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INOCULUM AND NPK FERTILIZATION OF BERSEEM: CHANGE IN RESPONSE TO MOLYBDENUM, ZINC, COPPER, BORON AND MAGNESIUM APPLICATION

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Berseem (*Trifolium alexandrinum L.*) is an important rabi fodder crop. A greenhouse pot trial was conducted on a medium textured alkaline calcareous soil to investigate the influence of Mo, Zn, Cu, B and Mg application on changes in response to inoculated berseem fertilized with NPK. In addition to the check treatment, NPK @ 25-100-50 kg ha^{-1} + Inoculum was applied alone and in combination with 2.5, 5, 5, 2 and 10 kg Mo ha^{-1} as $(NH_4)_2$ MoO_4, Zn as $ZnSO_4$, Cu as $CuSO_4$ B as boric acid and Mg as $MgSO_4$, respectively, in triplicate following randomized complete block design. Urea, single superphosphate and potassium sulphate were used to supply N, P and K, respectively. Four cuttings of fresh berseem were taken consecutively at five-week interval. Application of NPK fertilizer and inoculum together significantly ($P<0.05$) increased the fodder yield parameters of berseem. Among other elements Zn and Mo application had significantly ($P<0.05$) augmented response of berseem to NPK + inoculum. Statistically Mo and Zn application had same effect on the average weight and number of nodules parameters related to N fixation.

Key words: Berseem; Inoculum; Trace elements.

INTRODUCTION

Berseem (*Trifolium alexandrinum L.*) is an important "rabi" fodder crop cultivated on 0.820 million hectares annually [4]. It is a popular fodder crop because of high fodder yield during its growth period spaned over December to May, high palatability and protein contents for animal feed [3]. Berseem also plays an important role in soil fertility management through atmospheric N fixation [14]. Most of the work done so far on berseem fertilization in Pakistan had been concentrated on response to P fertilization [13] and improving N fixing capacity [2]. Neverthless, recently Alam and Sharif [1] reported Zn concentrations in berseem which would be deficient for the growth of young animals. These samples were collected from farmers' field in several districts of the Punjab. Magnesium concentration in fodder has also been found to be an important part of complex cause of hypomagnesemia of animals commonly called grass tetany [5]. The present report is an inventory of response of berseem to some selected nutrient elements important in the quality of berseem fodder for animal nutrition.

MATERIALS AND METHODS

A bulk surface soil sample (Ap horizon) was collected from the experimental farms of the National Agricultural Research Centre, Islamabad. Soil was air dried and ground to pass through a 2 mm sieve. Various physicochemical properties of the soil estimated according to standard procedures of USDA Handbook No. 60 [8], are reported in Table 1. Different fertilizer treatments, imposed in triplicate according to randomized complete block design to 21 pots each containing 8 kg of prepared soil, are given in Table 2.

For equilibrium, the soil in each pot following fertilizer application was irrigated and remixed twice thoroughly before sowing with ten seeds of berseem (*Trifolium alexendrinum* L.cv. Mescavi) per pot. The number of plants was thinned to five per pot after germination. The pots were irrigated with canal water when required. For quantifying the role of various fertilizer treatments on berseem growth different parameters; fodder yield (fresh weight of plants), plant height, number of nodules and dry weight of nodules were recorded or observed for each of the four cuttings taken consecutively at five-week intervals. Analysis of variance and Duncan's Multiple Range (DMR) test were carried out on all the data to test the significance of various treatments for their effect on berseem (fodder) growth [8].

RESULTS AND DISCUSSIONS

Different fertilizer treatments and inocula had significant ($P<0.05$) effect on fodder yield (fresh weight), plant

height, percent moisture and number of nodules in berseem as summarized in Fig. 1 and Table 3. Relative percent increase, calculated over the check, in different yield parameters by various fertilizer and inoculum treatments is also reported in Table 3.

