INFLUENCE OF UREA, NAA AND HAND DEFOLIATION ON YIELD PARAMETERS OF WINTER GUAVA cv. ALLAHABAD SAFEDA UNDER CHITWAN CONDITION

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ABSTRACT

The effect of crop regulating treatments on guava cv. Allahabad Safeda was studied at guava orchard of the Institute of Agriculture and Animal Science, Rampur, Chitwan, from May 2008 to Nov. 2008. The experiment was laid out in a RCBD with four treatments. The treatments were urea (15 %), NAA (800 ppm), Hand Defoliation (100% foliage removal) and control, replicating 5 times. In the rainy season crop the highest number of 317.40 fruits per plant was observed in control, but it was highest i.e., 206.60 fruits per plant in the hand-defoliated plants in winter. Similarly for rainy season, net yield (31.13 kg/plant) as well as the estimated yield (34.57 kg/tree) including the loss due to bird injury was the highest in control, but in winter, total yield was highest (27.87 kg/plant) in hand-defoliated plants. From the present study, HD was found most promising treatment for obtaining highest yield in Allahabad Safeda variety of guava under Chitwan condition. However this study need further testing for recommendation over a wide locations and environment.

Key words: *Psidium guajava,* urea, NAA, hand defoliation, yield

INTRODUCTION

Guava (*Psidium guajava* L.) is a popular plant fruit of the tropical and sub-tropical climate belonging to Myrtaceae family and popularly known as "poor man's fruit" owing to its nutritional value and overall consumer preference (Yadava, 1996). It is rich in vitamin C and pectin content. Naturally, newly developed guava twigs bear flowers twice a year, but in climatic condition like that of southern plains of Nepal similar to north India, 3 flowering periods have been reported (Pandey *et al.*, 1980). Compared to winter season crop (October-November harvest), the rainy season crop (July-August harvest) is insipid, watery, less nutritive, poor in quality, suffers from high incidence of fruit fly, wilt and bird injury. Similarly, rainy season being the main season for guava in the market of Nepal, large quantities of fruits are available for a very short period, forcing the producer to sell their produce at a cheaper price leading them to shift into other more profitable business. These problems could be solved by the use of crop regulation practices.

Manipulation of the flowering behavior will enable in producing this crop in distinct winter season, requiring flower regulation to obtain the most profitable crop by adopting proper methods. Although several methods of crop regulation like pruning, hand thinning of leaves and flowers, use of chemical regulators and other have been suggested and found promising in different countries, but strong indication about the most prominent method is limited in the context of Nepal. Therefore, the present study tries to evaluate the effect of defoliation on yield analysis of the plants to various defoliation methods.

MATERIALS AND METHODS

Area Description

The study was conducted at Guava orchard of the Institute of Agriculture and Animal Sciences, Rampur, Chitwan (latitude: 27°39'14"N, longitude: 84 ° 21'11"E elevation: 225 masl) from May 2008 to November 2008 (8.35°C- 34.09°C and RH 62.06-94.86 %). The soil of the guava orchard was sandy loam, deep and well drained (pH 6.6, Nitrogen 10 kg/ha, Phosphorus 42 kg/ha and Potassium 66 kg/ha).

Plant material and Treatments

The experiment was conducted on 6 years old guava plants of cv. Allahabad Safeda propagated through layering and planted 4m in square system. Studies were made on healthy plants of same age group which

were uniform in respect of size, vigor and productivity. All trees included in this study were subjected to uniform cultural practice before and during the field trial.

A randomized complete block design was used with five blocks and four treatments. Altogether there were 20 trees for the experiment and each plant was considered as an experimental unit. There were four treatments, viz: urea (15 %), NAA (800 ppm), Hand Defoliation (HD) and a control (distilled water spray). Except single application of HD treatment on May 23, 2008 all other treatments were applied twice on May 23, 2008 and June 6, 2008 respectively. Precaution was taken during spraying to prevent the possibility of spray drift contamination to other trees.

Analytical determination

Fruit set and drop

Four branches of uniform diameter (3-5 cm) representing four directions were selected from each plant and tagged. The total numbers of fruit set from the tagged branches were counted and the averages of four branches were considered as number of fruit set per branch and percent fruit set was calculated as,

$$\text{Percentage fruit set (\%)} = \frac{\textit{Total number fruit set per branch}}{\textit{Total number of floral bud emerged per branch}} \times 100$$

Initial number of fruit set from the tagged four branches representing the four directions from each plant was counted and the final number of fruit remained at harvesting was also counted. Finally, fruit drop per branch was calculated by subtracting number of fruits from the tagged four branches with the fruit set counted initially from those four branches. Percentage fruit drop was expressed as,

$$\text{Percentage drop (\%)} = \frac{\textit{Total number of fruit dropped per branch}}{\textit{Total number of fruits set per branch}} \times 100$$

Fruit yield

Yield per branch was expressed as an average of four branches initially tagged. Total fruit yield in terms of weight and number was recorded from the entire plant at the time of harvest and expressed as total yield for each plant selected for the study.

