WATER RELATION IN ONIONS: 1- INFLUENCE OF PLANT POPULATIONS AND INTERVAL OF FLOWERING STALK ERADICATIONS ON GROWTH AND YIELD OF GREEN AND DRY BULBS OF ONIONS (*Allium cepa* L. cv. Local Red) GROWN UNDER RAINFALLS AND SUPPLEMENTARY IRRIGATION

العلاقة المائية في البصل: ١- تأثير الكثافات النباتية وفترات إزالة الشماريخ الزهرية على النمو والحاصل الجاف والأخضر للبصل النامي تحت الأمطار والري التكميلي

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ABSTRACT

This experiment was carried out during the growing season of 2001-2002 and repeated in 2003-2004 in Mosul to investigate the effects of plant populations and intervals of flowering stalk removal on growth , dry bulbs and green yields of onions grown under irrigated and non-irrigated cultivations. The results of 2001-2002 growing season showed that supplementary irrigated onions significantly increased leaf fresh weight (14.4%), root dry matter percentage (7%), as compared to these of rainfalls. Low onion plant population (18 plants.m^{-2}) was superior over high onion plant population (36 plants. m^{-2}), as it substantially increased leaf numbers per plant (27.3%), leaf fresh weight (19.7%), fresh weight of dry bulb (25.9%), and yield of dry bulbs (62%). Moreover, this population significantly exceeded high population in 2003-2004 growing season in leaf fresh weight per plant (27.2%), bulb: leaves ratio (7.7%), and fresh weight of individual plant (6.7%). Weekly eradication of flowering stalks in 2001-2002 growing season appeared to be the most potent treatment, as it highly increased leaf numbers per plant (28.6%), bulb: leaves ratio (219%), bulb fresh weight (265%), yield of dry bulbs (263%), and root fresh weight (15.1%), in relation to that of no flowering stalk elimination which resulted in profound dry bulb yield reductions. On the other hand in 2003-2004 growing season, treatment of no flowering stalk eradication was superior on others, particularly on weekly eradication of flowering stalks, as it significantly increased the plant height (6.9%), leaf fresh weight (52.6%), and green onion yield (26.3%). The highest dry onion bulb yield (3.1 kg.m^{-2}) and green onion yield (6.64 kg.m^{-2}) were obtained from supplementary irrigated high onion population of weekly flowering stalk eradication, respectively, during 2001-2002 and 2003-2004 growing seasons.

الخلاصة

أنجزت هذه التجربة خلال موسمي النمو ٢٠٠١ - ٢٠٠٢ و ٢٠٠٣ -٢٠٠٤ في مدينة الموصل / العراق ، لدراسة تأثير الكثافات النباتية وفترات إزالة الشماريخ الزهرية على النمو والحاصل الجاف والأخضر للبصل صنف أحمر محلي النامي تحت الأمطار والري التكميلي . أظهرت النتائج بأن ري البصل تكميلياً أدى الى حصول زيادة معنوية في الوزن الطازج للأوراق (١٤٠٤%) ونسبة المادة الجافة للجذور (٧%) مقارنة مع تلك في البصل النامي تحت الأمطار . الكثافة النباتية الواطئة (١٨ نبات / م²) كانت أفضل من الكثافة النباتية العالية (٣٦ نبات / م²) حيث إنها أدت الى حصول زيادة معنوية في عدد الأوراق للنبات (٢٧٠٣ %) والوزن الطازج للأوراق (١٩.٧ %) والوزن الجاف للأبصال (٢٥.٩ %) وحاصل الأبصال الجافة (٦٢ %) في فصل النمو ٢٠٠١ – ٢٠٠٢ . والأبعد من ذلك إن هذه الكثافة أيضا تفوقت معنويا على الكثافة النباتية العالية في فصل النمو ٢٠٠٣ – ٢٠٠٤ في وزن الأوراق الطازج (٢٧.٢ %) ونسبة البصلة الى الورقة (٧.٧ %) والوزن الطازج للنبات (٦.٧ %) . إزالة الشماريخ الزهرية أسبوعيا كان أفضل الفترات للإزالة مقارنة مع المعاملة التي لم يتم إزالة الشماريخ الزهرية فيها والتي لم تعطي حاصلاً تسويقياً للبصل الجاف . الإزالة الأسبوعية أدت الى زيادة معنوية في عدد الأوراق للنبات (٢٨.٦ %) ونسبة البصلة الى الأوراق (٢.٩ %) والوزن الطازج للبصلة (٢٦٥ %) وحاصل الأبصال الجاف (٢٦٣ %) وحاصل الجذور الطازج (١٥.١ %) في فصل النمو ٢٠٠١ – ٢٠٠٢ . من الجانب الأخر في فصل النمو ٢٠٠٣ – ٢٠٠٤ لإنتاج البصل الأخضر كانت معاملة عدم إزالة الشماريخ الزهرية متفوقة معنوياً على المعاملات الأخرى خاصة تلك التي أزيلت شماريخها أسبوعياً في ارتفاع النبات (٦.٩ %) والوزن الطازج للأوراق (٥٢.٦ %) وحاصل البصل الأخضر (٢٦.٣ %) . أعلى حاصل للبصل الجاف (٣.١ كغم / م²) وحاصل البصل الأخضر (٦.٦٤ كغم /م²) تم الحصول عليهما من معاملة البصل المروي تكميلياً ذو الكثافة العالية والمزالة شماريخه الزهرية أسبوعياً على التوالي في فصل النمو ٢٠٠١ – ٢٠٠٢ و ٢٠٠٣ -٢٠٠٤ .

