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Effect of concentrations and methods of application of 2, 4-D and NAA on plant growth, flowering, yield and quality in summer season chilli (*Capsicum annuum* L.) cv. PANT C-1

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ABSTRACT : The present investigation was undertaken during summer season of 2010-11 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 quality in chilli. Among different concentrations of plant growth regulators, 45 ppm NAA was found superior to all other treatments in respect of most of the plant growth and flowering characters, while, 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 and quality. Improved yield and yield characters were observed in treatment combination, M_5C_3 (45ppm NAA used as seedling root dip for 30 minutes along with double spray). Applications of plant growth regulators promoted fruit set and thus, yield by influencing the percentage of short styled flowers in chilli cv. PANT C-1.

Key **W**ords : 2, 4-D, NAA, Chilli, *Capsium annuum*

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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 (Rylski and Halevy, 1975; Erickson and Markhart, 2001, 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 there by enhancing production of chilli per unit area and per unit time. The varying responses of chilli to plant growth regulators have been reported by Chattopadhayay and Sen (1974) and Balraj *et al.* (2002) .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 summer season of 2010-11 at Horticulture Research Farm, Gochar Mahavidhyalaya, Rampur Maniharan, Saharanpur, U.P. with five different application methods 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_2O_5 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 February 2010 and 45 days old seedling were transplanted during evening hours and a light irrigation was given to crop in March. The intercultural operations and plant protection measures were followed as per the recommendation of the crop.

RESEARCH ANALYSIS AND REASONING

The data on various attributes presented in Table 1 and 2 showed that plant growth characters, flowering ,yield and yield attributes were significantly influenced by main plots (methods of application) and sub-plot treatments (Different doses of plant growth regulators *i.e.* NAA and 2, 4-D) in chilli during summer season. Among the various methods seedling root dip for 30 min along with double spraywas found superior for improving plant growth characters *i.e.* plant height, primary branches and number of leaves per plant during summer season, while, among different concentrations of plant growth regulators, 45ppm NAA gave significantly maximum plant height (68.6 cm), primary branches (7.80) and number of leaves per plant (2193.20). The promoting effect of NAA on plant growth 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 Lata and Singh (1993), Prabhavathi *et al.* (2008); Prabhu (2006) and Joshi and Singh (2003).

The promotive effect of 45 ppm NAA on percentage of short styled flowers (66.19 %) and fruit set percentage (66.58%) might be ascribed to more efficient utilization of food for reproductive 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.

Table 1: Effect of different methods of application of plant growth regulators on growth, flowering and yield in chilli cv. PANTC-1 in summer season

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	Fruit Length (cm)	Seed weight per plant (g)	Weight of red ripened fruits per plant(g)	Ascorbic aicd content (mg/100g of fresh fruits)
Double spray (M_1)	64.90	8.18	1951.60	62.36	62.78	182.10	6.11	15.66	192.60	139.44
Seedling root dip for 15 min. (M_2)	63.10	7.34	2055.20	56.08	55.06	160.00	5.83	14.90	170.90	133.48
Seedling root dip for 30 min. (M_3)	62.20	7.38	2117.40	56.16	57.16	170.40	5.99	14.88	170.00	138.22
Seedling root dip for 15 min.+ DS (M_4)	63.00	7.46	2037.60	61.81	58.78	177.60	6.00	15.56	185.90	134.32
Seedling root dip for 30 min.+ DS (M_5)	66.80	7.96	2052.70	63.54	58.89	212.10	6.44	22.71	225.40	136.17
Mean	63.01	7.67	2042.90	59.99	58.53	180.40	6.07	16.74	189.00	136.32
C.D. (P=0.05)	3.08	0.47	35.68	2.14	1.40	2.61	0.29	1.12	3.72	4.11

Table 2: Effect of different doses of plant growth regulators on growth, flowering and yield in chilli cv. PANT C-1 in summer season

