JEB
Journal of Environmental Biology

Journal Home page : www.jeb.co.in
E-mail : editor@jeb.co.in

ISSN: 0254-8704 (Print)
ISSN: 2394-0379 (Online)
CODEN: JEBIDP

Effect of summer pruning and CPPU on yield and quality of kiwi fruit (*Actinidia deliciosa*)

K.K. Pramanick[1], Poonam Kashyap[1,2]*, D.K. Kishore[1] and Y.P. Sharma[1]

[1]Indian Agricultural Research Institute, Regional Station, Amartara Cottage, Shimla -171 004, India

[2]Project Directorate for Farming System Research, Modipuram, Meerut - 250 110, India

*Corresponding Authors Email : pakhihorti@gmail.com

Publication Info

Paper received:
21 October 2013

Revised received:
03 March 2014

Accepted:
05 May 2014

Abstract

A field experiment was conducted on bearing vines of kiwifruit cv. Abbott to find the effect of CPPU (N-(2-chloro-4-pyridyl)-N-phenylurea) and summer pruning on fruit yield, fruit size and quality. CPPU greatly stimulated fruit growth indicating that it can be a powerful tool for improving kiwifruit cropping. Application of CPPU at 10 ppm concentration was done by dipping the fruits for 10 sec in the aqueous solution of compound at petal fall and 30 days after petal fall. CPPU applied fruits increased size by 20-70 g over control. Summer pruning along with CPPU application proved to be more effective in obtaining fruits of high grades with increased fruit weight (95.37 g fruit^{-1}) and high quality. Summer pruning, when done by pinching1/5th at Petal Fall stage + CPPU dipping (10 ml l^{-1}) and pinching 1/5th continued till harvest, at one month interval resulted in increased fruit yield (54.80 kg vine^{-1}), high TSS (17.6 0 Brix), high total sugar (9.85%), advanced ripening by one week and reduced flesh firmness.

Key words

CPPU, Fruit yield, Kiwifruit, Summer pruning

Introduction

Kiwifruit (*Actinidia deliciosa* Chev.), also known as Chinese Gooseberry, has tremendous commercial potential in the Sub-Himalayan and other temperate fruit growing regions of India and has emerged as a success story, after apple, in temperate fruit production (Chandel *et al*., 2004). It is a vigorous, perennial, deciduous vine trained to a structure that gives support to the shoots and fruits when grown commercially. The mature vine has a permanent framework of cordons. The plants are either female, male or monoecious. Fruits mature during late summer to autumn, depending on the region with firmness decreasing slightly in the later stages of ripening. Fruits are generally harvested at an average total soluble solids of 8-10 °Brix. The fruits are consumed fresh or processed (Pandey and Sharma, 2000). The average Vitamin C content is about 100 mg ascorbic acid/ 100 g fruit. Fruit size and quality are the most important characteristics affecting price and marketing of kiwifruit. The amount of fruit supported by the vine directly affects yield, fruit quality and flower bud differentiation (Chandel *et al*., 2004) thus, subsequently affecting yield and fruit quality the following season. A high fruit number per vine has been found to be inversely correlated to the average fruit weight (Thakur and Chandel, 2004). Photosynthetically active leaves supply carbohydrates to the fruits, creating a relationship between leaf area and fruit size. Competition between vegetative growth and fruiting as well as among fruits within the same vine for carbohydrates, amino acids, mineral elements and water often exists. Average fruit weight has been shown to decrease with increasing fruit number (Chandel and Devi, 2010). Thus, the average fruit weight at harvest may be manipulated in orchards by pruning and growth promoters.

The growers of the Sub-Himalayan region are not getting their price mainly due to small size of the fruit. The situation calls for standardizing proper pruning and training operations and /or proper application of growth regulators. In fruit crops, various growth promoters like auxin, gibberellins and cytokinin have been found effective in improving fruit size and quality (Lorenzo *et al*., 2007; Basak, 2011; Ouma, 2012; Nafea and Abdulfatah, 2014). Cytokinins are plant growth regulators with the ability to enhance

plant cell division and cell expansion, as well as delay senescence. However, their use in kiwi fruit cultivation has been relatively limited. Recently, a synthetic cytokinin, CPPU (N-(2 chloro-4-pyridyl)-N phenylurea, has been found very effective in stimulating fruit growth in kiwifruit (Lorenzo *et al*., 2007). The influence of canopy structure on fruit size development will also have to be considered in order to tackle the problem with a holistic approach. At present the percentage of A-Grade fruits (Fruit weight > 70 g) is less than 5% which severely affects the marketability of the produce. Keeping this in view, an attempt was undertaken to increase the size and weight of the fruit to make maximum A-Grade fruits so that it can compete with the imported kiwifruit and get maximum price of the produce.

