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# QUALITY IMPROVEMENT IN PLUM THROUGH CPPU AND POTASSIUM IN THE NORTH WEST PLAINS OF INDIA

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**ABSTRACT**
Fruit size, weight, colour, TSS, acidity, TSS/acid ratio and total sugars is important components for the fruit quality of plum. By improving these parameters we can improve the quality of fruits. Foliar spray of CPPU (2.5 ppm and 5.0 ppm) and potassium salts ($KNO_3$ and $K_2SO_4$) at 1 per cent and 2 per cent were done at 7 DAFB and 14 DAFB on 12 year old plum plants. In this experiment we noted that all the CPPU treatments significantly increased fruit size and fruit weight whereas $KNO_3$ treatments improved colour, TSS, acidity, TSS/acid ratio and total sugars which contributed in the fruit quality of plum cv. Satluj Purple. According to this experiment we find the conclusion that fruit weight and size was maximum under CPPU 5.0 ppm 7 DAFB (36.13 g and 3.54 cm and 3.32 cm) length and breadth respectively and other quality parameters was maximum in $KNO_3$ 2% 7 DAFB and is the best treatment in TSS (12.48%), tss/acid ratio (18.35%), total sugars (7.52%), acidity (0.68%) and fruit colour (16.80 and 7.21) a and b value respectively.

## INTRODUCTION

Plum (*Prunus domestica* L.) is relatives of the peach, nectarine, plum and almond is considered as one of the most popular fruit found in Himalayan region of Darjeeling and Sikkim. Traditionally plums are growing in Darjeeling and Sikkim and mostly produced plums are used for fresh consumption, but very small quantities are processed into juices (Sherpa *et al.,* 2014). Plants like (*Prunus ferrugineum*) containing high total phenol and flavonoid contents can be considered as a medicinal source for the treatment and prevention of many free radical related diseases (Chanda *et al.,* 2013).

The cultivated plum belongs to two species, viz., *Prunus domestica* L. (European plum) and *Prunus salicina* L. (Japanese plum). The European plums require high chilling, have deep purple/blue skin, yellow flesh, oval/round shape and are free/ clingstone whereas Japanese plums require low chilling, have light to deep red skin, red to yellow flesh and are semi free/ clingstone. Most of the plum cultivars are self unfruitful and require cross-pollination. Satluj purple is the only plum variety which is recommended for planting in the sub-tropics of north India. It is self unfruitful and requires Kala Amritsari as a pollinizer. Fruit size is an important component of fruit quality in plum. Pruning of fruiting wood, thinning of flowers and fruits are generally used to reduce the crop load on the tree and increase fruit size and quality. Foliar application of certain bio-regulators and chemicals like CPPU and potassium salts is another practice which is gaining popularity for increasing fruit size and improving the quality of fruits in temperate fruit plants. Havlin *et al*. (2007) reported that the increased in quality (TSS and colour) with foliar application of K is related with role of potassium in translocation of sugars from leaves to fruits. Shirzadeh and Kazemi (2011) reported that increase in TSS content with foliar application of potassium in apple. Karim and Neven (2012) concluded that $GA_3$ combined with potassium sulphate had a significant effect on TSS and it was observed in 'Nova' tangerines. Pathak and Mitra (2010) found lowest amount of fruit acidity (0.31%), highest Brix/acid ratio (64.01%) and highest ascorbic acid content (49.67 mg 100 g/ aril) with the application of 600 g potassium in litchi. These results are also same as that of our results like potassium increases the TSS, colour, TSS/acid ratio and decrease acidity and CPPU increased fruit size and fruit weight by causing cell division and cell elongation in fruits. So there is a need to check the effect of potassium and CPPU on the quality of plum fruits because there is very less of few studies done on the effect of CPPU and potassium under different doses and time of application. To improve the prospects of plum cultivar in the state, it is essential to produce the marketable size fruits of good colour and quality. Keeping this view, the present studies were conducted to improve the quality of plum through the use of CPPU and potassium and related to this experiment.

Our objectives of this experiment are-

To optimize the ideal time and dose of CPPU and potassium in plum.

To determine the effect of CPPU and potassium on the fruit quality of plum.

