

## Influence of Foliar Application of $\text{KNO}_3$ on Fruit Pericarp Color Development and Yield of Litchi cv Dehradun

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**Abstract** The present investigation was carried on thirty five years old uniformly grown Dehradun litchi plants established at MS Randhawa FRS, Gangian (Hoshiarpur), Punjab, during the year 2015-16. They were sprayed with  $\text{KNO}_3$  @ 1.0, 1.5 and 2% at three different stages i.e. single spray 10 days after fruit set (DAFS) ; double spray after 10 and 20 DAFS and triple spray after 10, 20 and 30 DAFS and the control (water spray). The plants treated with K as foliar feeding significantly improved fruit size, aril/stone ratio, fruit pericarp color and marketable fruit yield over the control. Increment in fruit yield to the tune of 13.9% was recorded in trees treated with double spray of  $\text{KNO}_3$  1% over the control. Fruit size and fruit retention were also improved with different doses of K as foliar feeding. Fruit color coordinates estimated in terms of 'L' value was recorded the highest with one spray of  $\text{KNO}_3$  1.5% and 'a' value also increased with the increase in dose of  $\text{KNO}_3$  from 1 to 2% as well as single spray of  $\text{KNO}_3$  1.5%, however, 'b' color value was noted maximum with three sprays of  $\text{KNO}_3$  1%. Fruit pericarp color was also estimated in terms of hue angle and chroma as well as pericarp anthocyanin content was also calculated. From the present

studies, it is concluded that single foliar spray of  $\text{KNO}_3$  1% after 10 DAFS considerably improved fruit size, pericarp color, pulp/stone ratio, fruit retention and thereby fruit yield in litchi cv Dehradun.

**Keywords** Litchi, Potassium, Pericarp color, Yield.

### Introduction

Litchi (*Litchi chinensis* Sonn.) is an important ever-green subtropical non climacteric fruit crop (family Sapindaceae) of India. Litchi crop is widely distributed in the tropics and warm subtropics of the world. It has high commercial value in the international trade market. The fruits produced are indeed highly perishable due to rapid loss of bright red pericarp color and browning occurs generally within 1-2 days after harvest, however, the quality of edible portion (aril) remains lesser affected.

It is cultivated on 1988 ha with annual production of 26520 MT and productivity 15.1 Mt/ha in Punjab state [1] and approximately 90.3% of the total area cultivation is mainly situated in sub mountane districts. It is postulated that 10 MT litchi fruits annually remove nearly 67 kgN, 16 kg  $\text{P}_2\text{O}_5$  and 73 kg  $\text{K}_2\text{O}$  from the soil.

Yang et al. [2] in his work reported that fruit-strengthening potassium fertilizer (40% appropriately) should also be applied during the fruit enlargement

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period to promote litchi fruit expansion and to improve *Feizixiao* litchi yield and quality. Increase in fruit size with the application of K is due to increase in entry of water into the cells by osmotic processes which subsequently increase cell size [3]. Potassium also affects the process of phosphorylation, transportation of photo assimilates from source tissues via the phloem to sink tissues, enzyme activation, turgor maintenance, transpiration, photosynthesis, stress tolerance [4]. The relationship between the leaf nutrients and fruit quality attributes showed positive relationship between leaf K and the anthocyanin content [5]. Yadav et al. [6] reported that foliar application of  $\text{KNO}_3$  and other potassium salts (1, 2%) in Banarasi and Karaka ber cultivars improved fruit retention, fruit size, pulp/stone ratio.

The objective of the present investigations was to study the effect of different spray timings and  $\text{KNO}_3$  (15:0:45) concentrations as foliar feeding in Dehradun litchi cultivars, adequate information on foliar applications of nutrients as supplement to soil application on fruit sensory parameters and yield in different litchi cultivars is lacking under Punjab conditions.

