

EFFECT OF CYTOKININS AND BRASSINOSTEROID WITH GIBBERELIC ACID ON YIELD AND QUALITY OF THOMPSON SEEDLESS GRAPES

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ABSTRACT

The effects of Cytokinins and Brassinosteroid (BR) with Gibberellic Acid (GA₃) on yield and quality attributes were investigated in the Department of Horticulture, Mahatma Phule Agriculture University, Maharashtra, India during 2004-2005. The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 10 treatments. After October pruning (forward pruning) vines and bunches at specific stage of development were treated with respective plant growth regulators as per the treatments. i.e. GA₃, BR, N-(2-chloro-4-pyridyl) N-phenyl urea (CPPU) and Benzyladenine (BA). Application of GA₃ at 10 ppm at pre-bloom stage, 15 ppm at initiation of flowering, 25 ppm at 3 to 4 mm berry diameter stage in combination with 1 ppm BR, BA at 10 ppm twice at 4 leaf and berry setting stage, respectively and last application of GA₃ at 25 ppm at 7 to 8 mm berry diameter stage was found better for maximum berry diameter (19.60 mm), berry length (21.58 mm), berry weight (3.36 g), number of berries per bunch (131.78), number of bunches per vine (15.41), bunch weight (447.85 g) and yield (6.79 kg/vine, 15.09 MT/ha) with attractive grayish yellow colour berries. This treatment (T₁₀) also produced berries with considerable amount of Total Soluble Solid (TSS) (22.41 °B) and acidity (0.59 %) at the time of harvesting. The highest TSS (23.43 °B), lowest acidity (0.53 %), highest TSS : acidity ratio (44.31) and minimum days to harvest (132 days) were recorded in vines under control. The application of GA₃ in combination with BR and BA was found to be effective for cell elongation and cell division, which led to increase berry size, yield and quality of Thompson Seedless grapes.

KEYWORDS: Benzyladenine, Brassinosteroid, CPPU, GA₃, Grape, Quality.

INTRODUCTION

Grape (*Vitis vinifera* L.) is a widely grown fruit crop in the world. It is cultivated under temperate, sub-tropical as well as tropical climates of the world, over an area of 7,674,237 ha with a production of about 65,486 Lakh t (FAO, 2004). Considering the demands for grapes in both the national and international markets, it is obvious that good quality grape will fetch a more premium price in the market. High production of better quality grapes depends on various horticulture practices, cultural practices and plant growth regulators. Among the different growth regulators GA₃, BA, CPPU and BR play a significant role in increasing the productivity and improving the quality of grapes. Gibberellic Acid (GA₃) stimulates both cell division and cell elongation (Randhawa, 1971). Cytokinins or cytokinin like substances, which promote cell division and increase cell expansion along the lateral axis, can increase the berry size (Krishnamoorthy, 1981). Brassinosteroids are a

new group of plant hormones with a regulatory function in cell elongation and cell division (Clouse and Sasse, 1998). At present, table grape growers tend to increase the dose of plant growth regulators and repetitions of application to increase the berry size, which may disturb the berry quality. Therefore, stage of application and concentration of these plant regulators are to be standardized for better yield and quality. Hence present investigation was undertaken with the objectives of studying the effect of cytokinins and brassinosteroid with GA₃ on yield and quality of grapes and to standardize the application of cytokinins and BR with GA₃ in grapes.

MATERIALS AND METHODS

The present investigation was conducted in the Department of Horticulture, Mahatma Phule Agriculture University, Maharashtra, India, during 2004 - 2005. Three years old Thompson Seedless vineyard, spaced at 3.0 x 1.5 m and trained on bower system was used for this study. The experiment was laid out in randomized block design with three replications and ten treatments given in Table 1. Three experimental vines were maintained under each treatment with guard rows on each side. Plant growth regulators were sprayed, at the time of 4 leaf stage, pre bloom stage and initiation of flowering, while in case of 50 per cent cap fall and later stage of cluster development, clusters were dipped in the solution of respective plant growth regulators, as per treatments. Cultural operations were performed in accordance with standard commercial production practices for table grapes in this region. The observations on diameter, length, weight of berry, number of berries per bunch, number of bunches per vine, bunch weight, yield and quality parameters were recorded during the investigation. The TSS content was determined by using the refractometer and acidity was measured by titrating with 0.1 N NaOH. Statistical analysis was done by using methods as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect on berry attributes

