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EFFECT OF BALANCED NUTRITION ON YIELD AND NUTRIENT UPTAKE OF PEA (*PISUM STIVUM* L.) UNDER INDO-GANGETIC PLAINS OF INDIA

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ABSTRACT

A field experiment was conducted for two consecutive years (2006-07 and 2007-08) during *rabi* season to study the effect of balanced nutrition on growth, nodulation, yield, physiological and agronomic efficiencies of pea (*Pisum stivum* L.). Results showed that the higher fertility level (60-40-5, P_2O_5-S-Zn Kg/ha) was found most effective in enhancing the plant height, dry matter accumulation, nodulation, yield attributes and finally led to 0.29 t/ha (3.25 t/ha) higher seed yield over lowest fertility levels (30-20-2.5, P_2O_5-S-Zn Kg/ha). Fertility level F_2 registered higher nutrient uptake by seed (103.6, 14.7 and 12.5 kg/ha N, P and S, respectively) and Stover (73.4, 10.3 and 12.19 kg/ha N, P and S, respectively) of pea. However, agronomic efficiency of P, S and Zn and physiological efficiency of N, P and S were highest with F_1 treatment over F_2. Among the micronutrients application, integrated use of Mo, Co and B produced taller plant (115.78cm.), more dry matter (accumulation/plant (8.79g), maximum nodule number (44.50) and weight (36.95 mg) over control and alone application of micronutrients. Seed yield and nutrient uptake by seed and stover were also found higher with combined use of micronutrients.

INTRODUCTION

Leguminous crops are rich source of protein in vegetarian diet and play a significant role in correcting the widespread malnutrition in the country. Pea (*Pisum sativum* L.) is a popular pulse crop of India and provides variety of protein rich vegetarian dishes for humans. It is highly nutritive containing high proportion of digestive protein (22.5%), carbohydrate (62.1%), fat (1.8%), minerals (calcium, iron) and vitamins (riboflavin, thiamin, and niacin). Pulses are generally grown in soils with low fertility status or with application of low quantities of organic and inorganic sources of plant nutrients, which has resulted in deterioration of soil health and productivity (Kampawat, 2010). Application of balanced fertilizer increases vegetative growth and improves yield and quality of produce. The nutrients available to plant particularly nitrogen and phosphorus are important constituents of protein and phospholipids. Like other pulse crops, it has unique characteristics of maintaining and restoring soil fertility through biological nitrogen fixation. Phosphorus is key nutrient for increasing productivity of pulses and most important single factor responsible for poor productivity of pulses (Sarawgi *et al.,* 2005). Sulphur is essential for synthesis of proteins, vitamins and sulphur containing essential amino acids and is also associated with nitrogen metabolism (Najar *et al.,* 2011)

Micronutrients like cobalt, boron, molybdenum and zinc play an important role in increasing legume yield through their effect on the plant itself, nitrogen fixing symbiotic process and effective use of major and secondary nutrients. Molybdenum is known important to be a key element required by the microorganisms for nitrogen fixation (Roy *et al.,* 2006). It is structural component of nitrogenase enzyme which is actively involved in nitrogen fixation by *Rhizobium* bacteria in the root nodules of leguminous crops and simultaneously essential for absorption and translocation of iron in plants as well as seed. Boron has required to play an important role for synthesis of amino acids and protein. It also regulates carbohydrates metabolism, water absorption and necessary for translocation of sugar, phosphorus etc. and helps in the absorption of nitrogen and formation of nodules (Shaaban, 2010), Cobalt is being a constituent of cobalamine coenzyme required for formation leghaemoglobin in nitrogen fixation. Bacteria on root nodules of legumes require cobalt to synthesize B12 and fix nitrogen from air. Cobalt also promotes many developmental processes including stem and coleoptiles elongation, opening of hypocotyls books, leaf disc expansion and development (Kandil, 2007), Zinc deficiency is perhaps the most widespred (Roy *et al.,* 2006) and, decreases crop yield, delays crop maturity, reduces water and use efficiency and also reduces nodulation and nitrogen fixation (Ahlawat *et al.,* 2007). After green revolution advent of intensive agriculture has led to dramatic losses of soil fertility from cultivated soil. The inclusion of legumes in dominant rice-wheat cropping system as a break crop is expected to bring about yield stability and restoration of soil fertility. Keeping these in view, the present field experiment was undertaken to study the effect of balanced nutrition on performance of pea in Indo-Gangetic Plains of India.

