(wt. of crucible + cell wall contents) – (wt. of crucible) / (wt. of the sample)] x 100

*ADF (%) =(X-Y)/S*100*

Where, X = weight of oven dried crucible including ADF

Y = weight of empty oven dried crucible

S = sample weight on DM basis

Crude protein yield (CPY) was calculated by multiplying crude protein with total dry matter and the total digestible crude protein (TDCPY) was calculated by equation adopted by Iqbal et al., 2014.

TDCPY= (0.97X crude protein yield)- 0.67

The data recorded for various characters were subjected to statistical analysis according to procedure outlined by Cochran and Cox, 1963. All the comparisons were worked out at 5 per cent level of significance.

Results and Discussion

Yield and production efficiency

Data revealed that significantly higher green fodder biomass yield (19.62 t/ha, 12.23 t/ha and 5.80 t/ha at first, second and third cut, respectively), dry biomass yield (3.92, 2.94 and 2.78 t/ha at first, second and third cut, respectively) green (239.50 kg/ha/day) and dry (61.34 kg/ha/day) fodder production efficiency was recorded in those treatments where RDF was coupled with 25% RDN through FYM. This might be due to luxuriant vegetative growth accumulation where RDF was applied along with 25% RDN through FYM. These findings are in conformity with [6]and [7] [Table-1].

Further it was evident from the [Table-1] that there was significant effect of varieties on the fodder oat yield. Variety Kent out yielded other varieties to the tune of 21.17 and 5.09 t/ha at first and third cut, respectively. However, at the third cut variety Kent was statistically at par with Palampur-1. Whereas, at second cut JHO-851 produced significantly highest yield (12.91 t/ha) followed by Palampur-1 (9.75 t/ha) and Kent (9.51 t/ha), respectively.

This might be due to more regeneration capacity of JHO-851 after first cut as compare to other varieties. Kent recorded the highest green fodder production efficiency (233.73 kg/ha/day) and dry fodder production efficiency (58.54 kg/ha/day) followed by Palampur-1 (200.07kg/ha/day and 51.66 kg/ha/day, respectively) and JHO-851 (164.97 kg/ha/day and 42.85 kg/ha/day, respectively). The variation in green fodder yield and dry biomass yield might be related to inherent differences among varieties as improved yield from varieties could be attributed to improvement in growth parameters which lead to more green and dry biomass yield. The results are in conformity with the findings of [5].

Quality characters

Acid detergent fiber is an important forage testing technique used to calculate digestibility as its main constituents are cellulose and lignin. Among INM treatments RDF +25% RDN through FYM recorded the lowest cellulose and lignin content in term of ADF (to the tune of 30.21, 31.94 and 31.82 per cent at first, second and third cut, respectively), NDF (to the tune of 51.96, 51.33 and 52.00 per cent at first, second and third cut, respectively) [Table-2]. Whereas, statistically the maximum crude protein to the tune of 12.91 and 11.80 per cent at second and third cut, respectively was found in those treatments that were 100% RDF +25%

Table-3 *Effect of different INM treatments and varieties on soil pH, EC (dS/m) and OC (%) after the harvest of fodder oat*

Treatments	pH	EC (dS/m)	OC (%)
Integrated nutrient management			
T_1: (Recommended dose of fertilizers (RDF)	7.55	0.23	0.44
T_2: (RDF +25% RDN through FYM)	7.76	0.24	0.46
T_3: (75% RDF + 25% RDN through FYM)	7.56	0.23	0.46
T_4: (50% RDF +50% RDN through FYM)	7.56	0.24	0.48
T_5: (25% RDF + 75% RDN through FYM	7.72	0.23	0.48
Sem(±)	0.07	0.01	0.01
CD (5%)	N.S	N.S	N.S
Varieties			
V_1: (Kent)	7.66	0.23	0.46
V_2: (JH0-851)	7.54	0.23	0.46
V_3: (Palampur-1)	7.7	0.23	0.47
Sem(±)	0.06	0.01	0.01
CD (5%)	N.S	N.S	N.S
V×T	N.S	N.S	N.S
Initial status	7.6	0.21	0.47

Table- 4 *Effect of different INM treatments and varieties on available N (kg/ha), P (kg/ha) and K (kg/ha) after the harvest of fodder oat*

