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Response of different levels of zinc and farmyard manure on growth and yield of pea (*Pisum sativum* L.)

Suresh Kumar, M.K. Sharma, Atul Chandra and B.D. Sharma
Department of Horticulture, College of Agriculture, S.K. Rajasthan Agricultural University, Bikaner (Rajasthan)-334006

Abstract

A field experiment was conducted to study the effect of zinc and farm yard manure (FYM) on growth and yield of pea (*Pisum sativum* L.) during *Rabi*, 2009-10. The results revealed that application of 40 kg zinc sulphate ha^{-1} significantly increased vine length at harvest (77.12 cm), number of branches per plant at harvest (5.66), days taken for first flowering (47), number of nodules per plant at harvest (46.28), number of pods per plant (17.22), number of grains per pod, average pod length (cm), average weight of pod (g), weight of grains per green pod (g), shelling percentage (45.61), biomass content (45.86 q ha^{-1}) and green pod yield (78.95 q ha^{-1}) over control where no zinc was applied. Similarly, application of FYM at 350 q ha^{-1} significantly increased vine length at harvest (80.06 cm), number of branches per at harvest (5.79 cm), days taken for first flowering (49), number of nodules per plant at harvest (48.59), number of pods per plant (18.20), number of grains per pod, average pod length (cm), average weight of pod (g), weight of grains per green pod (g), shelling percentage (48.50), biomass content (47.09 q ha^{-1}) and green pod yield (81.35 q ha^{-1}) over control where no FYM was applied. The combined effect of zinc (40 kg ha^{-1}) and FYM (350 q ha^{-1}) was found significant pertaining to number of branches per plant at harvest (6.15), days to first flowering (51) and green pod yield (80.03 q ha^{-1}) compared to control and in respect to green pod yield, it was found statistically at par with 0, 150 and 250 q of FYM coupled with 40 kg ha^{-1} zinc application.

Key words: *Pea, zinc, FYM, growth, yield, interaction*

Introduction

Pea (*Pisum sativum* L.) is an important vegetable crop grown throughout India as well as in Rajasthan. In India, it is grown mainly as winter vegetable in the plains of North India and as summer vegetable in the hills. It is highly nutritive and rich source of digestible proteins (7.2%) along with carbohydrates (15.9%) and mineral matter like calcium (20 mg/100g), while dried pea grain contains protein (19.7%), carbohydrate (56.5%), calcium (75 mg/100g) besides being a good sources of vitamins. Peas are utilized mainly as a vegetable and are also processed, dehydrated and canned for value addition (Aykroyd, 1963). The role of chemical fertilizers is important in order to meet out the nutrient requirement of the crop but continuous use of these on lands will have deleterious effects on physical, chemical and biological properties of soil, which in turn reflects on yield (Sarkar *et el.*, 1997) so that the most logical way to the management of long term fertility and productivity of the soil is the use of micronutrients with the combination of organic manures. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase the usage of organic manures with micronutrients which are known to improve physico-chemical properties of soil and supply the nutrients in available form to the plants. The role of micronutrients and their mechanism in plant metabolism are well known as the minor elements are known to act as catalysts in promoting organic reactions taking place in plants, the zinc deficiency is more frequently encountered in Indian soils, especially, in saline and sandy soils of Western Rajasthan than deficiency of other micronutrients, particularly when the soils are either highly alkaline or are weathered and coarse (Duarte *et al.*, 1961). Response to zinc fertilizers in zinc deficient soils is obvious as reported for several crops including pea (Reddy *et al.*, 1995).

Among the various factors responsible for higher yield potential, application of adequate quantities of FYM is considered as one of the most effective way for boosting the crop yield in soils of Western Rajasthan, which are very poor in organic matter and content. Organic manures especially FYM not only increase the yield but also improve physical, chemical and biological properties of the soil which in turn improve fertility, productivity and water holding capacity of soil. Besides this, Use of FYM increases soil organic matter content and had greater residual effects (Kumaran *et al.*, 1998). So far, the study on pea crop with reference to micronutrients and FYM was not carried out in this zone; hence, the present investigation was undertaken to study the effect of zinc and FYM on pea crop.