MATERIALS AND METHODS

A field experiment was conducted during 2006-07 and 2007-08 at Krishi Vigyan Kendra, Ghazipur, Uttar Pradesh on farmer's field where intensive practice of rice-wheat cropping system has been followed. The soil samples were collected from experimental site, processes and physic-chemical properties of soils were measured with the prescribed standard procedure (Jackson, 1973). The soil of experimental site was sandy clay loam in texture with slightly alkaline pH 7.6, organic carbon (0.34%), available nitrogen (228.0 kg/ha), available phosphorus (19.0 kg/ha), available potassium (209.5 kg/ha) and available sulphur (15.0 kg/ha). The status of soil micronutrients viz. Co (0.10 mg/kg), B (0.20 mg/kg) and Mo (0.08 mg/kg) was also low. In the study, the treatments consisted of two fertility levels of P,S and Zn viz F_1 : (30:20:2.5 kg/ha of P_2O_5, sulphur and zinc) and F_2 : (60:40:5 kg/ha of P_2O_5 sulphur and zinc) combined with eight micronutrients viz. Mo : control, M_1 : Co 2.0 kg/ha, M_2 : B 0.3%, M_3 : Mo 1.0 kg/ha, M_4 : Co 2.0 kg/ha + B 0.3% (foliar application), M5 : Co 2.0 kg/ha + Mo 1.0 kg/ha, M_6 : B 0.3% + M0 1.0 kg/ha, M_7 : Co 2.0 kg/ha + B 0.3% + Mo 1.0 kg/ha alongwith the absolute control (no addition of nutrient and bio-inoculants) was used for comparison. The experiment was design under factorial randomized block design with three replications. The recommended dose of nitrogen (20 kg/ha) and potassium (30 kg/ha K_2O) was applied in each plot uniformly as basal at the time of sowing. All the nutrients were applied as basal except boron, for which foliar application was done at 45 and 60 days after sowing. The macro and micronutrient inputs were applied through various sources. The cultural practices were done as per recommended package of practices. The various parameters like plant height, dry matter accumulation/plant, nodules number, nodule dry weight was recorded at pod development stage and yield and yield attributes were recorded at harvest. The final plant samples were collected at harvest from each plots, cleaned, oven dried at 60ºC and ground in a steel grinder. The nutrients like N, P and S content in seed and stover were determined by modified Kjedahl method, vanadomolbedophosphoric yellow colour method and turbidimetric method, respectively (Jackson 1973). Composite soil samples were collected from the crop field, plot wise after harvesting. The various soil parameters viz.organic carbon, pH, available N, P and K, Bo and Mo were analyzed as per the method described by Jackson(1973). Available sulphur and boron were determined turbidimetrically (Chesnin and Yien, 1951) and in hot water (Jackson, 1973), respectively. Micronutrients were determined by methods of Lindsay and Norvell (1978). Statistical analyses were done as per standard method prescribed by Gomez and Gomez (1984). Agronomic efficiency [see yield of fertilized plot (kg) seed yield of control (kg)/quantity of fertilizer applied (kg)] and physiological efficiency [total dry matter yield of fertilized plot (kg)- total dry matter yield of control plot (kg)/nutrient uptake by fertilized plot (kg)-nutrient uptake by control plot (kg)] were calculated as described by Baligar *et al.* (2001).

RESULTS AND DISCUSSION

Growth attributes and nodulation

The table 1 presents the results on the effect of fertility level and micronutrients on crop growth attributes and nodulation. The increasing the fertility levels which reveals in increased the plant height (117.0 cm) and dry matter accumulation/plant (8.79 g). Among the micronutrients the highest plant height (115.8 cm) and dry matter accumulation/plant (8.8 g) was recorded with combined application of Co, B and Mo in comparison to absolute control. The study observed the treatments application either Integrated or alone of micronutrients was also effective in enhancing the dry matter accumulation/plant over control. The increased fertility level might be provided the better environment for root growth and nutrient availability in root zone, thus, crop received higher water and nutrient from soil promoting greater translocation of photosynthates in plant parts. These findings are in close conformity with the findings of Kumar (2011). Fertility levels showed significant impact on number and weight of nodules which is mentioned in table 1. The trend was found might be due to better root amplification with increasing level of fertility. Phosphorus being constituent of nucleic acid and different form of proteins might have stimulated cell division resulting in increased growth of plants, although the effect of S and Zn also cannot be overlooked. Application of Co, B and Mo either alone or in combination found increased nodule number and its dry weight significantly. The maximum nodule number/ plant (44.5) and dry weight (36.9 mg) of nodules was recorded with integrated use of Co, B and Mo which may plays synergistic effect on nodulation and nodule dry weight (Kandil, 2007).

