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e-mail : letmepublish@rediffmail.com
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EFFECT OF SELENIUM ON DRY MATTER YIELD, CHEMICAL COMPOSITION AND NUTRIENT UPTAKE BY BERSEEM (*TRIFOLIUM ALEXANDRINUM)* IN RELATION TO ITS INTERACTION WITH PHOSPHORUS

Arvind Kumar

Department of Ag. Chemistry and Soil Science, R.K.(P.G.) College, Shamli - 247 776 (U.P.).

ABSTRACT

Selenium application at different levels (0-10ppm) significantly decreased the fresh and dry matter yield, content and uptake of nitrogen, phosphorus, calcium, magnesium and sulphur in berseem. However, selenium application increased its content and uptake in plants. Application of phosphorus showed favourable effect on dry matter yield. The increasing levels of applied phosphorus increased the yield as well as the content & uptake of phosphorus. Phosphorus application increased selenium content in plants showing synergistic effect.

Key words : Selenium, Phosphorus uptake, Synergistic effect.

INTRODUCTION

Selenium, though a non- essential element for plant except few species, is an element of agronomic importance. Looking through the literature on selenium (Se) one will find it variously described as "Fickle as a moon", the element with a "schizophrenic chemical personality" etc. The low selenium concentration in fodder crops from many areas have resulted in an increasing interest in raising the selenium content of fodder plants by field treatment with selenium, which raises the question of a possible ecological hazards. The biological half-life of selenium in the tested animals is reported to be very short and no bioaccumulation as such has been seen (Hodson *et al*., 1980, Gissel Nielsen, 1973). Thus from an ecological point of view field treatment with physiological level of selenium possibly has no negative impact on the environment.

Selenium stimulates plant growth, may be because it substitutes, in definite enzymatic paths of some essential nutrients like sulphur and phosphorus. Although, phosphorus was also found to detoxicate selenium toxicity in some plants (Singh and Bhandari, 1974). However, the definite mechanism of its action is yet to be confirmed. Visual symptoms of selenium toxicity have never been observed in plants growing on seleniferous soils in field. Since visual symptoms do not provide conclusive evidence of selenium toxicity in the field, it becomes necessary to make chemical analysis of plants to confirm the presence of excess selenium. The capacity of different plant species to accumulate selenium also varies widely (Rosenfeld and Beath, 1964).

Interactions between selenium and phosphate have also been reported by (Singh, 1979). Although, conflicting results on selenium phosphate relationship have been found, most investigations have found that soil addition of phosphorus increased selenium accumulation (Singh

and Malhotra, 1976). Carter *et al.* (1972) investigated the effect of phosphorus addition to phosphorusdeficient calcareous soils and found that phosphorus fertilization increased the selenium concentration of alfalfa from both native and applied selenium.

Singh and Malhotra (1976) reported a positive correlation between phosphorus fertilization and selenium uptake in berseem clover. They found that phosphorus application increased the plant selenium concentration at all levels of applied phosphorus. They also found an increase in plant phosphorus concentration resulting from addition of Se^{4+} to the soil. They speculated that this resulted from a release of hydroxyl bound phosphorus by the added selenium.

MATERIALS AND METHODS

Pot culture experiment was carried out to suggest the remedial measures for its deficiency or toxicity

Pots

The earthen pots of 8'' diameter and 8'' height size with a hole at the bottom were used for pot culture experiment.

Crop seeds

Berseem (*Trifolium alexandrium*) was grown and the variety chosen was "PusaJaint".

Sources of selenium and phosphorus

Pure A.R. grade sodium selenite, calcium hydrogen phosphates were used as source of selenium and phosphorus, respectively.

Double distilled water

With the intention of avoiding possible contamination only double distilled water collected from "glass distillation assembly" was used in pot culture experiment for irrigation purpose and in chemical analysis of plants.

