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Enhancement of Yield, Nitrogen use Efficiency, Production Economics of Fodder Oat through Selection of Appropriate Genotype and Nitrogen Fertilizer Application

Saikat Sarkar [a*], Gangadhar Nanda [a], Devendra Singh [a], Sunil Kumar [a], Santosh Kumar Singh [b] and Hrishikesh Nath [a]

[a] Department of Agronomy, PGCA, Dr. Rajendra Prasad Central Agricultural University, Pusa-848125 (Bihar), India.
[b] Department of Soil Science, PGCA, Dr. Rajendra Prasad Central Agricultural University, Pusa-848125 (Bihar), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Growing fodder oat (*Avena sativa* L.) genotype with high yielding potential with adequate nitrogen could enhance the fodder yield and quality to bridge the gap between demand and supply of green fodder. Therefore, an experiment was performed to evaluate the effect of different genotypes and nitrogen levels on yield, nitrogen use efficiency, production economics, and agro-meteorological

**Corresponding author: E-mail: isarkarsaikat1998@gmail.com;*

parameters of fodder oat at Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar. Six oat genotypes, *viz.*, Kent, JO-07-28, OS-403, OS-6, HFO-904 and HFO-906, were sown with 40, 80 and 120 kg of nitrogen per hectare. The experiment was set up using a split-plot design, with three replications of the genotypes in the main plots and N levels in sub-plots. Results revealed that genotype JO-07-28 was significantly superior to Kent (check) with respect to green fodder yield whereas both were comparable to each other with respect to dry matter yield, crude protein content and yield. Kent showed maximum N, P and K uptake and heat use efficiency, helio-thermal and photo-thermal unit efficiency. However, genotype JO-07-28 yielded the highest net returns (Rs. 27421/ha), B:C ratio (1.85), and economic efficiency (Rs. 271/ha/day). Among other nitrogen levels, application of 120 kg N/ha recorded the maximum yields of green fodder (371 q/ha) and dry matter (91 q/ha), crude protein content and yield, N uptake, net returns (Rs. 23096/ha), B:C ratio (1.71) and economic efficiency (Rs. 231/ha/day) and heat use efficiency (7.60), helio-thermal and photo-thermal unit efficiency which were statistically equivalent to 80 kg N/ha. Genotype JO-07-28 and HFO-904 were the most N efficient genotype in terms of partial factor productivity of N fertilizer and nitrogen utilization efficiency, respectively. Enhancement in level of N application reduced the nitrogen use efficiency.

Keywords: Economic efficiency; fodder oat; heat use efficiency; nitrogen fertilization; nitrogen use efficiency.

1. INTRODUCTION

The Indian economy is mainly based on agriculture in which livestock plays a significant role. The livestock sector contributes 4.11% and 25.6% to the Indian and agriculture GDP, respectively. India is the world's largest livestock owner (536.76 million), with a total bovine (cattle, buffalo, mithun and yak) population of about 303.76 million [1]. While the global cattle population stood at over one billion, India had the highest cattle population followed by Brazil, China and the United States [2]. India is the highest milk producer in the world, followed by the USA, Pakistan, China, and Brazil. Feeding forage significantly enhance the profitability as feed accounts for largest share of the total cost involved in livestock rearing [3]. Current level of green fodder could not meet their demand and showed 11.4 and 26.4% deficit, respectively. So it is imperative to select better genotypes with respects to fodder yield and quality to bridge the current gap between demand and supply for sustainable livestock rearing.

Nitrogen is the most important of all the major nutrients for improving crop productivity, both quantitatively and qualitatively. In the majority of fodder crops, nitrogen fertilizer increases the production of dry matter [4]. Oat is an important winter cereal forage crop mostly grown in irrigation systems, particularly in India's Central, Northern, and Western states [5]. Oat responds significantly to the application of nitrogen in terms of green and dry fodder and crude protein up to a certain level. On the other hand, excessive nitrogen application to fodder oats under specific environmental circumstances causes a high amount of nitrate accumulation in the leaves of plants, which could be harmful to ruminants [6]. Further, this could also lead to N losses like leaching, volatilization and denitrification causing environmental pollution [7]. Therefore, determining the ideal nitrogen dosage for enhanced fodder oat production is crucial. So, the current investigation designed to assess the effects of different nitrogen levels on the yield, nitrogen use efficiency, production economics and agro-meteorological parameters of fodder oat genotypes taking into account all of the previously mentioned facts.

