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Original Research Article

Effect of Phosphorus and Manganese Application on Yield, Content and Uptake of Nutrient by Oat (*Avena sativa* L.)

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A B S T R A C T

A field experiment was conducted to study the effect of phosphorus and manganese on yield and their uptake by oat. Application of phosphorus and manganese on yield and their uptake by oat. Phosphorus and manganese application have a significant favorable effect on green foliage and dry matter yield of oat. The content and uptake of nutrient were also affected by the application of phosphorus and manganese. Oat crop responded significantly to phosphorus and manganese levels. Application of phosphorus improved the content of nitrogen, phosphorus and potassium but depressed the manganese content. Similarly high level of manganese increased the nitrogen and manganese content but reduced the K content. However high level of Mn did not show any significant enhancement on phosphorus content. The uptake of these nutrients improved with higher levels of phosphorus and manganese . Optimum dose of phosphorus and manganese for oat production was found 30 mg kg^{-1} and 10 mg kg^{-1} respectively.

Keywords

Phosphorus, Manganese, Yield, Uptake of Nutrient, Oat

Introduction

Phosphorus and manganese being essential nutrient, play an important role in several metabolic functions of plants. These two nutrients interact in both plant and soil affect the availability and utilization of each other. Evidently the nutrition of plants depends on several factors other than the ability of soil to supply the elements . Among these may be mentioned the rate of nutrients absorption mobility within the plant and its distribution to functional sites. Each one of these processes is affected by interactions between micro and macro–nutrients. Such interaction take place in the soil and its plants. Because these interactions modify the nutrition of plants, they must be understood and considered in providing an adequate nutrient supply. Since the information on phosphorus and manganese relationship is scanty in the literature this investigation was undertaken to study phosphorus and manganese nutrition relationship in oat. The present study was, therefore, undertaken to investigate the effect of phosphorus and manganese and their interaction on yield and their uptake by oat grown in sandy loam soil.

Materials and Methods

The investigation was carried out as a pot experiment at R.B.S college, Bichpuri, Agra. The field experiments were conducted on a sandy loam soil, with pH 8.00, EC 0.60 (dSm^{-1} at 25^0 C), organic carbon 0.46, $CaCO_3$ 0.60 (%), available N 182.5 (kg ha^{-1}), available P 13.60 (kg ha^{-1}), available K 125.00 (kg ha^{-1}), available DTPA-Mn 2.80 (ppm), during rabi season in the year of 2000-2001. The treatment consisted of four levels each of phosphorus (0, 15, 30 and 45 mg kg^{-1}) and four levels of manganese (0,5,10 and 20 mg kg^{-1}). These treatment combinations were replicated thrice in a randomized block design (RBD) having 16 treatment combinations in 48 pots. Forty-eight earthen pots lined with polythene sheet of similar size and shape was selected. After mixing the soil lot thoroughly, 5 kg of soil were filled in each pots. Nitrogen, potassium, phosphorus and manganese were applied through urea single super phosphate (S.S.P) muriate of potash (M.O.P) and manganese chloride respectively. The oat was sown on 4th December, 2000. Equal amount of water was applied to the pots at the time of irrigation. Deionized water was used for this purpose. Variety used was Kent. The first cutting of oat was harvested on February 7th, 2001. The second cutting of oat was harvested on March 22th, 2001. The data pertaining to first and second cutting fresh weight and dry weight recorded. The plant samples were analyzed for different elements. Nitrogen was estimated by "Colorimetric methods of analysis" vol. II page 813-816 by Snell and Snell (1955), phosphorus by ammonium molybdate Vanadate yellow colour method as described by Chapman and Pratt (1962), potassium by flame photometer, manganese by Periodate method of Willard and green house(1917) as described by Johnson and Ulrich (1959).

Results and Discussion

There was highly significant effect of phosphorus nutrient on green foliage and dry matter yields of oat with successive increase in phosphorus level (Table-1). All the higher doses of phosphorus application were found significantly superior over control in enhancing the green foliage yield of oat crop in its first and second cutting, except phosphorus application @ 15 mg kg^{-1} could not responded significantly over control in second cutting of oat crop. Added doses of phosphorus did not cause a significant enhancement in green foliage and dry matter yield of oat in Ist and IInd cutting. However, highest green foliage and dry matter yield was obtained with the application of phosphorus @ 45 mg kg^{-1} in both of cutting. Interaction effect of phosphorus and manganese on green foliage and dry matter yield of oat crop was found non-significant.

