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Effect of foliar application of zinc on growth and yield of garden pea (*Pisum sativum* L.) in Assam condition

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Abstract

A field experiment was conducted during the months of November-January 2018-19, at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat to study the effect of foliar application of zinc on growth and yield of garden pea (*Pisum sativum* L.) with five different treatments and four replications. Among the various treatments, the highest plant height (59.15cm) and number of branches (11.60) were recorded with T₄ (0.75% Zn), followed by T₃ (0.50% Zn). T₃ also recorded the highest fresh weight (39.30g) and dry weight (9.08g) of the plant a harvest as well as highest root weight per plant (0.73g). In case of yield attributing characters, the highest weight of the pod (6.63g), number of seeds per pod (7.59), weight of the seeds per pod (3.65g), shelling percentage (55.60%) and pod yield (56.31g/plant; 14.74t/ha) were recorded in case of T₃ (0.50% Zn). However, the highest number of pods per plant (15.80) was recorded with T₂ (0.25% Zn), which was very closely followed by T₃ (0.50% Zn). In many instances the trend decreases after a particular point, due to negative effect of excess micronutrient application than the optimum amount needed, which affects the plant in various ways. In a broader view, it can be suggested from the present study, that the one with 0.50% zinc application (T₃) turns out to be the optimum treatment, beneficial towards improving the growth and yield attributing characters.

Keywords: Garden pea, zinc sulphate, micronutrient, foliar application

Introduction

Garden pea (*Pisum sativum* L.), belonging to the leguminaceae family is a cool season herbaceous annual crop originally from the Mediterranean basin and near east, is now grown in many parts of the world. India is one of the top five pea producing countries of the world (Rawal and Navarro, 2019) [23]. It is the third most important pulse crop at global level and the third most important rabi pulse of India. Garden pea is one of the most nutritious leguminous vegetable rich in phytonutrients, minerals, vitamins, antioxidants, proteins, fiber, and has low quantity but high quality fat, having several health benefits, like preventing stomach cancer, arthritis, alzheimer's, diabetes and enhancing immunity. In addition to human body, being a leguminous crop it fixes nitrogen in the soil and is beneficial for the agricultural field as well.

Zinc is an essential micronutrient for crop nutrition, as it is involved in many physiological functions and enzyme activities, which are needed for protein and auxin synthesis, carbohydrate metabolism, maintenance of the cellular membrane and pollen formation. Unfortunately, about 50% of Indian soils are deprived of zinc (Singh and Sampath, 2011) [29], which leads to visible abnormalities in plants like stunted growth, chlorosis, smaller leaves, spikelet sterility and increases the plant susceptibility to high light or temperature injury and fungal infections. Naturally, soil is the only source for zinc availability to plants. But the soil zinc is being depleted by the intensive cropping system and high yielding varieties, which makes zinc deficiency a major problem all over the country. The deficiency of zinc has increased from 44% to 48% and it is expected to further increase up to 63% by 2025 (Shukla and Tiwari, 2014) [27]. The poor use efficiency of the soil zinc application has compelled the search for alternatives and hence different modes have been widely studied and adopted (Yashona *et al.*, 2018) [33]. One such alternative, suitable for the micronutrients is the method of foliar application. A very efficient method, which may show the most favourable response with low rate but multiple applications, in a proper time frame of growing period.

Considering different reports, application of zinc is necessary for healthy crop growth and higher yields and its foliar application has shown some positive effects in various crops. Based on this background, the present investigation was carried out for assessing the growth and yield of garden pea as influenced by foliar application of zinc, in the form of zinc sulphate ($ZnSO_4$) in Assam condition.

Materials and Methods

A field experiment was conducted in the rabi season of 2018-19, in the Experimental Farm of the Department of Horticulture, Assam Agricultural University. For precisely assessing the effects of various treatments during the period of investigation, all the plants were subjected to uniform cultural practices. The experiment was laid out with Randomized Block Design in four replications. There were five treatments, consisting of T_1 [0% Zn (Control)], T_2 [0.25% Zn (11.9g $ZnSO_4$ /l water)], T_3 [0.50% Zn (23.8g $ZnSO_4$ /l water)], T_4 [0.75% Zn (35.7g $ZnSO_4$ /l water)] and T_5 [1.00% Zn (47.6g/ $ZnSO_4$ /l water)], which were applied in the form of foliar application twice, that is 20 days after sowing and 35 days after sowing respectively. Basal application of FYM @5t/ha and urea, SSP, MOP and Boron @21.73kg/ha, 75 kg/ha, 62.5 kg/ha and 10 kg/ha respectively were done during the time of plot preparation. The variety used in this experiment was DS-10, an erect and dwarf mid-season pea variety. The seeds were treated with *Rhizobium leguminosarum* @100g/ kg pea seeds, before sowing, for which slurry was prepared by mixing the rhizobium culture with water, and then the seeds were soaked in that slurry, 4 hours prior to sowing. The green pods were harvested at horticultural maturity of young tender stage after full pod filling. The parameters regarding growth and yield of the crop were carefully observed and recorded in their proper time. All the recorded data were subjected to statistical analysis as per the standard procedure as described by Panse and Sukhtame (1985) [20].