## Materials and Methods

The present studies were carried out on 35 years old fully mature and healthy plants of litchi cultivar Dehradun planted at 9.0 m × 9.0 m. The uniform cultural practices were given to all the trees as per recommendation of Package Practices for Fruit Crops Punjab Agricultural University [7]. The experimental site was situated in the sub-mountain zone of Punjab (India) between latitude of 31°N and longitude of 75°E at an elevation of 248.9 m above the mean sea level. This region receives annual rainfall nearly 600-800 mm, where 75% of the total rainfall is received during months of July to September and 15% in the winter months from December to February.

### Experimental design and treatments

The experiment was layout by factorial randomized block design (FRBD) and trees were sprayed (in addition to soil application of recommended doses of fertilizers) with different concentrations of  $\text{KNO}_3$  (15:0:45)

i.e. 1.0%, 1.5%, 2.0% and the control at three different sub treatments (stages) i.e. 10 days after fruit set (single spray), 10 and 20 days after fruit set (double spray) and 10, 20 and 30 days after fruit set (triple spray). Each treatment was replicated three times and total number of plants was thirty six. In litchi cultivar Dehradun, fruit set was observed on 25<sup>th</sup> April, 2015 and subsequently trees were sprayed at the ten days interval from fruit set depending on the basis of respective treatment. The plants were sprayed with foot sprayer during early morning hours after dissolving calculated dose of respective treatment in 75 lt of water and Tween 20 (0.01%) sticker was used as a spreader.

### Physical dimensions

The length (mm) and diameter (mm) of ten fruits picked randomly from each replication was measured with the help of digital Vernier's Callipers and average was calculated.

### Proportion of fruit components

The pericarp, aril and stone of sample fruits were separated manually and weighed. The aril/stone ratio was estimated by the average contribution of aril and stone in each sample.

### Color measurement

Color of the whole litchi fruit was measured by a Hunterlab Colorimeter, DP-9000 standard model (Hunterlab Associates Laboratory, Inc., Reston, VA). The 'L' scale ranges from no reflection, i.e., black (L=0) to perfect diffuse reflection, i.e., white (L=100). The 'a' scale ranges from negative values for green to positive values for red and the 'b' scale ranges from negative values for blue to positive values for yellow. Hunter color parameters (L, a, b) at four arbitrary positions on the circumference of the litchi fruit were recorded. The average of these color parameters were reported.

### Anthocyanin of pericarp

The total anthocyanin content was calculated as follows:

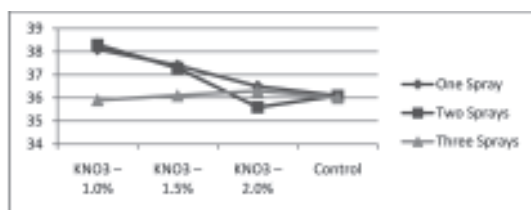


Fig.1 Effect of foliar application of KNO<sub>3</sub> on fruit length (mm) in litchi cv. Dehradun

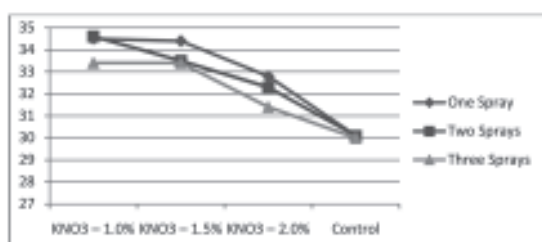


Fig.2 Effect of foliar application of KNO<sub>3</sub> on fruit diameter (mm) in litchi cv. Dehradun

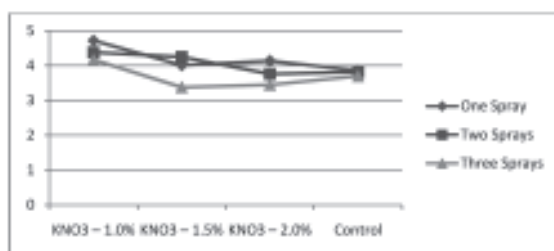


Fig. 3 Effect of foliar application of KNO<sub>3</sub> on fruit aril/stone ratio in litchi cv. Dehradun

