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Effect of different plant growth regulators on the growth, yield and quality of pepper cultivars

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Abstract

In order to investigate the impact of different plant growth regulators on the growth and yield of chillies cultivars, an experiment was conducted at National Tea & High Value Crops research Institute (NTHRI) during summer 2017. The experiment was laid out in Randomized complete block design (RCBD) with split plot arrangement having three replications. It consist of two chillies cultivars viz. Magma and wonder Hot which were allotted to the main plot and different types of Plant Growth regulators (PGR) viz., (i) control (without PGR), (ii) NAA (20 ppm), (iii) NAA (40 ppm), (iv) NAA (60 ppm), (v) GA3 (30 ppm), (vi) GA3 (60 ppm), (vii) GA3 (90 ppm) which were assigned to the sub-plot. The results of the experiment revealed significant variation among characters studied. Tallest plant (53.90 cm),more number of branches plant^{-1} (18.63), No of leaves plant^{-1} (75.02), fruit diameter (12.52mm), fruit length (15.00cm), fresh weight of 10 fruits (38.71g), Number of fruit per plant^{-1} (42.48) and yield (16.17t/ha) were found in cultivar Magma plots. In case of different Growth regulators, Maximum plant height (55.06 cm), greater number of branches plant^{-1} (22.09), number of leaves plant^{-1} (83.89), fruit length (16.04 cm), Fruit diameter (13.52 mm), fresh weight of 10 fruits (44.71g), number of fruits plant^{-1} (48.71) and yield (17.09 t/ha) were recorded from plots treated with naphthalene acetic acid (NAA) at the rate of 60 ppm. Whereas the minimum for these characters were obtained from control plots. In interaction between cultivars and plant growth regulators, maximum plant height (55.16.cm), number of branches plant^{-1} (22.20), number of leaves plant^{-1} (86.69), fruit length (16.16cm), fruit diameter (13.67mm), number of fruit plant^{-1} (49.26) and yield (17.17t/ha) were received from plants treated with naphthalene acetic acid (NAA) at the rate of 60 ppm in cultivars magma plots and minimum to these parameters were found in control plots in cultivar wonder hot. The results of the present study suggest that naphthalene acetic acid (NAA) can be practiced for increasing the production of chillies.

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Introduction

Chilli (*Capsicum annuum* L.) is one of the most important fruit vegetable in the sub-tropical areas which is mostly used as a condiment crop. Hot peppers are popular food additives, valued for their color, pungency, and aroma (Bosland, 1992). It have been originated in Peru and from there it was spread to other part of the world (Raju and Luckose, 1991). Nutritionally, chillies are rich source of vitamins and minerals nutrients (Agusiobo, 1976, Keshinro *et.at.,* 1983). It is an excellent source of carotenoid, anti-oxidant, phenolic compound which prevent cancer, diabetes liver cirrhosis and cardiovascular diseases in human body (Navarro *et al.*, 2006; Nwose, 2009). Chillies main Producers are sub-tropical countries like India, Japan, Mexico, Turkey, Pakistan United States of America and African countries (Panda, 2010). China is the leading producer of chillies in the world and it has 36 percent share in total world production. Globallys 36.46 million metric tons of chillies are produced annually on an area of 2.12 million hectare. In Pakistan, it is mainly cultivated at an area of 1.85 million hectare with production of 0.9 million tons. (FAO, 2014)

Chillies can grow under wide range of climatic condition but they are extremely sensitive to hot and wet growing condition, the weather which prevails in the summer season in Pakistan (Ahmad, 2002). Generally chillies cultivation is effected by adverse weather of summer which causes premature fall of flower and fruit which is due to physiological and hormonal imbalance resulted in low yield of chillies (Rylski, 1973; Rylski and Halevy, 1975; Erickson and Markhart, 2001).

Plant growth regulators (PGRs) are extensively used in horticultural crops to enhance plant growth and improve yield by increasing fruit number, fruit set and size (Batlang, 2008). Studies on the impact of plant growth regulators on solanacous crops showed that the foliar spray of different plant growth regulators has been successful in reducing flower and fruit drops which results an increase in production of chlli per hectare (dhayay and Sen, 1974. Minraj and Shanmugavelu, 1987., Balraj *et al.*, 2002 and Joshi *et al.* 1999).

