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Effect of calcium nitrate foliar application on quality and yield of Byadgi Chilli

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Abstract
A field experiment was conducted during *kharif* 2016 in the farmer's field at Agadi village (Tq: Hubbli) in Dharwad district, Karnataka to study the effect of calcium nitrate foliar spray on quality and yield of Byadgi chilli. Quality attributes of chilli fruits revealed that, treatment which received 3 foliar sprays of $Ca(NO_3)_2$ at 1.5 per cent recorded significantly highest colour value (280.22 ASTA units) closely followed by treatment that received three foliar spray of $Ca(NO_3)_2$ at 1.0 per cent (274.66 ASTA units) and treatment with two sprays of $Ca(NO_3)_2$ at 1.5 per cent (272.74 ASTA units) and highest oleoresin content (20.39 %) with three sprays of 1.5 per cent $Ca(NO_3)_2$ which was on par with treatments T_8 (19.16 %) and T_3 (16.98 %) that received 1.5 and 1.0 per cent foliar spray of $Ca(NO_3)_2$ on 75th DAT respectively but differed significantly from all other treatments. Highest dry fruit yield (21.76 q ha^{-1}) was observed due to three foliar sprays of $Ca(NO_3)_2$ at 1.5 per cent and differed significantly from all other treatments. Control which did not receive foliar spray of calcium nitrate recorded lowest quality parameters and yield (12.76 q ha^{-1}).

Keywords: *Calcium nitrate*, chilli, quality, yield

Introduction
Chilli is considered as one of the most important commercial spice cum vegetable crops and is widely used as universal spice. Chilli is a long duration and indeterminate crop requires higher amounts of nutrients at grand growth (60 DAT) and fruit development (90 DAT) stages. Flower and fruit dropping is a major problem in chilli crop and it is terminal in bearing habit. Calcium is responsible for stiffness and strength of stem, branches, petioles, pedicels etc. Calcium gives strength to the stalk or pedicel of the flower. Shortage of calcium results in distortion of terminal buds leading to flower dropping. Calcium is highly immobile in the plant and to meet the immediate and timely requirement of calcium particularly at flowering and fruiting stage, foliar spray of calcium nitrate [$Ca(NO_3)_2$], a speciality fertilizer is a good option. It contains 18.8 per cent Ca and 15.5 per cent N and water soluble. But studies on the concentration, time and frequency of foliar application of calcium nitrate are limited. Hence the present study is undertaken to study the effect of foliar spray of $Ca(NO_3)_2$ on quality and yield of Byadgi chillies.

Materials and methods
A field experiment was conducted in the farmer's field at Agadi village in Dharwad district, during *kharif*, 2016 on a Vertisol. 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 6.90g 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. The experiment was laid out in randomized complete block design with twelve treatments and three replications. Treatments include 1.0 and 1.5 per cent concentration of calcium nitrate sprayed on 45, 60 and 75th day after transplanting in combination. 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. The fertilizers were applied in ring method and mixed with soil. The concentrations of calcium nitrate foliar solutions were fixed based on their pH value in water. One and 1.5 per cent solutions of calcium nitrate had pH of 7.29 and 6.93 respectively, while still higher concentrations recorded marked acidic values. Hence, to avoid adverse effect of acidic pH on plants, 1.0 and 1.5 per cent were chosen.

Results and discussion

Quality parameters

Significant difference existed between treatments with respect to colour value of red chilli fruits (Table-1). The highest colour value (280.22 ASTA units) was noticed in the treatment (T_{10}) that received three foliar applications of 1.5 per cent $Ca(NO_3)_2$ closely followed by treatment (T_5) that received three foliar applications of one per cent $Ca(NO_3)_2$ (274.66 ASTA units) and T_9 (272.74 ASTA units) that received two foliar applications of 1.5 per cent $Ca(NO_3)_2$. These three treatments were on par with each other, but differed significantly from rest of the treatments. This might be due to Foliar applied calcium and nitrogen through $Ca(NO_3)_2$ were directly absorbed by the developing fruits, these Ca and N participate in the synthesis of capsanthin and capsorubins the vital constituents of red colour components in chillies. Similar observations were also made by Tandon *et al.* (1964) [8] and Kolay (2000) [4].

