Environment & Ecology 29 (1) : 5—10, 2011
 ISSN 0970-0420

Effect of Cobalt, Boron and Molybdenum at Different Fertility Status on Vegetative Growth at Reproductive Stage of Pea (*Pisum sativum* L.)

D. K. SINGH[1], P. KUMAR[2], S. K. SINGH[1], R. P. SINGH[1]
V. DWIVEDI[1] AND A. K. BAJPAI[1]

[1]*Krishi Vigyan Kendra,* [2]*Department of Environmental Science, P. G. College*
[2]*Ghazipur 233001, UP, India*

Abstract

A pot experiment was conducted during the winter season of 2006-07 and 2007-08 to study the effect of cobalt, boron and molybdenum on plant height, fresh weight and dry weight at reproductive stage of pea at two fertility status namely 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, per kg soil). The study reveals that plant height, fresh weight and dry weight of the plant at flowering and pod filling stage increased significantly with increasing levels of soil fertility in both the years. The macronutrients helped in better growth of root and shoot system enhancing the surface area of root and shoot for development of nodule and fruit setting. The micronutrients have shown significant impact on plant metabolism absorption and translocation of materials synthesis of essential macro and micro molecule and enzyme synthesis and their activity regulation.
Key words : Fertility, Micronutrient, Dry weight, Plant height, Pea.

Pulses, the cheapest source of protein alleviate various nutritional deficiencies besides helping in maintenance of soil health and sustenance of productivity of cropping system by increasing biological nitrogen level. Pulses accounts for one fifth of total area under food grain crop and contribute about 1/12th of the total food grain production in India with 35% of area and 27.1% of total production of world (1). Pea is highly nutritive and contains high proportion of digestive protein (22.5%) carbohydrate (62.1%), fat (1.8%) and minerals. The supply of balanced nutrients is an important factor for complete growth and higher yield. Adequate supply of not only the macro nutrient but also the micronutrients is required for growth of the plant to attain high productivity. Due to intensive farming macro and micronutrients level of soil has depleted abruptly and often micronutrients limits the plant growth under these conditions. Cobalt, boron and molybdenum are essential for the nodulation and growth of *Rhizobium,* the nitrogen fixing microbe and nitrogen fixation. Molybdenum play an important role in nitrogenase and nitrate reduces activity. Boron not only boost the nodulation but it regulates the absorption of water and is essential for synthesis of ATP, DNA, RNA and pectins. It regulates the carbohydrate metabolism and is necessary for the translocation of sugar and phosphorus. Cobalt is essential for synthesis of vitamin B_{12} needed for development of symbiotic microorganism. An experimental study was made to study the effect of Co, B and Mo application on plant height, fresh weight and dry weight at flowering and pod filling stage.

Methods

A pot experiment was conducted during winter

Table 1. Chemical analysis of the soil.

Soil	2006-07	2007-08
pH	7.6	7.5
EC (milli mhos/cm)	0.28	0.39
$CaCO_3$ (%)	0.50%	0.51%
CEC emole (P+)/kg	12.75	12.72
Organic carbon (%)	0.34	0.36
Available N (kg/ha)	228	234
Available P (kg/ha)	19.0	19.5
Available K (kg/ha)	225	240
Available S (kg/ha)	15	18
Available Co ppm	0.1	0.1
Available B ppm	0.2	0.2
Available Mo ppm	0.08	0.08

Table 2. Effect of Co, B and Mo at different fertility status on plant height at flowering stage of crop.

Micronutrients	Plant height (cm) 2006-07 F_1	F_2	Average	2007-08 F_1	F_2	Average
Control	73.50	83.00	78.25	80.10	90.50	85.30
Co 2 ppm	83.73	94.60	89.16	91.25	103.14	97.19
B 0.3%	81.55	92.15	86.85	88.90	100.45	94.68
Mo 1 ppm	82.23	92.88	87.55	89.65	101.28	95.46
Co 2 ppm + B 0.3%	84.75	95.75	90.25	92.35	104.40	98.38
Co 2 ppm + Mo 1 ppm	85.35	96.40	90.88	93.05	105.15	99.10
B 0.3% + Mo 1 ppm	83.10	93.85	88.48	90.60	102.35	96.48
Co 2 ppm + B 0.3% + Mo ppm	86.70	97.90	92.30	94.50	106.80	100.65
Mean	80.48	90.93	85.70	87.73	99.12	93.42
Absolute control	69.80	–	–	76.00	–	–