Treatments	N (kg/ha)	P (kg/ha)	K (kg/ha)
Integrated nutrient management			
T_1: (Recommended dose of fertilizers (RDF)	217.43	13.18	114.41
T_2: (RDF +25% RDN through FYM)	221.50	13.78	120.64
T_3: (75% RDF + 25% RDN through FYM)	228.66	13.12	112.66
T_4: (50% RDF +50% RDN through FYM)	230.55	13.23	116.15
T_5: (25% RDF + 75% RDN through FYM)	247.04	13.43	117.42
Sem(±)	9.60	0.22	7.71
CD (5%)	N.S	N.S	N.S
Varieties			
V_1: (Kent)	220.28	13.31	114.19
V_2: (JH0-851)	222.35	13.43	111.11
V_3: (Palampur-1)	244.48	13.30	123.49
Sem(±)	7.43	0.17	5.97
CD (5%)	N.S	N.S	N.S
Initial status	210.80	13.25	110.50

RDN through FYM was applied, but at third cut RDF + 25% RDN through FYM (T2) was statistically at par with 100% RDF (T1) (11.66%) and 75% RDF +25% RDN through FYM (T3) (11.54%). The low percentage of ADF and NDF are desirable characters in different animal forages. Low ADF values mean that forage has higher energy value and digestibility while NDF of forage is inversely related to the intake capacity or the amount of forage that animal is able to consume. The decrease in ADF and NDF content with increase in level of nitrogen in100% RDF +25% RDN through FYM might be due to increase in succulence of plant by reducing formation of polysaccharides. Similar results are obtained by [6] in oats. Whereas, in term of crude protein forage with higher value of CP is considered better in terms of quality. The maximum crude protein (12.45, 12.91 and 11.80 %), crude protein yield (1.19 t/ha) and total digestible crude protein yield (0.49t/ha) in treatment RDF +25% RDN through FYM might be due to higher doses of nitrogen which may have increased the nitrogen concentration in plant and hence the crude protein content. Similar findings are made by [6] who also reported that crude protein percentage increased with the increase of nitrogen fertilizer. Thus, increase in protein concentration due to added nitrogen reduce the dependency on protein supplements and hence is desirable character [4].

Among varieties significant variations in the ADF and NDF have been noticed in first cut where Palampur-1 and Kent recorded highest ADF and NDF respectively. The variation in quality parameters of varieties might be related to inherent differences among them. [6] also reported the highest NDF content (57.45%) in variety Kent. There was no significant variation in the ADF, NDF% due to varieties at second and third cut. Non-significant variations among the varieties with respect to crude protein (%) was found at all the harvesting intervals. The result is conformity with findings of [6]. Kent also out yielded in crude protein yield (1.08t/ha) and total digestible crude protein yield (0.38 t/ha). Hence perform better in irrigated subtropics.

Soil quality

Though non-significant effect on soil pH, EC and organic carbon content of soil was recorded under the influence of integrated nutrient management (INM) and varieties as depicted in [Table-3]. However, a marginal change in soil pH organic carbon content of the soil was noticed, while EC was slightly increased over the initial value under different treatments after harvest of fodder oat. The highest value of available soil nitrogen (247.04 kg/ha) was observed where 25% RDF was incorporated along with 75% RDN through FYM, Whereas, highest value of phosphorus (13.78 kg/ha) and potassium (120.64 kg/ha) was observed where RDF+25% RDN through FYM was incorporated. The respective build up percentage of available N, P and K over initial value is 17.19, 4.0 and 9.2, respectively. Similar results were observed by [8] However, in varieties numerically the highest value of available nitrogen (244.48 kg/ha) and potassium (123.49 kg/ha) was observed in the plot where Palampur-1 variety of fodder oat was grown whereas highest soil available phosphorus was in JHO-851(13.43 kg/ha) [9, 10] [Table-4].

Application of research: The integration of organic and inorganic sources of nutrients to fodder crops not only increase productivity of fodder oat but also enhance its qualitative traits. Keeping this in view an experimental trial was laid to evaluate yield and quality traits of fodder oat (*Avena sativa* L.) varieties under integrated management techniques in irrigated sub- tropics of Jammu region.

Research Category: Quality Fodder Production, INM

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Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Research Farm of Agronomy

Cultivar / Variety / Breed name: Kent, Palampur-1

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
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