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Influence of plant growth regulators and foliar nutrients on growth and yield of chilli

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Abstract

Application of growth promoters and stimulants containing plant growth regulators is a common practice among chilli farmers in Sri Lanka. An experiment was conducted in *Yala* season 2017 (minor season; May to September) and *Maha* season 2017/18 (Major season; October to February) to identify the influence of analytical grade plant growth regulators Gibberellic Acid (GA_3), Naphthalene Acetic Acid (NAA) and one commercial product containing of 10% GA_3, 6% Ca and 2% B, followed by Albert solution as a foliar nutrient spray, on growth and yield of hybrid chilli (*Capsicum annuum* L), variety MICH hy 1. The experiment consisted of two factors, (1) application of different plant growth regulators, i.e. T1 - 50 ppm GA_3, T2 - 100 ppm GA_3, T3 - 50 ppm commercial product, T4 - 100 ppm commercial product, T5 - 50 ppm NAA, T6 - control with distilled water spray) and (2) two levels of Albert solution (with or without). The treatments were applied at the flower initiation stage. The Albert solution was applied three days after application of the plant growth regulator. Another dose of Albert solution was applied 20 days later. Application of GA_3 and the commercial product significantly increased the plant height and canopy width while it reduced the SPAD meter value, which is an indication of the chlorophyll content. Application of plant growth regulators did not influence the green chilli yield.

Key words: Albert solution, Chilli, Foliar spray, Gibberellic Acid, Naphthalene Acetic Acid

Introduction

Chilli (*Capsicum annuum* L.) is one of the most important cash crops grown in Sri Lanka. It has become an essential ingredient in Sri Lankan meals (Kannangara and Karunathilake, 2013). The annual extent of chilli in 2016 was about 15,267 ha (Agstat, 2017) and the potential yield is approximately 32 t/ha for green chilli from local hybrids (DOA, 2015). The MICH hy 1 is the first hybrid chilli variety developed in Sri Lanka, which has many desirable characters such as high yield potential, moderate-resistance to chilli leaf curl complex and moderate-resistance to Chilli Leaf Curl Virus during the *Maha* seasons and moderate susceptibility during *Yala* season. It also shows moderate resistance to *Cucumber mosaic virus*. Therefore, there is a huge potential to expand the cultivation of MICH hy 1 to obtain better profits. However, a proper agronomic management package need to be developed for the variety to enhance the crop yield.

Gibberellic acid (GA_3) is a naturally occurring plant growth regulator found in plants and fungi. The gibberellins are metabolic products of fungus *Gibberella fujikuroi* (conidial state *Fusarium moniliforme*), a pathogen of rice. The characteristic effects of GA_3 are increase in shoot growth, inter-node extension, increased leaf-growth and enhanced apical dominance (Brain, 1959; Marth *et al*., 1956; Gupta and Chaknabarty, 2013).

Experiments conducted in order to find the effect of GA_3 and Naphthalene Acetic Acid (NAA) on growth and yield have revealed that their use is effective at various concentrations only on some crops (Maboko and Plooy, 2015). The NAA, which is a synthetic auxin (Flasinski and Hac-Wydro, 2014), has increased growth and yield of capsicum when applied at a concentration of 60 ppm (Singh *et al*., 2017). Dry matter and yield of cowpea (Ullah *et al*., 2007) and chilli (Natesh *et al*., 2005) have also increased with the application of NAA.

Although hybrid chilli seeds are expensive, the return to investment on green chilli production is high with hybrid chilli. Many farmers in Sri Lanka tend to use different foliar fertilizers, growth promoters and growth stimulants with the objective of increasing growth and yield of chilli. Although scientific information on the impact of plant growth regulators (PGRs) on crop production is available from other countries, availability of

such information in Sri Lanka in commercial agriculture is limited. Hettigedara and De Silva (2018) reported that growth of chilli was significantly increased with the application of GA_3 and GA_3-containing commercial products though the crop yield was significantly reduced. As the nutrients supplied for the plants with commercial fertilizers, this may not be adequate for increased vegetative growth and yield increment in chilli. Therefore, provision of additional nutrients using the Albert solution as a foliar spray, in addition to the fertilizer recommendation of Department of Agriculture would be advantageous. This research was conducted with the objective of investigating the effect of selected PGRs coupled with foliar nutrient supplements on growth and yield of a chilli hybrid grown in Sri Lanka.