2. MATERIALS AND METHODS

The current study was carried out during *Rabi* season of 2021-22 at the Forage Research Block of the Cattle Farm, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar. Throughout the crop season, the crop received 41.9 mm of rainfall (Fig. 1). The experiment was set up using a split-plot design, with three replications of the genotypes in the main-plots and N levels in sub-plots. Six oat genotypes, *viz.*, Kent, JO-07-28, OS-403, OS-6, HFO-904 and HFO-906, were sown with 40, 80 and 120 kg of nitrogen per hectare. In this experiment, split-plot design was adopted because although two factors are to be tested in the experiment simultaneously but one factor may require to be tested with higher precision than the others. N levels were kept in sub-plots for greater precision in fertilizer response than genotypic effects. The plot size for individual treatment combination was 5.0 m × 4.0 m. The distance between two replications was kept at 75 cm, which acted as an irrigation channel to ensure proper irrigation and for other cultural operations. Fodder oat genotypes were continuously sown at a row spacing of 25 cm with a seed rate of 100 kg/ha on November 25, 2021.Application of half of the nitrogen, full quantity of phosphorous and full quantity of potassium was made before the sowing process. Twenty-one days after sowing (DAS), the remaining nitrogen was applied. Urea, diammonium phosphate, and muriate of potash were the sources of fertilizers for nitrogen, phosphorus, and potassium, respectively. The standard operating procedures for all other cultural operations were followed. When the fodder oat reached 50% flowering stage, it was manually harvested. Leaf related parameters like no. of green leaves/tiller, no. of dry leaves/tiller, total no. of leaves/tiller, length and width of flag leaf were noted from randomly selected five plants/plot at harvest stage. After each net plot's crop stand was harvested, it was weighed using an electronic weighing device to determine green fodder yield (GFY) which was then converted from kg/plot to t/ha. Dry matter content of the fresh fodder was determined by placing it in hot air oven till constant weight was achieved to determine the dry matter yield (DMY). Production efficiency in terms of green fodder and dry matter yield was worked out by dividing the GFY and DMY with duration of the crop (days) [8]. After calculating the dry matter's N content and multiplying it by a factor of 6.25, the crude protein content was obtained. This was then multiplied by the dry matter yield to obtain the crude protein yield. P and K contents were also determined and N, P and K uptake was worked out. Nitrogen use efficiency (NUE) parameters like partial factor productivity of Nitrogen (PFPN) and nitrogen utilization efficiency (NUtE) were worked out following Rostamaza et al. [9], Nanda and Nilanjaya [10] and Yadav et al. [7]. Production economics was also worked out keeping the cost of inputs and price of output as per prevailing rates. Agro-meteorological parameters like GDD, PTU, HTU, HUE, PTUE and HTUE were worked out as per Sattar et al. [11] using 5ºC as the base temperature of forage oat [12]. An analysis of variance was performed on the data for the split plot design. [13]. Pearson correlation co-efficient was calculated using R software (version 4.3.1) to study the relationship between important variables.