INTRODUCTION

Bolting is one of the major constraint factor facing the production of dry onion bulbs, particularly in fall season in Mosul, where rainfall usually commences on November and continued through the ensuing winter then ceased at the end of April. Production of dry onion bulbs under rainfall incidence in Mosul was possible only in fall season where a heavy rapid bolting was observed and a non-marketable yield was obtained when onion was grown in spring season under rainfall incidences of the same year (Al-Juboori, 2005). The main concern of planting onion is to avoid too early planting in fall season. However, onion need to be planted early enough to go through the winter, but small enough to avoid flower stalk development or bolting. Onion plants that are pencil size or larger with three or more true leaves will readily bolt when exposed to prolonged low temperatures (Boudreaux, 1998). Water scarcity is another problem facing onion production in Mosul because of the topography which imparts higher cost for irrigation. Therefore, an attempt was made to make use of irregular rainfall incidences in Mosul for the benefit of producing green and dry onion bulb yields of high quality through supplementary irrigation, plant populations and flowering stalk eradications.

MATERIALS AND METHODS

This experiment was carried out during 2001-2002 growing season at Yarimja vegetable farm, Yarimja, Mosul, and repeated in 2003-2004 growing season at Danadan Research field, Mosul Univ., Mosul, to investigate the influences of plant populations and intervals of flowering stalk eradications on growth and yield of green and dry bulb of onions grown under rainfalls and supplementary irrigation. A Split Split Plot within Factorial Randomized Complete Block Design (Split Split F-RCBD) was used. The main plots (A) were supplementary irrigated onions (A1) and rain fed onions (A2). The sub main plots (B) were low plant population (B1= 18 plant.m^{-2}) and high plant population (B2= 36 plant.m^{-2}). Whereas, the sub sub main plots (C) were weekly eradication (C1) and every 2 weeks eradication (C2) or no flowering stalks eradication (C3). Therefore, (2x2x3=12) treatments were included in this experiment, each was replicated 4 times and each replicate was represented by a (0.85x4m) furrow planted with either 2 rows (population 1) on the upper thirds of both sides or 4 rows (population 2) on the lower and upper thirds of both sides, with 15 cm plant intra spaces.

