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Effect of Micronutrients on Productivity and Profitability of Pea (*Pisum sativum sub sp. hortense*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was conducted to investigate the effects of micronutrients on productivity and profitability of pea (*Pisum sativum sub sp. hortense*) at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the winter season of 2019- 2020. The experiment was laid out in the Randomized Block Design comprising of 9 treatments including control with different concentrations of boron and zinc applied to the pea crop *viz*., Control, Boron-20(0.06%), Boron-20(0.09%), ZnSo4 (0.03%), ZnSo4 (0.05%), Boron-20(0.06%) + ZnSo4(0.03%), Boron-20(0.06%) + ZnSo4(0.05%), Boron-20(0.09%)+ ZnSo4(0.03%) and Boron-20(0.09%)+ZnSo4 (0.05%) which were replicated thrice. Garden Pea variety "Azad Pea-3" was sown at row to row spacing of 30 cm x plant to plant spacing of 10 cm.

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The crop was uniformly fertilized by 20 kg N, 40 kg P_2O_5, 40 kg K_2O /ha through urea and diammonium phosphate and muriate of potash. However, Zinc and boron was applied through zinc sulphate and borax as per the requirement of the treatments. The results indicated that the application B-20(0.09%) + ZnSO4(0.05%) recorded the highest quantity of seeds per pod (9.27g) number of pods per plant (25.63), yield per plant (64.23g), fruit yield (135.37 q/ha) which was closely followed by application of B-20(0.09%)+ZnSO4(0.03%). Further, application B-20(0.09%) + ZnSO4(0.05%) recoded higher B:C ratio (4.06) as compared to control (2.72). Thus, application of B-20(0.09%) + ZnSO4(0.05%) was found to the best treatment among all the treatments in improving the productivity of garden pea for the resource poor farmers of India.

Keywords: Garden pea; growth; zinc; boron; yield and economics.

1. INTRODUCTION

India is the world's largest producer and consumer of pulse crop. It contributes about a quarter to the world's total pulse production. While one-third of world's total acreage under pulses is in India, pulses play a vital role in Indian food chain particularly for vegetarians and contribute about 14 per cent of the total protein of average Indian diet. Among the pulses, which is also taken as vegetable, is Garden pea scientifically known as *Pisum sativum L*.(2n=14) which belongs to the family Leguminosae is a herbaceous plant that blooms once a year in winter. The plant is semi-erect, but it has a tendency to climb on support if available. It is the world's third most important legume crop [1]. Garden pea is mainly grown in the states of Uttar Pradesh, Bihar, Haryana, Punjab, Himachal Pradesh, Orissa and Karnataka [2]. The area and production of pea in India during 2019-20 were estimated to be 563 thousand hectares and 5703 million tonnes respectively, with a productivity of 10MT/ ha [3].

Pea is highly rich in protein and carbohydrate. It also has a good amount of lysine and tryptophan, fibre, sugar, salt, potassium, iron, zinc, vitamin along with fair amount of vitamins A and C [3]. It has a variety of health benefits such as prevention of stomach cancer, arthritis, diabetes and boosting immunity. Apart from the human body, being a leguminous crop, it fixes atmospheric nitrogen into the soil and improved the soil fertility. But there exists a vast gap between potential productivity and actual productivity of pea. So to meet this, proper fertilization of micro nutrient along with major nutrient is essential. Among micro-nutrients, zinc is an important micronutrient in crop nutrition since it is involved in a variety of physiological functions and enzyme activities, including protein and auxin production, glucose metabolism, cellular membrane maintenance and pollen generation. Unfortunately, zinc deficiency affects roughly half of Indian soils [4] which causes stunted growth, chlorosis, reduced leaves, spikelet sterility and increased susceptibility to high light temperature and fungal infections which are observable problems in plants. However, the intense cropping method and high yielding varieties deplete soil zinc, making zinc shortage a severe issue across the country. Zinc insufficiency has risen from 44% to 48% and it is anticipated to rise to 63 percent by 2025 [5]. Because of the low efficiency of soil zinc delivery, the yield is affected. As a result, various approaches have been explored and used [6]. Foliar application is one such option that is appropriate for micronutrients. A very effective strategy that may yield the best results with a low rate is multiple applications at the proper time of growth period. Zinc treatment is required for healthy crop growth and increased yields.

