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Naphthalene acetic acid and ferrous sulphate induced changes in physico-chemical composition and shelf-life of *ber*

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ABSTRACT

The *ber* (*Zizyphus mauritiana* L.) fruits of cv. Gola were subjected to various treatments of naphthalene acetic acid (NAAI) and ferrous sulphate to determine their effect on physico-chemical characteristics and shelf life of fruits. NAA @ 0, 50, 75 and 100 ppm and ferrous sulphate @ 0, 0.2, 0.3 and 0.4% were applied alone as well as in combination form during fruit development stage (pea size). The results revealed that 100 ppm NAA and 0.4% $FeSO_4$ was found most effective in significantly increasing the fruit weight (18.35 & 22.95%), fruit length (23.11 & 27.95%) and fruit width (20.15 & 17.9%) respectively over the control. Though, the TSS of fruits was slightly reduced. The application of 75 ppm NAA and 0.3% $FeSO_4$ helped in maintaining the marketability and also reduced the fruit weight loss (2.19 and 2.41%) and fruit decay loss (10.37 and 9.81%), respectively over the control. Application of 100 ppm NAA and 0.4% $FeSO_4$ was found most economical than the other treatments.

Key words: *Ber*, NAA, ferrous sulphate, shelf-life, fruit quality.

INTRODUCTION

Ber (*Zizyphus mauritiana* L.) is cultivated globally because of its nutritive value having good amount of vitamins C, A and B complex. The storage life of *ber* fruit is very short, hardly 2-4 days at ambient conditions that is a greatest problem for its successful transportation and marketing (Bavishkar *et al*., 4). Limited study has been made on shelf-life of *ber* with the exogenous application of micro-nutrients and plant growth regulators. It has been reported that NAA significantly reduces fruit drop, increases yield and improves fruit quality and storage (Banik *et al*., 3; Iqbal *et al*., 6). There are some reports indicating that the use of NAA is more effective in fruit formation, abscission, cell elongation, apical dominance, photoperiod and geotropism than others PGRs. Similarly, iron plays vital role in the plant metabolism and increases the TSS content of fruits and yield of *ber*. Hence, the ferrous sulphate along with NAA were used in the present study to improve the yield and quality of *ber* fruit with extended storage life.

MATERIALS AND METHODS

A field trial was conducted to study the changes on quality and storability of *ber* (*Zizyphus mauritiana*.L) cv. Gola by the foliar application of NAA and ferrous sulphate at Horticulture Farm of CIPHET, Abohar (Punjab) during 2010-2011. Ten-year-old *ber* trees spaced at 8 m × 8 m apart were used for the study. The trees were pruned during the month of May. The sprays were applied as foliar either alone or in combination at the pea size of fruit development followed by second spray after 20 days of first spray. The experiment comprised of four doses of NAA (control, 50, 75 and 100 ppm) and four spray of ferrous sulphate (control, 0.2, 0.3 and 0.4%) with all possible combinations (Table 2). The experiment was laid out in factorial randomized block design with four replications. The plants were grown under the recommended agricultural package and practices, while the guidelines of integrated pest management were also followed.

Effect of different treatments in relation to storage of *ber* fruits was conducted using uniform size fruits. Ten fruits were marked and kept separately for recording changes in physiological loss in weight and decay loss, under ambient storage conditions. Physical parameters like fruit weight (g), fruit length (cm) and width (cm) was carried out by Vernier callipers. While fruit firmness (g/cm^2) was estimated by texture analyzer using a of 5 mm probe to a constant distance 2 mm inside the skin by a constant speed 20 mm per sec. and the peak of resistance force of the skin was recorded periodically. Chemical attributes includes determination of total soluble solids in juice (^{o}Brix) was recorded by digital hand refractometer, total acidity (%) was determined according to the methods of AOAC (1), while ascorbic acid by method given by Ranganna (10). The experiment data were analyzed following RBD to test the significance of using the Minitab-16 software. The differences in quantified concentrations were evaluated using F test at $P < 0.05$.

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Table 1. Details of treatments used in the study.

