Journal of Horticultural Science & Ornamental Plants 13 (3): 346-356, 2021
ISSN 2079-2158

DOI: 10.5829/idosi.jhsop.2021.346.356

Effect of Hand and Chemical Thinning on Yield and Fruit Quality of "African Rose" Cv Plum under Palmate Training Pattern

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Abstract: This research was conducted during two successive seasons of 2020 and 2021 to study the effects of chemical and hand thinning on "African Rose" cv plum trees (6 years old) grown at 2 x 3 meters apart in Sandy soil under palmate training pattern in a private orchard located at Sadat city Menoufia governorate. Nine treatments were applied: Three treatments with Hockley Alpha (Naphthyl acetic acid 0.45% + Naphthyl acetamide 1.20 %) at 120 g / 200 L of water, three treatments with MAP (Mono ammonium phosphate) at 2% or 2000 g /100 L of water were sprayed three times the first at 50% flowering, the second time at 50% flowering first spray then after 15 days second spray and the third time at final fruit set. hand thinning two treatments the first is Hand thinning + Hockley Alpha at 4weeks after full bloom and the second is Hand thinning alone compared with control. Results showed that MAP treatments and hand thinning alone increased fruit abscission, decreased fruit number per tree, improved fruit weight, diameter and fruit yield (kg/tree) compared to control. Economical study cleared, the cost of hand thinning is twice the cost of spraying MAP and the highest total income / feddan LE with lowest cost for MAP compared with hand thinning.

Key words: Plum · African Rose · Hand thinning · Chemical thinning · Yield

INTRODUCTION

Plum (*Prunus salacina* Lind) is a deciduous fruit tree related to Rosaceae family, which produces stone fruits (Drupe). Total cultivated area of plum trees is 2980 feddan, with productivity 14460 ton according to Agriculture Statistics of Ministry of Agriculture and Land Reclaimed Areas [1]. The "African Rose" cv plum is one of the varieties which trees can be trained with normal or under palmate training pattern (Double horizontal pattern) to take advantage of the sunlight to early harvest time and improve the quality of the fruits and good coloring. It is also a variety of self-pollinating plum, abundant flowers, fruits it resulted in small fruits, low yields and decrees fruit quality. Heavy flowering and fruiting is major problem of African Rose plum cultivars. Flower thinning, fruitlet thinning can be achieved by manual or hand and chemical strategies whereas thinning allows sunlight and air to penetrate the branches, so improving evenness of ripening , there is a risk of branches breaking if trees over crop, thinning lessens the demand on the tree's resources so it is able to make good growth and develop fruit buds for the following year so avoiding the risk of Alternate bearing , young trees allowed to crop too heavily will be set back [2]. The main objective of thinning is to improve fruit size and quality when a tree is carrying a very heavy crop, the fruits are often small, poor quality and low price [3]. Previous research have shown that hand and chemical thinning play an important role, prevention of fruit set or stimulation of increased fruitlet abscission amendment in the yield and quality of the crops mainly depends on the concentration and time of application [4].

Thinning has a paramount importance in producing and used for many years may be necessary on a range of tree fruit including apples, pears, plums, peaches and nectarines where is the request for big fruit of uniform size and quality is increasing in the market with regular yield [5-9]. Thinning important to save on labour cost and make better economic return [9-11].

Flower thinning and fruitlet thinning can be done by manual or hand and chemical strategies.

Hand thinning 4-5 cm distance between fruits on the branches one month after full bloom increased average fruit weighing, fruit volume and early the harvest date in

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plum and apricot [4]. Hand thinning methods by keeping 8 fruits and remove the other fruits for every 25cm on the branches of the tree [5].

Fruit weight, volume, TSS and leaf to fruit ratio increased by hand remove smallest fruit due to prevent the energy draining of the tree by pits [12, 13]. On nectarine thinning fruit at 10, 20 and 30% at pea stage improved fruit physical and chemical properties [14]. Hand thinning at 60% procedure at the fruit set stage gave good fruit quality [15].

But hand thinning compared with other methods, very stressful for workers, requires ladder to thinning the upper branches in the plum trees under palmate training pattern and time consuming and more expensive [13]. So using chemical thinning that are less expensive and time consuming compared to hand thinning.

Chemical thinning: used to solve this problem and to stimulate fruitlet drop, several of the chemicals used for fruitlet and flower thinning, essential for obtaining a good quality crop [16]. Such as Naphthalenacetic acid (NAA), Naphthyl acetamide (NAD) and need evaluate the potential of Mono ammonium phosphate (Map) foliar fertilizers as blossom thinner.