Yield and yield attributes

Yield attributes viz. number of pods/plant increased significantly with increase in fertility level depicted in Table 1. The fertility level, F_2 (60 kg P_2O_5 + 40 kg S + 5 kg Zn/ha) was found higher number of pods/plant (24.80) over fertility level, F_1. This might be due to phosphorus, sulphur and zinc helped in translocation of photosynthates resulting better pod formation as well as seeds. These results supported the finding of Kumar (2011) and Shivran *et al.*, (2000). The table 1 reveals the number of pods/plant increased significantly with either effective combination of micronutrients or alone over control. The number of pods/plant (24.8) was recorded with application of Co+Mo closely followed by Co+B (24.2) and Co alone (24.5). Thus, Co was the single most important micronutrient which influencing pods number and rest of the micronutrients perhaps, did not leave significant impact on number of pod/ plant as because combined application of Co, B and Mo produced maximum numbers (6.63) of Seed/ pod as because helped in translocation of photosynthates to pods and seeds

Table 1: Effect of fertility level and micronutrients on growth, yield attributes and yield of Pea (Pooled data over 2 years)

Treatment	Plant height(cm)	Dry Matter accumulation/ plant(g)	Nodule number /plant	Nodule dryweight/ plant(mg)	Number of pods/plant	Seed Yield (t/ha)	Biological yield(t/ha)
Fertility Levels							
F_1(30+20+2.5 kg/ha P_2O_5 +S+Zn)	103.6	7.87	37.19	30.87	23.41	2.96	6.81
F_2(60+40+5 kg/ha P_2O_5 +S+Zn)	117.06	8.81	42.23	35.08	24.8	3.25	7.48
Sem+	0.16	0.06	0.07	0.06	0.18	0.004	0.01
CD (P=0.05)	0.47	0.18	0.19	0.16	0.52	0.011	0.03
Micronutrients							
M_0(Control)	98.15	7.18	24.75	20.52	23.05	2.18	
M_1 (Co, 2 kg/ha)	111.83	8.49	41.5	34.45	24.53	3.24	5.02
M_2 (B, 0.3%)	108.93	8.28	39.69	32.95	24	3.14	7.44
M_3 (Mo, 1 kg/ha)	109.81	8.31	40.75	33.85	24.05	3.17	7.22
M_4 (Co, 2 kg/ha + B, 0.3%)	113.2	8.6	41.63	34.56	24.66	3.28	7.28
M_5 (Co, 2 + M0, 1 kg/ha)	113.99	8.66	43.38	36.02	24.82	3.3	7.54
M_6 (B, 0.3% + Mo, 1 kg/ha)	110.97	8.43	41.5	34.46	23.56	3.2	7.58
M_7 (B 0.3 % + Co 2 + Mo, 1 kg/ha)	115.78	8.79	44.5	36.95	24.18	3.35	7.35
Absolute control	87.48	6.5	19.5	16.19	20.26	1.71	3.93
Sem+	0.32	0.12	0.13	0.11	0.36	0.008	0.02
CD (p=0.05)	0.94	0.35	0.37	0.32	1.05	0.022	0.05

Table 2: Effect of fertility level and micronutrients on N, P and S uptake by pea (Pooled data over 2 years)

	N (kg/ha)		P (kg/ha)		S (kg/ha)	
Treatment	Seed	Stover	Seed	Stover	Seed	Stover
Fertility Level						
F_1(30+20+2.5 kg/ha P_2O_5 +S+Zn)	93.89	65.56	12.75	8.37	8.96	9.03
F_2(60+40+5 kg/ha P_2O_5 +S+Zn)	103.61	73.46	14.73	10.3	12.51	12.19
Sem+	0.13	0.14	0.08	0.1	0.22	0.21
CD (P=0.05)	0.37	0.4	0.22	0.28	0.64	0.61
Micronutrients						
M_0(Control)	69.13	47.36	9.07	6.05	6.45	6.26
M_1 (Co 2 kg/ha)	102.83	72.77	13.88	9.19	11.06	10.83
M_2 (B 0.3%)	99.65	70.16	13.39	9.03	40.7	10.47
M_3 (Mo 1 kg/ha)	100.57	70.38	13.63	9.36	10.99	10.81
M_4 (Co 2 kg/ha + B 0.3%)	104.32	74.08	14.4	9.99	11.53	11.38
M_5 (Co 2 + M0 1 kg/ha)	104.9	74.26	14.7	10.09	11.71	11.76
M_6 (B 0.3% + Mo 1 kg/ha)	101.83	71.44	14.57	9.85	11.17	11.14
M_7 (B 0.3 % + Co 2 + Mo 1 kg/ha)	106.74	75.61	16.27	11.12	12.3	12.22
Absolute control	53.55	36.34	7	4.66	5.12	4.66
Sem+	0.25	0.28	0.16	0.19	0.44	0.42
CD (p=0.05)	0.73	0.81	0.45	0.56	1.28	1.22

Table 3: Interaction effect between fertility level and micronutrients on dry weight, seed yield, nitrogen and sulphur uptake by seed.

