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MORPHOLOGICAL AND PHYSILOGICAL STUDIES ON FLOWERING, POLLINATION AND FRUITING OF "PICUAL" OLIVE TREES

I- EFFECT OF SOME GROWTH REGULATORS AND BORIC ACID ON FLOWERING AND FUITING OF PICUAL TREES

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ABSTRACT

Response of flowering and fruiting of Picual olive trees to paclobutrazol (PP333), uniconazole (UC), sitofex (CPPU) and boric acid (H_3BO_3) were tested during 1996/97 and 1997/98 seasons. PP333 and UC (250, 500 ppm) sprayed at pre bloom; CPPU (20 ppm) or H_3BO_3 (250, 500 ppm) at pre bloom or post bloom. PP333, UC and H_3BO_3 were effective to induce earlier emergence of inflorescences, increase the number of inflorescences and showed influence on sex expression percentages. H_3BO_3 was the most effective treatment to increase pollen germination and fruit set percentage. On the other hand, CPPU sprayed two weeks after full bloom yielded the largest and heaviest fruits and the highest flesh/fruit percentage. However, H_3BO_3 and CPPU treatments after FB resulted in higher fruit oil content.

Keywords: Olive- Picual- pollination- flower- growth regulators- pollen grains- fruiting

INTRODUCTION

Olive tree (*Olea europea* L.) is native to the Mediterranean region and plays an important role in the economy of many countries. The acreage of olive cvs. in Egypt was estimated as 103000 Feddans in 2000. Picual cv. - which was introduced from Spain to Egypt- is considered one of the best and the most widely planted cultivars. Some problems face and affect olive trees productivity, one of them is the failure of trees to set satisfactory yield due to insufficient number of perfect flowers and low fruit set percentage as well as the development of undersized, misshapen fruits called shotberries due to the absence of suitable pollination (Grigggs *et al*., 1975 and Hartmann *et al*., 1980).

Flowering and fruiting of olive trees differ greatly according to cultivars and environmental conditions (Fouad *et al*., 1992 and Hassan, 1996), and it could be markedly stimulated by some treatments i.e., paclobutrazol (Antognozzi and Preziosi, 1986; Laz, 1993 and Porlings and Voyiatzis, 1999); sitofex (Antognozzi and Proietti, 1995) and boric acid (Viti *et al*., 1990; Bartolini *et al*., 1993 and Atia, 1995).

The present study aimed to improve the low productivity of Picual olive trees by spraying the trees with PP333, UC, CPPU and H_3BO_3 either at pre or post bloom. Also the effects of these chemicals on improving fruit quality were examined.

MATERIALS AND METHODS

The present investigation was carried out during two successive seasons 1996/1997 and 1997/1998 on Picual olive trees of 8-10 years grown in a private orchard in Giza Governorate. The trees were planted six meters apart mixed with another olive cultivars.

Chemical treatments were applied through spraying the trees with some growth regulators and boric acid either pre or post bloom as follows:

1- Control treatment (untreated)

2- Paclobutrazol (PP333) as foliar application at 250 or 500 ppm at the second half of December of both seasons before the occurrence of floral induction (Desouky, 1970).

3- Uniconazole (UC) as foliar application at 250 or 500 ppm at the second half of December of both seasons.

4- Sitofex (CPPU) as foliar spray at 20 ppm at the second half of December of both seasons or post bloom sprays (two weeks after full bloom).

5- Boric acid (H_3BO_3) as foliar application at 250 or 500 sprayed three times; the first one at the second half of December 1996 and 1997 seasons, the second one after inflorescence emergence and the last spray during flower balloon stage.

Each treatment was applied to three replicate trees in complete randomized block design. During both seasons of the study, twenty shoots (one year old) were chosen at random and labelled for every replicate tree to the following determinations:

1-Flowering Behaviour

a- Date of inflorescences emergence: recorded as soon as the first signs of inflorescence parts were recorded.

b- Flowering date: time of beginning and full bloom was recorded when 10% and 80% of total flowers were opened, respectively. The end of blooming was recorded at the date in which all flowers were opened.

c- Flowering density: numbers of inflorescences on the labelled shoots were recorded and number of inflorescences/ meter was calculated.

d- Sex expression: samples of 30 inflorescences were taken from the middle portions of the shoots of every replicate tree. Numbers of total flowers and perfect flowers were counted, then the percentage of perfect flowers to total flowers was calculated.

e- Germination of pollen grains: pollen grains were collected from inflorescence samples, germination of pollen grains was estimated by the method of Escober and Martin (1987).