T1	Control (No application)
T2	50 ppm foliar application of NAA
T3	75 ppm foliar application of NAA
T4	100 ppm foliar application of NAA
T5	0.2% foliar application of ferrous sulphate
T6	0.2% foliar application of ferrous sulphate + 50 ppm foliar application of NAA
T7	0.2% foliar application of ferrous sulphate + 75 ppm foliar application of NAA
T8	0.2% foliar application of ferrous sulphate + 100 ppm foliar application of NAA
T9	0.3% foliar application of ferrous sulphate
T10	0.3% foliar application of ferrous sulphate + 50 ppm foliar application of NAA
T11	0.3% foliar application of ferrous sulphate + 75 ppm foliar application of NAA
T12	0.3% foliar application of ferrous sulphate + 100 ppm foliar application of NAA
T13	0.4% foliar application of ferrous sulphate
T14	0.4% foliar application of ferrous sulphate + 50 ppm foliar application of NAA
T15	0.4% foliar application of ferrous sulphate + 75 ppm foliar application of NAA
T16	0.4% foliar application of ferrous sulphate + 100 ppm foliar application of NAA

RESULTS AND DISCUSSION

There was positive effects of spraying of NAA with different doses of ferrous sulphate were recorded on physical characteristics of fruits, *i.e.* weight, length and width. Data depicted in (Figs. 1&2) revealed that treatment combination T-11 (75 ppm NAA + 0.3% $FeSO_4$) significantly increased the average fruit weight, length, width over control (Table 3). Treatment T-3 (75 ppm NAA) showed highest significant value in this respect. The increase recorded due to T-4 (100 ppm NAA) was at par with T-3 level. The percent increase with the application of T-3 (75 ppm NAA) was (15.36, 18.00 and 15.70%), respectively over control. On the other hand, treatment T-9 (0.3% $FeSO_4$) enhanced average fruit weight (19.13%), length (22.28%) and width (12.23%), over control. The interactions between NAA with ferrous sulphate were also noticed significant in increasing fruit weight and size. The findings are in accordance with the results obtained by Stern *et al*. (12). This increase in fruit size may be attributed to the increase in cell division and cell elongation caused by NAA (Kaseem *et al*., 7; Ranjan *et al*., 11). Furthermore, the increase in cell size following NAA application possibly indicates its ability to mobilize carbohydrate uptake and thus enlarge the cells considerably. Another possibility is that NAA increases the elasticity of the cell wall, thereby enabling its enlargement due to increasing the rate of fruit growth, eventually leading to an increased yield of large fruits (Arteca, 2).

Ferrous sulphate mediated increase in fruit weight and size is because of improved chlorophyll content of *ber* leaves that in turn might have increased the

Table 3. Comparative changes in fruit weight, fruit length and width as influenced by pre-harvest treatments.

Source	df	Avg. fruit wt.		Fruit length		Fruit width	
		F	P	F	P	F	P
Block	3	4.77	0.006**	30.60	0.000**	8.90	0.000**
$FeSO_4$	3	118.88	0.000**	91.38	0.000**	153.14	0.000**
NAA	3	54.82	0.000**	78.79	0.000**	104.89	0.000**
$FeSO_4$*NAA	9	2.61	0.016**	2.23	0.037*	3.01	0.007**
R^2		92.55%		93.26%		94.84%	