However, information regarding the effectiveness of PGRs on growth and yield of chilli is meager in Pakistan. The present study was, therefore, conducted with suggested concentration of different PGRs as foliar spray to determine the effective growth regulators promoting growth and yield in commercial chilli cultivars, namely Magma and Wonder Hot.

Material and methods

This research" Effect of different growth regulators on the growth and yield of chillies Cultivars" was conducted at National Tea and High Value Crops Research institute, Shinkiari, Mansehra, Pakistan during the year 2017. The lay out of the experiment was in randomized complete block design (RCBD) with split plot arrangement having three replication. Different Plant growth regulators (PGR)viz., (i) control (without PGR), (ii) NAA (20 ppm), (iii) NAA (40 ppm), (iv) NAA (60 ppm), (v) GA3 (30 ppm), (vi) GA3 (60 ppm), (vii) GA3 (90 ppm) which were assigned to the sub-plot and cultivars Magma and Wonder hot were assigned to the main plot. There were 14 sub-plots in each replication. Total experimental area was 152 m 2. Nitrogen and phosphorous were applied at the rate of 120kg urea and 60kg per hectare, respectively. All phosphorus and half of the nitrogen were applied prior to seed sowing, and the remaining nitrogen was applied in stem elongation stage (45-50 days after planting). In the study, data regarding Plant height (cm), number of leaves per plant, No of Branches per plant, fresh fruit weight (g), No of fruit per plant, fruit length (cm), Fruit Diameter (mm) and Yield kg per hawas recorded during the growth and after the harvesting of crop.

Statistical Analysis

Results were analyzed using statistix 8.1, statistical software for analysis of variance. Least Significant Difference (LSD) test was used to compare the means of the obtained results in this research ($p < 0.05$).

Result and discussion

Plant height (cm)

Cultivars, Plant growth regulators (PGR) and its interaction had significant effect on plant height (Table 1).

In case of cultivars, taller plants (53.90cm) were observed in plots where cultivar Magma plants were planted and shorter plants of 53.68cm were obtained from plots where cultivar wonder hot plants were planted. These findings are in line with those of Engles (1984) who stated that cultivars of chilies showed variation among plant height.

It might be due to varietal nature of these cultivars. Similar results were also reported by EARO (2005), Ado (1987) and Gomez *et al.* (1988). In case of different growth regulators, maximum plant height (55.06cm) was recorded from plots treated with naphthalene acetic acid (NAA) at the rate of 60 ppm whereas as minimum plant height (51.09cm) was noted in control plots. Increase in plant height in naphthalene acidic acid (60 ppm) treated plot might be due to rapid increase in cell division and cell elongation in the meristematic region. These findings are in accordance with work reported byDicks (1980) and Revnappa (1998). In case of interaction between Cultivars and plant growth regulators, maximum plant height (55.16cm) was recorded in cultivars Magma plants when it is treated with naphthalene acetic acidic (NAA) at the rate of 60 ppm whereas minimum plant height was observed in cultivars wonder hot plants in control plot.

Table 1. Plant Height (cm), No of Branches plant^{-1}, No of leaves plant^{-1}, No of fruit plant^{-1}, fresh fruit weight (g) as effected by different cultivars and Plant Growth regulators.

Treatments	Plant Height (cm)	Noof Branches/ Plant	No of Leaves /plant	No of fruit/plant	10 Fresh Fruit Weight (g)
Cultivars					
Magma	53.90 A	18.653 A	75.021 A	42.483 A	38.719 A
Wonder Hot	53.68 B	18.284 B	70.470 B	41.187 B	37.280 B
LSD	0.1551	0.1963	0.0942	0.0469	0.0257
Plant Growth Regulators (PGR)					
NAA (20 ppm)	54.43 C	18.800 C	77.370 C	44.585 C	40.800 C
NAA (40 ppm)	54.72 B	20.698 B	80.800 B	47.018 B	43.108 B
NAA (60 ppm)	55.06 A	22.092 A	83.895 A	48.715 A	44.713 A
GA3 (30 ppm)	53.48 F	17.308 F	67.733 F	38.900 F	34.608 F
GA3 (60 ppm)	53.75 E	17.712 E	70.940 E	40.808 E	37.150 E
GA3 (90 ppm)	54.04 D	18.082 D	74.497 D	43.112 D	38.748 D
Control	51.09 G	14.590 G	53.985 G	29.707 G	26.868 G
LSD	0.0569	0.0462	0.0598	0.0228	0.0212
Interaction					
VxP	Fig.1	Fig.2	Fig.3	Fig.4	Fig.5