Fertility LevelMicrobutrient	Dry weight /plant (g)		Seed yield (kg/ha)		Uptake by seed)kg/ha)N S			
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
M_0	7.0	7.4	2.05	2.32	64.35	73.91	5.73	7.18
M_1	8.0	9.0	3.08	3.39	97.74	107.92	8.94	13.17
M_2	7.8	8.8	2.99	3.29	94.65	104.64	8.67	12.73
M_3	7.8	8.8	3.02	3.31	95.50	105.64	9.05	12.93
M_4	8.1	9.1	3.13	3.44	99.28	109.35	9.70	13.36
M_5	8.1	9.2	3.16	3.44	100.09	109.71	9.79	13.63
M_6	7.9	8.2	3.06	3.34	97.05	106.61	9.18	13.10
M_7	8.3	9.3	3.22	3.49	102.42	111.06	10.62	13.97
Sem+	0.17		0.01		0.36		0.63	
CD (P=0.05)	0.5		0.03		1.04		1.81	

supported by Tsyganov and Vildflush (2004) and Valenciano *et al.* (2010).

Seed and biological yield of pea was significantly influenced by fertility levels showed in Table 1. Crop received higher fertility level displayed Superimposition over lover fertility levels and produced 3.25 and 7.48 t/ha seed and biological yield, respectively. The experimental soils, deficient in available phosphorus and sulphur, has responded significantly to increasing fertility level, build-up through addition of P, S and Zn. The same findings was observed byf Kaprekar *et al.* (2003),

Table 4: Effect of fertility level and micronutrients on physiological and agronomic efficiency of pea.

Treatment	Physiological Efficiency (kg/kg)			Agronomic efficiency (kg/kg)		
	Nitrogen	Phosphorus	Sulphur	Phosphorus	Sulphur	Zinc
Fertility Level						
F_1(30+20+2.5 kg/ha P_2O_5 +S+Zn)	41.49	316.56	371.1	41.82	62.73	501.86
F_2(60+40+5 kg/ha P_2O_5 +S+Zn)	40.71	268.85	246.06	25.72	3859	308.68
Micronutrient						
M_o(Control)	41.32	337.71	415.57	10.68	16.02	128.16
M_1 (Co 2 kg/ha)	41.03	313.53	317.39	36.93	55.4	443.21
M_2 (B 0.3%)	41.23	309.89	316.68	34.95	51.82	414.57
M_3 (Mo 1 kg/ha)	41.37	299.34	298.64	35.21	52.81	422.49
M_4 (Co 2 kg/ha + B 0.3%)	40.88	287.56	288.4	38.07	57.11	456.87
M_5 (Co 2 + M0 1 kg/ha)	40.98	281.99	278.55	38.6	57.9	463.22
M_6 (B 0.3% + Mo 1 kg/ha)	41.13	270.45	290.46	36.12	54.18	433.45
M_7 (B 0.3 % + Co 2 + Mo 1 kg/ha)	40.83	241.17	262.94	40.01	60.02	480.17

Agrawal and Sharma (2005), Mevada *et al.* (2005). Micronutrients application was also found effective in producing more seed and biological yield over control. Integrated use of the micronutrients was found more effective over their alone application in terms of seed (3.25 t/ha) and biological (7.48 t/ha) yield of pea. This is perhaps due to micronutrient enhanced the survival and multiplication of microorganism, more nitrogen fixation, transport of sugars and better uptake and assimilation of available nutrients by the plants during the entire growth period. Similar results have been reported by finding of Kumar *et al.*, (2009), Tsyganov and Vildflush (2004) and Valenciano *et al.*, (2010).

Nutrients uptake

Table 2 showed the nutrient uptake by seed and stover was significantly influenced by fertility levels. The fertility level, F2 registered maximum N, P and S uptake by seed (103.6 kg N, 14.7 kg P and 12.5 kg S/ha) and Stover (73.5 kg N- 10.3 kg P and 12.2 kg S/ha), respectively. The maximum N, P and S uptake was obtained by seed and stover associated with higher fertility level due to maximum seed and stover yield. These results corroborate with the findings of Reddy *et al.* (2001). The use of micronutrients likes Co, B and Mo either alone or in combination also enhanced N, P and S uptake by seed and stover significantly over control. The maximum N, P and S Uptake by seed and stover were recorded with integrated use of micronutrients. All these nutrients management has helped in higher acquisition of atmospheric nitrogen in nodule by symbiotic microbes making it available to the plant and resulting into its higher uptake by pea crop has been reported by Kumar *et al.*, (2009).