*, **Significant at 5 and 1% levels

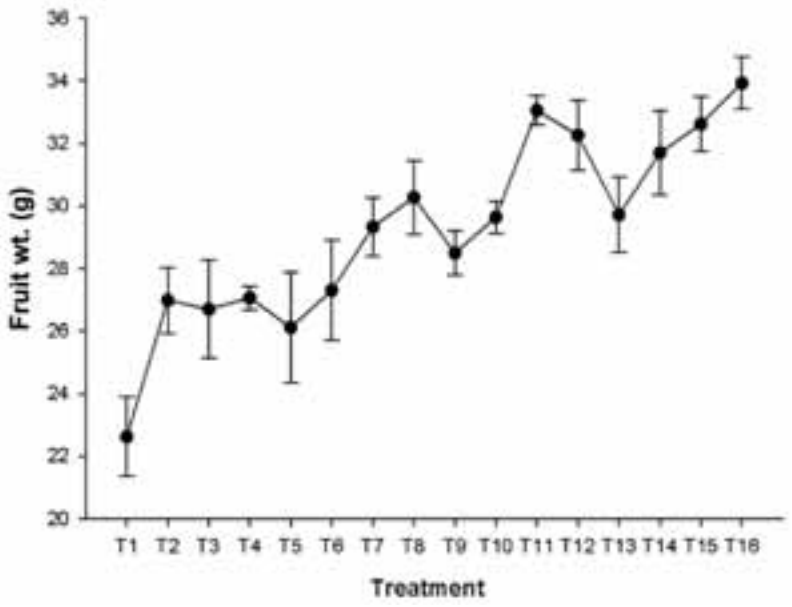

Fig. 1. Effect of different treatments of NAA and ferrous sulphate on fruit weight.

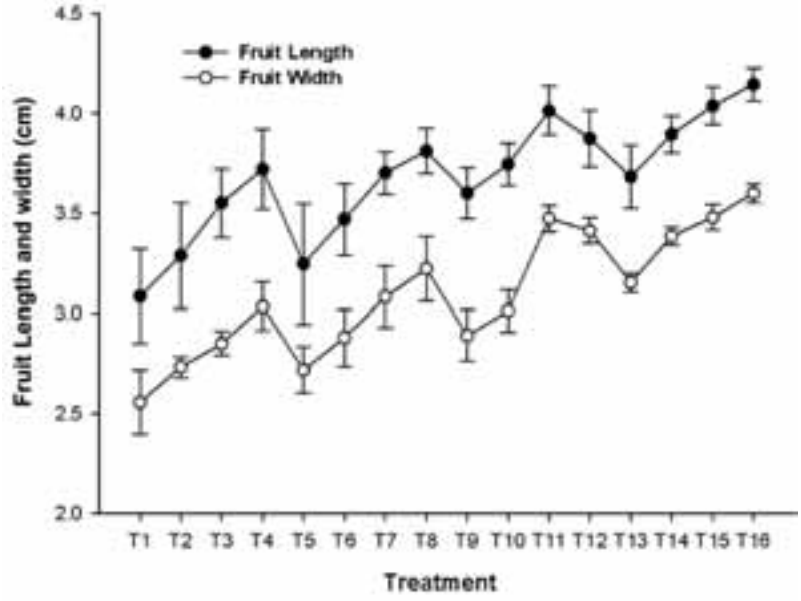

Fig. 2. Comparative changes in fruit length and width as influenced by pre-harvest treatments of NAA and ferrous sulphate.

photosynthetic efficiency of *ber* leaves and greater production of assimilates. The greater production of photosynthates and their translocation to economic sinks may be the reason of improved yield characters. In contrast to other constituents TSS increased with increased NAA concentration and was found maximum in T-4 (100 ppm NAA) (18.69% over control). Results depicted in (Fig. 3) are similar to those achieved by Kumar and Shukla (8), and Sawant *et al*. (9). Like NAA 100 ppm, ferrous sulphate upto 0.3% appreciably enhanced the TSS (16.06%) over control. However, the interaction between NAA and ferrous sulphate was found non-significant in increasing the TSS of fruits. The increased TSS with ferrous sulphate may be attributed to an increased photosynthetic activity and more production of starch and consequently

