Research Article

Effect of Forchlorfenuron and N-Acetyl Thiazolidine 4-Carboxylic Acid on Physical Parameter of Apricot (*Prunus armeniaca* L.*)* cv. New Castle

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Abstract

Being the third important stone fruit crops of India, apricot still requires a great improvisation in production point of view. Bio-regulators are being used by the growers to increase the yield by improving the yield attribute parameters. Keeping the objective to increase the yield, in the recent studies; twenty six-year-old apricot cv. New Castle trees were subjected to 11 treatments viz. Forchlorfenuron (CPPU) at 5 and 10 ppm and N-acetyl thiazolidine 4-carboxylic acid (NATCA) at 50 and 100 ppm and their combinations were applied at pink bud and petal fall stage during the year 2015 and 2016. Out of the two time of spray the petal fall stage was found to be superior in both the years. Foliar spray of CPPU at 10 ppm increased the physical parameters like pulp weight (16.10 g, 12.13 g/fruit), stone weight (2.6 g and 1.94 g/stone) and pulp to stone ratio (7.15:1) over control. Keeping all the observations in consideration CPPU 10 ppm at petal fall stage was found to be best among all the treatments.

Keywords: Forchlorfenuron (CPPU), N-acetyl thiazolidine 4-carboxylic acid (NATCA), Foliar Spray, Petal Fall stage, Stone weight, Pulp weight, Pulp to Stone ratio

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Introduction

Horticultural products are of great value to feed the growing population of the world. Acquiring the world free from hunger and to meet the growing food demand new insights and techniques are required in order to achieve sufficient and sustainable yields. Therefore, to search and test the efficacy of a new product continuous research should be followed up in this field. Instead of conventional mineral fertilizer biostimulants are very good alternatives to do research in such fields [1]. Biostimulants are defined as ‘‘materials, other than fertilizers, that promote plant growth when applied in small quantities’’ and are also referred to as ‘‘metabolic enhancers’’ [2].

In order to enhance the fruit size and quality plant growth regulators has been commercially used in many stone fruit crops [3]. Stress including biotic and abiotic alter the level of endogenous hormones and ultimately affect the crop growth, which can be overcame by application of exogenous growth regulators to enhance the yield. Qualitative and quantitative aspect of fruit growth can be achieved by using the plant growth regulators which in return increase the productivity [4].

Forchlorfenuron, a synthetic cytokinin with strong growth regulation activities has been found very effective in enhancing fruit growth by stimulating cell division and cell elongation. It has been found highly effective in increasing fruit size in some fruit crops [5]. Besides, it also modifies other fruit characteristics such as shape, dry matter content, carbohydrate metabolism and ripening process. Its treatment could also increase firmness of individual fruit, reducing TSS content and TSS /acid ratio of fruit, as well as, promote starch degradation but had no effect on titratable acid content [6].

Elanta Super is an organic growth promoter which contains N Acetyl Thiazolidine 4- Carboxylic Acid (NATCA), 10% Folic acid with 0.2% adjuvant, used for plant growth increase in both fruit & production quality. It is a derivative of organic amino acid, which helps to develop fruits to its optimum level of size, shape, quality and taste. It is also useful for fruit setting, enhances quality, size, colour as well as taste and keeping quality of fruits. It is also a stabilizer buffer, to tolerate certain types of stresses more effectively [7].

A low-moderate chilling New Castle is the most commercial cultivar of apricot (*Prunus armeniaca* L.) in the mid-hills of Himachal Pradesh. This cultivar ripens towards the third week of May when no other fruit is available and hence fetches higher prices in the market. However, with the advancement of age, its fruit size and quality decreases which has less demand in market. In Himachal Pradesh, apricot is being cultivated at an elevation of 900 m to 2000 m above mean sea level over an area of 3660 ha with an annual production of 4704 MT in 2014-15 [8]. Leading growing districts are Solan, Shimla, Sirmour, Chamba, Kullu, Mandi, and Kinnaur. This study aimed to throw some light of the prospective on the use of CPPU and NATCA singly or in combinations to promote the yield quantitatively and qualitatively in New Castle Apricot.

