PRE-HARVEST ETHEPHON APPLICATION INFLUENCES GROWTH AND DEVELOPMENT OF BANANA IN CHITWAN, NEPAL

Bishal Shrestha* and **Sheela Shrestha****
*Assistant Professor
Department of Horticulture
Agriculture and Forestry University (AFU)
bshrestha@afu.edu.np
**B.Sc. Ag.
Nepal Polytechnique Institute

ABSTRACT

An experiment was conducted to study the effect of pre-harvest application of different doses of ethephon on the growth and development of banana (cv. Jhapali Malbhog) in Chitwan. The experiment was laid out in single factorial randomized block design with six treatments which was replicated thrice. Treatments used were five different doses of ethephon (200, 400, 600, 800 and 1000 ppm) and untreated plant served as control. Result showed that pre-harvest application of ethephon had positive influence on the growth and development of banana during winter. Early harvest at 100.23 days was possible with the treatment 800 ppm which was statistically at par with the treatments 1000 ppm and 600 ppm whereas control took maximum days for harvest (116 days). Longest fruit (10.94 cm) was obtained with the treatment 400 ppm whereas fruit from control were the shortest (8.19 cm). Maximum fruit weight (63.27 g) was recorded with treatment 800 ppm which was at par with treatment 600 ppm. Fruit with minimum weight (40.27 g) was recorded with control. Highest TSS of 23.27 and 10.78 °Brix was recorded with treatment 600 ppm at ripening and at harvest respectively whereas minimum TSS of 16.41 and 7.78 °Brix at ripening and at harvest was recorded with treatment control and 200 ppm respectively. Pulp to peel ratio was found high (1.65) with treatment 600 ppm whereas least (1.44) was observed with 1000 ppm. These results suggest that pre-harvest application of ethephon of dose 600 ppm was ideal for the growth and development of banana.

Keywords: *Earliness, fruit length, fruit weight, quality*

Introduction

Banana (*Musa* spp.) belonging to the family Musaceae is one of the most preferred, widely available, cheapest fruits spread all over the world which is a great combo package of dietary fiber and nutrients. Hundred grams of banana pulp provides 100 kilo calories (K.C., Gautam & Tiwari, 2009). It is adopted in tropical and subtropical regions. In Nepal it is common in home garden of frost free areas of Terai to 1500 m

altitude of mid-hills (Gautam & Dhaka, 1993). It also occupies special place in social and economical aspects and gradually has become the high value crop. Banana occupies 4th position in Nepal among the major fruit crops growing area after citrus, mango and apple with an area of 21,633 ha and the total productive area of 19,313 ha. The productivity is of 15.97 MT/ha with the production of 24,108 MT . Chitwan, Rautahat, Nawalparasi west and Bardiya districts of Nepal are recognized as banana zones under Prime Minister Agriculture Modernization Project (PMAMP). Banana cultivation is considered as an important factor for the upliftment of farmer's economy. Jhapali Malbhog is a famous cultivar with superior quality, storability, palatability (Basnyat, Shrestha, Dhital & Thapa, 1996) and higher demand which is commercially grown in Jhapa, Morang, Sunsari, Chitwan and Nawalparasi districts.

As banana production takes around a year it has been given major importance towards the food security. But still banana farming faces several problems during cultivation such as moisture and nutrients deficiency, sometimes waterlogging, lack of quality saplings, and winter injury. Among these, winter flowering is one of the major problems experienced by the farmers in banana cultivation in Chitwan (Basnyat et al., 1996). Exposure to 5 ℃ for 24 hours only will also induce obvious symptoms (Jones, Freebairn & McDonnell, 1978). Mild symptoms of injury include a slight darkening of the vascular tissue and latex vessel whereas severe symptoms are characterized by a dull yellow skin, browning of the skins, failure to ripen, loss of flavor, hardening of the central placenta and increased susceptibility to mechanical injury (Pantastico, Grierson & Soule, 1967). It is well known fact that bananas are highly sensitive to chilling injury. The problems of choke throat, delay ripening, small size fingers in banana during the month of November have been commonly reported by banana growers in Chitwan.

Nowadays, ethephon or ethrel, is a source of ethylene isan important plant growth regulator used in agriculture for the multiple purposes such as seed germination, defoliation, flowering, fruit ripening, color development, senescence etc. (Zhou et al., 2010). Adoption of new innovation to reduce the problems faced by banana growers during winter season is of utmost importance. Hence, this research work aims at finding out the solution to the problem that most banana farmers are facing in Chitwan by improving the growth and development of banana during winter.