Materials and Methods

The experiment was conducted during *Yala* season 2017 (minor cultivating season; March to September) and *Maha* season 2017/18 (Major cultivating season; October to February) at the research fields of the Field Crops Research and Development Institute (FCRDI) at Mahailuppallama (8°06' 42.73" N and 80°28' 03.27" E, Elevation 117 m amsl), located in the North Central province (DL_{1b} agro-ecological region) of Sri Lanka. The soil type of the study location is classified as Reddish Brown Earths (USDA Soil Taxonomy - Typic Rhodustalfs; FAO classification - Rhodic Otherieutic Cutanic Luvisols) (Mapa *et al*., 2010).

Land preparation, fertilizer application, and organic matter applications were practiced as recommended by the Department of Agriculture (Kannangara and Karunathilake, 2013). Thirty days old seedlings, raised on standard field nurseries, were planted in plots at the spacing of 60 cm x 45 cm. Only one plant was kept in one hill. Plots size was 4.8 m x 2.7 m, arranged in a Randomized Complete Block Design (RCBD) with three replicates. The GA_3 used for the study was 90% analytical grade and the commercial product NapGibb® comprised 10% GA_3, 6% Ca and 2% B.

The experiment consisted of two factors, (1) application of different plant growth regulators, i.e. T1 - 50 ppm GA_3, T2 - 100 ppm GA_3, T3 - 50 ppm NapGibb® (commercial product), T4 - 100 ppm commercial product, T5 - 50 ppm NAA, and T6 - control with distilled water spray), and (2) two levels of Albert solution i.e. with (10 g in 4.5 L water)

and without. All treatments were applied at the flower initiation stage of the chilli crop as a foliar spray using a hand sprayer until the whole canopy got wet with the solution. The Albert solution was applied at three days after application of PGRs as a foliar spray using a hand sprayer until the whole canopy got wet with the solution. A second dose of Albert solution was applied 20 days after the first application. Each plant was sprayed with 10 ml of the solutions at the initial flowering stage and 20 ml of the Albert solution at the second dose application.

Plant height, canopy width, green chilli yield, chlorophyll meter SPAD-502 (Konica Minolta Sensing, Inc., Japan) readings at one month after the first application of PGRs and Albert solution were recorded. Analysis of variance (ANOVA) was carried out using the Statistical Analysis System ver. 9.1.3 portable (SAS institute Inc.). Mean separation was performed using Duncan's Multiple Range Test at P=0.05.

Results and Discussion

Growth performance

The interaction effect of PGR and Albert solution was not statistically significant (P>0.05) for all parameters measured. Application of GA_3 and commercial product significantly increased the plant height on 40^{th} and 100^{th} day after planting (Table 1). The increased intermodal length owing to the impact of GA_3 is responsible for the increased plant height. Gibberelic acid plays an important role in stem or internodes elongation and it stimulates cell division and expansion in response to light or dark (Gupta and Chaknabarty, 2013). The results are in agreement with those of Singh *et al*. (2015), Kumar *et al*. (2014) and Maboko and Plooy (2015) who reported that application of GA_3 recorded higher plant height in garden pea, tomato and sweet pepper, respectively.

Table 1. Effect of applied plant growth regulators on plant height (cm)

	40 Days after planting		100 Days after planting	
	***Yala* 2017**	***Maha* 2017/18**	***Yala* 2017**	***Maha* 2017/18**
Albert solution				
Without Albert solution	31.4 a	36.7 a	51.3 a	48 a
Sprayed with Albert solution	30.5 a	36.8 a	48.4 a	49 a
Plant Growth Regulator				
50 ppm GA_3	31 a	37.1 ab	52.2 a	49.6 ab
100 ppm GA_3	36 a	38.8 a	52.7 a	50.6 ab
50 ppm Commercial product	33.2 a	38.9 a	52.4 a	49.6 ab
100 ppm Commercial product	34.9 a	40 a	51.4 ab	51.1 a
50 ppm NAA	24.9 b	33.4 bc	45.2 b	46.2 b
Control - Distilled water	24.8 b	32.2 c	45.1 b	43.9 c
CV %	10.5	9.1	10	7.3

Within a column, means followed by same letters are not significantly different by DMRT at P=0.05

Application of GA_3 and the commercial product significantly increased the canopy width at 40 days after planting (Table 2), but such an impact was not observed at 100th day after planting.