Materials and Methods

The present investigations was carried out in the 26 years old apricot cv. New Castle planted in a spacing of 3×3 meter at experimental orchard of the Department of Fruit Science, Dr. Y.S. Parmar University of Horticulture and Forestry during the years 2015 and 2016. For the experiment, thirty trees were selected on the basis of uniform vigour and were maintained under uniform cultural practices during the entire course of investigation. The two bio-regulators i.e. CPPU (5 and 10 ppm), NATCA (50 and 100 ppm) and their combinations CPPU + NATCA (5 + 50 ppm) are applied at two different stage i.e. pink bud and petal fall stage, while the untreated plant remain the control (**Table 1**).

Eleven treatments with three replications was setup with Randomized Block Design (RBD). For each treatment, 10 litres of spray solution was made. In order to decrease the surface tension of the droplets and facilitate absorption, a few drops of Teepol were added to the solution prior to spray. The spray solutions of different plant growth regulators were applied on the trees with the help of foot sprayer to wet the developing buds and flower completely without causing runoff at morning hours without obstruction of wind drift.

Table 1 Description of application of forchlorfenuron(CPPU) and N-acetyl thiazolidine 4-carboxylic acid

Treatments	Chemicals	Concentration (ppm)	Time of application
T_1	CPPU	5	Pink bud
T_2	CPPU	10	Pink bud
T_3	CPPU	5	Petal fall
T_4	CPPU	10	Petal fall
T_5	N-ATCA	50	Pink bud
T_6	N-ATCA	100	Pink bud
T_7	N-ATCA	50	Petal fall
T_8	N-ATCA	100	Petal fall
T_9	CPPU + N-ATCA	5 + 50	Pink bud
T_{10}	CPPU + N-ATCA	5 + 50	Petal fall
T_{11}	CONTROL		

Ten fresh fruits were weighed and the stone from these fruits were removed, washed under tap water, dried to remove excess water and finally weighed. Both the pulp and stone were weighed separately on electronic top pan balance and the average pulp and stone weight was expressed in gram per fruit (g/fruit). The pulp to stone ratio was worked out by dividing the weight of fruit flesh (flesh weight = fruit weight - stone weight) by the weight of stone. The fruit firmness (kg/cm^2) was determined by digital pressure tester (Effegi Penetrometer-FT 327) which recorded the pressure necessary for the plunger to penetrate the flesh of apricot fruits. The total soluble solids (^{o}Brix) content in fruits were determined by Erma hand refractometer. The refractometer was calibrated with distilled water before use and a few drops of fruit juice were placed on the prism and the reading was recorded. The titratable acidity (as g malic acid/ 100 ml juice), total sugars (%), reducing sugars (%) and non-reducing sugars (%) were determined according to the procedure outlined by Ranganna [9]. The TSS/ acid ratio was obtained by dividing the corresponding value of total soluble solids to the malic acid content of the fruit juice.

Results

Pulp weight

It is evident from the **Figure 1** that the pulp weight was increased significantly by different plant growth regulator treatments. In the year 2015, the values of average pulp weight varied from 11.62 to 16.10 g/fruit. The maximum fruit weight (16.10 g/fruit) was recorded in the treatment T_4 (10 ppm CPPU at petal fall), which was however, statistically at par with T_{10} (5 ppm CPPU + 50 ppm NATCA at petal fall), T_3 (5 ppm CPPU at petal fall stage) and T_8 (100 ppm NATCA at petal fall). The minimum pulp weight (11.62 g/fruit) was registered in control, which was however, statistically at par with T_5 (50 ppm NATCA at pink bud) and T_6 (100 ppm NATCA at pink bud).

In the next year, the maximum pulp weight (12.13 g/fruit) was found in the treatment T_3 (5 ppm CPPU petal fall) that was closely followed by T_4 (10 ppm CPPU at petal fall stage), T_{10} (5 ppm CPPU + 50 ppm NATCA at petal fall), T_8 (100 ppm NATCA at petal fall) and T_7 (50 ppm NATCA at petal fall), which were however, statistically at par with each other. The pulp weight was found to be lower in control (8.74 g/fruit) in comparison to the remaining treatments except T_5 (50 ppm NATCA at pink bud) and T_6 (100 ppm NATCA at pink bud).

