COMPARATIVE EVALUATION OF NAPHTHALENE ACETIC ACID AND UREA FOR PREVENTING PREMATURE FRUIT DROP AND IMPROVING FRUIT YIELD AND QUALITY IN BER (ZIZIPHUS MAURITIANA LAM.) CV. SUFFON

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ABSTRACT

A study was conducted during 2011-12 and 2012-13 at Horticultural Research Institute, AARI, Faisalabad, Pakistan to study the effect of urea and naphthalene acetic acid (NAA) to control premature fruit drop, improve fruit yield and quality in ber cv. Suffon. The experiment was laid out in RCBD with six treatments. The treatments were T1 (control), T2 (NAA 20 ppm), T3 (NAA 40 ppm), T4 (urea 1.5%), T5 (NAA 20ppm + 1.5% Urea) and T6 (NAA 40 ppm + 1.5% urea). Spray was applied two times i.e. first spray was accomplished in last week of October and second spray in the last week of November. Physico-chemical characteristics like fruit weight (13.57 g), fruit length (33.96 mm), fruit breadth (27.59 mm), vitamin-C (132.25 mg/100g) and yield (112.33 kg/tree) were recorded as maximum in T5. Minimum acidity percentage (0.31%) and fruit drop percentage was found significantly different in T5 (35.86%) and T1 (50.04%). It was concluded that T5 (NAA 20 ppm + 1.5% urea) is the most suitable combination of chemicals to control fruit drop, improve fruit yield and quality in ber cv. Suffon.

KEYWORDS: Ziziphus mauritiana Lamk; ber; fruit drop; growth regulators; nutrients, naphthalene acetic acid; urea; yield; Pakistan

INTRODUCTION

Ber (Ziziphus mauritiana Lamk.) is native to the area spreading from Indo-Pak to south western China and Malaysia (30° south to 30° north). It can be cultivated on wide range of climatic conditions due to its hardy nature like, less irrigation requirements, tap root system, sunken stomata, heavy cuticle on leaves and deciduous behaviour in extreme summer. Improved budded varieties can fetch high market price locally and can be exported as well (20). Ber is one of the tasty and nourishing fruit that is rich of vitamin-C, protein and minerals. It is easily digested and mild laxative. A number of products

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can be prepared from ber fruit like juice, candy, butter, jelly and syrup etc. (1).

Pre-mature fruit drop in ber is the foremost concern for ber growers. Only 20 to 30 percent fruits reaches upto maturity and is being marketed. Heavy fruit drop is a major issue among ber growers now a days in ber orchards mainly pre-mature fruit drop occur due to various physiological and climatic disorders (14). Though a variety of pathological and entomological aspects are also involved in fruit drop, but upto 50 percent pre-mature drop takes place due to physiological abnormalities like embryo abortion, fruit shrivelling and formation of abscisic acid layer in fruit stalk (10).

Bal (1) reported that about 60 percent fruit is dropped in ber cv. Umran significantly reducing the yield and profit of ber growers. He further stated that only 20 to 30 percent fruit reaches to maturity and is being marketed.

A number of physiological and biochemical actions are responsible for pre-mature fruit drop. Physiological studies demonstrate that hydrolyzing enzymes are involved in softening of middle lamella, and then fruit attached merely with branch through vascular bundle only gradually drops (25). Various external (climatic, phytotechnical, biotic, diseases) and internal (pollination conditions, seed setting in fruit, hormonal levels) factors are responsible for fruit drop. If leaf area is not properly developed then it also causes more fruit drop (18). Bangerth (4) proved that young fruits abscission necessarily related to auxin i.e. as auxin level goes down the drop increases that can be controlled through exogenous application of auxin. Bal (1) described that pre-mature fruit drop in ber upto December is due to physiological disorders. Foliar sprays of growth regulators, micro and macro nutrients in various combinations can be used to control fruit drop and improve quality (23). Singh and Vashishtha (22) used urea and NAA to improve fruit set percentage and yield in ber. Foliar feeding is only rapid and committed solution to control fruit drop. As ber is deep tap rooted tree, so basal application may not be the solution to cope with the situation. Nutrients can easily be taken up by the plants through the foliar feeding.