Naphthalene acetic acid and Naphthyl acetamide commonly abbreviated as NAA and NAD are an ingredient in many commercial horticultural products [17]. NAA useful to flower thinning in plums and apricots after the time of full bloom, well before initial fruit set can be judged and when sprayed several weeks after fruitlet set in spring [4]. Application of NAA for thinning of blossoms at full bloom improved fruit quality and yields in Japanese plum [18]. Meland [19] applied with NAA in plum trees (after full bloom) had a better effect in increased fruitlet drop and given better final fruit quality. NAA spraying at 20 ppm on apricots at 4weeks after full bloom given biggest fruit weight [20]. Sally [21] reported that NAA can thin effectively between full bloom and 21 day after full bloom, the earlier it is applied, the better the response in fruit volume of European Pear. NAA can thin at the end of flowering as well as two weeks later in apple and pear [22]. Spray NAA at 60 ppm on nectarine after 3 weeks from petal fall improved fruit volume, weight, highest soluble solids of fruits, tallest shoot elongation and leaf area [14]. Spray NAA at 40 ppm when applied 4 weeks after full bloom improve the yield and increase the leaf to fruit ratio in nectarine [23].

NAA application on Apricot improved fruit size and quality [24]. NAA increased fruit size in apple and pear [22]. NAA at 20 and 40 mg L-1 and NAD at 40 and 80 mg L-1 increased fruit weight on apricot [13].

MAP is mono ammonium phosphate (Nitrogen + Phosphorous) at all concentrations induced fruitlet abscission and its effect was the same as NAA and NAD. Spraying langra mango trees with phosphorus sources (MAP) and urea at full bloom stage and one month latter gave the best foliage chemical composition , the highest fruit yield and the best fruit qualities [25]. Urea4% and 6%; Ammonium Thiosulphate 2% & 4) were applied as foliar spray at full bloom stage to decreased number of fruits and increased fruit quality on Japanese plum [18]. Tthinning applied 4 or 6 weeks after full bloom in citrus by urea or MAP improve fruit quality [26]. Urea (ammonium) can thin apple when applied during early bloom [22]. Thinning by urea 5% at full bloom led to thinning fruitlets and increase fruit size, the number of cells per fruit and larger fruit weight in pear trees. [27]. Urea significantly reduced fruit set in pistachio [28]. Apply urea at 0.2, 0.4 and 0.6% significantly increased fruit drop in apricot [13]. Treatments with 6% urea at first opening of flowers decreased fruit set led to increased fruit size [29]. Urea at 4 and 6% after fruit set were applied increased fruit drop and fruit color [30]. Nitrogen foliar fertilizers increased the fruit diameter by Methylene urea at 55% increase the fruit size [31].

However, blossom and fruit thinning is not being practiced commercially by the growers because of non-availability of sufficient literature and recommendations for the African Rose plum cultivar.

So the aim of this study is Effect of different treatments on thinning the flower and fruitlets by hand and chemical thinning with naphthalene acetic acid, Naphthyl acetamide (NAA + NAD) and (MAP) Mono Ammonium Phosphate to reduce competition between them for Nutrients to increase fruit quality and yield with lowest cost in the plum trees under palmate training pattern planted in the desert land.

MATERIALS AND METHODS

This study was applied during two successive seasons of 2020 and 2021 on “African Rose "cv plum trees under palmate training pattern (Double horizontal pattern) grown in private orchard located at Sadat, Menoufia governorate. Plum trees (5 years old in 2020 and 6 years old in 2021 season) planted at 2 x3 meters (700 trees / fadden) apart in sandy soil under drip irrigation system. Twenty seven uniform" African Rose" cv trees were selected for this investigation. The selected trees were healthy, similar in the vigor, as possible and received the same cultural practices.

The trees were subjected to the ordinary orchard management. Each treatment consisted of three replicates with one tree for each replicate and four arms selected one each replicate for measurements (Two arms right and two arms left) the perimeter of the tree under palmate training pattern.

The Following Nine Treatments Were Applied:

T1: Spraying with Hockley Alpha (NAA +NAD) at 50% flowering.
T2: Spraying with Hockley Alpha (NAA +NAD) twice at 50% flowering (first spray) and after 15 days (second spray).
T3: Spraying with Hockley Alpha (NAA +NAD) at final fruit set.
T4: Spraying with MAP (Mono ammonium phosphate) at 50% flowering.
T5: Spraying with MAP (Mono ammonium phosphate) twice at 50% flowering (first spray) and after fruit set (second spray).
T6: Spraying with MAP (Mono ammonium phosphate) at final fruit set.
T7: Hand thinning + Hockley Alpha. Spraying with Hockley Alpha (NAA +NAD) at 50% flowering (first spray) and after 15 days (second spray) after that hand thinning at 4 weeks after full bloom by keeping 8 fruits for every 25 centimeters on the branches of the tree.
T8: Hand thinning alone at 4 weeks after full bloom by keeping 8 fruits and remove the other fruits for every 25cm on the branches of the tree.
T9: Control (sprayed with water).

