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Effect of Irrigation levels on the growth and yield of olive trees (*Olea europaea* L. cv.Ashrasie)

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Abstract

This study was performed at olive orchard at the Engineering College, University of Salahaddin- Erbil, Kurdistan, Iraq, during the growing season 2000-2001, on a sandy silty loam soil. The objectives of this study were to find out the responses of olive trees (*Olea europaea* L. cv. Ashrasie) to five irrigation frequencies (0,1,2,3 and 4) during drought season and to determine their effects on tree growth and yield. Numbers of replicates were three trees as a replicate. Forty-five trees of fourteen years old, Ashrasie cultivar were used, each nine uniform size trees distributed randomly among the 5 treatments in RCBD experiment. Irrigation treatments carried out at monthly intervals during the dry season, starting on June 1, by constant amounts of water for each treatment up to reach 60 cm soil depth to field capacity, using basin irrigation method. Irrigation treatments resulted significant increases in the shoot elongation and thickening percentages, leaf area at harvest, fruit yield and quality characteristics. As well as oil contents. The highest values of shoot elongation and thickening percentages were achieved when three irrigation treatments were used, while the best results of each leaf area at harvest, as well as oil content fruit quality characteristics such as fruit weight and size, pulp/stone ratio, were obtained from fourth irrigation treatment.

Introduction

Olive (*Olea europaea* L.) belongs to the family (*Oleaceae*), in which the olive is the only species producing edible fruit. They are evergreen trees bear purple or nearly black fruits, with the good foliage, may be highly ornamental. Most of the species of the genus *Olea* are tropical, trees however of *Olea europaea*, will not bear fruit, unless there is more winter chilling than in the tropics (Chandler, 1958). Most Scientists believe that the olive tree originated in the east of Mediterranean basin, particularly the region of Hilal El-Khasieb, which includes: Iraq, southern Turkey, Syria, Lebanon, and Palestine, the existence of natural wild orchards grown on the mountains of northeastern Iraq (Agha & Daoud, 1991). The basic olive prevailing regions are the Mediterranean countries, or their synonyms in the environments.