2- Fruiting Behaviour

a- Fruit setting: numbers of fruit setting on representative labelled shoots per each replicate tree were recorded at the first of June 1997 and 1998 seasons (about 45 days after full bloom) and every 30 days interval during the fruit development.

b- Fruit dropping: fruit dropping percentage was recorded every 30 days from the first of June till the first of September on the previous labelled shoots.

c- Fruit physical and chemical characteristics: black mature samples were collected at the mid of October of both seasons of the study from the examined shoots and subjected to the following measurements:

Fruit weight (gm), fruit volume (cm^3), fruit length (cm), fruit width (cm), fruit shape index, seed weight (gm), flesh/fruit (%), fruit moisture content (%) and fruit oil content (percentage/ 100 gm dry weight) by means of the soxhelt extraction apparatus using Hexan of 60-80oC boiling point as described by A.O.A.C. (1975).

The obtained data were statistically tested for analysis of variance using MSTAT package (1998) and significant differences among the various treatments were compared using L.S.D values at probability of 0.05 according to Waller and Duncan (1969).

RESULTS AND DISCUSSION

1- Flowering Behaviour

a-Inflorescences emergence:

According to Table (1) it can be observed that, the first sings of inflorescences for all treated olive Picual trees occurred during the period from March 27 th to March 29th in 1997 season and from March 8th to March 11th in 1998 season. Generally, inflorescences emergence started earlier in the second season than in the first one by about 12 days. This may be attributed to the difference in climatic conditions prevailing in both seasons.

On the other hand, foliar sprays of PP333, UC or $H_3 BO_3$ each at 250 or 500 ppm were effective in inducing earlier emergence of inflorescences in both studied seasons by about 1-3 days compared to control trees. On the other hand, foliar spraying of 20 ppm. CPPU had no effect on the date of inflorescence emergence. In the this respect, Fouad *et al*. (1992a); Atia (1995) and Hassan (1996) observed that inflorescence emergence of olive trees occurred during February and March according to cultivar and season.

b- Flowering date:

Beginning of bloom, full bloom and blooming duration of tested Picual olive trees are presented in Table 1. Generally, blooming started from May 1th to May 5 th in 1997 season and from April 19th to April 21th in 1998 season according to different treatments under investigation. Blooming duration, however, extended for 14 days and ended in May 14th – 16th in the first season, while in the second one blooming lasted for 18 days and ended in April 30 th to 2th May. Furthermore, full bloom ranged from May 9th to May 11th in 1997 and from April 25th to April 27th in 1998 season.

From the obtained results, it can be noticed that, foliar sprays of Picual olive trees with PP333, UC or $H_3 BO_3$ each at 250 or 500 ppm resulted in relatively earlier blooming by 1-3 days as observed previously concerning date of inflorescences emergence. Generally, blooming initiated 4-6 weeks after inflorescences emergence. Such differences were also noticed by

Griggs *et al*. (1975), Fouad *et al*., (1992a) and Hassan (1996). On the contrary Atia (1995) found that pre-flowering sprays of boric acid to Picual olive trees had no effect on their flowering dates.

c-Flowering density:

Flowering density as number of inflorescences per meter (Table, 2) responded significantly to all tested treatments in both studied seasons as compared with control trees which exhibited the significant least average number of inflorescences per meter. The highest numbers of inflorescences per meter were recorded under the treatments of 500 ppm PP333, 500 ppm UC and 250, 500 ppm boric acid. Other treatments, however, were in between. Similar results obtained by Laz (1993) indicated that foliar sprays of some olive cultivars with 250 ppm paclobutrazol resulted in increasing the number of inflorescences per meter. In this respect, Atia (1995) also observed that spraying Picual olive trees with boric acid increased number of inflorescences per meter.

d-Sex expression:

Sex expression as percentage of perfect flowers to total flowers are presented in Table (2), it was 37.95% and 56.84% in 1997 and 1998 seasons, respectively for the untreated control trees. Studying the effect of different treatments on sex expression it showed that, boric acid at the two concentrations used as well as PP333 and UC each at 500 ppm were the most effective treatments and resulted in the highest significant percentages in both studied seasons, followed in decreasing order by treatments of PP333 and UC each at 250 ppm.