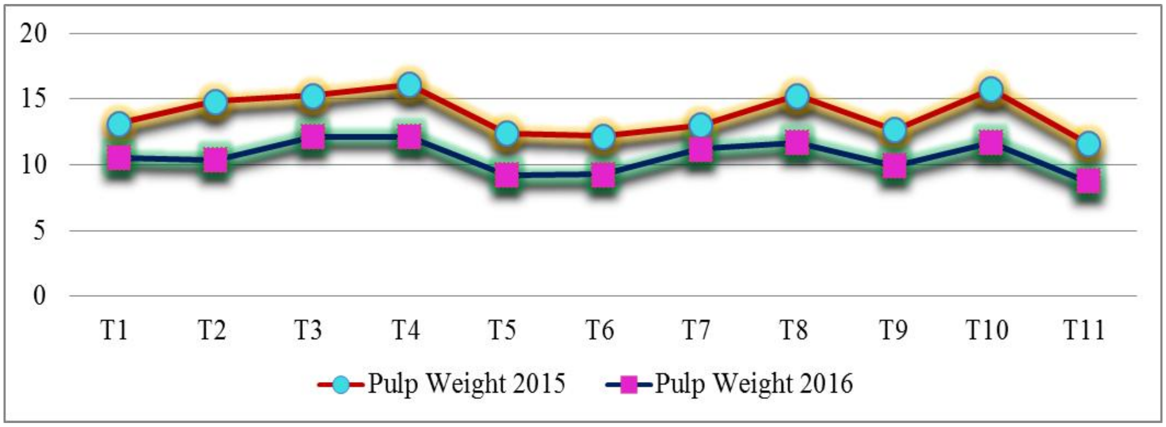

Figure 1 Effect of forchlorfenuron and N-acetyl thiazolidine 4-carboxylic acid on pulp weight of apricot cv. New Castle

Stone weight

A significant difference was observed in the stone weight value after the application of forchlorfenuron and N-acetyl thiazolidine 4-carboxylic acid in different stage which was given in the **Figure 2**.

In the year 2015, the average weight of a stone was varied from 1.91 g to 2.26 g with the application of bio-regulators. However, the highest value (2.6 g/stone) was registered in the treatment T_3 (5 ppm CPPU at petal fall), which was on par with T_4 (10 ppm CPPU at petal fall stage), T_8 (100 ppm NATCA at petal fall), T_{10} (5 ppm CPPU + 50 ppm NATCA at petal fall) and T_7 (50 ppm NATCA at petal fall). The stone weight was observed significantly lowest in control (1.91 g/stone).

In the year 2016 the stone weight was found to be heaviest (1.94 g/stone) in T_4 (10 ppm CPPU at petal fall) which was statistically at par with T_8 (100 ppm NATCA at petal fall), T_3 (5 ppm CPPU at petal fall stage), T_{10} (5 ppm CPPU + 50 ppm NATCA at petal fall) and T_7 (50 ppm NATCA at petal fall). The lightest value of stone weight (1.56 g/ stone) was noticed in the control which was statistically at par with T_5 (50 ppm NATCA at pink bud).