Materials and Methods

The experiments were conducted on 16–year-old kiwifruit vines of cv. Abbott planted at a spacing of 4 m x 4 m and trained on cross-bar trellis at the experiment farm of IARI Regional Station, Shimla, H.P., India. The vines were maintained under uniform cultural practices during the course of the studies. Seventy two kiwi fruit plants were selected for different pruning treatments and application of bio-regulator *i.e.* CPPU. Summer pruning (started in June) was done by heading back of shoots to different levels at different times depending upon the treatment. During summer pruning, shoots were pruned back to different pruning intensities *viz*., 4 nodes level, 6 nodes level and pinching of 1/5th growth. Summer pruning was done at three different times *i.e.* at complete petal fall, 30 days after petal fall and pinching 1/5th of the growth from petal fall till harvest. CPPU at 10ppm was applied by dipping the fruits for 10 seconds in aqueous solution of the compound at petal fall stage as well as 30 days after petal fall stage.

Two experiemnts *viz*., summer pruning alone and summer pruning in combination with bio- regulator (CPPU) were laid out in a simple Randomized Block Design. Under each experiment six treatments and one control having three replicates each were maintained. In control, water was sprayed and no summer pruning was done.

After harvest, total yield and yield of different grades was determined on the basis of total fruit weight of different grades (A grade > 70g, B grade 50-70 g and C grade < 50g). The size of the fruits were measured in terms of length and diameter with the help of vernier calliper and fruit weight was taken on a top pan balance (Tapsons TAPT Series precision balance). TSS (^{o}Brix) and sugar percentage were recorded by standard procedures of AOAC (1990). Economic viability of various treatments was ascertained by comparing the net benefits of various treatments with control. For this purpose, current grade-wise farm gate prices of kiwifruit *viz*., 'A' grade (fruit weight > 70 g) Rs 40, B grade (50-70 g) Rs 30 and C grade (< 50 g) Rs 10 per Kg were used. The data recorded was statistically analysed in accordance with the method designed by Gomez and Gomez (1984). The difference in treatment means were evaluated using F test at $P < 0.05$.

Results and Discussion

Significant variation ($p < 0.05$) in total fruit yield of different grades was observed in vines subjected to summer pruning at different nodes in combination with bio-regulator treatment. Summer pruning treatments alone had significant effect ($p < 0.05$) on graded fruit. However, in combination with bio-regulator, they exhibited significant effect on total fruit yield, as well as grades of fruit. The highest yield of 52.82 kg vine^{-1} was obtained in summer pruning treatment by pinching 1/5th growth at complete petal fall and continued till harvest at one month interval, which was followed by 50.49 kg vine^{-1} in pruning at 6-Node level (NL) at complete petal fall stage (Table 1). These treatments were statistically at par with each other but significantly superior to control in respect of the total fruit yield. The lowest yield of 45.50 kg vine^{-1} was obtained from vine kept as control. The proportion of grade 'A' and 'B' fruits in the total yield also increased by summer pruning.