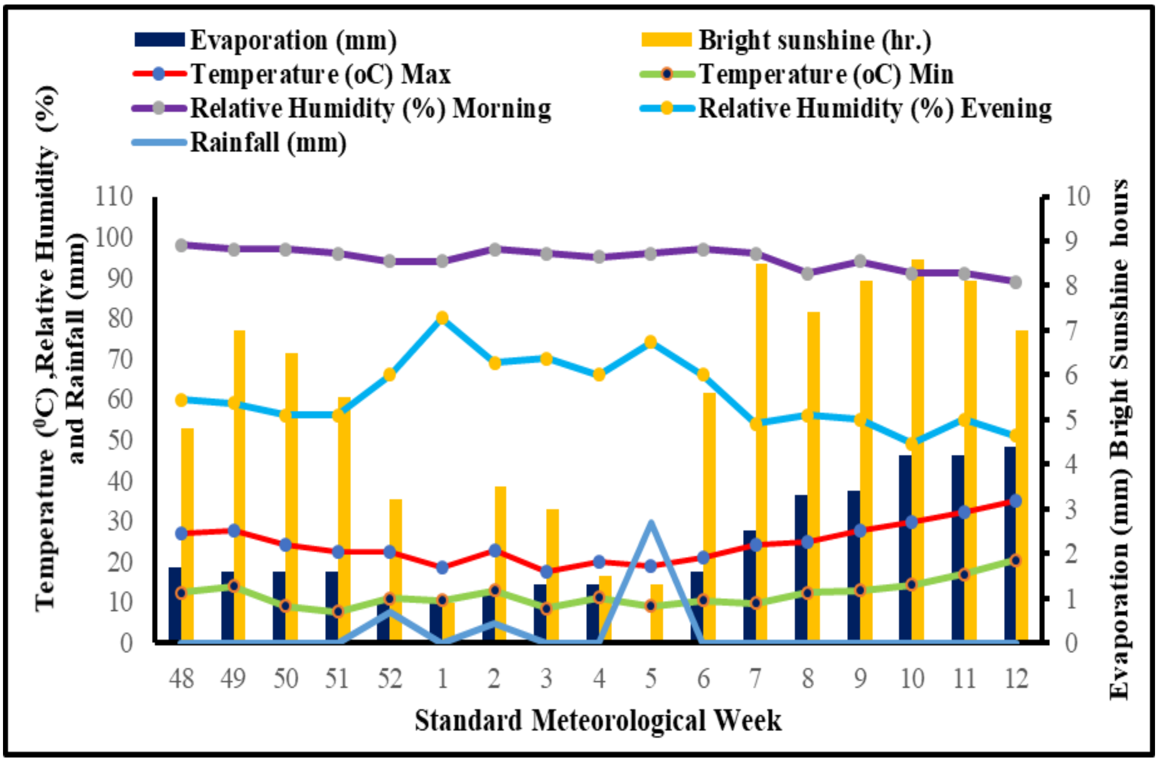

Fig. 1. Standard meteorological week wise data during the experimental period

3. RESULTS AND DISCUSSION

3.1 Leaf Parameters

Genotypes caused significant variation on no. of dry leaves/tiller, total no. of leaves/tiller, length and width of flag leaf (Table 1). Among genotypes, OS-403 exhibited highest number of dry leaves (3.9) as well as total leaves per tiller (7.0) which was notably higher than other genotypes except for no. of dry leaves/tiller for which it was at par with OS-6 (Table 1). The highest length and width of flag leaf was noted with HFO-904 (49.6 cm) and OS-403 (2.5 cm), respectively which was significantly superior over other genotypes except for flag leaf length for which HFO-904 and HFO-906 were comparable with each other. The differences in these leaf parameters are ascribed to variation associated with genotypes. N levels caused significant variation on total no. of leaves/tiller, length and width of flag leaf (Table 1). The maximum total no. of leaves/tiller (6.6), flag leaf length (45.4 cm) and flag leaf width (2.1 cm) were obtained when 120 kg N/ha was applied with percent improvement of 10.0%, 6.6% and 10.5% over 40 kg N/ha. However, application of 80 kg/ha of N also gave same leaf width (2.1 cm). The interaction impact between genotypes and nitrogen levels in relation to the number of green leaves was non-significant across all the growth stages.

3.2 Fodder Yield

Biomass accumulation was the most important factor that contributed to the green and dry fodder yield. Genotype JO-07-28 recorded the highest green and dry fodder yield (396 q/ha and 88 q/ha, respectively) and least by OS-6 (Table 2). However, Kent also produced the highest dry matter yield (88 q/ha). Higher fresh fodder yield with JO-07-28 was because of improved tiller number per meter row length and increased plant height [14]. Patel et al. [15] and Satpal et al. [16] made similar observations as well. Data (Table 2) revealed that the maximum yield of green fodder and dry matter (371 q/ha and 91 q/ha, respectively) were resulted with 120 kg N/ha which were statistically equivalent with 80 kg, conversely, applying 80 kg of nitrogen greatly enhanced the yield of dry matter and green fodder compared to 40 kg. These findings corroborate the conclusions of Godara et al. [17] and Dabhi et al. [18]. As the nitrogen level was raised to 120 kg N/ha, the yield of dry matter and the production of green fodder in oats increased correspondingly.