It can be also noticed that foliar sprays of 20 ppm CPPU to Picual olive trees induced a slight increase in percentage of perfect flowers in both studied seasons, although such increment did not attain the significant level. Moreover, it is clear from Table (2) that percentage of perfect flowers was generally higher in 1998 season than in 1997 one. Similar results were obtained by Fouad *et al*., (1992a) , Eassa (1993) and Hassan (1996) that the sex expression percentage varied in the same cultivar from season to another.

In addition, Atia (1995) working on Picual olive trees obtained significant response in percentage of perfect flowers as a result of boron treatment. Similar trend was also obtained by Laz (1993) that spraying olive trees with 250 paclobutrazol significantly increased their percentage of perfect flowers.

e-Germination of pollen grains:

According to the results in Table (2) it can be noticed that, the percentages of pollen grains germination for untreated control trees were 44.25 and 39.52% in 1997 and 1998 seasons. In addition, the most marked effect was noticed with boric acid treatments which resulted in the highest significant values, and the higher rate of boric acid (500 ppm) proved to have higher significant effect than the lower one (250 ppm). On the other hand, the other treatments did not encourage the germinability of pollen grains rather than control treatment.

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These results are in accordance with those obtained by Griggs *et al*., (1975) who mentioned that germination of olive pollen grains ranged from 31.0 to 69.0% . The same trend was found by Fouad *et al*., (1992a) on 35 olive cultivars as pollen germination varied according to cultivar and season and that it ranged from 31.0% to 91.1% . Many studies on different olive cultivars also showed a wide variation in their pollen grain germination (Eassa, 1993 and Hassan, 1996).

As for boric acid treatments the present results are contradictory to those of Atia (1995) on Picual olive trees as he recorded an increase in the percentage of pollen grains germination after boron treatments.

2- Furiting behaviour:

a-Fruit set:

Numbers of setted fruits obtained from control (untreated trees), were (28.81 , 23.31, 23.07 and 22.78), and (32.20, 22.96, 13.62 and 13.27) fruits /meter in the counting dates of 1997 and 1998 seasons, respectively (Table, 3).

It is evident from the present results that, boric acid at both 250 and 500 ppm have the significantly higher fruit set than all other treatments tested. It is also noticeable from Table (3) that paclobutrazol, uniconazol and sitofex treatments gave relatively higher numbers of fruits setted/ meter compared to control treatment, although these increment were non significant in spite of PP333 treatments at 250 and 500 ppm in the initial fruit set (recorded at the June 1st) during the second season of study.

In addition, the obtained results showed some differences in percentages of fruit set between the two studied seasons as the recorded numbers of initial fruit set (in the first of June) were higher in the 1998 season than in 1997 one, although the reverse was noticed for the finial fruit set (recorded at the first of September) as the first season was the higher in this respect. This in the first order, is due to the fruit dropping percentages provident in each season of study. In addition, it is evident from the present results that fruit set was correlated directly with flower density and percentage of perfect flowers.

These results agree with those previously found on olives by Fouad *et al*. (1992a), and Hassan (1996) that fruit set differed according to cultivars and seasons. In addition, there was a direct correlation between the percentages of perfect flowers and number of setting fruits.

In this respect, Atia (1995) found that sprayed olive trees with boron increased initial and final fruit set. Moreover, Antogonazi and Preziosi (1986); Laz (1993) and Porlings and Vayiatzis (1999) reported that, fruit set of olive trees was increased by paclobutrazol treatments.

b- Fruit drop:

Fruit drop percentage recorded periodically during 1997 and 1998 for different treatments are presented in Table (4). It can be noticed that, marked and higher dropping percentages in the fruitlet took place during the early period of fruit development (about 45 days from fruit set). Thereafter, the percentages of fruit drop gradually decreased to its minimum values at pre-harvest. This observation was true for all investigated treatments in the two studied seasons.

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In this respect, Hassan (1996) reported that most olive fruit abscission was observed during the initial fruit growth 4-45 days after full bloom.

