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Influences of different levels of calcium nitrate foliar application on quality attributes, flower drop and yield of Byadgi chilli (*Capsicum annuum* L.) under a non-calcareous vertisol

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Abstract
A field experiment was conducted to study the influence of different levels of calcium nitrate foliar application on quality attributes, flower drop and yield of Byadgi chilli in farmer's field Dharwad Karnataka India. The experiment was laid out in RCBD design with 12 treatments and 3 replications. Result showed that treatment which received three foliar sprays of 1.5 per cent Ca (NO3)2 recorded significantly highest colour value (280.22 ASTA units), oleoresin content of 20.39 per cent, dry fruit yield of 21.76 q ha^{-1} and lowest flower drop 10.02 per cent with three foliar sprays of 1.5 per cent $Ca(NO_3)_2$. Control recorded lowest color value and yield and highest flower drop which did not received any foliar spray of Ca $(NO_3)_2$. The experiment revealed that 1.5 per cent concentration is more superior in improving the yield and quality of Byadgi chillies over 1.0 per cent concentration.

Keywords: Calcium nitrate, colour value, flower drop, oleoresin, yield

Introduction

Byadgi chilli is one of the famous variety of chilli mainly grown in Karnataka state of Indian. It is named after the town of Byadgi which is located in the Haveri district of Karnataka. The business involving Byadagi chillis has the second largest turnover among all chilli varieties of India. The chief use of red chilli throughout the world is as a spice on account of its pungency, fascinating red colour and distinct flavour. Now a days, value added chilli products such as oleoresin, essential oil and chilli powder have gained greater importance in the global market than whole chilli. Colour is one of the most important quality attribute of red chilli which governs the market price. Pigments constituting the colour are a complex mixture of carotenoids. Oleoresin is the true essence of spice and can replace whole or ground spices without impairing their flavour and aroma (Sivaraman *et al.*, 2001) [3]. Oleoresin represents the complete flavour of the spice and contains both volatile and nonvolatile components. Out of the total oleoresin export, nearly 50 per cent is contributed by chilli oleoresin and is the single largest oleoresin used in the world.

Intensive agriculture and extensive use of chemical fertilizers has created deficiency of certain major plant nutrients in the soil. Calcium is one of the most critical secondary nutrients that is vital for the growth and strength of the plants body. Its deficiency may cause heavy losses both qualitatively and quantitatively. Lack of Calcium produces a general breakdown of cell membrane structures with resultant loss in retention of cellular diffusible compounds and results in flower and fruit drop and extensively reduced the yield of the crop.

Use of Calcium nitrate is popular in agronomic situations where a readily soluble source of nitrate and calcium is needed. Nitrate moves freely with soil moisture and can be immediately taken up by plant roots. Unlike other common nitrogenous fertilizers, Ca $(NO_3)_2$ application does not acidify soils. Broadcasting of Ca $(NO_3)_2$ is desirable in some circumstances because of the risk of ammonia volatilization losses. In addition, some crops prefer nitrate sources of N. Applications of Ca $(NO_3)_2$ also provides supplemental Ca for plant nutrition. Some soils may contain considerable amounts of Ca, but it may not be sufficiently soluble to meet plant demands. Since Ca is not mobile in the plant, it is important to apply Ca just in time at critical growth stages. Hence the present investigation was under taken.

Materials and Methods

A field experiment was conducted during kharif season of 2016, with protective irrigation, to investigate the influence of different levels of calcium nitrate foliar application on quality attributes, flower drop and yield of Byadgi chilli (*Capsicum annuum* L.) in a non-calcareous Vertisol in farmer's field at Agadi village Dharwad district Karnataka India. The experiment was laid out in RCBD design with 12 treatments and 3 replication, including 1.0 and 1.5 per cent concentration of calcium nitrate sprayed on 45, 60 and 75th day after transplanting in combination. The soil of the experimental field was clay in texture, with pH 7.30 and EC of 0.26 dSm^{-1}. The organic carbon, free lime, available nitrogen, phosphorus, potassium, sulphur, exchangeable calcium and magnesium contents were 6.90 g kg^{-1}, 2.56 per cent, 180.65 kg ha^{-1}, 16.85 kg ha^{-1}, 282.24 kg ha^{-1}, 20.25 kg ha^{-1} and 14.50 (c mol (p^{+}) kg $^{-1}$) and 5.50 (c mol (p^{+}) kg $^{-1}$), respectively. One month old chilli (Cv. Dyavnur) seedlings were transplanted at 75 cm x 75 cm spacing. Recommended NPK fertilizers (100:50:50 kg ha^{-1}) were applied in the form of urea, diammonium phosphate and muriate of potash respectively and FYM was applied at 25 t ha^{-1}. Nitrogen was applied into two split doses, basal dose of 50 per cent at the time of transplanting and remaining half dose at 45 days after transplanting.

