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Effect of different concentration of CPPU and fruit thinning on yield and quality of Kiwifruit cv. ALLISON AND HAYWARD

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ABSTRACT : The investigations were carried out during 2011 and 2012 at Regional Horticultural research station, Bajaura, to study the effect of different concentration of CPPU and fruit thinning on yield and quality of Kiwifruit cv. Allison and Hayward.The vines were ten years old at the start of study. One hundred twenty six uniform vines were selected in each cultivar. The trees were planted 6x3 m apart. The shoots of the each vines were tagged after fruit set and the tagged shoots were thinned (2 fruits/shoot, 3 fruits/shoot, 4 fruits/shoot, 5 fruits/shoot and 6 fruits/shoot). Tagged and thinned fruit vines of Allison and Hayward were sprayed with different concentration of CPPU (2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm) two weeks after fruit set. The results indicated that the maximum fruit yield, fruit weight, fruit length and fruit breadth was obtained when 4 fruits/shoots were retained and CPPU 10 ppm was sprayed in case of both the cultivars. Thinning treatments did not have any significant effect on fruit chemical properties. *i.e.* total soluble solid (TSS), titratable acidity, reducing sugars and total sugars content in both seasons of investigation. The results revealed that highest total soluble solids (TSS) and lowest acidity was obtained when vines were sprayed with CPPU 10 ppm as compared with control. Therefore, from these studies it can be concluded that thinning with 4 fruits/shoot resulted in optimum thinning and maximum production of 'A' grade fruits of better quality along with spray of CPPU @ 10 ppm with highest increase in net benefits over control, which is considered to be the best combination treatment used for producing maximum yield and improving fruit quality, especially fruit weight.

KEY WORDS : Sitofex, Fruit thinning, Allison, Hayward

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To improve fruit size and to increase the yield, new growth regulator namely CPPU, the synthetic cytokinin derived from phenylurea (CPPU) or forchlorophenuron was proposed to replace GA3 which cause a reduction on bud burst and fertility as well as fruits abscission and post harvest decay in the next seasons. Fruits of different fruit trees from early blooming are larger at maturity than those from later blooms. Therefore, the potential final size in some fruits may be determined before anthesis (Hasegawo and Nakajima, 1990 and Marguery and Sangwan, 1993). Flower and fruit thinning are standard cultural practices performed in fruit crops to increase the fruit size (Lahav *et al*., 1989). Therefore, increasing fruit size should be one of the strategies to increase the yield and marketability of the fruit. CPPU is a cytokinin type which shows potent cytokinins activity in many plants. Application of CPPU at 1 to 20 ppm causes great effects on fruit size. The effectiveness was associated with methods of applications, the type of desired response, the developmental stage of the plant at time application and other variables. It inhibits flower shedding in most fruit crops. It has an extremely low order of toxicity both to plants and to animal systems (Nickell, 1985). The basic relationships between cytokinin signaling, cell division and fruit growth are well established. Final fruits size depends on the combined effects of the number of cells present at fruit set, the number of subsequent cell divisions and the extent of cell expansion. The present studies were, therefore, under taken to study the

effect of different concentration of CPPU and fruit thinning on yield and quality of Kiwifruit.

RESEARCH METHODS

The investigations were conducted during 2011 and 2012 on Kiwifruit (*Actinidia deliciosa* A. Chev.) cv. Allision and Hayward at Regional Horticultural research station, Bajaura .The average minimum temperature of the station ranged between 10.5 and 26.4^0 C. The vines were ten years old at the start of study. One hundred twenty six uniform vines were selected for each cultivar. The trees were planted 6x3 m apart on T-bar trellis system. The shoots of the each vines were tagged after fruit set and the tagged shoots were thinned according to the following treatments combinations:

- 2 fruit/shoot
- 3 fruit/shoot
- 4 fruit/shoot
- 5 fruit/shoot
- 6 fruit/shoot
- Control.

The thinned vines of cv. Allison and Hayward were subsequently sprayed with different concentration of CPPU two weeks after fruit set.

