



Improve Yield and Fruit Quality of Plum cv "African Rose" by Different Thinning Treatments



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THE present study was carried out during 2017-2018/2018-2019 on 5 years old plum trees cv. (African Rose) budded on Mariana rootstock to discuss the importance of thinning flowers and fruits on plum fruit quality. Treatments were as follows: control trees without thinning, hand blossom thinning, hand fruit thinning, Ethephon at 100 ppm, NAA (Naphthalene acetic acid) at 20 ppm and BA (6-Benzyladenine) at 400 ppm. Results indicated that, all thinning treatments increased fruit drop and the highest fruit drop % was found with Ethephon treatment at 100 ppm in both seasons. Also, all treatments reduced fruit number per tree compared to control but increased fruit yield (4-6 kg/tree) and that may be as a result of increase fruit weight and size which subsequently increase yield price. Thinning treatments under study increased fruit physical characteristics and the highest fruit weight was obtained from hand fruit thinning treatment in both seasons. All thinning treatments advanced harvest date and increased yield. Data also revealed that the highest percentage of carbohydrates and C/N ratio in leaves were recorded with hand fruit thinning treatment compared to the other thinning treatments. So, we can recommend this treatment to early harvest date, high fruit yield and fruit quality, subsequently higher fruit yield price.

Keywords: Plum, Hand thinning, Chemical thinning, African rose.

Introduction

Plum is one of the most favorite deciduous fruits in Egypt. Total cultivated area of plum trees is 2984 Feddan, with productivity 1483 Ton (Agriculture Statistics of Ministry of Agriculture and Land Reclaimed areas. Economic Affairs Sector, 2017). Plum trees bear an excess number of flowers that resulted in small fruit size and reducing fruit quality, so, it requires flower and fruit thinning to reach the balance between vegetative and fruiting growth. This balance is gained by different fruit thinning methods (Costa et al., 2013).

Fruit thinning is removing a portion of the yield before maturing on the trees. It's an important practice to avoid production of fruits with a small size and little quality (Yashwant, 2016). So, it's needed for a high fruit quality, optimum size, color and taste for class (A) fruits. Also, its

necessary to produce high yields and to improve fruit sugar content and fruit pulp firmness as they are an important parameter for good marketing and storability conditions (Seehuber et al., 2011).

Thinning can be made by hand, by chemicals (Ethrel, BA, NAA etc.) or mechanically (Goffinet et al., 1995). The main indexes of estimating the amount of thinning are, leaf / fruit ratio, fruit size, distance between fruits and the total number of fruits per tree. Two fruits must be left at maximum on each spur (Mitra et al., 1991).

Flowers or fruits can be thinned by hand. Hand thinning has great advantages and more accurate that doesn't pollute the environment (using no chemicals), don't damage the leaves and decrease the competition between the developing fruitlets. Hand thinning of fruits is a very important process in fruit practice because it is a method of obtaining

the optimum quantity of fruits, which have high physical and chemical qualities (Iordanescu *et al.*, 2009). On the other hand, hand thinning is common and high cost practice, due to the labor involved and thus increase the cost especially that most of the producers are small farmers with limited resources (Meitei *et al.*, 2013, Pavanello *et al.*, 2018). Furthermore, by comparison between hand thinning and other methods of thinning, hand thinning is the most expensive method and waste a long time (Ryugo, 1988). Link (1973) stated that application of hand thinning in apple trees resulted in an improvement in fruit characteristics like color and TSS%. Hand thinning increased fruit weight, volume and characteristics significantly. Moreover, hand thinning improved TSS and other fruit characteristics. Dhinesh and Yadave (2004) observed that hand thinning of peaches increased fruit weight significantly in India. Son (2004), reported that hand thinning significantly increased fruit weight and TSS% of 'Priana' and 'Beliana' apricot (*Prunus armeniaca*) cultivars.

Chemical thinners agents are common methods used for thinning, it has been long established, but the most important factor, is the choice of the used chemical. There are many chemicals used in this respect for example, Ethephon (Ethrel) and 6-Benzyladenine (BA). Also, using these chemical thinners depend on, flowering stage, cultivar, tree age and temperature of the air (Seehuber *et al.* 2013, Pavanello and Ayub 2014).