Result and Discussion

Quality attributes

The treatment that received three foliar applications of 1.5 per cent Ca(NO3)2 showed highest colour value (218.22 ASTA units) in the treatment T_{10} which was closely followed by treatments T_5 and T_9 and showed a significant difference between the treatments. While lowest color value was recorded in treatment that received three water spray which closely followed by NAA spray treatment T_{11}. This may be due to foliar application of $Ca(NO_3)_2$ which directly absorbed by the developing fruits as Ca and N sources which participate in the synthesis of capsanthin and capsorubins which are vital constituents of red chillies. Similar observations were also made by Tandon *et al.* (1964) [5] and Kolay (2000) [2]. Highest colour value of fruits may also due to increased uptake of potassium from the soil as reported by Somimol (2012) [4] and Veerendra Patel (2014) [6]. The lowest value in the water spray treatment may have some dilution effect due lower concentration of Ca and N in the fruits.

Table 1: Effect of foliar spray of calcium nitrate on quality parameters of chilli (cv. Dyavnur)

Treatments	Colour value (ASTA units)	Oleoresin (%)
T_1 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 DAT	245.71	13.01
T_2 - 1.0% $Ca(NO_3)_2$ foliar spray at 60 DAT	234.25	13.11
T_3 - 1.0% $Ca(NO_3)_2$ foliar spray at 75 DAT	191.38	16.98
T_4 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	239.87	14.13
T_5 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75 DAT	274.66	16.60
T_6 - 1.5% $Ca(NO_3)_2$ foliar spray at 45 DAT	258.04	14.88
T_7 - 1.5% $Ca(NO_3)_2$ foliar spray at 60 DAT	248.20	12.78
T_8 - 1.5% $Ca(NO_3)_2$ foliar spray at 75 DAT	217.63	19.16
T_9 - 1.5% $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	272.74	15.15
T_{10} - 1.5% $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75 DAT	280.22	20.39
T_{11} - 50 ppm NAA foliar spray at 60 DAT	213.66	12.85
T_{12} - Control (water spray at 45,60 and 75 DAT)	169.84	11.60
S. Em. ±	7.62	0.52
C.D. (0.05)	22.36	1.52

Treatment that received 1.5 and 1.0 per cent foliar spray of $Ca(NO_3)_2$ on 75th DAT recorded highest oleoresin content with 20.39% which was on par with treatments T_8 (19.16%) and T_3 (16.98%) and differed significantly from all other treatments. Lowest oleoresin content (11.60%) was recorded in control which was on par with treatment T_{11} that received 50ppm NAA spray. High oleoresin content was due to greater synthesis of volatile fatty oil in chilli seeds due to the presence of calcium responsible for seed formation and translocation of photosynthates to developing fruits resulting in higher weight of pericarp. Similar finding were obtained by Veerendra Patel (2014) [6] and Hariadh Babu *et al.* (2010) [2].

Per cent flower drop

Before and after spray at 45 DAT

Before spray the highest values of per cent flower dropped was recorded in treatment control (33.34%) which was closely followed by treatments T_3, T_7 and T_6 and lowest recorded in treatment T_4 (19.01%). It was found that there was non-significant difference exited between treatments. After foliar spray the minimum flower drop was recorded in treatment T_{10} that received one foliar spray of 1.5% Ca $(NO_3)_2$ at 45 DAT and the highest per cent flower dropping was recorded in the treatment T_{12} that received one water spray followed by other treatment that did not received foliar spray of Ca $(NO_3)_2$ and showed that Ca $(NO_3)_2$ has significantly influenced the flower dropping. The minimum per cent of flower dropping recorded was due to more absorption of calcium and nitrogen supplied through foliar application, as calcium gets translocated to terminal parts which strengthen the pedicel of flower and reduced the flower dropping in plant.

Table 2: Effect of foliar spray of calcium nitrate on per cent flowers dropped in chilli