Comparison between	SE ±	CD (P = 0.05)	SE ±	CD (P = 0.05)
Means of fertility	0.94	2.66	0.97	2.74
Means of micronutrients	0.94	2.66	0.97	2.74
Interaction F × M	1.33	3.76	1.37	3.88
Treatment vs Control	2.66	7.53	2.74	7.76

at agricultural research farm of Krishi Vigyan Kendra, Ghazipur in the year 2006-07 and 2007-08. Mechanical (2) and chemical characteristics of the soil were determined by standard method (Table 1). The pot experiment was conducted in a glass house in completely randomized design with three replications. Available cobalt, boron and molybdenum were determined by DTPA extract method (3), hot water soluble method (4) and ammonium oxlate extraction method (4) respectively.

The soil was alluvial sandy loam with slightly alkaline nature pH 7.6 and 7.5, low in organic carbon 0.34 and 0.36%, available nitrogen 228 and 234 kg/ha, phosphorus 19 and 19.5 kg/ha, available potassium 225 and 240 kg/ha in 2006-07 and 2007-08. Soil was taken just before starting the experiment from a depth of 0—15 cm. Soil samples were air dried and crushed to pass through 20 mm mesh sieve for analysis. The

Table 3. Effect of Co, B and Mo at different fertility status on plant height at pod filling stage of crop.

Micronutrients	Plant height (cm) 2006-07 F_1	F_2	Average	2007-08 F_1	F_2	Average
Control	88.20	99.60	93.90	96.10	108.70	102.40
Co 2 ppm	100.47	113.52	107.00	109.55	123.78	116.66
B 0.3%	97.86	110.58	104.22	106.68	120.58	113.63
Mo 1 ppm	98.67	111.45	105.06	107.55	121.55	114.55
Co 2 ppm + B 0.3%	101.70	114.90	108.30	110.90	125.30	118.10
Co 2 ppm + Mo 1 ppm	102.42	115.68	109.05	111.65	126.20	118.93
B 0.3% + Mo 1 ppm	99.72	112.62	106.17	108.70	122.85	115.78
Co 2 ppm + B 0.3% + Mo ppm	104.04	117.48	110.76	113.40	128.20	120.80
Mean	96.57	109.11	102.84	105.26	118.98	112.12
Absolute control	83.76	–	–	91.20	–	–

Comparison between	SE ±	CD (P = 0.05)	SE ±	CD (P = 0.05)
Means of fertility	1.11	3.14	1.23	3.48
Means of micronutrients	1.11	3.14	1.23	3.48
Interaction F × M	1.57	4.44	1.74	4.92
Treatment vs Control	3.14	8.88	3.48	9.85

Table 4. Effect of Co, B and Mo at different fertility status on fresh weight per plant at flowering stage of crop.

Micronutrients	Fresh weight in (g/plant) 2006-07 F_1	F_2	Average	2007-08 F_1	F_2	Average
Control	44.10	49.80	46.95	48.06	54.30	51.18
Co 2 ppm	50.24	56.76	53.50	54.75	61.88	58.32
B 0.3%	48.93	55.29	52.11	53.34	60.27	56.81
Mo 1 ppm	49.34	55.73	52.53	53.79	60.77	57.28
Co 2 ppm + B 0.3%	50.85	57.45	54.15	55.41	62.64	59.03
Co 2 ppm + Mo 1 ppm	51.21	57.84	54.53	55.83	63.09	59.46
B 0.3% + Mo 1 ppm	49.86	56.31	53.09	54.36	61.41	57.89
Co 2 ppm+B 0.3% + Mo 1 ppm	52.02	58.74	55.38	56.70	64.08	60.39
Mean	48.29	54.56	51.42	52.64	59.47	56.05
Absolute control	41.88	–	–	45.60	–	–
Comparison between	SE ±	CD (P = 0.05)		SE ±	CD (P = 0.05)	
Means of fertility	0.56	1.60		0.62	1.74	
Means of micronutrients	0.56	1.60		0.62	1.74	
Interaction F × M	0.80	2.26		0.87	2.46	
Treatment vs Control	1.60	4.52		1.74	4.92	

pot experiment was conducted in a glass house, each earthen pot was cleaned 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 macronutrients.