Hockley Alpha (Naphthyl acetic acid 0.45 % + (Naphthyl acetamide 1.20%) foliar spray at 120 g / 200 L of water. MAP is Mono ammonium phosphate $NH_4H_2PO_4$ (Nitrogen 12.1% +Phosphorous 61%) at 2 % (2000 g /100 L of water).

Measurements

Fruit Set (%): The percentage of fruit set at two weeks after full bloom in both seasons per 4 arms were labeled on tree was calculated by:

$$\text{Fruit set percent} \frac{\text{Number of fruit set}}{\text{Total number flowering}} \text{X100}$$

Fruit Retention (%): The percentage of fruit retention was calculated one week before harvesting per 4 arms were labeled on tree by the following equation:

$$\text{Fruit retention percent} \frac{\text{No of retained fruits}}{\text{No of fruit set}} \text{X100}$$

Fruit Yield: At the commercial picking at commercial time (27/5/2020) in the first season and (25/5/2021) in the second season fruit yield was calculated by multiplying number of fruits per tree x fruit weight.

Fruit Quality: Ten fruits from each tree were picked to measurement the physical and chemical properties of mature fruits that carried out when fruits of control attained maturity (full color development) according to stands recorded by Kader [32]. Physical and chemical characteristics were evaluated as following:

Fruit Physical Characteristics

Fruit Weight (g): Average of fruit weight was determined by weighting a sample of fruits from each replicate and the average fruit weight was calculated.

Fruit Size (cm^3): Was determined by using water displace meter method.

Fruit Length and Dimensions (cm): Fruit length and diameter in cm was measured by using a vernier caliper.

L/D Ratio: Was measured by dividing the fruit length on fruit diameter.

Fruit Firmness ($Lb/Inch^2$): Was determined from the two sides of fruits by using a pressure tester (Advance Force Gorge RH13, UK).

Fruit Chemical Characteristics

Total Soluble Solids (TSS %):

TSS (%): Was determined in fruit juice sample by using a hand refractometer (Portable Refractometer ATC).

Titratable Acidity (%): Was determined in terms of anhydrous malic acid as a percentage after titration by 0.1 N sodium hydroxide using phenolphthalein as an indicator A.O.A.C. [33].

Total Sugars: Was determined according to the method of Tasun *et al.* [34].

Anthocyanin: Was determined according to the method of Hsia *et al.* [35].

Vegetative Growth: Four current season's shoots were selected from each replicate for determining the following measurements".

Shoot Length (cm): Was measured on October 1st by using a ruler.

Shoot Thickness (cm): Was measured on October1st at the base of shoot by using a vernier caliper.

Number of Leaves/Shoot: Was measured on October 1st by counting the number of leaves per each shoot.

Leaf Area (cm^2): Was measured for the 5th and 6th leaves from the base by using a leaf area meter.

Leaf to Fruit Ratio (LFR): Was calculated by dividing leave number per shoot/fruit number per shoot.

Leaves Mineral and Carbohydrates Contents: Samples of leaves per each treatment were taken from the shoot mature leaves (the 5th and 6th leaves from the base) on July 15th, cleaned, oven dried at 70°C and the following contents were estimated in the dried samples:

Total Carbohydrates: Were determined according to the method of Dubois *et al.* [36].

Nitrogen Percentage: Was determined in the digested solution by the modified microkjeldahl method as described by Plummer [37].

C/N Ratio: Total carbohydrates / Total nitrogen

Phosphorus Content: Was determined colorimetrically according to the method of Jackson [38].

Potassium Content: Was determined against a standard using flame photometer Piper [39].

Feasibility Study:

Cost/fed (LE) = Cost of sprayed material for one tree x number of additions x number of trees / fed (700 tree).

Yield/fed (Ton) = Fruit yield kg/tree x No. of trees / fed (700 tree).

Income/fed (LE) total = Price of one kg plum in the farm x tree yield ton/fed

The price of one kg plum = (8.5 & 8 LE) the price of farm gate and before the offer in marketing in the first and second season respectively.

Net profit = Treatments cost – horticultural practices cost. Horticultural practices cost = 20000 LE/Fed.