3.3 Production Efficiency

Production efficiency relies on two factors, those are dry matter yield and the duration of the crop to attain 50 % flowering. The highest production efficiency was recorded in Kent as because of the shorter duration of the crop than in other genotypes, and the dry matter yield of Kent was statistically comparable with JO-07-28 (Table 2), which had the maximum DMY. However, the lowest production efficiency was observed in HFO-904. This is due to the longer duration of the crop and having a lower dry matter yield. Production efficiency is remarkably influenced by various nitrogen levels (Table 2). Application of N at 120 kg ha^{-1} resulted in a maximum production efficiency which was statistically comparable to applying 80 kg and significantly higher over 40 kg. However, the lowest production efficiency was noticed with applying N at 40 kg ha^{-1}. The increase in production efficiency brought on by the higher nitrogen dose may be attributable to the lush vegetative growth manifested in plant height, tiller count, accumulation of dry matter, all of which increased photosynthetic activity and, consequently, production efficiency. That is very close to the finding of Luikham et al. [19]. The interaction impact among genotypes and N levels in relation to production efficiency was observed to be non-significant.

3.4 Fodder Quality

Kent and JO-07-28, these two genotypes of fodder oat, remained on par with each other in terms of crude protein content (CPC) and crude protein yield (CPY) and were superior to the rest of the genotypes (Table 2). However, the lowest CPC and CPY were resulted in genotype HFO-904. These observations are comparable with the results of Godara et al. [17] who also observed genotypic variation in CP content in fodder oat. Data revealed that nitrogen application has noticeably influenced the crude protein content and yield in fodder oats. Nitrogen applied at 120 kg ha^{-1} has resulted in maximum CPC and CPY over 80 and 40 kg ha^{-1}(Table 1). The lowest CPC and CPY were observed with 40 kg N ha^{-1}. Sheoran et al. [20] and Patel et al. [21] were also found similar finding. The interaction impact between genotypes and nitrogen levels in relation to crude protein content and yield was observed to be non-significant.

Table 1. Leaf parameters of fodder oat as affected by different genotypes and N levels

Treatments	No. of green leaves/tiller	No. of dry leaves/tiller	Total no. of leaves/tiller	Flag leaf length (cm)	Flag leaf width (cm)
Genotypes					
Kent	3.7	2.2	5.9	38.8	1.7
JO-07-28	3.7	2.7	6.3	45.3	2.0
OS-403	3.1	3.9	7.0	43.5	2.5
OS-6	3.1	3.0	6.1	40.3	1.9
HFO-904	3.7	2.8	6.4	49.6	2.1
HFO-906	3.1	2.9	6.0	48.5	1.9
SEm±	0.2	0.3	0.2	1.2	0.1
CD (p<0.05)	NS	0.9	0.5	3.6	0.3
N levels (kg/ha)					
40	3.2	2.8	6.0	42.6	1.9
80	3.4	2.9	6.3	44.9	2.1
120	3.6	3.0	6.6	45.4	2.1
SEm±	0.1	0.1	0.1	0.8	0.0
CD (p<0.05)	NS	NS	0.3	2.3	0.1

Table 2. Fodder yield, production efficiency and fodder quality as affected by different genotypes and N levels

Treatments	Green fodder yield (q/ha)	Dry matter yield (q/ha)	DM (%)	Production efficiency (q/ha/day)		CP (%)	CPY (q/ha)
Genotypes				GFY	DMY		
Kent	358	88	24.41	3.90	0.96	10.13	8.89
JO-07-28	396	88	22.31	3.92	0.87	9.81	8.70
OS-403	328	86	26.14	3.00	0.78	9.37	8.03
OS-6	319	76	23.69	3.26	0.77	9.74	7.43
HFO-904	359	77	21.32	3.50	0.75	8.82	6.81
HFO-906	363	85	23.43	3.62	0.85	9.09	7.79
CD (p<0.05)	32	9	1.90	0.37	0.08	0.52	0.97
N levels (kg/ha)							
40	329	73	22.14	3.30	0.73	9.13	6.64
80	362	87	24.00	3.61	0.86	9.59	8.31
120	371	91	24.52	3.69	0.90	9.75	8.88
CD (p<0.05)	19	5	0.65	0.19	0.05	0.27	0.58

Table 3. Nutrient content and uptake of fodder oat as affected by different genotypes and nitrogen levels

