

Effect of Soil and Foliar Application of Potassium Iodate (KIO₃) on growth and Yield of Byadgi Chillies (*Capsicum annuum* L.) in a Vertisol

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Abstract A field experiment was conducted in farmer's field during *kharif* season of 2014-15 to study the effect of soil and foliar application of potassium iodate (KIO₃) on growth and yield of Byadgi chillies (*Capsicum annuum* L.) in a Vertisol. Experiment consists of thirteen treatments and three replications. Potassium iodate (KIO₃) was given through soil (5.0 and 10 mg kg⁻¹) at 45 DAT and foliar spray (0.2 and 0.3%) at 60 and 90 DAT either alone or in combination with soil application. Highest plant height, number of branches, dry matter yield and fruit yield were recorded with soil application of 10 mg kg⁻¹ of potassium iodate (KIO₃) closely followed by the application of five mg kg⁻¹ as well as with control. Treatments which received only soil

application of KIO₃ recorded higher values compared to those treatments which received soil plus foliar application of KIO₃ irrespective of the concentrations and frequency of foliar spray. Foliar spray of KIO₃ at 0.2 and 0.3% resulted in reduced fruit yield (8.56 and 8.43 q/ha for 0.2 and 0.3% foliar spray respectively).

Keywords Potassium iodate (KIO₃), Fruit yield, Chilli, Growth parameters.

Introduction

Iodine is a trace element that is fundamental for human health. It is naturally present in fish, eggs, meat, dairy products and to a lesser extent in grains, fruits and vegetables. For an adult, the recommended daily allowance of iodine is 150 g. Nevertheless, its deficiency is one of the most serious public health issues worldwide and nearly one-third of the human population still has an insufficient iodine intake. Inadequate iodine intake impairs the thyroid gland function in all age groups and in cases of severe deficiency there is damage to the foetus, infant mortalities, endemic goitre, irreversible mental retardation. In order to counteract iodine deficiency its supplementation through iodizing the table salt is fol-

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lowed in many countries. However, excessive consumption of table salt has recently contributed to increased occurrence of cardiovascular diseases. Animals and plants in the food chain ultimately depend upon soil iodine which ranged from 1.55 to 12.93 mg kg⁻¹ and in water from water 0.05 to 4.5 µg/liter. Therefore supplementation of iodine in food chains through plant uptake is believed to be a cost-effective way to improve human nutrition and help to reduce the worldwide incidence of iodine deficiency disorders [IDD].

Chilli occupies an important place in Indian diet. It is an indispensable item in the kitchen consumed daily as a condiment in one or the other form. Chillies are cultivated for the purpose of vegetable, pickles, spice and condiments. Indian chilli is considered to be world famous for its color and pungency. Some varieties are famous for the red color because of the pigments capsanthin and capsorubin, while others are known for biting pungency attributed to an alkaloid "Capsaicin" (C₁₈H₂₇NO₃).

The important carriers of iodine are potassium iodide (KI), potassium iodate (KIO₃), potassium periodate (KIO₄) and iodoacetic acid (CH₂ICOOH). Among them potassium iodate is most extensively used for the biofortification of vegetables. Information on the content of iodine in chilli plants and biofortification of red chilli fruits through foliar and soil application of iodine carriers is lacking. Further soil iodine content may not be sufficient to enrich iodine content in red chillies. With the objective of enriching chilli fruits with iodine, through the use of KIO₃ there may be some adverse effects of growth and yield. Hence, the present investigation was to study the effect of potassium iodate on growth and yield of Byadgi chillies (*Capsicum annum* L.).