Treatments	45 DAT		60 DAT		75 DAT	
	Before spray	After spray	Before spray	After spray	Before spray	After spray
T_1 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 DAT	24.58	17.83	36.12	25.80	28.82	16.33
T_2 - 1.0% $Ca(NO_3)_2$ foliar spray at 60 DAT	22.11	21.93	38.69	21.14	29.40	15.64
T_3 - 1.0% $Ca(NO_3)_2$ foliar spray at 75 DAT	29.37	26.54	37.91	33.63	38.96	18.87
T_4 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	19.01	11.49	37.45	18.54	28.15	15.94
T_5 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75 DAT	19.41	9.84	34.83	17.56	21.63	12.83
T_6 - 1.5% $Ca(NO_3)_2$ foliar spray at 45 DAT	26.96	9.09	35.04	16.42	24.86	11.26
T_7 - 1.5% $Ca(NO_3)_2$ foliar spray at 60 DAT	29.05	29.16	40.79	17.29	25.59	11.73
T_8 - 1.5% $Ca(NO_3)_2$ foliar spray at 75 DAT	23.12	24.38	41.38	42.84	32.38	14.92
T_9 - 1.5% $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	19.11	09.31	74.80	18.54	28.71	14.36
T_{10} - 1.5% $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75 DAT	19.51	9.03	59.56	15.44	20.43	10.02
T_{11} - 50 ppm NAA at peak flowering stage (60 DAT)	19.19	16.08	60.79	29.35	34.78	16.17
T_{12} - Control (water spray)	33.43	42.36	62.47	41.75	39.26	21.97
S.Em. ±	0.85	0.69	1.85	0.64	0.43	0.35
C.D. (0.05)	NS	2.04	5.41	1.89	1.25	1.02

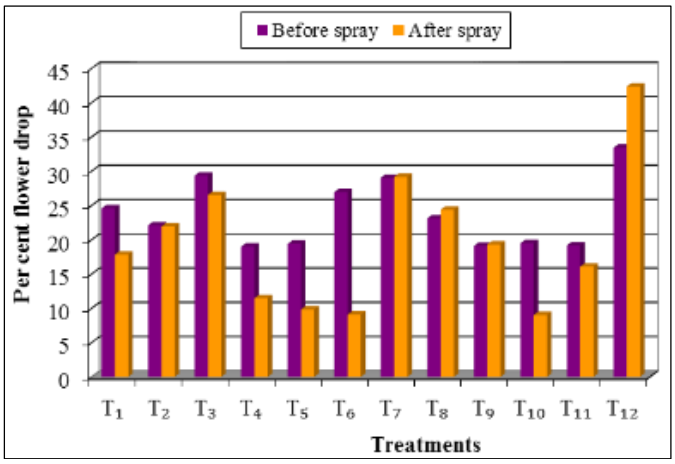

Fig 1: Effect of foliar spray of calcium nitrate on per cent flower drop in chilli (cv. Dyavnur) at 45 DAT

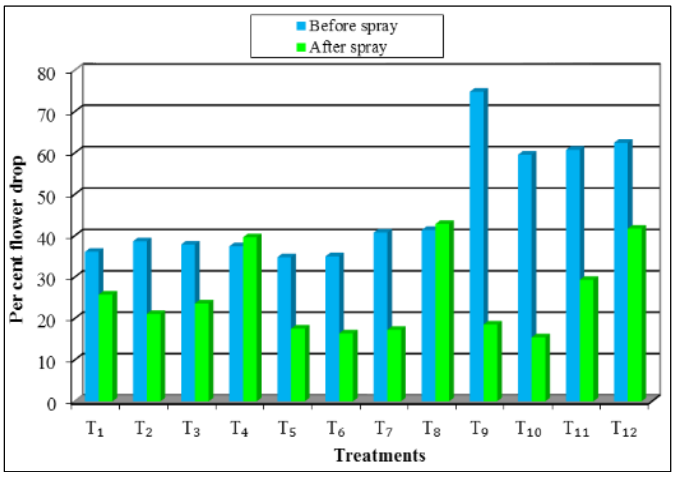

Fig 2: Effect of foliar spray of calcium nitrate on per cent flower drop in chilli (cv. Dyavnur) at 60 DAT

Before and after spray at 60 DAT

The data collected before 60 DAT highlighted that lowest value of flower drop (34.83%) was recorded in treatment T_5 which was on par with treatments T_1, T_2, T_3 and T_4. Highest flower drop (74.80%) was recorded in treatment T_9 which different significantly from all other treatments. After foliar spray, minimum flower drop (15.44%) was recorded in treatment T_{10} that received two foliar spray of Ca $(NO_3)_2$ and was on par with treatment T_6 (16.42%). This is because of calcium role in strengthening the cell wall which causes stiffness of the terminal axes, higher concentration (1.5%) of Ca in nutrient solution and higher volume of spray solution resulted in reduced flower dropping and the nitrate nitrogen initiated the growth of the plants that increased number of flowers.

