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Evaluation of bio-efficacy and phytotoxicity of gibberellic acid on chilli

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ABSTRACT

The investigation was carried out at C-Block farm, kalyani, Bidhan Chandra Krishi Viswavidyalaya during 2015-16 in chilli cv. Beldanga to study the effect of gibberellic acid on growth and yield parameters in chilli. During seedling stage, roots are dipped with different concentrations (0, 10 and 20 ppm) of gibberellic acid and transplanted, which were further sprayed with gibberellic acid (GA_3) of three more concentrations (20, 30 and 40ppm) at flowering stage. The experiment was laid out in RBD with three replication. Among different treatments maximum plant height (64.10 cm), plant spread (63.83 cm in East-West and 62.67 cm in North-South) and number of primary branches (8.65) at 150 DAP was found with 20 ppm seedling dip and 40 ppm foliar spray followed by 20 ppm seedling dip and 30 ppm foliar spray. In respect to the yield parameters, Early fruit maturity (38.13 days), maximum yield (152.64 g plant^{-1}), maximum number of fruits plant^{-1} (84.67), maximum fruit weight (2.61 g) and maximum fruit set (30.15%) was observed in 20 ppm seedling dip and 40 ppm foliar spray followed by 20 ppm seedling dip and 30 ppm foliar spray.

Keywords : Chilli, gibberellic acid, growth, phytotoxicity, yield.

Among the important commercial vegetable and spice crops at global level, chilli (*Capsicum annuum* L.) is the most prominent one (Chattopadhyay *et al.*, 2011). As a Solanaceous crop, it is grown in almost all parts of the tropical and subtropical regions of the world. The commercial species of the genus *Capsicum* includes *Capsicum annuum* L., *C. frutescens* L., *C. chinense* Jacq, *C. pubescens* R. & P. and *C. baccatum* L. (Bosland and Votava, 2000; Wang and Bosland, 2006; Ince *et al.*, 2010). India is the largest producer of chillies in the world followed by China. In India, Chilli was grown in an area 775 thousand hectare and production 1492 thousand tonnes and the productivity was 1.93 tonnes per hectare in 2014-15. (Anon, 2015). Though India is the leading producer, the average yield of chilli is very low (1.93 t ha^{-1}) as compared to developed countries (Geetha and Selvarani, 2017). The production of chilli is reduced due to flower and fruit drop, which are caused by physiological and hormonal imbalance in the plants particularly under unfavorable environments, such as extremes of temperature *i.e.* too low or high temperatures (Rylski, 1973; Rylski and Halevy, 1975; Erickson and Makhart, 2001). The production of chilli is governed not only by the inherent genetic yield potential of the cultivars but is greatly influenced by several environmental factors and cultivation practices. The manipulation of growth and increasing productivity and quality is the basis for most plant-related research. Plant growth regulators are considered as new generation of agro-chemicals after fertilizers, pesticides and herbicides to augment yield and quality. The plant growth regulators are known to enhance and stimulate the translocation of photo assimilates thereby helping in better retention of flowers and fruits. Besides this, the growth regulators have the ability to cause accelerated growth in plants. Studies on the effect of plant growth regulators in chilli had revealed that the application of some of the plant growth regulators was effective in reducing the flower and fruit drops thereby enhancing production of chilli per unit area and per unit time (Thapa *et al.*, 2003). Some research works like effect of inorganic and biofertilizers (Khan and Chattopadhyay, 2009) nutrient management (Pariari and Khan, 2013; Anitha and Geethakumari, 2006**)**, impact of biozyme (Manna *et al*., 2012),growth regulators (Sharangi *et al*., 2003) on chilli are done earlier but very few literatures are available on the effect of gibberellic acid on chilli in West Bengal condition (Sreenivas and Sharangi, 2017). The most widely available plant growth regulator is GA_3 or gibberellic acid, which induces stem and internode elongation, seed germination, enzyme production during germination and fruit setting and growth (Davies, 1995). Gibberellic acid (GA_3) is a chemical substance that occurs naturally in many plants. It is an important growth regulator that have many uses to modify the growth, yield and yield contributing characters of plant (Rafeekher *et al.*, 2002). The present study was therefore, conducted with different concentration of gibberellic acid as foliar spray to find out its effective concentration on growth and yield enhancement of commercial chilli cv. Beldanga. The phytotoxicity study of gibberellic acid at varied concentrations was also conducted.

MATERIALS AND METHODS

The study was conducted at the C. Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. The experimental site was situated at 23.5^0 N latitude and 89^0 E longitude with an elevation of 9.75m

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above mean sea level. The field experiments were undertaken during autumn-winter season. The soil texture of the farm was sandy loam having neutral reaction, with good water holding capacity and medium fertility. Research activity was initiated to study the growth, yield and quality of chilli cv. Beldanga as influenced by GA_3. The chilli cultivar was collected from local farmers of Mohanpur and Gadamara, 24 Parganas (North) of West Bengal. The seedlings were treated dipping in GA_3 suspension (0, 10 and 20 ppm) before transplanting. Field treatment was done by spraying with the same plant growth retardant (PGR) at varying concentrations (20, 30 and 40 ppm) once during flowering and again at 20-30 DAFS (days after first spraying) as per the mandate. Observations were recorded on morphological, phenological, yield and yield attributing parameters.

