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Analysis of vegetative growth by spraying of forchlorfenuron and N-acetyl thiazolidine 4-carboxylic acid on 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. The experiment was laid out in completely randomized block design with three replications in the experimental fruit orchard of Department of Fruit Science, Dr YSPUHF, Nauni, Solan. 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 vegetative character like annual shoot growth (61.66 cm), trunk girth (5.38 %) and leaf area (32.42 cm^2) over control. However an increase the chlorophyll content of leaves (2.61 mg/g fresh weight) was noticed by NATCA (100 ppm) at petal fall stage.

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

Introduction

Being the third important stone fruit crop next after peach and plum, in respect to area and production; apricot (*Prunus armeniaca* L.) still require an attention towards its increasing yield by decreasing the fruit drop and increasing the fruit size. 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 (Anonymous, 2015) [1]. Leading growing districts are Solan, Shimla, Sirmour, Chamba, Kullu, Mandi, and Kinnaur.

A low-moderate chilling New Castle is the most commercial cultivar of apricot 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. Many of the commercially available plant growth regulators are used in stone fruit production which enhance fruit size and quality and delay the storage disorder (Lurie, 2010) [8]. It is obvious that changes in the level of endogenous hormones due to biotic and abiotic stress alter the crop growth and any sort of manipulation including exogenous application of growth substances would help for yield improvement. Plant growth regulators provide effective means for the improvement of productivity as a result of direct influence on the qualitative as well as quantitative aspects of fruit growth (Taiz and Zeiger, 1998) [14].

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 (Antognozzi *et al*., 1997; Cruz-Castillo *et al.*, 2002) [2, 4]. 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 (Nevine *et al*., 2016) [10].

Elanta Super is a 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 (Berg, 1986). 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 treatment with three replication 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.

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		

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.

Annual shoot growth

Ten shoots from the current season's growth were randomly selected from all over the periphery of each tree. The length of these shoots was measured with measuring tape at the end of growing season and the average shoot length was expressed in centimetre (cm).

Trunk girth

Tree girth was recorded at 30 cm above the ground level with the help of measuring tape once before the start of the growth and again after the completion of the growth. The results of increase in the tree girth over the growing season were expressed in percentage.

Leaf area

From each experimental tree, 25 fully developed and matured leaves were randomly selected from all the four directions of the tree periphery and detached during the last week of June. These leaves are then pressed overnight between the herbarium sheets for full expansion. Their area was measured with the help of Portable Laser Leaf Area Meter (CI-202) in the laboratory and average values were expressed in square centimetre (cm^2).

Chlorophyll content

From the each experimental tree, 10 fully developed and mature leaves were randomly selected from all four direction of the tree periphery during the last week of June and chlorophyll content of the leaves was measured by the portable Chlorophyll Fluorometer (Opti-Sciences < $OS\text{-}30_p$>; made in U.S.A.). The results were expressed as chlorophyll content in mg/g of fresh weight.

Result and Discussion

It is evident from the data presented in Fig: 1-4 depicted that pre harvest application of different plant growth regulators exerted a significant influence on annual shoot growth, trunk girth, leaf area and chlorophyll content of leaves. The annual shoot growth values under various treatments ranged from 42.53 to 61.66 cm. The maximum shoot growth (61.66 cm) was recorded in the trees under the treatment T_4 (10 ppm CPPU at petal fall), which was however, statistically at par with the treatments T_3 (5 ppm CPPU at petal fall) and T_8 (100 ppm NATCA at petal fall), but significantly higher than the remaining treatments. The minimum annual shoot growth (42.53 cm) was recorded in the trees under control which was markedly lower than all other treatments.

The percent increase in trunk girth didn't show any consistent variation with the application of different bio-regulator treatments; however its value ranged from 4.16 to 5.38 per cent under different treatments (Fig 2). The maximum increase in trunk girth (5.38 %) was recorded in the treatment T_4 (10 ppm CPPU at petal fall) and minimum (4.16 %) was recorded in trees under the treatment T_5 (50 ppm NATCA at pink bud).

The pooled data showed a similar trend with respect to the application of growth regulators. The average leaf area was recorded significantly higher (32.42 cm^2) in T_4 (CPPU 10 ppm at petal fall), which was quite similar with the treatments T_3 (5 ppm CPPU at petal fall) and T_{10} (5 ppm CPPU + 50 ppm NATCA at petal fall). The smaller leaves (25.60 cm^2) were observed in control.