Soil was plowed twice then dissected according to the proposed design. One gypsum block was settled at 30 cm depth from top surface of the furrow to track soil moisture fluctuation during the growing season (Allen, *et al*., 1998). Bulb sets of 2-2.5 cm diameter of Local Red onion cultivar were planted on December, 3rd , 2001, for the production of dry onion bulbs and on December, 7th , 2003, for the production of green onions. Compound N, P, K fertilizer (27, 27, 0) was broadcasted immediately after planting, at rate of 20 g.m^{-2}) and repeated on February, 3rd ,2001 and on February, 10th, 2004. Flower stalk eradication was started on 15th January and was contiued to harvesting. Watering was applied whenever the reading mean of gypsum blocks approaches the corresponding 25% soil AWC depletion (table, 1). However, supplementary irrigation was hold in May to enhance bulb dormancy and to reduce disease infections (Nagel, 2004). Plants were harvested on May, 25th , 2002, then plant height, leaf numbers per plant and bulb: leaves ratio were recorded. Leaves and roots were weighed to obtain their fresh weight, then root, bulb and leaves sample were weighed and were oven dried at 60°C for 72 h., reweighed to calculate their dry matter percentages. Plants of each furrow were tied and were hanged on tree branches in the field for 1 week to cure them (Zandestra, *et al*., 2004), thereafter, bulbs were weighed to obtain their yield. While, green onion plants were harvested on March, 12th , 2004. Plant height, leaf number per plant, doubled plants, bolted plants and bulb: leaves ratio were recorded, then leaves, bulbs and roots were weighed to obtain their fresh weight. Thereafter, their samples were weighed and oven dried at 60°C for 72 h. and reweighed to calculate their dry matter percentages.

RESULTS AND DISCUSSION

Effect of irrigation: Results of 2001-2002 growing season (table, 3) revealed that supplementary irrigated onion plants significantly increased leaf fresh weights per plant (14.4%), and root dry matter percentage (7%), in relation to these of rainfalls. Supplementary irrigated onions were also superior over these of rainfalls in 2003-2004 growing season, in which it showed increases of (23.7%) in fresh weight of individual bulb. However, rainfall onions exceeded that of well watered by 48.9, and 4.2%, respectively, in percentages of leaf and bulb dry matter percentages (table, 3a). The obtained results of both growing seasons manifested that rainfall incidences (table,1) provided a soil moisture very close to that provided by supplementary irrigation. Therefore, profound differences were not detected between them. In general supplementary irrigation is dependent on rainfall incidences of any given year, previous studies in north Iraqi provinces highly recommended the use of supplementary irrigation (Abdel, 1990; Abdel, 1995). However, in 2003-2004 growing season rainfalls were very low in mid February to early days of march. Thus, the gap was apparent between irrigated and non-irrigated onions (table, 4). Because of their limited root system, onions require a constant supply of water throughout the growing season and if rain is inadequate supplementary irrigation is required (Zandestra, *et al*., 2004).

Table (1) Meteorological data during 2001-2002 growing season.

Parameters	Months					
Months	December	January	February	March	April	May
Maximum Temperature (C°)	11.7	11.7	14.8	19.6	24.9	33.1
Minimum Temperature (C°)	3.1	1.3	2.3	4.9	10.89	16.4
Maximum RH (%)	95.3	99.2	99.3	95.9	94.6	90.7
Minimum RH (%)	62.5	44.6	37.9	25	23.2	21.6
ET0 Blany Cridle (mm.day-1)	1.13	1.12	1.15	2.29	2.46	3.03
Rainfalls (mm)	107.2	44.7	104	24.2	86.2	8.5
Applied water (cm)	0.0	0.0	0.0	10.07	0.0	0.0
Irrigation frequency	0.0	0.0	0.0	1.0	0.0	0.0

Meteorological data during 2003-2004 growing season.

Parameters	Months				
Months	November	December	January	February	March
Maximum temperature (C°)	21.2	14.1	13.5	14.2	22.4
Minimum temperature (C°)	7.8	5.5	5.1	5	7.7
Relative humidity (%)	62	79.8	79.7	75	62.1
Rainfalls (mm)	83.5	72.6	88	61	75.8

Table (2). Physical analysis for loam soil of Yarimja field (2001-2002).

Soil separation ($g.Kg^{-1}$	Particle sizes (%)	Soil bulk density ($g.cm^{-3}$)	Soil field capacity (%)
Clay	159.8	1.58	0.21
Silt	556		
Sand	294.2		

Physical analysis for silty loam soil of Danadan field (2003-2004).

