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Research Article

Effect of Nano Urea Scheduling on Productivity, Profitability and Residual Fertility of Multi Cut oat (*Avena sativa* L.)

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Abstract

Field study was carried out at Instructional Dairy Farm, Nagla, G. B. Pant University of Agriculture and Technology, Pantnagar in the Rabi season of 2021-22 to evaluate the 'Effect of nano urea scheduling on productivity, profitability and residual fertility of multi cut fodder oat (*Avena sativa* L.)'. Nano urea scheduling had significant effect on productivity, profitability and residual soil fertility of multicut fodder oat. The results showed 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 green and dry forage yield and also net return 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 green fodder yield was 3.1 and 3.3% and dry fodder yield 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. The residual available N, P and K were also found higher at 125 RDN that was at par with 100% RDN. Therefore it is concluded that multicut oat may be grown with application of 100% RDN i.e. 120:60:40 ::N:P_20_5:K_20 kg/ha and for organic oat fodder, vermicompost may be applied @4.5 t/ha as basal followed by two spay with nano urea @ 4ml/l at 1st and 2nd cut for higher productivity, profitability and sustainability in Tarai region of Northern Himalaya and may also be replicated in whole northern-Western regions of India.

Keywords: Fodder Yield; Nano Urea; Nutrient Uptake; Vermicompost; Residual Fertility

Introduction

The green fodder of oat (*Avena sativa* L.) is a highly succulent, 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 [17] and mainly grown in temperate parts of Europe, USA and Canada. In India, Gujrat, Andhra Pradesh, Telangana, Maharshtra and also hilly tracts of southern plateau are leading states in oat production [4] covering acreage nearly more than 1.0 lakh ha with average productivity of 35-40 t/ha. It is also good in making silage and hay, used during lean period [14]. Besides the oat grains are rich in antioxidants, ß-glucone, minerals, vitamin E, polyunsaturated fatty acids and other phytochemicals that are beneficial for human health [13].

Balanced plant nutrition and its optimization is a daunting task among agronomic practices for maximizing the production with higher nutrient use efficiency and sustainably of the systems. Chemical fertilization in form of urea, Diammonium phosphate, Muriate of Potash and complex fertilizers are the major source of plant nutrients but integrated nutrient management has higher productivity, profitability and sustainability [3]. With growing awareness and adverse effect of chemical fertilization, the demand of organic products including dairy products has increased and so the organic fodder production is on high demand among dairymen. Recently nano fertilizers like nano urea, nano DAP, nano Zn etc. are available

for commercial crop production. The nano fertilizers are required in less quantity, easy to handle, improve seed germination, seedling growth, N metabolism and carbohydrate and protein synthesis and improve crop productivity [5] with higher nutrient use efficiency [6]. Nano materials also improve plant resistance to biotic and abiotic stress and enhance over all plant health [16]. Hence nano urea is a good option to replace urea in agricultural production.

Despite the growing prominence of fodder oat, almost negligible research work on integration of organic, inorganic and nano fertilizers and its impact on oat fodder production have 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 productivity, profitability and residual soil fertility of multi cut fodder oat (*Avena sativa L.)*' was undertaken to maximize the oat fodder productivity and economics in North-West region of India.

Material and Methods

Field experiment was carried out at Instructional Dairy Farm, Nagla, G. B. Pant University of Agriculture and Technology, Pantnagar in *Rabi* season 2021-22 to study the 'Effect of nano urea scheduling on foliage yield and economics of multi cut fodder oat (*Avena sativa L.)'.* The experimental site was located in the *Tarai* region of Shivalik range of Himalayas in between latitude of 29° N to longitude of 79.3° E and at an altitude of 243.84 meter above the mean sea level. During the experimental period, weekly mean maximum and minimum temperature was ranged between 16-34^{0}C and 4.3 to 17.1^{0}C, respectively with relative humidity from 31.3 to 93.9%. There were 9 rainy days with over all rainfall of 154.3mm during crop season. The soil was slightly 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 and 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 varieties 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. The sufficient rainfall was in 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 Das at 50% flowering stage. The growth attributes were recorded at 50% flowering stage, while mean CGR and RGR at 0-50 DAS, 50-75 DAS and 75-135DAS. 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. The soil samples taken after harvest of crop were analyzed for soil pH, organic carbon and available N, P and K.