Materials and methods

The experiment was conducted at College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Rabi* season of 2009-10. The experiment consisted twelve treatments comprising of three levels of zinc (0, 20 and 40 kg ha^{-1}) and four levels of FYM (0, 150, 250 and 350 q ha^{-1}) in factorial randomized block design with three replications. The zinc was applied through zinc sulphate in soil before sowing. The soil of

experimental field was sandy loam with pH of 8.54, organic carbon 0.12 per cent, available N_2 87.72 kg ha^{-1} and available zinc 0.24 ppm. The test crop (Pea cv. Azad P-2) was sown at a spacing of 30 x 7 cm. The recommended basal dose of N:P:K @ 25:40:50 kg ha^{-1} was applied uniformly in the plots. Inter cultural operations were followed according to package and practices. The pickings of green pods were done at three times *viz.* 86th, 100th and 113th DAS. The final harvesting of plants at half dry stage of plants was done at 123rd DAS subjected to record total biomass content on dry weight basis including dry weight of green pod yield. Observations on different growth parameters at given stage and on yield parameters at every picking of green pods were recorded on ten randomly selected plants from each treatment in every replication eliminating the border effect and analysed statistically as per the standard procedures to test the significance.

Result and discussion

Effect of zinc and FYM on growth parameters

The data presented in Table 1 showed significant increase in vine length at harvest (77.12 cm), number of branches per plant at harvest (5.66) per plant, days to first flowering (47) and number of nodules per plant at harvest (46.28) was observed under the application of zinc sulphate at 40 kg ha^{-1} compared to control. The promotive effect of zinc on plant growth parameters obtained in the present study may be attributed to the involvement of zinc in various physiological and biochemical processes in pea plants. The application of zinc lead to an increase in plant growth attributes which might be due to active synthesis of tryptophane; a precursor of auxin, besides the synergistic effect of zinc which may serve as a source of energy for the synthesis of auxin, the same could be attributed as one of the factor for the growth of plant (Raghav and Singh, 2004). This could also be attributed to its role in metabolic activity mainly in protein synthesis in plant as well as nitrogen fixation (Nagaraju and Yadahalli, 1996). Raghav and Sharma (2003) reported that soil application of 40 kg ZnSO4 ha^{-1} gave the highest plant height in tomato, okra and pea i.e. 69.3 cm, 69.5 cm and 48.7 cm, respectively. Kasturikrishna and Ahlawat (2000) recorded significantly more number of root nodules per plant in pea crop with the application of zinc at 5 kg ha^{-1}.

A data presented in Table 1 also showed significant increase in vine length at harvest (80.06 cm), number of branches per plant at harvest (5.79), days to first flowering (49) and number of nodules per plant at harvest (48.59) with the application of FYM at 350 q ha^{-1} compared to control. This was due to the organic manures would have improved the soil physical conditions and increased nutrient availability resulting in a better vegetative growth and increased yield of pea crop (Rafi *et al.*, 2002). Further, the better growth and development of plants with application of FYM might be due to increased availability of nitrogen as well as other required nutrients to the plants throughout the season. The prolonged period for flower initiation may be due to more availability of nutrients through FYM resulting into more vegetative growth period; hence, delay in flowering. These results are in agreement with the findings of Rafi *et al.* (2002) in tomato, Subbarao and Sankar (2001) in brinjal and Arumugam and Anuburani (2008) in tomato. Ghuge *et al.* (2007) also observed better growth in cabbage with organic manure application. The interactive effect of zinc and FYM (Table 3) has been found significant in respect to number of branches and days taken to first flowering. The application of 40 kg zinc along with 350 q FYM ha^{-1} significantly increased number of branches per plant at harvest (5.79) and days taken to first flowering (49) compared to control. This might be due to inadequate availability of nutrients through zinc and FYM resulting into more vegetative growth (Manolikar *et al.*, 2007).

Effect of zinc and FYM on yield parameters

The fertilization of pea with zinc sulphate at 40 kg ha^{-1} significantly increased yield attributing character *viz.* number of pods per plant (17.22), number of grains per pod (7.30), average pod length (6.59 cm), average weight of pod (7.05 g), weight of grains per pod (3.23 g), shelling percentage (45.61), total biomass content (45.86 q ha^{-1}) and green pod yield (78.95 q ha^{-1}) over control (Table 2). This might be due to the main function of zinc in plant as a metal activator of several enzymes like dehydrogenase, proteinase and peptidases (Prasad and Kumar, 2010). The beneficial effect of zinc on the yield and yield parameters may be attributed to the fact that soil application of zinc resulted in increased supply of the available zinc to the plants which resulted in proper growth and development of the plants. The essential role of zinc has been established as a component of several enzymes concerned with carbohydrate and nitrogen metabolism, in addition to its involvement directly or indirectly in regulating the various physiological processes of plants (Marschner, 1995). Zinc application contributed in increase in yield probably owing to its influence on auxin synthesis, nodulation and nitrogen fixation which promotes plant growth and development, there by favourably influencing yield attributes and grain yield (Islam *et al.*, 1989). The present findings are in confirmity with the findings of Dube *et al.* (2003) in tomato cv. Pusa Ruby. Increase in fruit length of okra with application of zinc was reported by Kumar and Sen (2005). Further, the data (Table 2) indicated that FYM at 350 q ha^{-1} significantly increased the number of pods per plant (18.20), number of grains per pod (7.59), average pod length (6.98 cm), average weight of pod (7.46 g), weight of grains per pod (3.62), shelling percentage (48.50), total biomass content (47.09 q ha^{-1}) and green pod yield (81.35 q ha^{-1}) over control. The beneficial effect of farm yard manure on yield attributes was probably due to enhanced supply of macro as well as micronutrients during entire growing season. It might have attributed to higher manufacture of food and it subsequent partitioning in sink. The reason for increased yield with the application of farm yard manure could be attributed to solubilization effect of plant nutrients by the addition of FYM leading to increased uptake of nutrients especially NPK as reported by Subbiah *et al.* (1982). The increase in number of pods per plant and seeds per pod in pea with organic manure application was reported by Bhattarai *et al.* (2003). Increase in the yield of

