

Effect of exogenous application of plant growth regulators on quality and yield of bell pepper (*Capsicum annuum* L) under NVPH

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ABSTRACT

The investigations were carried out at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat during Rabi 2015 under NVPH. The experiment comprised ten treatments involving three levels of each plant growth regulator (PGR) namely NAA 20, 40 and 60 ppm; GA₃ 25, 50 and 75 ppm and 2,4-D 2.5, 5 and 7.5 ppm and was laid out in a randomized block design with three replications. Bell pepper responded variably for quality parameters upon exogenous application of different PGRs. The fruits harvested from plants sprayed with 20 ppm NAA exhibited significantly maximum fruit volume (281.21 cm³) except control and 40 ppm NAA. However maximum pericarp thickness of 6.5 mm was observed in 7.5 ppm dose of 2,4-D whereas minimum physiological loss in weight of 9.43 and 23.41 per cent at 6th and 9th day after picking was significantly favoured by 7.5 ppm 2,4-D and 20 ppm NAA respectively. Ascorbic acid content remained unaffected by any of the treatments. The superiority of NAA at the rate of 20 ppm was also reflected by bell pepper plants in terms of maximum fruit breadth (7.95 cm), average fruit weight (185.00 g), fruit yield per plant (3.00 kg), marketable yield per m² (10.75 kg) and total yield per m² (11.44 kg) except fruit length which was observed to be maximum in plants treated with 75 ppm GA₃.

Keywords: Bell pepper; PGRs; protected condition; quality; yield attributes

INTRODUCTION

Bell pepper or capsicum (*Capsicum annuum* L) belonging to the family Solanaceae is one of the most popular and highly valued vegetable crops grown partly or in abundance in different regions of the world. It is believed to be the native of tropical South America. It is highly nutritious vegetable containing 870 IU vitamin A, 17.5 mg ascorbic acid, 0.6 mg thiamin, 0.03 mg riboflavin and 0.55 mg niacin per 100 g edible of fruit (Joshi and Singh 1975).

Growers are not in a position to produce good quality capsicum with higher productivity due to various biotic, abiotic and crop factors under tropical situations (Ochigbo and Harris 1989). Use of plastics in horticulture has given an edge over open cultivation where partial to full control over environmental parameters such as temperature, humidity, light intensity, light duration, CO₂ levels, irrigation levels,

nutrient uptake, spacing, growing medium and root development can be achieved (Baghel et al 2003, Navale et al 2003). Growing of bell pepper under protected condition has been reported to give high productivity of good quality produce in developed countries. Hence there is a need to evaluate the performance of bell pepper under controlled condition for getting higher productivity of excellent quality under Indian conditions.

Overlapping of vegetative and reproductive phases in bell pepper leads to shedding of immature flowers and young fruits thereby limiting yield potential. Fruit set percentage is found to be not more than 8.8 and extent of flower drop ranges from 50-95 per cent depending on the season of cultivation. A great potential exists in increasing yield levels either by reducing flower drop or by increasing fruit set percentage. Use of plant growth regulators (PGRs) is a common horticultural practice to improve yields. The PGRs are a wide

category of compounds that can promote, inhibit or change plant physiological or morphological processes at very low concentrations. PGRs can affect rooting, flowering, fruiting and fruit growth, leaf or fruit abscission, senescence, regulation of some metabolic processes and plant resistance to temperature or water. Thus the use of PGRs has become an important component of the agro-technical procedures for most of the cultivated plant species (Monselise 1979). The growth promoters like NAA and 2,4-D enhance the source-sink relationship and modified translocation of photosynthates which help in better retention of flowers and fruits at various later stages of crop growth. Consistent efforts have been made to reduce the flower and fruit drop in bell pepper by spraying NAA (Pandita et al 1980). The application of GA₃ in tomato plants has been shown to induce marked stem elongation, increased fresh weight, accelerated flowering and greater number of flowers per plant and increase in fruit set (Davies 1995). Therefore investigations were aimed at finding out the suitable plant growth regulators and their concentrations for increasing quality and yield in bell pepper.

MATERIAL and METHODS

The experiment was carried out at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat during Rabi 2015 under multispan saw-tooth type naturally ventilated polyhouse (NVPH) on bell pepper cv Indra. The location is situated at a latitude and longitude of 20° 57' N and 72° 54' E respectively with an altitude of about 12 m amsl characterized by high humid climate with annual rainfall of more than 1600 mm. The experiment comprised ten treatments viz control (T₁), NAA 20 ppm (T₂), NAA 40 ppm (T₃), NAA 60 ppm (T₄), GA₃ 25 ppm (T₅), GA₃ 50 ppm (T₆), GA₃ 75 ppm (T₇), 2,4-D 2.5 ppm (T₈), 2,4-D 5 ppm (T₉) and 2,4-D 7.5 ppm (T₁₀) in a randomized block design (RBD) with three replications. Bell pepper plants were grown on raised beds of the size of 100 x 40 x 50 cm (width x height x path) at a spacing of 45 x 30 cm and fertigated with NPK at the rate of 25:25:25 kg/ha along with common dose of 0.5 kg *Trichoderma viride*, phosphorous solubilizing bacteria, *Azotobactor*, *Pseudomonas fluorescens* each, 0.4 tonnes vermicompost and 5.0 kg micronutrients (Grade-5) at the time of planting. Two sprays of each treatment was made during cropping season. First spray was made at the time of 50 per cent flowering and second at 20 days after first