Olive tree will grow between (25^o-45^o North) and(17^o-45^o South) latitudes (Hassan, 1995).The economic main importance's of olives are; oil and pickle olives. Olive oil regarded as the elements of food technology, industry medicine, and considerably the best oils which are free from harmful Cholesterol, it can also be used for manufacture. Other uses of olive trees are; the wood furniture or fuel, leaves and fruit residues after the removal of the pit as animal feed or organic manure, trees as ornamentals or good wind break (FAO & UNDP, 1977), (Al-Khafaji *et al* .1990). Northern Iraq considered to be suitable for olive production with a necessity of supplemental irrigation during summer months, as well as fertilizer application in case of infertility of the soil. Therefore studies on irrigation and fertilization of olives can be beneficial. The main subjective of this study are to find out the effects of irrigation and foliar urea application as the most important cultural practices to improve olive production in Northern Iraq. Ashrasie, is one of the most common olive cultivar in Iraq. Which is mainly used for green pickles. Fruit has elliptical shape, with the base similar to apple is circular, medium to big size at maturation, and irregular white flecks circular on the fruit surface, pith color is yellowish white, mellow, and medium in length(Al-Sabbagh,1980) , (Hamzah, 1985),(Al-Khafaji *et al*., 1990), (Agha and Daoud, 1991).Olive trees, like any other tree species, require irrigation, particularly at dry season in of which annual rainfall is less than the plant water demand. Irrigation requirements of olive and tree species are different according to the location, species ages …..etc.Chandler (1958) reported that olive trees even at dry farming conditions can produce higher yields than any other fruit crops, because of less transpiration rates and deeply soil penetrating roots. In order to bear good yields, olive trees require irrigation at 4-5 week intervals (Chandler 1958), in areas of no rains in summer with hot and dry air, even in climates of high winter rainfalls.Since the inflorescence, fruit set, growth and maturation take place at the period between late spring and late autumn, during as the driest and hottest months of the year and the most critical period for olive irrigation, so, it is necessary to apply supplementary irrigation between May and October (FAO & UNDP, 1977). Agabbio (1977) carried out an irrigation trial on the Ascolana Tenera table olive variety to test the possible effects of high water volumes for three years, the irrigation treatments were: (a) $20m^3$/tree/season at weekly intervals, (b) $11m^3$/tree/season at biweekly intervals, and (c) $8m^3$/tree/season at triweekly intervals. Fruit characteristics like fresh weight, volume, fruit length and mesocarp thickness were found better on trees watered once every three weeks. Doorenbos *et al*. (1979) reported that olive trees are commonly grown without irrigation in areas of annual rainfall 400 to 600 mm, but are even found in areas of about 200 mm rainfall. For high yields, 600 to 800mm is required. Water deficits in the spring adversely affect yield development and active growth, causing a reduction in yield during the same year and possibly the next. When the crop is grown fully under irrigation, application of water could be discontinued only during the period between onset of flowering and the beginning of stone hardening. Under conditions of little winter rain (less than 500 mm) irrigation is applied at two to three weeks before flowering, when the fruit reaches one-third to almost full size. For oil production, irrigation supply must be discontinued early enough to give a dry period during ripening, this will have little effect on the oil content but will reduce the water content of the fruit. The fruits of irrigated trees reach a high oil content later in the season compared to those of rainfed trees. Oil content as percentage of fresh weight tends to be higher in rainfed than in irrigated trees but little difference is noted with oil content expressed as percentage of dry matter. Baratta *et al*. (1985) studied the effects of irrigation on the characteristics of olives, cv. Nocellara del Belice for two years in a sandy soil with a rapid drainage. The trees were irrigated to field capacity in early July; or July and early August; or July, August and early September. Fruit yield/tree, fruit size distribution, flesh to nut ratio and shoot length were accounted. The results showed that small amounts of water (800-1000 m^3/ha) could assure good yields in such environmental conditions. Giannakaris (1985) used three levels of irrigation on chalkidikis olive cultivar to investigate their effects on fruit yield, the three levels were: (a) irrigation in early March to late October, (b) irrigation in early March to late May and (c) no irrigation (control). It was found that treatment (a) compared to control significantly increased yield, fruit size and percentage of oil content, and caused a longer annual vegetative growth and an increase in trunk perimeter. Treatment (b) compared to control, increased yield, fruit size and lengthened the annual vegetation growth, but to a lower degree than treatment (a). Agabbio and Dettori (1987) used five irrigation intervals ranging from week to five week intervals on olive trees. Fruit characteristics like volume, weight, thickness, length width as well as mesocarp stone thickness and the ratio mesocarp-stone were recorded. They found distinct variability regarding the growth and the productive behavior of the trees. Al-Khafaji *et al*. (1990) reported that olive trees need

irrigation at late autumn and early spring, in addition to supplementary irrigation during summer months. They also reported that young olive trees require 8-10 irrigation during summer compared to 3-5irrigation.Agha and Daoud (1991) noted several critical stages concerning olive irrigation, as follows:
prior to flowering, post set, pit hardening and fruit swelling. No irrigation is required for the first stage because adequate soil water sufficient for flowering is available, while the other stages require irrigation. Metheney *et al*.(1994) subjected Manzanilla olive trees to various levels of irrigation and found that water stress resulted in less shoot growth and earlier bloom periods, a logarithmic relationship was observed between the average number of fruits per tree and the average shoot growth resulting for various irrigation levels. The reports of Qutna *et al*.(1994) show that adequate moisture in the soil around the year is necessary to increase yields and fruits of high quality. Antognozzi *et al*. (1995) found that under irrigation system, fifteen years old, Ascolana Tenera, produced larger fruits with a higher water content than non-irrigated trees, while, pulp firmness was not affected by irrigation. Hassan (1995) showed that the olive trees must be irrigated during the dry season for obtaining good vegetative growth, yield increase, larger fruits, higher pulp-stone ratio and suppression of wilted fruits. Ismail *et al*. (1999) found that the olive fruits from irrigated plants had increased fruit weight, moisture and oil content as compared to non-irrigated plants. Patumi *et al*. (1999) tested four irrigation levels in three olive cvs. Kalamata, Ascolana Tenera, and Nocellara del Belice in southern Italy. They found they found the increase in yield as well as the higher oil yield for all the three cultivars under irrigation system, however the pulp-stone ratio and quantity of triglycerides in fruits were similar for all the treatments.

