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EFFECT OF FOLIAR APPLICATION OF CALCIUM NITRATE AND BORIC ACID ON QUALITY ATTRIBUTES OF STRAWBERRY

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ABSTRACT

The present experiment entitled "Effect of Foliar Application of Calcium Nitrate and Boric Acid on Quality attributes of strawberry *(Fragaria x ananassa* Duch.) cv. Camarosa" was carried out at the New Nursery, Adhartal, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh). The experiment was laid out in Randomized Block Design with ten treatments and three replications along with one control. The results revealed significant improvements in quality parameters of strawberry fruits due to foliar application of calcium nitrate and boric acid. Among the treatments, the maximum TSS (8.5 °Brix), minimum acidity percentage (0.76%) maximum total sugars (7.72%), non-reducing sugars (4.73%) reducing sugar (2.99%) and ascorbic acid content (37.63 mg/100g) was recorded in treatment T_9 (RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT). The study concluded that foliar application of boric acid (0.4%) and calcium nitrate (0.4%) in combination with RDF significantly enhanced the qualitative attributes of strawberry cv. Camarosa and can be recommended for improving fruit quality under the agro-climatic conditions of Jabalpur.

Keywords **:** Strawberry, Foliar spray, Ca $(NO_3)_2$, H_3BO_3, Quality attributes

Introduction

Strawberry (*Fragaria* × *ananassa* Duch.), belonging to the family Rosaceae originated from the hybridization of two American species *viz*., *Fragaria chiloensis* Duch. and *Fragaria virginiana* Duch. It is a perennial, herbaceous and diminutive plant. It has been suggested that 100 gm of strawberry contains approximately 60 mg of ascorbic acid, 150 mg of potassium, 15 mg of calcium, and 100 mg of phenolic compounds such as proanthocyanidins and anthocyanins (Qureshi *et al*., 2023). Strawberry is a temperate fruit crop but can be successfully cultivated in sub-tropical and tropical areas of the world. It requires an optimum day temperature of 22°C to 23°C and a night temperature of 7°C to 13°C for maximum growth and development. It is a short-day plant, as it needs a photoperiod of 8 to 12 hours for around 10 days. Temperature is the main influencing (Kumar *et al*., 2025) factor on strawberry quality as opposed to light or relative humidity, with larger temperature differences between the day and night periods increasing total soluble solids in the harvested fruit.

Strawberry is one of the most sensitive fruit crops to nutrient management and the optimum supply of both macro- and micronutrients can improve both yield and quality. Apart from macronutrients, micronutrients are actively involved in plant metabolic processes like photosynthesis, synthesis of chlorophyll and numerous enzymatic activities (Parmar *et al*., 2021). Micronutrient foliar feeding has been showed to significantly improve plant growth, yield and fruit quality by minimizing nutrient losses and enhancing nutrient use efficiency.

Calcium nitrate participates in physiological functions such as nutrient absorption, optimum plant

cell elongation and cell wall formation. The application of calcium to fruits both prior to and after harvesting provides protection against physiological deterioration, retardation of maturity and improvement of fruit quality (Irfan *et al.,* 2013). Due to calcium compounds have been reported to extend the shelf life of many fruits by maintaining their firmness and minimizing respiration rate proteolysis, disease incidence and tissue break down and thus reducing the percent loss in weight. Boron requirements have also been reported to be greater in reproductive than in vegetative structures, as it is involved in several processes such as flowering, pollen tube growth, and fruit ripening. It is essential for cell-wall and protein synthesis, sugar transport, cell division and differentiation, membrane functioning, root elongation, regulation of plant hormone levels, and generative growth of plants (Esringu *et al.,* 2011). In strawberry, the application of boron reduced abnormal fruit development, increased fruit weight and yield and reduced leaf.

Considering the importance of calcium and boron in improving fruit quality characteristics of strawberry, the present investigation was undertaken to evaluate the effect of foliar application of calcium nitrate and boric acid on quality attributes of strawberry cv. Camarosa.

Material and Methods

The present experiment was conducted during the winter season of 2024–2025 at the New Nursery, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya. All the necessary facilities required for cultivation and maintenance of the crop were provided by the department.

Tissue-cultured strawberry plants cv. Camarosa were transplanted in holes made on polythene mulch at a spacing of 60 cm × 30 cm. Fertilizers were applied through soil as recommended dose of fertilizers (RDF: NPK @ 80:40:40 kg ha^{-1}) along with foliar application treatments. Water-soluble micronutrients, namely calcium nitrate and boric acid, were used as foliar sprays according to the treatment combinations. Foliar application was initiated at 45 days after transplanting (DAT) and repeated at 15-day intervals up to 75 DAT. Quality parameters were assessed from five randomly selected fruits collected from each treatment in every replication. The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments with three replications.