spray. Plants in control plots were sprayed with clean water. All cultural practices and pest control measures were applied as and when needed. The data were taken from randomly selected five plants from each plot on the characters namely fruit volume, pericarp thickness, physiological loss in weight, ascorbic acid, fruit length, fruit breadth, average fruit weight, fruit yield per plant, marketable yield and total yield. The data were statistically analyzed to find out the variations resulting from the experimental treatments by employing F-test. The mean values were subjected to statistical analysis (<http://icargoa.res.in/wasp2.0>).

RESULTS and DISCUSSION

The data on performance of bell pepper cv Indra in response to exogenous application of different levels of PGRs are presented as mean values with statistical notation in Tables 1 to 2.

Quality parameters

The results of various quality parameters viz fruit volume, pericarp thickness, physiological loss in weight and ascorbic acid are presented in Table 1. It is explicated from the data that fruit volume was significantly influenced by exogenous application of PGRs. Among various treatments T₂ (20 ppm NAA) recorded maximum fruit volume (281.21 cm³) which was at par with T₁ (259.92 cm³), T₃ (256.81 cm³) and T₅ (249.75 cm³). This could be due to the fact that NAA hastens the cell elongation and division which results in increase in fruit size, increased uptake of nutrients and build up of sufficient photosynthates enabling the increase in size of fruits (length and breadth) ultimately resulting in increased fruit volume. Similar findings were reported by Katwale and Saraf (1990) and Kiranmayi (2014) in chilli and Singh et al (2012) in bell pepper. Treatment T₁₀ (7.5 ppm 2,4-D) excelled all other treatments significantly for pericarp thickness (6.5 mm) which was followed by T₉ (5.5 mm), T₈ (5.2 mm), T₂ (4.8 mm) and T₁ (4.7 mm). This might be due to the reason that plants treated with 2,4-D produced flattened fruits and caused more accumulation of carbohydrates in fruit pericarp leading to increased thickness. Analogous results were reported by Gelmese et al (2010) and Tiwari and Singh (2014) in tomato.

Minimum physiological loss in weight (PLW) on 6th day after picking was noticed in treatment T₁₀ (9.43%) which was at par with T₃ (9.47%), T₈ (9.90%), T₂ (9.90%), T₄ (10.00%), T₉ (10.16%) and T₁

Table 1. Effect of exogenous application of PGRs on quality parameters of bell pepper under protected condition

Treatment	Fruit volume (cm ³)	Pericarp thickness (mm)	Physiological loss in weight (%)		Ascorbic acid (mg/100g)
			6 th day	9 th day	
T ₁ (Control)	259.92	4.70	10.74	26.17	81.60
T ₂ (20 ppm NAA)	281.21	4.80	9.90	23.41	82.71
T ₃ (40 ppm NAA)	256.81	4.10	9.47	25.25	83.23
T ₄ (60ppm NAA)	227.97	3.90	10.00	28.44	84.67
T ₅ (25 ppm GA ₃)	249.75	3.70	14.21	33.27	87.70
T ₆ (50 ppm GA ₃)	225.44	3.50	14.62	36.42	86.30
T ₇ (75 ppm GA ₃)	193.06	3.50	16.54	43.35	86.67
T ₈ (2.5 ppm 2,4-D)	205.21	5.20	9.90	27.20	89.13
T ₉ (5.0 ppm 2,4-D)	194.59	5.50	10.16	27.88	91.30
T ₁₀ (7.5 ppm 2,4-D)	187.88	6.50	9.43	26.15	91.78
SEm±	11.19	0.20	0.56	1.06	2.53
CD _{0.05}	33.24	0.60	1.66	3.14	NS
CV (%)	8.49	8.09	8.40	6.15	5.06

Table 2. Effect of exogenous application of PGRs on yield parameters of bell pepper under protected condition