Table 2. Effect of applied plant growth regulators on canopy width (cm)

	40 Days after planting		100 Days after planting	
	***Yala* 2017**	***Maha* 2017/18**	***Yala* 2017**	***Maha* 2017/18**
Albert solution				
Without Albert solution	23.4 a	26.5 a	46.3 a	41.8 a
Sprayed with Albert solution	21.8 a	26.6 a	43.6 a	43.3 a
Plant Growth Regulator				
50 ppm GA_3	25.1 a	27.2 a	49.1a	42.4 a
100 ppm GA_3	24.7 a	28.7 a	46.5 a	43.3 a
50 ppm Commercial product	24.8 a	28.5 a	44.9 a	41.7 a
100 ppm Commercial product	21.3 ab	28.4 a	45.2 a	45.1 a
50 ppm NAA	17.9 b	23.2 b	42.1 a	43.5 a
Control - Distilled water	20.2 ab	23.6 b	42.1 a	39.6 a
CV %	**17**	**9.3**	**15**	**8.5**

Within a column, means followed by the same letters are not significantly different by DMRT at P=0.05

At one month after spraying, the SPAD meter values were significantly different ($P<0.05$) among the treatments. The highest values recorded from the plants treated with 50 ppm NAA and in the Control treatments (Table 3). After spraying of the PGR GA_3 and GA_3-containing commercial product, the chilli plants showed a rapid growth due to internodal elongation. However, the colour of those plants was light green as indicated by the SPAD readings.

Table 3. SPAD meter values of the leaves at one month after spraying the plant growth regulator and Albert solution

	***Yala* 2017**	***Maha* 2017/18**
Albert solution		
Without Albert solution	42.4 a	40.3 a
Sprayed with Albert solution	41.7 a	40.4 a
Plant Growth Regulator		
50 ppm GA_3	37.6 c	37.1 bc
100 ppm GA_3	37.0 c	35.7 c
50 ppm Commercial product	37.4 c	38.4 b
100 ppm Commercial product	35.4 c	36.6 bc
50 ppm NAA	53.9 a	47.7 a
Control - Distilled water	51.0 b	46.5 a
CV %	**5.3**	**4.7**

Within a column, means followed by the same letter are not significantly different by the DMRT at P=0.05

Crop yield

Although the plant height was positively and significantly affected by the application of GA_3 and GA_3- containing commercial product, no such impact was observed on the green chilli yield with the applications of PGRs or Albert solution ($P>0.05$; Table 4). The characteristic internodal and stem elongation impact of GA_3 has increased the plant height and canopy width of chilli. However, the canopy width at later staged of plant growth was also not positively influenced by the PGRs. Therefore, the same size canopies may lead to having same number of flower buds and pods, and ultimately the similar green chilli yield among treatments. Maboko and Plooy (2015) also reported that the application of GA_3 and NAA had no beneficial effect on sweet pepper yield. The additional nutrient supplement through Albert solution did not influence any growth or yield parameter in the present study. The recommended amounts of Albert

solution applied, may not be adequate to support or maintain the lush growth observed soon after the application of PGRs.

Application of PGRs as various commercial products is a common practice among the chilli farmers in Sri Lanka. As this experiment was conducted using both analytical grade GA_3 and commercial GA_3 product, the results revealed that their use will not give economic benefits to the farmers. Lush growth observed after the application of PGRs did not had a positive impact on chilli yield. Results further revealed that use of the recommendations of the Department of Agriculture, *i.*e. application of both organic and inorganic fertilizer, will provide high green chilli yields, without any foliar nutrient supplement and application of PGRs.

Table 4. Green chilli yield (t/ha)

	2017 *Yala*	**2017-18 *Maha***
Albert solution		
Without Albert solution	18.6 a	24.3 a
Sprayed with Albert solution	15.5 a	22.4 a
Plant Growth Regulator		
50 ppm GA_3	18.71 a	21.83 a
100 ppm GA_3	17.11 a	22.66 a
50 ppm Commercial product	17.62 a	22.53 a
100 ppm Commercial product	15.95 a	23.43 a
50 ppm NAA	17.61 a	26.24 a
Control - Distilled water	16.05 a	23.38 a
CV%	**29.8**	**25.4**

Within a column, means followed by the same letters are not significantly different by the DMRT at P=0.05

Conclusion

Application of plant growth regulators (GA_3 and GA_3- containing commercial product NapGibb®) increased the plant height of chilli throughout the growth period and canopy width at early stages. However, none of them was beneficial for increasing green chilli yield. Application of Albert solution as a foliar spray did not influence the growth

and yield of chilli. Farmers are advised to use the recommendation given by Department of Agriculture, *i.e*. use of organic and inorganic fertilizer, for obtaining better yields from chilli.

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