Number of Branches per Plant

All the treatments had significant on No of Branches per plant (Table-1). In case of cultivars, more branches (18.65) were noted in Magma plants whereas fewer. Branches (18.28) were observed in cultivars wonder hot plants. However variation in number of branches per plant for cultivars might be due to genetic potential of these cultivars (Imtiaz *et.al.* 2016).

In case of plant growth regulators, maximum branches (22.09) were recorded in plants treated with naphthalene acetic acid (NAA) at the rate of 60ppm.Whereas minimum branches per plant (14.59) were observed in untreated plots. It is observed that numbers of branches are directly proportional to the height of a plant. It might be due to the fact that taller plants have more growing points (nodes) as compared to shorter plants which resulted in more number of branches in taller plants. These results are in line with those of Kubal (1999) who noted maximum number of branches in NAA treated plants as compared to control. Pandita *et al.*, (1989) get more number of branches from chilli by spraying NAA twice. In case of interaction between cultivars and plant growth regulators, maximum number of branches per plant (22.20) was recorded in cultivars Magma plants when treated with Naphthalene acetic acid (NAA) at the rate of 60 ppm. Whereas minimum number of branches (13.94) were noted in cultivars Wonder Hot plants in untreated plots.

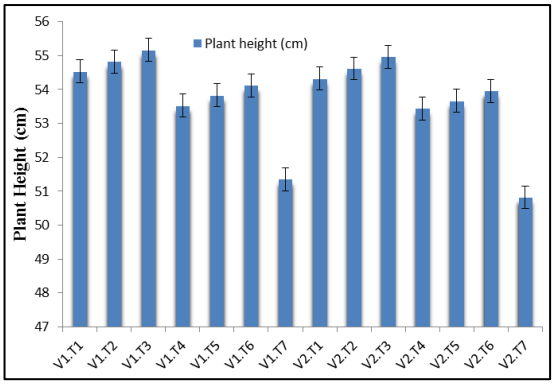

Fig. 1. Interaction effect of Plant Growth regulators and cultivars on plant Height (cm).

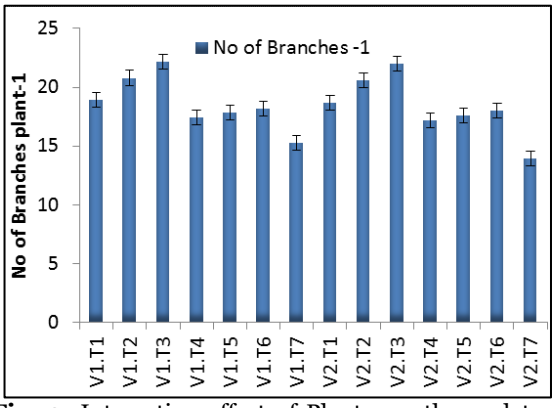

Fig. 2. Interaction effect of Plant growth regulators and cultivars on No of branches-1.

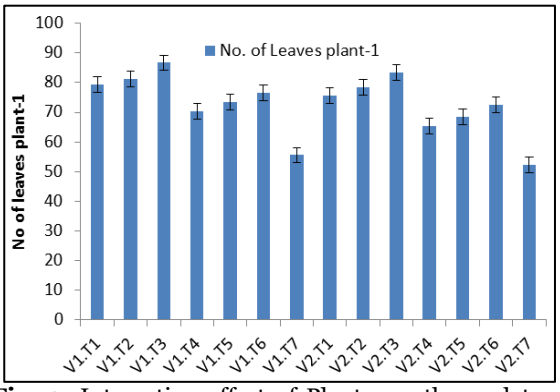

Fig. 3. Interaction effect of Plant growth regulators and cultivars on No of Leaves plant-1.