- T_1 CPPU @ 2.5 ppm
- T_2 CPPU @ 5.0 ppm
- T_3 CPPU @ 7.5 ppm
- T_4 CPPU @ 10.0 ppm
- T_5 CPPU @ 12.5 ppm
- T_6 CPPU @ 15.0 ppm
- T_7 Control.

The trees received the uniform recommended cultural practices. Complete Randomized Block Design was applied. Each treatment was replicated three times.The data on fruit yield, fruit size and weight were recorded using standard procedure. The fruit length and breadth were measured with the help of vernier calliper. Fruit weight was measured with the help of top pan balance. The unit sample consisted of ten fruits and the results were expressed in cm/fruit for size and g/fruit for weight. The total soluble solids were determined with refractrometer (0-32 ^{0}B). Titratable acidity was determined by titrating fruit pulp solution against N/10 NaOH using phenolphthalein as indicator. Total sugar and reducing sugar content were determined as per method of AOAC (1980).

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarised under following heads:

Fruit yield:

Data pertaining to effect of fruit thinning and CPPU concentration and their interaction on fruit yield of kiwi cv. Allison and Hayward are tabulated in Table (1 and 2). The data revealed that in both the cultivars the maximum fruit yield (50.8 and 55.5 kg /tree) was obtained when 6 fruits/ shoot were retained and minimum fruit yield was obtained when 2fruits/shoot were retained. As for the effect of the different concentrations of CPPU, it is clear that all the CPPU concentrations significantly increased fruit yield as compared to control. The maximum fruit yield was recorded when kiwi fruit vine were sprayed with 10 ppm CPPU, whereas fruit yield of treatments 12.5 ppm CPPU and 15 ppm CPPU were at par with each other. With respect to the interaction, the data exhibited that, the highest yield (kg/tree) was obtained when 6 fruits/shoots were retained and CPPU 10 ppm was sprayed. These findings are in agreement with those obtained by Nickell (1985), Rizk (1998) and Fawzi and Hafez (2004) on grapevines and Guirguis *et al.* (2009) on persimmon and Chandel and Devi (2010) on Kiwifruit, who reported that, CPPU application significantly increase the total yield. Therefore, the application of 10 ppm CPPU is considered the best combination treatment for producing maximum yield of Kiwifruit.

Fruit weight and size:

According to information presented in Table (1 and 2), it is clear that, the highest values of fruit weight (88.6 and 93.5 g), length (3.2and4.4 cm) and breadth (6.2 and 5.8 cm) were obtained when 4fruits/shoot were retained and lowest values of fruit weight (53.8 and 52.3g), length (2.9 and 3.7 breadth (6.1 and 5.0 cm) were obtained with control. This hold was true in both seasons. Regarding the effect of CPPU concentration the data revealed that fruit weight, fruit length and fruit breadth were gradually increased by increasing the concentration of CPPU. In both the cultivars *i.e.* Allison and Hayward heaviest and largest fruits were produced when frequently increased commercially by reducing crop load using hand thinning. The increase in fruit size could be attributed directly to the CPPU effects. Exogenous application of CPPU acts early on cell division in the fruit let and also on subsequent growth. Thus, the fruit becomes bigger in size due to the efficient cells, the building blocks of fruit mass and also because the cells have been able to attract so much water, minerals and carbohydrates that enable the fruit to expand to large size (Kano, 2003). Moreover, the increase in both fruit weight and dimensions due to application of CPPU may be described to its positive action on enhancing both cell division and cell elongation, as well as, its great role in activating the biosynthesis of proteins, RNA and DNA (Nickell, 1985). However, the interaction between thinning and CPPU concentrations, were significant. The heaviest and largest fruits were obtained by the application of CPPU10 ppm.