Treatments	Nutrient content (%)			Nutrient uptake (kg/ha)		
	N	P	K	N	P	K
Genotypes						
Kent	1.62	0.36	1.75	142.2	32.0	154.4
JO-07-28	1.57	0.27	1.70	139.2	24.2	151.1
OS-403	1.50	0.25	1.56	128.5	21.2	133.6
OS-6	1.56	0.26	1.51	118.8	20.3	112.6
HFO-904	1.41	0.21	1.49	109.0	16.5	114.7
HFO-906	1.45	0.23	1.66	124.7	19.7	143.2
CD (p<0.05)	0.08	0.02	0.10	15.4	3.2	19.6
N levels (kg/ha)						
40	1.46	0.22	1.51	106.2	16.2	110.1
80	1.53	0.27	1.60	132.9	23.7	138.0
120	1.56	0.29	1.73	142.1	27.1	156.7
CD (p<0.05)	0.04	0.02	0.07	9.3	1.8	9.6

3.5 Nutrient Content and Uptake

Different oat genotypes in relation to N, P and K content and uptake differed significantly (Table 3). Kent resulted in higher N, P and K content and uptake than other genotypes. HFO-904 resulted in the lowest N, P, K content and uptake, with an exception in OS-6, which recorded the lowest K uptake. This may be because of the linear correlation between chlorophyll content and nitrogen content in plant tissues and because of maximum relative chlorophyll content was recorded in Kent and the lowest chlorophyll content was found in HFO-904, the NPK content and uptake were found to be highest in Kent and lowest in HFO-904.The maximum N, P, K content and uptake were resulted from applying N at 120 kg ha^{-1} and the minimum N, P, K content and uptake were observed with 40 kg ha^{-1} (Table 3). This may be the result of the oat plant's poor development at low fertility levels, whereas greater nitrogen levels led to better plant growth and, thus, better crop nutrient uptake. These observations are comparable with the results revealed by Bhat et al. [22,23] who disclosed that the uptake of N, P and K were raised by increasing nitrogen rates up to 120 kg ha^{-1}. The interaction impacts between genotypes and nitrogen levels in relation to N, P and K content and N, P and K uptake were found to be non-significant.

3.6 Nitrogen Use Efficiency

The highest partial factor productivity (PFP) of N was recorded in genotype JO-07-28, which was statistically equivalent with Kent, OS-403, HFO-906 and noticeably higher over OS-6 and HFO-904 (Table 4). However, the lowest PFP of N was observed in OS-6. Because the highest dry matter yield was found in JO-07-28 and the lowest dry matter yield was found in OS-6, the PFP of N was highest in JO-07-28 and the lowest in OS-6. The highest nitrogen utilization efficiency was recorded in HFO-904, which was statistically similar with OS-403, HFO-906 and significantly higher than genotypes Kent, JO-07-28 and OS-6. However, the lowest nitrogen utilization efficiency was observed in Kent. The differences in NUE may be because of genotypic variation. Data (Table 4) showed that maximum PFP of N and nitrogen utilization efficiency was produced by applying 40 kg ha^{-1} of N, which was noticeably higher over other nitrogen doses. It might be because of the less applying of N dose causes minimum loss of nitrogen and resulted more utilization of nitrogen and increased productivity. However, the lowest PFP of N and nitrogen utilization efficiency was observed due to applying nitrogen at 120 kg ha^{-1}. This may be because of more application of N dose causes maximum loss of nitrogen and resulted in less utilization of nitrogen, so productivity also become less. Similar finding have been observed by Nanda and Nilanjaya [10]. The interaction impact between genotypes and N levels in relation to nitrogen use efficiency was observed to be non-significant.

3.7 Effect on Economics

The information about the cost of cultivation, gross return, net return and B:C ratio are shown in Table 5. The price per quintal of the green fodder was Rs. 150 which was taken into account when calculating gross return. Perusal of the data (Table 5) revealed that genotype JO-07-28 had the highest gross return (Rs. 59455/ha), net return (Rs. 27421/ha), B:C ratio (1.85), and economic efficiency (Rs. 271/ha/day) among all genotypes which was at par with HFO-906 regarding B:C ratio and Kent and HFO-906 regarding economic efficiency. The maximum gross return (Rs. 55652/ha), net return (Rs. 23096/ha), B:C ratio (1.71) and economic efficiency (Rs. 231/ha/day) were obtained with 120 kg N/ha application, which was statistically equivalent to 80 kg N/ha.

