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FOLIAR APPLICATION OF N-PHENYL-PHTHALAMIC ACID AFFECTS POLLINATION, FRUIT SET, YIELD, FRUIT CHARACTERS AND OIL CONTENT OF TWO OLIVE CULTIVARS

Mikhail, E. G. ; I. M. S. Osman and K. G. Goargiuos
Olive and semiarid zone fruits Dep.
Horticulture Research Institute, Agriculture Research Center, Giza, Egypt

ABSTRACT

This study was carried out through 2011, 2012 and 2013 seasons in a private farm at Cairo- Alexandria desert road on 9-years-old of "Manzanillo" and "Picual" olive cultivars. The trees were planted at 4 x 6 m apart on sandy loam soil under drip irrigation system. Nevirol (N-Phenyl-Phthalamic acid) applications at different concentrations at 0, 50, 100, 150 or 200 ppm were foliar sprayed at full blooming stage.

Results showed that 50 ppm Nevirol was more effective in improving fruit set percentage (by about 28.0 %), retained fruits %, fruit yield (by about 14.2 %) over the control once. On the other hand, fruit characters; fruit weight, size, dimensions, shape, flesh weight, seed weight, fruit moisture and oil content were not affected by Nevirol treatments, hence 200 concentration were ppm significantly decreased fruit characters of the two studied olive cvs. However, histological studies showed that 50 ppm Nevirol enhanced fruit set by improving pollen tube growth through the style than the other higher concentrations of Nevirol or control.

INTRODUCTION

The olive (*Olea europaea* L.) belongs to family Oleaceae and is considered to be as the most important fruit trees producing oil. It is also used for pickling and appetizer. Olive trees in Egypt suffer from low yield and alternate bearing, phenomenon. Low fruit set may be related to such environmental factors, which influence both bud development and also pollination and fertilization (Cuevas *et* al., 1994).

Nevirol (60 % N-Phenyl-Phthalamic acid + 40 % carrier and auxiliary materials) is a new fruit setter which can be increased pollination as well as auxin-synergistic preparation (Racsko *et al*., 2006). Nevirol treatments enhanced the ovule longevity and receptivity of the stigma and supported better pollination processes (Besan, 1988; Ebeed, 1996 and Nariman *et al*., 1997). It also improved fruit setting and yield of cherries, plums, grapes, apple and mango (Racsko and Lakatos, 2003; Thurzo *et al*., 2008 and Nasrati *et al*., 2011). On the other hand, Khub and Nosrati, 2013 and Nosrati and Khub 2013 reported that, Nevirol treatments eventually increased yield with higher nutrient supply but decreased fruit quality of sour and sweet cherry. Helal and El-Said (1981) on eggplant, Abou El-Nasr and Wanas (1992) on apple, Ebeed (1996) and Nariman *et al*., (1997) on mango found that at low concentrations of Nevirol, most of the pollens germinated in the anther, while at higher concentrations there were fluoresced and empty pollens in the anther as well as they stated that higher levels of Nevirol may

be due to unbalanced levels of growth promoters and inhibitors in treated pollens. Hadadinejad, et al., (2014) found that, PPA (N-phenyl-phetalamic acid) is an auxin synergist, and as such, it had a positive effect on grapevine fruit set with a decrease of apical dominance of the terminal buds; metabolites deviated to clusters that resulted in better berry characteristics. Further research is recommended to investigate the mechanism of PPA effect through the use of hormone assessment tools. PPA treatment can be applied in horticultural practice in combination with application of nutrients to maximize yield productivity in terms of quality and quantity.

This study aimed to investigate the effect of foliar applications of Nevirol on pollination, fruit set, fruit drop, retained fruits, yield, fruit quality and its oil content of both Manzanillo and Picual olive cultivars.

MATERIALS AND METHODS

The present study was carried out during (2011 to 2013) growing seasons on Picual and Manzanillo olive trees (9-years-old), planted in a private farm at Cairo Alexandria desert road. Trees were uniform in their shape and size as possible, planted at 4 x 6 meters apart on sandy loam soil and irrigated with drip irrigation system by underground water. Trees received the common organic and chemical fertilizer program. Also, irrigation and pest control program were executed according to (Elsayed & Saad El-Din, 2011).

