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Effect of Foliar Application of Growth Enhancer on the Growth and Yield of Tea (*Camellia sinensis* (L.) O. Kuntze)

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ABSTRACT

This study was conducted to determine effect of growth enhancer on the growth and yield of tea. The commercially available growth enhancer (NOVELGRO ALPHA©) in Indonesia was tested with TRI 4042 cultivar grown in low country intermediated zone of Sri Lanka. Shoot growth, number of plucking points per bush, height increment of plucking table, time taken for leaf unfolding were recorded weekly intervals and ten consecutive plucks were obtained to estimate yield of made tea for the period from January to April 2013.

Comparatively high shoot growth, number of plucking points per bush and height increment of plucking table were recorded in growth enhancer treated tea bushes when compared to control tea bushes. Lesser number of days was required to unfolding of successive leaves in growth enhancer treated tea bushes than control tea bushes. Comparatively higher yield was observed in tea bushes of treatment plots (1695 kg/ha/yr) than control plots (1474.2 kg/ha/yr). However, significant differences of these parameters with control were not observed. Since this is short-term study, further long-term study on effect of growth enhancer (Novelgro Alpha©) on growth and yield of tea is needed.

KEYWORDS: *Camellia sinensis*, Foliar application, Growth enhancer, Growth, Yield

INTRODUCTION

Tea, *Camellia sinensis* (L.) O. Kuntze is Sri Lanka's topmost agricultural export crop. It is one of the major plantation crops grown from nearly sea level to 2200 m elevation and the total tea extent is estimated to be 200,000 ha of which approximately 59% is managed by smallholders contributing to about 70% of the national production. In 2011, Sri Lanka produced 327.5 million kg of tea earning an estimated Rs.164, 854 million (Anon, 2012). Sri Lanka is the fourth largest tea producing country which provides employment over 1.5 million people.

Tea can be grown under wide range of Agro- ecological regions in Sri Lanka, broadly categorized under three groups according to the elevation namely low grown, medium grown and high grown teas. Comparatively high yields of tea were recorded in low elevations of Sri Lanka due to high ambient temperature condition in low country and adaptation of good agricultural practices by small holders. Most of the tea estates in mid country are marginal and their productivity is low. The average yield of tea (1,400 kg/ha/yr) in Sri Lanka is very low when compared to yield of tea grown in Kenya. Presently with increasing labor charges in tea industry in Sri Lanka, the cost of production of tea has been increased. So tea growers are facing difficult situation to maintain tea cultivation as a profitable venture.

The suggesting ways of increase productivity of tea lands are introducing high yielding cultivars, adaptation good agricultural practices, use of growth enhancers etc.

Many studies have been conducted by introducing high yielding cultivars and adapting good agricultural practices to enhance productivity of tea. However, there are few researches on use of enhancers for increasing productivity of tea.

This study was mainly focused on effect of growth and yield of tea plant by using growth enhancer (NOVELGRO ALPHA©) introducing from Indonesia. It is a liquid form chemical including macro and micro nutrients with cytokinin and can be used as foliar application. Naturally cytokinins are synthesized in roots and then transported to other plant parts (Bangerth, 1993). Stimulation of cell division, (Halmann,1990) growth of lateral buds and promote apical dominance (Sachs and Thiman, 1967; Bangerth *et al.*, 2000), stimulation of shoot initiation and bud formation, Leaf cell enlargement that stimulation of leaf expansion are some functions of cytokinins.

Therefore, the objective of present study was to evaluate effect of foliar application of

growth enhancer on growth and yield of tea plant.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP) during the period of January to April 2013. The experimental site was situated in the low country intermediate zone (IL1a), at an elevation of 25 m above mean sea level (Panabokke, 1996).

Experimental Design

Three-year-old, field established tea plants of TRI 4042 cultivar, was selected for the experiment.

Experimental design was a randomized complete design (RCD) with three replicates. There were two plots (treatment and control) in each replicate and twenty tea bushes representing each plot were demarcated by guard row to reduce edge effects.

Growth Enhancer

Commercially available growth enhancer (NOVELGRO ALPHA©) was obtained from PT. Novelvar Company, Jakarta, Indonesia. Chemical composition of NOVELGRO ALPHA is given in Table 1.

