Research Article

Response of Thiourea and Zinc on Quality Characteristics and Economics of Cauliflower (*Brassica oleracea* var. *botrytis* L.)

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Abstract

A field experiment was conducted to study the effect of thiourea and zinc on quality and economics of cauliflower (*Brassica oleracea* var. *botrytis* L.) variety Snowball-16 during *Rabi* season of 2015-16 at Horticulture Farm, S.K.N. College of Agriculture, Jobner. The experiment consisted of sixteen treatment combinations with four levels of thiourea (Control, 500 ppm, 750 ppm and 1000 ppm) and four levels of zinc (Control, 2.5, 5.0 and 7.5 kg/ha) in randomized block design with three replications. The results indicated that application 1000 ppm thiourea significantly increased NPK and Zn content and ascorbic acid and protein content in curd of cauliflower. Although, application of 750 ppm thiourea was found statistically at par to 1000 ppm thiourea. Similarly, application of zinc 7.5 kg/ha significantly increased all the quality parameters of cauliflower, but it was found statistically at with zinc 5.0 kg/ha for quality attributes. The interactive effect of 1000 ppm thiourea along with 7.5 kg/ha zinc, being statistically at par to application of 1000 ppm thiourea + 5.0 kg/ha zinc but found significantly superior with respect to maximum net returns (Rs 218077/ha) and B: C ratio (2.61).

Keywords: *Brassica oleracea* var. *botrytis*, Thiourea, zinc, quality, net return and B:C ratio

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Introduction

Cauliflower (*Brassica oleracea* var. *botryitis* L.) is an important vegetable crop. It is grown round the year for its white tender curd formed by the shortened flower bud. It is widely cultivated all over India and abroad for its special nutritive values, high productivity and wider adaptability under different ecological conditions. It is used as vegetable, curries, soup and pickles. It is a rich source of nutrients and per 100 g edible portion of curd contains vitamin-A (51 IU), vitamin-C (75 mg), riboflavin (0.10 mg), thiamin (0.04 mg), nicotinic acid (1.0 mg), calcium (33 mg), phosphorus (57 mg), potassium (138 mg), moisture (90.8 g), carbohydrates (4.0 g), protein (2.6 g), fat (0.4 g) , fiber (1.2 g), iron (1.5 mg), etc. [1]. It is evident that without use of some micronutrient viz., Zn, Cu, Fe etc., it is not possible to get the maximum benefit of N, P and K. Zinc is another essential nutrient and taken up by the plant in ionic form (Zn^{++}). It is applied in the form of complex with a chelating agent like EDTA or $ZnSO_4$ i.e. the principal salt, used as fertilizer.

Zinc is a co-factor of over 300 enzymes and constituent of many proteins that are involved in cell division, nucleic acid metabolism and protein synthesis. Crop yield is often limited by low level of Zn in soils of arid and semi arid regions [2]. Most of the soils of Rajasthan are alkaline in nature and characterized by high pH ranging between 8 and 9. The uses of zinc in such soils are known to help in lowering the pH of soil, consequently increasing their uptake, in turn increase in yield of crop.

Besides nutrients, thiourea also plays an important role in maximizing yield potentials of the crop in arid and semi arid regions as it may prove beneficial by inducing stress tolerance. Furthermore, it plays a vital role in the physiology of plants both as a sulphydryl compound and to some extent as an amino compound like urea. The stimulating action of thiourea in various physiological activities of plant is well known. It has also been reported that thiourea regulate the plant growth by maintaining higher photosynthetic rate up to the reproductive stage and increased the yield by improving carbon partitioning towards sink [3].

Material and methods

The field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner, Jaipur during *Rabi* season 2015-16. Geographically, Jobner is situated 45 km in West of Jaipur at 26^0 05' North latitude, 75^0 58' East

longitude and at an altitude of 427 metres above mean sea level. In Rajasthan, this region falls under agro-climatic zone-IIIA (Semi-Arid Eastern Plains). Maximum temperature in summer ranges between 30 and 48^{0}C whereas, in winter, temperature falls down to as low as -1^{0}C. The average rainfall varies between 250 and 500 mm; most of which is received in rainy season from July to September but the amount has declined over the recent years. The mean daily temperature maximum and minimum during the growing season of cauliflower fluctuated 37.2 and 2.1^{0}C, relative humidity ranged from 41 to 67 per cent. The mean value of evaporation from USWB class pan ranged from 1.9 to 7.1 mm. There was a total rainfall of 3.6 mm during the period of experimentation. The soil analysis has been showed that the soil was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon (0.15 %) with low available nitrogen (128 kg/ha), phosphorus (16.63 kg/ha) and sulphur (8.4 mg/g) and medium in potassium content (154.1 kg/ha).