Quality parameters such as total soluble solids (TSS), titratable acidity, ascorbic acid, reducing sugars, total sugars and non-reducing sugars were analysed using standard procedures. TSS was measured with a hand refractometer and expressed as °Brix. Titratable acidity and ascorbic acid were estimated following the methods described by Ranganna (1986). Reducing sugars and total sugars were determined by the Lane and Eynon (1923) method as modified by Ranganna (1986), while non-reducing sugars were calculated by subtracting reducing sugars from total sugars.

Table 1 : Details of treatments imposed in strawberry cv. Camarosa

Treatments details	
T_1	Control - 100% RDF (NPK- 80:40:40 kg N, P_2O_5 & K_2O ha^{-1})
T_2	RDF + Boric Acid (0.2%) Foliar Spray at 45,60,75 DAT
T_3	RDF + Boric Acid (0.4%) Foliar Spray at 45,60,75 DAT
T_4	RDF + Boric Acid (0.6%) Foliar Spray at 45,60,75 DAT
T_5	RDF + Calcium Nitrate (0.2%) Foliar Spray at 45,60,75 DAT
T_6	RDF + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT
T_7	RDF + Calcium Nitrate (0.6%) Foliar Spray at 45,60,75 DAT
T_8	RDF + Boric Acid (0.2%) + Calcium Nitrate (0.2%) Foliar Spray at 45,60,75 DAT
T_9	RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT
T_{10}	RDF + Boric Acid (0.6%) + Calcium Nitrate (0.6%) Foliar Spray at 45,60,75 DAT

Results and Discussion

Data pertaining to TSS, Acidity and Ascorbic acid content was presented in Table 2. From the current study it was observed that calcium nitrate and boric acid through foliar application increases the fruit quality. The quality of strawberry fruit under various treatments was significantly improved by applying RDF to the soil at the time of transplanting and by applying foliar spray calcium nitrate and boric acid at 45, 60, and 75 DAT. Records of the impact of calcium nitrate and boric acid treatment on strawberries total soluble solids revealed that the highest TSS (8.5 ºBrix) was recorded with RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) foliar spray at 45,60,75 DAT (T_9). Application of calcium and boron channelled translocation and accumulation of photosynthates and soluble solids into the fruits thereby increase in the total soluble solids. Present results regarding TSS are in accordance with the findings, in guava Mandal *et al.* (2012). These results are collaborated with the findings of Asrey *et al*. (2004) in strawberries and Raese and Drake (1993) in apple as such higher TSS and sugar concentrations may be attributed to a reduction in respiration due to Ca applications, leading to less utilization of sugars in various metabolic processes.

Higher TSS induced by chemical treatments viz. calcium and boron might be due to lesser utilization of sugars in metabolic processes as a result of reduced respiration. The reduced rate of respiration could also cause accumulation of organic acids which have oxidized at slower rate. Increase in TSS content with calcium sprays have been also reported by Raese and Drake (1993) in apple and pear.

Data pertaining to acidity percentage of strawberry as influenced by Calcium nitrate and Boric acid application showed significant differences. The minimum acidity percentage (0.76%) was recorded in T_9 with RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) foliar spray at 45,60,75 DAT. Interaction effect of calcium and boron lower acidity in fruits may be ascribed to the higher accumulation of sugars, better translocation of sugars into fruit tissues and conversion of organic acid into sugars. Present results were in accordance with results of Beniwal *et al.* (1992).

Ascorbic acid content was significantly influenced by Calcium nitrate and boric acid application. Maximum ascorbic acid content (37.63 mg/100g) was recorded in T_9 [RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) foliar spray at 45,60,75 DAT]. The results on ascorbic acid were in close conformity with the findings in guava who reported higher ascorbic acid content in strawberry with the application of calcium and boron in combination. Present results were in close proximity with the findings of Raina *et al.* (1990) in peach, Langthasa and Bhattacharya, (1991) in lemon. Increased ascorbic acid in guava fruit might have been due to higher synthesis of organic acids, on account of maximum availability of plant metabolism.

Table 2 : Effect of Foliar application of Calcium Nitrate and Boric Acid on TSS (°Brix), Acidity (%) and Ascorbic Acid (mg/100g) of strawberry.

