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Influence of methods of application and concentrations of plant growth regulators on plant growth, flowering, yield and yield attributes in winter chilli (*Capsicum annuum* L.) cv. PANT C-1

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ABSTRACT : The present investigation was undertaken during winter season at Horticulture Research Farm of Gochar Mahavidhyalaya, Rampur Maniharan, Saharanpur, U.P on chilli cv. Pant C-1 to find out the most suitable concentration, time and method of application of plant growth regulators for growth, flowering, fruit set, yield and yield attributes in winter chilli. Among different concentrations of plant growth regulators, 45 ppm NAA was found superior to all other treatments for improving growth, yield and yield attributes,). Application of 45 ppm NAA increased number of fruits, fruit length and fruit girth thus resulted in higher red ripened fruit yield in winter chilli cv. Pant C-1.Among methods of application, seedling root dip for 30 minutes along with double spray at flower bud initiation stage and 20 days later to it, was found superior for plant growth , yield and yield attributes studied. Improved yield and yield attributes were observed in treatment combination, M_5C_3 (45 ppm NAA used as seedling root dip for 30 minutes along with double spray) among all the interactions.

KEY **W**ORDS : Plant growth regulators, Plant growth, Flowering, Attributes, Chilli (*Capsicum annuum*) cv. PANT C-1

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Chilli (*Capsicum annuum* L.) is very important spice and condiment crop grown in many states of India for local consumption and export. There are about 25 known wild varieties, though most cultivated peppers are variations of the annuum species. The production of chilli is governed not only by the inherent genetic yield potential of the cultivars but it is greatly influenced by several environmental factors and cultivation practices. The production of chilli is reduced due to flower and fruit drop, which is caused by physiological and hormonal imbalance in the plants particularly under unfavourable environments, such as extremes of temperature *i.e.* too low or high temperatures (Erickson and Markhart, 2001 and Joshi and Singh, 2003). Studies on the effect of plant growth regulators in solanaceous fruit and vegetable crops have revealed that the application of some of the plant growth regulators has been found effective in reducing the flower and fruit drops thereby

enhancing production of chilli per unit area and per unit time. The varying responses of chilli to plant growth regulators have been reported by Balraj *et al.* (2002); Arora *et al.* (2014) and Arora *et al.* (2015). However, precise information is lacking on most suitable plant growth regulator, their concentration, method and time of application in different varieties and for specific characters with respect to various agro-climatic conditions. Keeping in view, the effect of plant growth regulators to influence plant characteristics and necessity of finding suitable method and concentration of plant growth regulators for chilli, present investigation was undertaken in chilli cv. PANT C-1, a promising variety for northern region of India.

RESEARCH PROCEDURE

The present investigation was conducted during winter undertaken during winter season in 2010-2011 at Horticulture Research Farm, Gochar Mahavidyalaya, Rampur Maniharan, Saharanpur, U.P with five different methods of application of plant growth regulators (NAA and 2,4-D) as main plot treatments and eight different concentrations of PGRs along with water as control as sub-plot treatments. The experiment was laid out in Split Plot Design with three replications. Each plot accommodated 45 plants per replication per treatment at spacing of 45 cm x 45 cm. A basal dose of 60 kg N, 80 kg P_2O5 and 80 kg K_2O per hectare was applied at the time of field preparation. Remaining 60 kg N per hectare was applied at the time of side dressing in two equal split doses at 30 and 60 days after transplanting. The nursery sowing was done in the September and 45 days old seedling were transplanted during evening hours and a light irrigation was given to crop in October. The intercultural operations and plant protection measures were followed as per the recommendation of the crop.

RESEARCH ANALYSIS AND REASONING

The results obtained are presented in Tables 1 to 4.

The data on various attributes presented in Table 1 and 2 showed that plant growth characters, flowering,

Table 1: Effect of methods of application of PGRs on growth, flowering, yield and yield attributes in winter chilli cv. PANT C-1

