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Effect of phosphorus and molybdenum on fodder yield nutrient contents and their uptake by oat crop (*Avena sativa* L.)

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Abstract

A field experiment was conducted to study the effect of phosphorus and molybdenum on yield and their uptake by oat. Application of phosphorus and molybdenum on yield and their uptake by oat. Application of phosphorus up to 60 kg ha⁻¹ increased grain and straw yield. Molybdenum application at 20 kg ha⁻¹ gave highest green and dry matter yield of oat. Molybdenum uptake by oat crop tended progressively with increasing level of phosphorus. The maximum value of molybdenum uptake by oat was recorded with highest level of nitrogen.

Keywords: Phosphorus, molybdenum, quality, yield, nutrient uptake, oat

Introduction

Oat rank fourth in importance in world production of cereal's exceed only by wheat, rice and maize. A greater proportion of oat crop in fed directly to live stock than any other cereal. It is high in protein, fat, vitamin B and in minerals such as phosphorus and iron. The nutrient elements of major significance for yield and quality of oat are nitrogen, phosphorus, molybdenum. Phosphorus is essential element required for plant growth and root development. It is known to be associated with several vital function in plant body. The availability of phosphorus from soil to plants depends on the equilibrium of phosphorus around the root zone. The equilibrium is influenced mainly by salt concentration, p^H, calcium carbonate and nature of exchangeable complex and organic matter.

Molybdenum, one of the important members of this group is of special significance due to its contribution in activation of several enzyme system and physiological activities encountered inside the plant body. Molybdenum is constituent part of the enzyme nitrate reductase concerned with the reduction of nitrate to nitrite in both micro-organism and higher plants. It is also known to be specific inhibitor for acid phosphate. Deficiency of molybdenum has been shown to decrease the concentration of surars, particularly reducing sugars, suggesting an involvement of molybdenum in carbohydrate metabolism.

Materials and Methods

The field experiment were conducted at the Agriculture farm of R.B.S. College, Bichpuri, Agra during Rabi seasons of 2018-19. The experimental soil had EC 3.2 dsm⁻¹, p^H 8.5, organic carbon 0.45%, available N186.50, P 25.50, K 220.10 kg ha⁻¹ and molybdenum 3.5 mg kg⁻¹. The experiment was laid out in randomized block design with four levels of phosphorus (control, 20, 40, 60 kg P₂O₅ ha⁻¹) and three levels of molybdenum (control, 10 and 20 kg ha⁻¹) with three replications. The recommended dose of potash, half amount of nitrogen and phosphorus & molybdenum applied at the time of sowing as basal dressing and rest amount of nitrogen applied as top dressing. Phosphorus and molybdenum were supplied through single super phosphate and ammonium molybdate as per treatment. The oat was sown on November 15, 2018. And irrigated at the proper time as judged by the appearance of soil and crop. The plants were harvest for fodder at two cuttings i.e. first cutting at 30 days after sowing however second cuttings after 30 days of first cutting. At the time of harvest the green foliage yield was recorded and after drying in oven the dry matter yield was recorded.

The plant samples were analysed for N content by Snell and Snell(1955) method. The phosphorus content was determined in acid extract by ammonium vanadate molybdate yellow colour method as described by Chapman and Pratt (1961). Potassium was estimated in the same extract after making suitable dilution with the help of flame photometer. Molybdenum was estimated by atomic spectrophotometer. The uptake values of N,P,K and Mo by oat crop were calculated by using the content (%) of nutrient and its corresponding yield values. The soil samples collected after harvest were analyzed for organic carbon, available N, P, K, pH, EC. As per procedures.