Chemical structure of N-phenyl phetalamic acid (phenyl phetalamic acid) known as Nevirol. This research was investigated the effect of auxin-synergistic preparation of Nevirol (N-Phenyl-Phthalamic acid) solutions a foliar application on "Picual" and "Manzanillo" olive trees. A randomized complete block design with three replicates per each treatment (one tree per replicate) were adopted in this study. Foliar sprays were persued at full blooming stage, according to the following treatments:

1- Control.
2- Spraying Nevirol at 50 ppm.
3- Spraying Nevirol at 100 ppm.
4- Spraying Nevirol at 150 ppm.
5- Spraying Nevirol at 200 ppm.

Measurements:

I- Vegetative growth: shoot length was measured (cm).

II- Fruiting

Number of fruit set at the beginning of May, and number of fruits in mid June and before harvesting at the beginning of September. Number of fruit drop and retained were calculated as percentage and per meter as related to shoot length.

III- Fruit quality: Thirty fruits per each tree were randomly picked to determine fruit quality parameters:

Fruit weight (g), fruit size, fruit length (cm), fruit diameter (cm.) fruit shape index, fruit moisture content, flesh weight percentage and seed weight (g).

IV- Yield: average yield per tree was estimated for each treatment (kg/tree).

V- Oil percentage as dry weight. By means of extracting oil using petroleum ether at 60-80 °C boiling point as described by A.O.A.C. (1984)

VI- Statistical analysis.

The obtained data during experimental seasons were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1985). Differences between treatments were compared by using Duncan's multiple range test (Duncan, 1955) described in the SAS (SAS, 1986) at 5 % level.

VII- Histological studies:

Ten pistils and styles from each replicate were collected 8 days after floral application and fixed in FPA (Formalin: Propionic acid: Ethyl Alcohol, 5: 5: 90; v/v/v, respectively). Samples of pistils and styles were prepared as A.O.A.C. (1984) and then examined with Leica Fluorescence Microscop.

RESULTS AND DISCUSSION

I- Vegetative growth:

Data in Table (1) showed that, Nevirol treatments encouraged shoot length in the 1st season where 100, 150 and 200 ppm concentrations significantly induced longer shoots. On the other hand, Nevirol treatments significantly depressed the shoot length of Manzanillo and Picual olive cvs. throughout 2nd and 3rd seasons of study where shoots of control trees were longer. However, this may reflect the accumulation effect of Nevirol compound (N-Phenyl-Phthalamic acid) on vegetative growth.

Table (1): Effect of Nevirol treatments on shoot length, fruit set, No. of fruit drop/m and fruit drop (%) of Manzanillo and Picual olives during 2011, 2012 and 2013 seasons.

Characters	Shoot length (cm.)		Fruit set		Fruit set/m		No. of fruit drop/m		Fruit drop (%)	
Treatments	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual
	2011 season									
Control	24.17B	23.40C	12.20C	12.67C	50.58C	54.14B	23.31B	24.49B	2.83A	3.10B
50	24.77AB	24.70BC	16.43A	16.07A	66.41A	65.10A	14.62D	19.51C	2.40B	3.13B
100	26.20A	26.33AB	15.03B	14.47B	57.42BC	55.02B	18.84C	22.84B	2.83A	3.30A
150	25.90A	24.87A-C	14.03B	13.73B	54.33BC	55.25B	19.48C	22.81B	2.73A	3.13B
200	25.40AB	26.57A	3.53D	4.37D	13.96D	16.45C	28.57A	35.11A	1.03C	1.53C
	2012 season									
Control	27.37AB	28.47A	11.37B	7.30B	41.58B	25.61C	10.55B	12.23A	1.20B	0.90BC
50	26.67BC	26.33BC	12.07A	9.23A	45.27A	35.03A	10.48B	14.25A	1.27B	1.33A
100	28.30A	25.73BC	10.73BC	8.03B	37.96C	31.28B	11.75B	12.44A	1.27B	1.00A-C
150	25.57C	25.57C	10.50C	7.80B	41.07B	30.54B	13.00B	14.53A	1.37B	1.13AB
200	25.67C	26.77B	4.73D	4.97C	18.45D	18.60D	59.91A	13.43A	2.83A	0.67C
	2013 season									
Control	28.17A	27.77A	10.97B	11.73C	39.01C	42.29C	21.59A	24.77B	2.37A	2.90A
50	26.23BC	26.03B	16.00A	15.03A	61.02A	57.76A	12.45B	19.30B	1.97AB	2.90A
100	26.60B	25.97B	12.13B	12.50B	45.66B	48.15B	14.40B	23.22B	1.73B	2.90A
150	27.17B	25.67B	11.73B	12.60B	43.11BC	49.10B	19.62A	23.02B	2.30A	2.90A
200	25.33C	26.13B	4.30C	4.23D	16.85D	16.23D	10.91B	32.10A	0.47C	1.37B