Table 1 : Effect of fruit thinning and CPPU spray on physico-chemical characteristic of Kiwi fruit cv. Allison

Treatments		Fruit physico-chemical characteristic							
Thinning (A)	CPPU concentration (B)	Fruit yield kg/tree	Fruit weight (g)	Fruit breadth (cm)	Fruit length (cm)	TSS (ºB)	Acidity (%)	Reducing sugars (%)	Total sugar (%)
2fruits/shoot	2.5 ppm	24.0	67.3	5.4	2.9	11.0	1.4	4.5	6.2
	5.0 ppm	29.0	82.0	5.8	3.0	13.0	1.3	5.5	7.1
	7.5 ppm	27.0	83.6	6.1	3.2	13.7	1.2	5.7	7.9
	10.0 ppm	29.0	110.0	7.0	3.2	15.0	1.0	7.7	8.8
	12.5 ppm	28.0	99.5	6.8	3.2	11.2	1.2	7.0	8.1
	15.0 ppm	26.0	96.3	6.6	3.5	10.7	1.2	6.3	7.0
	Control	20.0	59.3	5.2	2.9	10.7	1.0	4.4	5.6
Mean		26.1	85.4	6.1	2.6	12.1	1.1	5.8	7.2
3fruits/shoot	2.5 ppm	35.6	65.6	5.4	2.7	12.0	1.4	5.1	6.5
	5.0 ppm	32.6	80.6	5.5	3.1	12.4	1.3	5.4	7.5
	7.5 ppm	33.0	83.0	6.0	3.0	13.6	1.2	5.9	8.0
	10.0 ppm	35.6	104.3	7.4	3.3	15.0	1.1	7.3	9.3
	12.5 ppm	34.6	95.0	6.8	4.0	12.0	1.2	7.0	8.1
	15.0 ppm	33.2	94.9	6.5	3.4	11.5	1.2	7.2	8.2
	Control	45.2	54.0	5.2	2.8	10.5	1.2	4.8	5.5
Mean		35.6	82.4	6.1	3.1	12.4	1.2	6.1	7.5
4fruits/shoot	2.5 ppm	41.2	62.9	6.5	2.8	11.2	1.3	4.7	5.6
	5.0 ppm	45.2	79.6	6.8	6.7	12.2	1.2	5.2	6.2
	7.5 ppm	43.2	82.6	5.8	3.0	13.2	1.1	5.6	7.5
	10.0 ppm	55.0	118.3	6.7	3.0	14.7	1.0	7.6	8.1
	12.5 ppm	48.2	114.9	6.9	3.5	12.0	1.3	6.8	7.4
	15.0 ppm	49.2	109.6	6.4	3.2	11.2	1.4	7.3	7.2
	Control	40.4	52.6	4.8	2.8	10.1	1.4	4.6	4.8
Mean		46.0	88.6	6.2	3.2	12.0	1.2	5.9	6.6
5fruits/shoot	2.5 ppm	48.0	62.3	5.8	2.3	11.2	1.4	5.0	5.1
	5.0 ppm	46.0	79.0	6.6	2.9	12.7	1.3	6.2	6.5
	7.5 ppm	45.0	81.3	5.9	3.6	13.0	1.2	6.0	7.0
	10.0 ppm	58.0	100.0	6.6	3.6	14.3	1.1	7.6	8.9
	12.5 ppm	55.0	94.6	6.9	3.7	12.6	1.3	6.1	8.2
	15.0 ppm	50.0	96.0	6.0	2.9	11.5	1.2	6.4	8.0
	Control	42.0	51.0	5.1	2.6	10.6	1.0	4.8	4.3
Mean		49.1	80.6	6.1	3.0	12.2	1.2	6.0	6.8
6fruits/shoot	2.5 ppm	50.0	60.2	5.4	2.3	10.7	1.5	5.0	5.0
	5.0 ppm	51.0	78.0	6.0	3.1	11.0	1.4	5.5	6.5
	7.5 ppm	45.0	81.6	5.2	2.8	12.0	1.3	6.4	7.0
	10.0 ppm	59.0	98.2	6.2	2.8	15.1	1.1	7.7	8.4
	12.5 ppm	53.0	96.8	6.2	3.4	11.3	1.2	6.3	7.9
	15.0 ppm	52.0	97.2	5.3	3.3	11.0	1.2	6.2	7.7
	Control	46.0	48.6	4.8	2.7	10.1	1.3	4.5	5.9
Mean		50.8	80.0	5.4	2.9	11.6	1.2	5.9	6.9
Control	2.5 ppm	39.0	50.2	6.4	3.2	11.4	1.3	5.5	5.9
	5.0 ppm	41.0	52.6	6.1	3.0	12.0	1.2	5.9	7.4
	7.5 ppm	39.0	54.5	6.0	2.8	12.5	1.1	6.5	8.2
	10.0 ppm	45.0	62.0	6.0	2.2	14.8	1.0	7.2	9.2
	12.5 ppm	43.0	59.0	6.5	3.6	11.2	1.2	7.0	8.3
	15.0 ppm	42.0	57.6	6.7	3.1	12.0	1.3	6.9	8.4
	Control	39.2	41.3	5.5	2.5	10.4	1.4	4.6	5.4
Mean		41.3	53.8	6.1	2.9	12.0	1.2	6.2	7.5
$CD_{0.05}$ A		2.1	3.0	0.2	0.6	NS	NS	NS	NS
B		2.0	2.0	0.1	0.4	0.1	0.1	0.1	0.4
AxB		3.0	4.1	0.3	1.0	1.0	0.4	0.2	0.6