Result and Discussion

There was highly significant effect of P nutrition on green and dry foliage yield of oat with successive increase in P level (Table-1). It is quite clear that green fodder production was higher at 2nd cutting with each level of phosphorus. The maximum green foliage yield and dry matter yield of oat was noted under highest level of phosphorus (60 kg ha⁻¹) at both cuttings. Similarly the percent increase in green foliage of oat with P1(20 kg ha⁻¹), P2 (40 kg ha⁻¹) and P3 (60 kg ha⁻¹) levels of phosphorus over control were 10.41,18.02 and 26.85 percent at 1st cutting and 6.33,10.81 and 17.28 percent at 2nd cutting respectively. These results are in agreement with the opinion of Ahmed *et al.*, (1986)^[1], Singh (2004)^[12] and Lal *et al.*, (2013)^[8]. The percent increase in dry matter yield of

oat were 11.15,16.96 and 19.15 percent in 1st cutting and 9.23,14.03 and 16.02 percent in 2nd cuttings respectively. These results are in favour of Singh *et al.*, (2005)^[11, 14] and Sarawgi *et al.*, (2008). It is also clear from table-1 that the levels of molybdenum affected significantly the green foliage yield and dry matter yield of oat in both cuttings. It is also seen that green and dry fodder production was higher at 2nd cutting with each levels of molybdenum. The percent increase in green foliage yield of oat due to M1 and M2 levels of molybdenum over control were 10.79 and 20.04 percent at 1st cutting and 7.66 and 16.69 percent at 2nd cutting, respectively. Our findings are in agreement with these of Gangwar and Singh (1992), Singh and Singh (1995), Kumawat *et al.*, (2009)^[6, 7] and Lal *et al.*, (2013)^[8]. Dry matter yield of oat were 8.52, 8.72 percent in first cutting and 8.56 and 8.78 percent in 2nd cutting respectively over control. These results are in accordance with those of Chimania *et al.*, (1972), Kumar *et al.*, (1977) and Dahiya *et al.*, (1990), Singh and D Singh (2006)^[13], Singh *et al.*, (2007) and Brady and weil (2008)^[3], Kumawat *et al.*, (2009)^[6, 7]. It is evident from table-2 that levels of N,P,K and Mo contents of oat increased significantly with increasing levels of phosphorus as compared to control at both cuttings. The maximum N,P, K and Mo content were noted with highest levels of phosphorus (P3)@ 60 kg/ha over control at both cuttings. Similar results were also observed by Singh *et al.*, (2005)^[11, 14], Tripathi *et al.*, (2006)^[15] and Lal *et al.*, (2013)^[8], Patel *et al.*, (2005)^[10].

Table 1: Effect of phosphorus and molybdenum on green foliage and dry matter yield (t ha⁻¹) of oat crop.

Treatment	Green foliage yield (t/ha)		Dry matter yield (t/ha)	
	Ist cutting	IInd cutting	Ist cutting	IInd cutting
Phosphorus levels				
P ₀	31.35	34.69	8.15	8.45
P ₁	34.72	36.95	9.07	9.24
P ₂	37.18	38.55	9.55	9.65
P ₃	39.95	40.85	9.73	9.82
S.Em+-	0.579	0.402	0.022	0.028
C.D. at%5	1.58	1.14	0.065	0.082
Molybdenum Levels				
M ₀	32.17	36.32	8.28	8.24
M ₁	35.75	39.18	8.42	8.46
M ₂	38.82	42.55	8.60	8.68
S.Em+-	0.414	0.368	0.240	0.022
C.D. at%5	1.20	1.07	0.067	0.068

Observation of data given in Table-2 indicated that the molybdenum levels significantly affect N,P,K contents of oat at both cuttings. However, The contents of oat increased with increasing levels of molybdenum at both cuttings as compared to each preceding lower level of molybdenum. The maximum contents(N,P,K) of oat was noted with Highest level of molybdenum(20 mg kg⁻¹)under both cuttings. Similar results were reported by Singh and Kumar(1995) and Singh *et al.*, (2007) and Bambara and Ndakidemi (2010)^[2], Kumawat *et al.*, (2009)^[6, 7], and Gupta and Ram Lal(1967), Khare and Deshpande (1986), Singh and Singh (1988) and Kumawat *et al.*, (2009)^[6, 7] for Potassium content. It is also noted that each higher level of molybdenum resulted significantly higher molybdenum content of oat in comparison to preceding lower level of molybdenum. The maximum molybdenum content was noted at M2 @ 20 mg kg⁻¹ level of molybdenum at both the cuttings. Similar findings were also reported by Singh (1994), Gupta *et al.*, (1995) and Sharma and Singh (1999), Singh *et al.*, (2007), Kumawat *et al.*, (2009)^[6, 7].

