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Original Research

Deblossoming Monsoon Crop of Guava (*Psidium guajava* L.) cv. Surahi Affects Yield and Quality of Winter Crop

Muhammad Azhar Bashir[a], Ammara Noreen[a*], Muhammad Ikhlaq[a], Kashif Shabir[a], Faheem Altaf[b] and Naheed Akhtar[b]
[a] Horticultural Research Station, Bahawalpur, Pakistan
[b] Horticultural Research Sub-Station, Dera Ghazi Khan, Pakistan

ABSTRACT

Monsoon crop of guava is hit by fruit fly during July-August that results into huge loss to the producers. Spray of urea and Naphthalene acetic acid (NAA) is used to drop flowers and fruits of monsoon crop to get higher yield of winter crop. This study was carried out at Fruit Orchard of Horticultural Research Station, Bahawalpur during 2015-2017 to determine the optimum concentration of selected chemicals to drop flowers and immature fruits of monsoon crop. Plants with distilled water spray were treated as control (T_1). Other treatments included urea @ 5% and 10% (T_2 & T_3), NAA @ 0.05 and 0.1% (T_4 & T_5) as 1st spray and repeated the same spray after fortnight, combination of urea (5%) as 1st spray followed by NAA (0.05%) as 2nd spray (T_6) or urea (10%) 1st spray followed by NAA (0.1%) as 2nd spray (T_7). Consolidated means of parameters over two years' study indicated that the highest fruit yield (68.6 kg/plant), the maximum weight per fruit (168.3 g), number of fruit/plant (375), pulp content (55.5%), pulp thickness (1.05 cm), total soluble solids (14.3 °Brix), ascorbic acid content (176.7 mg / 100 g pulp) and total sugars (7.6%) were obtained as a result of highest flower drop (96.7%) and fruit drop (76.9%) with lowest fruit set (2.9%) from non-target monsoon fruiting in response to 0.1% NAA (T_5) sprayed twice at fortnight interval, proceeded after the application of 0.05% NAA two spray fortnightly (T_4). The plants under control remained at bottom with respect to parameters i.e. flower and fruit drop, at top with highest fruit setting in monsoon crop that led to the lowest yield of winter crop.

Keywords: *Growth regulators, chemicals, productivity, crop regulation.*

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INTRODUCTION

Guava (*Psidium guajava* L.) ranks 5th in production (489100 tons) and area (65600 hectares) in Pakistan. Punjab leads the other provinces in production (373000 tons) and area (52500 hectares). It stands at 3rd position in the province, after citrus (1st) and mango (2nd) with respect to area and production (Anonymous, 2016). High ascorbic acid and pectin contents in guava fruit favors it for value addition using pulp in jelly, jam, marmalade and soft drinks. Two crop seasons (winter and monsoon) may be credited for availability of fruit throughout the year. Hazardous attack of fruit fly on monsoon crop demands to destroy the flowers or premature fruits manually or by foliar spray of synthetic growth regulators or other chemicals to get high yielding single crop in winter. Although, guava bears twice in a year, but it is wise to let the plant for restoration of photosynthates and nutrients for winter crop by skipping monsoon crop.

Manual deblossoming by clipping, shaking or beating with sticks is a common practice but not recommended one due to bad effects. Foliar spray of chemicals e.g. urea, potassium and synthetic growth regulators for deblossoming is a commercial practice (Radha and Mathew, 2007). Two foliar spray of urea @ 15% in April-May fortnightly lowered monsoon crop and boosted yield of guava in winter (Singh et al., 1994). Variety and concentrations of chemicals may differ in response for deblossoming in guava. Foliar application of urea @ 10% on cv. Allahabad Safeda and that of potassium iodide @ 0.05% on cv. Sardar of guava proved the most appropriate to enhance the productivity of guava in winter (Singh and Singh, 2000). Allahabad Safeda cultivar was completely devoid of blossoms in monsoon when urea @ 10, 15 and 20% and NAA @ 0.04, 0.06, 0.08 and 0.1% were applied before blooming and at blooming. Maximum production in winter resulted from the application of NAA @ 0.08% very similar to that of urea @ 10% (Singh et al., 1992). Removing half current growth plus manual drop of blossoms, foliar spray of NAA @ 0.06, 0.08 & 0.1% as well as urea @ 10 and 15% restricted monsoon crop that have positive influence on productivity of winter crop (Tiwari et al., 1992). Similar effect was observed when NAA @ 0.06 or 0.08% was applied at the start of May, which restricted monsoon crop and boosted productivity and quality of winter crop as compared to un-sprayed plants (Tiwari and Lal, 2007). NAA spray @ 100-200 mg L^{-1} in April effectively dropped flowers (Yadav, 2007). It was also reported that two sprays of urea @ 15% at flowering during summer increased yield and improved quality of fruits in winter significantly (Khan et al., 2013). Application of 10% urea

