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Studies on Exogenous Application of Cppu and Ga_3 on Yield, Fruit Quality Characters and Seedlessness in Watermelon

[1]T. Susila, [2] S. Amarender Reddy, [3]M. Rajkumar, [4]G. Padmaja and [4]P.V. Rao

[1]Herbal Garden, Rajendranagar, [2]College of Horticulture, Rajendranagar,
Dr YSRHU Horticultural University Hyderabad-500 030, India
[3]Fruit Research Station, Sangareddy-501001, India
[4]College of Agriculture, ANGRAU, Rajendranagar, Hyderabad-500 030, India

Abstract: A field experiment was conducted during 2006-2007 and 2007-2008 seasons at Herbal garden, Rajendranagar, Hyderabad, India to study the influence of exogenous application of CPPU and GA_3 yield, fruit quality characters and seedlessness in watermelon. The experiment consists of 12 treatments (CPPU-50 ppm (T_1), CPPU-100 ppm (T2), CPPU-200 ppm (T3), GA_3-100 ppm(T_4), GA_3-200 ppm(T_5), CPPU 50 ppm + GA_3 100 ppm(T_6), CPPU 50 ppm + GA_3 200 ppm (T_7), CPPU 100 ppm + $GA_3$100 ppm(T_8), CPPU 100 ppm + GA_3 200 ppm(T_9), CPPU 200 ppm + GA_3 100 ppm(T_{10}), CPPU 200 ppm + GA_3 200 ppm(T_{11}) and untreated control(T_{12}). The mean fruit set (47.83) was maximum in plants treated with CPPU 200 ppm + GA_3 100 ppm (T_{10}). The mean fruit weight (3.56 kg) was maximum in plants treated with CPPU 100 ppm + GA_3 100 ppm (T_8). The mean number of normal seeds (28.00) were minimum in plants treated with CPPU 200 ppm (T_3). The mean total soluble solids content (12.27) was maximum in plants treated with CPPU 200 ppm + GA_3 100 ppm (T_{10}). The total sugars content (11.87) was maximum in plants treated with CPPU 200 ppm + GA_3 100 ppm (T_{10}). Significant differences were not observed among the treatments with respect to lycopene content.

Key words: Watermelon · CPPU · Gibberellic acid · Yield

INTRODUCTION

Watermelon is one of the most common cucurbits grown in India. The newly developed plant growth regulator, CPPU a urea derivative cytokinin promotes fruit growth in Grape [1], pears [2] and kiwi fruit [3] as well as increasing fruit set in melon [4]. Gibberellins have been used successfully for inducing seedlessness and improving the grapes yield in grapes. In Grape it is evident that pre-bloom application is more effective because Gibberellic acid applied at this stage not only acts as a pollenicide but also causes ovule degeneration [5, 6]. Commercial application of GA_3 has so far been perfected in grapes to produce seedless grapes. In the present study different concentrations of CPPU and gibberellic acid and their combinations were tried to examine the possible enhancement of yield, fruit development and to produce seedlessness in watermelon.

MATERIALS AND METHODS

The present investigation was carried out during 2006-2007 and 2007-2008 at Herbal Garden Scheme, Rajendranagar, Hyderabad, India on watermelon cv. Sugar Baby. The experiment consists of 12 treatments (T_1-CPPU-50 ppm, T_2-CPPU-100 ppm, T_3-CPPU-200 ppm, T_4-GA_3-100 ppm, T_5-GA_3-200 ppm, T_6-CPPU 50 ppm + GA_3 100 ppm, T_7-CPPU 50 ppm + GA_3 200 ppm, T_8-CPPU 100 ppm + $GA_3$100 ppm, T_9-CPPU 100 ppm + GA_3 200 ppm, T_{10}-CPPU 200 ppm + GA_3 100 ppm, T_{11}-CPPU 200 ppm + GA_3 200 ppm and T_{12}-untreated control). Watermelon seeds were sown on during December 2nd week at a spacing of 3.0 m x 0.9 m during both the years. Well decomposed farm yard manure @ 20 t ha^{-1} was applied for all the experimental plots uniformly as basal application. Nitrogen @ 80 kg ha^{-1} in the form of urea was applied in three equal split doses, one as basal application and other two split doses at 30 and 45 days