NS=Non-significant

Table 2 : Effect of fruit thinning and CPPU spray on fruit yield of Kiwi fruit cv. HAYWARD

Treatments		Fruit physico-chemical characteristic							
Thinning (A)	Sitofex concentration (B)	Fruit yield kg/tree	Fruit weight (g)	Fruit breadth (cm)	Fruit length (cm)	TSS (^{0}B)	Acidity (%)	Reducing sugars (%)	Total sugar (%)
2fruits/shoot	2.5 ppm	27.0	82.6	5.2	3.6	10.7	1.3	6.1	8.0
	5.0 ppm	29.6	89.0	5.5	4.5	11.0	1.2	6.9	9.3
	7.5 ppm	30.0	95.3	5.3	4.2	12.0	1.1	8.1	9.6
	10.0 ppm	35.0	115.0	6.5	4.4	15.1	1.0	9.0	10.2
	12.5 ppm	37.5	110.6	5.2	4.0	11.3	1.2	7.9	9.5
	15.0 ppm	39.2	109.6	6.0	4.7	11.0	1.3	8.0	9.4
	Control	22.3	55.6	4.0	3.4	10.1	1.4	5.8	6.4
Mean		31.5	93.8	5.3	4.1	11.6	1.2	7.4	8.9
3fruits/shoot	2.5 ppm	32.6	74.6	5.4	3.7	11.4	1.6	7.8	7.2
	5.0 ppm	35.2	84.0	5.3	3.9	12.0	1.4	8.7	8.9
	7.5 ppm	38.0	97.3	5.5	4.1	12.5	1.2	8.2	9.0
	10.0 ppm	39.6	110.6	6.9	4.2	14.8	1.1	9.3	10.2
	12.5 ppm	37.0	106.3	5.5	3.5	11.2	1.3	8.1	9.6
	15.0 ppm	38.6	104.6	5.0	4.2	12.0	1.2	7.3	8.6
	Control	30.0	64.3	4.1	3.5	10.4	1.0	6.3	9.2
Mean		35.8	91.6	5.3	3.8	12.0	1.2	7.9	8.9
4fruits/shoot	2.5 ppm	39.0	83.2	6.0	3.7	12.3	1.5	6.9	7.4
	5.0 ppm	42.0	85.0	6.3	5.9	13.6	1.2	7.8	8.5
	7.5 ppm	46.0	90.0	5.9	4.1	14.2	1.1	8.2	8.9
	10.0 ppm	44.0	125.3	7.0	5.2	15.1	1.0	9.6	9.9
	12.5 ppm	45.0	110.9	5.9	4.5	12.6	1.2	9.1	8.6
	15.0 ppm	43.0	105.0	5.8	4.2	13.6	1.2	8.9	9.1
	Control	35.0	55.6	4.0	3.5	11.0	1.3	6.3	6.4
Mean		42.0	93.5	5.8	4.4	13.2	1.2	8.1	8.4
5fruits/shoot	2.5 ppm	44.2	80.1	5.5	3.9	11.2	1.6	7.2	7.2
	5.0 ppm	49.2	97.0	5.8	4.2	12.7	1.5	7.9	7.5
	7.5 ppm	50.2	99.7	6.0	3.9	14.3	1.4	7.8	8.4
	10.0 ppm	60.2	100.3	6.9	4.5	15.3	1.2	9.8	9.4
	12.5 ppm	55.2	98.2	6.6	5.0	14.6	1.0	7.9	8.3
	15.0 ppm	58.2	96.9	6.4	4.9	12.3	1.3	8.4	8.9
	Control	39.4	45.2	4.3	3.9	11.0	1.2	6.8	8.3
Mean		50.9	88.2	5.9	4.3	13.0	1.3	7.9	8.2
6fruits/shoot	2.5 ml Sitofex/litre	48.0	90.2	5.2	3.9	11.7	1.6	7.1	7.2
	5.0 ml Sitofex/litre	51.0	94.5	6.0	3.1	12.0	1.4	7.5	8.1
	7.5 ml Sitofex/litre	56.0	96.2	5.9	4.2	14.0	1.3	8.4	9.3
	10.0 ml Sitofex/litre	69.0	98.0	6.2	5.4	14.9	1.2	9.7	9.4
	12.5 ml Sitofex/litre	59.0	95.1	6.2	3.3	12.3	1.3	8.3	8.6
