

Effect of Manual Thinning and Mepiquat Chloride on Enhancing Fruiting of Two Olive Cultivars in the off Year

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Abstract: The effects of manual thinning by removing 25 and 50% of the fruit set and foliar application of Pix (Mepiquat chloride MC: N, N-dimethylpiperidinium chloride) at 500, 1000, 1500 and 2000 ppm (during the 'on' season) were assessed as tools to enhance fruiting of Picual and Manzanillo olive cultivars in the off season. Data clarified that manual thinning by removing 50% of the fruit set was the most effective treatment in increasing flowering density, sex ratio setting and yield. The attained effect was assumed to be due to reducing the number of fruits in the 'on' year which lead to increasing stored nutrients and assimilates in the 'on' year and or due to decreasing the inhibitory effect of seeds on floral bud induction and differentiation leading to better flowering and fruiting in the 'off' year.

Key words: Olive • Biennial bearing • Manual thinning • Mepiquat chloride flowering • Fruiting

INTRODUCTION

Olives are one of the most important fruit crops grown worldwide basically due to their nutritional and economic importance. Its cultivation is dedicated to arid regions. In Egypt olive cultivation expanded rapidly to each 50000 Ha [1]. Olive cultivation is met with some constrains of the most important is irregularity in bearing. Several techniques were used to diminish or overcome the biennial bearing in olives. Thinning is one of these techniques used. [2-5]. Effect of thinning was dedicated to that, the thinning reduces the crop load leading to the availability of more nutrients and assimilates that would increase the flower bud induction and differentiation [6, 7]. Also, reducing 'on' year crop leads to lowering number of seeds which have negative impacts on flower bud differentiation [8-10]. This was due to synthesis of gibberellins by the seeds [4, 8, 11]. Another used technique was the usage of growth retardants. Several growth retardants were applied they were gibberellins inhibitors of the triazole group [4, 12-15]. Their physiological effect was decreasing the bio synthesis of gibberellins which are known to inhibit the floral bud induction and differentiation [6, 7, 16]. As the majority of these regulators are now rejected. Focus should be concentrated on newly introduced ones as Pix (Mepiquat chloride MC: N, N-dimethylpiperidinium chloride) which

is classified as a growth retardant. It was found to retard growth of Kyoho grapes and to enhance the fruit quality [17]. The scope of this investigation is to detect the effect of both manual thinning and foliar application of Mepiquat chloride on enhancing flowering, fruiting and fruit quality of Picual and Manzanillo olive cultivars in the off year.

MATERIALS AND METHODS

The present investigation was carried out in a private orchard located in Northern Sinai for two successive seasons i.e. 2006/2007 and 2007/2008. On 15 years old of Manzanillo and Picual olive trees grown in sandy soil at 7X6m spacing and were subjected to normal cultural practices recommended by the ministry of agriculture. Twenty one olive trees were considered from each cultivar for each season of the investigation. The selected trees were uniform in size, in their 'on' year of bearing and bore almost the same crop. Trees of each cultivar in each season were subjected to one of the following treatments: Manual thinning: by removal of 25 and 50% of the fruit set after fruit set and prior to pit hardening i.e. the first week of June 2006 and 2007. This treatment was given the symbols thinning 25and 50%. Spraying Pix: at 500, 1000, 1500 and 2000 ppm (Mepiquat chloride MC: N, N-dimethylpiperidinium chloride) on the first week of June in

2006 and 2007 seasons. This treatment was given the symbols Pix 500, Pix 1000, Pix 1500 and Pix 2000 while the control trees (untreated) were sprayed with water only. The randomized complete blocks design was used and each treatment was replicated three times with one tree for each replicate. The following season i.e. the expected "off" year season, 32 one year old shoots (15-25 cm long) were selected at the four directions and tagged. The basic flowering and fruiting parameters were measured on these twigs.

Flowering Parameters: At the full bloom stage (80% open flower stage) the following parameters were measured on tagged twigs: flowering density (number of inflorescence/meter), length of inflorescence (cm.), number of axis/inflorescence, number of flowers/inflorescence and sex ratio (number of perfect flowers: total number of flowers).

Fruiting Parameters: initial fruit set percentage (three weeks after full bloom) (number of fruit set /total number of flowers X 100), Percentage of retained fruits at harvest (number of retained fruits at harvest/total number of flowers) and the percentage of shot berries (number of shot berries /total number of flowers X 100).