Nitrogen at 20 mg/kg, potassium 30 mg (K_2O) / kg, phosphorus 30 and 60 mg (P_2O_5) 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. Foliar application of 0 and 0.03 mg/kg boron was done after 45 and 60 days of sowing. Weeding and irrigation were done as and when required.

Results and Discussion

Height of Plant

Heights of the plant at flowering stage reveal

Table 5. Effect of Co, B and Mo at different fertility status on fresh weight per plant at pod filling stage of crop.

Micronutrients	Fresh weight in (g/plant) 2006-07 F_1	F_2	Average	2007-08 F_1	F_2	Average
Control	52.92	59.82	56.37	57.66	65.22	61.44
Co 2 ppm	60.29	68.13	64.21	65.73	74.27	70.00
B 0.3%	58.71	66.36	62.54	64.01	72.35	68.18
Mo 1 ppm	59.19	66.90	63.05	64.53	72.93	68.73
Co 2 ppm + B 0.3%	61.02	68.97	65.00	66.54	75.18	70.86
Co 2 ppm + Mo 1 ppm	61.44	69.45	65.45	66.99	75.72	71.36
B 0.3% + Mo 1 ppm	59.82	67.62	63.72	65.22	73.71	69.47
Co 2 ppm + B 0.3% + Mo 1 ppm	62.40	70.56	66.48	68.04	76.92	72.48
Mean	57.94	65.48	61.71	63.16	71.39	67.27
Absolute control	50.26	–	–	54.72	–	–
Comparison between	SE ±	CD (P = 0.05)		SE ±	CD (P = 0.05)	
Means of fertility	0.68	1.92		0.74	2.09	
Means of micronutrients	0.68	1.92		0.74	2.09	
Interaction F × M	0.96	2.71		1.04	2.95	
Treatment vs Control	1.92	5.42		2.09	5.91	

Table 6. Effect of Co, B and Mo at different fertility status on dry weight per plant at flowering stage of crop.

	Dry weight in (g / plant)					
	2006-07			2007-08		
Micronutrients	F_1	F_2	Average	F_1	F_2	Average
Control	5.50	6.30	5.90	6.00	6.50	6.25
Co 2 ppm	6.36	7.19	6.78	6.90	7.80	7.35
B 0.3%	6.16	6.99	6.58	6.73	7.60	7.16
Mo 1 ppm	6.25	7.04	6.64	6.80	7.65	7.23
Co 2 ppm + B 0.3%	6.43	7.28	6.85	6.95	7.90	7.43
Co 2 ppm + Mo 1 ppm	6.50	7.33	6.91	7.05	7.95	7.50
B 0.3% + Mo 1 ppm	6.30	7.13	6.71	6.85	7.75	7.30
Co 2 ppm + B 0.3% + Mo 1 ppm	6.60	7.45	7.03	7.10	8.10	7.60
Mean	6.09	6.89	6.49	6.64	7.45	7.04
Absolute control	5.30	–	–	5.70	–	–
Comparison between	SE ±	CD (P = 0.05)		SE ±	CD (P = 0.05)	
Means of fertility	0.071	0.202		0.08	0.22	
Means of micronutrients	0.071	0.202		0.08	0.22	
Interaction F × M	0.101	0.285		0.11	0.31	
Treatment vs Control	0.202	0.571		0.22	0.62	

that fertility levels brought tremendous improvement in height of plant (Table 2). Maximum plant height of 90.93 and 99.12 cm was recorded in 2006-07 and 2007-08 respectively under F_2 fertility level. Increase in plant height by F_2 over F_1 was 12.98 and 5% during first and second year. The micronutrients also showed significant impact on plant height at both fertility doses during both the years. Plant height increased by 13.94, 10.99, 11.88, 15.33, 16.14, 13.07 and 17.95 cm during 2006-07 and by 13.93, 10.99, 11.91, 15.33, 16.17, 13.10 and 17.99 cm during 2007-08 by the application of Co, B, Mo, Co + B, Co +Mo, B + Mo, Co + B + Mo over control.