The shoot growth, tree height, tree spread and tree volume were markedly affected by different plant growth regulator treatments. The increase in different tree growth attributes with CPPU treatment might be due to its cytokinin like action which leads to rapid cell division and cell elongation (Thomas and Katterman, 1986) [16]. Another reason for stimulation of growth may be related to an increase in RNA and DNA content, polymerase activity, and protein synthesis (Nickell, 1985) [11]. Fathi *et al.* (2011) [6] also observed similar increase in vegetative growth of Costata persimmon following the application of CPPU. Thakur (2014) [15] and Hota *et al*. (2017) [7] also found similar result in respect to increase in annual shoot growth, trunk girth and leaf area by applying 10 ppm CPPU at petal fall stage in apricot cv. New Castle.

The data on chlorophyll content of the leaves in Fig-4 reveal that different treatments exerted significant influence chlorophyll content. The maximum chlorophyll (2.61 mg/g fresh weight) was recorded in the treatment T_8 (100 ppm NATCA at petal fall), which was however, statistically at par with the treatment T_7 (50 ppm NATCA at petal fall), but significantly higher than the remaining treatments. The minimum chlorophyll (1.94 mg/g fresh weight) was observed in control which was statistically similar with the treatment T_3 (5 ppm CPPU at petal fall) and T_1 (5 ppm CPPU at pink bud).

Exogenous amino acids are absorbed by the leaves, promoting chelation and transport of mineral nutrients, increasing levels of proline and hydroxyproline, (which in turn may augment tolerance to biotic and abiotic stress), stimulating enzymatic systems (such as those of nitrate reductase, malate dehydrogenase, phosphorylase, phosphatase and peptidase), enhancing flower and fruit set, increasing chlorophyll concentration and photosynthetic output. As a result, application of amino acid biostimulants has been associated with accelerated biomass accumulation and/or increased fruit yield in several crops (Maini, 2006) [9].

In present study NATCA enhance the chlorophyll content of the leaves, in accordance with the results of Sabir *et al.* (2014) [13]; who recorded higher chlorophyll in leaves of grapevine with the application seaweed extract (amino acids). Dubravec and Licul (1983) [5] reported an increase in chlorophyll content in the samples with the application of Agrispon and Ergostim (NATCA) which are similar active ingredient and products that of Elanta Super. Similar findings were also found by Ramteke and Khot (2015) [12] who reported that increased chlorophyll content of grapevine leaves were obtained from plants treated with 1 ml Elanta Super along with 15 ppm GA_3 + 1 ppm CPPU.