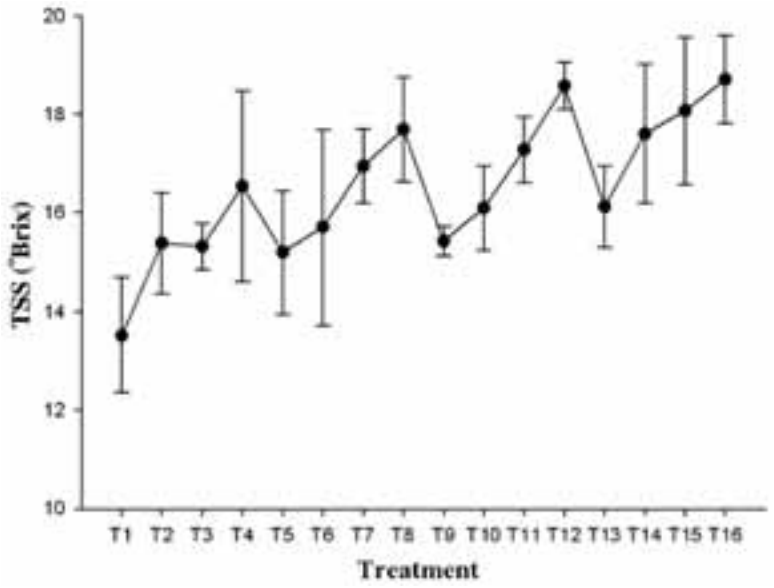

Fig. 3. Comparative changes in TSS as influenced by pre-harvest treatments of NAA and ferrous sulphate.

conversion into sugars. The results are similar to those of Dutta and Banik (5).

It was observed that plant growth regulator NAA with all combination with ferrous sulphate besides increasing fruit weight and fruit size and TSS successfully, the ascorbic acid content of fruits was not increased appreciably and it was found statistically at par among different treatment combinations. NAA had also effect on acidity content of fruits which varied from 0.24 to 0.26%.The untreated fruits contained more acidity than the fruits treated with different treatment combinations. The decrease in fruit acidity owing to the application these treatments might be because of the acids that might have been quickly converted into sugars and its derivatives by the reaction of glycolytic pathway. Weight loss (%) increased gradually till the end of the storage period (Fig. 4). This increase can be probably due to moisture loss from the *ber*

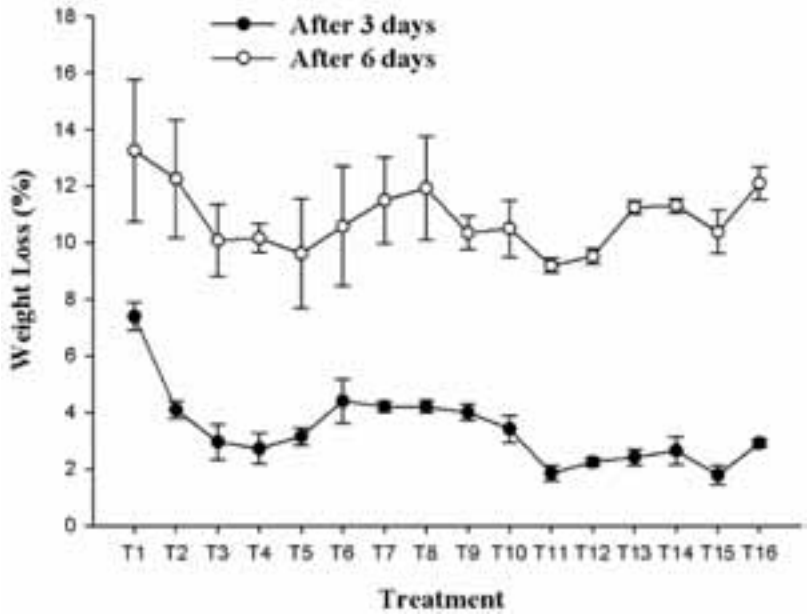

Fig. 4. Comparative changes in weight loss (%) as influenced by pre-harvest treatments of NAA and ferous sulphate.

Table 4. Comparative changes in quality and shelf-life as influenced by pre-harvest treatments.

Source	df	TSS		Acidity		Ascorbic acid		Wt. loss 3rd day		Wt. loss 6th day		Decay loss 3rd day		Decay loss 6th day	
		F	P	F	P	F	P	F	P	F	P	F	P	F	P
Block	3	4.22	0.010**	0.66	0.580	1.41	0.253	7.35	0.000**	2.15	0.107	4.43	0.008**	0.86	0.471
$FeSO_4$	3	15.35	0.000**	0.69	0.565	1.77	0.167	269.32	0.000**	12.09	0.000**	310.13	0.000**	946.00	0.000**
NAA	3	20.73	0.000**	0.53	0.667	0.15	0.927	167.26	0.000**	8.86	0.000**	247.31	0.000**	151.90	0.000**
$FeSO_4$*NAA	9	0.45	0.900	0.61	0.785	0.34	0.955	108.34	0.000**	9.65	0.000**	45.89	0.000**	17.60	0.000**
R^2		73.52%		19.76%		22.51%		98.09%		77.64%		97.90%		98.71%	