Statistical Analysis: The experimental treatments were arranged in a randomized complete block design with three replicates and each replicate consisted of one tree. Obtained data were subjected to analysis of variance according to Snedecor and Cochran [40]. Means were compared using the Duncan multiple range test at 5% level [41].

RESULTS AND DISCUSSION

Fruit Set, Fruit Retention Percentage and Yield: Data in Table (1) showed that twice spray with MAP and Hand fruit thinning + Hockley Alpha (NAA+NAD) gave the lowest fruit set percentage in the first and second seasons respectively.

The lowest fruit retention percentage was recorded with Hockley Alpha (NAA+NAD) after fruit set in first season and Hand fruit thinning + Hockley Alpha (NAA+NAD) in second season compared to the control which gave the highest significantly fruit set and fruit retention in both seasons.

The highest significantly yield was detected by hand fruit thinning followed by MAP twice spray in the first season and MAP twice spray followed by hand fruit thinning in the second season compared to the control which produced the lowest yield in both seasons due to (Table 2) the lowest fruit weigh in control in both season compared to the biggest fruit from Hand fruit thinning and MAP twice sprays treatments.

Fruit Physical Characteristics: The results showed hand fruit thinning led to significant in fruit weight and fruit size in 2020 and 2021 seasons followed by MAP twice sprays compared to the control and which the lowest significant percentage of fruit weight and size (Table 2) and (Fig. 1).

Also, fruit length and fruit diameter were affected by these treatments. In compared with the control, hand fruit thinning alone, hand fruit thinning + Hockley Alpha (NAA+NAD) and MAP twice sprays in both seasons were the most effective in inducing statistically the highest fruit length and diameter (Table 2).

Data in Table (3) cleared that statistically the firmest fruits were dedicated to control in both seasons. On the contrary, significantly the least fruit firmness was attained by using hand fruit thinning + Hockley Alpha (NAA+NAD) and MAP twice sprays for both seasons respectively.

Table 1: Effect of treatments on fruit set, retention percentage and yield (Kg/tree) of "African Rose" plum in 2020 and 2021 seasons

	Fruit set %		Fruit retention %		Yield (Kg/tree)	
Treatment	2020	2021	2020	2021	2020	2021
Hockley Alpha at 50% flowering	44.48	21.63	37.18	35.46	23.67	47.20
Hockley Alpha spray twice*	45.29	26.31	37.22	40.52	19.36	34.72
Hockley Alpha after fruit set	40.27	18.13	29	34.84	23.52	42.98
MAP at 50% flowering	28.13	28.52	38.67	38.87	25.87	27.75
MAP spray twice**	25.05	20.87	58.87	43.27	26.09	61.48
MAP after fruit set	32.88	29.63	36.90	40.24	25.63	26.89
Hand fruit thinning + Hockley Alpha	32.07	15.87	39.43	33.62	19.87	26.80
Hand fruit thinning alone	26.46	28.63	51.67	39.39	31.84	54.55
Control	52.85	31.96	68	48	13.47	17.81
LSD at 0.05	1.11	1.93	1.54	0.71	0.74	0.72

*At 50% flowering first spray and after 15 days second spray.

**At 50% flowering first spray and after fruit set second spray.

Table 2: Effect of treatments on fruit weight, fruit size, fruit length, fruit diameter and fruit shape index (L/D ratio) of "African Rose" plum in 2020 and 2021 seasons

	Fruit Weight (g)		Fruit size (cm^3)		Fruit length (cm)		Fruit diameter (cm)		Fruit shape index (L/D ratio)	
Treatment	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Hockley Alpha at 50% flowering	46.41	46.33	47.14	47.33	4.08	4.22	4.13	4.38	0.99	0.96
Hockley Alpha spray twice*	47.50	34.20	45.71	34	4.08	3.94	4.23	3.85	0.95	1.02
Hockley Alpha after fruit set	44.13	44.4	42.50	46	4.06	4.12	3.95	4.35	1.03	0.95
MAP at 50% flowering	43.11	42.55	43.33	43	4.09	4.18	4.05	4.34	1.01	0.97
MAP spray twice**	47.88	73.40	48	74	4.15	5.12	4.65	5.17	1.02	1.00
MAP after fruit set	41	31.26	40	31.33	3.90	3.85	4.09	3.88	0.81	0.99
Hand fruit thinning + Hockley Alpha	42.50	68.72	41.50	69	4.45	5.00	4.80	5.07	1.02	0.88
Hand fruit thinning alone	62.05	73.45	64.28	74	4.10	5.05	4.59	5.13	0.97	0.98
Control	36.66	25.53	38.16	25.5	3.79	3.48	3.84	3.59	0.99	0.97
LSD at 0.05	1.37	1.67	1.09	1.89	0.33	0.28	0.29	0.29	0.11	0.0014

*At 50% flowering first spray and after 15 days second spray.