Corresponding Author: T. Susila, Herbal Garden Scheme, Dr YSR Horticultural University, Rajendranagar, Hyderabad-500030, India.

after sowing. Phosphorous @ 50 kg ha^{-1} in the form of single super phosphate and potassium @ 50 kg ha^{-1} in the form of muriate of potash were applied as basal dose. The solutions of different treatments were applied with a writing brush to the ovaries of opened flowers at anthesis. Standard cultural practices were followed during the entire crop period for all the treatments. The experiment was laid out in randomized block design and replicated thrice. The data were recorded on per cent fruit set, number of fruits per vine, yield per vine, average fruit diameter, average fruit weight, number of normal seeds and empty seeds per fruit, seed weight, rind thickness, total soluble solids (TSS), lycopene and total sugars. All the recorded data were analyzed statistically.

RESULTS AND DISCUSSION

Number of fruits per vine was highest in T_7-CPPU 50 ppm + GA_3 200 ppm (2.94) while T_{10}-CPPU 200 ppm + GA_3 100 ppm (2.89) and T_3-CPPU 200 ppm (2.72) were at par (Table 1). Increase in number of fruits in these treatments might be due to higher fruit set. CPPU alone and in combination with GA_3 significantly improved the fruit set. Maximum fruit set was observed in T_{10}-CPPU 200 ppm+ GA_3 100 ppm (47.83%). All the treatments having CPPU registered higher fruit set than control. Lowest fruit set was observed in untreated control (22.33%). Similar enhancement in fruit set have been reported earlier in Japanese persimmon [7], melon [8, 9] and grape [4, 10, 11] and it was presumed to be effective for a wide range of plant species.

Increase in fruit diameter with GA_3 application was evident from the data (Table 1). Both the concentrations of GA_3 significantly increased the fruit diameter over all other treatments. Higher fruit diameter was recorded in T_4-GA_3 100 ppm (18.90 cm). Farooq and Hulamani [12] also reported increase in bunch length and width of grape due to application of gibberellic acid. Retameles *et al*. [13] noticed a significant increase in berry size in grape cv. Thompson seedless when treated with GA alone or GA in combination with CPPU. Nitsch *et al.* [14] suggested that fruit size and shape are closely related with seed number and seed distribution in many species. Kurata [15] also observed that fruit development is related to seed numbers in watermelon. Both the concentrations of GA_3 significantly improved the fruit weight (Table 1). Application of T_8-CPPU 100 ppm + GA_3 100 ppm (3.56 kg) enhanced the fruit weight while T_4-GA_3 100 ppm (3.54 kg) and T_5-GA_3 200 ppm (3.51 kg) were at par. Lesser fruit weight was recorded in T_1-CPPU 50 ppm (1.88 kg). The present results are in line with those obtained by Nickell [1] who observed that CPPU along with GA_3 increased the berry weight in Thompson seedless grapes than CPPU and GA_3 alone. Increase in fruit weight could be attributed to increase in cell division due to CPPU and increase in cell elongation was due to the action of GA_3. Martin *et al*. [16] used cytokinins together with gibberellins and the positive influence on fruit shape in apples by increasing the length: diameter ratio. Lee *et al*. [17] reported that application of GA_3 + KT-30 at 7 days after full bloom increased berry weight by 30 per cent in Kyoho grape.

Table 1: Effect of exogenous application of CPPU and Gibberellic acid on yield attributing characters of watermelon