Methods

Collection of soil

Soil, for pot experiment was collected from the Research farm of C.C.R. (P.G.) College, Muzaffarnagar. The surface (0-15cm) soil in bulk was collected from a plot which was under jowar cultivation during the previous season. The soil was air dried and processed by passing through 2mm sieve before filling it into the pots.

Soil analysis

The soil was analysed for the various physical and chemical properties for the characterization of the soil. The results are furnished in table 1.

Table 1 : Important Physico-Chemical Characteristics of the soil.

S. No.	Characteristics	Value
1.	Mechanical analysis	Sand (%) 60.0 Silt (%) 19.0 Clay (%) 19.0
2.	Textural class	Sandy Loam
3.	pH (1:2.5 water)	8.0
4.	Electrical conductivity (1:2.5 water)	8.0
5.	Organic Carbon (%)	0.45
6.	Calcium Carbonate (%)	1.20
7.	Total nutrients:	
	Nitrogen (%)	0.054
	Phosphorus (%)	0.034
	Sulphur (ppm)	76.0
	Selenium (ppm)	0.37
8.	Available nutrients:	
	Nitrogen (ppm)	105.0
	Phosphorus (ppm)	6.4
	Sulphur (ppm)	16.0
	Selenium (ppm)	0.067

The experiment comprising of four levels of selenium and four levels of phosphorus was conducted as per details given below :

Treatments

(a) Levels of selenium (ppm)	Symbol
Control	Se_0
2	Se_1
5	Se_2
10	Se_3
(b) Levels of phosphorus (ppm)	Symbol
Control	P_0
25	P_1
50	P_2
75	P_3
Experimental design	R.B.C.
Replications	3
Total number of pots	48

The earthen pots of similar size and shape were selected, cleaned and lined with polythene sheets. The processed 4 kg soil was filled in each pot. Recommended doses of NPK were applied through urea, superphosphate and murate of potash respectively. Soil in each pot was pulvirized at appropriate moistureand required amount

of fertilizers and chemicals for the supply of selenium and phosphoruswere mixed well with the soil. Twenty seeds of berseem C. Var. "PusaJaint" were sown. The equal amount of double distilled water was applied to each pot. Seedling appeared emerging out on 6th day after sowing. After one week of germination thinning was done leaving 10 plants per pot. The plants were irrigated with equal amount of double distilled water as and when required.

The crop was harvested for the first cut after 55 days of sowing. The second cutting was taken after 35 days of first cutting. Immediately after first cut fresh weight from different pots was recorded. The plant samples were left in air for partial drying and then dried in hot air oven at 60^0C. for 24 hrs. the dry weight of plants from each pot recorded separately.

Chemical analysis of plants

The dried plant samples were grinded in microstainless steel grinder and stored in a wide mouth stoppered bottles. The ground plant material was analysed for nitrogen, phosphorus, calcium, magnesium, sulphur and selenium.

Nutrient uptake

The uptake of N, P, K, Ca, Mg, S and Se was worked out by multiplying its content value with corresponding dry matter yield.

Statistical analysis

The data regarding yield (fresh weight and dry weight), chemical composition of plants & nutrient uptake were tested statistically. The interpretation of result is based on F values at 5% level. Critical difference (C.D.) has been worked out for comparing the difference between the level of a significant treatment.

RESULTS AND DISCUSSION

The data regarding the effect of Se in relation to P on fresh weight of berseem at both the cuttings are presented in table 2 along with its statistical interpretation

A study of table 2 revealed that fresh weight of berseem decreased significantly with the application of Se at Istand IInd cuttings. The decrease in the fresh weights was significant for each level as compared to control. The reductions in fresh weights with 2.0, 5.0 and 10ppm Se were 20.2, 36.6 and 62.4 percent at the stage of Ist cutting over the control respectively. The corresponding reductions in fresh yield at the IInd cutting were 20.2, 36.3 and 61.9 percent.

Application of P at different levels to the soil significantly enhanced the fresh yield of berseem at both the cuttings. Application of P upto 75ppm gave consistent increasein fresh weight in both cuttings.