Estimated yield loss

The yield loss due to bird attack was calculated with the help of regression equation between fruit diameter and fruit weight of uninjured fruit obtained from selected plants in the experiment. The average fruit diameter of injured fruit was recorded treatment wise and finally it was regressed with the previously obtained equation from uninjured fruits to obtain estimated weight of injured fruit.

Regression equation between fruit diameter and fruit weight for the estimation of yield loss in rainy season due to bird damage in the control plants, urea treated plants and NAA treated plants obtained from the experiment were respectively,

i. $y = 2.8938x + 55.442$
ii. $y = 16.951x - 4.9724$
iii. $y = 20.201x - 21.228$

In these equations, y is the estimated fruit weight and x is the average fruit diameter of the bird injured fruits.

Finally, the total number of fruits injured in a particular treatment was multiplied with the estimated fruit weight calculated from the above equation to obtain the estimated yield loss. Since, no loss was observed due to bird during the rainy season, hence, the estimated yield loss was calculated in yield during rainy season only.

Estimated yield

It was calculated by adding the total yield with the yield loss due to bird injury separately for each treatment.

Statistical Analysis

Analysis of variance (ANOVA) was used to test differences among the four treatments and means were separated using Duncan's multiple range test (DMRT) at the 5 % level of significance.

RESULTS AND DISCUSSION

Fruit set and Fruit drop

The number and percent of fruit set in rainy season was significantly higher (27.70 fruits/branch and 66.27 %) in the control (Table 1). Although the two treatments consisting of urea (6.30 fruits/branch and 15.22 %) and NAA (5.90 fruits/branch and14.56 %) had very less count as well as percent fruit set per branch, they were significantly higher than the hand-defoliated plants, which were obviously having no flowers to set any fruits in the rainy season. The percentage of flowers that were able to set into fruits in the rainy season was the highest (66.27 %) in the control as compared to urea (15.22 %) and NAA (14.56 %) treatments. Higher percentage of fruit set in control in comparison to other treatments was due to the effect of the treatments which increased percent flower abscission in treatments except control. There was no fruit set in the rainy season in hand-defoliated plants.

In winter, higher number and percentage of fruit set (17.05 fruits/branch and 73.18 %) was observed from NAA (800 ppm) treatment, and the difference was non-significant from the fruit set (16.20 and 70.24) on the plants treated with urea (15 %) and HD plants (16.65 fruits/branch and 70.65 %).

Improved fruit set due to hand thinning was also recorded by Mitra *et al.* (1982) and Singh (1986), who found hand thinning of flower buds on May resulted in 82 % fruit set in winter season compared to 78 % in control. Shigeura *et al.* (1975) reported that fruit setting can markedly be increased and fruit development controlled by growth manipulation through defoliation. The increased fruit set in winter crop could be due to the auxin stimulus involved in fruit set which comes not only from the pollen, but also from the ovary. The possibility thus exists that the pollen substances is a co-enzyme or activator of enzymatic systems present in the ovary which liberate active hormones from the storage reserves (Choudhary *et al.*, 1997).

The effect of the treatments on fruit drop per branch was found significantly different in both rainy and winter season, but most importantly, percent drop due to the effect of treatments was found significantly different in rainy season. The effect of the treatments used in rainy season did not show any significant effect on fruit drop in winter season crop (Table 1).

Table 1. Effect of urea, NAA and HD on fruit set and fruit drop in guava cv. Allahabad Safeda at Rampur, Chitwan during May- Nov., 2008