* Corresponding author
E-mail: ammaranoreen91@gmail.com (A. Noreen)

solution or 0.06% NAA at maximum blooming in May is recommended to obtain better single crop of guava (Bal, 2005). It was observed that when 50% deblossoming without defoliation was done, fruits from those trees showed highest TSS (12.2%) during summer season while maximum reducing sugars (2.6%) in winter crops. It was concluded that fruit quality (reducing sugars, ascorbic acid and TSS) of guava cv. 'Gola' was significantly affected by deblossoming (Khan et al., 2013).

Surahi cultivar of guava is more attractive for fruit fly to tarnish the fruit of monsoon crop, resultantly leaving less return to the guava producers in the market. So, manual or chemical method is used to discard flowers or premature fruits. However, no such data is available regarding cheaper and easier way to discard summer crop in guava cv. Surahi. Keeping in view the ways of discarding monsoon crop through spray of plant growth regulator e.g. NAA or urea to fetch high market value from winter crop of guava fruits, the project in hand was conducted to improve quality and yield of guava cv. Surahi during winter season under semi-arid environment of southern Punjab.

MATERIALS AND METHODS

The experiment was conducted at Horticultural Research Station, Bahawalpur during 2015-2017. Guava plants uniform in size, age (15-year old), health and vigour of cv. Surahi were selected. There were seven treatments including control (T_1), 5% urea (T_2), 10% urea (T_3), 0.05% NAA (T_4), 0.1% NAA (T_5), 1st spray of 5% urea followed by 2nd spray of 0.05% NAA (T_6) and 1st spray of 10% urea followed by 2nd spray of 0.1% NAA (T_7). For T_1 to T_5, 1st spray was done at the time of 50% blooming (mid-April) followed by the 2nd spray of same chemical (first week of May). While in case of T_6 and T_7 1st spray of urea was done in mid-April and during first week of May, 2nd spray of NAA were applied each year. All other cultural practices remained the same for all the experimental units.

Ten twigs of each plant were tagged for data collection. Before application of treatments, number of flowers per twig were recorded. Flowers drop (%), fruit set (%) and fruit drop (%) were calculated after 15 days of 2nd spray by given formulae.

$$\text{Flower drop (\%)} = \frac{\text{Number of dropped flower}}{\text{Number of total flowers}} \times 100$$

$$\text{Fruit drop(\%)} = \frac{\text{Number of fruit dropped}}{\text{Number of total fruit set}} \times 100$$

$$\text{Fruit set (\%)} = \frac{\text{Number of fruit set}}{\text{Number of total flowers}} \times 100$$

All the pickings of each tree were summed up to calculate yield per plant (kg) from winter crop of guava each year and averaged over number of plants per treatment per replication. Fruit weight (g) was measured by electronic scale (SF-400). Pulp thickness (cm) was measured by electronic digital caliper. Pulp content of fruits was estimated by using the following formula.

$$\text{Pulp content (\%)} = \frac{\text{Weight of fruit pulp}}{\text{Total fruit weight}} \times 100$$

Total soluble solids content (°Brix) was recorded by Refractometer (BX-1 Atago, Japan). Acidity (%) of juice was measured by Pocket Brix-Acidity Meter (Atago, Japan). Ascorbic acid content (mg/100 g pulp) was determined by using titration method (Saleem et al., 2008). Ten ml of guava fruit juice was diluted with oxalic acid solution (0.4%). Five ml of filtered aliquot was titrated to light pink colour end point using 2,6-dichlorophenol indophenol dye. Total sugars (%) (reducing + non-reducing sugars) were measured by using the method as described by Shafiq et al. (2011).

Experimental design and statistical analysis

The experiment was laid out in Randomized Complete Block Design (RCBD) with 03 replications. One plant was used for each treatment in each replication. Two years' data were pooled and subjected to Fischer's Analysis of Variance technique. The treatment means were compared by Duncan's Multiple Range test (DMRT) at $\alpha = 0.05$ (Steel et al., 1997).