during storage in ambient conditions. NAA alone was noticed highly significant in reducing weight loss. Spraying with T-3 (75 ppm NAA) showed the lowest weight loss percentage (2.196%) after third day and after sixth days (10.37%) respectively of storage in ambient conditions (Table 4). It was further observed that T-9 (0.3% $FeSO_4$) alone reduced the weight loss (2.41 and 9.89%) after three and six days of storage. The interaction treatment T-11 (NAA 75 ppm + 0.3% $FeSO_4$) has been found effective in reducing weight loss as lowest loss in weight was noticed in this treatment. While, highest weight loss percentage (3.89 %) was recorded after three days of storage for fruits of the control or T-1 treatment. The obtained results are similar to those achieved by (Tecchio *et al*., 13) on 'Niagra Rosada' grapes who found that NAA spraying significantly reduced the increase in weight loss (%) in comparison with control. Ferrous sulphate @ 0.3% significantly reduced weight loss (2.41 and 9.89%) after three and six days of storage. As shown in (Fig. 5), a gradual but, significant increase in fruit decay (%) was observed up to the end of storage period. Control fruits exhibited the highest significant decay percentage (0.25 %). On the other hand, fruits of T-11 (75 ppm NAA + 0.3% ferrous sulphate) showed the lowest decay percentage up to third day of storage while the least decay loss was observed with T-15 (75 ppm NAA and 0.4% $FeSO_4$) after sixth day of storage. Further the data shown in (Fig.5) also indicate that the lowest decay was recorded with the application of 0.4% ferrous sulphate spray.

The higher concentrations of NAA applied on ber increased its yield attributing characters over control. The ascorbic acid content of fruit did not show any response to NAA and ferrous sulphate application. Furthermore, it can be concluded from the study that those *ber* fruits treated with T-11 (75 ppm of NAA + 0.3% $FeSO_4$) showed least weight loss. However, the lowest decay loss was found in T-15 (75 ppm NAA + 0.4% $FeSO_4$).

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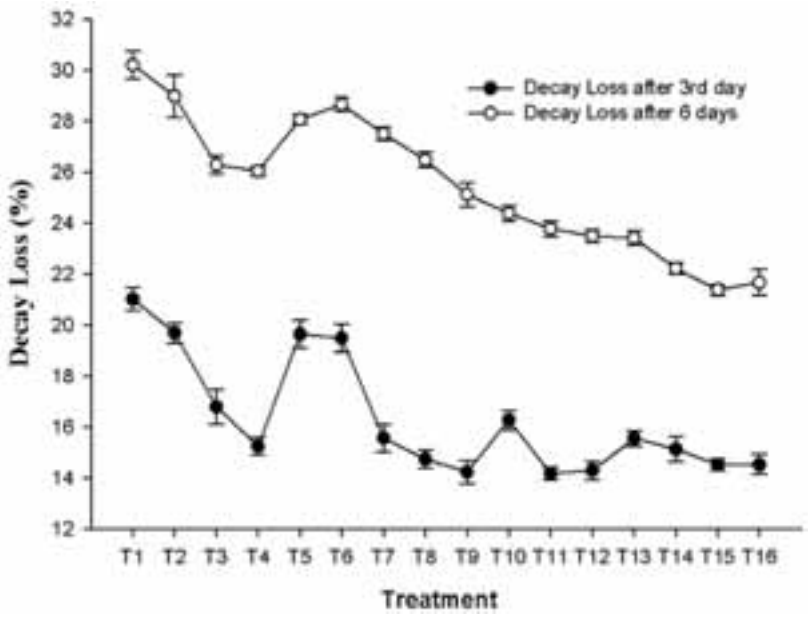

Fig. 5. Comparative changes in decay loss as influenced by pre-harvest treatments.

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