The experiment was laid out in Randomized Block Design (RBD) with three replications. This experiment comprised of 16 treatment combinations with four levels of each thiourea (Control, 500, 750 and 1000 ppm) and zinc (Control, 2.5, 5.0 and 7.5 kg/ha). The treatments were randomly allotted to different plots using random number table of Fisher and Yates, 1963 [4].

Treatment application

Thiourea and Zinc

Thiourea was applied as four levels (Control, 500 ppm, 750 ppm and 1000 ppm) before transplanting as roots dip of seedling for 15 minutes and foliar spray 25 days after transplanting. The weighed quantity of zinc as per treatment was applied before transplanting through fertilizer grade $ZnSO_4$ (21 % Zn) and mixed with soil and incorporated as per treatments. Observations to be recorded of experiment according to nutrient base are given (**Table 1**) with estimating methods.

Table 1 Nutrients analysis

Nutrient content	Estimating method
Nitrogen content in curd (%)	Nesselar's reagent in spectrophotometer method (Snell and Snell, 1949) [5]
Phosphorus content in curd (%)	Digesting plant samples with Tri-acid mixture of HNO_3 : H_2SO_4 : $HClO_4$ and was estimated by vanadomolybdo phosphate yellow colour method (Jackson, 1967) [6].
Potassium content in curd (%)	Determined by using triacid, potassium standard solution (Richards, 1954) [7] by flame photometer.
Zinc content in curd (ppm)	Determined by the analysis of suitable aliquat of digest –ll with atomic absorption spectrophotometer "Varian Techron AAS 120" (Lindsay and Norwell, 1978) [8].
Protein content in curd (%)	Calculated by multiplying nitrogen per cent of curd by the factor 6.25 (A.O.A.C., 1990) [9].
Ascorbic acid content in curd (mg/100g)	Diluting the known volume of juice with 3% metaphosphoric acid and titrating it with 2,6-dicholorophenol-indophenol solution (A.O.A.C.,1990) [9], till the faint pink colour was obtained.

Economics of treatments

The economics of the treatments is the most important consideration for making any recommendation to the farmers for its wide adoption. For calculating economics, the average treatment yield along with prevailing market rates of the produce and cost of inputs were used. B: C ratio was computed by dividing gross returns with cost of cultivation for each treatment.

Statistical analysis

To test the significance of variation in data obtained from various yield and quality characters, the technique of analysis of variance was adopted as suggested by [10] for randomized block design. Significance of difference in the treatment effect was tested through 'F' test at 5 per cent level of significance and CD (critical difference) was calculated, wherever the results found significant.

Result and Discussion

Effect of thiourea on quality attributes

Data of present investigation (**Table 2**) revealed that increasing levels of thiourea significantly increased the NPK content and zinc content in curd. The maximum NPK and zinc content (0.379, 0.330, 2.920 per cent and 47.74 ppm), respectively was recorded with application of 1000 ppm thiourea whereas it was recorded minimum under control.

Application of 750 ppm thiourea remained statistically at par with 1000 ppm thiourea and indicated an increase of 95.38, 73.68, 42.43 and 28.28, 17.85, 13.09 per cent in case of NPK content and significant increase of 21.97 and 7.40 per cent in case of zinc content over control and 500 ppm thiourea, respectively. Data presented in (Table 1) also indicated that increasing levels of thiourea had significant effect on the protein and ascorbic acid content in curd. The maximum protein (2.37%) and ascorbic acid content (71.00 mg/100g) was obtained with 1000 ppm thiourea whereas minimum (1.84% and 59.88 mg/100g) was recorded under control. Application of 750 ppm thiourea was found at par with 1000 ppm thiourea and registered a significant increase of 28.80 and 10.23 per cent, respectively in case of protein content and significant increase of 18.57 and 9.48 per cent in case of ascorbic acid content over control and 500 ppm thiourea, respectively.