**At 50% flowering first spray and after fruit set second spray.

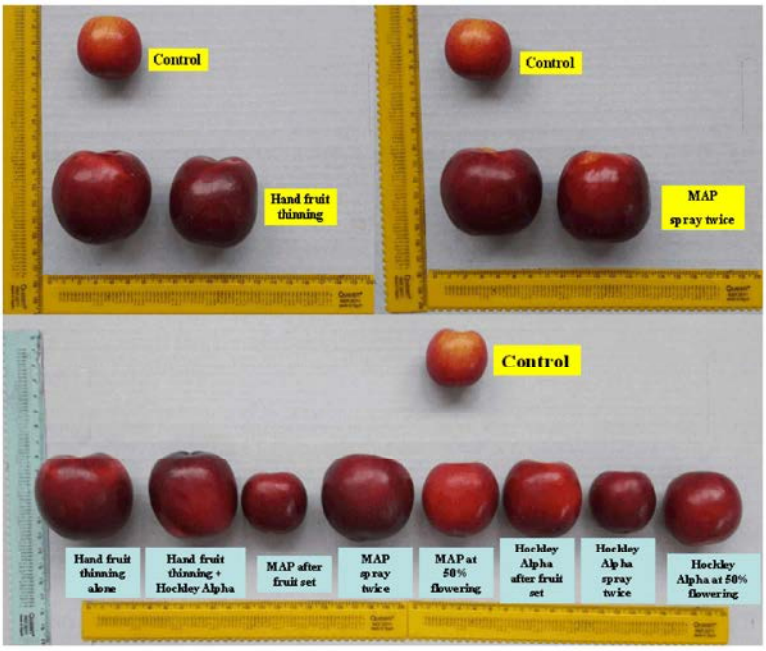

Fig. 1: Effect of conducted treatments on fruit of "African Rose" plum

Table 3: Effect of treatments on average fruit firmness, TSS and acidity of "African Rose" plum in 2020 and 2021 seasons

	Firmness (lb/inch^2)		TSS %		Acidity%	
Treatment	2020	2021	2020	2021	2020	2021
Hockley Alpha at 50% flowering	10.33	8.50	10	10.75	0.050	0.091
Hockley Alpha spray twice*	10.33	9.50	11.50	11.25	0.096	0.091
Hockley Alpha after fruit set	10.83	9.20	12	11.20	0.070	0.110
MAP at 50% flowering	10.67	8.65	11	11.25	0.026	0.091
MAP spray twice**	10.67	8.13	12.50	13	0.039	0.091
MAP after fruit set	10.67	9.22	12	12.50	0.036	0.100
Hand fruit thinning + Hockley Alpha	9.25	8.50	11.25	12.15	0.038	0.100
Hand fruit thinning alone	10.33	8.22	14	13.50	0.045	0.051
Control	11.16	9.60	11.5	11.20	0.114	0.110
LSD at 0.05	0.43	0.55	0.46	0.55	0.15	0.26

*At 50% flowering first spray and after 15 days second spray

**At 50% flowering first spray and after fruit set second spray

Table 4: Effect of treatments on fruit total sugars and fruit anthocyanin pigment of "African Rose" plum in 2020 and 2021 seasons

	Total sugars %		Anthocyanin (Mg/100gm)	
Treatment	2020	2021	2020	2021
Hockley Alpha at 50% flowering	6.72	7.15	0.752	0.851
Hockley Alpha spray twice*	8.11	8.23	0.689	0.762
Hockley Alpha after fruit set	6.90	7.51	0.797	0.938
MAP at 50% flowering	6.31	8.54	0.812	0.951
MAP spray twice**	8.84	10.31	1.103	1.130
MAP after fruit set	8	10.05	0.911	1.050
Hand fruit thinning + Hockley Alpha	7.84	9.30	0.854	0.980
Hand fruit thinning alone	9.95	10.97	0.951	1.080
Control	6.55	6.78	0.647	0.702
LSD at 0.05	0.69	0.58	0.038	0.029

*At 50% flowering first spray and after 15 days second spray

**At 50% flowering first spray and after fruit set second spray

Fruit Chemical Characteristics: Hand fruit thinning in both seasons induced significantly the highest TSS. Results attributed to MAP twice spray followed with significant differences compared with the control. Results in Table (3) showed that all treatments did alter the juice acidity in both of the considered seasons.