Materials and Methods

A field experiment was conducted on Byadgi chilli Cv Dyavnur during *khariif* 2014-15 in farmer's field at Agadi village (Taluk : Hubli) in Dharwad district situated in the northern transitional zone (Zone-8) of Karnataka. The soil of the experimental site is Typic Chromustert with a pH of 7.2, EC 0.29dSm⁻¹,

organic carbon 6.06 g/kg, available nitrogen 175.6 kg ha⁻¹, phosphorus 17.44 kg ha⁻¹, potassium 268 kg ha, sulfur 18.56 kg ha⁻¹ and the DTPA extractable micronutrients were sufficient. The initial water soluble iodine content in soil was 1.68 mg kg⁻¹. The experiment was laid out in randomized block design with thirteen treatments and three replications. A basal dose of 150 : 75 : 75 N, P₂O₅ and K₂O kg ha⁻¹ along with FYM (25t/ha) is applied to all the treatments. One month old chilli seedlings were transplanted in the field at a spacing of 75 × 75 cm. KIO₃ contains 18% K and 59% iodine. KIO₃ was cured with soil to get 5 mg kg⁻¹ and 10 mg⁻¹ dosage (53.33 mg and 106.66 mg of potassium iodate with 10kg/g separately for each plot respectively) a three days before application to soil and applied in the form of ring around plants at 45th DAT, while it was applied through foliar spray on 60th and 90th DAT. The treatment details are furnished in table.

Growth observations like plant height, number of branches and dry matter weight, yield and yield parameters (100 fruit weight and number of fruit per plant per picking) were recorded at the time of harvest.

Treatment details

- T₁ Control (water spray at 60 and 90 DAT),
- T₂ KIO₃ soil application @ 5 mg/kg at 45 DAT,
- T₃ KIO₃ soil application @ 10mg/kg at DAT,
- T₄ KIO₃ 0.2% foliar spray at 60 and 90 DAT,
- T₅ KIO₃ 0.3% foliar spray at 60 and 90 DAT,
- T₆ KIO₃ soil application @ 5 mg/kg at 45 DAT + 0.2% KIO₃ foliar spray at 60 and 90 DAT
- T₇ KIO₃ soil application @ 5 mg/kg at 45 DAT + 0.2% KIO₃ foliar spray at 90 DAT
- T₈ KIO₃ soil application @ 5 mg/kg at 45 DAT + 0.3% KIO₃ foliar spray at 60 and 90 DAT
- T₉ KIO₃ soil application @ 5 mg/kg at 45 DAT + 0.3% KIO₃ foliar spray at 90 DAT
- T₁₀ KIO₃ soil application @ 10mg/kg at 45 DAT + 0.2% KIO₃ foliar spray at 60 and 90 DAT
- T₁₁ KIO₃ soil application @ 10 mg /kg at 45 DAT + 0.2% KIO₃ foliar spray at 90 DAT
- T₁₂ KIO₃ soil application @ 10 mg/kg at 45 DAT + 0.3% KIO₃ foliar spray at 60 and 90 DAT
- T₁₃ KIO₃ soil application @ 10 mg/kg at 45 DAT + 0.3% KIO₃ foliar spray at 90 DAT

Results and Discussion

Growth attributes such as plant height, number of

Table 1. Effect of soil and foliar application of potassium iodate (KIO_3) on plant height, number of branches and total dry matter yield of chilli at harvest. Soil application at : 45th DAT, DAT-Days after transplanting, RDF-150 : 75 : 75kg N, P_2O_5 and K_2O ha^{-1} respectively + FYM (25 t/ha) is common for all the treatments.