3.8 Agro-meteorological Parameters

Genotypes caused significant variation on days to 50% flowering, accumulated GDD, accumulated HTU, accumulated PTU, HUE, HTUE and PTUE (Table 6). Genotype Kent took 91.7 days to reach 50% flowering stage which was noticeably lower than other genotypes. However, OS-403 took 109.1 days to reach 50% flowering stage which was markedly higher than other genotypes. OS-403 exhibited the highest values for AGDD (1338.3), AHTU (7324.3) and APTU (14800) which was notably higher than other genotypes. However, the highest HUE (8.30), AHTUE (1.75) and APTUE (0.76) were noted with Kent which was significantly superior over other genotypes. Data (Table 6) revealed that N levels caused significant variation on days to 50% flowering, accumulated GDD, accumulated HTU, accumulated PTU, HUE, HTUE and PTUE. The maximum values for days to 50% flowering (101.2 days), accumulated GDD (1204.8^{0}C day), accumulated HTU (6191.2^{0}C day hr.), accumulated PTU (13231.1^{0}C day hr.), HUE (7.60 kg/ha ^{0}C/day), HTUE (1.50 kg/ha^{0}C/day/hr.) and PTUE

(0.69kg/ha^{0}C/day/hr.) were obtained when 120 kg N/ha was applied with per cent improvement of 1.5%, 2.1%, 3.3%, 2.3%, 23.2%, 22.9%and 23.2%over 40 kg N/ha.

3.9 Correlation Studies

Correlation studies among different parameters (Table 7) indicated that GFY had a positive correlation with nitrogen uptake (r= 0.698**), no. of green leaves/tiller (r= 0.667**), flag leaf length (r= 0.500*). Similarly, dry matter yield had a positive correlation with nitrogen uptake (r= 0.962***), crude protein (r= 0.568*) but negative correlation with partial factor productivity of N fertilizer (r= -0.565*) and nitrogen utilization efficiency (r= -0.548*). Days to 50% flowering had a positive relation with no. of dry leaves/tiller (r= 0.806***), no. of total leaves/tiller (r = 0.783***), flag leaf length (r= 0.486*) and flag leaf width (r= 0.907***), accumulated GDD (r= 0.999***), HTU (r= 0.996***) and PTU (r= 0.999***). Crude protein yield had an positive relation with dry matter yield (r= 0.962***) and crude protein content (0.770***) and no. of green leaves/tiller (r= 0.475*). PFPN had a negative correlation with DMY (r= -0.565*), nitrogen uptake (r= -0.590**) and crude protein yield (r= -0.590**). Nitrogen utilization efficiency had negative correlation with crude protein content (r= -0.998***), nitrogen uptake (r= -0.752***), crude protein yield (r= -0.752***) and dry matter yield (r= -548*) but was positively correlated with flag leaf length (r= 0.555*).

Table 4. Nitrogen use efficiency of fodder oat as affected by affect of different genotypes and nitrogen levels

Treatments	Nitrogen use efficiency	
	Partial factor productivity of N (kg DM/kg N applied)	**Nitrogen utilization efficiency (kg DM/kg N uptake)**
Genotypes		
Kent	125.7	62
JO-07-28	130.4	64
OS-403	129.8	67
OS-6	107.0	64
HFO-904	112.7	71
HFO-906	125.4	69
CD(p<0.05)	14.3	4
N levels (kg/ha)		
40	181.8	69
80	108.1	65
120	75.6	64
CD (p<0.05)	9.3	2

Table 5. Production economics of fodder oat as affected by different genotypes and nitrogen levels

Treatments	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net Return (Rs./ha)	B: C ratio	Economic efficiency (Rs./ha/day)
Genotypes					
Kent	32034	53677	21642	1.67	236
JO-07-28	32034	59455	27421	1.85	271
OS-403	32034	49133	17099	1.53	157
OS-6	32034	47778	15743	1.49	161
HFO-904	32034	53917	21882	1.68	213
HFO-906	32034	54587	22552	1.70	224
CD (p=0.05)	-	4845	4845	0.15	50
N levels (kg/ha)					
40	31512	49336	17823	1.57	178
80	32034	54285	22251	1.69	222
120	32556	55652	23096	1.71	231
CD (p=0.05)	-	2876	2876	0.09	28

Table 6. Duration and agro-meteorological parameters of fodder oat as affected by different genotypes and nitrogen levels