In general, the highest statistical fruit total sugars content was attributed to the hand fruit thinning followed by foliar spray with MAP twice in both seasons. In the different stages of spraying for Hockley Alpha (NAA+NAD) and MAP showed that Hockley Alpha (NAA+NAD) and MAP spray twice gave the highest content of fruit total sugars in both seasons (Table 4).

Statistically the highest fruit anthocyanin pigment was due to applying the MAP twice followed by hand fruit thinning compared to the control (0.647 & 0.702) in both seasons. In the different stages of spraying for Hockley Alpha (NAA+NAD) after fruit set and MAP twice sprays gave the highest content of fruit anthocyanin compared to the control which gave the lowest fruit anthocyanin pigment in both seasons (Table 4) and (Fig. 1).

Vegetative Growth: MAP twice sprays and hand fruit thinning were the most effective treatments in inducing statistically longest shoots, widest shoot diameter, the highest number of leaves per shoot, the highest leaf area and the highest Leaf to fruit ratio in both seasons. On contrary in both seasons, significantly the shortest shoot, narrowest shoot diameter, the least number of leaves, the least leaf area and the least leaf to fruit ratio were dedicated to control (Table 5).

Leaf Carbohydrates and Mineral Contents: With respect to leaf content of carbohydrates, it was at statistically the highest content with hand fruit tinning followed by foliar twice spray with MAP compared to the control in both seasons (Table 6).

Table 5: Effect of treatments on average shoot length, shoot diameter, number of leaves/shoot, leaf area and leaf to fruit ratio of "African Rose" plum in 2020 and 2021 seasons

	Shoot length (cm)		Shoot diameter (cm)		Number of leaves/shoot		Leaf area (cm^2)		Leaf to fruit ratio	
Treatment	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Hockley Alpha at 50% flowering	29.33	33.33	0.35	0.35	28	30	11.28	12.79	4.55	4.89
Hockley Alpha spray twice*	35	43	0.40	0.40	29	37	13.88	14.95	4.67	6.08
Hockley Alpha after fruit set	28.60	30.70	0.31	0.30	28	34	12.10	12.89	5.36	6.57
MAP at 50% flowering	46	54	0.40	0.41	44	50	14.61	16.06	7.64	8.67
MAP spray twice**	56	65	0.51	0.52	52	76	18.48	19.77	8.81	13.06
MAP after fruit set	35.60	47	0.41	0.40	35	41	15.19	16.83	6.51	7.85
Hand fruit thinning + Hockley Alpha	42.70	47.30	0.37	0.37	36	49	15.47	16.38	7.71	10.49
Hand fruit thinning alone	51.70	61	0.55	0.55	51	58	19.87	21.07	12.75	14.45
Control	22	26	0.30	0.30	18	26	11.39	12.21	3.33	3.96
LSD at 0.05	1.8	1.5	0.05	0.04	2.1	2.5	1.6	1.2	1.05	0.92

*At 50% flowering first spray and after 15 days second spray

**At 50% flowering first spray and after fruit set second spray

Table 6: Effect treatments on leaf carbohydrates, nitrogen, phosphorus and potassium contents of "African Rose" plum in 2020 and 2021 seasons

	C%		N%		C/N ratio		P%		K%	
Treatment	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Hockley Alpha at 50% flowering	17.58	23.25	1.81	2.12	9.71	10.97	0.191	0.222	1.52	1.78
Hockley Alpha spray twice*	20.95	27.70	1.51	1.77	13.87	15.65	0.245	0.287	1.57	1.84
Hockley Alpha after fruit set	19.35	25.59	1.71	1.99	11.38	12.86	0.197	0.231	1.65	1.93
MAP at 50% flowering	20.35	26.91	1.42	1.66	14.33	16.21	0.257	0.301	1.61	1.87
MAP spray twice**	23.39	30.92	1.33	1.55	17.58	19.95	0.331	0.387	1.72	2.01
MAP after fruit set	22.91	30.27	1.71	1.99	13.39	15.21	0.262	0.306	1.69	1.98
Hand fruit thinning + Hockley Alpha	21.02	27.79	1.47	1.72	14.31	16.16	0.245	0.287	1.67	1.95
Hand fruit thinning alone	24.78	32.76	1.42	1.66	17.45	19.74	0.285	0.333	1.81	2.11
Control	16.96	22.42	1.89	2.21	8.97	10.14	0.167	0.195	1.42	1.66
LSD at 0.05	0.49	0.62	0.28	0.23	0.91	0.51	0.022	0.027	0.17	0.2

*At 50% flowering first spray and after 15 days second spray.