Table 2 Effect of thiourea and zinc on quality attributes and economics of cauliflower

Treatments	**N content (%)**	**P content (%)**	**K content (%)**	**Zn content (ppm)**	**Protein content (%)**	**Ascorbic acid (mg/100g)**	**Net returns (Rs/ha)**	**B:C ratio**
Thiourea levels								
T_0 (Control)	0.294	0.190	2.050	39.14	1..84	59.88	78192	0.95
T_1 (500 ppm)	0.344	0.280	2.582	44.45	2.15	64.85	133188	1.61
T_2 (750 ppm)	0.373	0.320	2.830	47.60	2.33	69.55	152297	1.83
T_3 (1000 ppm)	0.379	0.330	2.920	47.74	2.37	71.00	184875	2.22
SEm±	0.008	0.005	0.040	0.82	0.04	1.52	2824	0.03
CD (P=0.05)	0.024	0.014	0.116	2.37	0.12	4.38	8155	0.09
Zinc levels								
Z_0 (Control)	0.300	0.198	2.097	39.61	1.87	60.15	107362	1.30
Z_1 (2.5 kg/ha)	0.337	0.269	2.550	44.48	2.10	64.73	128386	1.55
Z_2 (5.0 kg/ha)	0.370	0.326	2.832	47.79	2.32	69.61	147187	1.77
Z_3 (7.5 kg/ha)	0.383	0.327	2.903	48.20	2.40	70.80	165618	1.99
SEm±	0.008	0.005	0.040	0.82	0.04	1.52	2824	0.03
CD (P=0.05)	0.024	0.014	0.116	2.37	0.12	4.38	8155	0.09
Interaction (TxZ)	NS	NS	NS	NS	NS	NS	Sig.	Sig.

The increased accumulation of nutrients especially N, P and Zn in vegetative parts concomitant the improved metabolism led to greater translocation of these nutrients to reproductive structure of crop. Application of thiourea (seedling dip + foliar spray) resulted in better utilization of nitrogen and phosphorus in soil probably due to the fact that application of thiourea might have helped in improved metabolic process of plants and better growth & development leading to greater absorption of nutrients from rhizosphere. [11], while working at Bikaner also reported that thiourea being a sulphydryl compound significantly improved the root growth in clusterbean crop. This might be due to metabolic role of –SH group in root physiology and biochemistry. The findings of present experiment are in close conformity with those of [12] in mustard, [13] in garlic and [14] in potato.

Effect of zinc on quality attributes

Data given in (Table 2) further exhibited that levels of zinc application significantly increased the NPK and zinc content in curd. The maximum NPK and zinc content (0.383, 0.327, 2.903 per cent and 48.20 ppm) was recorded in treatment Z_3 (7.5 kg/ha zinc) over all the treatments except 5.0 kg Zinc/ha which was found to be at par with it. Application of 5.0 kg/ha zinc was found at par with 7.5 kg/ha zinc with an increase of 27.66, 65.15, 38.43 and 13.64, 21.56, 13.84 per cent over control and 2.5 kg/ha zinc, respectively in case of NPK content in curd however application of 7.5 kg/ha zinc registered an increase of 21.68 and 8.36 per cent more zinc content over control and 2.5 kg/ha zinc zinc content in curd, respectively. Data presented in Table 1 further revealed that different levels of zinc application significantly increased the protein and ascorbic acid content in cauliflower curd. Application of 7.5 kg/ha zinc recorded significantly higher protein (2.40%) and ascorbic acid content (70.80 mg/100g) in curd which was found to be at par with 5.0 kg/ha zinc. Application of 7.5 kg/ha zinc registered an increase of 28.34 and 14.28 per cent more protein content and 17.70 and 9.37 per cent more ascorbic acid content over control and 2.5 kg/ha zinc, respectively.

