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Effect of Cobalt, Boron and Molybdenum on Nitrogen Concentration in Pea (*Pisum sativum* L.)

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Abstract

A pot experiment was conducted during the winter seasons of 2006-07 and 2007-08 to study the effect of cobalt, boron and molybdenum on nitrogen concentration in pea (*Pisum sativum* L.) at fertility level F_1 (30 mg P_2O_5 + 20 mg S + 2.5 mg Zn per kg soil)and F_2 (60 mg P_2O_5 + 40 mg S + 5.0 mg Zn + 2 mg Co + 1 mg Mo per kg soil). Nitrogen (20 mg per kg) and potassium (K_2O) 30 mg per kg were applied to all the pots at uniform rates. Foliar application of boron was done after 45 and 60 days of sowing. The finding of the study reveals that treatment effect had significant superiority over control. The fertility level did not show any significant impact on nitrogen concentration in nodule in both the years. Nitrogen concentration in roots of pea showed significant treatment effect while the application of micronutrients had no substantial change in nitrogen concentration in roots. Nitrogen concentration in plants was significantly affected by application of micronutrients at both the fertility levels. Fertility effect was significant at both the fertility levels in percent nitrogen concentration in grains while micronutrients did not show a significant effect on nitrogen concentration in grains.

Key words : Micronutrient, Nitrogen concentration, Root, Straw, Grains.

Pulses being rich in protein, help in maintaining the nitrogen level in soil through biological nitrogen fixation. Out of the total pulses area of 22.85 million ha in India, peas are grown in 0.88 million ha with a production 0.71 million tonnes and productivity of 895 kg/ha. The legumes are used as break crop in intensive rice wheat system for yield, stability and restoration of soil fertility. Among micronutrients cobalt, boron and molybdenum are essential for the growth of *Rhizobium* and nitrogen fixation. Boron boosts nodulation in legumes, regulates water absorption and is essential for synthesis of ATP, DNA, RNA and pectins. It helps in absorption of nitrogen and is required for synthesis of amino acids and proteins. It regulates carbohydrates metabolism and is necessary for the translocation of sugar, phosphorus. Adequate availability of molybdenum in addition to cobalt and boron is pivotal for proper nodulation and higher yield of pea as it plays an important role for the activity of nitrogenase and nitrate reductase involved in nitrogen fixation. Cobalt is essential for microorganisms fixing atmospheric nitrogen. It forms vitamin B_{12} during growth and development of symbiotic microorganism. Improved growth, translocation and photosynthesis with application of cobalt have been observed in many plants. Cobalt influences leghemoglobin metabolism and ribonucleotide reducase in *Rhizobia*. Micronutrients viz. phosphorus and potassium are needed in biological nitrogen fixation. Phosphorus is important for root system. It promotes the lateral and fibrous roots. It is also needed by nodule bacteria. Potassium enhances carbohydrate transport to nodules sulfure is a constituents of plant proteins. Studies on integrated effect of vari-

Table 1. Chemical analysis of the soil.

	Soil	2006-07	2007-08
1	pH	7.6	7.5
2	EC (milli mhos per cm)	0.28	0.39
3	$CaCo_3$ (%)	0.50	0.51
4	CEC mole (P +) per kg	12.75	12.72
5	Organic carbon (%)	0.34	0.36
6	Available N (kg/ha)	228	234
7	Available P (kg/ha)	19.0	19.5
8	Available K (kg/ha)	225	240
9	Available S (kg/ha)	15	18
10	Available Co ppm	0.1	0.1
11	Available B ppm	0.2	0.2
12	Available Mo ppm	0.08	0.08

Table 2. Effect of Co, B and Mo at different fertility status on nitrogen concentration in nodules of pea.

Micro-nutrints	Nitrogen concentration (%) 2006-07 F_1	F_2	Aver-age	2007-08 F_1	F_2	Aver-age
Control	3.60	3.62	3.61	3.67	3.69	3.68
Co 2ppm	3.69	3.71	3.70	3.76	3.78	3.77
B 0.3%	3.67	3.69	3.68	3.74	3.76	3.75
Mo 1ppm	3.67	3.69	3.68	3.74	3.76	3.75
Co 2 ppm +B 0.3%	3.70	3.72	3.71	3.77	3.79	3.79
Co 2 ppm +Mo 1 ppm	3.71	3.73	3.72	3.78	3.80	3.78
B 0.3% + Mo 1ppm	3.68	3.70	3.69	3.75	3.77	3.79
Co 2ppm + B 0.3% + Mo 1ppm	3.71	3.74	3.73	3.78	3.81	3.80
Mean	3.66	3.67	3.66	3.73	3.75	3.74
Absolute control	2.85	–	–	2.91	–	–
Comparison between	SE ±	CD (P =0.05)		SE ±	CD (P = 0.05)	
Means of fertility	0.040	NS		0.041	NS	
Means of micronutrients	0.040	NS		0.041	NS	
Interaction F × M	0.057	NS		0.058	NS	
Treatment vs Control	0.114	0.322		0.116	0.328	

Table 3. Effect of Co, B and Mo at different fertility status on nitrogen concentration in root of pea.