S. No.	Treatments	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100g)
T_1	Control - 100% RDF (NPK- 80:40:40 kg N, P_2O_5 & K_2O ha^{-1})	7.41	0.94	30.93
T_2	RDF + Boric Acid (0.2%) Foliar Spray at 45,60,75 DAT	7.42	0.90	31.20
T_3	RDF + Boric Acid (0.4%) Foliar Spray at 45,60,75 DAT	7.62	0.85	33.26
T_4	RDF + Boric Acid (0.6%) Foliar Spray at 45,60,75 DAT	7.47	0.88	32.07
T_5	RDF + Calcium Nitrate (0.2%) Foliar Spray at 45,60,75 DAT	7.57	0.92	31.90
T_6	RDF + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT	7.86	0.87	33.60
T_7	RDF + Calcium Nitrate (0.6%) Foliar Spray at 45,60,75 DAT	7.60	0.93	32.50
T_8	RDF + Boric Acid (0.2%) + Calcium Nitrate (0.2%) Foliar Spray at 45,60,75 DAT	7.72	0.82	34.77
T_9	RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT	8.53	0.76	37.63
T_{10}	RDF + Boric Acid (0.6%) + Calcium Nitrate (0.6%) Foliar Spray at 45,60,75 DAT	7.85	0.79	35.10
	SEm (±)	0.21	0.02	1.36
	C.D. @ 5%	0.69	0.08	4.36

The maximum total sugars (7.72%), non-reducing sugars (4.73%) and reducing sugar (2.99%) was recorded in T_9 [RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) foliar spray at 45,60,75 DAT] as evident from Table 3. The possible reason for interaction effect of foliar application of calcium and boron for increase in total sugar content might be due to hydrolysis of starch yielding mono and disaccharide, which owned a simplest form of sugar and it could be one of the important reasons for the increase in total sugar content of fruits. The present results regarding increase in total sugar content of fruits are in accordance with the findings of Heshi *et al.* (2001) in pomegranate, Dutta (2004) in guava, Gill *et al. (*2012) in pear and Dar *et al.* (2012) in pear.

The possible reason for increase in non-reducing sugar content of fruits with the application of nutrients might be due to hydrolysis of polysaccharides to simpler from *i.e.,* mono and disaccharides and better transportation of nutrients to plant important role in the transport of assimilates and nutrients to the plant from leaves to their place of utilization, which helps to increase availability of nutrition and conclusively better quality evolution in term of nonreducing sugar content of fruits. These results colloborate the earlier records by Kaur and Dhillon (2006) in guava, and Bhat *et al.* (2009) in pear.

The present results regarding effect of boron and calcium on reducing sugar were in agreement with the finding of Bhatt *et al.* (2012). proposed that boric acid was bound to hydroxyl-rich organic molecules like sugars.

Table 3 : Effect of Foliar application of Calcium Nitrate and Boric Acid on Total Sugar (%), Reducing Sugar (%) and Non-Reducing Sugar (%) and of Strawberry

S. No.	Treatments	Total Sugar (%)	Non- Reducing Sugar (%)	Reducing Sugar (%)
T_1	Control - 100% RDF (NPK- 80:40:40 kg N, P_2O_5 & K_2O ha^{-1})	5.36	2.98	2.39
T_2	RDF + Boric Acid (0.2%) Foliar Spray at 45,60,75 DAT	6.29	3.57	2.72
T_3	RDF + Boric Acid (0.4%) Foliar Spray at 45,60,75 DAT	6.44	3.64	2.80
T_4	RDF + Boric Acid (0.6%) Foliar Spray at 45,60,75 DAT	6.30	3.57	2.73
T_5	RDF + Calcium Nitrate (0.2%) Foliar Spray at 45,60,75 DAT	5.93	3.35	2.58
T_6	RDF + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT	6.27	3.56	2.71
T_7	RDF + Calcium Nitrate (0.6%) Foliar Spray at 45,60,75 DAT	6.09	3.47	2.62
T_8	RDF + Boric Acid (0.2%) + Calcium Nitrate (0.2%) Foliar Spray at 45,60,75 DAT	6.79	3.87	2.92
T_9	RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) Foliar Spray at 45,60,75 DAT	7.72	4.73	2.99
T_{10}	RDF + Boric Acid (0.6%) + Calcium Nitrate (0.6%) Foliar Spray at 45,60,75 DAT	6.98	4.15	2.83
	SEm (±)	0.25	0.19	0.08
	C.D. @ 5%	0.80	0.59	0.25

Conclusion

Based on the findings of the present investigation, it can be concluded that foliar application of calcium nitrate and boric acid significantly improved the quality attributes of strawberry cv. Camarosa. Among the different treatments, T_9 [RDF + Boric Acid (0.4%) + Calcium Nitrate (0.4%) foliar spray at 45, 60 and 75 DAT] proved to be the most effective treatment by recording maximum total soluble solids, ascorbic acid, total sugars, reducing sugars and non-reducing sugars along with minimum acidity percentage. The improvement in fruit quality may be attributed to enhanced translocation and accumulation of sugars, reduced respiration rate and better physiological activity due to combined application of calcium and boron. Therefore, foliar application of boric acid (0.4%) and calcium nitrate (0.4%) along with recommended dose of fertilizers can be recommended for improving the quality of strawberry under the agro-climatic conditions of Jabalpur, Madhya Pradesh.

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