Boron is one of the critical micronutrients and is required for most plants optimal growth of many plants. It is required for the structural integrity of the plasma membrane. Boron increases K^+ ion absorption and membrane bound ATPase activity, causing hyperpolarization of the plasma membrane. It improves the opening and shutting of stomata. In legume crops, boron improves grain and straw yield, nutrient content, nutrient uptake and quality. The thick growth, brittle and outward curled juvenileleaves are among the indications of boron deficiency. The toxicity symptoms in plant have been observed as significant reduction in growth. The old leaves show marginal necrosis along with drastically reduction in size of Lamina on account of excessive boron. Considering all these aspects, a research study was carried out to study the effect of micronutrients on productivity and profitability of pea (*Pisum sativum sub sp. hortense*).

2. MATERIALS AND METHODS

A field experiment was conducted at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the winter season of 2019- 2020. The experimental site is situated at 25°31 N latitude at an elevation of 123.23 m above mean sea level falling in the sub-tropical region of India. The climate of this place is bestowed with hot and dry summers followed by cold and dry winters. The soil of the experimental field was sandy loam in texture, with good drainage and uniform texture, slightly alkaline (pH 7.68) in reaction, low in organic carbon (4.5 g/kg) and available nitrogen but medium in available phosphorus and potassium with electrical conductivity in the safer range. The experiment was laid out in the Randomized Block Design using different concentrations of micronutrients comprising 9 treatments combinations (viz., Control, Boron-20 (0.06%), Boron-20 (0.09%), ZnSo4 (0.03%), ZnSo4 (0.05%), Boron-20 (0.06%)+ZnSo4 (0.03%), Boron-20 (0.06%)+ZnSo4 (0.05%), Boron-20 (0.09%)+ZnSo4 (0.03%) and Boron-20 (0.09%)+ZnSo4 (0.05%) which were replicated thrice. For experimental purpose, Garden Pea variety “Azad Pea-3” was sown at row to row spacing of 30 cm x plant to plant spacing of 10 cm and it was uniformly fertilized by 20 kg N, 40 kg P_2O_5 and K_2O /ha through urea, diammonium phosphate and muriate of potash. However, zinc and boron was applied through zinc sulphate and boric acid as per the requirement of the treatments. The crop was managed as per regional recommendations of the crop.

Data pertaining to yield attributes and yield was obtained at harvest. For pod yield, from the individual plot, net plot was harvested and subsequently, the pod yield thus obtained were weighed and expressed in kg ha^{-1}. Among economic parameters, net return per ha was calculated by deducting cultivation cost from gross returns. Benefit cost (B:C) ratio was calculated by dividing net returns with total cost of cultivation to evaluate the economic viability of treatments. The mean values for all the characters in each replication were subjected to statistical analysis in the computer program SPAR-II developed by IASRI, New Delhi. Significant difference of sources of variation was tested at the probability level 0.05. The standard error of the mean (SEm±) and the CD value were indicated in the tables to compare the difference between the mean values.

3. RESULTS AND DISCUSSION

The data presented in Table 1 with respect to yield attributes and yield of garden pea revealed that the application of various treatments of boron and their combination have seen significant effect on quantity of seeds per pod, number of pods per plant, yield per plant and fruit yield. The highest quantity of seeds per pod (9.27g), number of pods per plant (25.63), yield per plant (64.23g), fruit yield (135.37 q/ha) was recorded with the application of B-20 (0.09%)+ZnSo4 (0.05%) which was closely followed by application of B-20 (0.09%)+ZnSO4 (0.03%). Further, combined application of boron– 20 @ 0.09% and+ ZnSO4 @ 0.05% gave 8.27% more number of seeds per pod, 40.07% increase in number of pods per plant and 35.87% increase in fruit yield over control. This may be due to the fact that when Zn and B were applied jointly, yield of garden pea seed was found to be higher than their individual application. Micronutrients (boron and zinc) may have boosted soil fertility and microbial multiplication as a result which there is higher nitrogen fixation, improved sugar transport and improved plant uptake and assimilation of available nutrients. Foliar application of borax 0.2 per cent at vegetative and flowering stages significantly enhanced the seed yield in mung bean compared to control [7]. Similar findings have been reported by Salih et al. [8] in tomato and Aslam et al. [9] and Zahoor et al. [10].