Methods and Procedures

Site selection. The experiment was carried out in farmer's field at Padampur, Chitwan, Nepal. The site has sub-tropical climate between the temperatures of 9 to 37 ℃ and maximum winter temperature rises to 27 ℃. The area receives an average annual precipitation of 2500 mm.

Duration of experiment. The experiment period was from 15th December 2020 to 20th March 2021.

Selection of cultivar. The experiment was carried out using the cultivar Jhapali Malbhog which was spaced at five meters between plant to plant and six meters between row to row. All recommended package of practices were followed to raise the crop.

Treatment details. The treatments used were different concentration of ethephon except treatment T1 which serve as control which are shown in Table 1.

Treatment preparation and application. Ethephon 39% SL (Kripon) which is a source of ethylene was sprayed on banana bunch at fruit development stage after measurement as per the treatments.

Table 1
Treatment combinations with different concentration of ethephon.

Treatments	Concentration (ppm)	Volume of ethephon/water (ml/l)
T1	Control	-
T2	200	0.2/2
T3	400	0.4/2
T4	600	0.6/2
T5	800	0.8/2
T6	1000	1/2

Experimental design. The experiment was conducted in single factorial completely randomized block design with six treatments which were replicated thrice. Each experimental unit consisted of five sample plants.

Parameters recorded. Different parameters regarding growth and development of fruit were recorded during study such as days to harvest, fruit length (cm), fruit weight (g), TSS at harvest (°Brix), TSS at ripening (°Brix) and pulp to peel ratio. Fruits from different treatments were harvested when they reached the physiological maturity stage. Fruit length was measured with the help of Vernier caliper whereas fruit weight including pulp and peel weight was recorded using the digital balance. TSS was measured using hand held refractometer.

Statistical analysis. The collected data were entered, tabulated and processed in Microsoft Excel. The recorded data on different parameters were analyzed using R-Stat software and the means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results

Number of days to harvest. Effect of ethephon on number of days to harvest banana (Figure 1) shows significant effect ($p<0.05$) among treatments applied where control took maximum number of days (116.00) to harvest banana. Minimum number of days (100.28) to harvest banana was recorded in plant treated with 1000 ppm ethephon which was statistically at par with the doses of 800 ppm (100.23 days) and 600 ppm (102.61 days). Plants treated with 200 ppm ethephon took 111.55 days to harvest banana which was followed by the treatment 400 ppm (106.92 days).

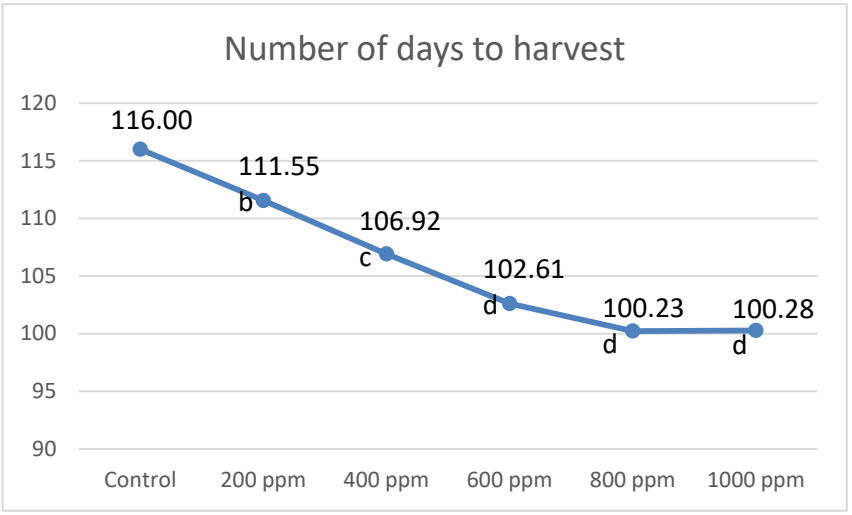

Figure 1: Effect of pre-harvest application of different doses of ethephon on number of days to harvest banana in Chitwan

Fruit size (length and weight). According to Figure 2, the graph showed significant differences among the treatments used regarding the individual fruit length and fruit weight. The longest fruit length (10.94 cm) was measured with the plants treated with ethephon 400 ppm which was statistically at par with the plants treated with ethephon 800 ppm (10.67 cm), 600 ppm (10.21 cm) and 200 ppm (10.1 cm). The shortest length of the fruit (8.19 cm) was measured with the control. The plants treated with ethephon 1000 ppm had intermediate length of 9.37 cm which was also statistically similar (10.10 cm) to the treatment 200 ppm.

