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Effect of nitrogen and phosphorus application on yield, content and uptake of nutrient by oat crop (Avena sativa L.)

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Abstract

A field experiment was conducted at Bichpuri in 2018-2019 to study the response of oat to Nitrogen and Phosphorus. The increase in grain and straw yield due to the application of N_1, N_2 and N_3 over control was in tune of 18.63, 27.25, 34.53 and 16.55, 22.57 and 30.04 % respectively. All the levels of P increased grain and straw yield significantly and P_2 maintained its superiority in this regard. From quality point of view N_3 level of nitrogen application and P_2 level of phosphorus application appeared to the best of protein content. Application of N and P at various levels increased N uptake by grain and straw of oat over control. The N_3 level of nitrogen application and P_2 level of phosphorus application enhanced the P and K uptake by oat crop over control. The combined application of N and P (N_3P_2) had significant and positive effect on crop productivity.

Key worlds: Nitrogen, Phosphorus, uptake, crop productivity, protein content

Introduction

Forage oat (Avena sativa) is one of the most important winter forage crops of India. Due to high forage yield palatability and nutritive value it has become very popular rabi forage crops in areas having limited irrigation facilities of almost all over the country. Nitrogen is a prime nutrient absorbed by crops in larger amounts and is the most limiting factor affecting crop production. Neither plants nor animals can grow success fully without phosphorus .It is an essential component of the organic compound often called the energy currency of the living cell: Adenosine tri phosphate (ATP). Phosphorus stimulates early root development, leaf size, tillering, flowering, grain yield. P deficient soils various soil factors including soil P concentration, soil temperature, moisture, pH, texture and bulk density and plant factors including root growth may affect the supply of P to the plant and thus the potential for crop responses to P fertilizer application. Hence, the present study was undertaken to study the response of oat to N and P application.

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Materials and Methods

The field experiment was conducted at Agricultural Research Farm of Raja Balwant Singh College, Bichpuri, (Agra) during rabi season of 2018-19. The experimental soil was sandy loam in texture having pH 7.9, EC 1.8 dSm^{-1} at 25^0C, organic Carbon(%) 0.36, Available N (kg/ha) 181.0, Available P (kg/ha) 28.60, Available K(kg/ha) 292.0. Four levels of N (0, 80, 100 and 120 (kg /ha) and three levels of phosphorus (0, 40 and 80 kg/ha) were tested in Factorial Randomized block design with three replications having 12 treatment combinations in 36 plots. Nitrogen and Phosphorus were applied as urea and P_2O_5, respectively at the time of sowing. Soil of the experimental field was sufficient in potash content but low in available nitrogen and organic carbon and medium in available phosphorus content. Variety Kent was used as seed of oat. The crop was allowed to grow up to 60 days after sowing and harvested. Plant samples were digested in di acid mixture and analyzed for N,P,K, by adopting standards procedures (Jackson,1973).

Results and Discussion

A study of Table 1 revels that the green foliage yield of oat increased significantly by 18.63, 27.25 and 34.53 percent respectively with N_1 (80Kg/ha), N_2 (100

Table 1: Effect of nitrogen and phosphorus application on grain and straw yield (q/ha) of oat crop

Phosphorus levels	Nitrogen levels N0	N1	N2	N3	Mean
Grain yield					
P_0	41.05	54.55	59.00	62.72	54.53
P_1	46.31	55.70	60.19	63.21	56.35
P_2	52.90	52.65	61.12	64.87	59.14
Mean	47.02	55.97	60.10	63.60	
	N	P	N x P		
SEm±	0.78	0.590	1.38		
CD(P=0.05)	1.266	1.016	2.374		
Straw yield					
	N0	N1	N2	N3	
P_0	81.09	99.11	104.63	110.68	98.88
P_1	85.75	102.19	107.06	113.82	102.21
P_2	95.12	109.52	110.08	117.05	106.69
Mean	87.32	101.94	107.26	113.85	
	N	P	N x P		
SEm±	0.888	0.666	1.547		
CD(P=0.05)	1.526	1.144	2.672		