Among various ber cultivars “Suffon” is being preferred by growers due to high yield, excellent eating quality, long shelf life, and extra income per unit area. Suffon is mid season maturing variety and well adapted to all ber growing areas of Punjab. Recently many complaints are being received from ber growers about its poor fruit set, more fruit drop and uneven ripening. The present study was planned to trim down fruit drop and enhance fruit yield and quality in ber cultivar “Suffon” by using different doses of NAA and urea.

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MATERIALS AND METHODS

Present study was conducted during 2011-12 and 2012-13 at Horticultural Research Institute, AARI, Faisalabad, Pakistan (71°34’ 11.68 E & 13°14’ 17.08 N, 343 ft altitude) to study the effect of urea and NAA to control premature fruit drop, improve fruit yield and quality in ber cv. Suffon. The experiment was laid out in RCBD with six treatments; T₁ (control), T₂ (NAA 20 ppm), T₃ (NAA 40 ppm), T₄ (Urea 1.5%), T₅ (NAA 20ppm + 1.5% Urea) and T₆ (NAA 40 ppm + 1.5% Urea). Spray was applied two times i.e., first spray was accomplished in last week of October and second spray in the last week of November. Twenty year old thirty six trees of cultivar “Suffon” were marked for this purpose by painting the treatment numbers at their stems. Every treatment was replicated thrice containing two trees per treatment.

Selected experimental units were applied with standard cultural practices and were irrigated with canal water. Pruning was carried out at 50 percent level during mid May. NPK was applied @ 1000-500-500g alongwith 40 kg FYM per tree during July. Nitrogen was applied in two split doses i.e., before flowering during July and at peak stage during October. Total two sprays were applied, first in last week of October at fruit set stage and second in last week of November (at active growth phase). Four uniform branches per tree were selected and tagged randomly in East, West, North and South directions of ber trees to record percent fruit drop. Percentage of fruit drop was calculated on the basis of number of fruits counted before spray and number of fruit harvested on tagged branches.

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\text{Fruit drop percentage} = \frac{\text{Number of fruits harvested}}{\text{Total number of fruits before spray}} \times 100
\]

To determine fruit quality a sample of 100 fruits were taken from each tree and physico-chemical analysis like fruit weight (g), fruit length (mm), fruit breadth (mm), seed weight (g), total soluble solids (%), acidity (%), vitamin-C (mg/100g), total sugar (%) were recorded. The fruit size was measured by electronic digital caliper; fruit weight by electronic scale (SF-400) and total soluble solids by hand refractrometer. Titratable acidity was determined by titrating samples with 0.1 M NaOH and was expressed as percentage. Vitamin-C content of fruit was quantified as described by Ruck (19). The reducing and non-reducing sugars were measured as described by Hortwitz (15). Finally, the fruit yield for all the pickings from each tree was recorded.
Data were analyzed statistically by using Fisher’s analysis of variance technique and treatments were compared using least significant difference (LSD) test at 5 percent probability level (24).

RESULTS AND DISCUSSION

Fruit drop (%)

The rate of cumulative fruit drop varied among treatments at various development stages of ber fruit. Fruit setting was counted during November and then at fruit harvesting stage during March. Maximum fruit drop percentage (50.04%) was recorded in T₁ (control) while minimum (35.86%) in T₅ (NAA 20 ppm + 1.5 Urea). (Table 1). Similar findings were reported by Pandey and Phatak (17) who used 20 ppm NAA with 1.5 percent urea to control fruit drop in ber cutivar Gola and recorded significant results. Bhati and Yadav (8) also found significant results to control fruit drop with 20 ppm NAA in Gola and Banarasi Karaka cultivars. It shows that 20 ppm NAA with 1.5 percent Urea has significantly increased fruit retention as compared to control. This decrease in fruit drop percentage might be associated with reduced amount of abscisic acid as NAA and urea spray enhances auxin production. Special effects of urea in controlling fruit drop may be due to its role in enhancing fruit vigor, so increasing food reserve till fruit harvesting. Similar results have also been reported by Sharma et al. (21) who applied 40 ppm NAA in guava and one percent urea in ber. Pandey and Phatak, (17) stated that ber fruit drop may be due to embryo abortion, nutrition competition and ultimately fruit shriveling. Results are also in conformation with the findings of Dhillon and Singh (12) who used urea to control fruit and flower drop in mango. Similar findings have also been reported by Chuahan and Gupta (11) in ber, who used urea to control ber drop. Auxin synthesis retained fruit drop by balancing hormone metabolism (7).