Similar trend of P application was noted by Vig and Dev (1978), Sukla and Singh (1979), Agarwal (1880) and Subbaro *et al.*, (1995) who observed a positive yield response to applied P fertilizer.

The data given in the table-1 clearly indicate that all the higher doses of Mn were found significantly superior over control in enhancing the green foliage and dry matter yield of oat crop in their Ist and IInd cutting. Further Mn application @ 10 mg kg^{-1} was found significantly superior over Mn application @5 mg kg^{-1} in first cutting of crop. However, in second cutting Mn @ 10 mg kg^{-1} was not responded significantly superior over Mn application @ 5 mg kg^{-1}, Mn application @ 20 mg kg^{-1} could not respond significantly superior over Mn application @10 mg kg^{-1} in both the cutting of oat crop. The response of crop to Mn application was also reported by Yadav *et al.*, (1983) and Singh (1990). The yield reduction

caused by higher level of Mn due to the nutrient imbalance which resulted in metabolic disturbances in plant (Singh and Pathak, 1968).

The data given in the table 2 clearly indicate higher doses of Mn were found significantly superior over control in enhancing the N content in oat crop over control in its first and second cutting except Mn application @ 5 mg kg-^{1} could not prove significantly over control in IInd cutting. A critical observation of the data indicate that additive doses of Mn did not significantly affect the N content of oat in Ist and IInd cutting. However, Mn application @ 20 mg kg-^{1} was found significantly superior over Mn application @10 mg kg-^{1} in II cutting. Further Mn application @ 20 mg kg-^{1} was proved significantly superior over Mn application @ 5 mg kg-^{1} in both cutting. These findings are also supported by Singh (1990), Singh (1996). Additional doses of P did not significantly alter the N content of oat crop. Bhargava and Motiramani (1976), Nimje and Seth (1985) also reported an increase in nitrogen content with P application. The interaction effect of P x Mn on N content was found non significant.

Application of P has a significant effect on P content in Ist and IInd cutting of oat. All the higher doses of P application significantly enhanced its content over control in both of the cutting. Further phosphorus application @ 30 and 45 mf kg-^{1} also found significantly superior over phosphorus application @ 15 mg kg-^{1} in Ist cutting however in second cutting P application @ 30 and 45 mg kg-^{1} did not respond significantly over P application @ 15 mg kg^{-1} further phosphorus application @45 mg kg-^{1} did not respond significantly over P application @ 30 mg kg-^{1} in both of the cutting. Similar results were also supported by Khan and Zende (1976), Ahmed et al, (1986), Khandkar and Shinde (1991) and Kumar and Verma (1999). Mn application did not show any significant response on P content in oat in its Ist and IInd cutting. Singh (1996) also supported that of P content decreased with Mn application. Interaction effect of P x Mn on P content was found non-significant. The data given in the table 3 clearly indicate that Mn application has a significant adverse effect on K content of oat crop. These finding are also supported by Singh *et al.,* (1998). A critical observation of the data indicate that additive doses of P application i.e. more than 5 mg kg-^{1} did not significantly enhance the K content of oat crop in both cutting. However highest K content was observed with the application of P @ 45 mg kg-^{1} in both cutting of oat crop. These finding are also supported by Joshi and Seth (1978), Agrawal (1978). The interaction effect of P and Mn on K content was found non-significant. The Mn application enhanced its content significantly in both the cutting of oat. All the higher doses of Mn application significantly enhanced its content over control. However, each added dose of Mn caused a significant enhancement in Mn content in Ist and IInd cutting of oat. These findings are in accordance with Dev *et al.*, (1983) also observed similar trend in chickpea. Dixit and Verma (1983), Singh (1990) and Singh (1996) also reported similar results. The data given in the table 4 indicate that higher doses of P application adversely affected the Mn content of oat. P application 45 mg kg-^{1} was significantly reduced the Mn content over control in Ist and IInd cutting of oat. However P application @ 30 mg kg-^{1} also caused a significant reduction in Mn content over control in Ist cutting of oat. Similarly P application @ 45 mg kg-^{1} significantly depressed the Mn content over P application @ 15 mg kg-^{1} in both cutting of oat. Similar findings were also reported by Gupta and Bhedra (1980). The interaction effect of P and Mn on Mn content in oat was found non significant.