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.

II- Fruit set:

The present results (Table, 1) showed a significant increase in both fruit set/shoot and fruit set/m. as affected with 50 ppm Nevirol treatment than control and the other treatments. It can be noticed that, increasing the concentration was accompanied by gradual and significant decrease of fruit set of both studied olive cvs. However, Nevirol treatment at 50 ppm showed effective increase fruit set/shoot of Manzanillo by 34.7, 6.2 and 45.9 %, as well as, Picual by 26.8, 26.4 and 28.1 % than control trees through the three studied seasons, respectively.

III- Fruit drop:

Number of dropped fruits/meter increased with increasing Nevirol concentration from 50 to 100 to 150 to 200 ppm. Otherwise, fruit drop percentage mostly decreased with concentration increment, this may be a result of initial fruit set decrease (Table 1).

IV- Retained fruits:

The present results (Table, 2) revealed that, 50 ppm Nevirol treatment significantly induced much more retained fruit percentages and per meter than control and other treatments throughout the three seasons of study. However, increasing Nevirol concentration significantly decreased retained fruits which may be as a result of decreased fruit set percentages (Table 1).

Table (2): Effect of Nevirol treatments on retained fruits %, retained fruit/m, retained fruit/m (%) and fruit yield of Manzanillo and Picual olives during 2011, 2012 and 2013 seasons.

Characters	Retained fruits		Retained fruits /m		Retained fruits/m (%)		Yield (kg/tree)	
Treatments	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual
	2011 season							
Control	9.37C	9.57C	38.79C	40.88B	76.69C	75.51B	40.00AB	36.00B
50	14.03A	12.93A	56.71A	52.39A	85.38A	80.49A	42.67A	42.33A
100	12.20B	11.17B	46.61B	42.48B	81.16B	77.16B	39.33AB	37.33B
150	11.30B	10.60B	43.73B	42.66B	80.52B	77.19B	38.67B	36.00B
200	2.50D	2.83D	9.87D	10.67C	71.43D	64.89C	22.00C	19.33C
	2012 season							
Control	10.17B	6.40B	37.19B	22.46C	89.46A	87.77A	29.67B	20.67B
50	10.80A	7.90A	40.51A	29.99A	89.52A	85.75A	34.00A	24.67A
100	9.47C	7.03B	33.48C	27.39B	88.25A	87.56A	29.00B	18.33C
150	9.13C	6.67B	35.73B	26.10B	87.00A	85.47A	27.00C	18.33C
200	1.90D	4.30C	7.42D	16.12D	40.09B	86.57A	16.67D	10.67D
	2013 season							
Control	8.60B	8.83C	30.60C	31.85C	78.41B	75.23B	41.67B	38.67B
50	14.03A	12.13A	53.52A	46.61A	87.55A	80.70A	46.00A	45.00A
100	10.40B	9.60BC	39.15B	36.96B	85.60A	76.78AB	40.67BC	39.67B
150	9.43B	9.70B	34.66BC	37.80B	80.38B	76.98AB	39.00C	39.33B
200	3.83C	2.87D	15.03D	10.95D	89.09A	67.90C	20.67D	20.33C

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.

