Response of Strawberry to Plant Growth Regulators and Their Effect in Vegetative Parameters, Flowering and Fruiting

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ABSTRACT

An experiment to know GA, NAA and Ethephon's (plant growth regulators) influences in vegetative, flowering and fruiting of strawberry was carried out in November, 2005 to February, 2006 at Kakani of Nuwakot district in RCBD design with ten treatments and four replications. The vegetative parameters were significantly affected by GA at its all concentrations. Among which GA 150 ppm showed the highest value of plant height (39.5 cm) and leaf number (11.7), whereas GA 100 ppm gave the longest petiole (7.9). NAA (20 and 50 ppm) also produced significantly longer petiole length. GA 50 ppm and NAA 20 ppm showed the highest flower number (20.54) and fruit number (16.3) respectively. Both fruit yield and fruit size improved with GA 50 ppm as compared to other treatments. Ethephon did not give visible significant increase over control; rather it produced inferior fruit with reduced vegetative growth.

Key words: Gibberellin, auxin, ethrel, vegetative growth, flowering, fruit yield

INTRODUCTION

Strawberry (Fragaria x ananassa. Duch.) is an attractive, luscious, tasty and nutritious fruit with a distinct and pleasant flavour. It is grown extensively in most temperate and in some subtropical countries. In present context, the demand of good quality strawberry is increasing in the domestic as well as international market (Nepal, 2004). For domestic consumption especially in hotels and restaurants, superb quality fruits are much preferred. But, it is becoming difficult to compete in international market as excellent grade fruits are in demand. In Nepal, problem in strawberry cultivation is lately demanding but fruit is small, which ultimately decrease the marketable yield and profit margin. Research activities on strawberry are lacking in this country as it is entirely new crop in our context. Therefore, the main problem to be addressed by this research is to improve the yield and quality parameters of strawberry fruits through the application of appropriate plant growth regulator and its proper concentration.

Plant growth regulators have been used to increase and enhance vegetative characters and reproductive characters. The application of gibberellic acid (GA) increased the number of flowers and developed 50 to 66% of the total number of flowers between Nov and Jan, while the control had initiated only 40% (Kirschbaum, 1998). Zielinski and Garren (1952) recorded 30% increased in fruit size by spray of 50 ppm of β- NAA made at half grown stage. Ethephon is also found to have variable effects on quality parameters of strawberry fruits (Manandhar, 2006). Hence the objectives of this study were:

to observe the effects of PGRs on the vegetative characters of strawberry

to record the effects of PGRs in flowering, fruit yield and fruit quality of strawberry

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MATERIALS AND METHODS

The field experiment was carried out at JAITI's Farm in Kakani VDC of Nuwakot district from November 2005 to February, 2006. Ten treatments including one water sprayed control were laid out in Randomized Complete Block Design (RCBD) with four replications. Three plant growth regulators viz. NAA, GA_3, Ethephon were used, each at 3 levels. The details of treatments were T_1=Control, T_2= NAA (10 ppm), T_3 =NAA (20 ppm), T_4 = NAA (50ppm), T_5 = GA_3 (50 ppm), T_6 = GA_3 (100 ppm), T_7 = GA_3 (150 ppm), T_8 = Ethephon (200 ppm), T_8 = Ethephon (500 ppm) and T_{10} = Ethephon (1000 ppm).

"Nyoho" was the strawberry cultivar used as a planting material. Double row planting system was followed with spacing 90cm X 40 cm X 20 cm. The required concentrations for each plant growth regulators were freshly prepared before the spray. These solutions were sprayed till runoff condition on November 2005 when maximum plant showed opened primary flowers. The data on vegetative parameters (viz; plant height, leaf number and petiole length), reproductive parameters (viz; flower number, fruit number, fruit yield and fruit size) were taken for observations. The observations were taken upto 22nd February, 2006 and data analysis was done through X-cel and MSTAT software packages.

RESULTS AND DISCUSSION

Vegetative parameters

Applications of plant growth regulators have positive influence on different vegetative parameters. GA showed significantly higher plant height as compared to the control. GA at 150 ppm resulted in maximum plant height (39.5 cm) and the value decreased with decrease in concentration of GA_3; which was significantly different (Table 1). Increase in height by GA was supported by Khokhar *et al.* (2004) that they found taller plants with higher dose of GA_3 (75 ppm) over other treatments. Increase in plant height may be due to the fact that GA regulates growth of strawberry plant by causing cell elongation and synthesis of endogenous auxin like substance in the plant system. Similarly, GA also showed significantly more leaves as compared to the control. This result might be due to increased cell division, cell elongation and a corresponding increase in epidermal and parenchyma's cells length affected by GA_3. Ethephon at 500 ppm also showed significantly more leaves as compared to the control and this result was on line with Choma and Himelrick (1982) who also found increase in number of leaves with the application of ethephon 500 ppm. However, 1000 ppm ethephon showed least number of leaves; this level of ethylene might have reduced both the synthesis and amount of auxin in leaves.