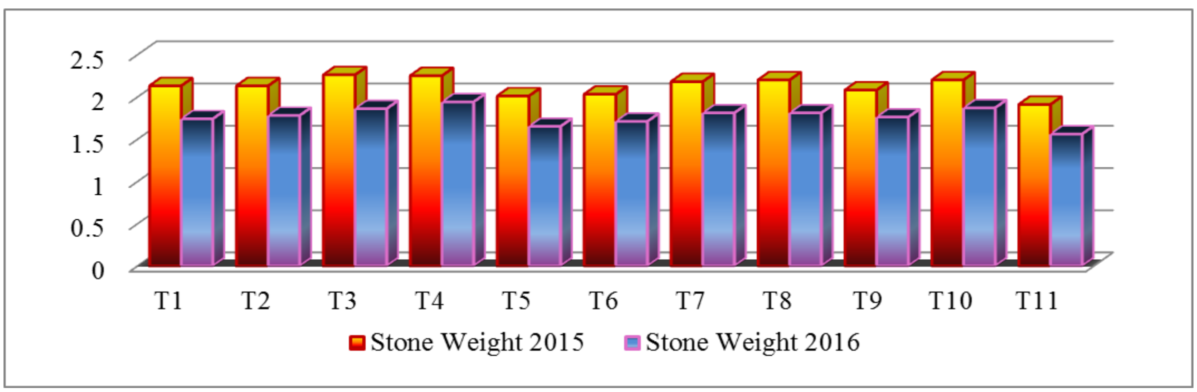

Figure 2 Effect of forchlorfenuron and N-acetyl thiazolidine 4-carboxylic acid on stone weight of apricot cv. New Castle

Pulp to stone ratio

It is evident from the **Table 2** and **Figure 3** that all treatments of plant growth regulators had significant effect on fruit pulp to stone ratio during the year 2015. The data show that pulp to stone ratio ranged from 5.96:1 to 7.15:1 under different treatments. The maximum value (7.15:1) pertained to the treatment T_4 (10 ppm CPPU at petal fall stage) which was however, statistically at par with the treatments T_3 (5 ppm CPPU at petal fall stage), T_8 (100 ppm NATCA at petal fall) and T_{10} (5 ppm CPPU + 50 ppm NATCA at petal fall). The minimum pulp to stone ratio (5.96:1) was observed in T_7 (50 ppm NATCA at petal fall), which was statistically at par with treatments T_1 (5 ppm CPPU at pink bud), T_5 (50 ppm NATCA at pink bud), T_6 (100 ppm NATCA at pink bud) and T_9 (5 ppm CPPU + 50 ppm NATCA at pink bud) and T_{11} (control).

Table 2 Effect of forchlorfenuron and N-acetyl thiazolidine 4-carboxylic acid on pulp to stone ratio of apricot cv. New Castle

Treatments	Pulp to stone ratio		
	2015	2016	Pooled
T_1	6.17	6.05	6.11
T_2	6.93	5.80	6.36
T_3	6.76	6.53	6.64
T_4	7.15	6.25	6.70
T_5	6.16	5.58	5.87
T_6	5.97	5.39	5.68
T_7	5.96	6.19	6.08
T_8	6.92	6.45	6.69
T_9	6.05	5.62	5.84
T_{10}	7.13	6.24	6.68
T_{11}	6.10	5.61	5.86
$CD_{0.05}$	0.45	NS	0.46

Figure 3 Cross section of Apricot showing the Pulp to Stone Ratio

In the year 2016, the pulp to stone ratio did not show significant variation under different treatments. Fruits from trees treated with CPPU at 5 ppm at petal fall stage (T_3) had the maximum pulp to stone ratio (6.53:1) and minimum(5.39:1) in T_6 (100 ppm NATCA at pink bud).

Discussions

Stone fruit growth is divided into three phases that are described classically as cell division, pit hardening, and cell expansion. Much attention has been given to the first and last stages due to their role in final fruit size, the most economically important fruit trait. The mechanism of stone hardening in Prunus has been investigated only to a limited extent [10]. Lignin accumulation is thought to be associated with the deposition of cellulose and hemicellulose [11]. Recently, studies on pit-less plum showed that this phenotype is due to a decrease in endocarp formation rather than a decrease in endocarp lignifications [12].

CPPU, a synthetic cytokinin, has also been found to be effective for enhancing fruit size by stimulating cell division and/or cell expansion in many fruit including sweet cherry [13, 14]. Abd El Raheem *et al.*, [15] also found a similar trend, when they applied CPPU and GA_3 the fruit juice content was increased significantly in Navel Orange.

Conclusion

From the above experiment it is concluded that spraying of bio regulators at petal fall stage is highly beneficial than the pink bud stage for apricot in the mid hill areas of Himachal Pradesh. Out of different bioregulators CPPU is found to be better than NATCA. CPPU at 10 ppm at petal fall stage increase the pulp weight, stone weight and pulp to stone ratio; which are yield attributing character of apricot plant.

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