**At 50% flowering first spray and after fruit set second spray

Table 7: Feasibility study for treatments applied on of "African Rose" plum in 2020 and 2021 seasons

	[1]Cost/fed (LE)		[2]Yield/fed (Ton)		[3]Income/fed LE total		[4]Net profit (LE)	
Treatment	2020	2021	2020	2021	2020	2021	2020	2021
Hockley Alpha at 50% flowering	344	344	16.569	33.04	140.836	264.32	120.836	244.32
Hockley Alpha spray twice*	688	688	13.552	24.304	115.192	194.432	95.192	174.432
Hockley Alpha after fruit set	344	344	16.464	30.086	139.944	240.688	119.944	220.688
MAP at 50% flowering	1.1	1.1	18.109	19.425	153.926	155.4	133.926	135.4
MAP spray twice*	2.2	2.2	23.73	43.036	201.705	344.288	181.705	324.288
MAP after fruit set	1.1	1.1	17.941	18.823	152.498	150.584	132.498	130.5884
Hand fruit thinning + Hockley Alpha	4.887	4.887	13.909	18.76	118.226	150.08	98.226	130.08
Hand fruit thinning alone	4200	4200	22.288	38.185	189.448	305.48	169.448	285.48
Control	water	water	9.429	12.467	80.146	99.736	60.146	79.736

*At 50% flowering first spray and after 15 days second spray.

**At 50% flowering first spray and after fruit set second spray

[1]Cost of sprayed material for one tree x number of additions x number of trees / fed (700 tree)

[2]Fruit yield kg/tree x No. of trees / fed (700 tree).

[3]Price of one kg plum in the farm x tree yield ton/fed. The price of one kg plum (8.5 & 8 LE) the price of farm gate and before the offer in marketing in the first and second season respectively.

[4] Net profit = Treatments cost – horticultural practices cost.

Horticultural practices cost = 20000 LE/Fed.

Foliar sprays twice MAP spray and hand fruit tinning in both seasons recorded the lowest leaf nitrogen content. Whereas, significantly the highest leaf nitrogen content was attributed to applying NAA+NAD once treatments at 50% flowering stage and control in both seasons.

Data in Table (6) clear that MAP spray twice and hand fruit tinning significantly induced the highest leaf C/N ratio content when compared with the control. However, the different stages of spraying for Hockley Alpha (NAA+NAD) and MAP showed that Hockley Alpha (NAA+NAD) twice spray and MAP twice sprays recorded the highest content of C/N ratio when compared with control in both season.

Compared with control and remaining treatments, it was found that applying MAP spray twice was the most effective treatment in inducing significantly the highest leaf phosphorus content followed by hand fruit tinning in both seasons. In the different stages of spraying for MAP showed that MAP twice sprays highest content of leaf phosphorus.

As for the leaf potassium content, it is evident from Table (6) that the hand fruit tinning followed by MAP spray induced statistically the highest leaf potassium content. Whereas significantly the lowest leaf potassium content were attributed to control in both seasons.

Feasibility Study for Treatments: In this study, the results showed that spraying the MAP twice gave the highest yield and fruits quality as hand fruit thinning alone. However, the economic feasibility study showed that the cost of hand fruit thinning is twice (4.200 LE) the cost of spraying twice for MAP (2.200 LE) in both seasons, which was given the highest Net profit in both seasons (181.705& 324.288L.E / fed) compared to the hand fruit thinning alone witch given Net profit in both seasons (169.448& 285.48 L.E / fed) while the control gave Net profit in both seasons.

Results of this study showed that Hockley Alpha (NAA+ NAD) and MAP treatments significantly enhanced the thinning at bloom stage and fruitlets in plums, which led to an increase in the fruit weighing, volume and the yield compared to the control and beneficent the fruit fineness characteristics of the fruits for the next reason.

Hockley Alpha (NAA+ NAD) and MAP have a similar effect to manual or hand thinning in low fruit set and a lack of competition for carbohydrates and nutrients among the fruits.

This results due to mode of action for NAA and NAD induced seed abortion; this presumably loss the ability of the fruits to rivalry for nutrients, lead up to fall of those with the less seeds, NAA disconnect oxidative phosphorylation, lead up to: loss in hormone content of the endosperm, reduced fruit growth, inhibition of embryo development and an increase in ethylene output, NAA implementation on apple fruitlets led to loss auxin diffuses in pedicels within 24 h and stayed low for more than 2 weeks, NAA reduced the transfer of carbohydrate from leaf to fruit in apple, NAA induced sinks in vegetative tissues that loss the quantity of metabolites reaching the fruit, NAA implementation encourages ethylene output in fruitlet and this increased concentricity could induce abscission [3].