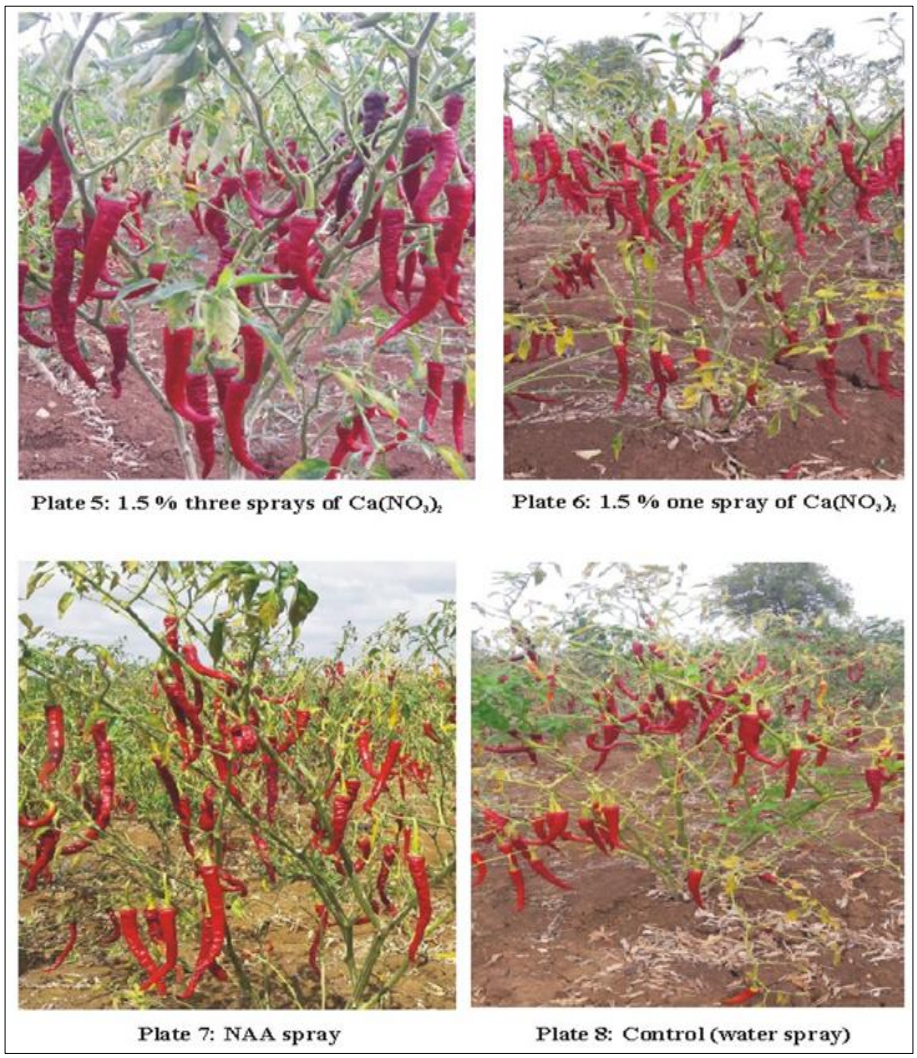

Fig 1: Effect of calcium nitrate [$Ca(NO_3)_2$] foliar application on chilli fruits at maturity stage

Highest colour value of fruits in this treatment was also due to increased uptake of potassium from the soil reported by Somimol (2012) [7] and Veerendra Patel (2014) [9]. Neelgar (2012) [5] reported enhanced color value of chilli fruits due to foliar spray of 10:26:26 water soluble fertilizer along with 0.5 per cent biomass. Lastly, control recorded lowest colour value (140.20 ASTA units) which might be due to inadequate supply of Ca and N to chilli plants. Further, there might be some dilution effect due to water spray leading to lower concentration of Ca and N in the fruits. Further, three water sprays might have caused some imbalance between Ca and K as well as between N and P, this might has resulted in decreased colour value of chilli 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

DAT - Days after transplanting

RDF - 100:50:50 N, P_2O_5 and K_2O kg ha $^{-1}$ + FYM (25 t ha $^{-1}$) is common for all the treatments