Results and Discussion

Growth parameters

Data pertaining to growth parameters are presented in Table 1. The perusal of results indicated that, both the measured plant height and the number of branches of the garden pea plants responded significantly to the applied treatments. T_4 with 0.75% Zn application recorded the highest plant height (59.15 cm), as well as the highest number of branches (11.60), which was followed by T_3 (0.50% Zn), T_5 (1.00% Zn) and T_2 (0.25% Zn). The lowest plant height (47.58cm) and number of branches (8.60) were noted in case of T_1 (Control). This can be attributed to the fact that zinc affects the regulation of

auxin synthesis, which is well known to be the growth promoting hormone and consequently activates the cell division and enlargement (El-Tohamy and El-Greadly, 2007) [5]. These results are in close conformity with Togay *et al.* (2004) [31], Pandey *et al.* (2010) [18] and Nadergoli *et al.* (2011) [13] who also reported great influence of zinc application on shoot length or height of the plant, and showed its positive effect on the same. In case of number of branches as well, the results are in harmony with the findings of Togay *et al.* (2004) [31], Ali and Mahmoud (2013) [2], Bhamare *et al.* (2018) [4] and Hamouda *et al.* (2018) [8]. No significant effect was observed in case of days to 50% flowering and therefore days to first harvest of the garden pea pods as well with respect to the different treatment applications. A similar result is also displayed by Bhamare *et al.* (2018) [4].

Fresh weight of the plant increased with the increasing dosage of zinc application, till it reached the highest weight (39.30g) in T_3 (0.50% Zn), and then showed gradual decrease. The dry weight of the plant at harvest also measured the highest (9.08g) in case of T_3 (0.50% Zn), followed by T_4 (0.75% Zn). This may be because of the favourable effect exhibited by zinc on biological processes and plant metabolism. Zinc also has stimulating effect on photosynthetic pigments and other enzyme activity, which then encourages the vegetative growth of plants (Sadeghzadeh, 2013) [24]. Moreover, by affecting the enzymes required, it influences nitrogen metabolism, energy transfer and protein synthesis as well (Hafeez *et al.*, 2013) [6]. The increase in fresh weight at harvest is also evident from the increase in plant height and number of branches. The number of leaves also increases with zinc application (Hamouda *et al.*, 2018) [8], and so does the root growth, nodule count and weight (Singh and Bhatt, 2013) [28]. Haider *et al.* (2018) [7] also reported of improvement of the root system, its length and proliferation. So together all these factors lead to growth and development of healthy well-built plants, which in turn increases the fresh weight of the plants at harvest, as reported by Pandey *et al.* (2010) [18], Yuan *et al.* (2016) [34] and Hamouda *et al.* (2018) [8], also the dry weight of the plant as reported by Karaman *et al.* (1999) [10], Stoyanova and Doncheva (2002) [30], Pandey and Gautam (2009) [19], Pandey *et al.* (2010) [18], Kumar *et al.* (2016) [11], Hamouda *et al.* (2018) [8] and Pal *et al.* (2019) [15]. The results reveal that the highest root weight per plant (0.73g) was accounted in case of T_3 (0.50% Zn). The increase in root weight is also reported by Pandey *et al.* (2010) [18], Singh and Sampath (2011) [29], Singh and Bhatt (2013) [28] and Jamal *et al.* (2018) [9]. However the shoot: root ratio in dry weight basis did not show any significant difference with the treatment application.

Table 1: Effect of zinc treatment on growth attributing characters of garden pea

Treatments	Plant height (cm)	No. of branches	Days to 50% flowering	Days to harvest	Fresh weight of the plant at harvest (g)	Dry weight of the plant at harvest (g)	Root weight/plant (g)	Shoot: Root (Dry weight basis)
T_1 [0% Zn (Control)]	47.58	8.60	45.75	76.75	23.54	6.58	0.32	19.75
T_2 [0.25% Zn(11.9g $ZnSO_4$ /l water)]	51.00	9.70	47.00	77.75	34.25	8.13	0.70	10.94
T_3 [0.50% Zn(23.8g $ZnSO_4$ /l water)]	55.80	10.75	46.50	77.50	39.30	9.08	0.73	12.86
T_4 [0.75% Zn(35.7g $ZnSO_4$ /l water)]	59.15	11.60	50.50	79.00	33.75	8.42	0.71	11.87
T_5 [1.00% Zn (47.6g/ $ZnSO_4$ /l water)]	53.73	10.25	48.75	78.50	28.54	7.85	0.54	13.68
S.Ed.	2.80	0.82	1.64	0.96	3.71	0.63	0.13	2.74
CD _{0.05}	6.11	1.79	NS*	NS*	8.09	1.37	0.28	NS*