**Fig. 1.** Effect of foliar application of KNO<sub>3</sub> on fruit length (mm) in litchi cv Dehradun. **Fig. 2.** Effect of foliar application of KNO<sub>3</sub> on fruit diameter (mm) in litchi cv Dehradun. **Fig. 3.** Effect of foliar application of KNO<sub>3</sub> on fruit aril/stone ratio in litchi cv Dehradun.

$$\text{Total absorbance for the sample per 100 ml} = \frac{e \times b \times c}{d \times a} \times 100$$

Where, a=Volume of sample, b=Volume made up of the extract used for color measurement, c=Total volume, d=ml of the extract used, e=Specific O.D Value at 535 nm wave length.

1 mg/ml of solution is equivalent to the absorbance of 98.2. Therefore,

$$\text{Total anthocyanin (mg/100 ml)} = \frac{\text{Total absorbance for the sample}}{98.2}$$

## Results and Discussion

### Fruit length and diameter

The effect of different concentrations and number of sprays of potassium applied in the form of KNO<sub>3</sub> considerably improved fruit size as compared to the control. Figure 1 depicts maximum fruit length (37.4 mm) was achieved with the spray of KNO<sub>3</sub> 1% and minimum (36.1 mm) in the control. The effect of numbers of sprays was higher (37.0 mm) with one spray of KNO<sub>3</sub> which was statistically significant than other treatments i.e. fruits from trees sprayed twice and thrice. The interaction effect of number of sprays and different KNO<sub>3</sub> concentrations on fruit length was

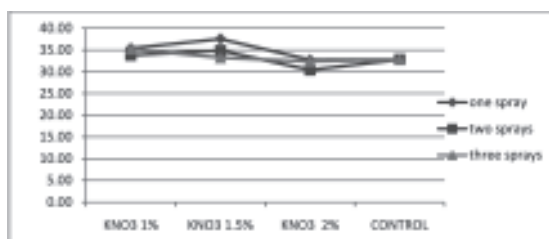


Fig.4 Effect of foliar application of KNO<sub>3</sub> on 'L' coordinate in litchi cv. Dehradun

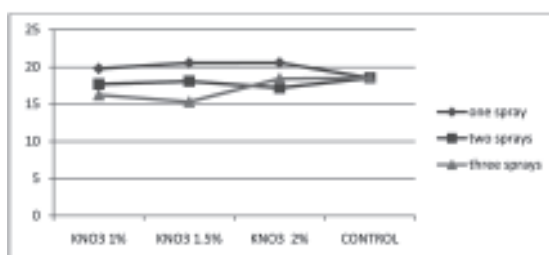


Fig.5 Effect of foliar application of KNO<sub>3</sub> on 'a' coordinate in litchi cv. Dehradun

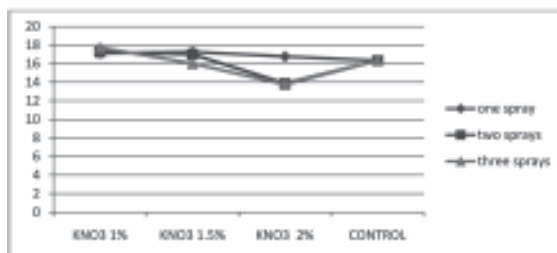


Fig.6 Effect of foliar application of KNO<sub>3</sub> on 'b' coordinate in litchi cv. Dehradun

**Fig. 4.** Effect of foliar application of KNO<sub>3</sub> on 'L' coordinate in litchi cv Dehradun. **Fig. 5.** Effect of foliar application of KNO<sub>3</sub> on 'a' coordinate in litchi cv Dehradun. **Fig. 6.** Effect of foliar application of KNO<sub>3</sub> on 'b' coordinate in litchi cv Dehradun.

significantly the highest (38.3 mm) when 1% KNO<sub>3</sub> was applied twice at the interval of 10 and 20 days after fruit set (DAFS) as compared to other treatments and the control. Mean while, (Fig. 2) the higher average diameter (34.2 mm) of Dehradun litchi fruits was recorded with KNO<sub>3</sub> 1% while minimum (30.1 mm) in the control. Number of KNO<sub>3</sub> sprays in litchi cv Dehradun also improved the fruit diameter and values were 33.0 mm, 32.5 mm and 32.1 mm with one, two and three sprays, respectively. However, the interaction effect between number of sprays and different KNO<sub>3</sub> concentrations on fruit diameter was statistically non significant. An increase in fruit length and

diameter was noted with the application of K on Red delicious apples [8].