Materials and Methods

The study was performed at an olive orchard, College of Engineering, University of Salahaddin-Erbil, Iraqi Kurdistan, located on 36^o07`N, $44^o$10`E and 415m (amsl*), during the season 2000-2001. The soil was a sandy silt loam (according to Smith and Mullins, 2001). Irrigation treatments were conducted every 30 days, at dry season, using basin irrigation method. The quantity of water used for irrigation depends on the soil moisture content, the depth soil irrigated reach the field capacity using the following equations:

$$FC\% = \frac{SP\%}{1.86}$$

In which FC: Field capacity
SP% : Soil saturation percentage just before irrigation.

$$\%FC - m\% = g$$

m% : Soil moisture percentage just before irrigation.
g : Quantity of water in grams needed to reach 100gm soil at given m% to field capacity.

Since the specific gravity of tap water is nearly 1, 1g of the water and 1 ml equivalent.The volume of water (liters) at each irrigation period was calculated as follows:

$$A = \Pi r^2$$

In which A: Area of circle
Π : Pi (The constant ratio)
r: Basin radius (1.25m)

$$\text{Thus} \quad A = \Pi (1.25)^2 = 4.909 \text{ m}^2$$

$$ISV = A.\ D.$$

ISV: Irrigated soil volume
A: Irrigated basin area
D: Depth of irrigation (60 cm)

$$\text{Thus} \quad ISV = 4.909 \times 0.60 = 2.945 \text{ m}^3$$

$$ISW = ISV \times \rho$$

ISW: Irrigated soil weight.
ρ : Soil bulk density (1540 $Kg.m^{-3}$)

Thus ISW = 2.945 x 1540 = 4535.7 Kg (weight of the soil at 60 cm depth {zone of active rooots})

Soil (Kg)	Water (Liter)
100	g
4535.7	x

$$x = \frac{4535.7 \times g}{100} = L$$

L : volume of water in liters, used at each irrigation, to reach 60 cm depth of the soil at given m% and sp% to field capacity.

According to above equations and calculations, and depending on the soil moisture content (m %) and the soil saturation (sp %) 24-30 hrs before irrigation, the irrigation treatments performed as follows:

1- No irrigation.
2- One irrigation (September 2).

3- Two irrigations (August 2, and September 2).
4- Three irrigations (July2, August 1 and August 31).
5- Four irrigations (June1, July1, July31 and August 30).
In table (1) are outlined m%, sp%, FC, irrigation scheduling and the volume of water which added at each irrigation treatment.

Normal cultural practices, such as pruning, suckers removing, cultivation and weed control were performed (Chandler, 1958 ; Hassan,1995) . The collected data subjected to analysis of variance and means separated by Duncan's Multiple Range test (Al-Rawi and Khalafullah, 1980). The field measurements included Shoot growth rate, in which 10 non-flowering shoots from all directions were selected randomly, and marked with yellow flagging tapes. At the beginning of growing season, the lengths of marked shoots were taken by measuring tape and their diameters with vernier. At the time of harvest, the same measurements were repeated for calculating shoot elongation% and shoot thickening % as follows:

$$\text{Shoot elongation } \% = \frac{\text{Shoot length at harvest - Initial shoot length}}{\text{Initial shoot length}} \text{ x } 100$$

$$\text{Shoot thickening } \% = \frac{\text{Shoot diameter at harvest - Initial shoot diameter}}{\text{Initial shoot diameter}} \text{ x } 100$$

While, Average leaf area (cm^2) for the fifth leaf from the apex of 20 one-year old, non fruiting shoots (selected randomly) in all directions of each individual tree. The leaves were removed completely, collected in polyethylene bags, then their areas were measured by using a leaf area meter (Model AM100, ADC Bioscientific Ltd.). The Fruit yield ($Kg/tree^-$) of each tree weighed at harvest using a CMS 25Kg weighing balance. The laboratory analyses including soil moisture at the depth of 25-30cm, collected in polyethylene bags, transferred to laboratory as quickly as possible for oven drying at 102-105^oC for 24 hrs., then m% calculated gravimetrically, *Soil saturation percentage (SP)*After sieving air dried samples through a 2mm sieve, saturated with distilled water and subjected to 102-105^oC, until constant the weights, then SP% calculated gravimetrically according to Jackson (1958), *Bulk density (ρ) d*etermined by core method as average of eight replicates according to Smith and Mullins (2001) . Leaf *Dry matter %(Total soilds)* calculated as (D.m.% = 100 – moisture %), *Fruit weight(g) as the average of* 100 fruits (selected randomly) taken by electronic balance, Fruit size of the 100 randomly selected fruits measured by cylinder method, stone weights of (g) were taken after removing and air drying of 100 random fruits by sensitive balance, Weight of pulp (g)given as (Weight of pulp (g) = Average fruit weight – average stone weight), Pulp: Stone ratio given as:

$$\text{Pulp : Stone ratio} = \frac{\text{Average pulp weight}}{\text{Average stone weight}}$$