Kg/ha), and N_3 (120 Kg/ha) levels of nitrogen over control. This could be attributed to increased availability of nutrients in the soil. Yield is the joint result of yield attributing characters like numbers year per plant, year length (cm) and numbers of grains per year. Similar results were reported by Munna lal et al. (2012), Jehangir, et al., (2013) and Neel Ratan and Singh (2013). A closer study of table revels that phosphorus application increased grain yield (q/ha) significantly over control. It is also evident from the table 1 that all the levels of P application increased the grain yield of oat significantly and P_2 maintained its superiority in this respect. The increase in the grain yield (q/ha) due to application of $P_1$and P_2 over control was in tune of 3.28 and 8.29 percent, respectively. The interaction between N and P also showed significantly increase in grain yield of oat. The treatment combination N_3 P_2 reported maximum grain yield in this experiment.

It can be seen from the data shown in table 1 that the application of nitrogen increased the straw yield significantly over control. It could be due to N and P in the soil. The nitrogen level N_3 maintained its superiority in regard of straw yield of oat. All the levels of nitrogen application also increased straw yield significantly. The increment in the straw yield due to application of 80,100 and 120 Kg/ha N was in tune of 16.55, 22.57 and 30.04 percent, respectively. Godara, et al. (2016) also reported similar results in this respect.

The application of phosphorus to oat crop also enhanced straw yield (q/ha) significantly. However, all the levels of P increased straw yield significantly and P_2 maintained its superiority in this regard. This increase in straw yield may due to enhanced root growth leading to more height and development of plant. Similar results were also reported by Neel Ratan and Singh (2013) and Jat et al. (2014). The interaction between N and P also showed significant increase in straw yield of oat. The treatment combination N_3 P_2 reported maximum straw yield on this experiment. The Protein content in grain and straw was significantly affected by N and P application at various levels. The minimum protein content in oat grain and straw was recorded under control, which may be ascribed to lower concentration of nitrogen in oat crop. From quality point of view N_3 level of nitrogen application and P_2 level of phosphorus application appeared to the best. This may be due to the fact that the plants accumulated more nitrogen with these treatments and ultimately showing more protein content percent. Sharma, et. al. (2001) and Tiwana, et al. (2002) also reported similar results. Since Protein content (%) is directly related to N content (%) of oat crop. As per data given in table 2, clearly show that the minimum protein yield of oat grain was recorded under control treatment. This may be attributed lower yield of oat grain. Protein yield of oat

Table 2: Effect of nitrogen and phosphorus application on protein content (%) in grain and straw of oat crop

Treatments	Protein content (%) in grain	Protein content (%) in straw	Protein Yield(kg/ha)
Levels of nitrogen			
N_0	7.71	2.80	417.25
N_1	8.12	3.03	518.57
N_2	9.20	3.15	563.56
N_3	9.24	3.16	599.13
Levels of phosphorus			
P_0	8.83	2.90	491.55
P_1	9.12	3.05	523.18
P_2	9.25	3.15	556.50
Grain	N	P	
SEm±	0.10	0.082	
CD(P=0.05)	0.188	0.141	
Straw	N	P	
SEm±	0.029	0.022	
CD(P=0.05)	0.051	0.028	
Protein yield	N	P	
SEm±	0.76	0.577	
CD(P=0.05)	1.321	0.990	

Table 3: Effect of nitrogen and phosphorus application on the Nitrogen, Phosphorus, and Potassium content (%) in grain and straw of oat crop

Treatment	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Levels of nitrogen						
N_0	1.38	0.47	0.19	0.09	0.52	1.98
N_1	1.48	0.52	0.22	0.10	0.59	2.07
N_2	1.50	0.54	0.23	0.11	0.61	2.09
N_3	1.53	0.55	0.24	0.12	0.63	2.12
SEm±	0.008	0.003	0.004	0.003	0.008	0.10
CD(P=0.05)	0.014	0.006	0.015	0.006	0.014	0.187
Levels of phosphorus						
P_0	1.41	0.48	0.20	0.09	0.54	2.01
P_1	1.46	0.58	0.23	0.11	0.59	2.08
P_2	1.51	0.52	0.24	0.12	0.62	2.13
SEm±	0.006	0.002	0.06	0.002	0.006	0.012
CD(P=0.05)	0.011	0.004	0.17	0.007	0.011	0.140

grain improved with all levels of nitrogen and phosphorus application over control. Tiwana, et al. (2002) and Godara et al. (2016) also reported similar results by chemical fertilizers.