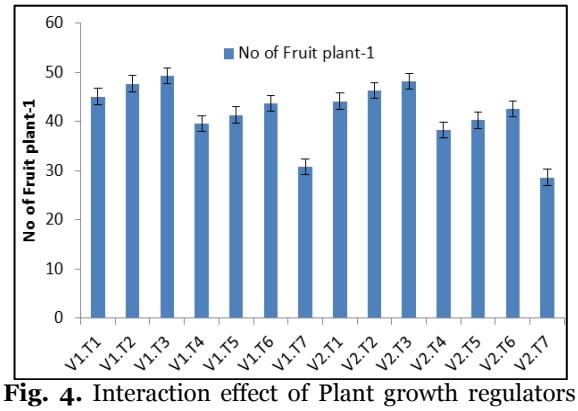

Fig. 4. Interaction effect of Plant growth regulators and cultivars on No of fruit plant-1.

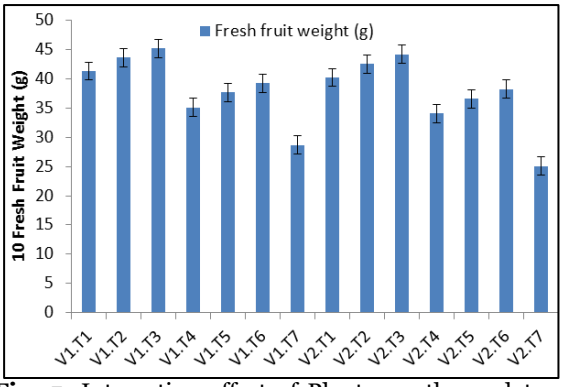

Fig. 5. Interaction effect of Plant growth regulators and cultivars on 10fresh Fruit weight (g).

Number of leaves per plant

Analysis of data indicated that cultivars, plant growth regulators and interaction between cultivars x plant growth regulators had significant effect on number of leaves per plant (Table-1). In case of cultivars, more leaves (75.02) were noted in cultivars Magma plants whereas less number of leaves per plant (70.47) was obtained from cultivars Wonder hot plants. In case of plant growth regulators, maximum number of leaves per plant (83.89) was recorded in plot treated with Naphthalene Acetic acid at the rate of 60 ppm whereas minimum number of leaves per plant (53.98) was observed in control plots. These findings are inconformity with those of Vaishampayan (1997) who observed that NAA foliar application enhances no of leaves per plant of chilli crop. The outcome of this study is similar with those of Sridhar (2009), Kubal (1999), Kannan (2009) and Singh (2012), who noted increased in number of leaves per plant in chilli by application of NAA. In case of interaction of between cultivars and plant growth regulators, highest number of number of leaves per plant (86.69) were noted in plot treated with naphthalene acetic acid (NAA) at the rate of 60 ppm in cultivar Magma plants whereas lowest number of leaves per plant (52.35) were obtained from cultivars Wonder hot plants in control plots.

Number of fruit per plant

Cultivars, plant growth regulators and interaction between cultivars and plant growth regulators had significant effect on No. of fruit per plant (Table-1). In case of cultivar, more fruit per plant (42.48) were

obtained from cultivar Magma plants whereas less fruit per plant (41.18) were noted in cultivar wonder hot plants. The maximum number of fruit per plant might be due to bigger canopy size which is directed related to more number of branches. Thus the highest number of branches resulted in maximum number of fruit per plant. These results are in line with those of Bosland and Votava (2000) who observed that wider canopy plants of chillies produced more number of fruit per plant as compared to small canopy plants. In case of plant growth regulators, maximum number of fruit per plant (48.71) was recorded from plots treated with naphthalene acetic acid (NAA) at the rate of 60 ppm whereas minimum fruit per plant (29.70) were obtained from untreated plots. It might be due to the fact the plant growth regulators acts as florigens which is helpful in initiation of flowering and fruit set thus the number of fruit per plant also increases. These results are in conformity with those of King *et al.*, 2006 who recorded the role of plant growth regulators in the promotion of flower initiation and fruit set. In case of interaction between cultivars and Plant growth regulators, highest number of fruit per plant (49.26) was obtained from plants treated with naphthalene acetic acid (NAA) at the rate of 60 ppm in cultivar Magma plants whereas lowest number of fruit per plant (28.63) was taken from cultivar wonder hot plants in control plots.