The petiole length was also significantly affected as the longest petiole (7.85 cm) was recorded on plants sprayed with GA_3 100 ppm (Table 1). NAA at 20 ppm and 50 ppm also showed significantly longer petioles over the control. Since developing leaves are one of the main sites of auxin biosynthesis, the elongating petiole tissues could receive sufficient amount of auxin from the young leaves directly and ultimately the petiole length enhanced due to rapid cell division and cell enlargement. Ethephon treatments did not increase in the length of leaf petioles but rather plants were shorter than in the control treatment. This is due to the fact that Ethephon behaves as growth retardant or at least not growth promoter in some vegetative parameters.

Table 1. Effects of plant growth regulators on various vegetative parameters of strawberry plants cv. Nyoho at Kakani, Nuwakot during 2005/06

Treatments (PGRs)	Plant height (cm)	Leaf number	Petiole length (cm)
Control	20.1 d	8.84 c	5.79 cd
NAA (10 ppm)	20.9 d	9.03 c	6.49 bc
NAA(20 ppm)	21.3 d	8.69 c	7.56 ab
NAA (50 ppm)	20.9 d	9.61 bc	7.10 ab
GA_3 (50 ppm)	24.6 c	11.12 a	7.17 ab
GA_3 (100 ppm)	34.7 b	11.28 a	7.85 a
GA_3 (150 ppm)	39.5 a	11.69 a	7.18 ab
Ethephon (200 ppm)	18.9 d	9.23 bc	5.30 d
Ethephon (500 ppm)	20.8 d	10.64 ab	5.72 cd
Ethephon(1000 ppm)	19.3 d	8.44 c	5.44 cd

Figures within column indicated by same letters are not statistically different at 5% level.

When these vegetative parameters are noted at different time intervals, it is apparent that the effect of GA was distinct and large differences in plant height could be observed between GA_3 and other treatments (fig. 1). There was continuous increase in the height of GA_3-treated plants at different time interval. In NAA and control, a slight increase in plant height was observed only 15 days after the spray and afterwards it became more or less constant. In case of ethephon treated plants, the differences in plant height before and after spray was not visibly distinct.

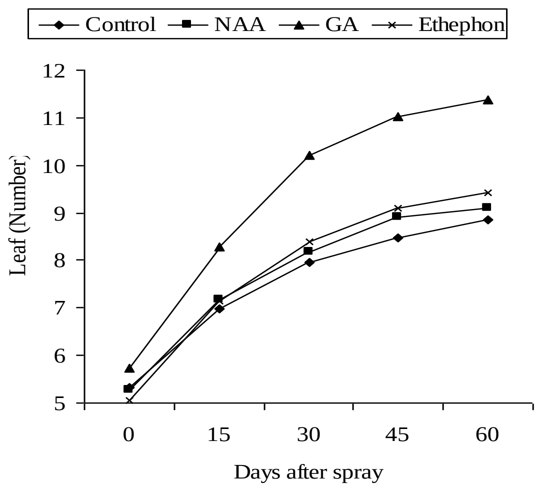

Figure 1. Plant height of strawberry plants cv. Nyoho at different time interval as influenced by GA_3, NAA, and Ethephon

At all observation dates, GA_3 treated plants showed maximum leaf number followed by ethephon and NAA; and plants under control had shown the least leaf number (Fig.2). However, there was no large difference between GA_3 and other treatments as in plant height. In all cases, there was rapid increase in leaf number at 15 and 30 days after spray and afterwards it started to increase at slow rate.

Longer petioles were contributed in strawberry plants by both GA_3 and NAA. Ethephon-treated plants showed the shortest petioles (Fig.3). It clearly indicates that GA and NAA are the growth-promoting hormone whereas ethephon is a growth retardant. The curves of all growth regulators showed rapid increase in petiole length at 15 days after spray. The rate of petiole growth became more or less constant at other days of time intervals. It indicated that these plant growth regulators were effective only for short period of time in case of petiole length.

Reproductive parameters:

Sprays of plant growth regulators such as GA_3, NAA and Ethephon affected flower number, fruit number, fruit yield and fruit size. GA_3 at all concentrations produced significantly more flowers as compared to the control. However, the highest number of flowers (20.54) was observed in plants treated with GA_3 50 ppm. Enhancement in flowering by GA_3 application is possible due to its effect on hastening flower truss growth when applied at floral initiation stage. Sharma and Singh (1980) also stated that application of GA after fruit bud differentiation helps in hastening the flowering in strawberry. Plants that received sprays of all levels of ethephon did not increase flower numbers; in fact the highest level (1000 ppm) recorded minimum flowers (Table 2).