The uptake of nitrogen by oat crop increased significantly with increasing levels of nitrogen in comparison 1 to control. It is quite clear that the uptake of nitrogen by oat crop was greater at 2nd cutting. The nitrogen level N₃ @ 120 kg ha⁻¹ significantly increased the nitrogen utilization by oat crop over control and N₁ @ 40 kg ha⁻¹ level of nitrogen at both the cuttings. It is also noted that comparatively more enhancement in nitrogen uptake by oat was found with highest level of nitrogen N₃ (120 kg ha⁻¹) at both the cuttings. These results are in accordance with those of Patel *et al.*, (2005)^[10]. Each higher level of molybdenum resulted more utilization of nitrogen by oat crop in comparison to preceding lower levels of molybdenum at both the cuttings. Maximum significant enhancement in nitrogen uptake by oat crop was recorded at highest level of molybdenum M₂ @ 20 mg kg⁻¹ as compared to control at both the cuttings. Similar results were observed by Singh (1994), Singh and Singh (1995), Sharma and Singh (1999) and Khan *et al.*, (2007)^[5] and Kumawat *et al.*, (2009)^[6, 7].

Table 2: Effect of Phosphorus and molybdenum on N,P, K and Mo content (%) of oat at 1st and 2nd cutting

Treatment	N content (%)		P content (%)		K Content (%)		Mo Content (%)	
	Ist cutting	2 nd cutting	Ist cutting	2 nd cutting	Ist cutting	2 nd cutting	Ist cutting	2 nd cutting
Phosphorus levels								
P ₀	1.14	1.13	0.17	0.19	2.13	2.02	39.55	38.28
P ₁	1.16	1.17	0.22	0.23	2.19	2.07	42.25	41.56
P ₂	1.20	1.20	0.24	0.24	2.29	2.17	45.24	44.48
P ₃	1.23	1.25	0.26	0.28	2.34	2.21	47.26	46.93
S.Em+-	0.006	0.005	0.005	0.006	0.006	0.007	0.38	0.37
C.D. at%5	0.017	0.013	0.017	0.019	0.015	0.019	0.64	1.09
Molybdenum Levels								
M ₀	1.11	1.11	0.19	0.20	2.11	1.93	39.85	36.43
M ₁	1.15	1.16	0.22	0.23	2.16	2.02	44.94	41.43
M ₂	1.19	1.21	0.25	0.26	2.18	2.09	53.38	48.48
S.Em+-	0.005	0.004	0.005	0.004	0.012	0.008	0.61	0.64
C.D. at%5	0.010	0.085	0.016	0.013	0.033	0.021	1.78	1.87

Table 3: Effect of Phosphorus and molybdenum on N,P, K (kg ha⁻¹) and Mo (g ha⁻¹) uptake by oat at 1st and 2nd cutting

Treatment	N uptake		P uptake		K uptake		Mo uptake	
	Ist cutting	2 nd cutting	Ist cutting	2 nd cutting	Ist cutting	2 nd cutting	Ist cutting	2 nd cutting
Phosphorus levels								
P ₀	91.40	95.61	16.67	18.95	174.72	171.71	324.53	325.84
P ₁	104.45	107.34	21.17	23.41	198.90	191.40	386.60	387.91
P ₂	113.85	115.02	25.12	26.35	218.05	208.62	436.00	435.33
P ₃	117.94	122.00	26.16	29.76	227.05	217.24	464.35	465.66
S.Em+-	0.53	0.62	0.28	0.36	0.43	0.26	5.13	6.55
C.D. at%5	1.54	1.79	0.80	1.01	1.26	1.07	16.49	19.01
Molybdenum Levels								
M ₀	91.32	91.40	16.63	18.95	172.35	168.23	326.33	318.85
M ₁	91.45	91.43	16.43	23.43	192.48	198.62	389.73	405.38
M ₂	91.52	91.48	16.75	25.32	206.68	216.85	398.33	416.95
S.Em+-	0.56	0.68	0.28	0.27	0.37	0.49	7.75	2.93
C.D. at%5	1.62	1.97	0.80	0.79	1.08	1.42	22.30	8.45