Table.1 Effect of phosphorus and manganese on green foliage and dry matter yield (gm pot^{-1}) first cutting and second cutting of oat crop

Treatment	Green foliage yield		Dry matter yield	
	Ist cutting	II nd cutting	Ist cutting	IInd cutting
Manganese levels (mg kg-^{1})				
0	15.82	18.84	2.18	4.45
5	17.48	20.05	2.42	4.88
10	19.14	20.90	2.65	5.11
20	19.59	21.03	2.71	5.11
SEm+-	0.40	0.46	0.07	5.29
CD at 5%	1.16	1.32	0.20	0.14
Phosphorus levels (mg kg-^{1})				
0	16.38	18.94	2.27	4.66
15	17.89	19.88	2.48	4.78
30	18.79	20.93	2.60	5.17
45	18.95	21.07	2.62	5.13
SEm+-	0.40	0.46	0.07	0.14
CD at 5%	1.16	1.32	0.20	0.40

Table.2 Effect of phosphorus and manganese on nitrogen, phosphorus , potassium and manganese content (%) first cutting and second cutting of oat crop

Treatment	Nitrogen content		Phosphorus content		Potassium content		Manganese content	
	Ist cutting	IInd cutting	Ist cutting	IInd cutting	Ist cutting	IInd cutting	Ist cutting	IInd cutting
Manganese levels (mg kg-^{1})								
0	2.08	1.79	0.91	0.29	2.79	2.14	15.28	16.55
5	2.26	1.77	0.42	0.30	2.78	2.10	19.78	20.75
10	2.38	1.86	0.42	0.31	2.75	2.09	22.10	23.30
20	2.44	2.05	0.40	0.30	2.73	2.05	24.18	24.53
SEm+-	0.06	0.04	0.01	0.01	0.02	0.01	0.34	0.41
CD at 5%	0.18	0.11	NS	NS	0.05	0.04	0.98	1.18
Phosphorus levels (mg kg-^{1})								
0	2.23	1.77	0.36	0.26	2.71	2.06	21.13	22.05
15	2.27	1.85	0.40	0.30	2.77	2.09	20.70	21.68
30	2.32	1.89	0.44	0.31	2.78	2.11	20.05	21.00
45	2.34	1.92	0.46	0.32	2.79	2.12	19.45	20.40
SEm+-	0.06	0.04	0.01	0.01	0.02	0.01	0.34	0.41
CD at 5%	NS	0.11	0.04	0.03	0.05	0.04	0.98	1.18

Table.3 Effect of phosphorus and manganese levels on nitrogen, phosphorus, potassium and manganese uptake(mg/pot) in first cutting and second cutting of oat crop

Treatment	Nitrogen uptake		Phosphorus uptake		Potassium uptake		Manganese uptake	
	Ist cutting	IInd cutting	Ist cutting	IInd cutting	Ist cutting	IInd cutting	Ist cutting	IInd cutting
Manganese levels (mg kg-^{1})								
0	45.598	77.626	9.044	13.115	61.061	95.155	0.033	0.073
5	54.694	86.828	10.237	14.705	67.233	102.632	0.048	0.101
10	63.096	95.000	11.196	15.819	72.819	106.755	0.058	0.119
20	66.097	108.545	10.944	15.632	73.892	108.586	0.066	0.130
SEm+-	2.363	3.089	0.457	0.670	1.985	2.986	0.002	0.003
CD at 5%	6.826	8.923	1.322	1.935	5.734	8.623	0.005	0.009
Phosphorus levels (mg kg-^{1})								
0	50.952	82.956	8.173	12.098	61.293	96.019	0.064	0.104
15	56.569	88.812	10.011	14.369	68.493	99.755	0.067	0.105
30	60.438	97.728	11.332	16.194	72.249	108.627	0.066	0.109
45	61.526	98.565	11.906	16.160	72.971	108.728	0.065	0.105
SEm+-	2.363	3.089	0.457	0.670	1.985	2.986	0.002	0.003
CD at 5%	6.826	8.923	1.322	1.935	5.734	8.623	N.S	N.S

Table.4 Effect of phosphorus and manganese levels on nitrogen, phosphorus, potassium and manganese total uptake (mg/pot) in oat crop.