Naphthalene acetic acid (NAA) is a synthetic auxin used in fruit thinning at certain concentration and induced fruit drop in different fruit crops (Yashwant, 2016). The optimum time for Naphthalene acetic acid application is (14-18) days after full bloom and that for a successful thinning application (Thomas, 1982). Moreover, the mode of action of NAA is by its effect on the developing of embryo and the interactions between hormones involved in the nutrition of the developing fruits (Edgerton 1973).

Fruit thinning rate and fruit quality varied between the cultivars and the used concentration of application. Effect of hand thinning treatment was similar to NAA application in apricot (Bolat and Karlidag, 1999). Son (2004) illustrated that spraying NAA at 20 ppm in 'Priana' and 'Beliana' apricots four weeks after full bloom resulted in an increase in the thinning percentage. In Florida sun peach, foliar treatment of NAA at petal fall had a great thinning effect (Farmahan, 1992). Spraying Naphthalene acetic acid at (40 and 60

ppm) in 'Redhaven' peaches 3 weeks after petal fall increased fruit thinning (Sharma *et al.*, 2003).

Yashwant (2016) declared that, Ethephon (Ethrel) is a synthetic compound (2-chloroethyl phosphonic acid) decomposes to ethylene gas, which is natural plant growth regulator. Moreover, it's known as an exogenous stimulant for ethylene production causing fruit abscission (Wertheim, 2000). Ethrel is a successful thinner under warm air conditions for stone fruits, but results are not always constant or predictable (Webster and Spencer, 2000). Applying Ethrel at 200-250 ppm in European plum (30-40) days after bloom had higher effect with temperature above 15°C at spraying time (Jakob, 1998). Moreover, Meland (2007) observed that 'Victoria' plum trees applied with Ethrel at 250 ppm (4 weeks after bloom) had a better effect in reducing fruit set percentage and crop load and also increased fruit quality. In peaches, Ethrel had a great thinning effect when it applied from flowering period to the pit hardening period (Byers *et al.*, 2003 and Greene & Costa, 2013). Weather temperature during and after treatment is the most important factor and must be considered because it affected the absorption and degradation of ethylene into ethephon (Yuan 2007).

BA (6-benzyladenine) is a synthetic cytokinin used as a thinning agent, its positive effect when it applied at fruit diameter (10 mm). Moreover, BA reduced the crop load and also increased fruit size (Robinson *et al.*, 1998). BA is used widely in apple fruits for thinning but it must be applied in the optimum time (Lakso *et al.*, 1999).

The objective of this study was to determine the most effective thinning treatment on plum fruit quality and yield.

Materials and Methods

This experiment was carried out during two successive seasons (2017-2018/2018-2019) on 5 years old "African Rose" plum trees similar as possible and budded on Mariana rootstock, trees planted at 3 X 4 m and grown in sandy soil in private orchard at South Tahreer City, EL-Beheira Governorate, Egypt. Six treatments were applied:

Unthinned tress (control).

BA (6- Benzyladenine) at 400 ppm (was applied 2 weeks after fruit set).

NAA (Naphthalene acetic acid) at 20 ppm (was applied 2 weeks after fruit set).

Hand blossom thinning at full bloom by removing 30% from flowers.

Hand fruit thinning 2 weeks after fruit set by removing 30% from fruits.

Ethephon at 100 ppm (was applied 2 weeks after fruit set).

Three trees were labeled for each treatment, four branches were chosen for measurements.

Field data

Shoot length and diameter (cm): four branches were tagged at the four directions of each tree; the average of shoot (one year old) length and diameter (cm) were measured in 1st of October.

Leaf area (cm²): it was measured by using leaf area meter (model 1203, CID.INC., USA.). Leaf samples were taken from the fourth to the seventh node in July.

Fruit drop%: [(Initial fruit number – Final fruit number) / Initial fruit number] x 100

Number of fruits per tree: was counted for each treatment, at harvest time.

Yield (Kg): at harvest time (end of May) yield per tree (Kg) was estimated for each treatment.

Leaf to fruit ratio (LFR): calculated by dividing leaves number per shoot / fruit number per shoot.

Harvesting date: fruits were collected on the attainment of full maturity, harvest date for each treatment was recorded.