Treatment	No.of fruits per vine	Yield per vine (kg)	Percent fruit set	Fruit diameter (cm)	Average fruit weight (kg)
T_1- CPPU 50 ppm	2.17	5.34	42.50	13.50	1.88
T_2- CPPU 100 ppm	2.30	5.94	40.83	13.93	2.16
T_3- CPPU 200 ppm	2.72	7.76	43.00	15.60	2.27
T_4- GA_3 100 ppm	2.48	9.37	32.50	18.90	3.54
T_5- GA_3 200 ppm	2.33	8.55	33.10	17.20	3.51
T_6- CPPU 50 ppm + GA_3 100 ppm	2.54	8.75	41.67	15.77	2.67
T_7- CPPU 50 ppm + $GA_3$200 ppm	2.94	8.90	46.11	15.93	2.54
T_8- CPPU 100 ppm + GA_3 100 ppm	2.30	9.98	41.33	17.53	3.56
T_9- CPPU 100 ppm + $GA_3$200 ppm	2.66	9.46	38.33	16.63	3.14
T_{10}- CPPU 200 ppm + GA_3 100 ppm	2.89	10.81	47.83	16.50	3.19
T_{11}- CPPU 200 ppm + $GA_3$200 ppm	2.22	7.08	45.83	15.10	2.59
T_{12}- Control	1.94	6.17	22.33	15.50	2.82
SEm ±	0.08	0.15	2.59	0.343	0.09
LSD (0.05)	0.23	0.43	7.37	0.975	0.27

Table 2: Effect of exogenous application of CPPU and Gibberellic acid on number of seeds and quality characters of watermelon

Treatment	Number of normal seeds	Empty seeds	Seed weight (g)	Rind thickness (cm)	Total soluble solids(^{0} Brix)	Total sugars (%)	Lycopene content (mg/ 100g^{-1})
CPPU 50 ppm	200.00	20.83	8.45	0.87	9.07	8.16	32.56
CPPU 100 ppm	181.00	133.00	6.92	1.03	10.20	8.55	32.41
CPPU 200 ppm	28.00	180.17	0.62	1.07	9.70	10.00	31.34
GA_3 100 ppm	340.67	69.67	13.08	1.02	11.23	11.39	32.23
GA_3 200 ppm	221.17	47.50	5.91	0.90	10.25	10.63	32.58
CPPU 50 ppm + GA_3 100 ppm	191.17	27.83	4.60	1.07	10.87	11.27	31.68
CPPU 50 ppm + $GA_3$200 ppm	102.50	163.83	5.17	1.33	9.40	9.85	31.90
CPPU 100 ppm + GA_3 100 ppm	422.33	40.33	12.99	0.87	9.55	9.94	32.46
CPPU 100 ppm + $GA_3$200 ppm	113.00	179.17	4.67	1.03	10.60	8.88	31.56
CPPU 200 ppm + GA_3 100 ppm	228.33	181.33	8.51	1.30	12.27	11.87	31.77
CPPU 200 ppm + $GA_3$200 ppm	122.00	181.83	5.49	1.17	10.52	8.37	32.39
Control	344.17	13.33	13.89	1.00	9.72	8.91	31.20
SEm ±	3.60	5.30	0.31	0.05	0.27	0.43	0.52
LSD (0.05)	10.24	15.87	0.90	0.16	0.76	1.21	NS

Application of T_{10}-CPPU 200 ppm + GA_3 100 ppm (10.81 kg) resulted in higher yield (Table 1). From the data it is evident that CPPU in the presence of gibberellic acid significantly improved the yield per vine than CPPU alone. Similar findings were also observed by Ramteke and Somkuwar [18] who reported improvement in yield of Thompson seedless grapes when CPPU was applied in combination with GA_3. It seems possible that CPPU and GA_3 at different concentrations had improved the internal physiology of developing fruits in terms of better supply of water, nutrients and other compounds vital for their growth and development which resulted in higher fruit set, fruit weight and ultimately greater yield compared to control. Ranipase *et al*., [19] reported a significant increase in berry length, diameter, berry weight and yield when CPPU 3 ppm + GA 25 ppm was applied to cv. Thompson seedless.