V- Fruit yield:

Fruit yield (Table 2) was significantly affected by Nevirol treatments where 50 ppm induced the highest fruit yield of Manzanillo (42.67, 34.0 and 46.0 kg/tree) and Picual (42.33, 24.67 and 45.0 kg/tree) olive cvs. throughout the three studied seasons, respectively. Moreover, by increasing the concentration, it resulted in lower fruit yield. Thus, 50 ppm Nevirol treatments increased fruit yield of Manzanillo by 6.7, 14.6 and 10.4 % as well as of Picual by 17.6, 19.4 and 16.4 % than control. These results revealed that Picual olive cultivar was more positively affected than Manzanillo to Nevirol treatments.

VI- Fruit characters:

The present results in Table (3) showed that the two studied olive cultivars almost have the same trend where Nevirol treatments at 50, 100 and 150 ppm as well as control, fruits attained the same weight, size, dimensions (length and diameter) and fruit shape index (length/diameter ratio). Also, flesh weight and seed weight Table (4). However, higher Nevirol concentration (200 ppm) significantly decreased the above mentioned fruit characters.

Table (3): Effect of Nevirol treatments on fruit (weight, volume, length, diameter and shape index) of Manzanillo and Picual olives during 2011, 2012 and 2013 seasons.

Characters	Fruit weight (g.)		Fruit volume (ml^3)		Fruit length (cm)		Fruit diameter (cm)		Fruit shape index	
Treatments	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual
	2011 season									
Control	5.98A	6.17A	6.00A	6.13A	2.46A	2.55A	2.10A	1.98A	1.17A	1.29A
50	6.07A	6.13A	5.97A	6.10A	2.50A	2.56A	2.08A	1.96A	1.20A	1.30A
100	6.05A	6.13A	5.97A	6.07A	2.51A	2.61A	2.09A	1.96A	1.20A	1.33A
150	6.09A	6.11A	5.87A	6.07A	2.53A	2.62A	2.10A	1.94A	1.20A	1.35A
200	5.05B	5.16B	5.10B	5.23B	2.28B	2.33B	1.92B	1.80B	1.18A	1.29A
	2012 season									
Control	6.28A	6.36A	6.07AB	6.20A	2.75A	2.80A	2.11AB	2.01A	1.30A	1.39A
50	6.21A	6.30AB	6.07AB	6.20A	2.74A	2.77A	2.10B	2.00AB	1.31A	1.38A
100	6.22A	6.25B	6.10A	6.17A	2.72A	2.77A	2.10B	1.99B	1.29A	1.40A
150	6.23A	6.27B	5.97B	6.23A	2.72A	2.78A	2.12A	2.00AB	1.28A	1.39A
200	5.20B	5.27C	5.13C	5.30B	2.42B	2.38B	1.90C	1.79C	1.27A	1.33A
	2013 season									
Control	6.17A	6.16AB	5.93A	6.03A	2.64A	2.75A	2.04C	2.00A	1.29A	1.38A
50	6.09B	6.18A	6.00A	6.03A	2.64A	2.70A	2.09AB	1.98A	1.27A	1.36A
100	6.10B	6.11B	5.97A	6.07A	2.52A	2.71A	2.07B	1.98A	1.27A	1.37A
150	6.08B	6.13AB	5.90A	6.13A	2.65A	2.70A	2.09AB	1.98A	1.27A	1.36A
200	5.09C	5.16C	5.03B	5.17B	2.32B	2.34B	1.88D	1.72B	1.24A	1.36A

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.

VII- Fruit moisture and oil content:

Table (4) shows that olive fruit moisture as well as fruit oil percentage on fresh or dry basis of Manzanillo and Picual cvs. were not affected by Nevirol treatments where different concentrations and control did not result in a clear trend.

Histological studies:

Histological studies cleared that foliar application of 50 ppm Nevirol effectively enhanced fruit set by improving pollen tube growth rate through the style (Fig.2) than higher Nevirol concentrations or control (Fig. 1).