Fruit characteristics

Ten mature fruits were selected for each treatment to determine fruit physical and chemical characteristics as follow:

Physical characters: Fruit weight (g), fruit size (cm³), fruit length and diameter (cm).

Chemical characters: Titratable acidity percentage was determined in fruit juice as malic acid according to A.O.A.C. (2005) by titration with 0.1 sodium hydroxide and phenol phthalene as indicator. Total soluble solids (TSS %) of fruit juice was carried out by using hand refractometer.

Mineral content

Leaf samples were taken from the fourth node to the seventh node in July, each sample was represented by 10 leaves per replicate for each treatment to determine the following:

Total carbohydrates percentage: carbohydrate content was determined according to the method of Smith et. al. (1956).

Nitrogen percentage: Total nitrogen was determined in 0.5 g sample by the modified method of Pregl (1945).

C/N ratio: Total carbohydrates / Total nitrogen.

Statistical analysis

The obtained data were subjected to analysis of variance in randomized complete block design (RCBD) according to Snedecor and Cochran (1980). Means were compared by using the method of new least significant differences (New L.S.D) described by Waller and Dunca (1969).

Results and Discussions

Effect of different thinning treatments on shoot length (cm), shoot diameter (cm) and leaf area (cm²)

Data in Table 1 show that, different thinning treatments gave a significant effect on shoot length. The significant highest values of shoot length were obtained from Ethephon treatment at 100 ppm, it recorded 92.67 cm and 88.50 cm, compared with control (61.33 and 56.33 cm) in both seasons respectively followed by NAA treatment (84.00 and 78.89 cm), BA treatment (74.68 and 70.36 cm), hand fruit thinning (74.00 and 69.00 cm) then hand blossom thinning (71.67 and 66.76 cm).

As for shoot diameter, application of different thinning treatments led to a great shoot diameter as it showed in Table 1, both Ethephon (100 ppm) and NAA (20 ppm) gave the significant highest values of shoot diameter followed by BA treatment in both seasons.

The highest leaf area was recorded from Ethephon (15.57 and 15.28 cm²) and NAA (14.73 and 14.88 cm²) in both seasons, followed by BA and hand fruit thinning treatments. The lowest leaf area was recorded in the control trees (10.28 and 10.37 cm²) in both seasons.

These results are in agreement with Singh (1996) who observed that, applying NAA in mango Dashehari cv. at 200 ppm, improved vegetative growth. Seong Tae (2001) showed that, NAA regulated shoot growth in persimmon. Byers, et al. (2003) stated that, reduction of crop load decrease competition for carbohydrates between vegetative and reproductive growth, thereby improve both and it was also preferable by leaf growth. Bloom

application of NAA at 50mg/l increased leaf area index of Shisheh Cup cv. pomegranate (Rahemi and Atahosseini, 2004). Also, Hassani and Rezaee (2007) revealed that, increasing in leaf area by using NAA may be due to the increasing in both supply of water and nutrient to the growing leaves after the reduction of crop load. NAA application at 40 ppm as fruit-let thinner (two weeks after petal fall), significantly increased both shoot growth and leaf area in nectarine (Snow Queen) cv. (Rajeev, 2013). Chandel and Singh (2015) found that, application of NAA at 60 ppm in (Silver King) nectarine (three weeks after petal fall) greatly increased annual shoot growth, tree spread and tree height.

On the contrary, Rimpika *et al.* (2014) declared that, applying Ethrel at 300 ppm (2 weeks after petal fall) reduced shoot growth, leaf area, tree spread and height in nectarine cv. May Fire. Also, applying Silver king cv. nectarine by Ethrel at 300 ppm (3 weeks after petal fall) reduced shoot growth, tree height, leaf area and tree spread (Chandel and Singh, 2015).

Fruit drop %

Data in Fig. 1 show that the highest fruit drop % was gained with Ethephon application at 100 ppm (52.41 and 54.89 %) in both seasons respectively, followed by NAA application at 20 ppm (48.22 %) in the first season and (49.57 %) in the second season, then application of 6-benzyladenine at 400 ppm (45.71 and 47.02 %) in both seasons. On the other hand, there weren't any significant differences between hand fruit thinning and hand blossom thinning. Moreover, the lowest fruit drop percentage was obtained from unthinned control trees in both seasons respectively (28.64 and 27.56%).