Regarding the individual fruit weight, maximum fruit weight (63.27 g) was measured with the plants treated with 800 ppm which was also at par with the plants treated with 600 ppm (62.69 g) whereas control had the minimum weight of 40.27 g. Plants treated with ethephon 1000 ppm had intermediate weight of 57.47 g which was significantly similar with the plants treated with ethephon 400 ppm

(57.90 g) which was then followed by treatment 200 ppm with an average weight of 49.88 g.

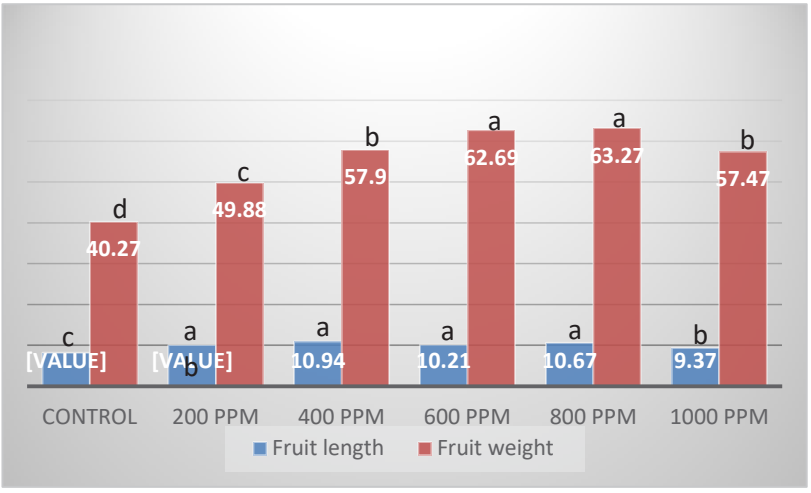

Figure 2: Effect of pre-harvest application of different doses of ethephon on individual fruit length (cm) and fruit weight (g) of banana in Chitwan

TSS at harvest and at ripening. The data on TSS of fruit presented in Table 2 showed significant differences ($p<0.05$) among the treatments used. TSS at harvesting was observed highest with the plants treated with ethephon 600 ppm (10.78 °Brix) which was statistically at par with the plants treated with ethephon 400 ppm (9.77 °Brix). The lowest TSS (7.78 °Brix) was observed with the treatment 200 ppm which was significantly similar to treatments 1000 ppm (8.48 °Brix), control (8.65 °Brix) and 800 ppm (8.83 °Brix).

Similarly, the maximum TSS (23.27 °Brix) at ripening was recorded with the plants treated with ethephon 600 ppm which was statistically at par with the plants treated with ethephon 400 ppm (20.03 °Brix). Minimum TSS (16.41°Brix) at ripening was recorded with the control which was significantly similar with the plants treated with 1000 ppm (17.67 °Brix), 200 ppm (18.76 °Brix), 800 ppm (19.63 °Brix) and 400 ppm (20.03 °Brix).

Table 2: Effect of pre-harvest application of different doses of ethephon on Total Soluble Solids (TSS) at harvest and at ripening of banana in Chitwan

Treatments	TSS at harvest (°Brix)	TSS at ripening (°Brix)
Control	8.65^{bc}	16.41^{b}
200 ppm	7.78^{c}	18.76^{b}
400 ppm	9.77^{ab}	20.03^{ab}
600 ppm	10.78^{a}	23.27^{a}
800 ppm	8.83^{bc}	19.63^{b}
1000 ppm	8.48^{bc}	17.67^{b}
SEm (±)	1.17	5.00
$LSD_{0.05}$	3.01*	3.01*
CV (%)	11.94	11.60
Grand mean	9.05	19.29

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% (p < 0.05). SEM (±) = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation.

Pulp to peel ratio. Figure 3 shows significant differences (p<0.05) regarding pulp to peel ratio of banana treated with pre-harvest application of different doses of ethephon. |The ratio was highest (1.65) with the plants treated with ethephon 600 ppm which was also at par (1.64) with the treatments 200 ppm and 400 ppm. The least ratio of pulp to peel (1.44) was recorded with the plants treated with ethephon 1000 ppm which was statistically similar with the plants treated with 800 ppm (1.46) and the control (1.49).