Application of CPPU at higher concentrations significantly reduced the number of normal seeds per fruit compared to other treatments (Table 2). Lowest number of normal seeds were observed in T_3-CPPU 200 ppm (28.00), while highest number were observed in T_8-CPPU 100 ppm + $GA_3$100 ppm (422.33). Reduction in seed number by CPPU treatments were also reported in McIntosh Apples (20). It is evident from the data that GA_3 also at higher concentrations in combination with CPPU significantly decreased the number of normal seeds in watermelon fruit T_7-CPPU 50 ppm + $GA_3$200 ppm (102.50). Increase in seed numbers in T_8-CPPU 100 ppm +GA_3 100 ppm might be due to increased fruit size in terms of fruit weight. Similar findings were also observed in pumpkin with GA_3 treatment [21]. From the present study it can be suggested that lower number of normal seeds in T_3-CPPU 200 ppm could be one of the reason for lower fruit weight. Application of CPPU alone at higher concentrations and in combination with GA_3 increased the empty seed coats . T_{11}-CPPU 200 ppm + $GA_3$200 ppm (181.83) significantly increased the empty seeds with only seed coats, while T_{10}-CPPU 200 ppm + $GA_3$100 ppm (181.33) and T_3-CPPU 200 ppm 181.33 were at par. Similar increase in empty seed coats with the application of CPPU was also observed in musk melon [22]. Gustafson [23] reported correlation between high auxin content and seedlessness. Kim *et al*. [24] however suggested that a genetic factor for parthenocarpy was associated with the higher IAA content in cucumber ovary. Elevated levels of IAA content in the ovary might be the reason for induction of parthenocarpy. There are also some reports that exogenously applied cytokinins increased the level of endogenous auxin in some plant tissues [25]. Higher number of empty seed coats in CPPU 200 ppm in the present investigation could be attributed to higher levels of auxin content. Earlier reports suggested that parthenocarpic fruits in cucumber was induced not only by the application of auxins [26] but also by gibberellins, cytokinins [27] and auxin transport inhibitors [28]. The actual role of the exogenous phytohormones on parthenocarpic fruit set was not yet so far understood.

The lowest seed weight was observed in T_3-CPPU 200 ppm (Table 2). The mean seed weight per fruit was minimum (0.62 g) in T_3-CPPU 200 ppm while the seed weight (13.89 g) per fruit was maximum in control. Lower seed weight in T_3-CPPU 200 ppm could be due to lowest number of normal seeds.

Rind thickness is a negative character in watermelon. A variety having lesser fruit weight will have lesser rind thickness and *vice versa* [29]. Among the treatments investigated the mean rind thickness (1.33 cm) was maximum in plants treated with T_7-CPPU 50 ppm + GA_3 200 ppm and T_{10}-CPPU 200 ppm +GA_3 100 ppm (1.30 cm) were at par (Table 2). Serrani *et al*. [30] found that with GA application in tomato resulted in thicker pericarp and this was attributed to increase in cell size. The lowest rind thickness was observed in T_1-CPPU 50 ppm alone.

Significant differences were observed among the treatments with respect to quality characters (Table 2). Significant increase in total soluble solids content was observed in T_{10}-CPPU 200 ppm + GA_3 100 ppm (12.27) (Table 2). Khan *et al*. [31] reported that gibberellic acid when applied at full bloom + one month later significantly increased the TSS of Kishmish charni grape. Cheema *et al*. [32] also recorded highest total soluble solids content by fruit thinning + two dips of fruit clusters of grape with 40 ppm GA_3. Total sugars were also significantly highest in application of T_{10}-CPPU 200 ppm + GA_3 100 ppm (11.87%) and T_4-GA_3 100 ppm (11.39%) were at par (Table 2). Khan *et al*. [31] also observed that gibberellic acid when applied at full bloom + one month later influenced significantly and increased the reducing sugar content in fruits of kishmish charni grape. The lycopene content did not differ significantly among the treatments. The range of lycopene is between 31.20 mg $100g^{-1}$ to 32.58 mg $100g^{-1}$ in different treatments.

CONCLUSION

Application of T_{10}-CPPU 200 ppm+ GA_3 100 ppm to watermelon flowers at anthesis resulted in maximum fruit set. Number of fruits per vine was highest in T_7-CPPU 50 ppm + GA_3 200 ppm and T_{10}-CPPU 200 ppm+ GA_3 100 ppm were at par. Application of T_8-CPPU 100 ppm + GA_3 100 ppm resulted in higher fruit weight. Application of T_{10}-CPPU 200 ppm + GA_3 100 ppm resulted in higher yield. Lowest number of normal seeds were observed in T_3-CPPU 200 ppm. CPPU 200 ppm and CPPU 200 ppm + GA_3 100 ppm significantly increased the empty seeds with only seed coats. Significant increase in total soluble solids content was observed in T_{10}-CPPU 200 ppm+ $GA_3$100 ppm.

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