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CONTENTS

Effect of nitrogen scheduling on fodder yield, quality and economics of multi cut fodder oat (*Avena sativa L.)*

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ABSTRACT: The study was conducted at Instructional Dairy Farm, Nagla, G. B. Pant University of Agriculture and Technology, Pantnagar in the *Rabi* season of 2021-22 to assess the 'Effect of nano urea scheduling on fodder yield, quality and economics of multi cut fodder oat (*Avena sativa* L.)'. Nano urea scheduling had significant effect on growth attributes, fodder yield, quality and economics of multicut fodder oat. The results revealed that application of 125% RDN (75 kg N basal followed by top dressing of 37.5 kg N each at 1st and 2nd cut) had significantly higher growth attributes, green and dry fodder yield quality and also economics with 6.9, 6.6 and 10.3% higher green fodder yield, 8.1, 7.2 and 11.1% higher dry fodder yield and 10.2, 8.5 and 16.8% higher net returns than 125% RDN+NU, 100% RDN and 100% RDN+NU treatments, respectively, Among the vermicompost treatments, the GFY was 3.1 and 3.3% and DFY was 3.8 and 2.2% higher under 75%RDNVC+NU than 100% RDNVC and 50% RDNVC+NU, respectively. The B:C ratio was higher under 75% RDNVC+NU than 100% RDNVC. Alone application of nano urea either at 45 DAS or 20 and 40 DAS followed by its spray at 1st and 2nd cut had significantly higher values than control but lower than other treatments. The crude protein content and production followed the similar trend as found in case of GFY and net return. Therefore it is concluded that multicut oat may be grown with application of 100% RDN i.e., 120:60:40:: N:$P_2 0_5$:$K_2 0$ kg/ha and for organic oat fodder, vermicompost may be applied @4.5 t/ha as basal followed by two spray with nano urea @ 4ml/l at 1st and 2nd cut for higher growth, foliage yield, quality and net profits in *Tarai* region of Northern Himalaya and may also be replicated in other oat growing regions of India.

Key words: Green fodder yield, LAI, nano urea, net return, oat, SPAD

Oat (*Avena sativa* L.) is an important fodder crop grown during the *Rabi* season from October to April in North India mainly in Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu &Kashmir and Bihar. It is also grown in Gujarat, Andhra Pradesh, Telangana, Maharashtra and also hilly tracts of southern plateau (Chakraborty *et al*., 2016) covering acreage nearly more than 1.0 lakh ha with average productivity of 35-40 t/ha. Oat is generally fed as greed fodder and the surplus green fodder is converted in silage and hay used during lean period (Suttie and Reynolds, 2004). It's green fodder is succulent, highly palatable and nutritious with 10-11.5% crude protein, 55-64% neutral detergent fibre (NDF), 30-32% acid detergent fibre (ADF), 22-23% cellulose, and 17-20% hemicelluloses and 60-65% digestibility at harvesting of 50% flowering stage. Presently the world acreage of oat is 9.97 m ha with 25.48 m tons production (USDA, 2022) and mainly grown in temperate parts of Europe, USA and Canada.

Balanced nutrition of oat is the pre-requisite of higher productivity. Both excess and lower nutrition lead to lower crop productivity and nutrient use efficiency. The nutrient requirement of oat is relatively higher than other *Rabi* fodder crops (Godara *et al*., 2012). Normally imbalanced chemical fertilizers are used to fulfill the nutritional crop requirements that not only damage the whole ecosystem such as polluted air, water, soil, degraded lands and increased green house gases (Bisht and Chauhan, 2021) but also affect the crop yield and quality. Therefore, integrated approach including organic and chemical fertilization has proved its utility over alone chemical fertilization (Bhatt *et al*., 2019). The beneficial effects of organic manures like vermicompost, FYM, compost etc. on crop, soil and environment have also been reported (Shaji *et al*., 2020).

Presently the demand of organic products is very high in different parts of the world due to adverse impact of chemical fertilization but the required availability of organic manures is a major hurdle in organic crop production. Similarly organic milk and dairy products are on increasing demand, so the organic fodder to feed the milch livestock. The organic manures like vermicompost and cakes are very costly and increase cost of fodder production in one hand and on other hand, the chemical fertilizers are costly, harmful and also not available timely. Therefore, the nano-particles or nano fertilizers are the

wonderful option available as new alternative to inorganic fertilizers for commercial crop production. Nano fertilizers are required in less quantity, easy to handle, improve seed germination, seedling growth, N metabolism and carbohydrate and protein synthesis, improve crop productivity (Iqbal *et al*., 2019) with higher nutrient use efficiency (Mahil and Kumar, 2019). Nano materials also improve plant resistance to biotic and abiotic stress and enhance over all plant health (Tiwari *et al*., 2012).