Yield (kg/tree)

Ber yield per tree (Table 1) also showed significant results. Maximum yield per tree (112.33 kg) was found in T₅ (NAA 20 ppm + 1.5% urea) followed by T₆ (100 kg) and T₄ (95.67 kg) and minimum yield per tree (78.33 kg) was recorded in T₁ (control). Results showed that T₅ is best treatment to control fruit drop and improve fruit yield and quality in ber. Singh et al. (23) also recorded significant rise in yield of ber cultivar Umran by applying 20 ppm NAA. Bhati and Yadave (8) also recorded increase in fruit yield with 30 ppm NAA and urea in Tikadi and Gola cultivars of ber.
Table 1. Effect of foliar application of urea and NAA on fruit drop, physico-chemical characteristics and yield of ber (Ziziphus mauritiana Lamk.) cv. Suffon

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fruit drop (%)</th>
<th>Fruit weight (g)</th>
<th>Fruit length (mm)</th>
<th>Fruit breadth (mm)</th>
<th>Seed weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (control)</td>
<td>50.04a</td>
<td>9.36d</td>
<td>20.46e</td>
<td>19.47C</td>
<td>1.00</td>
</tr>
<tr>
<td>T2 (NAA 20ppm)</td>
<td>44.55b</td>
<td>9.40cd</td>
<td>22.91de</td>
<td>20.01bc</td>
<td>1.00</td>
</tr>
<tr>
<td>T3 (NAA 40ppm)</td>
<td>42.37c</td>
<td>10.58bcd</td>
<td>25.06cd</td>
<td>21.71bc</td>
<td>1.00</td>
</tr>
<tr>
<td>T4 (urea 1.5%)</td>
<td>41.00d</td>
<td>12.30abc</td>
<td>28.40bc</td>
<td>22.54bc</td>
<td>0.99</td>
</tr>
<tr>
<td>T5 (NAA 20ppm + 1.5% urea)</td>
<td>35.86f</td>
<td>13.57a</td>
<td>33.96a</td>
<td>27.59A</td>
<td>0.99</td>
</tr>
<tr>
<td>T6 (NAA 40ppm + 1.5% urea)</td>
<td>39.68e</td>
<td>13.22ab</td>
<td>30.55ab</td>
<td>23.22b</td>
<td>0.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatments</th>
<th>TSS (%)</th>
<th>Acidity (%)</th>
<th>Vitamin-C (mg/100g)</th>
<th>Total sugar (%)</th>
<th>Yield (kg/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 (control)</td>
<td>12.87c</td>
<td>0.44a</td>
<td>104.25f</td>
<td>4.25f</td>
<td>78.33f</td>
</tr>
<tr>
<td>T2 (NAA 20ppm)</td>
<td>13.8bc</td>
<td>0.40b</td>
<td>117.45d</td>
<td>5.54e</td>
<td>81.67e</td>
</tr>
<tr>
<td>T3 (NAA 40ppm)</td>
<td>15.25b</td>
<td>0.39b</td>
<td>110.49e</td>
<td>6.90c</td>
<td>87.33d</td>
</tr>
<tr>
<td>T4 (urea 1.5%)</td>
<td>15.62b</td>
<td>0.40b</td>
<td>121.33c</td>
<td>6.10d</td>
<td>95.67c</td>
</tr>
<tr>
<td>T5 (NAA 20ppm + 1.5% urea)</td>
<td>19.22a</td>
<td>0.31c</td>
<td>132.25a</td>
<td>7.23b</td>
<td>112.33a</td>
</tr>
<tr>
<td>T6 (NAA 40ppm + 1.5% urea)</td>
<td>20.29a</td>
<td>0.31c</td>
<td>127.34b</td>
<td>8.90a</td>
<td>100.00b</td>
</tr>
</tbody>
</table>