Our results were supported by finding of Babu and Yadav (2002) who reported that, increasing of fruit drop % may be due to the reduction of transferring of (C) coming from leaves to the fruitlets after application with chemical thinners. Also, reduction in auxin translocation before drop of fruits increased ethylene production, reduced auxin synthesis and reduced metabolism ability of the fruits causing fruit drop. Furthermore,

TABLE 1. Effect of different thinning treatments on shoot length, shoot diameter and leaf area of plum cv. "African Rose"

Treatments	Shoot length (cm)		Shoot diameter (cm)		Leaf area (cm ²)	
	2018	2019	2018	2019	2018	2019
Control	61.33 d	56.33 f	0.25 d	0.24 d	10.28 d	10.37 d
6-Benzyladenine at 400 ppm	74.68 bc	70.36 c	0.55 bc	0.54 bc	13.44 b	13.56 b
NAA at 20 ppm	84.00 ab	78.89 b	0.65 ab	0.63 ab	14.73 ab	14.88 ab
Hand blossom thinning	71.67 cd	66.76 e	0.30 d	0.30 d	11.96 c	11.85 c
Hand fruit thinning	74.00 bc	69.00 d	0.47 c	0.46 c	13.37 b	13.39 b
Ethephon at 100 ppm	92.67 a	88.50 a	0.71 a	0.72 a	15.57 a	15.28 a

Means within each column followed by the same letter(s) are not significantly different at 5%

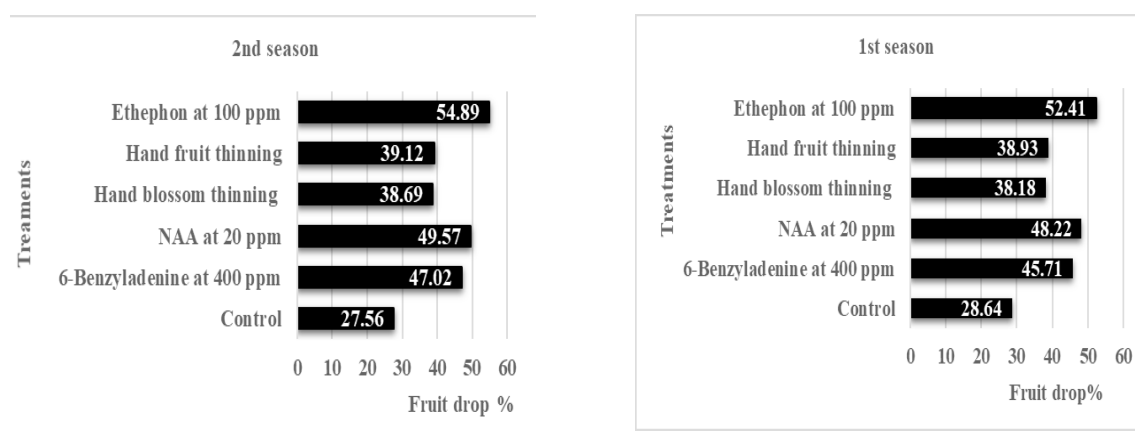


Fig. 1. Effect of different thinning treatments on fruit drop % in plum cv. "African Rose".

application of NAA at 30 to 80 mg l⁻¹ after petal fall led to formation of abscission zone between floral tube and pedicle in plum trees 'Stanley' cv. (Gonkiewicz and Nosal, 2006). Leila, et al. (2011) concluded that, fruitlet abscission was increased by chemical thinning, On the contrary, hand thinning gave benefit to select the removing of small fruits or damaged fruits by forest. Also, Salaya (2012) stated that Ethephon is absorbed by the plant parts and hydrolyzed to Ethylene gas, which ends up in inhibition of the synthesis or transport of phytohormone. Thus, Ethephon application will increase the tissue sensitivity to Ethylene gas and abscission happens as a consequence of enlarged synthesis and secretion of the protein cellulase.