For phytotoxicity study plants sprayed with GA 0.45 % SL at different concentrations (0, 30, 40, 60, 80, 120 and 160 ppm) as foliar spray. Ten plants are randomly selected from each plot and the total number of leaves these showing phytotoxicity symptoms, if any were counted. Observations were recorded at 0, 3, 5, 7 and 10 days after spray on yellowing, epinasty, hyponasty and scorching symptoms of the crop. The extent of phytotoxicity were recorded based on the following score.

Score	Phytotoxicity (%)
0	No phytotoxicity
1	0-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

The data collected were converted in to percentage. All the data collected were analyzed statistically.

$$\text{Percent phytotoxicity} = \frac{\Sigma \text{ Numerical ratings}}{\text{Highest grade of rating} \times \text{total number of plants examined}} \times 100$$

RESULTS AND DISCUSSION

From the graph 1, among different treatments maximum plant height (64.10 cm), plant spread (63.83 cm in East-West and 62.67 cm in North-South) and number of primary branches (8.65) were recorded in plants with 20 ppm seedling dip and 40 ppm foliar spray followed by 20 ppm seedling dip and 30 ppm foliar spray (150 DAP). Similar findings also reported by Kumar *et al.* (2014) and Khan *et al.* (2006) in tomato. This could be ascribed to the roles of GA_3 in promoting cell enlargement and cell division of which the two important processes enhanced plant height in tomato (Arteca, 1996). Plant height and number of branches plant^{-1} increased significantly with the increasing level of GA_3. This might be due to rapid increase in cell division and cell elongation in the meristematic region. These results are in conformity with those of Gupta and Gupta (2000) and Rai *et al.* (2006). Fruit maturity varied from 38.13 to 43.14 days, early maturity was observed in 20 ppm seedling dip and 40 ppm foliar spray.

There were significant differences observed for fruit set , maximum fruit set (30.15%) was observed in 20 ppm seedling dip and 40 ppm foliar spray followed by 20 ppm seedling dip and 30 ppm foliar spray (27.90). Maximum fruit length (71.16 mm), fruit width (35.26 mm), fruit weight (2.61g), number of fruits per plant (84.67) and yield plant^{-1} (152.64) recorded in 20 ppm seedling dip and 40 ppm foliar spray. Similar result was cited by Uddain *et al.* (2009) and Kumar *et al.* (2014) for number of fruits .Plant growth regulators have possibility to increase fruit length and diameter. Prasad and Kumar (2003) stated that plant growth regulators promote the cell wall loosening processes providing a state of extensive flexibility within the cell leading ultimately in plant growth. Sarkar *et al.* (2014a) and Choudhury *et al.* (2013) also reported that, plant growth regulators have great potentiality to facilitate the fruit length and diameter of summer tomato. Application of plant growth regulators significantly increases yield of fruit plant^{-1}. Application of GA_3 increased the fruit yield plant^{-1} as compared to the fruit set where hormone was not applied. This might be occurs due to higher number of fruit setting and single fruit weight plant^{-1} that increased by plant hormones. Hasanuzzaman *et al.* (2007) reported the highest fruit yield plant^{-1} with plant growth regulators on bell pepper. Sarkar *et al.* (2014b) and Choudhury *et al*. (2013) also reported that, application of plant growth regulators significantly increased single fruit weight of summer tomato. Similar result was cited by Uddain *et al.* (2009) and Kumar *et al.* (2014). Improvement in pepper growth and yield with GA_3 application compared to the control was observed. That 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, reduced respiration, enhanced translocation and accumulation of sugars and other metabolites. Inhibition of growth performance on exposure to the other PGRs occurred (Georgia *et al*., 2010).

No phytotoxicity symptoms were observed for 0, 30, 40, 60, 80 and 120 ppm of gibberellic acid even after 10

Table 1: Effect of gibberellic acid on yield and yield attributes of chilli cv. Beldanga