Soil separation ($g.Kg^{-1}$	Particle sizes (%)	Soil bulk density ($g.cm^{-3}$)	Soil field capacity (%)
Clay	143	1.55	20
Silt	563		
Sand	294		

Effect of plant populations: Results of plant populations of 2001-2002 growing season (table, 3) manifested that low onions population was paramount, as it significantly exceeded high onions population in leaf numbers per plant (27.3%), leaf fresh weights per plant (19.7%), fresh weight of individual dry bulb (25.9%), and yield of dry bulb (62%). Furthermore, low population in the next growing season highly exceeded the high population in leaf fresh weight per plant (27.2%), bulb: leaves ratio (7.7%) and plant fresh weight (6.7%). However, in 2003-2004 growing season, high population profoundly exceeded the low population by 2.6 10.38 and 9.8%, respectively, in dry matter percentages of leaves, bulb and root. The prevalence of low plant population in 2001-2002 growing season might be attributed to the higher bulb fresh weight 74.17g as compared to that of high population 58.91g, (table, 3a). Grower of onion usually desire large bulb by planting 2 rows per 40 inches bed, spacing the plant 4 inches apart in row, to enable them to produce yields at the rate of 1000-15000, 50 pound sacks per acre is about 80000 (Gorgan, *et al*., 2000). It is well known that high plant population created potent plant competition on nutrients, soil moisture and light which is resulted in a poor plant stature vulnerable to be attacked by pests (Abdel, 2006). However, in 2003-2004 growing season , high plant population was superior in green onion yield over low plant population. This dominance could be referred to the larger plant numbers per the same unit area, besides the poor onion stature is ignorable and could be accounted for the favor of green onion production, since it imparts softness to the leaves and immature bulb of the produced onions. Green onions will be ready to eat in 6-8 weeks, thinning of seed grown bulbs can also be eaten as green onions (Home, 2002).

Effect of flowering stalk eradications: Results of flowering stalk eradications in 2001-2002 (table, 3a) revealed that weekly elimination appeared to be the most effective interval. It highly increased leaf numbers per plant (28.6%), bulb: leaves ratio (219%), bulb fresh weight (265%), yield of dry bulb (263%), and root fresh weight (15.1%), as compared to treatment of no eradication. Furthermore, this eradication treatment substantially exceeded that of within 2 weeks eradications interval in yield of dry onion bulb (17.6%), and percentage of root dry matter (9.6%). However, results of 2003-2004, (table, 4b) relates the production of green onions manifested the superiority of non-eradicated flowering stalk treatment over other 2 treatments, especially that of weekly eradications, as it significantly exceeded the later in plant height (6.9%), leaf fresh weight per plant (52.6%), and green onion yield (26.3%). Moreover, it significantly exceeded that of every 2 week eradications interval in plant height (8.8%), leaf fresh weight per plant (55.5%), and green onions yield (34%). However, this treatment was inferior to eradication intervals, particularly to weekly intervals in bulb: leaves ratio (100%), bulb fresh weight (8.1%), and root fresh weight (17.9%). The superiority of non-eradicating treatment was brought up from the huge numbers of plant per unit area. However, the prevalence of weekly or every 2 weeks eradication treatments (table, 3a), apparently attributed to the photosynthetic assimilates source-sink balance alteration between vegetative and reproductive parts of onion plant (Wein, 1997). Bolting is almost entirely induced by cool temperatures and is not affected by day length. Once onion plants reach a certain size usually (7-10 leaves), exposure to night temperatures below 50°F for a period of 2-3 weeks, usually causes some bolting . Longer cold exposure result in a greater percentage of bolting. However, temperatures greater than 50°F do not result in bolting (Kelley and Grandberry, 2002). In our circumstances onion plants were exposed to a long cold period (table, 1), enough to ensure heavy flowering stalk formations. Once flowering stalks are initiated alteration of assimilate to the favor of reproductive parts is fulfilled. Therefore, a rapid emergence of flowering stalks are observed owing to the profound stalk growth rate (Abdel, 1995). In the case of weekly elimination of flowering stalks, rearrangement for the favor of vegetative resumptions is established on the account of flowering stalk developments. Thus, formation of bladeless leaves is resumed and bulbing process will continues as leaf base swelling is brought up by carbohydrate accumulation (Wein, 1997). Moreover, removal of flowering stalk spears time for bulbing as it lasted longer with weekly eradication than with every 2 weeks. However, no eradication makes the partially formed bulb as a source of carbohydrates for the stalk performance sink, finally , the produced bulbs are very poor, particularly when the stalk is emerged from the auxiliary bud in the middle of the bulb very close to the apical meristems or even the apical meristem it self. On the other hand, green onion production in 2003-2004 growing season, flowering stalks did not constitute any problem. Since, these stalks are young, soft, tender, possesses the same flavor of other pant parts and are not rejected by consumers. Subsequently, treatment of no eradication gave the highest green onion yield (5.32 $kg.m^{-2}$). Bolting was observed early in the season, especially at the mid of January in both growing season. Onion can form seed stalk prematurely (bolting) the year of seeding if they are subjected to cool temperature after reaching the five leaf stage. Temperature must be below 50°F fore several days to induce bolting. The effect is accumulative, more bolting occurs at low temperatures. Onion growth from sets and transplants are very susceptible to bolting because they can be induced to bolt before planting (Zandestra, *et al*., 2004).