Nitrogen content (%) in grain and straw ranged from 1.39 to 1.53 and 0.47 to 0.55, respectively. The application of nitrogen increased nitrogen content in oat grain and straw significantly. This increase in nitrogen content may be ascribed to greater availability of nitrogen in soil due to its application. Nitrogen content in oat grain and straw was further improved significantly due to application of N level (120 kg N ha^{-1}). Application of phosphorus to the oat crop at various levels also increased N content in the grain and straw of oat and higher N content was noted with the application of phosphorus @80 Kg P ha^{-1} .

The data presented in table 3 indicate that the phosphorus content in oat grain and straw increased significantly due to the application of N and P to this crop over control. This increase in phosphorus content is in consonance with the built up in soil test phosphorus values due to addition of phosphatic fertilizers. Similar results were reported by Hirpara, et al. (2011). The higher P content was noted under N_3 level of nitrogen application and P_2 level of phosphorus application in this experiment. Potassium content in grain and straw ranged from 0.52 to 0.63 and 1.98 to 2.12 percent. Addition of nitrogen and phosphorus improved the K content (%) in grain and straw over control.

The nitrogen uptake by grain of oat ranged from 67.27 to 99.19 Kg /ha. The corresponding range of N uptake by straw was from 41.63 to 63.05 kg/ha. Application of N at various levels increased N uptake by grain and straw of oat over control. The similar results were reported by Sharma, et al. (2002) and Sharma (2009). The magnitude of N uptake by grain and straw of oat was higher when N applied @ 120 kg/ha. Similarly, in case of P application the higher N uptake was obtained with P_2 level of phosphorus application in study. The increased uptake of N by oat grain and straw may be ascribed to more availability of N with added application of N to the soil coupled with greater yields.

A study of data revels the almost all the levels of both the treatments N and P significant beneficial effect on the utilization of P by oat grain and straw over control. The P uptake by the grain ranged from 9.64 to 15.86 Kg/ha. The corresponding range of P uptake by straw was from 8.07 to 13.64 Kg/ha. The N_3 level of nitrogen application and P_2 level of phosphorus application enhanced the P uptake by oat crop over control. This may be ascribed to increased grain and straw yields and improvement in P content in grain and straw of oat. The similar results were reported by Neel Ratan and Singh (2013). The values of K uptake increased from 25.49 Kg/ha at control to 41.05 Kg/ha with 120 Kg N/ha, likewise 30.43 at control to 37.69 kg/ha with 80 Kg P ha^{-1} by grain and 174.99 to 243.44 (0 N to 120 Kg N ha^{-1}) and 200.76 to 229.30 Kg ha^{-1} (0 P to 80 kg P ha^{-1}) in case of K uptake by oat straw. This increase in K uptake by oat crop might br due to higher yield of crop coupled with

Table 4: Effect of nitrogen and phosphorus application on the Nitrogen, Phosphorus, and Potassium uptake (Kg ha^{-1}) in grain and straw of oat crop

Treatment	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
Levels of nitrogen						
N_0	67.27	41.63	9.64	8.07	25.49	174.99
N_1	84.75	53.48	12.96	10.26	34.04	212.97
N_2	92.04	58.40	14.44	11.83	37.66	226.26
N_3	99.19	63.05	15.86	13.64	41.05	243.44
SEm±	1.99	1.27	0.18	0.38	0.98	1.66
CD(P=0.05)	3.400	2.163	0.292	0.635	1.665	2.833
Levels of phosphorus						
P_0	78.74	47.94	11.55	8.99	30.43	200.76
P_1	84.16	51.57	13.62	11.32	34.26	214.64
P_2	91.21	55.92	14.83	12.85	37.69	229.30
SEm±	1.486	0.946	0.129	0.279	0.729	1.239
CD(P=0.05)	2.551	1.624	0.220	0.477	1.250	2.126

enhanced P content percent.

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