Main plot treatments	Plant height (cm)	No. of primary branches	No. of leaves per plant	Percentage of short styled flowers (%)	Percentage of fruit set (%)	No. of red ripened fruits per plant	Weight of red ripened fruits per plant(g)	Fruit length (cm)	Fruit girth (cm)
Double spray (M_1)	63.70	7.27	2099.20	58.08	58.74	158.10	176.90	5.55	3.25
Seedling root dip for 15 min. (M_2)	62.40	6.31	2016.90	50.88	51.17	137.60	143.80	5.04	3.08
Seedling root dip for 30 min. (M_3)	64.20	6.51	2050.40	55.59	55.82	143.70	148.00	5.28	3.16
Seedling root dip for 15min.+DS (M_4)	61.90	6.89	1971.00	61.07	59.56	164.80	164.30	5.78	3.35
Seedling root dip for 30min.+DS (M_5)	65.80	6.99	1984.10	61.10	60.39	195.70	178.30	5.96	3.50
Mean	63.60	6.79	2024.30	57.35	57.13	159.90	162.30	5.52	3.27
C.D. (P=0.05)	3.16	0.54	44.22	2.49	1.40	3.48	3.72	0.25	0.21

Table 2: Effect of concentrations of plant growth regulators on growth, flowering and yield and quality in winter chilli cv. PANT C-1

Sub-plot treatments	Plant height (cm)	No. of primary branches per plant	No. of leaves per plant	Percentage of short styled flowers (%)	Percentage of fruit set (%)	No. of red ripened fruits per plant	Weight of red ripened fruits per plant(g)	Fruit length (cm)	Fruit girth (cm)
NAA 15 ppm	63.30	6.60	2036.00	47.34	47.42	152.30	159.80	5.36	3.24
NAA 30 ppm	69.30	7.26	2116.00	58.69	59.30	176.60	177.00	5.83	3.36
NAA 45 ppm	71.10	7.60	2259.00	67.51	64.10	207.40	198.60	6.43	3.62
NAA 60 ppm	63.70	7.37	2047.00	51.99	53.50	151.80	160.00	6.05	3.42
2,4-D 1 ppm	60.60	6.65	2063.00	64.16	64.00	149.10	150.40	5.92	3.21
2,4-D 2ppm	64.70	7.05	2064.00	70.36	69.90	171.70	186.80	5.33	3.35
2,4-D 4 ppm	65.00	7.33	2122.00	71.22	70.85	204.60	189.00	6.20	3.28
2,4-D 8ppm	58.90	5.63	1616.00	41.40	41.92	95.40	115.20	4.25	3.14
Control	55.70	5.63	1896.00	43.44	43.22	130.60	123.60	4.32	2.79
Mean	63.60	6.79	2024.00	57.35	57.13	159.90	162.30	5.52	3.27
C.D. (P=0.05)	3.42	0.43	41.69	2.33	2.73	4.66	4.16	0.30	0.17

yield and other yield attributes were significantly influenced by main plot (methods of application) and sub-plot treatments (different doses of plant growth regulators *i.e.* NAA and 2, 4-D) in chilli during winter season. Among the various methods, seedlings root dip for 30 min along with double spray was found superior for improving plant height, percentage of short styled flowers, percentage of fruit set, number and weight of red ripened fruits per plant during winter season. The favourable response of double spray along with seedling dip might have been because of the fact that seedling root dip was effective in initial stages for improving vegetative characters leading to enhanced source to sink relationship. The spray done later on maintained and improved the earlier improved behaviour of the plants. Similar beneficial effect of foliar spray at flower bud initiation stage was reported by Kannan *et al*., 2009 in paprika.

Among different concentrations of plant growth regulators, 45 ppm NAA gave significantly maximum plant height (71.10 cm), number of primary branches (7.60) and fruit length (6.43). The promoting effect of NAA on plant growth characters in chilli cultivar might be due to its action as a group of auxin compound which enhances the cell division and cell elongation. Similar results were reported by Joshi and Singh (2003) and Arora *et al*., 2014 in chilli. The promotive effect of 4 ppm 2,4-D on percentage of short styled flowers (71.22%) leading to higher fruit set (70.85%) and number of red ripened fruits per plant (204.60) might be ascribed to more efficient utilization of food for reproductive

Table 3: Effect of interaction between method and concentrations of PGRs on weight of red ripened fruit per plant during winter season