Effect of irrigation and population interactions: Results of irrigation and population interaction of 2001-2002 growing season (table, 3a) revealed that the highest yields (2.11 and 2.14 $kg.m^{-2}$) were confined to treatments of high plant population under both irrigated and non-irrigated cultivations, respectively. Because of high rainfall incidences which were resulted in ignorable differences between rainfed onions and supplementary irrigated ones, plant populations were prevailed on irrigation (table, 1). Rainfed onion of low population gave the highest leaf number per plant (11.75), leaf fresh weight per plant (161.2g), root fresh weight per plant (4.53g), and percentage of bulb dry matter (16.34%). While higher population of rainfed onions gave the highest values in bulb and root dry matter percentage (16.34 and 17.38%, respectively). On the other hand, the lowest yield was coincided by low population of rainfed. High population of supplementary irrigated onions highly reduced leaf numbers per plant (8.73), leaf fresh weight per plant (118.7g) and root fresh weight (3.97g). These reductions might be referred to the competition between plants on sources other than moisture availabilities. Results of irrigation and population interaction in 2003-2004 (table, 4a) displayed that rainfed of high population gave the highest leaf numbers per plant (8.25), bulb: leaves ratio (0.29), bulb and leaves dry matter percentages (9.24 and 10.3%, respectively). While, low population of supplementary irrigated onions manifested the highest leaf fresh weight per plant (187.6 g), and bulb fresh weight (48.1 g). On the other hand, the lowest yield (3.21 $kg.m^{-2}$), bulb: leaves ratio (0.25), and bulb fresh weight (33.55 g) were accompanied by low population of rainfed onions. Rainfall incidences during both growing seasons were almost very close to moisture that required by optimal onion growth, particularly during 2001-2002 growing season. Therefore, plant populations rolled the growth responses of onions, specially in 2003-2004 where the green yield was proposed and the experiment was curtailed early before plant competition reaches it maximum which is usually concomitant by high leaf area index and complete soil coverage.

Effect of irrigation and intervals of flowering stalk eradication interaction: Results of 2001-2002 growing season (table, 3b) showed that the highest plant height (108.1 cm) was coincided to non-eradicated onions of rainfed. Weekly removal of flowering stalks of irrigated and rainfed onions, especially these of rainfed resulted in the highest leaf numbers per plant (11.8), leaf fresh weight per plant (142.3 g), bulb: leaves ratio (0.69), yield of dry bulb (2.58 $kg.m^{-2}$), root fresh weight per plant (4.98 g), and percentage of root dry matter (17.8%). Onions of non-eradicated stalks showed the lowest values in most detected traits, particularly in supplementary irrigated onions, as it gave the lowest leaf numbers per plant (7.95), leaf fresh weights per plant (114.8 g), Bulb: leaves ratio (0.24), root fresh weight per plant (3.94 g), and root dry matter percentage (14.4%). Results of 2003-2004 growing season (table, 4b) manifested that supplementary irrigated and non-eradicated onions resulted in the highest plant height (83.75 cm), leaf fresh weight per plant (219.6 g), yield of green onion (5.39 $kg.m^{-2}$), and plant doubling percentage (30.54%). These increases were mainly due to the implication of flowering stalk in the green yield of the produced onions. Non-irrigated onions of weekly flowering stalk elimination exhibited the highest bulb: leaves ratio (0.35), and root dry matter percentage (11.53%). The lowest bulb: leaves ratio (0.16), root fresh weight (5.28 g) and percentage of doubled plants (27.13%) were accompanied to non-eradicated of rainfed onions. Irrigation and stalk eradications interaction (table, 3b) showed the prevalence of eradication intervals over irrigation in the responses of onion growth and development owing to the high rainfall incidences which were provided adequate soil moisture, thus watering was being no longer as limiting factor for growth and development responses. Flower stalk eradication intervals were being the crucial onion responses factor, particularly in 2001-2002 growing season where, experiment was restricted to produce a dry onion bulbs. Bolting is usually determined the yield of dry onions in fall cultivation (Abdel, 1995 and Al-Juboori, 2005). An extended warm period following planting produces a large over wintering plant (more than 1/4 inch shank diameter) which results in a high percentage of bolting when exposed to extended temperature below 50°F (Nagel, 2004).While, in the next season the experiment was curtailed early to produce green onion where, bolting is ignorable. Boudreux, (1998) stated that onion sold as green with green tops as they start to form bulb in the spring or later in the season as dry bulb.

