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Nitrate accumulation and utilization in fodder oats varieties as affected by different nitrogen levels

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Introduction

Importance of fodder crops in agriculture needs no emphasis because of the fact that regular fodder availability is basic requirement for livestock production. The area under fodder in Punjab is 2.03 million hectares with total production of 45 million tons, which is not sufficient to meet the maintenance requirements of livestock. To improve the quality of milk production it is important that animals are fed with good quality of fodder. Nitrogen is an essential primary nutrient for plant growth and plays an important role in productivity of forage crops. The application of N at various growth stages is one of the ways to increase forage productivity of crops. The excessive use of nitrogen can lead to deteriorate soil health and accumulation of nitrate-N in fodders above the permissible limit (>5000 ppm) which is toxic to animals. Some of the crops such as Sudan grass, pearl millet and oats are potent accumulators of nitrate.

Oats is the most important winter cereal crop grown in northern, western and central India. Oats is gaining importance throughout the world due to its uses as human food, animal feed and fodder crop. One of reasons of nitrate toxicity in oats is high input of fertilizer. When growing conditions are favorable, plants take up nitrogen in form of nitrate. The nitrate is rapidly converted into ammonia which is incorporated into the plant protein. Unfavorable growing conditions can interfere with nitrate use and cause it to accumulate in the plant. Nitrate toxicity arises when nitrate conversion into nitrite is faster than its utilization into ammonia.

Nitrate reductase (NR) is considered a key enzyme in nitrogen metabolism. It is not only rate limiting enzyme in inorganic nitrogen assimilation but also the major regulatory step in N metabolism (Young *et al*., 2009). NR is considered to catalyze the NO_3^- assimilation because it initiates the reaction when NO_3^- is available. NR activity is modified rapidly in response to level of nitrate, CO_2, light, carbon skeletons and nitrogen metabolites.

In the present study inter relationship between crude protein level, nitrate-N value and NR activity in relation to N inputs has been worked out.

Materials and Methods

The field experiment was done at Forage Research Farm, PAU during *Rabi* season 2014-15. The experiment was laid out in three replications. Sixteen treatment combinations with four varieties of oats i.e. Kent, OL-9, OL-10, and OL-125 (NC) and four nitrogen levels of 0, 50, 75 and 100 kg N/ha were formulated. The half quantity of nitrogen fertilizer was applied after 15 days of sowing and remaining half was applied after a week of previous application as per the treatments. Samples were collected at three developmental stages i.e. 30, 45 and 60 days of growth. CP content was determined according to standard AOAC (1970) method. Nitrate-N was estimated according to Cotaldo *et al*., (1975). NR activity in fresh leaf samples was done according to the procedure of Hageman and Hucklesby (1971). The enzyme activity was expressed in terms of $\mu mol\ h^{-1}\ g^{-1}$ Fw.

Results and Discussion

The overall response of crude protein over the growing season was significantly affected by pattern of N fertilization at all three developmental stages (Table 1). Under the influence of N levels CP content was significantly higher at 30 DAS (30.1%) followed by 45 DAS (20.3%) and 60 DAS (16.3%). The CP values increased significantly with increasing dose of fertilization and were maximum at 100 Kg N/ha and this was due to increased N application (Amandeep, 2012). Among different varieties mean CP level was maximum in OL-10 (22.7%) and minimum in Kent (21.7%). The overall interaction between different varieties, levels of N fertilization and growth stages for CP content was significant.

Table 1: Crude protein levels in fodder oats at different growth stages under the influence of N fertilization

		Crude Protein (%)			
		Days after sowing			
Variety	**N level**	**30**	**45**	**60**	**Mean**
OL-9	0	26.5	17.8	14.7	19.6
	50	28.8	20.7	16.2	21.9
	75	32.2	22.1	17.6	24.0
	100	33.0	23.1	18.6	24.9
	Mean	**30.1**	**20.9**	**16.8**	**22.6**
Kent	0	28.7	16.2	12.6	19.2
	50	29.1	19.6	14.5	21.1
	75	30.1	21.1	15.5	22.2
	100	33.8	23.2	16.0	24.3
	Mean	**30.4**	**20.0**	**14.7**	**21.7**
OL-10	0	28.1	16.4	15.4	20.0
	50	31.7	19.5	16.2	22.5
	75	32.6	20.9	16.7	23.4
	100	33.8	23.6	17.5	24.9
	Mean	**31.6**	**20.1**	**16.4**	**22.7**
OL-125	0	20.8	15.5	15.3	17.2
	50	25.4	19.6	16.8	20.6
	75	31.3	21.9	18.2	23.8
	100	33.2	23.4	19.6	25.4
	Mean	**27.7**	**20.1**	**17.5**	**21.7**
Overall mean		**30.1**	**20.3**	**16.3**	**22.2**
CD at 5 %		A= variety 0.19, B= N level 0.19,C= Growth stage 0.17, AB= 0.39, AC= 0.34, BC= 0.34, ABC= 0.68			