The maximum 'A' grade and 'B' grade fruits were obtained in treatment of pinching 1/5th growth at complete petal fall and continued till harvest at one month interval being 23.13 and 22.80 kg vine^{-1} respectively, which also produced minimum 6.89 kg of 'C' grade fruits. The minimum yield of 'A' grade fruits 9.22 kg vine^{-1} and maximum 'C' grades fruits (20.96 kg vine^{-1}) was harvested from control vines. Total yield, yield of different grade fruits, fruit size and weight was significantly increased by the application of cytokinin based growth regulator (CPPU) in combination with light summer pruning. These results are in agreement with the findings of Chandel and Devi (2010) who observed significant increase in yield of different grade fruits as a result of CPPU application, The growth stimulating capabilities of CPPU in kiwifruit have been reported by various authors (Woolley and Cruz-Castillo, 2006; Lorenzo *et al*., 2007; Brown and Woolley, 2010) Significant impact of summer pruning on increased production of A grade fruits and better size fruits have also been reported (Miller *et al*., 2001; Chandel *et al*., 2004). Summer pruning helps in reducing vegetative growth to lessen carbohydrate losses and the competition between vegetative and fruit growth (Miller *et. al*, 2001). In addition, summer pruning opens the canopy for natural pollinators (bees), allows more airflow within the canopy, and maximizes light interception – all of which promote fruit quality (Grant *et al*., 1994; Henzell *et. al*, 1986). Fruit size of kiwifruit is greatly influenced by source-sink relationship as reported by Boyd and Barnett (2011).

The data regarding fruit size, in terms of length and width, is presented in Table 1. Maximum fruit length (71.63mm) and width (52.11mm) was recorded in pinching 1/5th growth at complete petal fall and continued till harvest at one month interval treatment, followed by fruit length 67.93mm and width 51.29mm in pruning at 6-node level (NL) at complete petal fall stage

Table 1 : Effect of summer pruning on yield and quality attributes of kiwi

Treatment	Fruit yield (kg vine^{-1})				Fruit size(mm)		Average fruit weight (g)	TSS (ºB)	Acidity (%)	Total sugar (%)	Fruit firmness (Kg)
	"A" Grade	"B" Grade	"C" Grade	Total yield	Length	Width					
4NL at complete petal Fall	18.56	16.75	14.26	49.57	60.87	51.01	72.13	15.79	0.90	8.62	10.09
4NL at 30 DAPF	16.59	17.08	15.26	48.93	57.27	50.03	68.80	15.83	0.89	8.52	10.21
6 NL at complete petal Fall	20.33	19.78	10.38	50.49	67.93	51.29	78.07	15.57	0.88	8.70	10.15
6 NL at 30 DAPF	18.75	17.53	12.34	48.62	60.40	51.14	75.87	15.40	0.87	8.60	10.01
Pinching 1/5th growth at complete Petal Fall and contd. till harvest at one month interval	23.13	22.80	6.89	52.82	71.63	52.11	80.23	15.85	0.82	8.69	10.07
Pinching 1/5th growth at 30 DAPF and contd. till harvest at one month interval	20.05	18.05	10.12	48.22	63.53	52.01	78.90	15.82	0.89	8.66	10.16
Control	9.22	15.32	20.96	45.50	55.42	48.73	45.20	15.35	0.98	8.13	10.97
$CD_{0.05}$	14.61	7.46	14.53	3.57	4.42	2.68	23.29	0.40	0.23	0.37	0.91

NL: Node Level, DAPF: Days After Petal Fall, CPPU: [N-(2-chloro-4-pyridyl)-N-phenylurea]

treatment. The minimum fruit length (55.42mm) and width (48.73mm) was found in control, which was significantly lower ($p < 0.05$) as compared to all other treatments. The average fruit weight was increased by summer pruning treatments (Table 1). The maximum fruit weight of 80.23 g was recorded in pinching 1/5th growth at complete petal fall and continued till harvest at one month interval treatment, which was although at par with pruning at 6=node level (NL) at complete petal fall stage treatment, but significantly higher than other treatments. However, the minimum fruit weight of 45.20g was recorded in control vines. The mechanism of action of bioregulators for enhancing kiwifruit size seems to be related to increase in the level of endogenous cytokinins, gibberellins and auxins (Brown and Woolley, 2010; Famiani *et al*., 1999, 2007), which promote greater cell division and/or expansion (Woolley and Cruz-Castillo, 2006; Antognozzi *et al*, 1997) and greater attraction of water and carbohydrates towards the fruits (Antognozzi *et al*., 1997).