Ash % of leaves determined by muffle fernace at 450^{o}C for 4hrs. According to A.O.A.C.(1975),Total Nitrogen% of leaves determined by microkjeldahl method as described by Rowell (1996). Total carbohydrates % of leaves determined by the method described in Shaffer and Hartmann (1921). C/N ratio at harvest time calculated by dividing the total carbohydrate values by the total nitrogen values according to Chandler (1958). Fruit Oil% determined by the soxhlet extraction (diethyl ether) method, according to A.O.A.C. (1975).

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Results and Discussion

Vegetative growth (Table 2):

As a result of irrigation treatments, a_3 and a_4 were significantly greater than other levels for a_2, with respect to shoot elongation and thickening, a_3 and a_4 were superior to a_2 and a_1 except with two irrigation a_2 for shoot thickening this could be related to more available moisture in the first active vegetative growth period that commonly occurs from April to early July and considered as a critical water period (Doorenbos *et al*., 1979). These results agree with Giannakaris (1985), Hassan (1995) and Magliulo *et al*. (1999). Concerning a_3 which had more value than a_4, indicates that the most critical water period for olive trees was early July onward according to Doorenbos *et al*. (1979). And a_o resulted in the significant lower values, this may be related to less activity of the trees in their photosynthesis performance due to water deficit which rendered on one hand that stomatal conductance to be at it's least activity, and on the other hand carbohydrates to be less hydrolyzed and then less mobilized towards the meristematic growing points according to Chandler (1958), Salisbury and Ross (1978), Taiz and Zeiger (1998) and Hopkins (1999). These results agree with those of Metheney *et al*. (1994) and Celano *et al*. (1999).The irrigation treatment a_3 caused significantly thicker shoots than other levels except for a_4, these indicates that the irrigation in July and onward was more beneficial for olive tree growth four irrigations starting in early June caused less shoot growth, indicates that the olive trees under the study conditions preferred three irrigation frequency to obtain best growth, and on the other hand, it is an indication of a little toleration of olive trees to high irrigation frequencies. the significant lower value was due to a_o. These results agree with those of FAO&UNDP (1977), Doorenbos *et al*. (1979), Orunfleh and Shatanawi (1987), Metheney *et al*. (1994).The average leaf area of olive trees at the time of harvest affected significantly by irrigation levels, in which a_4 significantly increased leaf area compared to a_o and a_3 but not a_1 and a_2. There are two flushes of active vegetative the growth in olive trees, the first flush occurs from April to early July and the second at mid-August and onwards depending on the length of growing season, and between these two flushes there is a reduction of vegetative growth (Doorenbos *et al*. 1979). On the other hand some pressures from root growth due to irrigation at the beginning of the reduction of growth may be resulted. These facts may be the reasons of why a_4, a_2 and a_1 caused higher values of leaf area than a_0, while a_3 was similar to a_0 , because a_3 treatment

was started on July 1 which accompanied by the period of vegetative growth reduction. These results agree with those of Celano *et al*. (1999). There was significant effect of irrigation on leaf dry matter%, the highest value was obtained from a_0, while he lowest value was recorded from a_4. In general the increase in amount of irrigation resulted in the increase of leaf dry matter%. These results are likely due to the higher amounts of water transpired from the leaves of no-irrigation treatment without any water compensation except that of the seasonal precipitation reservoirs, and consequently resulted in leaf moisture percentage, and as known there is a negative relationship between moisture and dry matter in plant tissues when they expressed as percentages(%). These results concurred with Irving and Drost (1987), Rieger (1995), Aleare *et al*. (1999) and Celano *et al*. (1999). The carbohydrates to nitrogen ratios in olive tree leaves at the time of fruit harvesting. It was noticed that a_o was significantly higher than all other irrigation treatments, due to the higher value of total carbohydrates, and the lower value of total N. This is agrees with Chandler (1958). As concerning ash percent, a_4 resulted in a higher value and significantly all other treatments may be due to the high amounts of available mineral nutrients which resulted from the greatest amount of available water applied by the treatment a_4. These results agree with the results of Brun *et al*. (1985), Qutna *et al*. (1994) and Celano *et al*. (1999).