RESULTS AND DISCUSSION

Flower drop (%)

The highest percentage of flower drop (96.7%) was obtained when NAA @ 0.1% was applied, NAA @ 0.05% got 2nd rank with 90% flower drop and it ranked 3rd with 89.3% flower drop in response to 10% urea as 1st spray and 0.1% NAA as 2nd spray. The aforesaid treatments remained statistically at par in their effect on flower drop. Urea @ 10% dropped more flower (57.3%) than that of urea @ 5% (42.8%). The least percentage flower drop (27.3%) was found in plants under control. These treatments differ significantly from each other (Table 1).

Deblossoming may result in three physiological effects of growth

Table 1: Effect of urea and NAA sprays on flower drop, fruit set and fruit drop in summer crop and yield of winter crop of guava (two years pooled data).

Treatments	Flower drop (%)			Fruit set (%)			Fruit drop (%)			Yield per plant (kg)		
	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean
T_1= Control (distilled water)	24.3d	30.2d	27.3d	32.3a	41.5a	36.9a	11.2c	13.5e	12.4f	40.2c	44.6c	42.4c
T_2= Two sprays of urea @ 5%	41.4c	44.2c	42.8c	28.2a	24.7b	26.5b	21.1bc	23.2de	22.2e	46.6bc	53.3bc	50.0b
T_3= Two sprays of urea @ 10	58.7b	55.8b	57.3b	20.2b	18.6b	19.4c	28.8b	33.6d	31.2d	50.2b	57.5b	53.9b
T_4= Two sprays of NAA @ 0.05%	87.5a	92.4a	90.0a	5.2cd	6.2c	5.7de	58.7a	69.5b	64.1b	60.5a	67.7a	64.1a
T_5= Two sprays of NAA @ 0.1%	96.8a	96.6a	96.7a	3.1d	2.7c	2.9d	64.3a	89.4a	76.9a	64.8a	72.3a	68.6a
T_6= 1st spray of urea @ 5% + 2nd spray of NAA @ 0.05%	83.4a	85.0a	87.2a	11.6c	9.7c	11.1e	23.5b	52.7c	38.1d	57.4ab	62.2b	59.8a
T_7= 1st spray of urea @ 10% + 2nd spray of NAA @ 0.1%	92.2a	86.3a	89.3a	3.2d	4.2c	3.7d	33.2b	71.6b	52.4c	61.5a	64.1a	62.8a

Means sharing similar letter(s) are statistically non-significant. Means were compared by DMR test at $\alpha = 0.05$.

Table 2: Effect of urea and NAA sprays on fruit weight, pulp thickness, pulp seed ratio and number of fruits per plant from winter crop of guava (two years pooled data).

Treatments	Fruit weight (g)			Pulp thickness (cm)			Pulp content (%)			Number of fruits/plant		
	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean
T_1= Control (distilled water)	112.6b	119.2d	115.8c	0.73b	0.67c	0.68c	37.5b	34.3c	35.9c	376b	315b	346b
T_2= Two sprays of urea @ 5%	127.4b	136.4c	131.9c	0.78b	0.75b	0.77bc	42.6b	37.6bc	40.1bc	373b	310b	342b
T_3= Two sprays of urea @ 10%	135.5b	143.5c	139.5b	0.81b	0.84b	0.83b	47.4b	39.7b	43.6b	411ab	331b	371a
T_4= Two sprays of NAA @ 0.05%	155.4a	162.8ab	159.1a	0.98a	0.93a	0.96a	53.5ab	47.3a	50.4a	382b	353a	368a
T_5= Two sprays of NAA @ 0.1%	163.3a	173.3a	168.3a	1.03a	1.07a	1.05a	57.7a	53.3a	55.5a	396b	354ab	375a
T_6= 1st spray of urea @ 5% + 2nd spray of NAA @ 0.05%	144.7a	152.4b	148.6b	0.95a	0.92a	0.93a	49.8ab	43.4b	46.6ab	375b	350a	363a
T_7= 1st spray of urea @ 10% + 2nd spray of NAA @ 0.1%	142.5ab	144.6c	143.6bc	0.94a	0.88b	0.91ab	54.1a	46.2a	50.2a	384b	362a	372a

Means sharing similar letter(s) are statistically non-significant. Means were compared by DMR test at α = 0.05.

regulators i.e. firstly change in balanced concentration of auxins in external and internal ends of fruit stems causing abscission layer development, secondly pre-mature embryo abortion, and thirdly termination of pollination through deblossoming. Plant growth regulators i.e. DNOC, NAD, 2,4-D, NAA and chemicals i.e. urea are known to be used for flower and fruit drop of monsoon crop to improve production of winter guava (Bal, 2005; Radha and Mathew, 2007; Singh, 2004).