Yield and its Parameters: At green maturity according to Lavee [18], fruits were harvested and weighed for determining Yield / tree (Kg). Representing samples of 100 fruits/ tree were randomly chosen for determining the following fruit characteristics: average fruit length (cm), diameter (cm) and weight (g) of 100 fruits were measured at harvest for each considered tree.

Statistical Analysis: Data with three replications for each parameter were tabulated and statistically analyzed according to Snedecor and Cochran [19]. The treatment means were compared by least significant differences (L.S.D.) test at 5% level of probability.

RESULTS AND DISCUSSION

Flowering Characteristics: Data in Tables 1 and 2 presents the effect of conducted treatments in the "on" year on the basic flowering characteristics in the expected of both Manzanillo and Picual olive trees respectively.

Flowering density in the expected "off" year was significantly enhanced by all of the conducted treatments for both seasons and cultivars. Compared with the control and remaining treatments, the thinning 50% treatment

resulted in significantly the highest flowering density amounting to (41.19 and 30.03 inflorescence/m) and (21.3 and 38.03 inflorescence/m) for both Manzanillo and Picual cultivars in both seasons respectively. All of the Pix treatments had lower effects than the hand thinning treatment. Yet, it's worth mentioning that the effect of the Pix 1500 was statistically equal to the thinning 25% in the second season only for both cultivars.

Inflorescence length was enhanced in the expected "off" year by all of the conducted treatments. Differences were insignificant from control in the case of both the Pix 500 and 1000 treatments in Manzanillo cv in both seasons and the Pix 2000 treatment in the second season only. As for the Picual cultivar differences between the Pix 1000 and 1500 treatments in the first season and Pix 1000 and 2000 in the second season and control were insignificant. Significantly the longest inflorescences were due to the thinning 50% treatment for both cultivars and both seasons. Pix 1500 led to significantly highest results compared with all Pix treatments. These results were significantly lower than all the manual thinning treatments in the first season whereas, it was statistically equal to the thinning 25% in the second season only for both cultivars.

Number of axis/inflorescence was significantly increased by both thinning treatments and the Pix 1500 treatment in Manzanillo cultivar For both seasons compared with control. As for the Picual cv, compared with control significant increments were dedicated to only 50 % thinning in the first season and to both thinning treatments in addition to the 1500 and 2000 Pix treatment in the second season. Highest significant number of axis/inflorescence was attributed to the thinning 50% treatment for both cultivars and seasons.

Number of flowers/inflorescence was significantly increased by the both thinning treatments compared with the control for both cultivars and seasons. Both treatments were statistically equal in the first season. Whereas the thinning 50% was significantly higher than the thinning 25% in the second season. The effect of the Pix treatments varied for both cultivars and seasons. With Manzanillo cultivar the effect of Pix 500 and 1000 treatments were statistically equal to control in the first season. Whereas, the effect of Pix 500 was also equal to control in the second season. Remaining treatments had statistically increasing effects compared with control. As for the Picual cv, the effect of all Pix treatments were insignificant from control in the first season. In the second season however, both Pix 500 and 1000 were statistically equal to control. Remaining treatments resulted in significant increments compared with control.

Table 1: Effect of hand thinning and pix spray on flowering parameters of Manzanillo olive cultivar in 2007 and 2008 seasons

| Treatments | Flowering density | | Inflorescence length (cm) | | No. axis/ inflorescence | | No. flowers/ inflorescence | | Sex ratio | |
|------------|-------------------|-------------|---------------------------|-------------|-------------------------|-------------|----------------------------|-------------|-------------|-------------|
| | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season |
| Control | 30.36 | 23.75 | 3.17 | 4.06 | 8.80 | 10.33 | 11.56 | 14.06 | 69.67 | 87.13 |
| Thin 25 % | 37.95 | 26.72 | 3.82 | 4.28 | 9.52 | 10.73 | 14.69 | 15.29 | 73.04 | 91.60 |
| Thin 50 % | 41.19 | 30.03 | 4.00 | 4.63 | 9.73 | 11.06 | 15.56 | 16.42 | 75.95 | 93.81 |
| Pix 500 | 32.89 | 24.70 | 3.28 | 4.13 | 8.64 | 10.36 | 12.25 | 14.29 | 71.34 | 88.30 |
| Pix 1000 | 34.89 | 25.55 | 3.25 | 4.19 | 8.70 | 10.58 | 12.31 | 14.97 | 71.55 | 89.63 |
| Pix 1500 | 36.96 | 26.24 | 3.47 | 4.26 | 9.24 | 10.65 | 13.91 | 15.27 | 72.48 | 90.92 |
| Pix 2000 | 36.28 | 25.97 | 3.34 | 4.23 | 9.05 | 10.54 | 13.55 | 15.14 | 71.23 | 90.06 |
| LSD at 5% | 0.40 | 0.50 | 0.16 | 0.18 | 0.33 | 0.28 | 0.92 | 0.57 | 0.68 | 0.56 |