Table (2): Vegetative growth parameters of olive trees as affected by different irrigation levels.

Irrigation treatments	Shoot Elongation %	Shoot thickening %	Average leaf area (cm^2)At harvest	Leaf Dry Matter %	Leaf C/N ratio	Leaf Ash %
a_o: No Irrigation	44.154c*	33.897c	4.585b	55.275a	12.914a	7.740b
a_1: One Irrigation	59.999b	44.442bc	4.772ab	45.506b	10.884b	7.746b
a_2: Two Irrigation	67.701ab	34.970c	5.019ab	44.811b	10.863b	7.658b
a_3:Three Irrigation	79.188a	60.506a	4.605b	39.583c	10.558b	7.911b
a_4: Four Irrigation	77.153a	48.690ab	5.451a	39.542c	10.093b	8.417a
* Numbers with the same letters are not different significantly by Duncan's Multiple Range Test at $P \geq 0.05$						

Yield components (Table 3):

A_4 was superior to all other treatments as far as fruit yield per tree is concerned which may be due to the performance of irrigation at phase I (cell division) and phase II (cell enlargement) and so on, whereas the first irrigation of as was carried out at phase II, but phase I was deprivated. These results agree with Agabbio (1977), Ghosh(1985), Giannakaris (1985), Patumi *et al*. (1999)and Esparza *et al*. (2001a), furthermore the amount of (Rainfall + Irrigation) in a_4 was about 600 mm, which is considered to be adequate for good yield according to Doorenbos *et al.*(1979). There was significant difference in oil yield due to irrigation treatments, and the highest value was recorded for a_4 which was significantly higher than other irrigation treatments except a_3. the result may be due to the sufficient amount of water both as irrigation and rainfall which agree with Doorenbos *et al.*(1979) . All irrigated treatments were significantly higher in average fruit weights than non-irrigated treatment (a_o). These results indicate that the fruit weights get an increasing tendency with increasing water levels which led to the increase of fruit moisture contents and consequently weights, in addition to the availability of more substances the fruit growth required. These results agree with Agabbio

(1977), Agabbio and Dettori (1987) and Ismail *et al*. (1999). The irrigation treatment a_4 had significantly higher fruit size values than other irrigation levels, since there was an available water amount during phase I (cell division) as a result of the first irrigation in June and the continual growth of fruits during the last phases. Regarding irrigation (a_2) treatment it was significantly higher than a_0 in it's effect on fruit size, indicates that the irrigation in August can compensate irrigation deficit during the last months, this may be due to the second stage of fruit growth (cell enlargement) accompanied by the irrigation at August and considered as a critical water period for olive fruit production according to Doorenbos *et al*. (1979). These results agree with the results of Giannakaris (1985), Agabbio and Dettori (1987), Antognozzi *et al*. (1995) and Hassan (1995). The irrigation treatments resulted in slightly significant differences in fruit pulp:stone ratios, in which, a_4 was significantly higher than a_o only but not than the irrigated treatments, this treatment was likely appeared to be more effective on pulp weight than stone weight, so, the value of pulp/stone ratio resulting from a_4 was significantly the highest values. These results agree with those of Agabbio and Dettori (1987), Hassan (1995) and Patumi *et al*. (1999).

Table (3): Yield components of olive trees as affected by Different irrigation levels

Irrigation Treatments	Fruit yield (Kg.tree$^-$)	Fruit weight(g)	Fruit size (cm^3)	Pulp/Stone ratio	Oil yield (Kg.Tree$^-$)
a_o: No Irrigation	14.756b*	2.649b	2.590c	4.103b	5.084b
a_1: One Irrigation	15.156b	3.223a	3.212bc	5.152ab	4.537b
a_2: Two Irrigation	17.650b	3.361a	3.373b	5.071ab	5.265ab
a_3:Three Irrigation	17.106b	3.377a	3.717bc	5.256ab	4.845b
a_4: Four Irrigation	24.467a	3.593a	4.152a	5.498a	6.606a

*Numbers with the same letters are not different significantly by Duncan's Multiple Range Test at $P \geq 0.05$