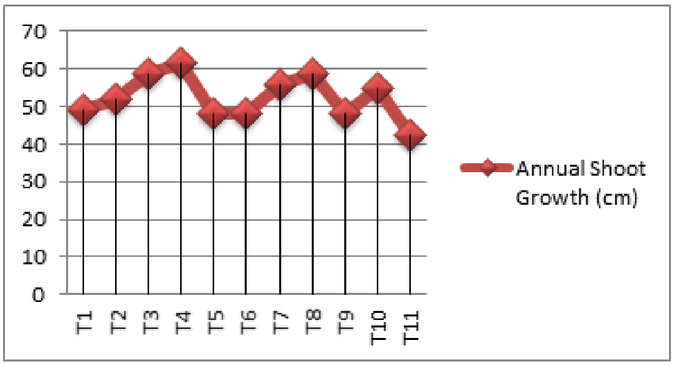

Fig 1: Effect of CPPU & N-ATCA on annual shoot growth of apricot cv. New Castle

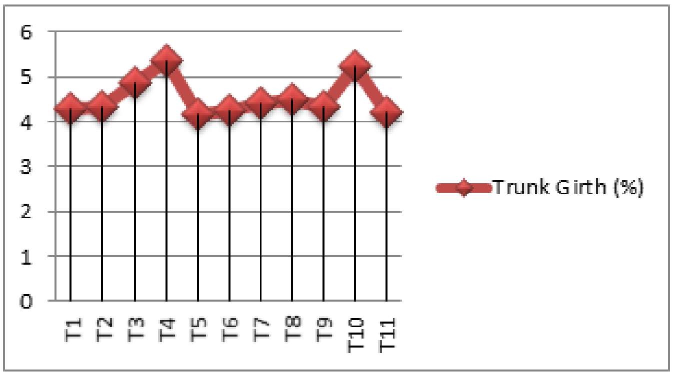

Fig 2: Effect of CPPU & N-ATCA on trunk girth of apricot cv.New Castle

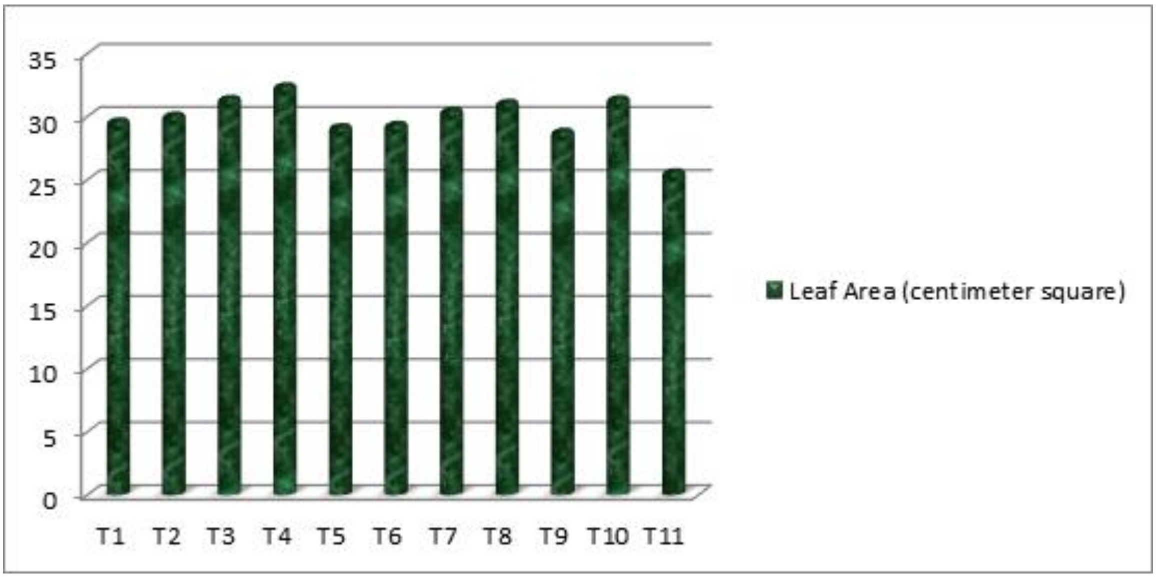

Fig 3: Effect of CPPU & N-ATCA on leaf area of apricot cv. New Castle

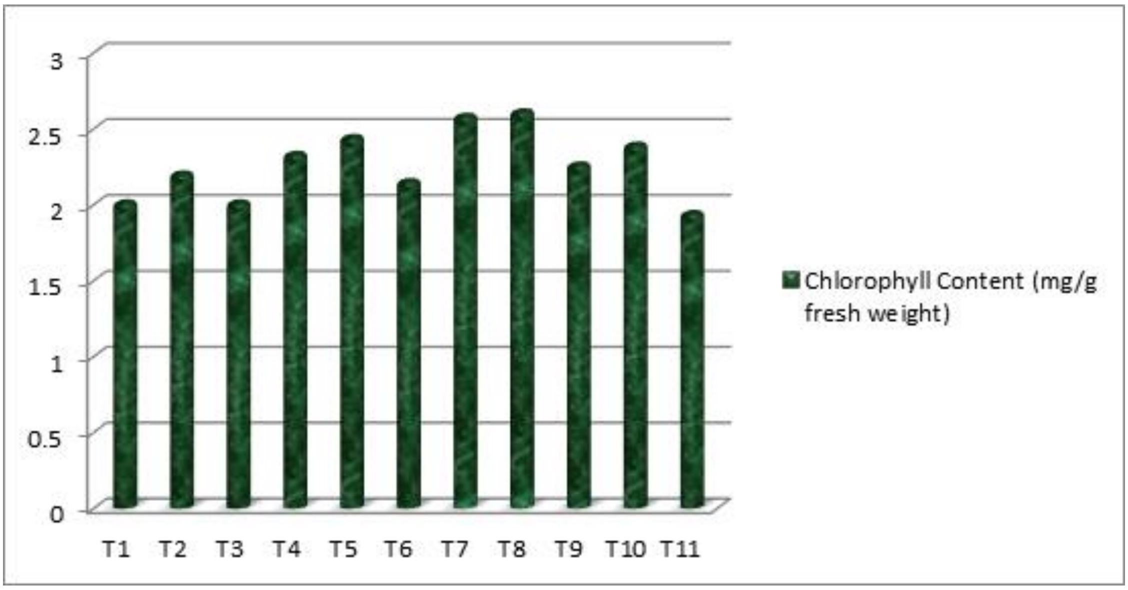

Fig 4: Effect of CPPU & N-ATCA on leaf chlorophyll content of apricot cv. New Castle

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