The increases in fresh weight with 25, 50 and 75ppm applied P were 6.7, 14.3 and 23.7 percent respectively at the Ist cutting over the control. Almost similar increases in fresh weight due to different level of applied P were recorded in IInd cutting. The heighest fresh yield was recorded in the IIndcutting with 75ppm P application.

The interaction between Se and P was significant at both the cuttings.

The fertilization with selenium and phosphorus alone and their interaction exhibited a prominent effect on the fresh and dry matter yield of berseem at both the cuttings. A general decrease in fresh and dry matter yield observed with successive level of added selenium may be attributed to the toxic effect of added selenium on the growth of plants. Similar decrease in dry matter yield of tobacco, soybean and wheat with the application of added selenium was also reported by Martin and Trelease (1938), Rosenfield and beath (1964) and Patel and Mehta (1969).

Result on the effect of successive levels of phosphorus on selenium contents in plants indicated that phosphorus levels increased selenium contents in plants and vice-versa. Moreover, interaction between selenium and phosphorus levels was also significant. These results are in congruity with findings of Carter *et al*. (1972), Singh and Malhotra (1976), Singh and Singh (1978), who also reported a positive correlation between phosphorus fertilization and selenium content of plant. The two possible explanations of this positive correlation between the two ions (i) phosphate and selenatemay react competitively for fixation site. When phosphate is added to soil it may displace selenate on some of the sorption sites, making selenium more plant available. (ii) greater root growth may result from phosphate fertilization thereby providing the plant with a larger root-soil contact area and a large volume of soil from which to extract selenium.

It was observed that content of N, P, Ca, Mg and S as well as uptake of these nutrients increased with the addition of phosphorus. On the other hand selenium application reduced content and uptake of N, P, Ca, Mg and S. Results on phosphorus and selenium interaction reveals that addition of increasing levels of phosphorus reduced the selenium accumulation in plants (table 3b). On the other hand increased phosphorus uptake by the plants. The higher uptake of phosphorus was because the soil was low in available phosphorus and crop responded to phosphorus application by absorbing more phosphorus. Thus more biomass was recorded with additional

Table 2 : Effect of selenium and phosphorus levels on fresh weight and dry weight (g/pot) of berseem at both the cuttings.Ist cutting at 55 days after sowing and IInd cutting 35 days after Ist cutting.

Level of Se(ppm)	Symbol	Fresh weight (g/pot)		Dry weight (g/pot)	
		Ist cutting	IInd cutting	Ist cutting	IInd cutting
Control	Se_0	7.35	9.52	2.20	2.86
2	Se_1	5.86	7.60	1.75	2.27
5	Se_2	4.66	6.06	1.40	1.81
10	Se_3	2.76	3.63	0.84	1.09
Level of P(ppm)	Symbol				
Control	P_0	7.35	9.52	2.20	2.86
25	P_1	7.85	10.15	2.35	3.05
50	P_2	8.40	10.88	2.52	3.28
75	P_3	9.09	11.77	2.73	3.54

S Em±	C.D. (5%)	S Em±	C.D. (5%)	S Em±	C.D. (5%)	S Em±	C.D.(5%)	
Se levels	0.005	0.013	0.003	0.009	0.002	0.005	0.002	0.007
P levels	0.005	0.013	0.003	0.009	0.002	0.005	0.002	0.007
Se x P levels	0.010	0.027	0.006	0.018	0.003	0.010	0.005	0.014

Table 3a : Effect of selenium and phosphorus levels on nutrient content in berseem at Ist and IInd cutting.