	15.0 ml Sitofex/litre	64.0	94.0	5.3	4.6	13.2	1.3	7.8	8.0
	Control	42.0	57.3	4.8	3.9	10.1	1.0	6.5	6.2
Mean		55.5	89.3	5.6	4.0	12.6	1.1	7.9	8.1
Control	2.5 ml Sitofex/litre	50.2	47.0	5.1	3.5	11.9	1.6	6.4	6.4
	5.0 ml Sitofex/litre	55.2	54.3	5.5	4.0	13.0	1.5	7.2	7.2
	7.5 ml Sitofex/litre	59.2	55.0	4.1	4.1	13.7	1.3	7.6	8.3
	10.0 ml Sitofex/litre	62.3	59.3	5.9	4.0	14.5	1.1	9.4	9.0
	12.5 ml Sitofex/litre	60.0	56.3	5.0	4.2	13.3	1.2	8.5	7.4
	15.0 ml Sitofex/litre	61.9	55.0	5.1	3.5	12.4	1.1	8.1	7.3
	Control	39.5	39.3	4.6	3.1	10.6	1.0	5.5	5.1
Mean		49.8	52.3	5.0	3.7	12.7	1.2	7.5	7.2
$CD_{0.05}$ A		3.0	4.0	0.1	0.5	NS	NS	NS	NS
B		2.4	3.2	0.1	0.3	0.9	0.1	0.2	0.3
AxB		4.1	5.2	0.4	0.8	1.8	0.4	0.3	0.5

NS=Non-significant

Fruit chemical properties:

Data presented in Table (1 and 2) revealed that, thinning treatments did not have any significant effect on fruit chemical properties *i.e.* total soluble solid (TSS), titratable acidity, reducing sugars and total sugars content in both seasons of investigation. The present results concealed that different CPPU concentration considerably increased TSS%, while titrarable acidity significantly decreased with increasing CPPU concentration. The highest total soluble solids and lowest acidity were achieved when fruit vines were sprayed with 10 ppm CPPU during the two seasons. Different CPPU concentration significantly increase the reducing sugar and total sugar content of Kiwifruit cv. Allison and Hayward as compared to control. This increase in TSS and sugar content with CPPU application may be attributed to early ripening induced by CPPU due to more ethylene evolution (Costa *et al*., 1997). The observation of Biasi and Cost (1991) and Chandel and Devi (2010) also corroborate these findings, who reported that CPPU treatment increased TSS and sugar content and reduced acidity in Kiwifruit. It is concluded that one spray two weeks after fruit setting of10 ppm CPPU induced an outstanding promotion on fruit weight, fruit yield and quality of Kiwifruit cv. Allison and Hayward. Further, this promising treatment had no adverse effects on fruit quality.

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