At pod filling stage plant height was 22.63 and 22. 99% more than absolute control during both the years (Table 3). Fertility effect was also significant and application of F_2 produced 12.54 and 13.69 cm taller plants than F_1 in the year 2006-07 and 2007-08

Table 7. Effect of Co, B and Mo at different fertility status on dry weight per plant at pod filling stage of crop.

	Dry weight in (g/plant)					
	2006-07			2007-08		
Micronutrients	F_1	F_2	Average	F_1	F_2	Average
Control	6.70	7.20	6.95	7.30	7.50	7.40
Co 2 ppm	7.61	8.65	8.13	8.33	9.35	8.84
B 0.3%	7.44	8.40	7.92	8.11	9.15	8.63
Mo 1 ppm	7.48	8.49	7.98	8.16	9.10	8.63
Co 2 ppm + B 0.3%	7.70	8.75	8.23	8.43	9.50	8.96
Co 2 ppm + Mo 1 ppm	7.78	8.83	8.30	8.48	9.55	9.01
B 0.3% + Mo 1 ppm	7.58	8.58	8.08	8.25	9.30	8.78
Co 2 ppm + B 0.3% + Mo 1 ppm	7.90	8.95	8.43	8.60	9.70	9.15
Mean	7.33	8.25	7.79	8.00	8.86	8.43
Absolute control	6.40	–	–	6.60	–	–
Comparison between	SE ±	CD (P = 0.05)		SE ±	CD (P = 0.05)	
Means of fertility	0.09	0.24		0.09	0.26	
Means of micronutrients	0.09	0.24		0.09	0.26	
Interaction F × M	0.12	0.34		0.13	0.37	
Treatment vs Control	0.24	0.68		0.26	0.74	

respectively. Application of micronutrients also showed significant impact on height of plant. Application of Co, B, Mo, Co + B, Co + Mo, B + Mo, Co+B+Mo showed an increase in height of 13.95, 10.99, 11.88, 15.33, 16.13, 13.06 and 17.96 cm during 2007-08 respectively. F_2 fertility level produced significantly taller plants than F_1. Significant increase in plant height was noted due to application of Co, B and Mo in fertility treatments over control. The interactive effects of different treatments were non-significant at both the stages during both years. These findings are in close conformity with the findings of Singh (5), Singh and Bahadur (6), Tripathi et al. (7), and Srivastava and Ahlawat (8).

Fresh Weight

Fresh weight per plant at flowering stage shows that treatment effect was significant over absolute control and the fresh weight was 25.17 and 22.92% more than absolute control during 2006-07 and 2007-08 respectively (Table 4). The fertility level brought tremendous improvement towards fresh weight per plant. Maximum weight of 51.42 g during 2006-07 and 59.47 g during 2007-08 was observed under F_2 fertility level. Increase in the weight of plant at F_2 over F_1 was 12.98 and 12.97% during first and second year respectively. The significant impact of micronutrients was also observed in both fertility doses during both the years. The fresh weight was increased by 13.95, 10.99, 11.88, 15.33, 16.14, 13.07 and 17.95 g during 2006-07 and by 13.95, 11.0, 11.91, 15.33, 16.17, 13.11 and 17.99 g during 2007-08 by the application of Co, B, Mo, Co + B, Co + Mo, Co + B + Mo over control.

The fresh weight per plant at pod filling stage shows that treatment effect was significantly superior over absolute control like flowering stage (Table 5). The fresh weight was 22.78 and 30.46% more than absolute control during 2006-07 and 2007-08 respectively. The fertility effect was also significant and application of F_2 produced 7.54 and 8.23 g more fresh weight of plant than F_1 during 2006-07 and 2007-08 respectively. Micronutrients also showed significant impact in fresh weight of plant at pod filling stage. Increase in fresh weight of plant over control by the application of Co, B, Mo, Co +B, Co + Mo, B + Mo, Co + B + Mo was 13.90, 10.94, 11.85, 15.30, 16.10, 13.03 and 14.38 g during 2006-07 and 13.93, 10.97, 11.86, 15.33, 16.14, 13.06 and 17.96 g during 2007-08 respectively.