Studying the effect of different treatments on fruit drop percentages during both seasons showed that non of the treatments used did not affect the fruit drop percentages of Picual olive trees.

c- Fruit physical and chemical characteristics:

1- Fruit weight and volume:

The obtained results (Table, 5 and Plate, 1) indicated that, control (untreated trees) recorded values of fruit weight of 4.52 and 5.02 gm in 1997 and 1998 seasons and fruit volume of 4.50 and 5.00 cm^3 in the two studied seasons, respectively. It can be concluded that, both fruit weight and volume showed higher values in the second season of study than the first one. Similarly, Fouad *et al*. (1992b) and Laz (1993) showed some differences in olives fruit weight from season to other .

Regarding the effect of tested treatments, foliar sprays of 20 ppm CPPU after two weeks from full bloom was the superior treatment in this respect and giving the heaviest and largest fruits (6.98, 7.73 gm) and (6.80, 7.80 cm^3) in the first and second seasons, respectively.

In addition pre-bloom treatments of PP333 at 250 or 500 ppm, UC at 250 or 500 ppm and CPPU at 20 ppm significantly increased fruit weight and volume of treated trees. However foliar spray of CPPU at 20 ppm during the 1998 season had insignificant effect in this respect.

It can be noticed also from the present results (Table 5) that spraying 250 and 500 ppm $H_3 BO_3$ for three times at the second half of December, after inflorescences emergence and during flower ballon stage to Picual olive trees had no effect on their fruit weight or volume.

These results are in harmony with those of Laz (1993) who concluded that, foliar sprays of 250 ppm PP333 to four olive cultivars for one, two or three successive seasons resulted in increasing fruit weight. In addition, the favourable effect of CPPU on the olive fruit weight and size were previously recorded by Antognozzi (1995).

2- Fruit dimensions and shape index:

Results presented in Tables (5) cleared that fruit length, fruit width and fruit shape index of Picual olive trees was affected by PP333, UC, CPPU and $H_3 BO_3$ treatments. Spraying CPPU (20 ppm) two weeks after full bloom to Picual trees resulted in the highest significant increase in fruit length and fruit width in the two studied seasons. These values are generally attributed to fruit weight and volume.

On the other hand, the trees that received boric acid treatments yielded fruits with the least values of length and width similar to those of control fruits.

Concerning the fruit shape index, the present results Table (5) cleared that, UC at 500 ppm as well as $H_3 BO_3$ at 500 ppm treatments recorded the highest values, in other words produced fruits with oblong shape.

In this respect Fouad *et al*. (1992b) recorded a great variation in olive fruit dimensions and shape index according to different cultivars and seasons. Meanwhile, Laz (1993) observed that foliar sprays of 250 ppm PP333 to four olive cultivars resulted in higher values of fruit length and width.

3- Seed weight:

The obtained results (Table, 6) revealed that, seed weight obtained for CPPU treatment was the heaviest (1.19 and 1.21 gm in the two studied seasons, respectively) followed by PP333 treatments (0.99, 1.12 gm for 250 ppm and 1.06 , 1.02 gm for 500 ppm in the two studied seasons, respectively).

On the other hand H_3BO_3 at both concentrations used showed a lower values of seed weight (0.72 , 0.86 gm with 250 ppm and 0.84, 0.89 gm with 500 ppm in 1997 and 1998 seasons, respectively). Generally, these results are in parallel with those obtained before concerning fruit weight .

In this respect, Fouad *et al*. (1992b) concluded that olive seed weight differed according to cultivar and ranged from 0.26 – 0.30 gm for Frantoio cv. and from 1.45 – 1.48 gm for Toffahi cv. in 1988 and 1989 seasons, respectively.

4- Flesh / fruit percentage:

Results presented in Table (6) showed the effect of PP333, UC, CPPU and boric acid on flesh /fruit %of Picual olive fruit. The flesh percentages were 80.77 and 82.71 for the control trees in 1997 and 1998 seasons, respectively. In addition, the results revealed a highest significant increase in flesh % due to post-bloom CPPU treatment at 20 ppm as it recorded percentages of 83.80 and 85.70 in the two studied seasons, respectively. Meanwhile a reduction in this percentage was observed for boric acid treatments. It can be noticed that, treatments which produced higher fruit weight showed also a higher flesh percentage.