The highest yield of 54.80 kg vine^{-1} was obtained in summer pruning treatment of pinching 1/5th growth at complete petal fall, in combination with CPPU dipping (10 ml l^{-1}) and pinching 1/5th continued till harvest at one month interval, which was followed by 51.45 kg vine^{-1} in pruning at 6 NL at complete petal fall stage, in combination with CPPU dipping (10ml l^{-1}) (Table 2). These treatments were statistically at par with each other but significantly superior to control with respect to total fruit yield. The lowest yield of 45.50 kg vine^{-1} was obtained from control vine. The proportion of grade 'A' and 'B' fruits in the total yield was also increased by summer pruning in combination with CPPU application. The maximum 25.15 kg vine^{-1} 'A' grade and 22.80 kg/vine 'B' grade fruits were obtained in treatment of pinching 1/5th growth at complete petal fall in combination with CPPU dipping and continued till harvest at one month interval, along with the production of 6.85 kg of 'C' grade fruits. The minimum yield of 'A' grade fruits 9.22 kg vine^{-1} and maximum 'C' grades fruits (20.96 kg vine^{-1}) was harvested from control vines. The increased yield in kiwifruit, in the present investigation, may be due to larger fruit size and weight induced by CPPU (Famiani *et al*., 2007) and summer pruning (Miller *et al*., 2001). Kiwi vines treated with Benefit ® kiwi have been shown to have a 26.4g fruit weight increase as compared to untreated vines as suggested by Brown and Woolley (2010). Similarly Woolley and Cruzcastillo (2006) reported 16.9g increase in weight of *Actinidia chinensis* selection. The proportion of grade 'A' fruit was increased. Vasilakakis *et al.* (1997) found that small size fruits in kiwifruit cv. Hayward were mainly due to overloading of vines. CPPU may be attributed to its effects in promoting larger fruit growth by increased cell division as CPPU is a cytokinin like substance. Greene (1995) in apple, and Famiani *et al*. (1999) in kiwifruit also obtained larger and heavier fruits following cytokinin based treatments. The maximum fruit length (72.63 mm) and width (52.21 mm) was recorded in pinching 1/5th growth at complete petal fall in combination with CPPU dipping and continued till harvest at one month interval treatment, followed by fruit length 69.53 mm and width 52.11 mm in pinching 1/5th growth at 30 days after petal fall (DAPF) in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment. The minimum fruit length (55.42 mm) and width (48.73mm) was found in control, which was significantly lower as compared to all other treatments (Table 2). The average fruit weight was increased by summer pruning in combination with CPPU dipping treatments (Table 2).

The maximum fruit weight of 95.37 g was recorded in the treatment of pinching 1/5th growth at complete petal fall in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment, followed by 87.19 g in the treatment of pinching 1/5th growth at 30 DAPF in combination with CPPU dipping and pinching 1/5th continued till harvest at one

Table 2 : Effect of summer pruning in combination with CPPU application on the yield and quality attributes of kiwi

Treatment	Fruit Yield (kg vine^{-1})				Fruit size(mm)		Average fruit weight (g)	TSS (ºB)	Acidity (%)	Total sugar (%)	Fruit firmness (Kg)
	"A" Grade	"B" Grade	"C" Grade	Total yield	Length	Width					
4NL at complete petal Fall+ CPPU dipping (10ml l^{-1})	21.50	15.75	13.25	50.50	61.78	52.01	79.33	17.5	0.80	9.5	9.87
4NL at 30 DAPF + CPPU dipping(10ml l^{-1})	17.55	18.05	14.25	49.85	58.72	50.03	75.91	17.2	0.85	9.4	10.05
6 NL at complete petal Fall+ CPPU dipping(10ml l^{-1})	20.35	19.75	11.35	51.45	69.53	51.92	84.18	17.5	0.74	9.6	9.92
6 NL at 30 DAPF + CPPU dipping(10ml l^{-1})	18.75	17.55	12.35	48.65	61.04	51.41	83.78	17.1	0.80	9.3	10.01
Pinching 1/5th at Petal Fall and CPPU dipping (10ml l^{-1}) and pinching 1/5th contd. till harvest at one month interval	25.15	22.80	6.85	54.80	72.63	52.21	95.37	17.6	0.59	9.85	9.77
Pinching 1/5th at 30 DAPF and CPPU dipping (10ml l^{-1}) and pinching 1/5th contd. till harvest at one month interval	22.05	19.05	8.15	49.25	69.53	52.11	87.19	17.1	0.67	9.7	9.97
Control	9.22	15.32	20.96	45.50	55.42	48.73	45.20	15.35	0.98	8.2	10.97
$CD_{0.05}$	16.82	8.51	15.17	3.71	4.52	3.61	25.23	0.80	0.17	0.7	1.19