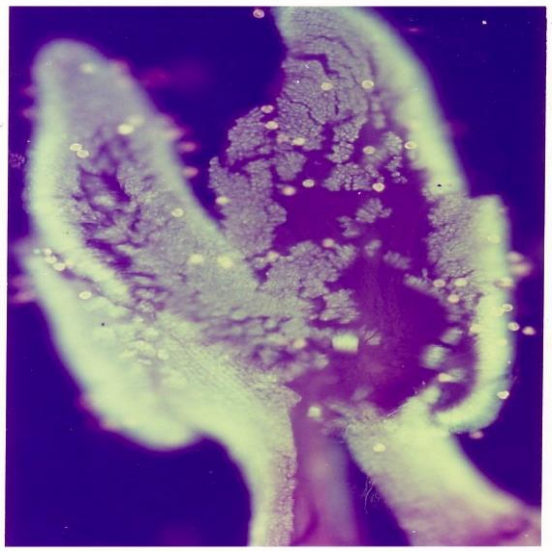

Fig. (1): Fluorsced and empty pollens due to spray with 150 ppm Nevirol (X100)

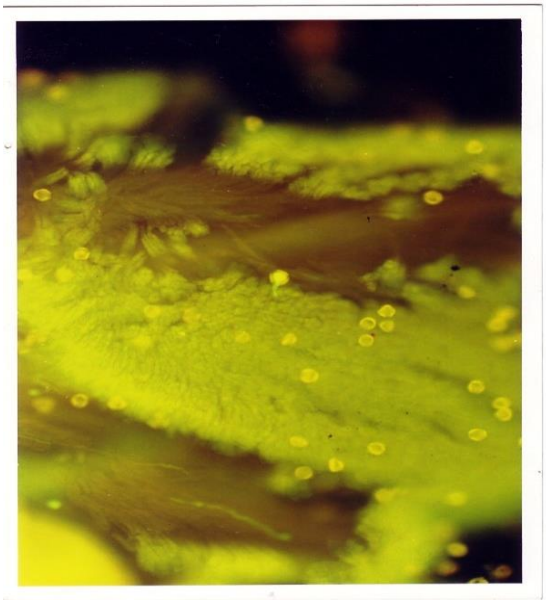

Fig. (2): Normal pollens and pollen tube growth due to spray with 50 ppm Nevirol (X100)

General Discussion and Conclusion

Nevirol (60 % N-Phenyl-Phthalamic acid + 40 % carrier and auxiliary materials) is a new fruit setter increases pollination as well as auxin-synergistic preparation (Racsko *et al*., 2006). Nevirol treatments increased the ovule longevity and receptivity period of the stigma eventually increase the effective pollination period (EPP) and supported better pollination of pollen grains germination in the anther before dehiscence take place (Besan, 1988; Ebeed, 1996 and Nariman *et al*., 1997). Ebeed (1996) found that spraying "Taymour" mango panicles with 100 ppm Nevirol at ballon stage proved to be the proper treatment for chemical emasculation of flowers, where the pollen grains in anthers after spray were empty and degenerated whereas the stigma, style and ovules were very good viable. Moreover, Nevirol at 400 or 800 ppm induced stigma and style fluorescence 3-4 days after application, while ovules remained viable for 7 days. Nevirol improved fruit setting and yield of cherries, grapes and apple (Racsko and Lakatos, 2003; Thurzo *et al*., 2008 and Nosrati *et al*., 2011). On the other hand, Khadivi and Nosrati, 2013 as well as Nosrati and Khadivi 2013 reported that, Nevirol treatments increased fruit yield of sour and sweet cherry with higher nutrient supply but decreased fruit quality. Also, Ebeed (1996) and Nariman *et al*., (1997) stated that low concentrations of Nevirol were effective of enhancing fruit set of mango. Overall, it could be concluded to Picual and Manzanillo olive trees with Nevirol at 50 ppm at full bloom to accomplish outstanding fruit quality and yield.

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تـأثير معـاملات الـرش بحمـض الفيثالميـك علـى التلقيح والعقد والمحصـول وصـفات الثمار ومحتوى الزيت لصنفي الزيتون

عماد جرجس ميخائيل , إبراهيم محمد سيد عثمان و كمال جرجس جورجيوس

قسم بحوث الزيتون وفاكهة المناطق شبه الجافة - معهد بحوث البساتين- مركز البحوث الزراعية – الجيزة- مصر

أجريت هذه الدراسة خلال ٢٠١١، ٢٠١٢ و ٢٠١٣ فى مزرعة خاصة على طريق مصر الإسكندرية الصحراوى على أشجار الزيتون صنفى بيكوال ومنزانيللوا عمر ٩ سنوات. الأشجار كانت مزروعة على أبعاد ٤ × ٦ متر فى تربة رملية تحت نظام الرى بالتنقيط.