Table 2: Effect of hand thinning and pix spray on flowering parameters of Picual olive cultivar in 2007 and 2008 seasons

| Treatments | Flowering density | | Inflorescence length (cm) | | No. axis/ inflorescence | | No. flowers/ inflorescence | | Sex ratio | |
|------------|-------------------|-------------|---------------------------|-------------|-------------------------|-------------|----------------------------|-------------|-------------|-------------|
| | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season |
| Control | 14.95 | 31.57 | 2.50 | 3.29 | 7.26 | 9.85 | 8.76 | 15.35 | 79.78 | 72.81 |
| Thin 25 % | 18.06 | 35.34 | 2.64 | 3.51 | 7.48 | 10.22 | 9.60 | 16.39 | 85.54 | 81.39 |
| Thin 50 % | 21.30 | 38.03 | 2.70 | 3.62 | 7.68 | 10.44 | 10.04 | 17.16 | 89.39 | 86.27 |
| Pix 500 | 15.46 | 32.20 | 2.57 | 3.38 | 7.34 | 9.94 | 8.96 | 15.46 | 82.63 | 77.77 |
| Pix 1000 | 16.28 | 33.75 | 2.55 | 3.39 | 7.38 | 9.99 | 9.09 | 15.69 | 83.75 | 78.91 |
| Pix 1500 | 17.54 | 34.86 | 2.54 | 3.50 | 7.43 | 10.18 | 9.23 | 16.31 | 84.92 | 80.46 |
| Pix 2000 | 16.84 | 34.00 | 2.42 | 3.42 | 7.39 | 10.12 | 9.00 | 16.07 | 84.54 | 79.91 |
| LSD at 5% | 0.29 | 0.51 | 0.16 | 0.13 | 0.29 | 0.23 | 0.57 | 0.70 | 0.56 | 0.61 |

Table 3: Effect of hand thinning and pix spray on fruiting parameters of Manzanillo olive trees in 2007 and 2008 seasons

| Treatments | Initial fruit set% | | Percentage of retained fruits | | Shot berry % | |
|------------|--------------------|-------------|-------------------------------|-------------|--------------|-------------|
| | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season |
| Control | 9.94 | 11.08 | 5.53 | 5.80 | 0.00 | 7.53 |
| Thin 25 % | 11.55 | 12.41 | 6.61 | 8.27 | 0.00 | 6.97 |
| Thin 50 % | 12.78 | 13.61 | 7.25 | 9.28 | 0.00 | 3.49 |
| Pix 500 | 10.60 | 11.20 | 6.11 | 6.58 | 0.00 | 4.66 |
| Pix 1000 | 10.80 | 12.26 | 6.18 | 6.95 | 0.00 | 3.07 |
| Pix 1500 | 11.27 | 12.37 | 6.29 | 7.32 | 0.00 | 3.58 |
| Pix 2000 | 11.16 | 12.28 | 6.10 | 7.14 | 0.00 | 2.57 |
| LSD at 5% | 0.97 | 0.46 | 0.33 | 0.39 | 0.00 | 0.69 |

Table 4: Effect of hand thinning and pix spray on fruiting parameters of Picual olive trees in 2007 and 2008 seasons

| Treatments | Initial fruit set% | | Percentage of retained fruits | | Shot berry % | |
|------------|--------------------|-------------|-------------------------------|-------------|--------------|-------------|
| | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season |
| Control | 18.80 | 10.31 | 9.23 | 6.07 | 48.83 | 23.55 |
| Thin 25 % | 21.50 | 15.46 | 11.40 | 7.37 | 29.84 | 15.84 |
| Thin 50 % | 24.22 | 18.56 | 12.59 | 7.87 | 19.94 | 6.46 |
| Pix 500 | 19.84 | 11.94 | 9.66 | 6.77 | 21.11 | 13.67 |
| Pix 1000 | 20.82 | 13.78 | 10.71 | 7.01 | 34.43 | 11.70 |
| Pix 1500 | 21.41 | 14.40 | 11.21 | 7.21 | 28.08 | 10.83 |
| Pix 2000 | 21.24 | 14.14 | 10.78 | 7.05 | 14.09 | 8.55 |
| LSD at 5% | 0.29 | 0.59 | 0.30 | 0.39 | 0.36 | 0.75 |