Number of fruits per tree, yield (kg), leaf to fruit ratio and harvesting date

All thinning treatments significantly decreased number of fruits per tree (Table, 2). Control trees gave the highest number of fruits per tree (509 and 585.33) in both seasons and that may be a result of having the lowest fruit drop percentage (28.64 and 27.56 %) through 2018 and 2019 seasons. Among thinning treatments findings in Table 2 showed that, the significant lowest values of fruit number per tree were recorded from Ethephon treatment (283.00 and 330.00) in both seasons respectively.

Yield per tree had taken another trend than number of fruits per tree, Table 2 showed that, the significant highest values of yield (kg) were obtained from hand fruit thinning in both seasons respectively (31.46 and 34.53 kg) and the lowest yield was gained from Ethephon treatment in both seasons respectively (19.90 and 21.88 kg). Control and other treatments were between them. It is noticeable that, although hand fruit thinning

after 2 weeks of fruit set treatment recorded less number of fruits/tree (315.70 and 368.70) but it caused the highest fruit yield (31.46 and 34.53 kg/tree) through the two studied seasons.

Leaf to fruit ratio presented a great variation between all thinning treatments. The results depicted in Table 2 indicated that treatment of Ethephon was the highest leaf / fruit ratio (42.00 in the 1st season and 38.32 in the 2nd season) and the lowest LFR was from control trees (22.33 in the 1st season and 17.00 in the 2nd season).

Reduction in yield may be due to the reduction in number of fruits per tree after application of different thinning methods as a result of higher fruit drop percentage. The present findings are in line with Gianfagna (1990) who declared that, there was a great reduction in yield after ethephon application. Moreover, Claudia and Damerow (2011) concluded that, hand fruit thinning of plum trees decreased number of fruits in both seasons. Also, LFR was affected by reduction in fruit number per tree; trees have the lowest number of fruits have the highest value of leaf to fruit ratio, decrease in crop load by different thinning treatments resulted in an increase in the leaf to fruit ratio.

Regarding harvest date all thinning treatments under study caused fruits to ripen earlier than control fruits in both seasons (Table 2). Ethephon treatment at 100 ppm was the earliest fruits to ripen 15 May in both seasons. Control fruits were the last in harvesting (2 and 3 June in the 1st & 2nd seasons) for both seasons. Ethephon advanced fruits harvesting and that might due to the increase production of ethylene in fruits treated with Ethephon and increasing physiological activity in fruits. However, earlier harvest date clearly means higher yield price.

TABLE 2. Effect of different thinning treatments on number of fruits per tree, yield, leaf to fruit ratio and harvesting date of plum cv. "African Rose"

Treatments	No. of fruits per tree		Yield (kg/tree)		Leaf to fruit ratio		Harvest date	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	509.00 a	585.33 a	27.65 b	28.68 c	22.33 f	17.00 f	2 June	3 June
6-Benzyladenine at 400 ppm	394.00 b	454.00 b	28.18 b	30.56 b	26.67 e	22.66 e	19 May	20 May
NAA at 20 ppm	364.07 bc	419.67 c	28.27 b	30.50 b	31.00 d	29.33 d	21 May	23 May
Hand blossom thinning	355.00 bc	432.33 c	25.32 b	29.08 b	35.67 c	30.67 c	28 May	30 May
Hand fruit thinning	315.70 cd	368.70 d	31.46 a	34.53 a	39.33 b	34.66 b	24 May	26 May
Ethephon at 100 ppm	283.00 d	330.00 e	19.90 c	21.88 d	42.00 a	38.32 a	15 May	15 May

Means within each column followed by the same letter(s) are not significantly different at 5%

Similar results were reported by Sharma *et al.* (2001) by using Ethrel on Redheaven peaches and Meitei *et al.* (2013) by using Ethrel at 100 ppm and 150 ppm on peach cv. (Flordasun).

Fruit physical characteristics

Fruit weight and size

In this respect Table 3 showed that, hand fruit thinning treatment gave a high significant effect on fruit weight (99.67 and 93.67 gm) and size (98.69 and 90.12 cm³) in the 1st and 2nd seasons respectively, followed by NAA at 20 ppm (77.67 and 72.67 gm) for weight and (76.71 and 71.70 cm³) for size. On the other hand, the smallest fruit in weight and size were from control trees in both seasons under study (54.33 and 49.00 gm) for weight and (53.53 and 46.28 cm³) for size.