Fruit set (%)

NAA @ 0.1% caused the lowest fruit set (2.9%), proceeded by 10% urea as 1st spray and 0.1% NAA as 2nd spray giving 2nd rank with 3.7 % fruit set, 0.05% NAA stood at 3rd position with 5.7 % fruit set. Treatment containing 5% urea as 1st spray and 0.05% NAA as 2nd spray indicated 11.1% fruit set that had similar effect as that of 0.05% NAA. On the other hand, plants under control resulted in the highest percentage fruit set (36.9%), followed by 26.5% by 5% urea and 19.4% by 10% urea sprays. All these treatments differ statistically from each other (Table 1).

Guava bears twice in a year and let the choice for producer to pick single crop of winter as per advice of experienced growers (Radha and Mathew, 2007; Tiwari and Lal, 2007). The lowest percentage fruit set is a clue leading to depriving of monsoon fruiting (Singh and Singh, 2000; Singh et al., 1994). A number of plant growth regulators are under use currently and beneficial in certain management packages to get high productivity at the verge of low expenses (Tiwari et al., 1992).

Fruit drop (%)

The highest fruit drop (76.9%) ocurred when NAA @ 0.1% was applied, proceeded by 64.1% fruit drop by 0.05% NAA (two sprays at fortnightly interval). Plants sprayed with 10% urea as 1st spray and 0.1% NAA as 2nd spray showed 52.4% fruit drop, proceeded by plants sprayed with 5% urea as 1st spray and 0.05% NAA as 2nd spray with 38.1% fruit drop. Significant differences were found among these four treatments. Urea @ 10% caused more fruit drop (31.2%) than that of urea @ 5% (22.2%). The least incidence of fruit drop (12.4%) was found in plants under control treatment. All these treatments were significantly different from each other (Table 1).

Dropping fruit with chemicals targeting monsoon crop by applying NAA and urea on various guava cultivars is already documented (Tiwari et al., 1992; Tiwari and Lal, 2007) since NAA is known for inducing seed abortion. Generally, growth regulators known for eliminating pre-mature fruits when used at higher concentrations are efficient at 20-100 mg/L. Chemicals applied at full bloom cover the flower parts i.e. stigma, ovary, calyx, corolla with a thin impervious film causing a physical hindrance for pollination (Singh, 2004).

Production (yield, number of fruits and average fruit weight)

Plants treated with NAA @ 0.1% produced the highest yield (68.6 kg), proceeded by plants provided with NAA @ 0.05% (64.1 kg), and plants provided with urea @10% as 1st spray and NAA @ 0.1% as 2nd spray (62.8 kg). Although, these treatments were statistically at par in production, but plants sprayed with 10% urea gave more production (53.9 kg) than the plants sprayed with 5% urea (50 kg) from a single plant. Lowest yield (42.4 kg) was obtained from plants under control (Table 1). The maximum number of fruits (375) and maximum fruit weight (168.3 g) in winter season were obtained from the plants which were sprayed with 0.1% NAA during summer. NAA @ 0.05% affected the parameters statistically with similar effect as seen with 0.1% NAA (Table 2).

Previous investigations and reports are in conformity with the statement that enhancing fruit / flower drop of monsoon crop either through chemicals or by manual maneuver for terminating monsoon crop via blossom or flower removal may result into an appropriate winter crop (Tiwari et al., 1992). Intensity of blossom/fruit drop of monsoon crop and production from winter crop possess a positive correlation. Because of improved fruit quality in winter, more return is expected from plants sprayed with growth regulators or chemicals to do deblossoming than the return from non-sprayed plants (Tiwari and Lal, 2007). Enhanced production of Surahi cultivar in winter in response to 0.1% NAA (T_5) or 0.05% NAA (T_4) or first spray with urea @ 10% and 2nd spray with 0.05- 0.1% NAA are suggested for this cultivar under semi-arid conditions of Punjab as per present investigations.