The present investigation had shown that levels of zinc significantly increased the zinc content in cauliflower curd, NPK content, protein content and ascorbic acid content. The initial available zinc status of the experimental soil was below the critical limits *i.e.* 0.5 ppm DTPA zinc. Thus, the application of zinc in soil increased the availability of zinc in the rhizosphere. The beneficial role of zinc in increasing cation exchange capacity (CEC) of roots helped in

increasing absorption of nutrients from the soil. Further, the beneficial role of zinc in chlorophyll formation, regulating auxin concentration and its stimulatory effect on most of the physiological and metabolic processes of plant, might have helped plants in absorption of greater amount of nutrients from the soil. Thus, the favourable effect of zinc on photosynthesis and metabolic processes augmented the production of photosynthates and their translocation to different plant parts, which ultimately increased the concentration of nutrients in the plant. Similar results were also reported by [15] in cauliflower, [16], [17] in cauliflower, [18] in mustard, [19] in knol-khol.

Economics of the treatments

Effect of thiourea on economics of cauliflower

A critical examination of the data presented in (**Table 2**) revealed that net returns (Rs/ha) and B:C ratio increased significantly with increasing levels of thiourea. The maximum net returns (Rs 184875 /ha) and B:C ratio (2.22) was recorded in 1000 ppm thiourea treatment while miminum was recorded under control (Rs 78192 /ha and 0.95). Application of 1000 ppm thiourea gave significantly higher net returns per ha and B:C ratio per ha over rest of the treatments which indicating an increase of 136.43, 38.80 and 21.39 per cent and 133.68, 37.88 and 21.31 per cent over control, 500 ppm thiourea and 750 ppm thiourea, respectively. It was probably because of magnificent role played by thiourea in improvement of growth, yield and quality attributes of cauliflower which ultimately resulted in significantly higher net returns and B:C ratio.

Effect of zinc on economics of cauliflower

Data (Table 2) further revealed that levels of zinc application also significantly enhanced the net returns (Rs/ha) and B:C ratio. The maximum net returns (Rs 165618 /ha) and B:C ratio (1.99) was noted with application of 7.5 kg/ha zinc whereas minimum was recorded in control (Rs 107362 /ha and 1.30). The increased net returns per ha and B:C ratio under 7.5 kg/ha zinc was found to be 54.26, 29.00 and 12.57 per cent and 53.07, 28.38 and 12.42 per cent higher over control, 2.5 kg/ha zinc and 5.0 kg/ha zinc, respectively. The superiority of treatment in increasing yield in comparison to added output led into increased net returns under this treatment over rest of treatments including control. Interactive effect of thiourea and zinc on net returns (Rs/ha) and B:C ratio

Data mentiond in (**Table 3**) showed that the combined application of different thiourea and zinc doses on net returns (Rs/ha) and B:C ratio were found to be significant. The application of 1000 ppm thiourea along with 7.5 kg/ha zinc recorded the maximum net returns (Rs 218077 /ha) and B:C ratio (2.61) in rest of the treatments except T_3Z_2 (1000 ppm thiourea + 5 kg Zn/ha) which was found statistically at par to it. The treatment combination of 1000 ppm thiourea with 7.5 kg/ha zinc proved as good as 1000 ppm thiourea along with 5.0 kg/ha zinc and found significantly superior to rest of the treatment combinations in both the cases.

The significant increase in yield under the application of thiourea and zinc was largely a function of improved growth and subsequent increase in curd yield. The interactive advantages of combining application of thiourea and zinc generally proved superior to the use of each component separately as their role described in previous subheadings.

Table 3 Interactive effect of thiourea and zinc on net returns and B:C ratio of cauliflower

Treatments	**Thiourea levels**							
Zinc levels	**Net returns (Rs/ha)**				**B:C ratio**			
	T_0	**T_1**	**T_2**	**T_3**	**T_0**	**T_1**	**T_2**	**T_3**
Z_0	54620	111282	125947	137599	0.66	1.34	1.52	1.65
Z_1	64903	119343	148082	181215	0.79	1.44	1.78	2.18
Z_2	84815	145181	156142	202609	1.03	1.75	1.88	2.43
Z_3	108432	156946	179018	218077	1.31	1.89	2.15	2.61
SEm±	5648				0.07			
CD (P=0.05)	16311				0.19			

Conclusion

On the basis of one year experimental results, it can be concluded that the combined application of 1000 ppm thiourea + 5.0 kg/ha zinc (T_3Z_2) was found most suitable in terms of net returns and B:C ratio (Rs 202609/ha and 2.43 : 1, respectively) and resulted in saving of 2.5 kg/ha zinc. Thus, applications of 1000 ppm thiourea along with zinc 5.0 kg/ha to cauliflower crop is recommendable.

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