Increasing of fruit weight and size may be due to the decreasing of fruits number per tree resulted in increasing of leaf to fruit ratio which increased photosynthates and decreased nutritional competition between growing fruits. These results were supported by findings of Vitagliano *et al.* (1985) on peach cv. Glohaven. Khalil and Stino (1987) who observed that, application of hand thinning significantly increased fruit weight of Sunred cv. nectarines. Also, hand thinning significantly increased fruit weight and size, also, NAA at 20 and 40 mg l⁻¹ fruit weight was increased. Meitei, *et al.* (2013) stated that, chemical fruit thinning (Ethrel at 150 ppm) significantly increased the fruit weight compared to control in peach cv. Flordasun.

On the other side, Ethephon application reduced fruit weight, and the highest concentration was more effective in reducing fruit weight of 'Gerdi' apricot (Leila, *et al.* 2011).

Fruit length (cm) and diameter (cm)

Data in Table 3 showed that, all thinning treatments under study were effective in increasing fruits length and diameter significantly compared to control, thus, the longest and widest fruits were obtained from hand fruit thinning treatment in both seasons, (5.20 and 5.10 cm) and (5.77 and 5.27 cm), followed by application of NAA at 20 ppm (4.27 and 4.15) and 5.03 and 4.60 cm), then application of BA at 400 ppm and hand blossom thinning.

Fruit firmness

As for fruit firmness data in (Table 3) declared that, fruits firmness was significantly increased in control fruits in comparison to all treatments. Control fruit firmness was 12.67 and 12.61 Lb/inch² in both seasons respectively, followed by hand fruit thinning treatment and hand blossom thinning. The lowest fruit firmness was recorded from Ethephon treatment (9.83 and 9.76 Lb/inch²) in both seasons.

Reduction in fruit firmness by chemical thinning applications may due to the great accumulation of nitrogen in fruits causing softening of fruits and increasing enzymes of cell wall softening. These findings are in line with Trevisan, *et al.* (2000) who observed that fruit firmness decreased by NAA application. Also, Saini, *et al.* (2003) showed that fruit firmness was significantly reduced by chemical thinning application. In peach Ethrel application resulted in reduction in fruit firmness (Sharma *et al.*, 2003). Furthermore, Dhillon and Bhatt (2011) stated that, Ethylene makes an important role in releasing enzymes related with fruit ripening and that leads to fruits softening. Fruit firmness had indirect relation with fruit size, the biggest fruit size the lower fruit firmness and vice versa (Rimpika *et al.*, 2014).

TABLE 3. Effect of different thinning treatments on fruit physical characteristics of plum cv. "African Rose"

Treatments	Fruit weight (gm)		Fruit size (cm ³)		Fruit length (cm)		Fruit diameter (cm)		Fruit firmness (Lb/ inch ²)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Control	54.33d	49.00 f	53.53e	46.28d	3.63d	3.55d	3.67cd	3.33cd	12.67 a	12.61 a
6-Benzyladenine at 400 ppm	71.53c	67.33 c	70.71 bc	67.23bc	4.03c	3.99c	4.53bc	4.17bc	10.95 cd	10.89 cd
NAA at 20 ppm	77.67b	72.67b	76.71b	71.70b	4.27b	4.15b	5.03ab	4.60ab	10.33cd	10.56 cd
Hand blossom thinning	71.30c	67.28c	71.41c	70.46b	3.87cd	4.11bc	4.27bc	4.13bc	11.67 bc	11.29 bc
Hand fruit thinning	99.67a	93.67a	98.69a	90.12a	5.20a	5.10a	5.77a	5.27a	11.83 ab	11.33 ab
Ethephon at 100 ppm	70.33c	66.33e	64.20d	64.13c	3.91b	3.79bc	3.63cd	3.97cd	9.83 e	9.76 e

Means within each column followed by the same letter(s) are not significantly different at 5%

TSS%, Acidity and T/A ratio

According to Table 4 it was found that, the greatest TSS percentage was obtained from hand fruit thinning treatment (13.51, 14.33%) followed by NAA at 20 ppm (12.93, 13.83%) and 6-Benzyladenine at 400 ppm (12.42, 12.95%). On the other hand, the lowest TSS percentage was obtained from control trees in both seasons.