The application of NPK @ 25-100-50 kg ha^{-1} with inoculum had significantly ($P<0.05$) increased fodder yield by 165% (fresh weight), plant height by 71% and number of nodules by 285%, over check. A markedly increasing cumulative response of berseem fresh weight and plant height was observed in the following order when NPK + inoculum was applied in combination with Zn, Mo, Mg, B and Cu. Cumulative effect on number of nodules was in the order of Zn, Mo, Cu, Mg and B (Table 3). Various fertilizer treatments did not affect the percent moisture in plants significantly.

Effect of NPK + inoculum on berseem fresh weight, plant height and number of nodules had been fairly constant at different times of cuttings. Fresh weight and nodules were markedly increased when NPK + inoculum was added in combination with Mo, Zn, Cu, B and Mg.

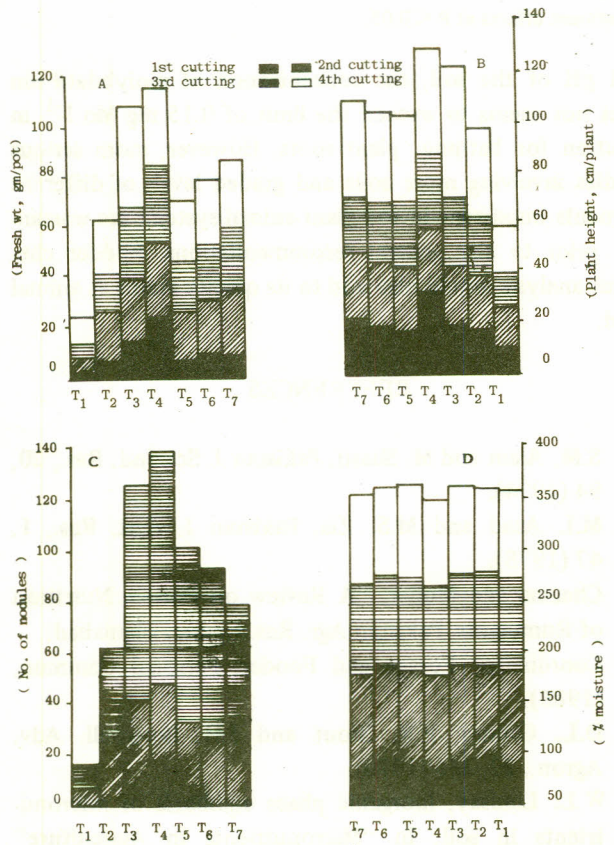

Fig. 1. Response of berseem (A) fresh weight, (B) plant height (C) No. of nodules and (D) % moisture to different treatments. T_1 = Control, T_2 = 25-100-50 (NPK kg^{-1})+Inoculum, T_3 = T_2+ Mo, T_4 = T_2+Zn, T_5 = T_2+Cu, T_6 = T_2+B, T_7 = T_2+Mg.

Generally a variable response was observed in fresh weight and number of nodules to different elements at various times of cutting. Even though the alkaline soils of Pakistan have been reported to contain enough Mo to sustain plant growth [9], combined application of NPK + inoculum with Mo increased 74% fodder yield, 26% plant height and 107% number of nodules than NPK + inoculum application alone. This would have been either due to supplementing the Mo required by inoculated plants or nullifying the depressive effect on Mo uptake by plants of SO_4 ion contained in single super phosphate as part of gypsum or both of them [11]. Addition of Zn at 5 kg ha^{-1} with NPK + inoculum increased fodder yield by 85%, plant height by 33% and number of nodules by 128% when compared to the NPK + inoculum treatment. Applications of Cu, B and Mg with NPK + inoculum did not seem to have a predominant

Table 1. Physico-chemical properties of soil.

Property	Unit	
Mechanical composition		
Clay	%	17.16
Silt	"	30.6
Sand	"	52.24
Textural class	–	Loam
pH	–	7.27
EC_e	dsm^{-1} at 25°C	0.885
O.m.	%	1.22
Total N	"	0.5
Available P	ug g^{-1}	18
Exchangeable K	"	44

Table 2. Various fertilizer treatments tested in this study.