Table 5: Effect of hand thinning and pix spray on Yield and its parameters in Manzanillo olive cultivar in 2007 and 2008 seasons

| Treatments | Fruit length (cm) | | Fruit diameter (cm) | | Weight of 100 fruits (g) | | Yield /Tree (kg) | |
|--------------|-------------------|-------------|---------------------|-------------|--------------------------|-------------|------------------|-------------|
| | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season |
| Control | 2.21 | 2.13 | 1.69 | 1.65 | 410.49 | 388.34 | 31.67 | 36.67 |
| Thin 25 % | 2.14 | 2.08 | 1.64 | 1.61 | 387.89 | 351.45 | 52.67 | 73.00 |
| Thin 50 % | 2.10 | 2.02 | 1.60 | 1.56 | 374.01 | 322.55 | 60.33 | 82.33 |
| Pix 500 | 2.19 | 2.13 | 1.68 | 1.65 | 391.51 | 354.34 | 46.33 | 63.33 |
| Pix 1000 | 2.11 | 2.05 | 1.61 | 1.58 | 377.63 | 314.95 | 48.33 | 65.33 |
| Pix 1500 | 2.11 | 2.05 | 1.61 | 1.58 | 372.82 | 320.81 | 51.33 | 67.33 |
| Pix 2000 | 2.09 | 2.03 | 1.59 | 1.57 | 362.90 | 288.82 | 46.33 | 64.67 |
| LSD at 5% 5% | 0.018 | 0.056 | 0.025 | 0.068 | 8.92 | 21.96 | 6.19 | 5.34 |

Table 6: Effect of hand thinning and pix spray on Yield and its parameters in Picual olive cultivar in 2007 and 2008 seasons

| Treatments | Fruit length (cm) | | Fruit diameter (cm) | | Weight of 100 fruits (g) | | Yield /Tree (kg) | |
|------------|-------------------|-------------|---------------------|-------------|--------------------------|-------------|------------------|-------------|
| | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season | 2007 Season | 2008 Season |
| Control | 2.89 | 2.74 | 2.01 | 1.96 | 591.55 | 551.89 | 22.67 | 42.33 |
| Thin 25 % | 2.86 | 2.70 | 1.99 | 1.93 | 569.01 | 534.92 | 43.67 | 127.33 |
| Thin 50 % | 2.82 | 2.64 | 1.96 | 1.89 | 538.73 | 477.27 | 53.33 | 137.67 |
| Pix 500 | 2.88 | 2.74 | 2.00 | 1.96 | 577.13 | 549.17 | 34.67 | 91.67 |
| Pix 1000 | 2.64 | 2.46 | 1.84 | 1.76 | 456.21 | 370.35 | 37.33 | 105.00 |
| Pix 1500 | 2.61 | 2.43 | 1.81 | 1.73 | 433.08 | 345.77 | 42.00 | 113.33 |
| Pix 2000 | 2.57 | 2.32 | 1.79 | 1.66 | 407.95 | 327.58 | 38.33 | 93.33 |
| LSD at 5% | 0.039 | 0.079 | 0.031 | 0.056 | 15.57 | 31.12 | 2.63 | 4.58 |

All of the conducted treatments increased evidently the sex ratio for both cultivars and seasons. Highest ratios were dedicated for the thinning 50% treatment for both considered cultivars and seasons.

Fruiting Parameters: Data in Tables 3 and 4 clarify the effect of performed treatments in the "on" seasons on setting parameters of Manzanillo and Picual cv in the expected "off" seasons.

Initial fruit set percentage was increased by the conducted treatments compared with control. The attained increments were insignificantly different from control in the case of Manzanillo cultivar treated with Pix 500 treatment in both seasons and Pix 1000 treatment in the first season only. Other treatments resulted in setting percentages that were significantly higher than control. The thinning 50% resulted in significantly the highest fruit set percentage for both considered cultivars. It is worth that the effect of the Pix 1500 treatment was statistically equal to that of thinning 25% treatment for both cultivars. This was untrue for Picual cultivar in the second season for the attained differences were insignificant.