## MATERIALS AND METHODS

The present studies were conducted at PAU Farm Orchard, Ladhowal during the year 2014. The orchard soil was deep,

well drained and loamy sand. All the trees received recommended doses of fertilizers (FYM 36 kg, Urea 360 g, SSP 570 g and MOP 360 g) and other cultural practices along with plant protection measures during the course of this study. Foliar sprays of CPPU (N-(2-chloro-4-pyridyl)-N'-phenylurea) @ 2.5 ppm and 5.0 ppm and potassium salts ($KNO_3$ and $K_2SO_4$) at 1 per cent and 2 per cent were done at 7 days after full bloom and 14 days after full bloom on 12 year old plum trees. Hand thinning was done during second week of March before pit hardening stage keeping 5-8 cm distance between fruits. Observations were recorded regarding physiochemical characteristics of plum fruits determined by using standard procedure (AOAC 1985).

**Fruit weight (g)**

The weight of 10 randomly selected fruits was recorded in grams and mean weight per fruit for each treatment as worked out.

**Fruit size (cm)**

Length and diameter across the cheeks of ten randomly selected mature fruits were taken with the help of weighing balance and means are worked out.

**Fruit colour**

The fruit colour was recorded with the help of colour difference meter (Model: Mini Scan XE Plus, Made: Hunter lab, USA) and expressed as a, b Hunter Colour values (Hunter 1975).

**Total soluble solids (%)**

Freshly extracted and thoroughly strained juice of ten fruits were taken out for determining TSS. The readings were recorded with the help of Bausch and Lamb hand refracto meter (0-32 per cent).

**Titratable acidity (%)**

Two ml of strained juice was diluted to 20 ml distilled water and then titrated against 0.1 N NaOH using phenolphthalein as an indicator. The appearance of pink coloured marked the end point. The acidity was expressed in terms of anhydrous malic acid by using following formulae:

$$\text{Acidity}(\%) = \frac{0.0067 \times \text{Volume of NaOH used}}{\text{Volume of juice taken}} \times 100$$

**TSS/ Acid ratio**

TSS/acid ratio was calculated by dividing the value of TSS with that of corresponding titratable acidity.

**Total sugars (%)**

10 gm of meshed pulp was taken in a 100 ml beaker and volume was made upto the mark with distilled water. 1 g of lead acetate was added for precipitation and allowed to stand for one and half hour. Then 1 g potassium oxalate was added to remove excess of lead and solution was filtered.

25 ml of the above filtered content were pipetted out in a 100 ml flask and to this, 25 ml distilled water and 5 ml HCL (60% by volume) was added and left for overnight at room temperature for acid hydrolysis. The flasks were heated on a water bath in such a way that the temperature rose to 68°C in 10 minutes flasks. Flasks were kept at 68°C for another 5 minutes. A piece of litmus paper was put into the flask and sugars were neutralized with 10 per cent NaOH in the initial stages and 0.1 N NaOH near the neutralization point. Fehling solution A and Fehling solution B were taken in another volumetric flasks and placed on the hot plate. Then titration with neutralized solution containing sugar was done using methylene blue as an indicator. The end point was recorded with the appearance of brick red colour. Total sugar was expressed in percentage by using following formulae:

$$\text{Total sugar}\% = \frac{\text{Fehling Factor (0.05)}}{\text{Volume of filtrate used}} \times \frac{\text{Dilution made}}{\text{Weight of sample used}} \times \frac{\text{Final volume made}}{\text{Volume of filtrate taken}} \times 100$$

## RESULTS AND DISCUSSION

**Fruit weight and size**

The data presented in Table 1 reveals that fruit weight and size of all the treatments were significantly higher than control in the present investigations. Maximum fruit weight (36.13 g) and size (3.54 cm length and 3.32 cm breadth) was recorded in CPPU 5.0 ppm applied 7 DAFB and it was statistically at par with all the CPPU treatments used in the present studies. $KNO_3$

**Table 1: Effect of CPPU and potassium on physical parameters of plum cv. Satluj Purple.**

| Treatments | Fruit weight(g) | Fruit size(cm) length | breadth | Fruit colour a | b |
|---|---|---|---|---|---|
| CPPU 2.5 ppm 7 DAFB | 35.80 | 3.53 | 3.32 | 9.39 | 13.80 |
| CPPU 5.0 ppm 7 DAFB | 36.13 | 3.54 | 3.32 | 9.33 | 13.83 |
| CPPU 2.5 ppm 14 DAFB | 35.10 | 3.42 | 3.23 | 9.17 | 14.04 |
| CPPU 5.0 ppm 14 DAFB | 36.04 | 3.44 | 3.24 | 9.05 | 14.48 |
| $KNO_3$ 1% 7 DAFB | 33.27 | 3.35 | 3.13 | 16.40 | 7.70 |
| $KNO_3$ 2% 7 DAFB | 34.05 | 3.37 | 3.12 | 16.80 | 7.21 |
| $KNO_3$ 1% 14 DAFB | 32.26 | 3.03 | 2.94 | 15.20 | 8.12 |
| $KNO_3$ 2% 14 DAFB | 33.78 | 3.12 | 3.01 | 15.64 | 7.74 |
| $K_2SO_4$ 1% 7 DAFB | 31.59 | 2.97 | 2.93 | 14.34 | 8.76 |
| $K_2SO_4$ 2% 7 DAFB | 31.70 | 3.01 | 2.94 | 13.07 | 9.75 |
| $K_2SO_4$ 1% 14 DAFB | 31.21 | 2.91 | 2.90 | 13.74 | 9.43 |
| $K_2SO_4$ 2% 14 DAFB | 31.12 | 2.90 | 2.86 | 14.38 | 8.38 |
| Hand thinning | 33.00 | 3.23 | 3.04 | 13.58 | 9.65 |
| Control | 29.47 | 2.76 | 2.66 | 10.03 | 12.65 |
| CD at 5 % | 1.33 | 0.14 | 0.13 | 1.94 | 1.60 |