The application of cytokinins and BR with GA₃ had significant influence on diameter, length and weight of berry and number of berries per bunch (Table 2). The highest diameter of berry (19.60 mm), length of berry (21.58mm) and weight of berry (3.36g) were recorded in treatment with application GA₃ at 10 ppm at pre-bloom stage, 15 ppm at initiation of flowering, 25 ppm at 3 to 4 mm berry diameter stage in combination with 1 ppm BR, 25 ppm GA₃ at 7 to 8 mm berry diameter stage, and BA at 10 ppm twice at 4 leaf and berry setting stage, (T₁₀) than all the other treatments. It was followed by application of GA₃ at 10 ppm at pre-bloom stage, 15 ppm at initiation of flowering, 25 ppm at 3 to 4 mm berry diameter stage in

The increase of berry size was due to the plant growth regulators applied in treatment T₁₀ viz., GA₃, BA and BR which were responsible for cell division and cell elongation. These effects of GA₃, BA and BR were reported by Randhawa (1971), Tambe (2001) and Mitchell *et al.* (1970), respectively. Enlargement of berry size leads to increase in berry weight. Furthermore, increment in invertase activity and hexose content by GA₃ (Francisco and Gomez, 2000), induction of protein synthesis by cytokinins (Coombe, 1976), activation of protein synthesis (Vladimir *et al.*, 2000 and Sivakumar *et al.*, 2002), nucleic acid synthesis (Vladimir *et al.*, 2000) and translocation of sugar from source to sink (Sivakumar *et al.*, 2002) by application of BRs may be responsible for the increase of size and berry weight. These results indicate that the combined application of GA₃ with BA and BR have synergistic effect on berry growth. Similar work was also reported by Shikhamany (2001) and Tambe (2002).

In the present study, treatment T₁₀ recorded significantly highest number of berries per bunch (131.78) over rest of the treatments. The increased number of berries might be due to increased fruit set and decreased fruit drop. Effects of combined application of GA₃ with BA, CPPU and BR on higher berry setting were also confirmed by several authors (Liu, 2002; Stephen *et al.*, 2003 and Vladimir *et al.*, 2000).

Effect on yield

The data presented in Table 2 revealed that the yield attributes i.e. number of bunches per vine, weight of bunch and yield were significantly affected by the application of cytokinins and BR with GA₃.

In the present investigation the highest number of bunches per vine (15.41) and maximum yield (6.79 kg/vine; 15.09 t/ha) were recorded in treatment T₁₀ i.e. application GA₃ at 10 ppm at pre bloom stage, 15 ppm at initiation of flowering, 25 ppm at 3 to 4 mm berry diameter stage in combination with 1 ppm brassinosteroid, 25 ppm at 7 to 8 mm berry diameter stage, and BA at 10 ppm twice at 4 leaf and berry setting stage, respectively. It was at par with treatment T₇, which recorded 15.36 bunches per vine and yield of 6.57 kg/vine (14.60 t/ha). The weight of bunch (447.85 g) was found to be significantly high in the treatment T₁₀ over rest of the treatments. Bearing increase in treatment T₁₀ may be due to maximum flowering, higher fruit set, carbohydrate accumulation and maximum leaf area.

More or less similar findings were reported by Tambe (2002). The reason for higher fruit set was same as for number of berries per bunch and this is in conformity with results reported by Liu (2002), Stephen *et al.* (2003) and Vladimir *et al.* (2000).

Table 2. Effect of cytokinins and brassinosteroid with GA₃ on berry, yield and quality attributes of Thompson seedless grapes.