NL: Node Level, DAPF: Days After Petal Fall, CPPU: [N-(2-chloro-4-pyridyl)-N-phenylurea]

month interval. However, the minimum fruit weight of 45.20g was recorded in control vines. Summer pruning treatments alone had significant effect on graded fruit which could be explained by the fact that it reduces vegetative growth resulting in lessening of carbohydrate loss and competition between vegetative and fruit growth (Chandel and Devi, 2010; Miller *et al*., 2001), however, in combination with bio-regulator they exhibited significant effect on total fruit yield as well as graded fruit, increased TSS, total sugars and decreased percent acidity as reported by Gerasopoulos and Drogoudi (2005) which indicated summer-pruning increased fruit soluble solids content (SSC).The higher TSS content might be attributed to higher rate of assimilation of photosynthates, as cytokinins are known to influence mobilization of metabolites and nutrients to the cytokinin treated portion of plants (Chandel and Devi, 2010)

Famiani *et al*. (1999) also reported an increase in total soluble solids and reduction in acidity with the application of thidiazuron in kiwifruit. Significant variation in fruit yield and yield of different grades fruit was observed in vines subjected to treatments of CPPU in combination with summer pruning. The highest yield and yield of 'A' and 'B' grades fruit was obtained in pinching 1/5th growth at complete petal fall in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment, which also gave lowest yield of 'C' grade fruits. The increase in total yield of 'A' and 'B' grades fruits, with the application of the treatment, was mainly attributed to increase in fruit size (Table 2), which incurred due to direct effect of CPPU on cell division and enlargement (Antognozzi *et al*., 1993). Similarly, Costa *et al*. (1997) reported that CPPU enhanced yield in kiwifruit. The increase in fruit size and weight with CPPU might be attributed to stimulation of cell division and elongation by CPPU, which increased the number and size of small cells in the outer and inner pericarp and increased cell number in core (Antognozzi *et al*., 1997). A significant increase in total soluble solids and sugar content was found in CPPU treated fruits. Fruits dipped in 10 ppm CPPU for 10 seconds gave highest TSS, total sugars and lowest acid content (Table 2). This increase in TSS and sugar content with CPPU application might be attributed to early ripening induced by CPPU due to more ethylene evolution (Costa *et al*., 1997). Woolley and Cruz-Castillo (2006) reported evidence that CPPU interacts positively with naturally occurring cytokinins in stimulating kiwifruit growth. Faminai *et al*. (2007) reported that the use of Thidiazuron (TDZ) produced squatter fruits and accelerated ripening of kiwifruit (lower flesh firmness and higher soluble solids content at harvest with respect to untreated fruits). The average fruit weight was increased indirectly by late pruning and directly only by 'light' early pruning. In a previous study, Boyd and Barnett (2011) assessed the effects on fruit of kiwi cultivars, due to manipulating whole vine carbon allocation by pruning. Total soluble solids, fruit acidity, total sugar and fruit firmness were not significantly affected by summer pruning treatments at different level (Table 1).

The highest TSS (17.6° Brix) was observed in pinching 1/5th growth at complete petal fall in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment and the minimum TSS (15.35° Brix) was