Despite the growing prominence of fodder oat, almost negligible research work on integration of organic and nano fertilizers and its impact on oat fodder production has been carried out. It is quite necessary to optimize the scheduling of organic and nano fertilizer for maximizing the oat fodder production in India. Therefore, the present study on 'Effect of nano urea scheduling on fodder yield quality and economics of multi cut fodder oat (*Avena sativa L.)*' was undertaken to maximize the oat fodder productivity and economics in Tarai region of Western Himalaya.

MATERIALS AND METHODS

Field experiment was carried out at Instructional Dairy Farm, Nagla, G. B. Pant University of Agriculture and Technology, Pantnagar in the *Rabi* season 2021-22 to study the 'Effect of nano urea scheduling on fodder yield, quality and economics of multi cut fodder oat (*Avena sativa L.)'. The experimental site was located in the *Tarai* region of Shivalik range of Himalayas at latitude of 29° N and longitude of 79.3° E with an altitude of 243.84 meter above the mean sea level. During the experimental period, weekly mean maximum and minimum temperature were ranged between 16 to 34^{0}C and 4.3 to 17.1^{0}C, respectively with relative humidity from 31.3 to 93.9%. There were nine rainy days with over all rainfall of 154.3mm during crop season. The soil was silty clay loam in texture with granular structure having soil pH 6.70, EC 0.25 dS/m, organic carbon 0.75%, available nitrogen, phosphorus and potassium, 200.4. 19.0 and 226.3 kg/ha, respectively. The experiment consisted of 12 treatments i.e., 125% RDN (75 kg Nha^{-1} basal + top dressing of 37.5 kg Nha^{-1} each at 1st cut (50 DAS) and 2nd cut (75 DAS), 125% RDN + NU (Nano urea spray @ 4 ml/l at 1st and 2nd cut), 100% RDN (60 kg Nha^{-1} basal + top dressing of 30 kg Nha^{-1} each at 1st cut (50 DAS) and 2nd cut (75 DAS), 100% RDN+NU, 75% RDN (45 kg Nha^{-1} basal +NU, 50 % RDN (30 kg Nha^{-1} basal) +NU, 100% RDNVC (vermicompost@ 6 tha^{-1}), 75% RDNVC (vermicompost@4.5 tha^{-1})+NU. 50% RDNVC (vermicompost@ tha^{-1})+NU, NU 45 DAS+1st cut+2nd cut (foliar spray), NU 20 & 45 DAS+1st cut+2nd cut (foliar spray) and control(without nitrogen) was laid out in randomized block design with three replications. The uniform basal application of 60Kg phosphorus and 40 kg potash was made in all treatments. The recommended dose of fertilizers was 120 kg N, 60 kg P and 40 kg Kha^{-1}. The dose of vermicompost was calculated so that it may fulfill the recommended dose of nitrogen. The vermicompost applied in experiment had 2.0% N, 0.72% phosphorus and 0.84% potash. IFFCO made nano urea was sprayed @ 500mlacre^{-1} (4ml/l). The oat variety Pant Forage Oat-3 (UPO-06-1) was planted manually on 15th November 2021 at line to line spacing of 30cm. Pendimethalin @ 1.0 kg ai/ha was applied as pre-emergence herbicide to control weeds. The crop was irrigated at 15, 35 and 82 days after sowing. Sufficient rainfall was received in the month of January to meet out the crop water requirement. The crop was 1st harvested at 50 DAS followed by 2nd cut at 75 DAS and final at 135

Table 1: Effect of nano urea scheduling on growth attributes of multi cut oat in *Tarai* region of Uttarakhand

Treatment	Pl ht (cm)	No. of tillers m^{-1}	Leaf area index	L:S ratio	SPAD value
125% RDN	44	206	2.93	0.74	43.7
125% RDN+NU	38	185	2.79	0.67	37.7
100% RDN	40	191	2.84	0.70	40.1
100% RDN+NU	38	180	2.73	0.65	37.9
75% RDN+NU	36	165	2.67	0.62	36.2
50% RDN+NU	36	156	2.64	0.61	35.8
100% RDN VC+NU	34	137	2.60	0.58	33.7
75% RDN VC+NU	36	147	2.65	0.60	35.6
50% RDN VC+NU	35	141	2.63	0.59	34.6
NU 45DAS+I&II cut	36	138	2.59	0.54	35.5
NU 20&40DAS+I&II cut	36	140	2.57	0.58	35.7
Control	27	112	2.35	0.47	27.0
SEm±	02	11	0.08	0.03	2.0
CD at 5%	06	32	0.24	0.10	6.0
CV (%)	10	12	5.43	9.78	9.9