chilli by organic manures has also been reported by Sharu and Meeradai (2001).

The interactive effect of zinc and FYM (Table 3) has been found significant pertaining to green pod yield. The combined application of zinc at 40 kg ha^{-1} along with 350 q FYM ha^{-1} significantly increased green pod yield (80.03 q ha^{-1}) compared to control and being statistically at par to 0, 150 and 250 q ha^{-1} FYM when each quantity applied with 40 kg ha^{-1} zinc sulphate. This increase in green pod yield might be due to the better efficiency of zinc and farm yard manure and there translocations (Sharma and Abraham, 2010). Besides, the organic manures form organometallic complexes with zinc, which resulted in the increase of its efficiency which lead to better growth of plants and consequently higher yield (Gupta and Handore, 2009).

Table 1. Effect of zinc and FYM on growth parameters of pea

Treatments	Vine length at harvest (cm)	Number of branches at harvest	Days to first flowering	Number of nodules per plant at harvest
Zinc levels ($ZnSO_4$ kg ha^{-1})				
0	66.45	4.99	45	40.78
20	73.13	5.39	46	43.67
40	77.12	5.66	47	46.28
S.Em. ±	1.29	0.08	0.2	0.8
CD (5%)	3.79	0.23	0.5	2.35
FYM levels (q ha^{-1})				
0	63.68	4.87	43	37.63
150	69.99	5.21	45	42.43
250	75.21	5.51	46	45.66
350	80.06	5.79	49	48.59
S.Em. ±	1.49	0.09	0.2	0.92
CD (5%)	4.38	0.26	0.6	2.71

Table 2. Effect of zinc and FYM on yield parameters of pea

Treatments	Number of pods per plant	Number of grains per pod	Average pod length (cm)	Average wt. of pod (g)	Wt. of grains per pod (g)	Shelling (%)	Biomass content (q ha^{-1})	Green pod yield (q ha^{-1})
Zinc levels ($ZnSO_4$ kg ha^{-1})								
0	14.8	6.37	5.72	6.28	2.71	42.9	41.34	69.47
20	16.22	6.89	6.22	6.74	3.02	44.46	43.66	74.38
40	17.22	7.3	6.59	7.05	3.23	45.61	45.86	78.95
S.Em. ±	0.24	0.12	0.11	0.12	0.06	0.87	0.48	1.12
CD (5%)	0.71	0.34	0.31	0.36	0.19	2.55	1.48	3.29
FYM levels (q ha^{-1})								
0	13.30	5.99	5.19	5.83	2.31	39.59	39.90	66.61
150	15.70	6.66	5.96	6.47	2.80	43.19	42.58	72.15
250	17.12	7.17	6.57	6.98	3.21	46.01	44.90	76.96
350	18.20	7.59	6.98	7.46	3.62	48.50	47.09	81.35
S.Em. ±	0.28	0.13	0.12	0.14	0.07	1.00	0.56	1.29
CD (5%)	0.82	0.39	0.36	0.42	0.22	2.94	1.63	3.79

Table 3. Interactive effect of zinc and FYM on growth and yield of pea

Number of branches per plant at harvest				
Treatments	F_0	F_1	F_2	F_3
Zn_0	4.49	4.89	5.26	5.32
Zn_1	4.94	5.41	5.31	5.90
Zn_2	5.19	5.32	5.96	6.15
S. Em±	0.16			
CD (5%)	0.46			
Days to first flowering				
Zn_0	42.67	44.67	45.33	47.33
Zn_1	43.33	45.00	46.33	48.67
Zn_2	44.00	45.67	47.67	51.00
S. Em±	0.33			
CD (5%)	0.97			
Green pod yield (q ha^{-1})				
Zn_0	51.62	71.07	73.01	82.19
Zn_1	71.13	62.56	81.98	81.82
Zn_2	77.08	82.81	75.89	80.03
S. Em±	3.85			
CD (5%)	11.28			

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