10 Fresh Fruit weight (g)

Statistical analysis of the data showed that different plant growth regulators, cultivars and its interaction had significant effect on 10 Fresh Fruit weight (g) (Table-1). In plant growth regulator treatments, maximum 10 fresh fruit weight (44.71g) was recorded from plant treated with naphthalene acetic acid at the rate 60 ppm whereas minimum 10 fresh fruit weight (26.86g) were observed in control plots. In different cultivars, maximum fresh fruit weight (38.71g) was noted in cultivars Magma plants whereas minimum fresh fruit weight (37.28g) was observed in cultivars wonder hot plants. The different fresh fruit weight of chillies cultivars may be due to genetic make of the variety or environmental condition in which they are evaluated. In case of interaction between cultivars and Plant growth regulators, maximum fresh fruit weight (45.24g) was noted in cultivars Magma plants when treated with naphthalene acidic acid at the rate of 60 ppm whereas minimum fresh fruit weight (25.07g) was recorded in cultivars wonder hot plants in untreated plots.

Fruit Diameter (mm)

Fruit diameter (cm) was significantly effect by plant growth regulators, cultivars and their interaction (Table-2). In cultivars, fruit diameter (mm) ranges from 12.26mm to 12.52 mm. Maximum fruit diameter (12.52mm) was obtained from cultivars Magma plants whereas minimum fruit diameter (12.26mm) was noted in wonder hot plants. In Plant growth regulators, greater fruit diameter (13.52mm) was recorded from plants treated with naphthalene acetic acid at the rate of 60 ppm whereas less fruit diameter (10.86mm) was obtained from untreated plots. It may be due to the fact that plant growth regulators hastens cell division and elongation which resulted in increases in fruit diameter.

In case of interaction between plant growth regulators and cultivars indicated that fruit diameter (13.67cm) was higher in plants treated naphthalene acetic acid at the rate 60 ppm x cultivar magma plants and lowest fruit diameter (10.56cm) was found in control plots x cultivar wonder hot plants.

Table 2. Fruit Diameter (cm), Fruit length (cm), Yield (tons/ha) as effected by different cultivars and Plant Growth regulators.

Treatments	Fruit Diameter (mm)	Fruit Length (cm)	Yield (t/ha)
Cultivars			
Magma	12.529 A	15.009 A	16.170 A
Wonder Hot	12.263 B	14.737 B	15.887 B
LSD	0.0711	0.0416	0.0852
Plant Growth Regulators (PGR)			
NAA (20 ppm)	12.805 C	15.423 C	16.245 C
NAA (40 ppm)	13.168 B	15.642 B	16.637 B

Treatments	Fruit Diameter (mm)	Fruit Length (cm)	Yield (t/ha)
Cultivars			
NAA (60 ppm)	13.520 A	16.048 A	17.098 A
GA3 (30 ppm)	11.863 F	14.647 F	15.858 F
GA3 (60 ppm)	12.125 E	14.858 E	16.017 E
GA3 (90 ppm)	12.427 D	15.137 D	16.193 D
Control	10.863 G	12.357 G	14.150 G
LSD	0.0293	0.0254	0.0475
Interaction			
VxP	Fig.6	Fig.7	Fig. 8

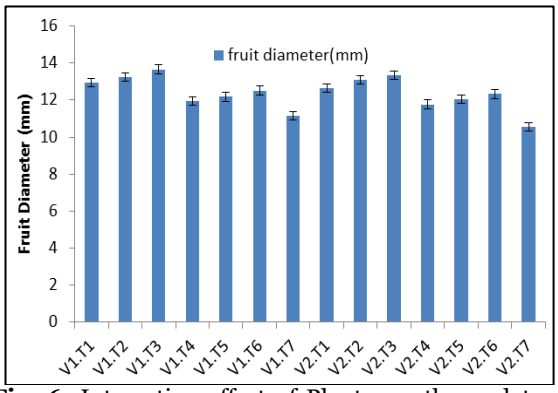

Fig. 6. Interaction effect of Plant growth regulators and cultivars on Fruit Diameter (mm).