#### Pulp/stone ratio

The perusal of data depicted in Figure 3 shows that the effect of foliar application of KNO<sub>3</sub> on litchi pulp/stone ratio was significantly higher (4.43) with KNO<sub>3</sub> 1%. The effect of the number of sprays was recorded maximum with one spray (4.2) and minimum (3.7) with three sprays. Among the interactions, maximum pulp/stone ratio (4.72) was noted with KNO<sub>3</sub> @ 1% as single spray which was significant higher than other treat-

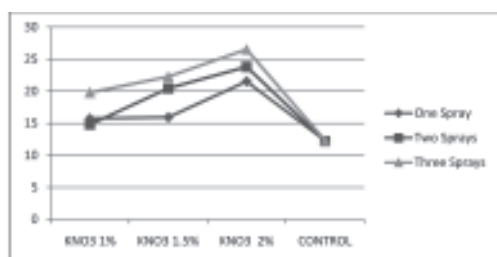


Fig.7 Effect of foliar application of KNO<sub>3</sub> on anthocyanin content in litchi cv. Dehradun

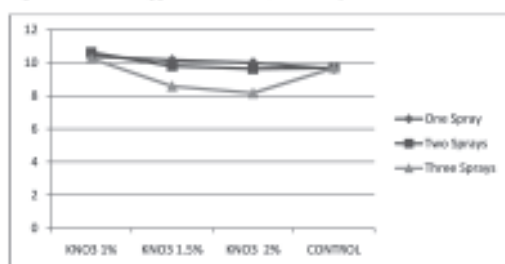


Fig.8 Effect of foliar application of KNO<sub>3</sub> on fruit retention in litchi cv. Dehradun

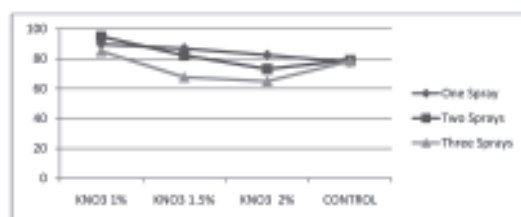


Fig. 9 Effect of foliar application of KNO<sub>3</sub> on fruit yield in litchi cv. Dehradun

**Fig. 7.** Effect of foliar application of KNO<sub>3</sub> on anthocyanin content in litchi cv Dehradun. **Fig. 8.** Effect of foliar application of KNO<sub>3</sub> on fruit retention in litchi cv Dehradun. **Fig. 9.** Effect of foliar application of KNO<sub>3</sub> on fruit yield in litchi cv Dehradun.

ments. The improvement in pulp/stone ratio with the sprays of different concentrations of KNO<sub>3</sub> is due to increase pulp weight which in turn increased the ratio.

#### Fruit color

Potassium nitrate also affected fruit pericarp color in litchi. As presented in Figure 4 the highest mean value of 'L' (35.1) was recorded in KNO<sub>3</sub> 1.5% followed by 34.5 in KNO<sub>3</sub> 1%, while the lowest in control. The effect of numbers of sprays on development of saturation lightness 'L' in fruit color was also significant and single spray of KNO<sub>3</sub> 1.5% had pronounced ef-

fect. Among the interaction, the effect was significantly higher with one spray of 1.5% than the other treatments and the control. Red pericarp color development in litchi fruit is indicated by 'a' coordinate (Fig. 5) and it was evident that the plants treated with KNO<sub>3</sub> 2% recorded significantly higher 'a' value (18.7) while lowest (14.1) was observed in the control. Among the number of sprays, one spray gave significantly highest mean 'a' value (18.8) over the other. Among the interaction, maximum value 'a' (20.73) was noted with combinations of single application of KNO<sub>3</sub> @ 1.5%. The 'b' value (Fig. 6) indicates the yellowness color of the fruit and the application of potassium nitrate had significantly affected the fruit color.