Treatment	Fruit length (cm)	Fruit breadth (cm)	Average fruit weight (g)	Number of fruits/plant	Fruit yield /plant (kg)	Marketable yield/m ² (kg)
T ₁ (Control)	7.88	7.78	171.00	22.00	2.74	9.52
T ₂ (20 ppm NAA)	8.03	7.95	185.00	26.00	3.00	10.75
T ₃ (40 ppm NAA)	7.36	7.27	169.03	16.03	2.33	7.92
T ₄ (60ppm NAA)	7.20	7.14	151.01	18.02	2.16	7.12
T ₅ (25 ppm GA ₃)	8.09	7.58	164.31	15.00	2.28	7.34
T ₆ (50 ppm GA ₃)	8.46	6.97	148.35	15.97	2.11	6.41
T ₇ (75 ppm GA ₃)	9.86	6.63	127.00	14.05	2.00	5.70
T ₈ (2.5 ppm 2,4-D)	6.06	7.23	135.01	15.03	1.81	4.74
T ₉ (5.0 ppm 2,4-D)	5.56	7.47	128.01	15.01	1.71	4.24
T ₁₀ (7.5 ppm 2,4-D)	4.22	7.57	123.63	12.00	1.53	3.46
SEm±	0.44	0.25	10.44	1.11	0.14	0.56
CD _{0.05}	1.31	0.73	31.01	3.30	0.43	1.67
CV (%)	10.47	5.80	12.04	11.38	11.55	14.49

(10.74%). However minimum PLW on 9th day after picking was noticed in treatment T₂ (23.41%) which was at par with T₃ (25.25%), T₁₀ (26.15%) and T₁ (26.17%). Plants treated with 2,4-D and NAA produced fruits with higher pericarp thickness so loss of water over a period of storage time could have been less. Gelmesa et al (2010) and Tiwari and Singh (2014) also observed the importance of pericarp thickness for better shelf-life in tomato. The mean data analyzed for ascorbic acid showed non-significant differences among treatments for ascorbic acid.

Yield parameters

The results on effect of exogenous application of PGRs on various yield parameters are presented in Table 2. The maximum length of fruit (9.86 cm)

was recorded in T₇ (75 ppm GA₃) which was followed by T₆ (8.46 cm), T₅ (8.09 cm), T₂ (8.03 cm), T₁ (7.88 cm), T₃ (7.36 cm) and T₄ (7.20 cm). The occurrence of higher fruit length upon GA₃ application at higher concentration may be due to quicker cell division and multiplication of cells in reproductive organs. This is in accordance with the results of Singh et al (2012), Vandana and Varma (2014) and Maboko and Du Plooy (2015) in bell pepper, Natesh et al (2005) in chilli and Desai et al (2012) in tomato.

The maximum fruit breadth (7.95 cm) was registered in the treatment T₂ (20 ppm NAA) which was at par with the treatments T₁ (7.78 cm), T₅ (7.58 cm), T₁₀ (7.57 cm), T₉ (7.47 cm), T₃ (7.27 cm) and T₈

(7.23 cm). This may be attributed to the increased supply of photosynthetic material and its efficient mobilization in plants giving rise to increased stimulation of fruit growth ultimately resulting in increased fruit breadth. These results also corroborate with the findings of Katwale et al (1990) in chilli and Singh et al (2012) in bell pepper.

The observations recorded on average fruit weight were found to be significant. T_2 noticed significantly highest fruit weight (185.00 g) which was at par with T_1 (171 g), T_3 (169.03 g) and T_5 (164.31 g). This could be due to the built up of adequate photosynthates enabling increase in size of fruits in terms of length and breadth. Related findings were reported by Singh et al (2012) and Maboko and Du Plooy (2015) in bell pepper, Sultana et al (2006) and Patel et al (2016) in chilli. The maximum number of fruits per plant (26.00) was obtained in T_2 (20 ppm) followed by T_1 (22.00), T_4 (18.02) and T_3 (16.03) of NAA. This might be due to rapid and better nutrient translocation from roots to apical parts of plant making treated plants physiologically more active thereby resulting in more number of flowers and higher fruit set. Similar results were reported by Chaudhary et al (2006) in chilli and Kannan et al (2009) and Singh et al (2012) in bell pepper.

The fruit yield per plant varied from 1.53 to 3 kg. The treatment T_2 resulted in maximum fruit yield per plant (3 kg) which was at par with T_1 (2.74 kg). Among various treatments T_2 (20 ppm NAA) recorded maximum marketable yield and total yield per m^2 (10.75 and 11.44 kg respectively) which was statistically at par with T_1 (9.52 and 10.35 kg respectively). This can be attributed to the presence of higher number of fruits per plant, number of pickings, average fruit weight and highest fruit yield per plant. These results are in close agreement with the findings of earlier researchers like Chaudhary et al (2006) in chilli, Kannan et al (2009), Sridhar et al (2009), Singh et al (2012) and Maboko and Du Plooy (2015) in bell pepper.

CONCLUSION

In the present study majority of quality and yield parameters displayed good amount of variability upon exogenous application of PGRs in bell pepper for various horticultural traits under NVPH. PGRs exerted a profound influence on various horticultural traits and offered a lot of scope to exploit their potential for protected cultivation. It can thus be concluded that

exogenous application of NAA and 2,4-D significantly increased quality as well as yield attributes. Among the different plant growth regulators the exogenous application of NAA at 20 ppm and 2,4-D at 7.5 ppm was found to be the better alternatives for boosting up the production of bell pepper cv Indra under protected cultivation.

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