Treatment	Nutrient content (Ist cutting)						Nutrient content (IInd cutting)					
	N(%)	P(%)	Ca(%)	Mg(%)	S(%)	Se(ppm)	N(%)	P(%)	Ca(%)	Mg(%)	S(%)	Se(ppm)
Se_0	1.45	0.63	0.81	0.19	0.19	0.33	1.40	0.53	0.76	0.18	0.17	0.30
Se_1	1.23	0.75	0.80	0.18	0.13	4.95	1.27	0.60	0.76	0.17	0.11	3.21
Se_2	1.01	0.75	0.76	0.16	0.11	29.65	1.07	0.57	0.73	0.16	0.09	13.36
Se_3	0.60	0.60	0.72	0.15	0.09	57.20	0.65	0.41	0.70	0.15	0.07	17.16
P_0	1.45	0.63	0.81	0.19	0.19	0.33	1.40	0.53	0.76	0.18	0.17	0.30
P_1	1.47	0.72	0.83	0.20	0.22	0.35	1.46	0.61	0.78	0.19	0.19	0.31
P_2	1.53	0.82	0.83	0.21	0.25	0.37	1.52	0.69	0.78	0.20	0.22	0.33
P_3	1.58	0.94	0.83	0.21	0.30	0.40	1.54	0.79	0.79	0.20	0.27	0.36
C.D.(5%)												
Se levels	0.005	0.006	0.004	0.002	0.004	0.069	0.006	0.003	0.003	0.002	0.003	0.009
P levels	0.005	0.006	0.004	0.002	0.004	0.069	0.006	0.003	0.003	0.002	0.003	0.009
Sex P levels	0.010	0.012	0.008	0.005	0.009	0.138	0.012	0.006	0.006	0.004	0.006	0.018

Table 3b : Effect of selenium and phosphorus levels on nutrient uptake by berseem at Ist and IInd cutting.

Treatment	Nutrient uptake/pot (Ist cutting)						Nutrient uptake/ pot (IInd cutting)					
	N(mg)	P(mg)	Ca(mg)	Mg(mg)	S(mg)	Se(µg)	N(mg)	P(mg)	Ca(mg)	Mg(mg)	S(mg)	Se(µg)
Se_0	31.95	13.81	17.85	4.18	4.11	0.71	40.04	15.06	21.83	5.14	4.86	0.84
Se_1	21.56	13.26	14.03	3.15	2.78	8.68	28.90	13.54	17.25	3.93	2.49	7.28
Se_2	15.40	10.50	10.64	2.24	1.54	41.51	19.40	10.33	13.23	2.90	1.03	24.21
Se_3	5.07	5.04	6.04	1.26	0.72	48.04	7.02	4.45	7.61	1.63	0.76	18.64
P_0	31.95	13.81	17.85	4.18	4.11	0.71	40.04	15.06	21.83	5.14	4.86	0.84
P_1	34.46	16.92	19.42	4.70	5.17	0.82	44.53	18.50	23.79	5.79	5.79	0.95
P_2	38.64	20.75	20.83	5.29	6.30	0.92	49.75	22.58	25.53	6.55	7.20	1.07
P_3	43.27	25.78	22.68	5.83	8.20	1.10	54.51	27.96	27.96	7.20	9.55	1.27
C.D.(5%)												
Se levels	0.164	0.144	0.078	0.047	0.077	0.168	0.143	0.108	0.106	0.051	0.067	0.072
P levels	0.164	0.144	0.078	0.047	0. 077	0.168	0.143	0.108	0.106	0.051	0.067	0.072
Sex P levels	0.328	0.289	0.156	0.092	0.154	0.336	0.286	0.216	0.211	0.102	0.134	0.143

phosphorus application. The results are in congruity with those obtained by Singh (1979), who found that phosphorus addition reduced selenium uptake by raya.

Uptake of N, P, Ca, Mg, S and Se by the berseem crop was also computed. Results showed that in general uptake of these nutrients increased with the application of phosphorus. Selenium application reduced the uptake of these nutrients. The finding of this study corroborate with the results obtained by Singh and Malhotra (1980).

CONCLUSION

From the present study, this could be concluded that available selenium content in the plants had been found positively correlated with the available selenium in soil. Even the lowest dose i.e. 2ppm of applied selenium producedharmful effect on plant growth, chemical composition and nutrient uptake. The use of phosphorus could not overcome the toxicity caused by excess use of selenium.

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