Sub plot / Main plot	NAA concentrations in ppm				2,4-D concentration in ppm				Control (C_9)	Mean
	15 ppm (C_1)	30 ppm (C_2)	45 ppm (C_3)	60 ppm (C_4)	1 ppm (C_5)	2 ppm (C_6)	4 ppm (C_7)	8 ppm (C_8)		
Double spray (M_1)	123.00	174.00	264	185.00	160.00	200.00	186	205.00	95.00	176.90
Seedling root dip for 15 min. (M_2)	140.00	162.00	128	167.00	130.00	172.00	158	91.00	146.00	143.80
Seedling root dip for 30 min. (M_3)	166.00	161.00	168	142.00	128.00	178.00	159	108.00	122.00	148.00
Seedling root dip for 15 min.+ DS (M_4)	185.00	178.00	188	167.00	148.00	182.00	210	94.00	127.00	164.30
Seedling root dip for 30 min.+ DS (M_5)	185.00	210.00	245	139.00	186.00	202.00	232	78.00	128.00	178.30
Mean	159.80	177.00	198.6	160.00	150.40	186.80	189	115.20	123.60	162.30
C.D. (P=0.05)										
For comparing main plots							3.72			
For comparing sub plots							4.16			
For comparing two sub plots within a main plot							9.32			
For comparing two main plots within a sub plot							9.53			

Table 4: Effect of interaction between method and concentrations of PGRs on seed content per 100gm of red ripened fruit yield

Sub plot / Main plot	NAA concentrations in ppm				2,4-D concentration in ppm				Control (C_9)	Mean
	15 ppm (C_1)	30 ppm (C_2)	45 ppm (C_3)	60 ppm (C_4)	1 ppm (C_5)	2 ppm (C_6)	4 ppm (C_7)	8 ppm (C_8)		
Double spray (M_1)	7.70	8.00	7.65	8.05	7.70	7.05	7.95	6.40	7.70	7.58
Seedling root dip for 15 min. (M_2)	8.25	8.15	8.75	8.55	9.15	7.75	8.65	8.85	7.24	8.37
Seedling root dip for 30 min. (M_3)	8.55	8.45	8.55	8.35	8.45	9.15	8.40	7.85	7.50	8.36
Seedling root dip for 15 min.+ DS (M_4)	8.35	8.85	9.95	9.45	9.25	9.50	8.15	5.25	7.35	8.46
Seedling root dip for 30 min.+ DS (M_5)	8.55	9.25	10.45	9.90	9.40	9.10	9.45	6.25	7.70	8.89
Mean	8.28	8.54	9.07	8.86	8.79	8.51	8.52	6.92	7.50	8.33
C.D.(P=0.05)										
For comparing main plots							0.16			
For comparing sub plots							0.29			
For comparing two sub plots within a main plot							0.66			
For comparing two main plots within a sub plot							0.65			

growth (flowering and fruit set), higher photosynthetic efficiency and enhanced source to sink relationship of the plant, increased uptake of nutrients and water, reduced transpiration and respiration, enhanced translocation and accumulation of sugar and other metabolites.

Among different interactions M_5C_3 (seedling root dip for 30 minutes along with double spray of 45 ppm NAA) gave maximum yield in terms of number and weight of red ripened chillies per plant due to increased fruit length and fruit girth. Similar increase in fruit yield due to foliar application of plant growth regulators was also confirmed by Joshi and Singh (2001) and Arora *et al*. (2014) in chilli. Higher number and weight of fruits per plant and seed yield with 45 ppm NAA might be due to better plant growth characters, more number of short styled flowers and higher fruit set than most of the treatments and further leading to improved fruit length and fruit girth. As, exogenous supply of growth regulators at critical stages of flowering and fertilization, ovary formation, fruit and seed development period etc. may enhance source to sink relationship, accumulation of photosynthates and efficient utilization of food reserves for the development of fruit, thus enhancing fruit and seed yield by influencing various yield attributes. These findings are in agreement with Rashmi (2003) in bottle gourd, Kannan *et al*. (2009) in paprika, Chauhan *et al*. (2014); Arora *et al*. (2015) in different chilli genotypes, Singh and Lal (2002) and Tiwari and Singh (2014) on tomato.

Conclusion :

Based on overall performance of methods of applications and concentrations of plant growth regulators on pant C-1, a commercially grown variety of chilli in Northern India, with upright fruit bearing habit, seedling root dip for 30 minutes along with double spray (First at flower bud initiation stage and second at 20 days after first spray) can be suggested to the farmers to maximize percentage of fruit set or number and weight of red ripened fruits per plant. For better plant growth, yield and yield attributes like fruit length and fruit girth of chilli during winter season, 45 ppm NAA can be suggested to farmers for maximizing the fruit and seed yield.

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