Table 2: Nitrate-N values (ppm) and NR activity (µmol h^{-1} g^{-1} Fw) in fodder oats at different growth stages under the influence of N fertilization

		Nitrate-N				Nitrate Reductase (NR)			
		Days after sowing							
Variety	**N level**	**30**	**45**	**60**	**Mean**	**30**	**45**	**60**	**Mean**
OL-9	0	1547	1820	539	1302	0.20	0.16	0.27	0.21
	50	1581	2471	737	1596	0.19	0.78	0.53	0.50
	75	1800	3443	1104	2116	0.20	0.89	0.87	0.65
	100	2831	5656	1175	3221	0.18	0.98	2.13	1.10
	Mean	**1940**	**3348**	**889**	**2059**	**0.19**	**0.70**	**0.95**	**0.62**
Kent	0	1449	2448	578	1492	0.19	0.19	0.24	0.21
	50	1542	2890	897	1776	0.20	0.82	0.76	0.59
	75	1762	3840	1010	2204	0.19	0.74	1.05	0.66
	100	2360	4782	1187	2776	0.18	0.99	1.25	0.81
	Mean	**1778**	**3490**	**918**	**2062**	**0.19**	**0.69**	**0.83**	**0.57**
OL-10	0	1651	1611	569	1277	0.19	0.18	0.36	0.24
	50	1771	2217	678	1555	0.19	0.28	0.95	0.47
	75	2132	3462	828	2141	0.18	0.97	1.08	0.74
	100	2534	5201	988	2908	0.19	1.09	1.23	0.84
	Mean	**2022**	**3123**	**766**	**1970**	**0.19**	**0.63**	**0.91**	**0.57**
OL-125	0	2091	1621	416	1376	0.19	0.20	0.17	0.19
	50	2227	2618	711	1852	0.19	0.48	0.63	0.43
	75	2348	3365	880	2198	0.19	0.84	1.04	0.69
	100	2505	4596	1020	2707	0.19	1.46	1.39	1.01
	Mean	**2293**	**3050**	**757**	**2033**	**0.19**	**0.75**	**0.81**	**0.58**
Overall mean		**2008**	**3252**	**832**	**2031**	**0.19**	**0.69**	**0.88**	**0.58**
CD at 5%		A= Genotype 29.4, B= N level 29.4, C= Growth stage 25.4, AB= 58.7, AC= 50.9, BC= 50.9, ABC= 101.7				A= Genotype NS, B= N level 0.04, C= Growth stage 0.04, AB= 0.09, AC= 0.08, BC= 0.08, ABC= 0.15			

Nitrate-N values varied significant in different varieties of oats with nitrogen fertilization and growth stages (Table 2). Among different developmental stages, NO_3^- -N content was maximum at 45 DAS (3252 ppm) followed by 30 DAS (2008 ppm) and levels were below toxic level at 60 DAS (832 ppm). Nitrate-N content increased significantly with N fertilization and maximum level was observed at 100 kg N/ha. Among the different varieties mean values of nitrate-N were maximum for Kent (2062 ppm) followed by OL-9 (2059 ppm), OL-125 (2031 ppm), OL-10 (1970 ppm).

At different developmental stages Nitrate reductase enzyme was more active at 60 DAS followed by 45 DAS and 30 DAS. A significant interaction between variety and N level was observed. NR activity did not respond significantly at 30 DAS with N level but increased significantly with N inputs at 45 and 60 DAS (Table 2). Among varieties the mean values did not change significantly but slightly higher levels were observed in OL-9.

Conclusion

It is concluded that Nitrate-N was higher at 30 and 45 DAS but come to permissible limit at 60 DAS at which stage first cut of fodder in multicut oats is taken. The low levels of Nitrate-N can be related to high NR activity at this stage.

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