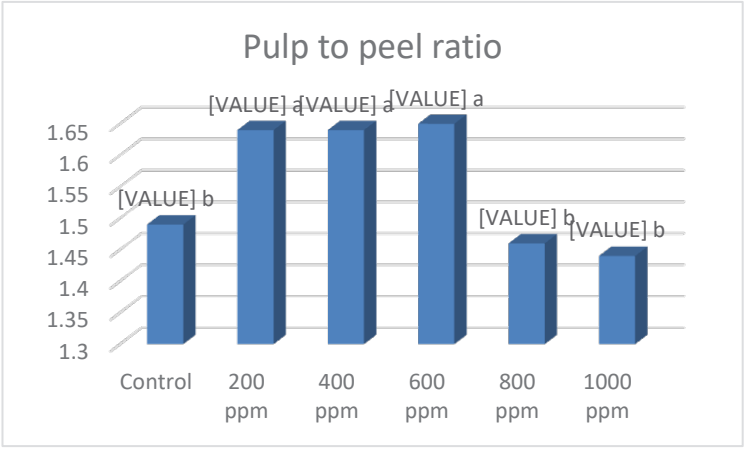

Figure 3: Effect of pre-harvest application of different doses of ethephon on pulp to peel ratio of fruit of banana in Chitwan

Discussion

Number of days to harvest. Days to harvest banana is lowered as the doses of ethephon were increased. Ethephon has been confirmed to accelerate the flowering, fruit maturation, ripening and senescence process which might have caused the earliness in maturity and thus harvesting of fruits.

Fruit size (length and weight). Length and breadth of fruit influencing the size of fruit is affected by the application of ethephon with an increase in size up to the range of 800 ppm. Orientation of cellulose micro fibrils which are found in cell wall can be influenced by the application of ethephon and hence, causing cell expansion and finally resulting in the growth of axis. Also changes in amino acids metabolism have been correlated with the induction of swelling. This findings thus confirm the increase in length and weight of banana fruits treated with ethephon.

TSS of fruit (at harvest and at ripening). TSS of fruit significantly increased at harvest and at ripening with most pronounce effect in ethephon treated fruits. As ripening commences, the TSS of fruit pulp increases due to the breakdown of starch into soluble sugars. Lower starch content has been observed with the higher levels of ethrel concentration and gradually decreases during ripening which indicates the rapid conversion of starch into sugars in ethrel treated fruits compared to untreated fruits (Dadzie & Orchard, 1997). Rapid induction of pre-climacteric and climacteric phases and onset of climacteric peak in respiratory metabolic pathways in starch hydrolysis could be the possible reason behind this. Similar results of increase in TSS of banana during ripening was also reported by Kulkarni, Kudachikar and Keshava, 2011.

Pulp to peel ratio. The result on pulp to peel ratio of banana shows increase in the ratio with the increase in concentration up to 600 ppm but the ratio was found to decrease with the increase in ratio above 600 ppm. The results are in line with the research findings of Mebratie, Woldetsadik, Ayalew and Haji, 2015; Pendharkar, Hiwale and Patil, 2011; Ahmad, Thompson, Hafiz and Asi, 2001. According to John and Marchal, 1995, pulp to peel ratio can be affected by the amount of fresh weight loss during ripening. The reason behind increase in pulp to peel ratio is correlated with the change in the osmotic pressure due to the rapid increase of sugar from carbohydrate breakdown in the pulp compared to the peel (Shrestha, 2010). This results in more absorption of water from the peel and the pulp to peel ratio increases accordingly. Further, water loss from the peel to the pulp and to the atmosphere is also responsible for the increase in pulp to peel ratio. This phenomenon is positively influenced by the ethephon treatment due to the enhanced movement of water from peel to pulp during ripening (Dadzie & Orchard, 1997).

Conclusion

The pre-harvest application of ethephon in banana had influenced the harvesting time, fruit size, TSS and pulp to peel ratio. All these facts and figures from this research suggest the effective use of ethephon at the dose of 600 ppm followed by 400 ppm. However, the effect of hormone on banana fruit could also be affected by the different doses of hormone, varieties and locations. Hence, recommendation is made to conduct similar studies with further coverage with multi-location and years to give validation to these preliminary findings which can bring concrete conclusions.

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