These interpretations are in harmonious with the results of this research and previous research that showed implementation of NAA at 20 mg.l-1 (4 weeks AFB) was a good treatment for fruit thinning that increased fruit abscission led to increased fruit weight and volume in apricot [42]. Thinning at the time of flowering have a higher fineness than the fruits from un-thinned trees [43, 44]. NAA at 10 ppm on ‘Priana’ and ‘Beliana’ apricot significantly biggest fruit weighing [20]. NAA (20ppm) was better quality in terms of high TSS and sugar content with good blend of acidity on Japanese plum [16].

Fruits from thinned trees had magnitude soluble solids due to the minimize fruit to leaf area ratio and loss competition for assimilates among the fruits. The reduced number of fruits per tree resulted in proper supply of carbohydrates and nutrients to the remained fruitlets for proper growth and development and ripening in sweet cherry [45, 46].

MAP in the study, after applying a spray twice, had a better effect in increasing the weight of the fruits by thinning the flowers and fruitlet. This can be explained the effect of MAP on P, K, carbohydrate and C/N ratio foliage contents by stimulation of all biosynthesis and bio translocation processes, which reflect on fruit contents and quality.

MAP consist of P element which known as nucleic acids DNA, RNA and ATP synthesis and Mg absorption and content as an essential component [25, 47, 48]. N containing compounds (MAP) known to be increased levels of arginine, the essential amino acid is crucial for their growth, development [49].

The results of this study are in harmonious with previous reports that MAP increased significantly all mango fruits physical characteristics (fruit length, fruit diameter and fruit volume, TSS) over the control of the significant lowest values [25]. Urea with different concentrations of urea at full bloom and the early fruitlet

stage led to fruit set drop by burning flowers and reduced competition for nutrients for the remaining fruits, which led to fruitlet weight increased, the number of cells per fruit and final fruit weight of pear trees, pistachio, apricot and Japanese Plum [27, 50, 42, 16].

Hand thinning significantly increased fruit weighing, size highest leaf fruit ratio and leaf carbohydrate content, fruitlet thinning prohibit the energy draining of the tree by pits. The reduction of the fruit set favored the improved of carbohydrate in leaves and soluble sugars in leaves and fruits [51]. Fruitlet thinning at 50% in citrus gave significantly higher carbohydrate because reduced competition for nutrients content for the remaining fruits compared with control [52].

Final fruit size depends to a great extent on the total number of fruits per peach tree [4, 53]. Early reduction of competition among developing fruits is of importance for increasing final fruit volume at maturity. Also, Hand thinning significantly highest fruit weight, volume and TSS increase significantly with increased thinning density of apricot, There is a direct relationship between manual thinning and the quality of apricot fruits in weight, volume and soluble solids [15, 20, 42, 54]. The loss initial fruit loading had a favorable significantly effect on the shoot length. While, control trees were bad qualities because the leaf to fruit ratio was not enough to fruit feeding [51].

From the previous study it is clear that the hand thinning for the fruits and the chemical thinning by burning the flowers using the MAP treatment spray twice led to a decrease in the percentage of fruit set, increase in the percentage of the number of leaves for each fruit, increase in the leaf content from the ratio of C/N ratio, potassium and phosphorous due to the lack of competition for nutrients because decrease the number of fruits per tree and consequently increasing fruit weight, fruit quality and quantity of the final crop compared to the control. witch the high percentage of fruit set, percentage of the remaining fruits, number of fruits on the trees due to characteristics of the" African Rose" plum variety led to an increase in competition for nutrients, which led to a small fruit weight, decrease in its quality and final yield in both seasons. Whereas the average fruit number in the control = 40 fruits /Kg , while hand thinning and chemical thinning by using the MAP led to the average fruit number = 13 fruits /Kg because the fruit weight in the thinning is triple fruit weight in the control in second season.

Feasibility study for treatments: Increasing the age of trees from 5 to 6 years and increasing the density of trees to 700 trees per Fadden (planted at 2 x3), application of the different thinning treatments (hand and chemical) led to increased yield and net profit of trees in the second season compared to the first season and the control, especially when using the hand thinning and the MAP spray twice, due to the reduction number of fruit per tree and reduction of competition nutrients content compared with control. This led to depletion of the nutritional content stored in the trees for the second season, which led to an increase in vegetative growth, arms, bud flowering and tree strength.

Hand thinning more expensive, twice cost than MAP chemical thinning, very stressful for workers, requires ladder to thinning the upper arms in the plum trees under palmate training pattern and time consuming.

CONCLUSION

Data concluded that, application chemicals thinning by MAP spray twice at 50% flowering and final fruit set led to flowering and fruitlet thinning, a good and cost effective approach toward reducing hand thinning expenses and achieving higher yield with good fruit quality and higher net profit per fed.

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