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	Fruit length (cm)	Seed weight per plant (g)	Weight of red ripened fruits per plant(g)	Ascorbic acid content (mg/100g)
NAA 15 ppm	67.20	7.41	1927.80	56.83	52.65	183.2	6.34	16.87	193.80	155.80
NAA 30 ppm	67.00	7.60	2184.40	58.72	60.60	184.6	6.35	17.15	194.60	183.60
NAA 45 ppm	68.60	7.80	2193.20	66.19	66.58	226.2	6.88	21.57	235.80	145.30
NAA 60 ppm	64.70	7.69	2134.20	55.84	58.46	156.8	6.29	14.05	164.20	127.51
2,4-D 1 ppm	61.60	7.31	2152.20	64.53	60.40	168.8	5.70	17.14	173.40	127.76
2,4-D 2ppm	64.30	7.70	2154.40	63.80	63.55	206.4	6.01	17.99	216.00	125.50
2,4-D 4 ppm	64.40	7.97	2190.60	64.64	64.85	213.6	6.90	19.19	218.80	126.80
2,4-D 8ppm	56.30	8.05	1673.60	55.96	56.99	133.8	5.67	12.16	142.00	92.00
Control	62.00	7.46	1775.60	53.42	42.70	150.6	4.53	14.56	162.00	142.66
Mean	64.01	7.67	2042.90	59.99	58.53	180.4	6.07	16.74	189.00	136.32
C.D. (P=0.05)	3.86	0.46	51.14	1.80	2.73	3.73	0.28	1.12	4.16	4.03

Table 3: Interaction between method and concentrations of PGRs on short styled flowers (%) during summer season

Main plot / Sub 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)	54.22	56.00	69.95	65.00	68.86	65.21	65.00	62.00	55.00	62.36
Seedling root dip for 15 min. (M_2)	53.60	53.00	58.00	54.00	59.50	55.00	57.50	59.00	55.16	56.08
Seedling root dip for 30 min. (M_3)	52.80	53.86	61.00	51.80	60.80	55.40	57.00	59.80	53.00	56.16
Seedling root dip for 15 min.+ DS (M_4)	59.00	64.00	69.00	55.50	65.00	70.00	70.40	52.00	51.40	61.81
Seedling root dip for 30 min.+ DS (M_5)	64.55	66.75	73.00	52.88	68.50	73.40	73.28	47.00	52.52	63.54
Mean	56.83	58.72	66.19	55.84	64.53	63.80	64.64	55.96	53.42	59.99
C.D. (P=0.05)										
For comparing main plots							2.14			
For comparing sub plots							1.80			
For comparing two sub plots within a main plot							4.03			
For comparing two main plots within a sub plot							4.35			

Table 4 : Interaction between method and concentrations of PGRs on weight of red ripened fruits (gm) during summer season

Main plot / Sub 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)	222	147	263	157	186	264	224	112	158	192.6
Seedling root dip for 15 min. (M_2)	147	178	188	182	142	178	174	178	171	170.9
Seedling root dip for 30 min. (M_3)	172	186	197	164	144	157	198	160	152	170.0
Seedling root dip for 15 min.+ DS (M_4)	192	206	238	156	167	212	216	124	162	185.9
Seedling root dip for 30 min.+ DS (M_5)	236	256	293	162	228	269	282	136	167	225.4
Mean	193.8	194.6	235.8	164.2	173.4	216.0	218.8	142.0	162.0	189.0
C.D. (P=0.05)										
For comparing main plots							5.15			
For comparing sub plots							4.43			
For comparing two sub plots within a main plot							9.91			
For comparing two main plots within a sub plot							10.66			

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); Satish *et al.* (2012) and Verma and Joshi (2000) in paprika.

Among different methods, seedling root dip for 30 minutes along with double spray of NAA gave maximum yield in terms of number and weight of red ripened chillies per plant, fruit length and seed weight per plant. Similar increase in fruit yield due to foliar application of plant growth regulators was also confirmed by Lata and Singh (1993), Revannappa (1993), Joshi and Singh (2001) in chilli. Higher fruit yield with 45 ppm NAA might be due to more number of fruits per plant, more fruit length and higher number of seeds per fruit and per plant. 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 yield components and fruit yield (Kannan *et al*., 2009). Similarly, ascorbic acid content, an important quality parameter, was also enhanced by seedling root dip for 30 minutes along with double spray of NAA. Similar work related to the present topic was also conducted by Prasath and Ponnuswami (2008), Ananthi *et al.* (2004), Ananthi (2002), Majumdar *et al.* (2000), Sharma *et al.* (1996), Anu and Peter (2000) and Sundharaiya (2012).

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 of 45 ppm NAA (First at flower bud initiation stage and second at 20 days after first spray) can be suggested to the farmers to maximize yield of chilli per unit area during summer season.

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