Maximum 'b' value (17.4) was recorded with KNO<sub>3</sub> 1% while, minimum 'b' value (15.1) was recorded with KNO<sub>3</sub> 2% as well as the control. The effect of number of sprays of KNO<sub>3</sub> was maximum with single spray (16.5). The effect of interactions was significantly higher with two sprays of KNO<sub>3</sub> 1%, however, it was at par with single spray of KNO<sub>3</sub> 1% (17.04) and three sprays of KNO<sub>3</sub> 1% (17.18). Lowest value was recorded in the fruits from trees sprayed with water in the control. The above findings are in confirmation with the literature as suggested by Yang et al. [9] that potassium fertilization improved fruit appearance, pigmentation index and 'L', 'a' and 'b' color coordinates of fruit tip and fruit body in Yanguang nectarines [9].

However, maximum anthocyanin content (Fig. 7) (23.95 mg) was observed in the pericarp of fruits from trees treated with KNO<sub>3</sub> @ 2% and minimum with control (water spray). The number of sprays also affected its content and maximum was observed with three sprays.

#### Fruit retention (%)

Figure 8 revealed that fruit retention percent in litchi (fruits/panicle) was affected with various KNO<sub>3</sub> treatments in litchi cv Dehradun. Significantly highest fruit retention percentage (10.42%) was observed with KNO<sub>3</sub> 1% (11.27%) and the lowest (9.27%) with KNO<sub>3</sub> 2%. The effect of number of sprays on fruit retention was also evident and significant increase (10.05%) was observed with one spray; however, effect of two sprays (9.94%) and three sprays (9.17%) of KNO<sub>3</sub> was lowest. The interactions effect among various treatments and number of sprays were also statistically significant and maximum fruit retention (%) was observed in trees treated with KNO<sub>3</sub> 1% when sprayed at an interval of 10 and 20 DAFS and minimum in three sprays of KNO<sub>3</sub> 2%. The results are in conformity with the available literature that foliar application of KNO<sub>3</sub> (1%) in Banarasi and Karaka ber cultivars improved fruit retention [6].

#### Fruit yield (kg/tree)

It is clear that (Fig. 9) foliar application of potassium nitrate influenced the fruit yield in litchi cv Dehradun

as compared to the control. It was evident from the observations that with an increase in the K dose, significant decrease in fruit yield was noted. The highest fruit yield (89.8 kg/tree) was obtained in trees sprayed with KNO<sub>3</sub> 1% followed by (78.8 kg/tree) in KNO<sub>3</sub> 1.5% and minimum (73.4 kg/tree) in KNO<sub>3</sub> 2% treatment. However, number of sprays also marked their effect on the yield of litchi fruits and trees sprayed once with KNO<sub>3</sub> produced maximum yield (84.1 kg/tree) followed by double spray (82.2 kg/tree) and minimum with three sprays (73.9 kg/tree). Among the interactions, maximum effect was noted with two sprays of KNO<sub>3</sub> 1%. The improvement in fruit yield was due to increase in yield related components like fruit size and fruit retention as evident.

The present findings also correlated with previous findings of Yang et al. [9] who reported that fruit yield and cost benefit ratio in litchi cv *Feizixiao* initially increased and then subsequently decreased with the increasing K<sub>2</sub>O/N ratio. The application of K (600 g plant<sup>-1</sup> year<sup>-1</sup>) in two equal splits i.e. after 15 days after fruit set and 15 days after harvest considerably increased fruit yield (91.84 kg plant<sup>-1</sup> year<sup>-1</sup>) as reported by Pathak and Mitra [10].

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