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Influence of Zinc on Zinc Use Efficiency in Broccoli in Mid Hills of Himachal Pradesh

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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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ABSTRACT

The present investigationt was carried out during rabi season of 2020-21 at the Experimental Research Farm of the Department of Vegetable Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh to find out the effect of zinc on the nutrient use efficiency in Broccoli cv. (Palam Samridhi). The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replications. Manures, synthetic fertilizers and micronutrients were replicated thrice in the form of nine treatments. The observations were recorded on marketable yield per plot (kg), Zn content in soil (mg kg^{-1}), Zn uptake in plants (kg ha^{-1}) and zinc use efficiency (%). The treatment combination having 50% N through vermicompost + 50% N through urea + RD of PK and FYM + $ZnSO_4$ @15 kg/ha produced best results for all the parameters studied.

Keywords: Integrated nutrient modules; uptake; synthetic fertilizers.

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1. INTRODUCTION

Broccoli (*Brassica oleracea* L. var. *italica* Plenck), a member of Brassicaceae family is a native of Eastern Mediterranean region, Italy being the main centre of diversity. The sprouting broccoli is believed to be the progenitor of the present quick growing cauliflower. In India, it was introduced during the second half of 20^{th} century. Its edible part is tender stems and immature buds [1]. Selection of proper fertilizer source, application at appropriate rate using correct formulation, right method of application, timely application and proper balancing of micronutrients with other nutrients in soil are some of the strategies which lead towards more yield and quality production of vegetables. Analysis of soil and plant samples indicated that 49 per cent of soils in India are potentially deficient in Zn [2]. Zinc is an essential micronutrient to increase the production and is taken up by plants in ionic form (Zn^{++}). Zinc is applied as zinc sulphate to the plants i.e. principal salt used as fertilizer. Zinc application increases sulforaphane content which is an anti-cancerous compound otherwise, due to zinc deficiency, sulforaphane content decreases and also results in reduced root growth with shortened internodes and chlorotic areas on older leaves in broccoli. Keeping in view the importance of zinc nutrition and its use efficiency, present experiment was conducted to study the effect of zinc fertilization in broccoli.

2. MATERIALS AND METHODS

The experiment was carried out in the experimental farm of the Department of Vegetable Science, Dr. Y S Parmar, UHF, Nauni, Solan to analyse the effect of integrated nutrient modules on growth and yield of broccoli. The Experimental Farm is located at an altitude of 1276 meters above mean sea level, about 14 km away from Solan, lying between 30º 52' North latitude and 77º 11' East longitude. During 2020-21 cropping season, the average maximum temperature varied from 21.5 to 30.6ºC while minimum from 2.3 to 25.0ºC and relative humidity from 43 to 81 per cent with 1.3 to 148.6 mm rainfall.

The experiment was laid out in a Randomized Complete Block Design having three replications. Seed sowing of broccoli in the nursery was done on 31^{st} August, 2020. Transplantation of healthy seedlings was done on 26^{th} September, 2020. Twenty plants were accommodated in each plot having dimensions of 3.0 × 1.8 m at a spacing of 60 × 45 cm. Before transplanting, measured quantities of manures and fertilizers as per treatments were mixed in well prepared plots after taking initial soil samples. The observations were recorded on marketable yield per plot (kg), Zn content in soil (mg kg^{-1}), Zn uptake in plants (kg ha^{-1}) and Zinc use efficiency (%).

Estimation of zinc content was done using atomic adsorption spectrophotometer [3]. Zinc (%) content in plant was then multiplied by its own biomass on dry weight basis computing nutrient uptake in kg ha^{-1}. Soil analysis was done for DTPA-Zn [4]. Zinc use efficiency was calculated using formula given by Fageria et al. [5] *i.e.* Apparent recovery efficiency (ARE) = (N_f - N_u/N_a) x 100, where N_f is the nutrient accumulation by the total biological yield (straw plus grain) in the fertilized plot (kg), N_u is the nutrient accumulation by the total biological yield (straw plus grain) in the unfertilized plot (kg) and N_a is the quantity of nutrient applied (kg).

3. RESULTS AND DISCUSSION

3.1 Marketable Yield per Plot (kg)

Yield is one of the most important characters that results from the interaction of various growth and yield related characters. Significant effect of various treatments on marketable yield per plot and per hectare was obtained. Maximum marketable yield per plot (13.20 kg) was observed in T_8 (50% N through vermicompost + 50% N through urea + RD of PK and FYM **+** $ZnSO_4$ @15 kg/ha) which was significantly superior over all other treatments like T_9 (12.17 kg/plot), T_7 (11.89 kg/plot) However, lowest marketable yield per plot (8.15 kg) was recorded in T_1 (absolute control). Increase in yield of broccoli with the use of zinc might be due to maximum content of zinc in plants coupled with other plant food material. Zinc also enhanced the absorption of beneficial elements by improving the cation exchange capacity of roots. Similar results were also reported by Lal et al. [6] in broccoli. Besides this, zinc activates the tryptophan synthesis and is also a precursor of IAA which increases the plant growth. Therefore, application of zinc might have resulted in increased photosynthesis, carbohydrate assimilation and ultimately maximum yield. These results are also supportive with the findings of Nagare et al. [7].