Table 1. Chemical composition of NOVELGRO ALPHA©

Ingredient	Concentration
Nitrogen (NH_4^+)	1.7 mg/l
Nitrogen (NO_2^-)	90.23 mg/l
Phosphoric Acid (P_2O_5)	46.8 mg/l
Soluble Potash (K_2O)	160 mg/l
Calcium (Ca)	46 mg/l
Magnesium (Mg)	118 mg/l
Iron (Fe)	tr mg/l
Copper (Cu)	0.4 mg/l
Zinc (Zn)	0.06 mg/l
Manganese (Mn)	0.02 mg/l

Treatments

Growth enhancer (NOVELGRO ALPHA©) (1 ml of Alpha in 1 l of water) was sprayed to tea bushes in treatment plots as a foliar application once in every 2 weeks. Alpha was sprayed early in the morning (at 6 a.m.) to minimize evaporation losses. Each and every plot was maintained with similar conditions to minimize variation. Since a drought condition prevailed during first two months of experimental period, all plots were irrigated when required. All agronomic practices were carried out as recommended by the Tea Research Institute (TRI) of Sri Lanka.

Weather Condition

The total rainfall, maximum and minimum temperatures were recorded daily during the experimental period.

Shoot Growth

Three shoots each having three leaves and active bud were randomly selected from each of three bushes per plot. They were plucked to the third leaf (removing two leaves and bud) and tagged for identification. A new generation of shoots growing from the plucked shoots was used for recording extension of shoots. After the emergence of scale leaves, the total length of the shoots was measured at weakly intervals using a ruler.

Number of Plucking Points

One bush from each plot was selected from the center of the plot and marked for counting shoots weekly. The total number of shoots on marked bushes was recorded by taking a direct count of harvested shoots and the growing shoots left in the bush after plucking.

Height of the Plucking Table

This was measured using permanently installed straight wooden poles at three random places within each plot. The height of the plucking table was marked on the pole using a permanent ink at the beginning and end of the experiment. The difference between the two marks on pole (average of three differences) was taken as the total increase in height.

Time Taken for Leaf Unfolding

Three shoots each having three leaves and active bud were randomly selected from each of three bushes per plot. They were plucked to the third leaf (removing two leaves and bud) and tagged for identification. Then the time taken from harvesting of previous shoots to unfolding of first, second, third leaf of newly growing shoot was recorded.

Yield

Each and every bush (20 bushes) in the plots was plucked weekly (ten consecutive plucks) to remove shoots with 2 to 3 leaves and a bud.

Harvested shoots were processed separately to manufacture made tea using miniature machines and weights of made tea were recorded. The resulting weight was calculated to extrapolate for yield of made tea per ha per year.

Statistical Analysis

Data were reported as means for three replicates. Two sample t test (SAS for Windows, Version 9.2, 2009, SAS Ins. Inc., Cary, USA) was conducted to identify differences among means. Statistical significance was declared at $P< 0.05$.

RESULTS AND DISCUSSION

Environment

The mean weekly rainfall and temperature variation from January to March 2013 in the experimental site were shown as Figure 1 and Figure 2 respectively. Since a well-distributed, moderate rainfall was not received throughout the experimental period the experimental plots were irrigated frequently to avoid drought stress to the plants. The maximum temperatures were ranged from 27 ^{0}C to 35 ^{0}C whereas; minimum temperatures were ranged from 18 ^{0}C to 23 ^{0}C throughout experimental period.