3.1 Relative Economics

The relative economics of the different concentrations of micro-nutrients treatments are presented in Table 2, revealed that the highest gross return of Rs. 338425/ha, net return of Rs. 271534/ha and benefit: cost ratio of 4.06 was realized with the application of B-20(0.09%)+ZnSo4(0.05%) which was closely followed by application of B-20(0.09%)+ZnSO4(0.03%). The minimum gross returns, net returns was recorded in the control. This is because of the increase in fruit yield. Thus, resulting in better net returns and B:C ratio in micro-nutrient treatments as compared to other treatments. Kumar et al. [11] also reported that micro-nutrient treatments resulted in highest net returns and B : C ratio as compared to control. Similar results were reported by Sharma et al. [12], Sanjida et al. [13] and Chatterjee and Bandyopadhyay [14].

Table 1. Effect of zinc and boron on yield attributes and yield of pea

Treatments	Seed weight per pod(g)	Number of seeds per pod	No of pods Per plant	Yield per Plant(g)	Yield(q/ha)
T_1–Control	2.44	7.26	15.36	41.55	99.63
T_2–B-20(0.06%)	2.47	8.11	19.83	50.51	103.70
T_3–B-20(0.09%)	2.50	8.16	21.28	51.79	106.53
T_4–ZnSo4(0.03%)	2.53	8.19	21.36	53.02	111.54
T_5–ZnSo4(0.05%)	2.58	8.27	22.12	54.12	116.23
T_6–B-20(0.06%)+$ZnSO_4$ (0.03%)	2.66	8.31	22.24	56.13	119.03
T_7-B-20(0.06%)+$ZnSO_4$ (0.05%)	2.73	8.36	23.69	58.95	128.70
T_8–B-20(0.09%) +$ZnSO_4$(0.03%)	2.82	9.10	24.27	60.43	133.43
T_9–B-20(0.09%)+$ZnSO_4$ (0.05%)	3.07	9.27	25.63	64.23	135.37
S.Em(±)	0.046	0.046	0.074	0.28	0.80
C.D	0.139	0.14	0.224	0.84	2.40

Table 2. Effect of zinc and boron on relative economics of pea

Treatments	Total cost of cultivation(/ha)	Grossreturn(/ha)	Net return (/ha)	B:C ratio
T1– Control	66880	249075	182195	2.72
T2–B-20(0.06%)	66883.5	259250	192366	2.88
T3–B-20(0.09%)	66885	266750	199865	2.99
T4–ZnSo4(0.03%)	66883.6	278850	211966	3.17
T5–ZnSo4(0.05%)	66884.9	290575	223690	3.34
T6–B-20(0.06%)+ZnSo4 (0.03%)	66886	297575	230689	3.45
T7-B-20(0.06%)+ZnSo4 (0.05%)	66887.4	321750	254862	3.81
T8–B-20(0.09%)+ZnSo4 (0.03%)	66890.5	333575	266684	3.99
T9–B-20(0.09%)+ZnSo4 (0.05%)	66891	338425	271534	4.06

4. CONCLUSION

It is concluded that application B-20(0.09%) + $ZnSO_4$(0.05%) recorded the highest quantity of seeds per pod (9.27g) number of pods per plant (25.63), yield per plant (64.23g), fruit yield (135.37 q/ha) which was closely followed by application o f B-20(0.09%)+$ZnSO_4$(0.03%). Further, application B-20(0.09%) + $ZnSO_4$(0.05%) recoded higher B : C ratio (4.06) as compared to control (2.72). Thus, application of B-20(0.09%) + $ZnSO_4$(0.05%) was found to the best treatment among all the treatments in improving the productivity of garden pea for the resource poor farmers of India.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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