TSS was improved and that might be due to the decrease in crop load by different thinning treatments and increasing the leaf to fruit ratio, which caused more nutrients synthesis and more accumulation of sugars in the remaining fruits on the tree and that caused an improving in the total soluble solids (Meitei et al., 2013). These results are in line with Saini et al. (2003) and Gupta and Kaur (2004) by using Ethrel on plum. Also, 70% hand thinning and 20 ppm NAA gave the highest TSS percentage in 'Priana' apricot.

As regarding to titratable acidity Table 4 declared that, the highest acidity percentage was obtained from control trees (1.53, 1.55%) in both seasons respectively and the lowest acidity was gained from hand thinning treatment (0.91,

0.90%). Other treatments were in between. Reduction of acidity in treated trees might be due to the conversion of organic acids into sugars (Meitei et al., 2013). Hand fruit thinning not only caused the significant highest TSS as well as the significant least acidity percentage, but also induced the significant highest TSS/acidity ratio. However, TSS/acidity balance means good taste of fruits.

Total carbohydrates %, nitrogen %, C/N ratio:

Concerning total carbohydrates content and C/N ratio, Table 5 revealed that, the highest total carbohydrates % and C/N ratio was obtained from hand fruit thinning in both seasons respectively. On the other hand, the lowest total carbohydrates % and C/N ratio was obtained from control trees. About nitrogen %, the highest value was obtained from control trees and the lowest was obtained from hand fruit thinning in both seasons. The highest C/N ratio which induced by hand fruit thinning means the highest carbohydrates accumulation (sugars in the fruits) and the least nitrogen% (consumed in flavor compounds) resulted in good taste.

TABLE 4. Effect of different thinning treatments on fruit chemical characteristics of plum cv. "African Rose"

Treatments	TSS%		Acidity%		TSS/ Acidity	
	2018	2019	2018	2019	2018	2019
Control	9.83 d	10.03 d	1.53 a	1.55 a	6.42 d	6.47 d
6-Benzyladenine at 400 ppm	12.42 b	12.95 b	1.23ab	1.22 ab	10.09 bc	10.61 bc
NAA at 20 ppm	12.93 ab	13.83 ab	1.03 bc	1.05 bc	12.55 b	13.17 b
Hand blossom thinning	12.31 b	12.50 b	1.32 bc	1.38 bc	9.32 c	9.05 c
Hand fruit thinning	13.51 a	14.33 a	0.91 d	0.90 d	14.84 a	15.90 a
Ethephon at 100 ppm	12.33 b	12.43 b	1.42 ab	1.53 ab	8.68 c	8.12 c

Means within each column followed by the same letter(s) are not significantly different at 5%

TABLE 5. Effect of different thinning treatments on Carbohydrates, Nitrogen and C/N ratio of plum cv. "African Rose"

Treatments	Carbohydrates %		Nitrogen %		C/N ratio	
	2018	2019	2018	2019	2018	2019
Control	23.83d	23.99e	2.911a	3.00 a	8.186f	7.996c
6-Benzyladenine at 400 ppm	27.97b	28.12b	2.14c	2.64 c	13.07c	10.65b
NAA at 20 ppm	28.96ab	29.00a	1.75cd	2.00 cd	16.54b	14.50a
Hand blossom thinning	26.02c	26.82c	2.60bc	2.81 bc	10.00e	9.544bc
Hand fruit thinning	29.69a	29.77a	1.55 d	1.99 d	19.15a	14.95a
Ethephon at 100 ppm	25.14cd	25.99d	2.25ab	2.69 ab	11.17 b	9.66 bc

Means within each column followed by the same letter(s) are not significantly different at 5%

These results are in line with Singh (1996) who found that, NAA application by 200 ppm increased the percentage of carbohydrates, C/N ratio, mineral content and dry matter accumulation in leaves and shoots of mango Dashehari cultivar.

Feasibility study

Feasibility study was made to estimate the economic return for the treatments under study. Table 6 showed that hand fruit thinning treatment gave the highest net profit in both seasons 64580 and 73140 (LE/fed), followed by NAA at 20 ppm treatment 53975 and 59675 (LE/fed) and BA treatment (53950 and 60175 LE/fed). The lowest net profit was obtained from control trees in both seasons 47690 and 50210 LE.