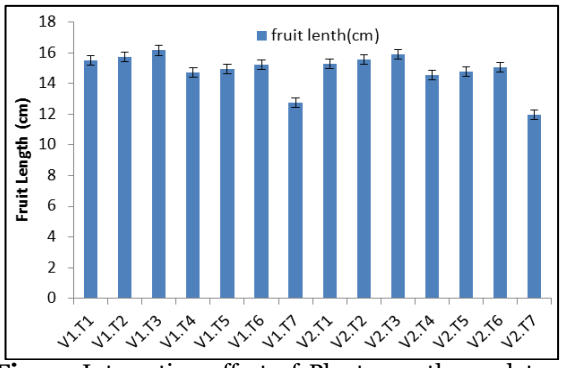

Fig. 7. Interaction effect of Plant growth regulators and cultivars on Fruit Length (cm).

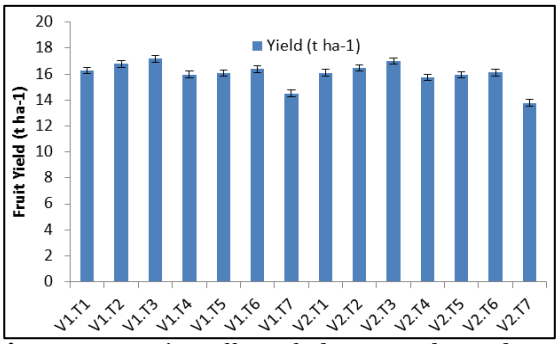

Fig. 8. Interaction effect of Plant growth regulators and cultivars on Fruit yield (t ha-1).

Fruit Length (cm)

Analysis of data indicated that plant growth regulators, cultivars and plant growth regulators x cultivars interaction had significant effect on fruit length (Table-2). In cultivars, lengthy fruit (15.00cm) were noted in cultivars magma plants whereas smaller fruit length (14.73cm) was recorded in cultivar wonder hot plants. Wide difference in fruit length might be due to variation in genetic constitution of the varieties which resulted in lengthy fruit of chillies. In Plant growth regulator, maximum fruit length (16.04cm) was recorded from plants treated with naphthalene acidic acid (NAA) at the rate of 60 ppm whereas minimum fruit length (12.35cm) was observed from untreated plants. In case of interaction between cultivar and plant growth regulator, lengthy fruit (16.16cm) was recorded in plants treated with naphthalene acidic acid at the rate of 60 ppm in cultivar magma plants whereas smaller fruit length (11.97cm) was noted in cultivar wonder hot plants in untreated plot.

Fruit Yield (T ha^{-1})

Perusal of the data indicated that cultivars, plant growth regulators and its interaction had significant effect on fruit yield (Table-2). The highest fruit yield (17.09t ha^{-1}) was recorded from plants treated with naphthalene acidic acid at the rate of 60 ppm whereas lowest fruit yield (14.15t ha^{-1}) was noted in untreated plots. These findings are in conformity with those of Patil and Ballal (1980) and Patil *et al.* (1985) who observed increased in fruit yield chillies due to foliar application Naphthalene acidic acid (NAA). Increase in production of chillies due to foliar application of naphthalene acidic acid (NAA) might be due to the fact that it increases photosynthetic activity and enhance production and accumulation of carbohydrates due to which flowering initiation and fruit set increases so the yield of the chillies is also more. In case of cultivars, maximum fruit yield (16.17t ha^{-1}) was obtained from cultivars Magma plants whereas minimum fruit yield (15.88t ha-1) was noted

in cultivars wonder hot plants. In case of interaction between cultivars and plant growth regulators, highest fruit yield (17.17t ha^{-1}) was obtained from plants treated with naphthalene acidic acid at the rate 60 ppm in cultivars magma plants whereas lowest fruit yield (13.78t ha^{-1}) was noted from cultivars wonder hot plants in control plots.

Conclusion

The cultivar Magma was superior in term of fruit yield of chillies while there is significant increase in growth and yield of chillies due to foliar application of different growth regulators especially naphthalene acidic acid. So the finding suggest that foliar application naphthalene acidic acid at the rate of 60 ppm with cultivars magma produces highest yield of chillies.

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