Results and Discussion

Fodder and crude protein yield

The green fodder and dry fodder yield of oat was significantly influenced by nano urea scheduling (Table 1). 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 and 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. [1] reported higher plant height, leaf area, number of leaves per plant, number of tillers per plant and per m^2 and green fodder yield in 100% RDF from inorganic fertilizer sources in contrast to organic manure. Higher GYF and DFY were attributed to taller plants and more tillers/m at higher dose of fertilization. The similar findings were also reported [9,10].

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. [2] also reported higher crude protein production at higher dose of balanced fertilization

Nutrient uptake

The uptake of N, P and K was affected significantly by nano urea scheduling (Table 1). The highest N uptake was recorded at 125% RDN that gave 9.6% higher N uptake than 100% RDN, though both treatments were non-significant to each other. The P and K uptake was also obtained significantly higher at 125% RDN with 7.9 and 9.9% and 7.7 and 7.8% higher, respectively than 125% RDN + NU and 100% RDN but were significantly similar with each other. It is also very clear that 75% RDNVC + NU had had N, P and K uptake than 100% RDNVC. Similarly the alone spray of nano urea treatments i.e. NU 45DAS + I and II cut and NU 20 and 40DAS + I and II cut, gave higher P and K uptake than 100% RDNVC. It may be possibly due to positive response of nano particles on metabolic activation of enzymes leading to more absorption and translocation of P and K from source to sink and it was also supported [8]. The slow release nano fertilizers increased significantly soil nutrients, soil microbial population and soil enzymatic activities [15].

Economics

Scheduling of nano urea had significant impact on gross return, net return and B:C ratio (Table 1). 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 50% 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 75% 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. The nano urea treated treatments had significantly higher gross, net returns and B:C ratio than control but lower than all other treatments. The higher net returns and B:C ratio were reported at application of inorganic fertilizers than organic manures [7].

Treatment	Fodder yield (t ha^{-1})			Nutrient uptake (kg/ha)			Economics (₹ha^{-1})		
	Green fodder	Dry fodder	Crude protein	N	P	K	Gross return	Net return	B:C ratio
125% RDN	46.29	8.50	0.71	113.32	30.11	119.49	1,38,896	99586	3.53
125% RDN + NU	43.29	7.86	0.64	101.89	27.90	110.90	1,29,895	90356	3.29
100% RDN	43.41	7.92	0.65	103.31	27.30	110.81	1,30,248	91726	3.38
100% RDN + NU	41.52	7.65	0.60	96.69	25.92	105.78	1,24,577	85232	3.17
75% RDN + NU	39.85	7.26	0.57	90.91	24.43	100.53	1,19,565	80454	3.06
50% RDN + NU	38.04	6.91	0.54	85.83	23.06	95.98	1,14,125	74967	2.91
100% RDNVC	37.32	6.63	0.49	79.68	20.74	90.94	1,11,965	49314	1.79
75% RDNVC + NU	38.50	6.94	0.54	85.89	20.86	94.27	115503	59152	2.05
50% RDNVC + NU	37.24	6.76	0.52	82.57	19.46	90.44	111731	62880	2.29
NU 45DAS + I and II cut	36.34	6.65	0.50	80.70	22.15	91.79	108703	68867	2.73
NU 20 and 40DAS + I and II cut	36.62	6.70	0.52	82.40	22.56	93.32	109875	69439	2.72
Control	30.97	5.36	0.39	61.83	14.29	70.09	92909	61044	2.92
Sem ±	1.64	0.30	0.02	3.60	1.10	4.17	4961	4931	0.12
LSD (0.05)	4.82	0.88	0.07	10.84	3.23	12.25	14556	14556	0.36
CV (%)	7.59	7.39	7.22	7.22	8.22	7.39	7.27	11.48	7.39

Table 1: Effect of nano urea scheduling on fodder yield, nutrient uptake and economics of multi cut oat.