Percentage of retained fruits was statistically increased by all of the conducted treatments in both seasons and for both considered cultivars. The supreme effect was dedicated to the thinning 50% treatment

compared with other treatments and control amounting to (7.25 and 9.28%) for Manzanillo cultivar and (12.59 and 7.87%) for Picual cultivar in both seasons respectively. The effect of thinning 25% ranked second with respect to all treatments. This effect was insignificantly different from that of Pix 1500 in the first season only for both considered cultivars and for that on Picual cultivar in the second season.

No shot berries were born on tagged twigs born on Manzanillo fruits in the first season in the case of treated and control untreated trees. In the second season however, this percentage was lowered by all of the conducted treatments compared with control. The effect of thinning 25% was insignificantly different from control. Other treatments resulted in significant effects. Highest significant effect was dedicated to Pix 1000 and 2000 treatments with insignificant differences between them. As for Picual cultivar, the percentage of shot berries was significantly lowered by all of the conducted treatments. Highest significant effect was due to the Pix 2000 treatment in both seasons.

Yield and its Parameters: Data in Tables 5 and 6 demonstrates the effect of conducted treatments in the "on" season on the yield and its parameters i.e. fruit weight, length and diameter in the expected "on" year.

Fruit length was significantly decreased by all of the conducted treatments except for the Pix 500 treatment for both cultivars and the thinning 25% for Manzanillo cultivar in the second season and for Picual cultivar in both seasons. The effects of these treatments were statistically equal to control. Highest significant decreasing effect in Manzanillo cultivar was to thinning 50% and Pix 2000 treatments in the first season and to thinning 25% and all Pix treatments except 500 in the second one. As for the Picual cultivar shortest fruits were born on Pix 2000 treated trees.

With respect to fruit diameter, treatment's effects concerning significance in reducing this parameter were in parallel to that on length.

Control fruits were significantly the heaviest compared with treated ones. Insignificant differences were dedicated to the Pix500 and thinning 25% treatments with respect to the Picual cultivar only. The Pix 2000 treatment resulted in significantly the lightest fruitiest. Comparable results were attributed to the Pix 1500 treatment in the case of Picual trees in the second season.

Control untreated trees bore significantly the least yield compared with treated trees of both cultivars. Whereas, thinning 50% trees bore significantly the highest yields amounting to 60.33 and 82.33 Kg/tree for Manzanillo cultivar and 53.33 and 137.67 Kg/tree for Picual cultivar in both seasons respectively.

As a general trend the thinning 50% treatment resulted in highest flowering parameters and setting parameters this was reflected on achieving highest yield but in a way with lower in fruit quality parameter.

Previous findings by Hartmann [2], Martin *et al.*, [3], Fernandez-Escobar *et al.*, [4] and, as shown presently by Dag *et al.*, [5] on 'Barnea' and 'Picual' indicated similar effects due to thinning. They illustrated that the attained effects is attributed to that currently developing seeds were shown to have a negative effect on flower bud differentiation [8,9]. Reduction in fruit number on the trees reduces the number of seeds which minimizes their inhibitory effect on the fruiting in the following season.

Pix 1500 treatments had effects on the aforementioned parameters that were quite similar to thinning 25%. Other Pix treatments resulted in considerable effects. Similar results were in parallel concerning the effect of growth retards on enhancing flowering and fruiting of olives [4, 12-15]. It was postulated that the physiological effect of these compounds was attributed to their inhibiting the GA synthesis which affects availability and distribution of assimilates that influence flowering [20].

In conclusion, the used treatments in "on" year enhanced the flowering and thus the fruiting of the considered cultivars in the expected off year. Highest efficiency was attributed to thinning 50% this could be attributed in our opinion to that the reduction of crop load in the on year would increase the available assimilates and absorbed nutrients and this would result in more flowering and thereby more fruiting in the expected "off" year as previously mentioned by Lavee [7]. In addition, reducing the crop in the on year would thereby reduce the number of seeds manufacturing GA or GA like substances which are known to reduce the floral induction [4,9,13] or after their translocation to the leaves cause them to synthesis floral induction inhibitors possibly caumarin [6] or affects assimilation availability or distribution [2].

In addition the relative effects of treatments on fruiting which is reflected on the fruit size could be of great importance to growers.

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