With respect to oleoresin content data presented in Table-1 highlighted that, treatment (T_{10}) that received three sprays of 1.5 per cent $Ca(NO_3)_2$ recorded highest oleoresin content (20.39 %) which was on par with treatments T_8 (19.16 %) and T_3 (16.98 %) that received 1.5 and 1.0 per cent foliar spray of $Ca(NO_3)_2$ on 75th DAT respectively but differed significantly from all other treatments. But treatment (T_{11}) that received 50 ppm NAA foliar spray at 60th DAT recorded oleoresin content of 12.85 per cent which was on par with treatments T_1 (13.01) and T_2 (13.11). High oleoresin content may be due to foliar spray of both calcium and nitrogen supplied through $Ca(NO_3)_2$ might have increased seed size as well as seed number in chilli seeds. This has resulted in increased oleoresin content in chilli fruits. High oleoresin content in treatments receiving higher concentration (1.5 %) and higher number of foliar sprays three (45 + 60 + 75 DAT) and two (45 + 60 DAT) of $Ca(NO_3)_2$ was attributed 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 results were observed by Veerendra Patel (2014) [9] and Hariadh Babu *et al*. (2010) [3]. Control (T_{12}) that received water spray recorded lowest (11.60 %) content which was on par with treatment T_7 that received 1.5 per cent $Ca(NO_3)_2$ spray at 60th DAT (12.78 %) but differed significantly from rest of the treatments. This is obvious because of absence of $Ca(NO_3)_2$ foliar spray that resulted in lower seed content in fruits.

Yield

Data presented in Table-2 showed that, dry fruit yield was significantly influenced by foliar spray of $Ca(NO_3)_2$. Foliar application of 1.5 per cent $Ca(NO_3)_2$ at 45th, 60th and 75th DAT (T_{10}) recorded highest fruit yield (21.76 q ha^{-1}) closely followed by treatment (T_6) that received one spray of $Ca(NO_3)_2$ 1.5 per cent on 45th DAT (21.38 q ha^{-1}) and treatment (T_7) that received 1.5 per cent foliar spray at 60th DAT (19.38 q ha^{-1}). All the three treatments were on par with each other. Further, treatments that received 1.5 per cent foliar spray recorded numerically higher fruit yield than treatments that received 1.0 per cent foliar spray. Lastly control (T_{12}) that received water spray recorded lowest dry fruit yield (12.76 q ha^{-1}) which was on par with treatment T_{11} that received 50 ppm NAA foliar spray at 60th DAT (14.48 q ha^{-1}). Foliar spray of $Ca(NO_3)_2$ resulted in increased absorption of Ca and NO_3-N by plant canopy, this NO_3-N might have enhanced fruit yield by enhancing cell division, that led to increased flowering and fruiting synergized by Ca present in $Ca(NO_3)_2$ (Das, 2007) [1] and also due to timely and spot availability of calcium and nitrogen in readily available forms to the chilli plants which resulted in better absorption of nutrients by plant leaves leading to more flowers and fruits. Similar observations on increased fruit yield in chilli crop due to foliar spray of mono potassium phosphate and KNO_3 were