Treatments	Plant height (cm)	Number of branches	Dry matter yield (g/plant)
T ₁ Control (water spray at 60 and 90 DAT)	94.80	15.83	87.46
T ₂ KIO_3 soil application @ 5 mg/kg	92.12	16.87	90.27
T ₃ KIO_3 soil application @ 10 mg/kg	95.20	17.07	90.67
T ₄ KIO_3 0.2% foliar spray at 60 and 90 DAT	92.93	14.93	83.20
T ₅ KIO_3 0.3% foliar spray at 60 and 90 DAT	93.47	14.87	83.16
T ₆ KIO_3 soil application @ 5 mg/kg + 0.2% KIO_3 foliar spray at 60 and 90 DAT	94.80	15.03	84.44
T ₇ KIO_3 soil application @ 5 mg/kg + 0.2% KIO_3 foliar spray at 90 DAT	93.47	15.07	86.32
T ₈ KIO_3 soil application @ 5 mg/kg + 0.3% KIO_3 foliar spray at 60 and 90 DAT	92.93	14.47	82.53
T ₉ KIO_3 soil application @ 5 mg/kg + 0.3% KIO_3 foliar spray at 90 DAT	90.01	14.90	81.68
T ₁₀ KIO_3 soil application @ 10 mg/kg + 0.2% KIO_3 foliar spray at 60 and 90 DAT	89.07	13.83	81.23
T ₁₁ KIO_3 soil application @ 10 mg/kg + 0.2% KIO_3 foliar spray at 90 DAT	92.12	13.60	77.23
T ₁₂ KIO_3 soil application @ 10 mg/kg + 0.3% KIO_3 foliar spray at 60 and 90 DAT	83.83	13.22	74.87
T ₁₃ KIO_3 soil application @ 10 mg/kg + 0.3% KIO_3 foliar spray at 90 DAT	91.23	13.80	77.52
SEm \pm	1.69	0.30	3.71
CD(0.05)	4.92	0.86	10.81
CV %	7.63	8.39	10.41

branches and total dry matter yield were found to be significantly influenced by KIO_3 application at harvest (Table 1). Highest plant height (95.20 cm), number of branches (17.07) and dry matter yield at harvest (90.67 g/plant) were recorded in the treatment (T₃) which received soil application of potassium iodate at 10 mg kg which was at par with treatment (T₂) that received soil application of KIO_3 at 5 mg kg^{-1} as well as control (T₁). This might be due to the presence of 18% potassium in KIO_3 . But organic matter present in soil retains the iodate ion very strongly and prevents its absorption by roots. Thus there is a negative role of soil organic matter on the mobility of iodine applied to soil through potassium iodate. Similar observations were reported by Kiferle et al. [1].

On the contrary treatments which received only foliar application of potassium iodate (T₄ and T₅) as well as soil + foliar application of KIO_3 (T₆ to T₁₃) recorded lower plant height and dry matter yield than those treatments which received only soil application of KIO_3 (T₂ and T₃). Further treatment (T₁₂) which received soil (10 mg kg) + foliar application of KIO_3 (0.3%) on 60 and 90 DAT recorded lowest plant height (83.83 cm) and dry matter yield (74.87

g/plant). Since KIO_3 contains 59% iodine and the two concentrations used in foliar spray (0.2 and 0.3%) have toxic effect on plant growth. There were yellowish brown patches on the leaves, leaves were paler in color and smaller in size. Kiferle et al. [1] reported that in tomato plants, foliar spray of potassium iodide (KI) and KIO_3 resulted in discolorations and necrotic areas on plants resulting in reduced photosynthesis leading to reduced plant height and dry matter yield.

The data presented in (Table 2) showed that there was a significant effect of soil and foliar application of potassium iodate on yield and yield parameters. Soil application of KIO_3 at 10 mg kg^{-1} on 45 DAT recorded maximum number of fruits (32.17), 100 fruit weight (148.33 g) and fruit yield (10.40 q ha^{-1}) which was on par with application of five mg kg^{-1} of KIO_3 through soil as (10.35 q ha^{-1}) well as with control (9.70 q ha^{-1}). It might be due to greater availability of potassium to plants applied through KIO_3 (18% K in KIO_3). The organic matter present in soil binds the iodate ion very strongly and prevents its absorption by plant roots which otherwise would have caused toxicity on plants. These results are in conformity with the results reported by Strzetelski et

Table 2. Effect of soil and foliar application of potassium iodate (KIO_3) on yield parameters and dry fruit yield of chilli. Soil application at : 45th DAT, DAT-Days after transplanting, RDF-150 : 75 : 75 kg N, P_2O_5 and K_2O ha⁻¹ respectively + FYM (25 t/ha) is common for all the treatments.