**Table 2: Effect of CPPU and potassium on chemical parameters of plum cv. Satluj Purple**

| Treatments | TSS (%) | ACIDITY (%) | TSS/ACID RATIO (%) | TOTAL SUGARS (%) |
|---|---|---|---|---|
| CPPU 2.5 ppm 7 DAFB | 9.88 | 0.73 | 13.53 | 5.76 |
| CPPU 5.0 ppm 7 DAFB | 9.75 | 0.75 | 13.00 | 5.63 |
| CPPU 2.5 ppm 14 DAFB | 9.57 | 0.74 | 12.93 | 5.33 |
| CPPU 5.0 ppm 14 DAFB | 9.27 | 0.75 | 12.36 | 5.23 |
| $KNO_3$ 1% 7 DAFB | 12.45 | 0.68 | 18.30 | 7.45 |
| $KNO_3$ 2% 7 DAFB | 12.48 | 0.68 | 18.35 | 7.52 |
| $KNO_3$ 1% 14 DAFB | 12.17 | 0.68 | 17.89 | 7.26 |
| $KNO_3$ 2% 14 DAFB | 12.30 | 0.67 | 18.35 | 7.37 |
| $K_2SO_4$ 1% 7 DAFB | 11.30 | 0.70 | 16.14 | 6.49 |
| $K_2SO_4$ 2% 7 DAFB | 11.90 | 0.72 | 16.52 | 6.72 |
| $K_2SO_4$ 1% 14 DAFB | 11.00 | 0.72 | 15.71 | 6.20 |
| $K_2SO_4$ 2% 14 DAFB | 11.07 | 0.71 | 15.59 | 6.42 |
| Hand thinning | 11.00 | 0.71 | 15.49 | 6.18 |
| Control | 10.03 | 0.75 | 13.19 | 5.87 |
| CD at 5 % | 0.64 | 0.02 | 1.19 | 0.45 |

and hand thinning treatments also recorded higher fruit weight and size than the $K_2SO_4$ treatments and control. Minimum fruit weight (29.47 g) and size (2.76 cm length and 2.66 cm breadth) was found in control. These results are in accordance with those reported by Caixi *et al*. (2007) and Kim *et al*. (2006) who found that CPPU was effective in enhancing fruit weight in pear and kiwifruit, respectively by stimulating cell division and cell expansion. Kittiwatsopon and Karintanyakit (2014b) also found that 5 ppm CPPU applied seven days before flowering or 10 ppm CPPU applied seven days after full bloom increased berry size in grape cv. Perlette. Serri and Hepp (2011) revealed that there was an increase in berry size with the application of CPPU in 'High Bush' Blueberries.

**Fruit colour**

Colour values 'a' and 'b' represent the intensity of red and green colour of fruits, respectively. The maximum 'a' value (16.80) was recorded in the fruits treated with 2% $KNO_3$ applied 7 DAFB and it was statistically at par with fruits of 1% $KNO_3$ applied 7 DAFB (16.40) and $KNO_3$ 1% and 2% applied 14 DAFB (15.20 and 15.64). The 'a' values of all the $KNO_3$ treatments were significantly higher than the 'a' values of all other treatments. The 'a' values of $K_2SO_4$ and hand thinning treatment were also statistically at par and significantly higher than CPPU treated and control fruits. Minimum 'a' value was recorded in CPPU treated fruits. The 'b' value was found to be maximum in CPPU treatments and it was significantly higher than all other treatments but statistically at par with control. Minimum 'b' values were recorded in $KNO_3$ treatments followed by $K_2SO_4$ treatments. The examination of data reveals that maximum intensity of red colour was noted in $KNO_3$ treatments and minimum in CPPU treatments whereas maximum intensity of green colour was found in CPPU treatments and minimum in $KNO_3$ treatments. The potassium spray positively affected the peel colour development in plum and more anthocyanin accumulation whereas inverse effect was observed with CPPU applications. The change in fruit colour depends upon the degradation of chlorophyll content and accumulation of colouring pigments like anthocyanins and carotenoids. Thakur *et al*. (2006) reported that berry colour was improved in Perlette grape by $K_2SO_4$ sprays. Peppi *et al*. (2008) found that clusters treated with CPPU in combination with ABA (300 or 600 mg/l at verasion) had higher anthocyanin content and better fruit colour than clusters treated only with CPPU in grape berries.