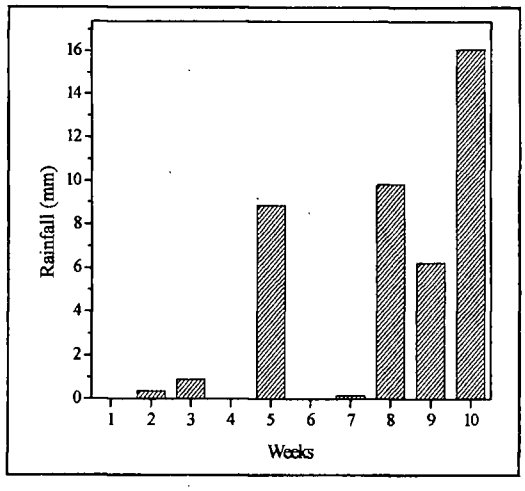

Figure 1. Mean Weekly Rainfall

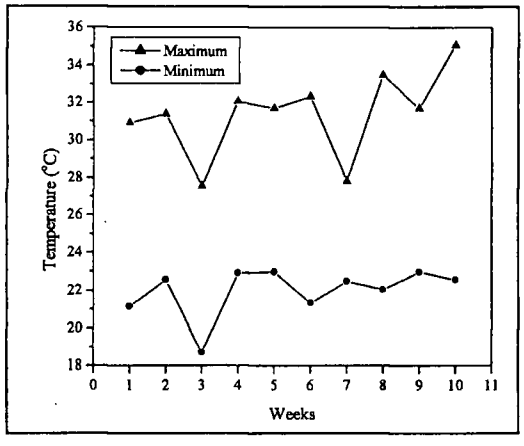

Figure 2. Mean Weekly Maximum and minimum Temperatures

Shoot Growth

Due to the rapid growth of tea shoots in the low country of Sri Lanka, shoot length, after opening of fish leaf increased approximately linearly with time. Both treatment and control had a similar shoot extension patterns with time (Figure 3). Higher shoot length was observed in treatment plots than control plots. This was probably due to effect of macro and micro nutrients included in growth enhancer. However, treatment difference in shoot extension was not statistically significant ($p<0.05$).

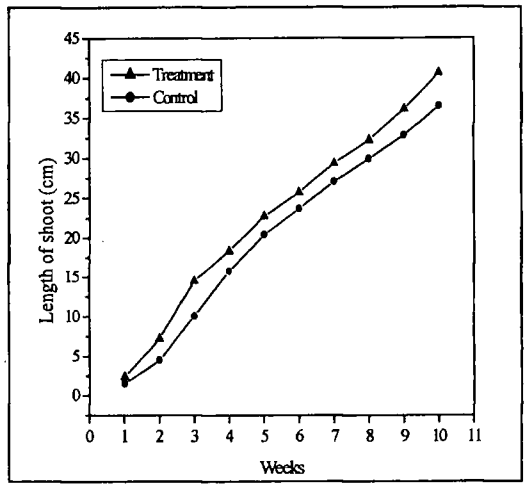

Figure 3. Length of shoots in treated and control tea bushes with time

Number of Plucking Points

The effect of growth enhancer on increment of number of plucking points per tea bush was not observed in first two weeks after application of treatment (Figure 4).

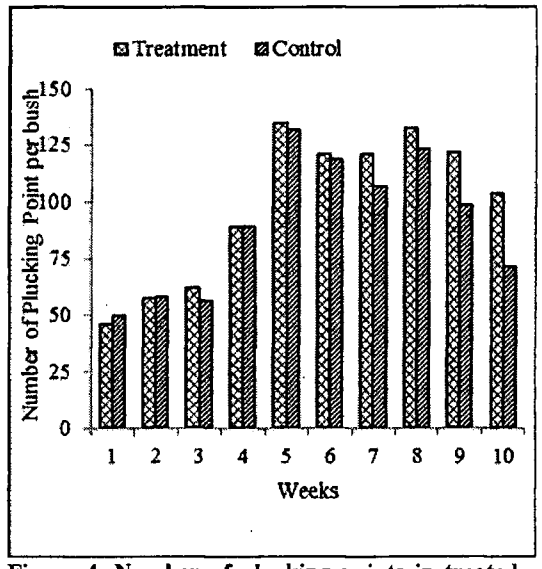

Figure 4. Number of plucking points in treated and control tea bushes with time

There was a slight increment in mean values of plucking points per bush after the 3rd week in treatment plots for which growth enhancer was applied and 3rd week onwards higher number of plucking points per bush was

observed in treatment plots than control plots. The highest difference between treatment (103 shoots per bush) and control (71 shoots per bush) was observed in 10th week after application of treatment. Reason for higher number of plucking points per bush in treatment plots was probably due to production of new shoots with application of growth enhancer. However, there were no significant differences of means of number of plucking points of growth enhancer applied bushes and bushes of control.