Treatments	No of fruits per plant per picking	Weight of 100 dry fruits (g)	Dry fruit yield (q/ha)
T ₁ Control (water spray at 60 and 90 DAT)	29.98	142.67	9.70
T ₂ KIO_3 soil application @ 5 mg/kg	30.83	147.15	10.35
T ₃ KIO_3 soil application @ 10 mg/kg	32.17	148.33	10.40
T ₄ KIO_3 0.2% foliar spray at 60 and 90 DAT	27.32	140.33	8.56
T ₅ KIO_3 0.3% foliar spray at 60 and 90 DAT	26.55	139.48	8.43
T ₆ KIO_3 soil application @ 5 mg/kg + 0.2% KIO_3 foliar spray at 60 and 90 DAT	28.05	140.58	8.66
T ₇ KIO_3 soil application @ 5 mg/kg + 0.2% KIO_3 foliar spray at 90 DAT	28.43	141.67	9.25
T ₈ KIO_3 soil application @ 5 mg/kg + 0.3% KIO_3 foliar spray at 60 and 90 DAT	26.43	139.33	7.90
T ₉ KIO_3 soil application @ 5 mg/kg + 0.3% KIO_3 foliar spray at 90 DAT	26.23	135.61	7.67
T ₁₀ KIO_3 soil application @ 10 mg/kg + 0.2% KIO_3 foliar spray at 60 and 90 DAT	25.72	134.67	7.55
T ₁₁ KIO_3 soil application @ 10 mg/kg + 0.2% KIO_3 foliar spray at 90 DAT	24.86	130.15	7.40
T ₁₂ KIO_3 soil application @ 10 mg/kg + 0.3% KIO_3 foliar spray at 60 and 90 DAT	23.67	125.51	6.95
T ₁₃ KIO_3 soil application @ 10 mg/kg + 0.3% KIO_3 foliar spray at 90 DAT	25.22	128.00	7.52
SEm±	1.59	6.08	0.56
CD(0.05)	4.65	NS	1.64
CV%	10.19	7.59	11.40

al. [2] and Kiferle et al. [1] who reported the negative role of organic matter on the mobility of iodine and stated that, iodate anion could be retained stronger than iodide by organic matter fraction of soil. Further there existed synergistic relationship between iodate anion and nitrate anion. This might have resulted in increased uptake of nitrogen by plants leading to increased fruit yield.

Critical review of the data revealed that, treatments that received only soil application of KIO_3 recorded higher values compared to those treatments which received soil plus foliar application of KIO_3 irrespective of the concentrations and frequency of foliar spray. Lowest number of fruits (23.67), fruit yield (6.95q ha⁻¹) and 100 fruit weight (125.51 g) were recorded with the application of 10 mg kg⁻¹ of KIO_3 through soil plus foliar sprays of 0.3% KIO_3 on 60 and 90 DAT. This might be due to greater toxic effect of iodine applied through soil plus foliar spray. Iodine absorbed by plant roots gets translocated through xylem to aerial parts and accumulates in stalk and leaves. Further foliar applied iodine through KIO_3 remains deposited on leaf and fruit surfaces without sufficiently being absorbed as ph-

loem vessels cannot transport iodine reported by Blasco et al. [3]. Thus there was increased toxicity of iodine on plants particularly mottling of leaves, chlorosis, brown spots, defoliation and dropping of flowers leading to decreased yield. Results of iodine toxicity due to soil and foliar sprays of iodine carriers on horticultural and fruit tree species were reported earlier by Caffagni et al. [4] and also by Weng et al. [5] in vegetables.

Treatments which received only foliar spray of KIO_3 (T₄ and T₅) recorded lower fruit yield (8.56 and 8.43 q ha⁻¹) than those which received only soil application. Foliar spray of KIO_3 resulted in toxic effect of iodine on leaves leading to reduced photosynthesis.

Thus from the present study it was inferred that, only soil application of potassium iodate (KIO_3) at 10 mg kg⁻¹ on 45 DAT along with RDF + FYM recorded positive effect on growth attributes, yield and yield attributes closely followed by application at 5 mg kg⁻¹ and control. But foliar application of potassium iodate at both the concentrations as well as soil

+ foliar application of KIO_3 had negative effect on growth and yield/ yield attributes of chilli.

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