recorded in control. All the treatments significantly reduced fruit acidity. The minimum fruit acidity (0.59%) was recorded in pinching 1/5th growth at complete petal fall in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment and the maximum fruit acidity (0.98 %) was recorded in control. All the treatments significantly increased the total sugar as compared to control. The maximum total sugar (9.85%) was recorded in pinching 1/5th growth at complete petal fall in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment where as, the minimum total sugar (8.20%) were observed in control fruits. The fruit firmness varied from 9.77 to 10.97 kg pressure. The maximum fruit firmness was recorded in control where as, minimum was recorded in pinching 1/5th growth at complete petal fall in combination with CPPU dipping and pinching 1/5th continued till harvest at one month interval treatment (Table 2). The highest TSS (15.85° Brix) was observed in pinching 1/5th growth at complete petal fall and pinching 1/5th continued till harvest at one month interval treatment and the minimum TSS (15.35°Brix) was recorded in control. All the treatments significantly reduced fruit acidity. The minimum fruit acidity (0.82%) was recorded in pinching 1/5th growth at complete petal fall and pinching 1/5th continued till harvest at one month interval treatment and the maximum fruit acidity (0.98%) was recorded in control. All the treatments significantly increased the total sugar as compared to control. The maximum total sugar (8.69%) was recorded in pinching 1/5th growth at complete petal and pinching 1/5th continued till harvest at one month interval treatment where as, the minimum total sugars (8.13%) was observed in untreated fruits. The fruit firmness varied from 10.01 to 10.97 kg pressure. The maximum fruit firmness was recorded in control where as, minimum was recorded in pinching 1/5th growth at complete petal fall and pinching 1/5th continued till harvest at one month interval treatment (Table 1). Results obtained in the present experiment are in confirmity with the findings of Chandel and Devi (2010) who reported that CPPU treatment resulted in increased TSS, sugar content and reduced fruit acidity in kiwifruit. Similar effects of summer pruning on TSS, total sugars, fruit acicidty and firmness have been reported by Rana *et al*. (2010); Guollo *et al*., (2013).

Data presented in Table 2 showed significant increase in fruit size and weight with the application of CPPU. The maximum fruit length (7.26 cm) and width (5.22 cm) was recorded in combination of summer pruning and 10 ppm CPPU treatment. The minimum fruit length (5.54 cm) and width (4.87 cm) was found in untreated fruits. Similarly, fruit weight significantly increased with the application of CPPU in combination with summer pruning as compared to control. The maximum fruit weight (95 g) was recorded in combination with summer pruning and CPPU treated fruits and minimum (45 g) in control. The fruits dipped in 10 ppm CPPU in combination with summer light pruning showed highest TSS, total sugar, lowest acid content and firmness content (Table 2). These treatments resulted in maximum production of 'A' grade fruits with better size, quality and accounted for higher increase in net benefits over control.

Based on the results obtained, it is concluded that pinching1/5th growth and CPPU dipping in 10 ppm (10 ml l^{-1}) at petal fall stage and thereafter pinching 1/5th continued till harvest at one month interval improved fruit size, yield, quality and gave higher returns.

Acknowledgment

Authors are thankful to the Director, IARI, New Delhi for providing the facilities and financial assistance in terms of institute project.

References

Alina Basak: Efficiency of fruitlet thinning in apple 'Gala must' by use of metamitron and artificial shading. J. Fruit Ornam. *Plant Res*., **19**, 51-62 (2011).

Antognozzi, E., F. Famiani and P. Proietti: Effect of CPPU treatments on fruit anatomical structure and quality of kiwifruit. *Acta Hort*., **444**, 459-63 (1997).

Antognozzi, E., F. Famiani, A. Palliotti and R. Goren: Effect of CPPU treatments on kiwifruit productivity. *Acta Hort*., **329**, 150-152 (1993).

AOAC : *Official Methods of Analysis.*Association of Official Agricultural Chemists, 13th Edn., Witz, W.H. Benjamin, Station, Washington, DC. p. 1018 (1990).

Boyd, L.M. and A.M. Barnett: Manipulation of whole-vine carbon allocation using girdling, pruning, and fruit thinning affects fruit numbers and quality in kiwifruit. *Hort. Sci*., **46**, 590-595 (2011).

Brown, E. and D.J. Woolley: Timing of application and growth regulator interaction effects on fruit growth of two species of *Actinidia*. *Acta. Hort*., **884**, 107-113 (2010).

Chandel, J. S. and Sarita Devi: Effect of CPPU, promalin and hydrogen cynamide on flowering, yield and fruit quality of kiwifruit. *Indian J. Horti*., **67**(Special Issue): 120-123 (2010).

Chandel, J.S., O.A. Bharti and R.K. Rana: Effect of pruning severity on growth, yield and fruit quality of Kiwifruit (*Actinidia deliciosa* Chev.). *Indian J. Horticult.*, **61**, 114-117 (2004).