Treatments	Fruit set				Fruit drop			
	Rainy Season		Winter Season		Rainy Season		Winter Season	
	Number /branch	Percent	Number /branch	Percent	Number /branch	Percent	Number /branch	Percent
Control (Water Spray)	27.70 a	66.27 a (54.51)	1.600 b	65.29 b (53.92)	5.05 a	20.08 b (26.50)	0.50 b	30.67 a (33.47)
Urea (15 %)	6.300 b	15.22 b (22.90)	16.20 a	70.24 a (56.95)	3.95 b	62.89 a (52.53)	4.05 a	25.00 a (29.97)
NAA (800 ppm)	5.900 b	14.56 b (22.35)	17.05 a	73.18 a (58.82)	4.15 b	70.39 a (57.09)	4.50 a	26.20 a (30.75)
Hand defoliation	0.00 c	0.00 c (2.87)	16.65 a	70.67 a (57.23)	0.00 c	0.00 c (2.866)	4.00 a	23.96 a (29.20)
SEm±	0.581	0.719	0.525	0.638	0.2922	1.501	0.3630	1.645
CV %	13.03	6.26	9.12	2.51	19.88	9.66	24.89	11.92

Means followed by different letters within the same column are significantly different by DMRT at $p<0.05$.
Figures in parenthesis represent the angular transformed values.

In the rainy season, number of fruits that dropped after set was significantly higher (5.05 fruits/branch) in the control as compared to rest of the treatments. For the rainy season crop, lowest fruit drop of 3.95 per branch was obtained from urea treated plants which was not significantly different (4.15 fruits drop/branch) from NAA (800 ppm) treated plants. The zero fruit drop as during rainy season under HD treatment was associated with no flowers due to manual removal of whole flowers from the plants. The percent fruit drop was the highest (70.39 %) in plants treated with NAA, which was closely followed (62.89 %) by urea

treatment. Both these percentage of drops were significantly higher than those recorded in the control treatment.

In the winter season, fruit drop per branch was similar between the three treatments except control. Control plants had the lowest (0.5 fruit/branch) fruit drop due to low number of fruit set. Similarly, percent fruit drop among the four treatments was non-significant; although the highest percent drop (30.67 %) was recorded in control followed by NAA (26.20 %) and urea (25.00 %). Lowest percent drop (23.96 %) was recorded in HD plants. This result showed that there was no residual effect due to the treatment application in the rainy season and the drop was only due to seasonal or environmental factors.
Present finding is supported by Singh and Reddy (1997), they obtained maximum fruit drop with NAA (800ppm) during the rainy season. Higher drop due to NAA might be due to the interference with normal flow of auxin down the pedicel which causes the suppression in the flow of the endogenous auxin causing fruit-let to abscise (Crowe, 1965).

Number of fruits and Fruit yield
Effects of different treatments on number of fruits per branch as well as per plant are presented in Table 2. The number of fruits/branch ranged from 0 to 19.75. The highest number of fruits (19.75 fruits/branch and 317.40 fruits/tree) was observed in control during rainy season. Urea (1.85 fruits/branch and 28.40 fruits/tree) and NAA (1.35 fruits/branch and 22.80 fruits/tree) treated plants had very low number of fruits. On contrary to the rainy season, the lowest numbers of fruits (1.05 fruits/branch and 17.8 fruits/tree) was obtained from the control in the winter season. The number of fruits was the highest (12 fruits/branch and 206.60 fruits/plant) in the hand-defoliated plants, but was non significant (11.35 fruits/branch and 197.80 fruits/tree) over urea treatment. Urea and NAA treatments were at par (11.95 fruits/branch and 188.40 fruit/tree).

Table 2. Effect of urea, NAA and HD on number of fruits and fruit yield in guava cv. Allahabad Safeda at Rampur, Chitwan during May- Nov., 2008

Treatments	Fruit number				Fruit yield (kg)			
	Rainy Season		Winter Season		Rainy Season		Winter Season	
	Per branch	Per tree	Per branch	Per tree	Per branch	Per tree	Per branch	Per tree
Control (Water Spray)	19.75 a	317.40 a	1.05 b	17.80 c	1.83 a	31.13 a	0.03 c	1.83 d
Urea (15 %)	1.85 b	28.40 b	11.35 a	197.80 ab	0.04 b	2.67 b	0.31b	21.60 c
NAA (800 ppm)	1.35 bc	22.80 b	11.95 a	188.40 b	0.04 b	2.24 b	0.38 a	23.93 b
Hand defoliation	0.00 c	0.00 b	12.00 a	206.60 a	0.00 b	0.00 c	0.41 a	27.87 a
SEm±	0.551	10.970	0.373	5.340	0.020	0.312	0.020	0.093
CV %	21.48	26.62	9.18	7.82	8.51	7.98	13.81	6.21

Means followed by different letters within the same column are significantly different by DMRT at $p<0.05$.

The present finding is supported by the observation of Gopikrishna (1981) and Singh (1986). They mentioned mass pruning reduced the number of fruits in rainy season along with production of more number of fruits in the winter crop.