Table 2: Effect of nano urea scheduling on foliage yield and economics of multi cut oat in *Tarai* region of Uttarakhand

Treatment	Green fodder yield(t ha^{-1})	Dry fodder yield(t ha^{-1})	Crude protein(%)	Crude protein yield(t ha^{-1})	Gross return(₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
125% RDN	46.29	8.50	7.18	0.71	1,38,896	99586	3.53
125% RDN+NU	43.29	7.86	6.92	0.64	1,29,895	90356	3.29
100% RDN	43.41	7.92	7.00	0.65	1,30,248	91726	3.38
100% RDN+NU	41.52	7.65	6.85	0.60	1,24,577	85232	3.17
75% RDN+NU	39.85	7.26	6.69	0.57	1,19,565	80454	3.06
50% RDN+NU	38.04	6.91	6.63	0.54	1,14,125	74967	2.91
100% RDN VC+NU	37.32	6.63	6.19	0.49	1,11,965	49314	1.79
75% RDN VC+NU	38.50	6.94	6.63	0.54	115503	59152	2.05
50% RDN VC+NU	37.24	6.76	6.56	0.52	111731	62880	2.29
NU 45DAS+I&II cut	36.34	6.65	6.48	0.50	108703	68867	2.73
NU 20&40DAS+I&II cut	36.62	6.70	6.54	0.52	109875	69439	2.72
Control	30.97	5.36	6.00	0.39	92909	61044	2.92
SEm±	1.64	0.30	0.11	0.02	4961	4931	0.12
CD at 5%	4.82	0.88	0.33	0.07	14556	14556	0.36
CV (%)	7.59	7.39	2.95	7.22	7.27	11.48	7.39

Rate of green fodder: Rs 300/- per quintal

Das at 50% flowering stage. The growth attributes were recorded at 50% flowering stage. The green and dry fodder yield was recorded at each cut and summed it to present the total yield. Finally the gross and net return and also B:C ratio was worked out on the basis of gross return.

RESULTS AND DISCUSSION

Growth attributes

The growth attributes i.e., plant height, number of tillers/ m row length, leaf area index and also SPAD values were affected significantly by scheduling of nano urea (Table1). The tallest plants were recorded at 125% RDN that was significantly at par with 125% RDN+NU, 100% RDN and 100% RDN+NU. 125% RDN and 100% RDN had 3.4 and 2.8% taller plants than their corresponding treatments with nano urea spray, respectively. Among the treatments with vermicompost alone or integrated with nano urea spray, 75% RDNVC+NU gave 4.7 and 2.3% taller plants than 100% RDNVC and 50% RDN+NU, respectively. Both treatments with nano urea spray had statistically similar plant height that was significantly higher than control. The higher plant height at higher dose of chemical fertilizers was attributed to more availability of nitrogen that boosted the plant growth and development resulted into taller plants and similar results were also reported by Rajesh (2021). The number of tillers was also reported significantly higher at 125% RDN that was statistically similar with 125% RDN+NU, 100% RDN and 100% RDN+NU. Among vermicompost treatments, 75% RDNVC+NU produced 12.3 and 10.6% more tillers than 100% RDNVC and 50% RDNVC+NU, respectively. There was no significant difference in number of tillers in both treatments with alone spray of nano urea, however both had significant more tillers than control treatment.

The leaf area index was recorded significantly highest in 125% RDN among all the treatments, however it was significantly equal to 125% RDN+NU, 100% RDN and 100% RDN+NU. Similarly, the 75% RDNVC gave little higher leaf area index than 100% RDNVC and 50% RDNVC+NU. The LAI values under alone application of nano urea were significantly higher than control but lower than all other treatments where either alone inorganic fertilizers or in integration with nano urea was applied. Higher LAI was increased with increasing dose of fertilization either inorganic alone or combined with nano urea, that improved plant height, number of leaves and leaf area resulting in to more LAI. Aziz *et al*. (2016) also reported higher growth attributes under nano composite NPK than conventional NPK in wheat. The L:S ratio had similar trend with highest value under 125% RDN that was statistically equal to 125% RDN+NU, 100% RDN and 100% RDN+NU. 75% RDNVC+NU had higher L:S ratio than 100% RDNVC and 50%RDNVC+NU but all treatments had significantly equal values. There was no significant difference in L:S values among NU 45DAS+NU spray at 1st cut +2nd cut and NU 20 & 40 DAS+ NU spray at 1st cut +2nd cut and control treatments. The positive correlation between nitrogen rates and leaf percentage was observed (Kumar et al., 2015). The similar trend was also observed in SPAD values. Bahuguna and Pal (2020) also reported higher SPAD values at higher dose of inorganic fertilization in baby corn at Pantnagar.