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تأثير مستويات مختلفة من الري والرش باليوريا في نمو وحاصل اشجار الزيتون (*Olea europaea L.* صنف الأشرسي)

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****كلية الزراعة ــ جامعة السليمانية**

الخلاصة

تم تنفيذ هذا البحث في بستان الزيتون العائد لكلية الهندسة،جامعة صلاح الدين– اربيل، كردستان، العراق،خلال موسم النمو ٢٠٠٠–٢٠٠١،وفي تربة مزيجية رملية غرينية.تهدف هذه الدراسة الى معرفة كيفية استجابة اشجار الزيتون(*Olea europaea L.*صنف الأشرسي)لخمسة مستويات من الري(المعاملة الديمية(a_0)،رية واحدة (a_1)، ريتان(a_2)،ثلاث ريات (a_3)واربع ريات(a_4))وثلاثة تراكيز من محلول اليوريا(0% (b_0)، ١,٥%(b_1)،٣%(b_2))رشاً على

الأوراق،وذلك لتحديد أي من المعاملات يكون تأثيرها أفضل على النمو الخضري والثمري،تم تنفيذ المعـــاملات العامليـــة بواقع ثلاثة مكررات والتي تضمن كل مكرر شجرة بكاملها،أستعمل خمس وأربعون شجرة من أشـــجار الزيتـــون صـــنف الأشرسي بعمر أربعة عشر عاماً،اذ تم توزيع كل خمسة عشرة شجرة متجانسة الحجم قدر الأمكان في كـــل قطـــاع على١٥ معاملات توافقية وبصورة عشوائية،واستعملت تجربة عاملية في تصميم القطاعات العشـــوائية الكاملـــة.تم تنفيـــذ معاملات الرش باليوريا قي موعد ١٣/مايس ولمرة واحدة فقط وذلك بعد عقد الثمار مباشرة،اذ تم رش الأشجار حتى البلـــل الكامل(Drip point)باستعمال مرشة ميكانيكية. أما معاملات الري فتم تنفيذها شهرياً خلال موســـم الجفـــاف ابتـــداءاً مـــن ١/حزيران، وباستعمال كميات متساوية من الماء في كل معاملة حتى وصول المحتوى الرطوبي للتربة عند الســـعة الحقليـــة ولعمق (٦٠سم) وذلك باستعمال طريقة الري بالأحواض.ان أهم نتائج هذه الدراسة يمكن اختصارها كما يلي:أدت معـــاملات الري زيادات معنوية في نسب استطالة وتثخن الأفرع، مساحة الورقة عند الحصاد، حاصل الثمار والزيت والصـــفات النوعية للثمار. ان اعلى القيم في نسب استطالة وتثخن الأفرع تم الحصول عليها عندما استعملت ثلاث ريـــات. أمـــا أحسن النتائج لكل من مسلحة الورقة عند الحصاد، حاصل الثمار والزيت، وأغلبية الصفات النوعية للثمار مثل وزن الثمـــار وحجمها، وزن اللحم والنواة، نسبة اللحم/ النواة، محتوى الثمار من النايتروجين الكلي،الفسفور،البوتاسيوم والرماد تم الحصول عليها من معاملة أربع ريات .بالنسبة الى معاملات الرش باليوريا، فان بعض من الصفات المدروسة تم ازديادها مثل نســـب عقد الثمار عند الحصاد،النايتروجين الكلي والرماد في الثمار. وأعلى النتائج حصلت عليها من ٣% يوريا كانـــت لتـــأثيرات التداخل نتائج معنوية عديدة، لأنه كان هناك زيادات معنوية في نسب استطالة وتثخن الأفرع نتيجة تداخل ثلاث ريات مـــع ١،٥و٣% يوريا على التوالي. في حين تأثرت مسلحة الورقة عند الحصاد معنوياً بواسطة أربع ريات عند ٣% يوريـــا. وهذه المعاملة أدت أيضاً الى أعلى قيم في نسب النايتروجين الكلي للآوراق والثمار، رماد الأوراق ورطوبة الثمـــار. في حين أن أحسن النتائج لكل من نسبة عقد الثمار عند الحصاد، وزن لحم الثمار ونسبةاللحم/النواة فتم الحصول عليها عنـــد تداخل أربع ريات مع ١،٥% يوريا.