Dry Weight Per Plant

Dry weight per plant as influenced by different treatments at flowering stage of the crop indicates that treatment effect was significant over control (Table 6). Increase in the dry weight per plant at F_2 over F_1 was 13.14 and 12.20% in first and second year respectively. The micronutrients also showed significant impact and plant dry weight increased by 14.91, 11.52, 12.54, 16.10, 17.11, 13.72 and 19.15% during 2006-07 and 17.6, 14.56, 15.68, 18.88, 20.00, 16.8 and 21.6% during 2007-08 by the application of Co, B, Mo, Co + B, Co + Mo, Co +B + Mo over control.

Dry weight per plant shows that treatment effect was significantly superior over control (Table 7). The treatment weight was 21.72 and 27.73% more than absolute control during 2006-07 and 2007-08 respectively. The fertility effect was quite significant and application of F_2 produced 12.55 and 10.75% more dry weight of plant than F_1 during 2006-07 and 2007-08 respectively. The increase in dry weight of plant over control due to application of Co, B, Mo, Co + B, Co + Mo, B + Mo, Co + B + Mo was 16.97, 13.95, 14.82, 18.41, 19.42, 16.25 and 21.29% during 2006-07 and 19.45, 16.62, 16.62, 21.08, 21.75, 18.64 and 23.64% during 2007-08.

Fresh and dry weights of plant were significantly affected by different fertility levels. The rate of increase in fresh and dry weight production was slightly slow in F_1 than F_2. Significant impact of Co, B and Mo application on fresh dry weight of plant was due to more assimilation and utilization of available nutrients by the plant's entire growth period. These results corroborate with the findings of Naik et al. (9), Bagheri et al. (10), Srivastava and Ahlawat (8), Singh et al. (11).

References

1. Ali M. S. and S. Kumar. 2000. Potentialities, limitation and technology of production. Tech. Bull. No. 3. *Direct. Pulses Res., Kanpur, India.* 17 pp.
2. Piper C. S. 1966. *Soil and plant analysis.* Academic Press, New York, USA.

3. Lindsay W. L. and W. A. Norvell. 1978. Development of a D. T. P. A. soil test for zinc, iron, manganese and copper. *Soil Sci. Am. J.* 42 : 421—428.
4. Jackson M. L. 1962. *Soil chemical analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, India.
5. Singh R. G. 1971. Effect of phosphate and molybdenum on growth, nodulation and seed yield of dhaincha (*Sesbania cannabina*). *Ind. J. Agric. Sci.* 41 : 231—238.
6. Singh Y. and V. Bahadur. 1990. Yield and growth response of garden pea (*Pisum sativum* L.) to N and P application. *Veg. Sci.* 17 : 205—209.
7. Tripathi B. M., S. S. Singh and S. P. Singh. 1991. Effect of nitrogen, phosphorus and weed control on growth and yield of vegetable pea. *Veg. Sci.* 18 : 11—51.
8. Srivastava T. K. and I. P. S. Ahlawat. 1995. Response of pea (*Pisum sativum*) to phosphorus, molybdenum and biofertilizers. *Ind. J. Agron.* 40 : 630—635.
9. Naik L. B., M. N. Sinha and R. K. Rai. 1991. Phosphorus utilization in pea (*Pisum sativum*) as influenced by time of sampling. *J. Nucl. Agric. and Biol.* 20 : 21—24.
10. Bagheri A., J. G. Paul, A. J. Rathjen, S. M. Ali and D. B. Moody. 1992. Genetic variation in the response of pea (*Pisum sativum* L.) to high soil concentration of boron. *Pl. and Soil* 146 : 261—269.
11. Singh Y. P., J. C. Tarfdar and B. R. Gupta. 1997. Sterilization for increased production of summer moong (*Vigna radiata*). *J. Ind. Soc. Soil Sci.* 95 : 526—528.