Interaction Effect

The interaction effect of fertility levels and micronutrient were found significant on dry weight/plant, seed yield and nitrogen and sulphur uptake by seed presented in table 3. The maximum dry weight were recorded with F_2 along with combined application of micronutrients, M_7 and was found at par to all the used micronutrients application except control under fertility level F_1 and F_2. This might be due to dry weight recorded at pod development stage and transformation of photosynthates was more under higher fertility level and micronutrient were also helped in photosynthesis and absorption of minerals and water (Reddy *et al.*, 2001). Nitrogen uptake by seed was recorded highest with treatments of M_7, under higher fertility level (F_2) and found significantly superior over rest of the treatment combinations. Similarly sulphur uptake by seed was recorded highest with combined application of micronutrient (M_7) under fertility level (F_2) but was found at par to all the micronutrients under F_2 except control and significantly superior to all the combination under fertility level F_1. The integrated source management improved the crop yields, produces quality grains as well as improved soil fertility (Sharma *et al.*, 2013; Meena, *et al.*, 2013). The highest sulphur uptake by seed in combined application of micronutrient under higher fertility level might be due to higher supply and increased uptake of sulphur through enhanced availability from the soil under higher fertility level. This was in the line of harmony with the findings of Singh *et al.*, 2009.

Physical and agronomic efficiency

Physiological efficiency represents the total biological yield per unit nutrient utilized is mentioned in table 4. The maximum physiological efficiency of nitrogen (41.5 kg/kg) phosphorus (26.9 kg/kg) and sulphur (246.06 kg/kg) were recorded with fertility level F_2 in comparison to F_1. Application of micronutrient could not bring any tangible impact on physiological efficiency of nitrogen, phosphorus and sulphur respectiely. The higher physiological efficiency were recorded with no micronutrients application over alone or combined application of micronutrients. This might be due to per unit increase in yield with per unit uptake of nutrient was low as compared to no application, because the enhancement of production up to a certain level with per unit uptake of nutrient after then production is increased with decreasing rate which fallows the law of diminishing return.

Maximum agronomic efficiency of applied phosphorus (41.82 kg/kg), sulphur (62.73 kg/kg) and zinc (501.96) was recorded with fertility level F_1 over F_2 because per unit production with per unit addition of nutrients were increased with decreasing rate which was responsible for lowering the agronomic efficiency of applied phosphorus, sulphur and zinc with higher fertility levels. Amongst micronutrient application, higher agronomic efficiency of phosphorus, sulphur and zinc were recorded with combined application of Mo, Co and B over its alone application and control. This might be due to combined application of micronutrients was found more effective in improving the nutrient use efficiency of applied phosphorus, sulphur and zinc over control as well as alone application.

These findings are in accordance with those of Ansari *et al.*, (2011) and Singh *et al.* (2010).

Based on two years study, it is concluded that balanced application of macro and micro nutrient was reveals the most effective for yield enhancement and quality of pea as well as increase the efficiency of applied nutrient.

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APPLICATION FORM

NATIONAL ENVIRONMENTALISTS ASSOCIATION (N.E.A.)

To,
The Secretary,
National Environmentalists Association,
D-13, H.H.Colony,
Ranchi - 834 002, Jharkhand, India

Sir,
I wish to become an Annual / Life member and Fellow* of the association and will abide by the rules and regulations of the association

Name ____

Mailing Address ____

____

Official Address ____

____

E-mail ____________________ Ph. No.____________(R)____________(O)

Date of Birth ____________________ Mobile No. ____________________

Qualification ____

Field of specialization & research ________________________________

Extension work (if done) ____________________________________

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Please find enclosed a D/D of Rs... No. .... Dated .... as an *Annual / Life membership fee.*

*Attach **Bio-data and some recent publications along with the application form when applying for the Fellowship of the association.**

Correspondance for membership and/ or Fellowship should be done on the following address :

SECRETARY,
National Environmentalists Association,
D-13, H.H.Colony,
Ranchi - 834002
Jharkhand, India
E-mails : m_psinha@yahoo.com Cell : 9431360645
dr.mp.sinha@gmail.com Ph. : 0651-2244071