In this respect Laz (1993) reported that foliar sprays of 250 ppm PP333 to four olive cultivars for one, two or three successive seasons increased average flesh/pit ratio.

5- Fruit moisture content:

Results presented in Table (6) showed the effect of different treatments applied on moisture content. It can be noticed that spraying Picual olive trees with CPPU at 20 ppm after two weeks from full bloom showed the highest fruit moisture content (62.83 and 62.53% in 1997 and 1998 seasons, respectively). Meanwhile 250 and 500 ppm PP333 treatments gave the least values (51.2, 57.1, 61.8 and 58.3) in the first and second seasons, respectively. In this respect, Fouad *et al.* (1992b) in a study on 35 olive cultivars concluded that moisture content of olive cultivars had general average of 63.28% and 61.54% in two studied seasons.

6- Fruit oil content:

Results in Table (6) showed the oil content on dry weight basis of Picual olive fruits. It was significantly different according to the applied treatment. Boric acid at both 250 and 500 ppm as well as CPPU at 20 ppm after two weeks from full bloom gave the highest significant fruit oil content during the two seasons of study.

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Plate (1): Effect of growth regulators and boric acid treatments on fruits and seed of Picual olive at ripe stage

1- Control
2- H_3BO_3 250 ppm
3- H_3BO_3 500 ppm
4- PP333 250 ppm
5- PP333 500 ppm
6- UC 250 ppm
7- UC 500 ppm
8- CPPU 20 ppm (pre bloom)
9- CPPU 20 ppm (post bloom)

Control treatment, however, showed the least fruit oil content. In this respect Laz (1993) concluded that foliar spraying of 250 ppm paclobutrazol increased oil content for Frantoio, Mission and Manzanillo fruits.

Finally, it can be concluded from the present study that applying foliar sprays of H_3BO_3, PP333 and UC improved flower density and percentage of perfect flowers. Also H_3BO_3 increased pollen germination and fruit set, CPPU improved fruit weight, volume, length, width and flesh/ fruit percentage while both H_3BO_3 and CPPU resulted in the highest fruit oil percentage.

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"صنف البيكوال"

١_ تأثير الرش ببعض منظمات النمو و حمض البوريك على التزهير و الإثمار

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*** المركز القومى للبحوث**

أجريت هذه الدراسة خلال موسمي ١٩٩٦ ـ ٩٧ و ١٩٩٧ ـ ١٩٩٨ لدراسة تأثير استخدام الباكلوبوترازول و اليونيكونازول والسيتوفكس وحمض البوريك على التزهير والإثمار لأشجار الزيتون صنف البيكوال. استخدمت منظمات النو وحمض البوريك رشاً على الأوراق بالتركيزات و فى المواعيد الأتية:-

استخدمت مادتي الباكلوبوترازول واليونيكونازول ٢٥٠ و ٥٠٠ جزء في المليون قبل التزهير والسيتوفكس بتركيز ٢٠ جزء في المليون وحمض البوريك ٢٥٠ و ٥٠٠ جزء في المليون قبل أو بعد التزهير.

أظهر الباكلوبوترازول واليونيكونازول وحمض البوريك تأثيراً فعالاً في تبكير ظهور النوارات وزيادة عدد النورات / المتر الطولى (كثافة التزهير) وكذلك النسبة الجنسية (% الأزهار الكاملة). أدى حمض البوريك بالإضافة إلى التأثيرات السابقة إلى زيادة نسبة انبات حبوب اللقاح وزيادة نسبة عقد الثمار. بينما نتج عن الرش بالسيتوفكس بعد التزهير بأسبوعين زيادة معنوية في حجم ووزن الثمار وأعلى نسبة لحم/ الثمرة. كما نتج عن المعاملة بحمض البوريك والسيتوفكس بعد التزهير زيادة في محتوى الثمار من الزيت.

لذلك يمكن التوصية في ضوء نتائج هذه الدراسة برش أشجار الزيتون الباكلوبوترازول وحمض البوريك لتحسين مواصفات التزهير وزيادة نسبة الإثمار وكذلك الرش بالسيتوفكس لتحسين جودة الثمار.