Fodder yield

The green fodder and dry fodder yield of oat was significantly influenced by nano urea scheduling (Table.2). The green fodder yield was measured significantly higher at application of 125% RDN with 6.9, 6.6 and 10.3% higher than 125% RDN+NU, 100% RDN and 100% RDN+NU treatments, respectively though all were non-significant to each other. Among vermicompost applied treatments had significantly similar green fodder yield but 75% RDNVC+NU had 3.1 and 3.3% higher yield than 100% RDNVC and 50% RDNVC+NU, respectively. Treatments where nano urea was sprayed at different growth stages i.e., NU 45DAS+NU spray at 1st cut +2nd cut and NU 20 & 40 DAS+ NU spray at 1st cut +2nd cut gave significantly 17% higher GFY than control but lower than other inorganic fertilizer+ nano urea treatments. Similarly, dry fodder yield followed above GFY trend and 125% RDN gave 8.1, 7.2 and 11.1% higher values than125% RDN+NU, 100% RDN and 100% RDN+NU treatments, respectively and 75% RDNVC+NU had 3.8 and 2.2% higher yield than 100% RDNVC and 50% RDNVC+NU, respectively. Higher GYF and DFY were attributed to taller plants and more tillers/m at higher dose of fertilization. Rajesh (2021) also reported similar findings.

Quality

The crude protein content was estimated significantly higher at 125% RDN that was significantly equal to 125% RDN+NU, 100% RDN and 100% RDN+NU. Treatments with 75% or 50% RDN coupled with nano urea had lower crude protein content but had higher values than all the treatments with either vermicompost or alone spray of nano urea. Similarly, the crude protein production was recorded significantly higher at 125% RDN with 11.1 and 9.5% higher than 125% RDN+NU and 100% RDN, respectively. 75% RDNVC+NU also had 8.9 and 4.2% higher crude protein production than 100% RDNVC and 50% RDNVC+NU, respectively. Nano urea sprayed treatments had lower crude protein content as well as production but greater than control. The higher crude protein production was contributed by higher crude protein content and dry matter production. Bahuguna and Pal (2020) also reported higher crude protein production at higher dose of balanced fertilization.

Economics

The scheduling of nano urea had significant impact on gross return, net return and B:C ratio (Table.2). The highest gross return was recorded at application of 125% RDN that was 6.9, 6.6 and 11.4% greater than 125% RDN+NU, 100% RDN and 100% RDN+NU treatments, respectively, while net return was 10.2, 8.5 and 16.8% higher under 125% RDN than 125% RDN+NU, 100% RDN and 100% RDN+NU treatments, respectively. Among the vermicompost +nano urea treatment, the 75% RDNVC+NU gave 3.1 and 3.3% more gross return than 100% RDNVC and 50% RDNVC+NU treatments but 50% RDNVC+NU had 27.5 and 6.3% more net return than 100% RDNVC and 100% RDNVC+NU, respectively. The B:C ratio was found lowest in 1005 RDNVC mainly because of higher cost of cultivation. Other treatments integrated with vermicompost and nano urea gave lower B:C ratio than treatments with inorganic fertilizers and nano urea. Nagavani and Subbian (2014) also observed higher net returns and B:C ratio with inorganic fertilizers than organic manures.

CONCLUSION

The above research findings revealed that multicut oat may be grown with application of 100% RDN i.e., 120:60:40:: $N:P_2O_5:K_2O$ kg/ha for higher growth, fodder yield, quality and net profits. In addition, the combined application of vermicompost @4.5 t/ha as basal followed by two spray with nano urea @ 4ml/l at 1st and 2nd cut as promising combination may also be preferred for better fodder quality with least chemical residues as well as higher system sustainability in *Tarai* region of Western Himalaya and may also be replicated in other oat growing regions of India**.**

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