Treatments (ppm)	Days to fruit maturity	Fruit set (%)	Fruit length (mm)	Fruit width (mm)	Days to 50% flowering	Fruit weight (g)	No. of fruits plant^{-1}	Yield plant^{-1} (g)
T_1 (0*with 20**)	40.05	16.95 cd	65.78	30.54	69.67 ab	2.28 c	57.52 de	98.56 d
T_2 (0* with 30**)	41.83	17.90 cd	66.93	30.52	67.67 ab	2.36 bc	69.21 bcd	122.45 bc
T_3 (0* with 40**)	39.96	25.89 ab	68.06	32.78	64.67 abc	2.31 c	66.35 bcde	139.67 ab
T_4 (10* with 20**)	41.00	14.86 cd	66.03	30.40	72.67 ab	2.34 bc	60.93 cde	106.85 cd
T_5 (10* with 30**)	40.11	25.07 ab	69.08	32.15	68.67 ab	2.29 c	68.67 bcd	132.59 ab
T_6 (10* with 40**)	41.10	24.24 ab	69.14	34.25	65.67 abc	2.41 bc	81.34 ab	131.59 ab
T_7 (20* with 20**)	41.91	20.97 bc	67.85	32.15	69.67 ab	2.25 c	63.39 cde	123.85 bc
T_8 (20* with 30**)	38.69	27.90 a	70.47	33.84	60.67 bc	2.53 ab	74.68 abc	145.26 a
T_9 (20* with 40**)	38.13	30.15 a	71.16	35.26	55.33 c	2.61 a	84.67 a	152.64 a
T_{10} (Control)	43.33	13.03 d	64.96	29.64	74.67 a	2.26 c	51.68 e	91.46 d
SEm (±)	**2.55**	**2.03**	**3.58**	**1.68**	**3.55**	**0.06**	**4.63**	**6.50**
LSD(0.05)	**NS**	**6.03**	**NS**	**NS**	**10.55**	**0.18**	**13.77**	**19.32**

Means with the same letter are not significantly different. Seedling dip with foliar spray***

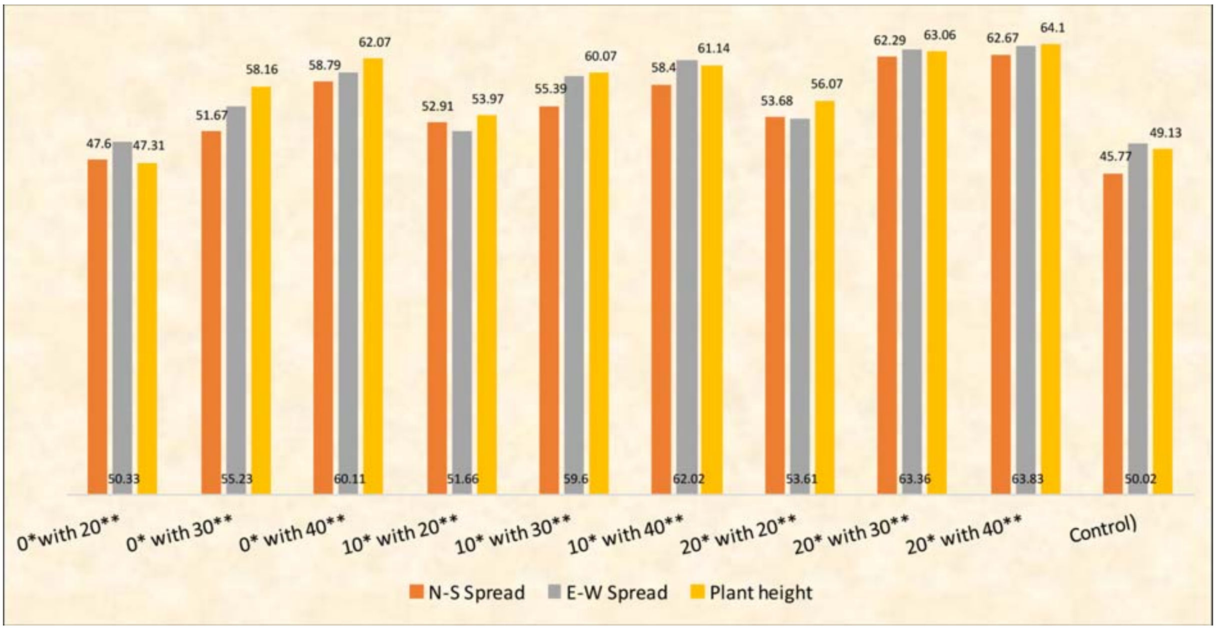

Fig. 1: Effect of gibberellic acid on plant height, spread (E-W and N-S) and number of primary branches

days of spray. Few phytotoxic symptoms were observed in 160 ppm of gibberellic acid spray. Maximum Percent phytotoxicity values were observed for the following symptoms like yellowing (6.67), epinasty (6.33), hyponasty (4.67) and scorching (4.67) for 160 ppm gibberellic acid after 10 days of spray. Studies like effect of some plant growth regulators on lindane and alpha-endosulfan toxicity to *Brassica chinensis* by Waraporn (2012) confirmed these findings.

It may be recommended that gibberellic acid sprayed with 20 ppm seedling dip with 40 ppm foliar spray and 20 ppm seedling dip with 30 ppm foliar spray is the best for chilli without any phytotoxicity symptoms up to 120 ppm.

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