<i>Treatment No.</i>	<i>Diameter of berry (mm)</i>	<i>Length of berry (mm)</i>	<i>Weight of berry (g)</i>	<i>Number of berries per bunch</i>	<i>Number of bunches per vine</i>	<i>Weight of bunch (g)</i>	<i>Yield per vine (kg)</i>	<i>Yield per ha (MT)</i>	<i>TSS (°B)</i>	<i>Acidity (%)</i>	<i>TSS: acidity ratio</i>	<i>Days to harvest</i>
T ₁	15.90a	17.69a	2.64a	100.38a	12.78a	285.99a	3.68a	8.18a	23.43g	0.53a	44.31f	132.00a
T ₂	16.17b	17.88b	2.67a	103.24ab	12.83ab	295.90b	3.80ab	8.44ab	22.87e	0.57bc	40.14C	134.33d
T ₃	17.43c	19.45f	3.03d	117.36d	14.30e	368.50f	5.23e	11.62e	22.54d	0.57bc	39.59b	136.11e
T ₄	16.58c	18.38c	2.76b	107.46bc	13.11bc	315.58c	4.16bc	9.24bc	22.38c	0.60de	37.41b	139.21g
T ₅	18.21g	20.21h	3.16e	122.65e	15.10fg	405.49h	6.10f	13.55f	21.58b	0.63f	34.29a	142.30i
T ₆	16.90d	18.89d	2.87c	110.92c	13.40c	337.25d	4.53cd	10.07cd	21.69b	0.62ef	35.13a	140.67h
T ₇	19.03h	21.00i	3.28f	127.90f	15.36gh	428.73i	6.57g	14.60g	21.34a	0.63f	34.01a	144.20j
T ₈	17.95f	19.99g	3.13e	120.15de	14.98f	391.50g	5.79f	12.87f	23.39g	0.55ab	42.67e	132.67b
T ₉	16.98d	18.98e	2.91c	112.10c	13.78d	348.27e	4.80d	10.67d	23.12f	0.56b	41.39d	133.31c
T ₁₀	19.60i	21.58j	3.36g	131.78f	15.41h	447.85j	6.79g	15.09g	22.41c	0.59cd	38.17b	137.20f
SE ±	0.061	0.028	0.014	1.716	0.101	0.569	0.136	0.302	0.042	0.007	0.412	0.113
CD at 5%	0.180	0.084	0.040	5.096	0.299	1.691	0.404	0.896	0.126	0.022	1.222	0.335

Means with same letter are statistically not significant at P=0.05

It was reported that, 6 BA after absorption was transported and finally accumulated in shoot tips and roots (Zhang and Huang, 2002) and was responsible for the formation of flower buds (Krieken *et al.*, 1989). Furthermore, cytokinins enhanced the mobilization of nutrient and amino acids to treated sites and it may also be beneficial for higher bearing capacity due to increase of carbohydrate accumulation (Letham, 1969)

Application of cytokinins i.e. BA and CPPU might be nullified by the effect of GA₃ which adversely affects flowering. BR is also responsible for flowering (Rao *et al.*, 2002) and exogenous application of cytokinins in combination with GA₃ helps to reduce Absisic acid concentration in the ovule, stimulating cell division, cell growth and increasing sink activity (Bangerth, 2004), which may contribute to considerable number of bunches per vine at harvest.

Maximum bunch weight and yield were recorded in treatment T₁₀ might be due to significant increase in berry size, berry weight and also related with proper nutritional supply to the developing bunches associated with photosynthetic capacity, translocation of photosynthates to the bunch and reduced berry drop. Higher flowering and higher fruit set are also responsible for maximum yield. The findings of this result are in close agreement with those reported by Anon. (1998) and Tambe (2002). Enhanced translocation of photosynthates and nutrients into treated site in the application of BR was also reported by Vladimir *et al.* (2000) and Sivakumar *et al.* (2002). The photosynthetic capacity was enhanced by BA (Sivakumar and Virendra, 2000) and BR (Vladimir *et al.*, 2000).

BR increased the level of ingredients, which are essential for synthesis of sugar, carbohydrates and nucleic acid in grapes (Anonymous, 1998).