**TSS, acidity and TSS/acid ratio**

The data on these aspects are presented in Table 2. The data shows that treatments had a significant effect on TSS and acid content of plum fruits. Highest TSS (12.48 %) and lowest acidity (0.67%) was recorded when $KNO_3$ 2 % was applied 7 DAFB closely followed by $KNO_3$ 1 % applied 7 DAFB and $KNO_3$ 1 % and 2% applied 14 DAFB. $K_2SO_4$ and hand thinning treatments also recorded higher TSS and lower acidity than CPPU and control. Lowest TSS and highest acid content was found in CPPU treated fruits. The TSS/acid ratio was also found to be maximum in $KNO_3$ treatments followed by $K_2SO_4$ and hand thinning and minimum in CPPU treatments. The reduction in TSS with CPPU treatments has also been reported in grapes by Reynolds *et al* (1992) and in kiwi fruit by Kim *et al* (2006). Less TSS recorded in CPPU treatments could be due to the reason that large size fruits might have exerted a diluting effect on TSS or caused a competition for carbohydrates among fruits. The maximum increase in TSS with $KNO_3$ and $K_2SO_4$ might be due to translocation of carbohydrates as a result of maintenance of assimilating power of leaves over a longer period. Increase in TSS could also be due to higher level of applied potassium as potash is helpful in the synthesis of large amounts of the carbohydrates, which increase the sweetness of the fruits. Kittiwatsopon and Karintanyakit (2014b) reported that 5 ppm CPPU applied seven days before flowering or 10 ppm CPPU applied seven days after full bloom increased acidity in grape cv. Perlette. Gill *et al* . (2012) reported that reduction in the acidity under potassium treatment might be owing to increased TSS of the fruits in pear cv. Patharnakh. Yadav *et al*. (2013) reported that the effect of the potassium compounds on TSS and ascorbic acid was significant with 2% $K_2SO_4$ as compared to other potassium compounds in ber cv. 'Banarasi Karaka'. Pathak and Mitra (2010) found lowest amount of fruit acidity (0.31%), highest Brix/acid ratio (64.01%) and highest ascorbic acid content (49.67 mg 100 g/aril) with the application of 600 g potassium in litchi

**Total sugars**

The data presented in Table 2 further shows that $KNO_3$, $K_2SO_4$

and hand thinning treatment significantly increased total sugars over control in plum. The $KNO_3$ 2% applied 7 DAFB recorded maximum total sugar (7.52%) closely followed by $KNO_3$ 2% applied 14 DAFB (7.37%) and $KNO_3$ 1% applied 7 DAFB and 14 DAFB (7.45% and 7.26%, respectively). The next best treatment was found to be $K_2SO_4$ 1% and 2% applied 7 DAFB. Minimum total sugars were recorded in CPPU treatments and control. Kim *et al*. (2006) reported that CPPU has tendency to delay fruit maturity and degradation of starch in the fruits. The reduction in sugar content in grapes due to CPPU application has been reported by Reynolds *et al*. (1992).The increase in total sugars by $KNO_3$ and $K_2SO_4$ might be due to translocation of carbohydrates as a result of maintenance of assimilating power of leaves over a longer period resulting in increased availability of sugars to fruits. These results are in conformity with the findings of Singh and Singh (1981) who reported that foliar spray of $KNO_3$ (1%) increased total sugars in 'Dancy' tangerines. Soliman and Osman (2003) reported that N + K (1.5 + 1.5) kg/palm gave the highest TSS% and total sugars content in date palm cv. 'Samany'. Kim *et al*. (2006) reported that total sugars increased by application of CPPU (1 mg/l and 5mg/l) in 'Hardy' kiwifruit.

From the present investigation, it is concluded that CPPU treatments increased fruit weight and size whereas, $KNO_3$ treatments improved fruit quality of Plum cv. Satluj Purple.

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