Treatments	Days to 50% F(day)	AGDD(^{0}C day)	AHTU(^{0}C day)	APTU(^{0}C day h)	HUE(kg/ha ^{0}C d)	HTUE(kg/ha ^{0}C day h)	PTUE(kg/ha ^{0}C day h)
Genotypes							
Kent	91.7	1054.6	5015.2	11476.7	8.30	1.75	0.76
JO-07-28	101.2	1201.5	6144.4	13188.4	7.37	1.44	0.67
OS-403	109.1	1338.2	7324.3	14800.0	6.40	1.17	0.58
OS-6	97.9	1149.5	5712.3	12580.4	6.60	1.33	0.60
HFO-904	102.7	1224.5	6339.0	13458.2	6.26	1.21	0.57
HFO-906	100.4	1189.6	6047.6	13049.7	7.17	1.41	0.65
CD (p<0.05)	4.7	74.2	614.3	867.8	0.71	0.17	0.07
N levels (kg/ha)							
40	99.7	1179.6	5990.6	12934.9	6.17	1.22	0.56
80	100.6	1194.6	6109.6	13110.6	7.28	1.44	0.66
120	101.2	1204.8	6191.2	13231.1	7.60	1.50	0.69
CD (p<0.05)	0.9	13.6	110.4	159.0	0.41	0.08	0.04

Table 7. Correlation among different studied parameters

Variable	GFY	DMY	D50F	NGLPT	NDLPT	NLPP	FLL	FLB	NU	CPC	CPY	PFPN	NUtE	AGDD	AHTU	APTU
GFY	—															
DMY	0.766 ***	—														
D50F	-0.062	0.055	—													
NGLPT	0.667 **	0.449	-0.260	—												
NDLPT	-0.328	0.032	0.806 ***	-0.568 *	—											
NLPP	0.092	0.369	0.783 ***	0.051	0.793 ***	—										
FLL	0.500 *	0.204	0.486 *	0.196	0.148	0.322	—									
FLB	-0.101	0.144	0.907 ***	-0.175	0.800 ***	0.840 ***	0.322	—								
NU	0.698 **	0.962 ***	-0.117	0.475 *	-0.059	0.280	-0.021	0.030	—							
CPC	0.286	0.568 *	-0.460	0.331	-0.202	0.001	-0.548 *	-0.234	0.770 ***	—						
CPY	0.697 **	0.962 ***	-0.117	0.475 *	-0.059	0.280	-0.021	0.030	1.000 ***	0.770 ***	—					
PFPN	-0.365	-0.565 *	-0.078	-0.320	-0.148	-0.416	-0.230	-0.284	-0.590 **	-0.453	-0.590 **	—				
NUtE	-0.257	-0.548 *	0.437	-0.292	0.167	-0.015	0.555 *	0.213	-0.752 ***	-0.998 ***	-0.752 ***	0.451	—			
AGDD	-0.079	0.061	0.999 ***	-0.267	0.817 ***	0.792 ***	0.459	0.919 ***	-0.106	-0.442	-0.107	-0.076	0.420	—		
AHTU	-0.092	0.065	0.996 ***	-0.268	0.824 ***	0.800 ***	0.438	0.927 ***	-0.099	-0.429	-0.099	-0.069	0.407	0.999 ***	—	
APTU	-0.081	0.061	0.999 ***	-0.267	0.818 ***	0.792 ***	0.456	0.920 ***	-0.106	-0.440	-0.106	-0.075	0.418	1.000 ***	0.999 ***	—

Note: GFY-green fodder yield, DMY-dry matter yield, D50F- days taken to 50% flowering, NGLPT- no.of green leaves/tiller, NDLPT- no.of dry leaves/tiller, NLPP- no.of total leaves/tiller, FLL- flag leaf length, FLB- flag leaf width, NU- nitrogen uptake, CPC- crude protein content, CPY- crude protein yield, PFPN- partial factor productivity of nitrogen, NUtE- nitrogen utilization efficiency, AGDD- accumulated GDD, AHTU- accumulated HTU, APTU- accumulated PTU

4. CONCLUSION

It can be inferred from the present investigation that genotype JO-07-28 performed better than other genotypes with respect to green fodder yield and net returns and B:C ratio. Genotype JO-07-28 and HFO-904 were the most N efficient genotype in terms of partial factor productivity of N fertilizer and nitrogen utilization efficiency, respectively. The performance of 120 kg N/ha and 80 kg N/ha were statistically comparable for green as well as dry fodder and profitability parameters but the nitrogen use efficiency parameter PFPN declined significantly with 120 kg N/ha. So, application of 80 kg N/ha could be the optimum dose for with respect to fodder yield and nitrogen use efficiency.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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