S. No.	Treatment
T_1	Control
T_2	25 kg N + 100 kg P + 50 kg K ha^{-1} as urea, single super phosphate and potassium sulphate respectively + inoculum.
T_3	T_2 + 2.5 kg mo ha^{-1} as $(NH_4)_2$ MoO_4
T_4	T_2 + 5 kg Zn ha^{-1} as $ZnSO_4$
T_5	T_2 + 5 kg Cu ha^{-1} as $CuSO_4$
T_6	T_2 + 2 kg B ha^{-1} as boric acid.
T_7	T_2 + 10 kg Mg ha^{-1} as $MgSO_4$

Table 3. Relative percent increase in different yield parameters by fertilizer and inoculum treatments.

Parameter	Stage of growth	NPK+Inoculum (T_2)	T_2+Mo	T_2+Zn	T_2+Cu	T_2+B	T_2+Mg
A. Fresh weight (g/pot)	1st cutting	Cc	Gb	la	Cc	Dc	Dc
	2nd "	Bc	Cb	Da	Bc	Cbc	Cab
	3rd "	Bd	Ea	Ea	Cc	Cbc	Db
	4th "	Bd	Da	Cb	Bcd	Bcd	Bbc
	Cumulative	165.1	360.6	390.9	198.8	233.9	267.6
B. Plant height (cm/plant)	1st cutting	Ac	Abc	Ba	Ac	Abc	Bb
	2nd "	Ab	Aab	Aa	Aab	Aab	Aa
	3rd "	Ac	Bab	Ba	Abc	Ac	Ac
	4th "	Ac	Ba	Bb	Ac	Ac	Bbc
	Cumulative	70.8	114.7	126.4	80.9	83.4	90.2
D. Number of nodules	2nd cutting	Cd	Fb	Ga	Ec	Cd	Ec
	3rd "	Cd	Ha	la	Gb	Gb	Dc
	Cumulative	285.6	699.3	779.7	539.8	488.7	396.0

Legend: A=<100, B= 100-200, C-200-300, D=300-400, E=400-500, F=500-600, G=600-700, H=700-800, I<800
Lower case letters represent - statistical significance of treatment effects at $P < 0.05$.

effect on various growth parameters as compared to NPK + inoculum treatment. Neverthless, they all had a significant contribution as compared to check (Table 3).

CONCLUSIONS

Since berseem is an important leguminous fodder crop, most of metal nutrient elements are involved in several biochemical processes of berseem important in N metabolism, photosynthesis and respiration, etc. [7]. Magnesium concentration in fodders has been found important in grass tetany of animals. Application of 2.5 kg Mo ha^{-1} used in this study is 1 ppm addition on soil basis. However, it is relatively higher than the usual rate of Mo application, particularly on an alkaline soil which has enough Mo to sustain most of the agricultural crop production [9]. This then can caution one not to exceed the critical limit of 10 ppm Mo in the fodder to avoid molybdenosis in livestock. Unfortunately not much is known about the behaviour of Mo in Pakistan soils. But considering the following two solubility relations reported in the literature of soil chemistry for Mo

$$\text{Soil} - \text{Mo} \rightleftharpoons MoO_4^{2-} + 0.8\ H^+ \quad \log K^o = 12.40 \qquad [12]$$

$$\text{Soil} - \text{Mo} + 2\ H \rightleftharpoons \frac{MoO_4^{2-}}{MoO_4^{2-}} \quad \frac{20.5}{10}\ (H^+)^2 \qquad [6]$$

and pH of the soil, the concentration of molybdate ion does not seems to exceed the limit of 0.15 mg Mo l^{-1} in solution for bathing plant roots. However, more serious studies involving more soils and graded levels of different elements important in soil-plant-animal systems are warranted prior to any general recommendations. Fodder chemical analysis would also add to its quality status as animal feed.

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