Before and after spray at 75 DAT

Treatment T_5 that received one per cent foliar spray of Ca $(NO_3)_2$ recorded the lowest (21.63%) flower drop percentage and differed significantly from other treatment before spray. It may due to foliar application of calcium in the form of Ca $(NO_3)_2$ were as highest value (39.26%) was recorded in treatment T_{12} that received water spray, followed by treatment T_{11} (34.78%). Those treatments which did not received foliar spray of $Ca(NO_3)_2$ at peak flowering stage lead to weaker pedicel due to absence of calcium that resulted in flower dropping. After foliar spray treatment T_{10} that received three foliar spray of 1.5% $Ca(NO_3)_2$ recorded the minimum percentage of flower drop (10.02%) which was closely followed by treatments T_6 and T_7 which received two foliar spray of $Ca(NO_3)_2$. Minimum flower drop was recorded because of higher calcium supplied through foliar spray of Ca $(NO_3)_2$ and greater absorption of Ca by leaves through cuticle. As calcium is a constituent of the cell wall and it increased the stiffness of the pedicel.

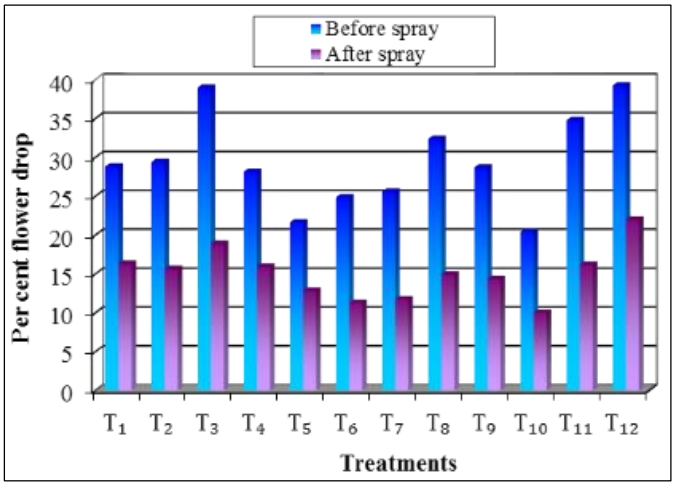

Fig 3: Effect of foliar spray of calcium nitrate on per cent flower drop in chilli (cv. Dyavnur) at 75 DAT

Yield

Dry fruit yield was significantly influenced by foliar spray of Ca $(NO_3)_2$, highest dry fruit yield (21.76 q ha^{-1}) recorded in the treatment T_{10} that received three foliar spray of 1.5 per cent Ca $(NO_3)_2$ which was closely followed by treatment T_6 (21.38 q ha^{-1}) and T_7 (19.38 q ha^{-1}) which received 1.5 per cent Ca $(NO_3)_2$ foliar spray at 45 and 60th DAT respectively and all other treatment were on psr with each other. Lowest dry fruit yield (12.76 q ha^{-1}) recorded in the treatment T_{12} which received water spray which was on par with treatment T_{11} that received 50 ppm NAA foliar spray (14.48 q ha^{-1}). Highest yield was obtained mainly because of increased absorption of calcium and nitrogen by plant canopy supplied through foliar spray of Ca $(NO_3)_2$. This lead to enhanced fruit yield by enhancing cell division and providing strength to the terminal axes which that led to increase flowering and fruiting synergized by Ca present in Ca $(NO_3)_2$ which has resulted in increased fruit yield. Similar results were observed by Kolay, 2000 [2] and Halina *et al*., 2016.

Table 3: Effect of foliar spray of calcium nitrate on yield parameters and dry fruit yield in chilli (Cv. Dyavnur)

Treatments	Fruit yield (q ha^{-1})
T_1 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 DAT	16.49
T_2 - 1.0% $Ca(NO_3)_2$ foliar spray at 60 DAT	17.84
T_3 - 1.0% $Ca(NO_3)_2$ foliar spray at 75 DAT	16.66
T_4 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	16.93
T_5 - 1.0% $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75 DAT	18.66
T_6 - 1.5% $Ca(NO_3)_2$ foliar spray at 45 DAT	21.38
T_7 - 1.5% $Ca(NO_3)_2$ foliar spray at 60 DAT	19.38
T_8 - 1.5% $Ca(NO_3)_2$ foliar spray at 75 DAT	17.93
T_9 - 1.5% $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	18.57
T_{10} - 1.5% $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75DAT	21.76
T_{11} - 50 ppm NAA at peak flowering stage (60 DAT)	14.48
T_{12} - Control (water spray at 45, 60 and 75 DAT)	12.76
S.Em. ±	1.51
C.D. (0.05)	4.42

Conclusions

Flower dropping in chilli crop can be reduced by two or three foliar sprays of calcium nitrate at 1.5 per cent concentration on 60th and 75th days after transplanting. Three foliar sprays of 1.5 per cent Ca(NO3)2 one each at 45th, 60th and 75th day after transplanting significantly improved the yield, colour value and oleoresin content of Byadgi chilli over NAA foliar spray and control. Three foliar sprays of Ca (NO3)2 are more effective than one and two sprays. 1.5 per cent concentration is more superior in improving the yield and quality of Byadgi chillies over 1.0 per cent concentration.

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