Conclusion

Data concluded that, all thinning treatments increased fruit quality characteristics in plum fruits. Although all thinning treatments significantly reduced number of fruits per tree, but they significantly increased fruit yield and that may be as a result of increasing fruit weight and size. In particular, hand fruit thinning was found to be the most effective treatment in thinning fruits and that due to being able to select and remove any small or damaged fruits, although, hand thinning is more expensive and consuming more time than other methods of fruit thinning. So, we recommend plum growers to hand fruit thinning 2 weeks after fruit set to have early fruit harvesting about (10 days), increase fruit yield about (4-6 kg/tree) and improve fruit quality, subsequently higher fruit yield price, followed by NAA and BA treatment specially in large areas of orchards.

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Conflicts of interest

No conflicts of interest to declare

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TABLE 6. Feasibility study for treatment applied on plum cv. "African Rose"

Treatments	Yield/Feddan (Ton)		Yield return/ Feddan (LE)		Treatments cost/F (LE)		Net profit (LE)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	9.67	10.03	67690	70210	-	-	47690	50210
6-Benzyladenine at 400 ppm	9.86	10.69	73950	80175	1550	1550	53950	60175
NAA at 20 ppm	9.91	10.67	74325	80025	350	350	53975	59675
Hand blossom thinning	8.88	10.17	71040	81360	4000	4000	51040	61360
Hand fruit thinning	11.01	12.08	88080	96640	3500	3500	64580	73140
Ethephon at 100 ppm	6.96	7.65	55680	61200	450	450	35680	41200

Net profit= treatments cost –horticultural practice cost.

Horticultural practice cost= 20000 LE/Fed

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تحسين جودة ثمار و إنتاجية البرقوق صنف "أفريكان روز" باستخدام معاملات خف مختلفة

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اجريت الدراسة الحالية خلال الفترة ٢٠١٧-٢٠١٨ / ٢٠١٨-٢٠١٩ لدراسة أهمية خف الأزهار والثمار على جودة ثمار البرقوق. تم استخدام معاملات مختلفة لتحديد أفضل معاملة لخف اشجار البرقوق عمر ٥ سنوات صنف (أفريكان روز) مطعومة على اصل ماريانا. كانت المعاملات على النحو التالي: اشجار الكنترول (بدون خف)، خف يدوي للأزهار (إزالة ٣٠ ٪ من الأزهار عند تمام التزهير) ، خف يدوي للثمار (إزاله ٣٠ ٪ من الثمار بعد اسبوعين من العقد) ، رش إيثيفون بمعدل ١٠٠ جزء في المليون ، رش NAA (نفتالين حمض الخليك) ٢٠ جزء في المليون ورش BA (٦-بنزيل أدينين) بمعدل ٤٠٠ جزء في المليون (بعد اسبوعين من العقد). أشارت النتائج إلى أن جميع معاملات الخف أدت إلى زيادة تساقط الثمار وكانت أعلى نسبة تساقط للثمار من معاملة الإيثيفون عند ١٠٠ جزء في المليون في كلا الموسمين. كما أدت جميع المعاملات إلى انخفاض عدد الثمار لكل المعاملات مقارنة بالكنترول ولكن كان هناك زيادة في الإنتاجية (٤-٦ كجم / شجرة) نتيجة لزيادة وزن وحجم الثمار مما أدى إلى زيادة سعر المحصول. أدت معاملات الخف تحت الدراسة إلى زيادة الصفات الفيزيائية للثمار وتم الحصول على أعلى وزن للثمار من معاملة الخف اليدوي في كلا الموسمين. جميع معاملات الخف أدت الي التبيكير في تاريخ الحصاد. كما أوضحت البيانات أن أعلى نسبة من الكربوهيدرات ونسبة C / N في الاوراق كانت من معاملة الخف اليدوي للثمار مقارنة بمعاملات الخف الأخرى. لذلك ، يمكننا أن نوصي بهذه المعاملة للتبيكير في ميعاد الحصاد وإنتاجية عالية من الثمار وجودة عاليه وبالتالي ارتفاع سعر المحصول.