Treatment	Total uptake			
	Nitrogen	Phosphorus	Potassium	Manganese
Manganese levels (mg kg-^{1})				
0	123.225	22.159	156.217	0.107
5	414.522	24.992	169.865	0.149
10	158.096	27.015	179.574	0.177
20	174.642	26.576	182.478	0.195
SEm+-	4.216	0.882	3.850	0.003
CD at 5%	12.175	2.547	11.120	0.011
Phosphorus levels (mg kg-^{1})				
0	133.907	20.271	157.312	0.152
15	145.381	24.379	168.248	0.157
30	158.166	27.526	180.876	0.162
45	160.031	28.516	181.699	0.157
SEm+-	4.216	0.882	3.850	0.003
CD at 5%	12.175	2.547	11.120	N.S

Higher doses of P up to 30 mg kg-^{1} significantly enhanced the N uptake by oat. Additive doses of P application could not cause a significant enhancement in N uptake value however P application @ 45 mg kg-^{1} was found significantly superior over P application @ 15 mg kg-^{1} in enhancing the N uptake by II cutting of oat crop. These findings are similar to those of Singh and Manohar (1982), Chauhan and Singh (1987). Interaction effect of P and Mn of N uptake was found non significant. Each additive dose of Mn application caused a significant enhancement in total N uptake by oat. However, Mn @ 10 mg kg-^{1} did not prove significantly superior over Mn application @ 5 mg kg-^{1} in enhancing the N uptake by its II cutting. Similarly in Ist cutting, Mn application @ 20 mg kg-^{1} could not prove significantly superior over Mn application @ 10 mg kg-^{1} in enhancing the N uptake by oat. These finding are in accordance with the findings of Sadaphal and Das, (1961), Singh (1990), Singh Kumar (1995), Singh (1996) and Singh and Singh(1998). Increasing doses of P significantly enhanced its uptake by oat. Mn application upto 10 mg kg-^{1} caused a significantly enhanced in P uptake. Higher doses of Mn i.e. 20 mg kg-^{1} depressed the P uptake by oat. Interaction effect of P x Mn on P uptake was found non significant. Higher doses of Mn application significantly enhanced the K uptake by Ist cutting of oat, IInd cutting and by both(total uptake) over control. However Mn application @ 5 mg kg-^{1} could not prove significantly superior over control in enhancing the K uptake by IInd cutting of oat. Each addition of Mn dose could not cause a significant enhancement in K uptake value by Ist cutting, II cutting and both the cutting(total uptake).However Mn application @ 20 mg kg-^{1} proved significantly superior over Mn application @ 5 mg kg-^{1} in enhancing the K uptake by Ist cutting and both the cutting of oat. These findings are similar to those of Dixit and Verma (1969) Singh and Raina (1981) Singh et al.(1998) and Lal *et al.*, (2012). P application upto 30 mg kg-^{1} significantly enhanced the K uptake by oat. Higher doses of Mn have a favourable effect on K uptake value by oat. Interaction effect of P x Mn on K was found non significant. P application did not cause a significant changes in Mn uptake value by oat. Increasing doses of Mn significantly enhanced the Mn uptake value by oat. These findings are similar to those of Dixit and Verma (1969), Shukla and Gupta(1975), Gill (1979), Gejendragadkar and Rathore (1987) Singh (1990), Dahiya *et al.*, (1996), Singh and Kumar (1995), Singh and Singh (1995), Singh (1990) and Singh and Singh (1998). Interaction effect of P x Mn uptake was found non- significant.

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