Rate of green fodder: Rs 300/- per quintal.

Residual soil fertility

The residual plant nutrients i.e., N, P and K were affected significantly by nano urea scheduling, but the residual soil pH and EC did not affected significantly by nano urea scheduling (Table 2), however the soil pH reduced compared to initial value at addition of either forms of nitrogen mainly because of acidification of soil as reported [12]. The EC was recorded higher at application of 125% RDN that did not differ significantly among the treatments. The organic carbon increased with application of either nitrogenous fertilizer or vermicompost compared to initial value with the highest value at 100% RDNVC that was statistically at par with 75% RDNVC + NU and 50% RDNVC + NU. [11] also reported higher organic carbon at addition of vermicompost. Similarly, the available N, P and K increased with application of either nitrogenous fertilizer or vermicompost compared to initial values. The highest available N was estimated at 125% RDN that was statistically equal to 125% RDN + NU, 100% RDN and 75% RDN + NU treatments. The available P and K was found slightly higher at 125% RDN + NU than 125% RDN, 100% RDN and 100% RDN + NU but remained non-significant to each other. The available K was also found significantly higher at 125% RDN + NU that remained non-significant with 125% RDN, 125% RDN + NU, 100% RDN,100% RDN + NU, 75% RDN + NU, 50% RDN + NU and 100% RDNVC treatments. Alone application of nano urea had, in general, lower soil pH, EC and available N but higher available P and K than initial values possibly due to catalyzing the enzymes that led to more availability and absorption of P and K [7].

Treatment	Soil pH	EC (ds/m)	Organic carbon (%)	Available Nitrogen(kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
Initial values	6.70	0.25	0.75	**200.4**	**19.4**	**226.8**
125% RDN	6.55	0.27	0.77	213.6	21.7	234.4
125% RDN + NU	6.60	0.26	0.76	209.0	21.8	234.7
100% RDN	6.56	0.26	0.75	211.2	20.6	234.2
100% RDN + NU	6.62	0.26	0.76	208.0	20.5	233.8
75% RDN + NU	6.64	0.25	0.75	206.0	20.5	233.8
50% RDN + NU	6.65	0.25	0.75	204.9	20.4	233.9
100% RDN VC + NU	6.58	0.26	0.80	206.5	20.3	230.8
75% RDN VC + NU	6.60	0.26	0.79	203.9	20.0	229.3
50% RDN VC + NU	6.61	0.25	0.78	200.0	19.8	227.0
NU 45DAS + I and II cut	6.60	0.25	0.75	194.7	20.5	234.2
NU 20 and 40DAS + I and II cut	6.60	0.25	0.74	194.0	21.4	233.8
Control	6.60	0.24	0.74	189.0	18.6	223.5
SEm ±	0.49	0.01	0.01	2.0	0.4	1.6
LSD (0.05)	NS	NS	0.02	6.0	1.3	4.8
CV (%)	1.29	2.65	1.35	1.7	3.8	1.2

Table 2: Effect of nano urea scheduling on residual soil fertility of multi cut oat.

Conclusion

The experimental findings indicate that multi cut oat can be grown with application of 100% RDN i.e., 120 kg along with 60 kg phosphorus and 40 kg potash recommended dose of fertilizers per hectare for higher productivity, profitability and residual soil fertility. In addition, basal application of vermicompost @ 4.5t/ha followed by two spray of nano urea @ 4ml/l water at 1st and 2nd cut may also be preferred for better fodder quality and residual fertility in *Tarai* region of Northern-Western India.

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