3.2 Zinc Content in Soil

Data in Table 1 shows that maximum zinc in soil (2.96 mg/kg) was reported in T_8 (50% N through vermicompost + 50% N through urea + RD of PK and FYM + $ZnSO_4$ @15 kg/ha) followed by T_9 (2.89 mg/kg) and T_7 (2.82 mg/kg) whereas minimum content of zinc (1.64 mg/kg) was obtained in T_1 (absolute control). This could be due to the role of organic manures in chelation which form organic chelates of higher stability and prevent these from fixation, precipitation, leaching and oxidation thereby increasing the zinc status of the soil. Similar results were also reported by Urmila [8]. The increase in zinc content of soil under treatment T_8 might be due to the direct addition of zinc fertilizer to soil. It might also be due to the fact that zinc sulphate is more water soluble and therefore, readily available making its effects visible in DTPA extractable micronutrient content in soil. Water solubility of zinc sulphate can be considered as an important criterion for availability of zinc in soil [9].

3.3 Zinc Uptake by Plant

Data in Table 1 shows that maximum zinc uptake (0.18 kg/ha) was recorded in T_8 (50% N through vermicompost + 50% N through urea + RD of PK and FYM **+** $ZnSO_4$ @15 kg/ha). Minimum zinc uptake (0.08 kg/ha) was recorded in T_1 (absolute control). Zinc uptake by the plants might have been increased with the integrated supply of organic manures and inorganic fertilizers. This increment could be due to improved soil health with organic manures resulting into maximum supply of nutrients in soluble and available form to the plants which increased the zinc uptake in plants [8]. Besides this, zinc increases the cation exchange capacity of roots and influenced maximum uptake of nutrients by the plants. These results are similar to those of Lal et al. [6].

Table 1. Effect of zinc on marketable yield per plot (kg), Zn content in soil (mg kg^{-1}), Zn uptake in plants (kg ha^{-1}) and nutrient use efficiency (%)

Treatment	Treatment Details	Marketable yield per plot (kg)	Zn content in soil (mg kg^{-1})	Zn uptake in plants (kg ha^{-1})	Zinc use efficiency (%)
T_1	Absolute control (no application of manures and fertilizers)	8.15	1.64	0.08	-
T_2	RD of NPK and FYM (125 kg: 75 kg: 52 kg + 200 q per ha)	9.53	1.92	0.10	-
T_3	RD of NPK and FYM + $ZnSO_4$ @15 kg/ha	9.81	2.18	0.14	0.73
T_4	30% N through vermi compost + 70% N through urea + RD of PK and FYM	10.18	2.07	0.12	-
T_5	50% N through vermi compost + 50% N through urea + RD of PK and FYM	10.35	2.10	0.12	-
T_6	70% N through vermi compost + 30% N through urea + RD of PK and FYM	10.48	2.12	0.14	-
T_7	30% N through vermi compost + 70% N through urea + RD of PK and FYM **+** $ZnSO_4$ @15 kg/ha	11.89	2.82	0.15	0.85
T_8	50% N through vermi compost + 50% N through urea + RD of PK and FYM **+** $ZnSO_4$ @15 kg/ha	13.20	2.96	0.18	1.22
T_9	70% N through vermi compost + 30% N through urea + RD of PK and FYM **+** $ZnSO_4$ @15 kg/ha	12.17	2.89	0.17	1.09
Mean		10.64	2.30	0.13	0.97
	$CD_{(0.05)}$	0.14	0.09	0.01	0.05

**RD Recommended dose*

3.4 Zinc Use Efficiency

Data in Table 1 shows that maximum nutrient use efficiency (1.22%) was observed in treatment T_8 (50% N through vermicompost + 50% N through urea + RD of PK and FYM **+** $ZnSO_4$ @15 kg/ha) followed by treatment T_9 (1.09%). Minimum nutrient use efficiency was observed in treatment T_3 (0.73%). This increase in Zinc use efficiency might be due to the combination of organic manures, inorganic fertilizers and micronutrient application. Due to organic manure application, concentration of nutrients in the soil increased resulting into maximum uptake of nutrients and nutrient use efficiency by the plants. These results are in line with those of Yashona et al. [10].

4. CONCLUSION

Results of the present investigation concludes that treatment T_8 (50% N through vermicompost + 50% N through urea + RD of PK and FYM + $ZnSO_4$ @15 kg/ha) came out to be the most effective treatment in relation to marketable yield per plot (kg), Zn content in soil (mg kg^{-1}), Zn uptake in plants (kg ha^{-1}) and Zinc use efficiency (%).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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