Enhancement in phosphorus levels significantly increased the phosphorus uptake by oat over control and preceding lower levels of phosphorus at both the cuttings. It is clear that the higher utilization of phosphorus by oat crop was noted at 2nd cutting. The maximum significant enhancement in phosphorus uptake was recorded with P₃@ 60 kg ha⁻¹ level of phosphorus as compared to control. Similar to these finds Patel *et al.*, (2005) [10] and Islam *et al.*, (2005) [4]. The utilization of phosphorus by oat crop significantly increased with increasing levels of molybdenum as compared to control comparatively, more phosphorus uptake was found at 2nd cutting. Therefore, the maximum utilization of phosphorus by oat crop was recorded at M₂ (20 mg kg⁻¹) level of molybdenum. Similar observations were also recorded by Dahiya *et al.*, (1990) and Kumawat *et al.*, (2009) [6, 7].

In general, the potassium uptake P₃ @ 60 kg ha⁻¹ levels of phosphorus as compared to control at both the cuttings. Comparatively more significant potassium utilization was recorded with highest level of phosphorus P₃ @ 60 kg ha⁻¹ over control at both the cuttings. The increase in potassium uptake may be due to increase potassium content and dry matter with the use of phosphorus levels in this experiment. Our findings in agreement with those of Patel *et al.*, (2005) [10]. The uptake of potassium increased significantly with increasing levels of molybdenum in comparison to control at both the cuttings. The more beneficial effect on potassium uptake by oat crop was noted with highest level of molybdenum M₂ (20 mg kg⁻¹) at both the cuttings. Higher values of potassium uptake with molybdenum application are apparently the result of favourable effect of these treatments on greater dry matter production similar were also noted by

Mishra and Tripathi (1973), Singh and Singh (1988) and Kumawat *et al.*, (2009) [6, 7]. From the data given in table -3 reflects that the utilization of molybdenum increased with raising the levels of phosphorus at both cutting of oat fodder crop. Comparatively more utilization of molybdenum by oat crop was recorded at 2nd cutting. It is clear that the molybdenum uptake increased significantly at P₂ @40 kg ha⁻¹ and P₃ @ 60 kg ha⁻¹ levels of nitrogen as compared to control at both the cuttings. The maximum value of molybdenum uptake by oat crop was found with highest level of nitrogen P₃ @ 60 kg ha⁻¹ at both the cuttings. It might be concluded from the above findings that the increased uptake of molybdenum by oat crop due to phosphorus application is attributed to enhance dry matter production and an increase in molybdenum content. Further study of table-3 reveals that the molybdenum uptake by oat crop increased significantly with increasing levels of molybdenum as compared to control at both the cuttings. Each higher level of molybdenum resulted more significant utilization of molybdenum in comparison and preceding lower level of molybdenum. The greater uptake of molybdenum was recorded at 2nd cutting. Similarly, the significant maximum enhancement in molybdenum uptake was recorded with highest level of molybdenum M₂ (20 mg kg⁻¹) at both the cuttings from these findings it is inferred that effect of molybdenum levels increased the dry matter and molybdenum content resulted enhanced molybdenum uptake of oat crop in this investigation. Similar to these findings Singh and Singh (1995) and Singh (1996) and Kumawat *et al.*, (2009) [6, 7], Lal *et al.*, (2016) [8].

The soil application of phosphorus @ 60 kg ha⁻¹ and molybdenum @ 20 kg ha⁻¹ as sodium molybdate may be recommended to the farmers for obtaining better production of oat fodder crop. Application of phosphorus and molybdenum improved the contents and utilization of nitrogen, phosphorus, potassium and molybdenum by oat fodder crop.

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