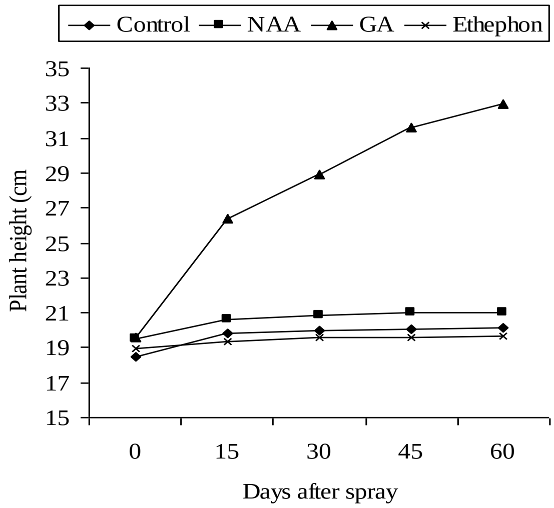

Figure 2. Leaf number of strawberry plants cv. Nyoho at different time interval as influenced by GA, NAA, and Ethephon

Irrespective of its concentration, NAA at all levels produced more fruit numbers than that of GA_3 and ethephon levels except 50 ppm GA_3 treatments, which produced fruit numbers as high as that in NAA treatments. In present study, increase in fruit number by NAA was due to maximum fruit set. The least number of fruit was harvested from the plants treated with GA 150 which was significantly lower than the control. Though GA at highest concentration produced more number of flowers, it was unable to give more fruits as most of them were aborted and this result resembled with the findings of Guttridge (1985).

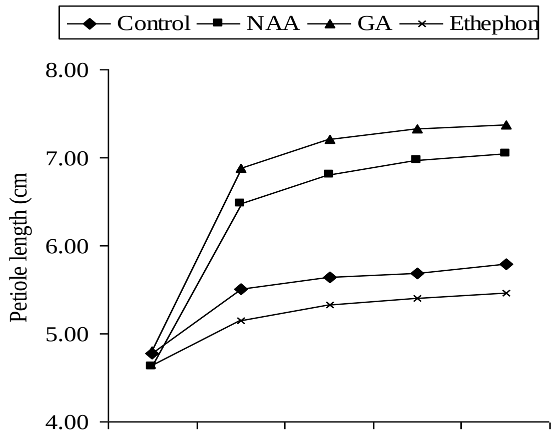

Figure 3. Petiole length of strawberry plants cv. Nyoho at different time interval as influenced by GA, NAA, and Ethephon

Maximum fruit yield (372.4 g/plant) was observed in plants sprayed with GA_3 50 ppm. In this study, higher level of GA (100 ppm and 150 ppm) and low level of NAA (10 ppm) were not effective to produce more fruit yield. Likewise, treatments with ethephon at all its concentrations gave lower fruit yield as compared to the control. Since ethephon is a growth retardant hormone and its effect could only be seen in the ripening of fruit, the effect on fruit yield was apparently non-existent. GA_3 at all concentrations and NAA at 50 and 20 ppm produced significantly longer fruits over the control. The earlier cell elongation and cell division at apical region by GA might have contributed to increased fruit length which was also explained by Moore et al. (1970). The contribution of NAA and GA in fruit size is due to the role of these hormones in transporting metabolites to the developing fruit which is considered as an extremely active metabolic "sink" and it is perhaps enough to contribute fruit growth. On the other hand, GA_3 50 ppm and 100 ppm were also found effective in increasing fruit width as the result was significant as compared to control.

Table 2. Effect of plant growth regulators on different reproductive parameters of strawberry cv. Nyoho Kakani, Nuwakot during 2005/06

Treatments (PGRs)	Total number of flowers/plant	Number of fruits/plant	Fruit yield (g/plant)	Fruit size	
				length	width
Control	14.41 de	12.3 bc	340.7 cd	3.25 c	2.10 c
NAA (10 ppm)	15.97 cd	14.3 ab	351.4 bc	3.38 bc	2.20 bc
NAA (20 ppm)	16.47 bcd	16.3 a	366.8 a	3.60 ab	2.20 bc
NAA (50 ppm)	16.56 bcd	15.2 a	361.4 ab	3.55 ab	2.25 bc
GA_3 (50 ppm)	20.54 a	15.6 a	372.4 a	3.75 a	2.43 a
GA_3 (100 ppm)	19.56 ab	12.3 bc	346.8 c	3.65 a	2.33 ab
GA_3 (150 ppm)	18.47 abc	9.6 d	323.8 e	3.58 ab	2.15 c
Ethephon (200ppm)	13.63 de	12.2 bc	339.6 cd	3.28 c	2.10 c
Ethephon (500ppm)	14.03 de	12.4 bc	340.6 cd	3.38 bc	2.23 bc
Ethephon (1000ppm)	12.47 e	11.3 cd	331.8 de	3.40 bc	2.23 bc

Figures within column indicated by same letters are not statistically different at 5% level.

CONCLUSION

From this present study, it appears that applications of plant growth regulators are necessary to enhance the vegetative and reproductive parameters contributing to fruit yield and quality. But all the plant growth regulators and their concentrations have not responded equally; some showed positive influence while others have growth retarding effect. GA_3 at 50 ppm was found superior among all the PGRs treatments as it was able to produce plants with enhanced vegetative growth in terms of plant height, leaf number and petiole length without affecting flowering, fruiting and fruit quality. NAA at 50 ppm and 20 ppm would also be useful as they could increase fruit number, fruit yield along with fruit size. But ethephon did not show any improvement over the control both in terms of vegetative parameters, flowering and fruit size.

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