Physical fruit characteristics (pulp thickness and pulp content)

All fruit quality parameters were significantly affected by the treatments applied. Thickest pulp layer (1.05 cm) and highest

Table 3: Effect of urea and NAA sprays on total soluble solids, acidity, ascorbic acid content and total sugars of fruits of winter crop of guava (two years pooled data).

Treatments	Total soluble solids (°Brix)			Acidity (%)			Ascorbic acid content (mg / 100 g pulp)			Total sugars (%)		
	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean	2015-2016	2016-2017	Mean
T_1= Control (distilled water)	11.6c	11.9c	11.8c	1.04a	1.08a	1.06a	138.6c	134.5d	136.6c	5.6b	5.2b	5.4b
T_2= Two sprays of urea @ 5%	12.4c	12.5bc	12.5bc	1.02a	0.96a	0.99ab	143.7c	147.7cd	145.7c	5.8b	5.5b	5.7b
T_3= Two sprays of urea @ 10%	13.5b	12.6b	13.1ab	0.93ab	0.95ab	0.94b	158.5bc	159.6bc	159.1b	6.2b	6.3a	6.3ab
T_4= Two sprays of NAA @ 0.05%	13.4b	13.2a	13.3a	0.83b	0.82b	0.83c	164.6b	166.1b	165.4b	6.6b	6.5a	6.6a
T_5= Two sprays of NAA @ 0.1%	14.7a	13.8a	14.3a	0.74b	0.67c	0.71d	179.7a	173.6ab	176.7a	7.7a	7.5a	7.6a
T_6= 1st spray of urea @ 5% + 2nd spray of NAA @ 0.05%	13.3b	14.3a	13.8a	0.78b	0.85b	0.82c	178.8a	173.4ab	176.1a	6.8a	6.5a	6.7a
T_7= 1st spray of urea @ 10% + 2nd spray of NAA @ 0.1%	13.5b	12.8b	13.2ab	0.85b	0.89b	0.87bc	175.3a	176.4a	175.9a	6.7a	6.8a	6.8a

Means sharing similar letter(s) are statistically non-significant. Means were compared by DMR test at α = 0.05.

pulp content (55.5%) in winter season were obtained from the plants which were sprayed with 0.1% NAA during summer. NAA @ 0.05% affected the parameters statistically with similar effect as seen with 0.1% NAA. Non-significance effect was also shared by those combination treatments urea @ 5% or 10% (1st spray) followed by NAA @ 0.05% or 0.1% (as 2nd spray) (Table 2). Results coincide with Khan et al. (2013) that best sized fruits were produced when 50% deblossoming without defoliation was applied.

Fruit chemical characteristics (total soluble solids, acidity, ascorbic acid content and total sugars)

The maximum total soluble solids (14.3 °Brix), ascorbic acid content (176.6 mg per 100 g pulp) and total sugars (7.6 %) and the minimum acidity (0.71%) were measured from the winter fruits of the plants sprayed with 0.1% NAA during summer. This treatment remained at par with fruits of the plants sprayed either @ 0.05% or 0.1% as 2nd spray, preceded by urea @ 5% or 10% as 1st spray with respect to TSS, vitamin C content and total sugars except acidity. Fruits from plants under control treatment imparted the minimum total soluble solids (11.8 °Brix), vitamin C content (136.6 mg per 100 g pulp) and total sugars (5.4%) but the maximum acidity (1.06%) as evident from Table 3. Biswas et al. (1989) also reported that fruits obtained by thinning possessed the maximum TSS. In current study larger fruits as a result of maximum deblossoming by 0.1% NAA may be due to the availability of maximum food reserves in winter. It may be concluded that deblossoming of guava increases ascorbic acid content in guava by increasing auxin. During fruit maturation, enzymes involved in sucrose metabolism, regulate the sugar accumulation as well as transformation in the fruits. Previously, fruit quality of winter crop was improved by deblossoming or it might be due to maximum nutrients stored in tree branches of winter crop to be utilized during fruit development in winter (Khan et al., 2013).

CONCLUSION

Monsoon crop of guava cannot bring good market value due to more vulnerability to fruit fly, particularly as happens with guava cv. Surahi each year. Resultantly, fruit loses quality and production that leads to less return or complete loss. Thus, by dropping flowers or premature fruits by chemicals other than manual methods targeting a single winter crop is an economic practice. Present findings set recommendation that 0.05 - 0.1% NAA proved very appropriate to discard monsoon fruiting to obtain quality fruit with improved production of Surahi cultivar in winter.

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