Micro-nutrients	Nitrogen concentration (%) 2006-07 F_1	F_2	Aver-age	2007-08 F_1	F_2	Aver-age
Control	2.50	2.54	2.52	2.58	2.62	2.60
Co 2 ppm	2.61	2.59	2.60	2.69	2.66	2.68
B 0.3%	2.59	2.57	2.58	2.67	2.65	2.66
Mo 1 ppm	2.58	2.57	2.58	2.66	2.65	2.65
Co 2ppm + B 0.3%	2.63	2.60	2.61	2.70	2.67	2.69
Co 2ppm + Mo 1ppm	2.62	2.59	2.60	2.69	2.67	2.68
B 0.3% + Mo 1 ppm	2.60	2.58	2.59	2.68	2.66	2.67
Co 2ppm + B 0.3% + Mo 1ppm	2.63	2.60	2.62	2.71	2.68	2.69
Mean	2.57	2.57	2.57	2.65	2.64	2.65
Absolute control	2.40	–	–	2.47	–	–
Comparison between	SE ±	CD (P =0.05)		SE ±	CD (P=0.05)	
Means of fertility	0.028	NS		0.029	NS	
Means of micronutrients	0.028	NS		0.029	NS	
Interaction F × M	0.040	NS		0.041	NS	
Treatment vs Control	0.080	0.227		0.083	0.234	

ous macronutrients at varying soil fertility in different leguminous plant are scare. Present study was made to study the effect of cobalt,boron and molybdenum on nitrogen concentration in nodule, root, straw and grain of pea (*Pisum sativum* L.).

Methods

A pot experiment was conducted during winter at agricultural research farm of Krishi Vigyan Kendra, Ghazipur, in the year 2006-07 and 2007-08. Certified seeds of pea Malviya 15 was used for the experiment. Te pot experiment was conducted in a glass house, each ear then pot wascleaned by fresh water and its outer and inner surfaces were colored by red and black paints respectively. The pots were filled with 10 kg field soil. Two fertility levels of soil were maintained in F_1 and F_2 both macro nutrients. Nitrogen at 20 mg/kg, potassium 30 mg (K_2O)/kg, and phosphorus 30 and 60 mg (P_2O_5) per kg and sulfur 20 and 40 mg per kg were applied in F_1 and F_2 micronutrient zinc 2.5 and 5 mg per kg, cobalt 0 and 2 mg per kg, molybdenum (ammonium molybdate) 0 and 1 mg/kg respectively were applied at the time of sowing in F_1 and F_2 respectively. Foliar application of 0 and 0.3 mg/kg boron was done after 45 and 60 days of sowing.Weeding and irrigation was done as and when required.

The processed nodules, root grain and straw were digested in diacid digest (sulfuric and perchloric acid (9 : 1) (1) and stored in plastic bottles for estimation of nitrogen. Total nitrogen was determined by Nessler's reagent method (1). Soil samples were taken from each earthen pot for analysis before cropping from a depth of 0—15 cm. Collected soil samples were brought to the laboratory, air dried ground and passed through 2 mm mesh sieve for analysis. The samples were analyzed for various physico-chemical properties (2). The soil was alluvial sandy loam with slightly alkaline in nature pH 7.6 and 7.5, low in or-

Table 4. Effect of Co., B and Mo at different fertility status on nitrogen concentration in straw of pea.

Micro-nutrients	Nitrogen concentration (%) 2006-07 F_1	F_2	Aver-age	2007-08 F_1	F_2	Aver-age
Control	1.655	1.685	1.670	1.650	1.680	1.665
Co 2ppm	1.714	1.741	1.728	1.713	1.750	1.731
B.0.3%	1.708	1.728	1.718	1.705	1.735	1.720
Mo 1ppm	1.695	1.725	1.710	1.693	1.730	1.711
Co 2 ppm +B 0.3%	1.721	1.750	1.736	1.720	1.760	1.740
Co 2ppm + Mo 1 ppm	1.716	1.746	1.731	1.715	1.755	1.735
B 0.3% + Mo 1 ppm	1.703	1.733	1.718	1.700	1.740	1.720
Co 2 ppm + B 0.3 % + Mo 1 ppm	1.723	1.750	1.736	1.720	1.760	1.740
Mean	1.695	1.719	1.707	1.693	1.724	1.708
Absolute control	1.635	–	–	1.640	–	–
Comparison between	SE ±	CD (P = 0.05)		SE ±	CD (P =0.05)	
Means of fertility	0.003	0.009		0.004	0.011	
Means of micronutrients	0.003	0.009		0.004	0.011	
Interaction F × M	0.005	0.013		0.005	0.015	
Treatment vs Control	0.009	0.026		0.011	0.030	

Table 5. Effect of Co. B and Mo at different fertility status on nitrogen concentration in grains of pea.