تم رش مركب النيفارول بمحاليل بتركيزات ٥٠ أو ١٠٠ أو ١٥٠ أو ٢٠٠ جزء فى المليون فى مرحلة التزهير الكامل.

أظهرت النتائج أن رش تركيز ٥٠ جزء فى المليون مركب النيفارول كان أكثر فعالية فى زيادة نسبة عقد الثمار (بحوالى ٢٨ %) مع زيادة كمية الثمار المتبقية حتى الجمع ومحصول الثمار (بحوالى ١٤.٢ %) عن أشجار المقارنة. على العكس من ذلك فإن صفات الثمار (وزن وحجم وأبعاد وشكل الثمار ووزن اللحم ووزن البذرة ونسبة الرطوبة وكذلك محتوى الثمار من الزيت) لم تتأثر بالمعاملات. حتى أن التركيز المرتفع (٢٠٠ جزء فى المليون) قلل معنوياً فى صفات الثمار.

وقد أظهرت الدراسات التشريحية أن رش ٥٠ جزء فى المليون من مادة النيفارول قد شجع عقد الثمار عن طريق تحفيز نمو الأنبوبة اللقاحية خلال الميسم أكثر من التركيزات الأعلى من مادة النيفارول أو نباتات المقارنة.

Table (4): Effect of Nevirol treatments on flesh and seed weight, fruit moisture %, oil % / dry and fresh weight of Manzanillo and Picual olives during 2011, 2012 and 2013 seasons.

Characters	Flesh weight (g)		Seed weight (g)		Fruit moisture (%)		Oil (%)/ d. w.		Oil (%) / f.w.	
Treatments	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual	Manzanillo	Picual
	1st season									
Control	5.01A	5.05A	0.97A	1.12A	56.42A	55.84A	39.32B	41.39C	17.13B	18.27BC
50	5.14A	5.03A	0.93A	1.10A	56.27A	56.54A	40.43A	42.52A	17.68A	18.48AB
100	5.13A	5.03A	0.92A	1.09A	56.77A	56.03A	40.11A	42.35AB	17.34B	18.62A
150	5.18A	5.00A	0.91A	1.11A	56.87A	56.11A	40.07A	41.86BC	17.30B	18.36A-C
200	4.43B	4.36B	0.63B	0.80B	56.55A	56.84A	39.88AB	41.96A-C	17.33B	18.11C
	2nd season									
Control	5.30A	5.19A	0.98A	1.17B	56.42A	55.69B	39.29C	41.20B	17.12A	18.25B
50	5.24A	5.14AB	0.96A	1.16B	57.16A	55.95B	40.37A	42.38A	17.29A	18.67A
100	5.27A	5.10B	0.94A	1.15B	56.46A	55.82B	39.66BC	42.14A	17.26A	18.61A
150	5.27A	5.08B	0.96A	1.19A	56.58A	56.84A	40.18AB	42.23A	17.26A	18.39AB
200	4.50B	4.43C	0.69B	0.85C	56.28A	56.43AB	39.38C	41.83A	17.18A	18.22B
	3rd season									
Control	5.21A	5.06AB	0.96A	1.10A	56.69A	55.53C	39.76B	41.28B	17.14B	18.23B
50	5.16A	5.10A	0.93B	1.08A	56.79A	56.63A	40.48A	42.55A	17.49A	18.56AB
100	5.19A	5.01B	0.91C	1.10A	56.78A	55.92BC	40.01AB	42.02AB	17.29AB	18.69A
150	5.15A	5.02AB	0.93B	1.11A	56.63A	56.22AB	39.84B	42.06AB	17.28AB	18.50AB
200	4.43B	4.35C	0.66D	0.81B	56.97A	56.20AB	40.12AB	41.58B	17.27AB	18.26B

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.