NS* = Non significant

Yield parameters

Data pertaining to yield attributing parameters are presented in Table 2. The application of zinc in various treatment doses had a significant promoting effect on the yield attributing characters like number of pods per plant, weight of the pods in grams, number of seeds per pod and weight of the seeds per pod in grams. In almost all the treatments T₃ (0.50% Zn) was found to give the highest value, except for number of pods per plant, where the highest number (15.80) was obtained in case of 0.25% Zn application (T₂), though T₃ followed really close and its performance was at par with T₂. This can be attributed to the fact that, application of zinc is essentially very beneficial for the reproductive yield of the crop, as it stimulates the male and female gametogenesis, which increases the number of flowers per plant. Then again, zinc application also stimulates the sporogenous tissue production, resulting in increase of pollen grain number per anther. In addition, zinc also facilitates the pollen stigma interaction by improving the stigma receptivity and functioning and also the pollen viability, and together, all these lead to proper germination of pollen grains and normal development as well as increase in yield parameters like number, size and weight

of the pods and seeds (Pandey and Gupta, 2012)^[16]. These results are in harmony with those obtained by Nadergoli *et al.* (2011)^[13], Kumar *et al.* (2012)^[12], Salehin and Rahman (2012)^[25], Ali and Mahmoud (2013)^[2], Pandey *et al.* (2013)^[17] and many others. Moreover, with the increase of number of seeds per pod and weight of the seeds per pod, the shelling percentage increases naturally. This explains the result obtained, which shows that the highest shelling percentage (55.60%) was obtained with T₃ (0.50% Zn), very closely followed by T₄ (0.75% Zn) and the lowest is in case of the control (T₁). The results are in accordance with the authors Kumar *et al.* (2012)^[12] and Ali *et al.* (2017)^[1]. Now naturally, with the increase of number of pods per plant, weight of the pods, number of seeds per pod and weight of the seeds per pod along with the foliar application of zinc, the pod yield definitely increases, as evident by the highest pod yield obtained in case of T₃ (0.50% Zn), followed by T₂ (0.25% Zn). Similar results are also reported by Tomar *et al.* (1990)^[32], Sangwan *et al.* (2004)^[26], Togay *et al.* (2004)^[31], Pandey *et al.* (2010)^[18], Quddus *et al.* (2011)^[22], Kumar *et al.* (2012)^[12], Pathak *et al.* (2012)^[21] and Bhamare *et al.* (2018)^[4].

Table 2: Effect of zinc treatment on yield attributing characters of garden pea

Treatments	Number of pods/plant	Weight of the pod (g)	Number of Seeds/pod	Weight of the seeds/ pod (g)	Shelling %	Pod yield	
						Per plant (g)	(t/ha)
T ₁ [0% Zn(Control)]	13.25	4.96	5.34	2.39	48.33	41.37	9.22
T ₂ [0.25%Zn(11.9g ZnSO ₄ /l water)]	15.80	5.92	7.42	3.06	52.43	53.18	13.66
T ₃ [0.50%Zn(23.8g ZnSO ₄ /l water)]	15.55	6.63	7.59	3.65	55.60	56.31	14.74
T ₄ [0.75%Zn(35.7g ZnSO ₄ /l water)]	14.38	6.41	7.34	3.53	55.28	51.34	11.96
T ₅ [1.00%Zn (47.6g/ZnSO ₄ /l water)]	13.50	6.23	7.17	3.13	50.41	49.01	11.07
S. Ed.	0.88	0.50	0.70	0.30	1.63	1.62	0.58
CD _{0.05}	1.92	1.10	1.54	0.67	3.55	3.53	1.26

NS* = Non significant

It can be noticed that in many of the parameters, though a positive trend was followed till a particular treatment, after that the values decreased gradually. This might be attributed to the fact that zinc being a micronutrient shows negative effect in the growth and development of the plant and other related aspects, when applied in even a slightly larger quantity than what the plant needs, leading to symptoms of toxicity. Moreover, since the zinc is applied in the form of foliar application, the plants receive it shortly and more efficiently with lesser loss than the soil application, which is another factor for even a little more of the zinc to the plants, to affect it negatively. In a broader view, the one with 0.50% zinc application (T₃) turns out to be the optimum treatment, which is in compliance with the percentage of zinc foliar application suggested by National Food Security Mission of India (Anon., 2015)^[3]. Similar results were also found in the works of Paivoke (1983)^[14] and Stoyanova and Doncheva (2002)^[30].

Conclusion

Application of zinc proved to affect the growth and development of garden pea in several ways. It can be concluded from the experiment, that T₃ with 0.50% zinc application is the most beneficial treatment among the rest, for almost all of the growth and yield attributing characters.

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