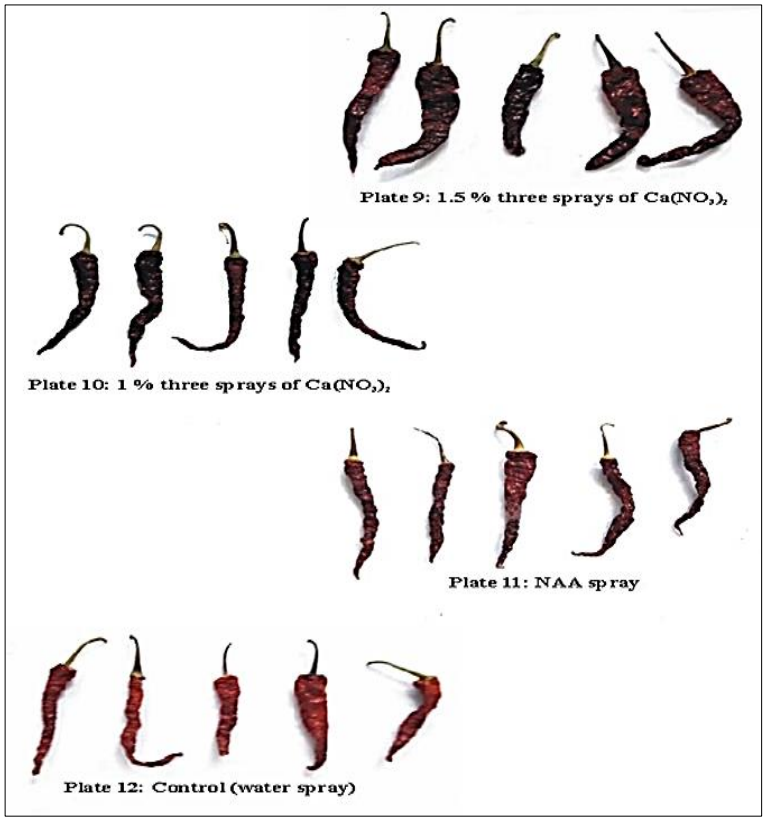

Fig 2: Effect of calcium nitrate [$Ca(NO_3)_2$] foliar application on chilli dry fruits

Reported by Veerendra Patel (2014) [9] and Somimol (2012) [7]. The results of the present investigation are in accordance with the findings of Sarkar *et al.* (1999) [6] and Chaity and Sarkar (2009) [2]. Control recorded lowest yield and yield attributes, because this treatment received only water spray along with basal dose of NPK. Water spray given in this treatment has made the plants more succulent and their might be dilution effect of Ca and N in plant, which has lead to more flower dropping causing reduced yield. Neelgar *et al.* (2012) [5] reported that, water spray has reduced flowering leading to reduced yield in chilli.

Table 2: Effect of foliar spray of calcium nitrate on yield parameters and dry fruit yield in chilli (cv. Dyavnur)

Treatments	No. of fruits/plant/picking	100 fruit weight (g)	Fruit yield (q ha^{-1})
T_1 - 1.0 % $Ca(NO_3)_2$ foliar spray at 45 DAT	29.33	230.00	16.49
T_2 - 1.0 % $Ca(NO_3)_2$ foliar spray at 60 DAT	31.28	235.05	17.84
T_3 - 1.0 % $Ca(NO_3)_2$ foliar spray at 75 DAT	29.73	231.33	16.66
T_4 - 1.0 % $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	30.85	233.82	16.93
T_5 - 1.0 % $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75 DAT	38.96	252.38	18.66
T_6 - 1.5 % $Ca(NO_3)_2$ foliar spray at 45 DAT	40.09	257.66	21.38
T_7 - 1.5 % $Ca(NO_3)_2$ foliar spray at 60 DAT	39.57	256.67	19.38
T_8 - 1.5 % $Ca(NO_3)_2$ foliar spray at 75 DAT	30.85	237.33	17.93
T_9 - 1.5 % $Ca(NO_3)_2$ foliar spray at 45 + 60 DAT	35.61	231.33	18.57
T_{10} - 1.5 % $Ca(NO_3)_2$ foliar spray at 45 + 60 + 75DAT	41.59	263.67	21.76
T_{11} - 50 ppm NAA at peak flowering stage (60 DAT)	26.16	226.67	14.48
T_{12} - Control (water spray at 45, 60 and 75 DAT)	19.29	224.33	12.76
S.Em. ±	2.64	2.15	1.51
C.D. (0.05)	7.76	6.31	4.42

DAT - Days after transplanting
RDF - 100:50:50 N, P_2O_5 and K_2O kg ha^{-1} + FYM (25 t ha^{-1}) is common for all the treatments

Conclusion

Three foliar applications of 1.5 per cent $Ca(NO_3)_2$ recorded significantly highest colour value closely followed by three sprays of $Ca(NO_3)_2$ at one per cent and two sprays of $Ca(NO_3)_2$ at 1.5 per cent. Irrespective of the concentrations, foliar spray of $Ca(NO_3)_2$ recorded higher value compared to control. Three foliar sprays of 1.5 per cent $Ca(NO_3)_2$ produced highest oleoresin content (20.39 %) which was on par with one foliar spray of $Ca(NO_3)_2$ at 1.5 per cent and 1.0 per cent on 75 DAT. Foliar application of NAA on 60 DAT and control with water spray recorded lower oleoresin content. Three foliar applications of 1.5 per cent $Ca(NO_3)_2$ recorded highest fruit yield (21.76 q ha^{-1}) closely followed by one and two foliar spray of $Ca(NO_3)_2$ at same concentration, while control recorded the lowest fruit yield.

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