Micro-nutrients	Nitrogen concentration (%) 2006-07 F_1	F_2	Aver-age	2007-08 F_1	F_2	Aver-age
Control	3.145	3.190	3.168	3.148	3.195	3.171
Co 2ppm	3.169	3.183	3.176	3.171	3.186	3.178
B 0.3%	3.166	3.180	3.173	3.166	3.181	3.173
Mo 1ppm	3.164	3.188	3.176	3.165	3.190	3.178
Co 2ppm + B 0.3%	3.173	3.183	3.178	3.174	3.183	3.178
Co 2ppm + Mo 1ppm	3.168	3.188	3.178	3.171	3.190	3.181
B 0.3% + Mo 1ppm	3.173	3.190	3.181	3.173	3.193	3.183
Co 2ppm + B 0.3% + Mo 1 ppm	3.180	3.185	3.183	3.183	3.185	3.184
Mean	3.162	3.182	3.172	3163	3.185	3.174
Absolute control	3.133	–	–	3.138	–	–
Comparison between	SE ±	CD (P = 0.05)		SE ±	CD (P = 0.05)	
Means of fertility	0.003	0.008		0.003	0.009	
Means of micronutrients	0.003	0.008		0.003	0.009	
Interaction F × M	0.004	0.012		0.005	0.013	
Treatment vs Control	0.008	0.024		0.009	0.026	

ganic carbon 0.34 % and 0.36%, available nitrogen 228 kg /ha and 234 kg/ha, phosphorus 19 kg/ha and 19.5 kg/ha and available potassium 225 kg/ha and 240 kg/ha 2006-07 and 2007-08 respectively (Table 1).

Results and Discussion

Table 2 shows the effect of Co, B and Mo on nitrogen concentration in nodule of pea plant (*Pisum sativum* L.). The treatment effect had significant superiority over control. It showed 28.42 and 28.52 percent more nitrogen concetration than control during 2006-07 and 2007-08 respectively. The fertility level did not show any significant impact on nitrogen concentration in nodule during both the years. The micronutrients also had no significant impact on both fertility doses and the range of concentration was 3.61 to 3.73 percent during 2006-07 and 3.68 to 3.80 percent during 2007-08. Nitrogen concentration was 40.62 and 48.28% more than control in 2006-07 and 2007-08 respectively. Nitrogen concentration in roots of pea was more or less similar under both the fertility level. The application of micronutrients could not show conspicuous change on nitrogen concentration in roots of pea (Table 3). The nitrogen concentration in control and treatment were 1.635 and 1.707 percent during 2006-07 and 2007-08 respectively in plant (Table 4). Fertility effect was also significant, the application of F_2 showed 1.719 and 1.724% nitrogen concentration in plants whereas at F_1 it was 1.695 and 1.693 percent during 2006-07 and 2007-08 respectively. A significant impact of micronutrients on nitrogen concentration in plants was recorded and the range of nitrogen concentration in plant was 1.67 to 1.736% during 2006-07 and 1.665 to 1.74 percent during 2007-08 from control to Co 2 ppm + B 0.3 percent + Mo 1ppm treatment. Nitrogen concentration in grain are presented in (Table 5) which shows that treat-

ment effect was significantly superior over control. The nitrogen concentration in absolute control and treatment were 3.172 and 3.138% during 2006-07 and 2007-08 respectively. Fertility effect was also significant and application of F_2 showed 3.182 and 3.185% nitrogen concentration in grain while it was 3.18 and 3.183% under F_2 during 2006-07 and 2007-08 respectively. Application of micronutrient did not show significant impact on nitrogen concentration in grains of pea. The range of nitrogen concentration in grain was 3.168 to 3.183 percent during 2006-07 and 3.171 to 3.184 percent during 2007-08 from fertility control to Co 2 ppm + B 0.3 percent + Mo 1ppm treatment (Table 5).

Significant effect of treatment was observed on nitrogen concentration in nodule, root, straw and grain during both the years of study fertility showed significant impact on concentration of nitrogen in straw and grain of pea. Application of Co and B improved nitrogen content in straw durin both the years. Combined effects of B × Mo and F × Mo were significant in grain. These results corroborate with the findings of Verma et al. (3), Singh et al. (4) and Bhariya et al. (5).

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