The crop regulating treatments caused a significant reduction in yield as compared to control during rainy season recorded per branch as well as per plant (Table 2). Significantly higher yield (1.83 kg/branch and 31.13 kg/plant) were recorded in the control plants during rainy season. The yield was almost nil in other treatments. On contrary to the yield obtained in rainy season, the lowest yield (0.03 kg/branch and 1.83 kg/tree) were recorded in the control during winter season, and the highest yield (0.41 kg/branch and 27.87 kg/tree) was obtained from hand-defoliated plants. This yield was significantly higher than the urea sprayed plants (0.31kg/branch and 21.60 kg/plant) as well as NAA sprayed plants (0.38 kg/branch and 23.93 kg/plant). Similarly the yield difference between NAA and urea treatment was also significantly different.

Significantly higher yield during winter season by hand deblossoming have also been reported by Teaotia and Pandey (1970) and Pandey *et al.* (1980), which supports the findings of the present study. Pruning of entire current season growth and hand thinning of flower buds in first week of May resulted in complete reduction of fruiting in rainy season crop at Pantanagar (Tiwari and Lal, 1984).

However some workers had found very encouraging results with chemical thinners for regulation. Chapman *et al.* (1978) found a 25 % urea spray plus wetting agent applied to 15-month-old guava seedlings of the variety GA9-EX39 produced a three-fold increase in yield over untreated plants at 22 months of age. A spray of NAA (800 ppm) was recommended by Singh *et al.* (1992) and Tiwari and Lal (1984) to obtain maximum yield of winter crop.

HD practices influence the source-sink relationship and biomass production of the crop. Skimmer *et al.* (1999) observed HD affecting regrowth process and carbon reserve remobilization. It brings about several morphological and physiological changes in plants (Collin *et al.*, 2000), which may cause changes in photosynthate accumulation, biomass production and subsequently affecting yield attributes.

Estimated loss and yield

During the rainy season a large number of birds, especially parrot were observed to damage the crop, and nil to very negligible bird injury was seen to injure the fruits in winter. Since, the preference of birds to a particular treatment and a particular direction was not noticed, only total number of damaged fruits per plant was recorded. The number of fruits damaged by birds along with yield during the rainy season was significantly the highest in the control (49.3 fruits/plant and 3.44 kg/plant), and the difference in number and yield damaged per plant in urea (7.75 fruits/plant and 0.74 kg/plant) and NAA (6.8 fruits/tree and 0.66 kg/tree) was non-significant (Table 3).

Table 3. Mean fruit diameter of bird damaged fruits, estimated fruit weight, estimated yield loss and estimated total yield per plant of guava cv. Allahabad Safeda during rainy season at Rampur, Chitwan during May- Nov., 2008

Treatments	No. of fruits/ plant damaged by birds	Estimated yield loss (kg/plant)	Estimated total yield (kg/plant)
Control	49.3 a	3.44 a	34.58 a
Urea (15 %)	7.75 b	0.74 b	3.41 b
NAA(800ppm)	6.8 b	0.66 b	2.90 b
Hand defoliation	0.00 b	0.00 b	0.00 c
SEm±	3.485	0.2665	0.3216
CV %	48.80	49.03	7.98

Means followed by different letters within the same column are significantly different by DMRT at $p<0.05$.
Figures in parenthesis represent the angular transformed values.

Hence, the estimated total yield calculated by the regression equation from control plants was significantly the highest (34.58 kg) from urea and NAA were 3.41 kg and 2.90 kg respectively.

CONCLUSION

In rainy season, number and percent of fruit set was significantly high in control whereas, in winter, number and percentage of fruit set was high in NAA but the set was non-significant with urea and HD. The higher number of fruit set in winter could be the auxin stimulus response coming from the ovary consisting of pollen substances which liberate active hormones from the storage reserves stimulating fruit set. Fruit drop was maximum on NAA treated plants during the rainy season, which could be due to the interference with normal flow of auxin causing abscission of fruit-let and the drop was non-significant in winter.

In rainy season, number and yield of fruits per plant was highest from control but very low yields were recorded from other treatments. The number and yield was highest from HD followed by urea and NAA in winter, which might be due to the influence in source-sink relationship and biomass production.

Therefore, from the present study, HD treatment is suggested for crop regulation in guava to obtain fruits of higher quality along with higher yield during winter season. The results obtained from the present study may or may not be exactly suited to other localities with similar or dissimilar environment conditions, further research to quantify these effects is needed at different locations, environment and time.

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