Costa, G., F. Succi, R. Quadretti, E. Sfakiotakis and J. Porlingis: Effect of CPPU and pollination on fruiting performance, fruit quality and storage life of Kiwifruit cv.Hayward. *Acta Hort.,* **444**, 467-72 (1997).

Famiani, F., P. Proietti, M. Pilli, A. Battistelli and S. Moscatello: Effects of application of thidiazuron (TDZ), gibberellic acid (GA3), and 2,4-Dichlorophenoxyacetic acid (2,4-D) on fruit size and quality of *Actinidia deliciosa* 'Hayward'. *New Zealand J. Crop Horticult. Sci.*, **35**, 341-347 (2007).

Famiani, F., A. Battistelli, S. Moscatello, M. Boco and E. Antognozzi: Thiadiazuron effects fruit growth, ripening and quality of *Actinidia deliciosa. J. Hort. Sci. Biotech.,* **74**, 375-380 (1999).

Gerasopoulos, D. and P. D. Drogoudi: Summer-pruning and preharvest calcium chloride sprays affect storability and low temperature breakdown incidence in kiwifruit. *Postharvest Biol. Technol.*, **36**, 303-308 (2005).

Gomez, K.A. and A.A. Gomez: *Statistical Procedures for Agricultural Research* (2nd ed.) John Willey and Sons Inc, New York, p. 680 (1984).

Grant, J. A., V.S. Polito and K. Ryugo: Flower development. In: J. Hasey, R.S. Johnson, J.A. Grant, and W.O. Reils (eds). Kiwifruit growing and handling. ANR Publ.: Oakland, CA, pp. 14-17 (1994).

Greene, D.W.: Thidiazuron effects on fruit set, fruit quality and return bloom of apples. *Hort. Sci.,* **30**, 1238-1240 (1995).

Guollo, G. B. Valentino, D. Agostino, Z., Rocco and I. Paplo: Effect of summer pruning on some fruit quality traits in Hayward kiwifruit. *Fruits*, **68**, 315-318 (2013).

Henzell, R.F., M.R. Briscoe, and D.R. Lauren: Evaluation of two plant growth regulators as chemical pruning agents for kiwifruit vines in summer. *New Zealand J. Exp. Agric*., **14**,199-203 (1986)

Lorenzo, E.R., B. Lastra, V. Otero and P.P. Gallego: Effects of three plant growth regulators on Kiwifruit development. *Acta Hort.,* **753**, 549-554 (2007).

Miller, S.A., F.D. Broom, T.G. Thorp and A.M. Barnett: Effects of leader pruning on vine architecture, productivity, and fruit quality in kiwifruit (*Actinidia deliciosa* cv. Hayward). *Scientia Hort*., **91**,189-199 (2001).

Nafea Shabaq, M. and Halala Abdulfatah K.: Effect of foliar applications of Ga3 and NAA for reducing alternate bearing of olive trees (*Olea europaea* L Cv. Ashrasie). *J. Agri. Vet. Sc*., **7**, 8-12 (2014).

Ouma George: Fruit thinning with specific reference to Citrus species: A Review. *Agri. Biol. J. N. Am*., **3**, 175-191 (2012).

Pandey, G. and Y.P. Sharma: Kiwi Fruit. T.K. Chattopadhyay (Ed.). A text book on pomology. Kalyani Publishers, New Delhi. **4**, p. 311 (2000)

Rana, V.S., J. Basar and A.S. Rehalia: Effect of time and severity of summer pruning on the vine characteristics, fruit yield and quality of kiwifruit. *Acta Hort*., **913**, VII International Symposium on kiwifruit (2010).

Thakur, A and J.S. Chandel: Effect of thinning on fruit yield, size and quality of kiwifruit cv. Allison. *Acta Hort.,* **662**, 359-364 (2004).

Vasilakakis, M., K. Papazdopoulos, E. Papageorgiov, E. Sfalciotakis and J. Portingis: Factors affecting the fruit size of Hayward Kiwifruit. *Acta Hort.,* **444**, 419-424 (1997).

Woolley, D. and J.G. Cruz-Castillo: Stimulation of fruit growth of green and gold kiwifruit. *Acta Hort.,* **727**, 291-294 (2006).