All the yield-contributing attributes were influenced by the application of BR, BA and CPPU. Thus, conformity of reason for yield increase is same as for number of bunches per vine and average weight of bunch. Sivakumar *et al.* (2002) reported BR application increased yield due to enhanced carbohydrate fixation, soluble protein and effective transportation of metabolites.

Tambe (2002) observed maximum yield by the application of GA₃ with BR at 1 ppm at 3-4 mm berry diameter stage. Vladimir *et al.* (2000) stated that BRs increase the crop yield due to enhancement of photosynthetic capacity and translocation of products. This helps to increase considerable amount of yield.

The application of 3 ppm CPPU at 3 mm berry size with GA₃ gave the highest yield per vine (Ranpise *et al.*, 1999). Yield increase by application of cytokinins might be due to increase in the nutrient and carbohydrate supply i.e. increase in sink activity. Importance of assimilates in fruit growth is well documented. Bangerth (2004) pointed out that application of cytokinins with GA₃ increased the sink activity and the application of BRs induced the sucrose transport (Petzold *et al.*, 1992).

Effect on maturity and quality attributes

The quality attributes such as TSS, acidity, TSS : acidity ratio and days to harvest were significantly influenced by application of cytokinins and BR with GA₃.

The highest value of TSS (23.43 °B), and the lowest acidity (0.53 %) were observed in control treatment, which was at par with treatment T₈ (23.39 °B, 0.55%, respectively). The lowest TSS (21.34 °B) was given in treatment T₇ whereas; the highest acidity (0.63 %) was obtained in treatments T₇ and T₅, which was at par with treatment T₆ (0.62%).

Higher TSS and lower acidity might be due to hastening of ripening because of high stimulation of ethylene production in only GA₃ treated bunches. GA₃ was reported to have increased the production of ethylene (Weaver and Singh, 1978). There was a progressive decrease in total acidity with an advancement of maturity.

The observations of increased TSS content and decreased acidity percentage by GA₃ treatments are in agreement with those reported earlier by Uarma (1991) and Singh *et al.* (1994). However, Ben (1990) observed lower percent TSS and higher percent acidity by repeated GA₃ applications. In present investigation, the lowest TSS and higher acidity were obtained in treatment T₇ (GA₃ with CPPU + BA). This could have been due to delaying in maturity. Significantly more days were required to reach the maturity stage (144.20 days) in treatment T₇ as against the rest of the treatments. This treatment delayed harvesting of grapes by about 12 days as compared to control to attain optimum TSS. This might be due to delaying of ripening, because of reduced ethylene production.

Ranpise *et al.* (1999), Bhujbal *et al.* (2002), and Michele and Dokoozlian (2004) noted that CPPU+GA₃ application delayed fruit maturation.

The data regarding TSS: Acidity ratio revealed that the highest TSS: acidity ratio (44.31) was recorded in the control. The treatment T₇

recorded minimum TSS: Acidity ratio (34.01), which was at par with T₅ (34.29) and T₆ (35.13).

GA₃ reduced fruit set accounting for better nutrition of the remaining berries and higher TSS: Acidity ratio (Singh and Singh, 1980). On the other hand, Bindra *et al.* (1980) concluded that more acidity associated with high yield and maximum TSS: Acidity hastened the ripening.

It was obvious that the reduced acidity with an increase in the total soluble solids resulted in increased TSS: Acidity ratio. These findings are in conformity with results reported earlier by Singh and Singh (1980), Singh *et al.* (1994) and Uarma (1991). BRs treatment enhanced TSS: Acidity ratio, which was confirmed by the findings of Tambe (2002). The lowest TSS: Acidity ratio was registered in treatment T₇, due to delaying maturity.

CONCLUSIONS

The present investigation indicated that application of 10 ppm GA₃ at pre-bloom stage, 15 ppm at initiation of flowering, 25 ppm at 3 to 4 mm berry diameter stage in combination with 1 ppm BR, 25 ppm at 7 to 8 mm berry diameter stage, and BA at 10 ppm twice at 4 leaf and berry setting stage was the most effective for obtaining higher yield with good quality grapes.

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