Height of the Plucking Table

A higher increment of plucking table height was observed in tea bushes in treated plots than control between the beginning and the end of the study (Figure 5). However, increment of plucking table height in treated plots was not statistically significant ($p<0.05$).

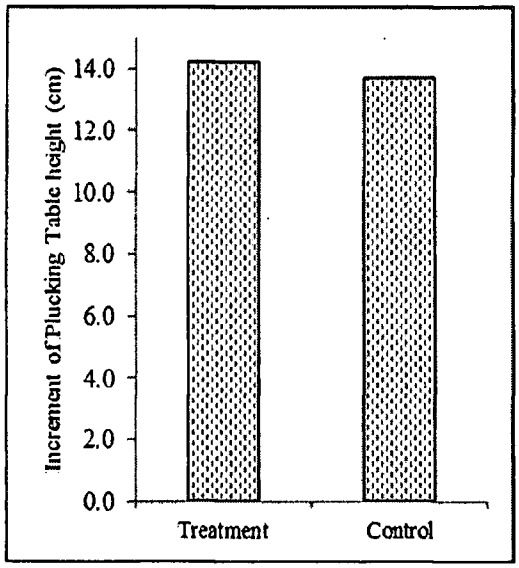

Figure 5. Increment of plucking table height in treated and control tea bushes

Time taken for Leaf Unfolding

According to the Table 2, the longest time taken for leaf unfolding was observed in first leaf compared to second and third leaves. Reason for this may be once the shoot was plucked, a less amount of assimilates may produce by the mother leaf remaining on the bush. Therefore, time taken to emerge the first leaf is longer than that of second and third leaves. Thus, after the emergence of first leaf the new leaf tissues actively produced assimilates which may leads to a rapid growth of second and third leaves.

Table 2. Time taken for leaf unfolding in treated and control tea bushes

Treatment	Time (Days)		
	1st leaf	2nd leaf	3rd leaf
GE treated	23	3	5
Control	27	4	6

GE=Growth Enhancer

The time taken for leaf unfolding in bushes of control plots was longer than that of bushes in treatment plots (Table 2). However, treatment difference in time taken for leaf unfolding was not statistically significant ($p<.05$).

Yield

Comparatively higher yield was observed in tea bushes of treatment plots (1695 kg/ha/yr) than control plots (1474.2 kg/ha/yr) (Figure 6). However, there was no significant difference of yields between treatment and control plots. The high yields of treatment plots were probably due to higher shoot growth (Figure 3) and number of plucking points per bush (Figure 4) in tea bushes of treatment plots than control. Both shoot growth and number of plucking points per bush determine the yield of tea (Wijerathne and Fordham, 1996). Indika and Abeysinghe (2009) also pointed out that the number of plucking points per bush is the most influenced growth parameter which determine yield of tea.

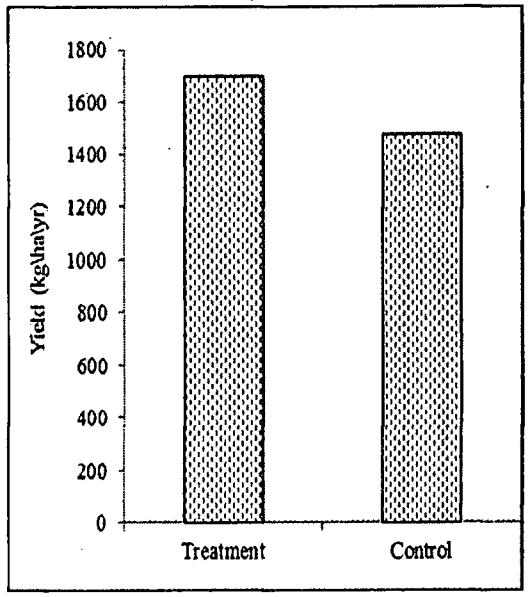

Figure 6. Yield of tea in treated and control bushes

CONCLUSIONS

Shoot growth, number of plucking points per bush, height increment of plucking table and yield of tea bushes which were applied growth enhancer were higher than control. However, significant differences of these parameters with control were not observed. Further long-term study on effect of growth enhancer (Novelgro Alpha©) on growth and yield of tea is needed.

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