Fruit weight, fruit length and fruit breadth

Results (Table 1) showed maximum fruit weight (13.57 g), fruit length (33.96 mm) and fruit breadth (27.59 mm) in T5 while minimum fruit weight (9.36 g), fruit length (20.46 mm) and fruit breadth (19.47 mm) was observed in T1. Further results also showed that all treatments applied gave better results as compared to control. Physiological study revealed that fruit size depends on photosynthetic activity and hence the healthy plants produced large sized healthy fruits. It may be beneficial effects of NAA on plant cell division and cell enlargement as NAA concentration increases the activities of parenchyma (13). Similar results have been reported by Teatoia and Chauhan (26). The results are also in conformity with the findings of Bhati and Yadav (8).

Seed weight

Data (Table 1) revealed that NAA and urea have no particular effects on seed weight. Results are supported by Bisla et al. (9) and Kedar and Gopal (16) who also recorded non-significant results when applied urea and NAA in different combinations.

Total soluble solids (TSS)

Data (Table 1) showed that maximum TSS (20.29 %) was recorded in T6 followed by T5 (19.22 %). It may be associated with availability of more
assimilates due to urea (nitrogen) application as various energy sources like amino acids and sugars contain nitrogen and NAA caused the movement of carbohydrate from the source towards sink (fruits). Similar effects of urea and NAA have been reported by Bal et al., (3).

**Acidity (%)**

Data (Table 1) showed that acidity percentage decreased with increasing concentration of NAA and urea. Maximum acidity percentage (0.44%) was found in T₁ (control) and minimum (0.31%) in both T₅ and T₆. Decreasing value of acidity indicates that when growth regulators were applied, organic acid was rapidly utilized at fruit maturity stage. Similar findings have been reported in ber by Chauhan and Gupta (11).

**Vitamin-C contents (mg/100g)**

Maximum vitamin C content (132.25mg/100g) was recorded in T₅ while minimum in T₁ (Table 1). Such rise in vitamin -C content may be associated with perpetual synthesis of glucose-6-phosphate during fruit development phase which is considered precursor of vitamin-C. These results are supported by Bankar and Prasad (5) who also showed increase in vitamin-C with the application of growth regulators.

**Total sugar (%)**

Data (Table 1) showed that maximum total sugar percentage (8.90%) was found in T₆ followed by T₅ while minimum (4.25%) in T₁. These values represent that sugar contents are improved when NAA and urea are applied in combination. Similar results have been reported in ber by Bal et al. (2) who recorded rise in sugar contents by applying various concentrations of growth regulators. Some other scientists (6, 10) have also reported the similar findings.

**CONCLUSION**

It was concluded that treatment T₅ (NAA 20 ppm + 1.5 % urea) is the best combination of chemicals to control fruit drop in ber cultivar “Suffon”. This combination of growth regulators is playing most effective role in improving physiochemical composition of ber fruits, maximizing the yield and minimizing the fruit drop. It is recommended to spray naphthalene acetic acid (NAA) @ 20 ppm + urea @ 1.5% two times once in last week of October and secondly in last week of November for controlling premature fruit drop and improving yield.
REFERENCES


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**CONTRIBUTION OF AUTHORS**

Naseem Sharif : Principal author conceived the idea, designed research, conducted research and prepared the writeup.
Malik Mohsin Abbas : Assisted in designing experiment, reviewed the literature.
Noor-ul-Nisa Memon : Helped in experimental design, data analysis and results and discussion.
Muhammad Afzal Javaid : Guided in research planning and facilitated in provision of experimental material.

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