Effect of the interaction of population and flowering stalk eradication intervals: Results of 2001-2002 growing season (table, 3b) revealed that highest yield of dry onion bulb (3.1 $kg.\ m^{-2}$) was confined to high onion population of weekly eradication of flowering stalks. However, the highest leaf numbers per plant (13), leaf fresh weight per plant (154.8 g), bulb: leaves ratio (0.68), bulb fresh weight (99.7 g), root fresh weight (4.9 g), and root dry matter percentage (16.63%) were confined to low onion population of weekly stalks eradications. The lowest yield of dry onion bulbs (0.46 $kg.m^{-2}$), and leaf fresh weight per plant (8.3 g) were found in low onion population of no flowering stalk eradications. Whereas, non-eradicated high onions population was the worst treatment, as it showed the lowest bulb: leaves ratio (0.19), bulb fresh weight (20.6 g), root fresh weight per plant (3.96 g), and bulb dry matter percentage (13.3%). These worse results might be attributed to the extreme competition on growth resources particularly light which was aggravated with the time as the plants leaf area index increased combined with flowering stalk rapid growth as a results of altering the assimilate sink for the benefit of stalk developments on the account of bulb formation or even altering the early stored carbohydrate in the bulb to a new assimilate source to reinforced stalk and seeds developments. Results of 2003-2004 growing season (table, 4b) displayed that the highest green onion yield (6.29 $kg.m^{-2}$) and plant height (83.3 cm) were observed in non-eradicated onions of high population. While, the highest leaf fresh weight per plant (251.2 g)and bulb fresh weight (47.86 g), were, respectively, found in weekly or every 2 weeks flowering stalk eradications of low onions population.. However, the lowest yield 2.88 $kg.m^{-2}$), plant height (74 cm), and leaf numbers per plant (8), were found in low onions population of weekly eliminated flowering stalks. The lowest bulb: leaves ratio (0.17), and bulb fresh weight (33.46 g) were obtained from high onion population of non-eradicated flowering stalks. Population and eradication interval interaction (table 3b) manifested that the highest yield was obtained from higher population of weekly eradication interval. This superiority might be referred to the higher plant numbers per unit area of smaller bulbs in relation to low population. However, low population of weekly eradication interval gave the highest bulb fresh weight, leaf fresh weight per plant. However, the lowest yield and bulb fresh weight were confined to non-eradicated onions, regardless to population. These results confirmed the conclusion of eradication dominance over population in development responses of onions. Similar results were reported by Al-Juboori, (2005).

Effect of irrigation, population and eradication interval interactions: Result of 2001-2002, (table, 2) showed that the highest yield of dry onion bulbs (3.1 $kg.m^{-2}$) was found in supplementary irrigated high onion population of weekly eradication interval. However, rainfed low onion population of weekly eradication interval manifested the highest leaf fresh weight per plant (158.3), bulb: leaves ratio (0.68), root fresh weight per plant (5.42 g), and leaf dry matter percentage (12.3%). While the highest individual bulb fresh weigh (100.4 g) was observed in supplementary irrigated low onion population of weekly eradicated interval. However, the lowest leaf number per plant (7.83), bulb: leaves ratio (0.18), bulb fresh weight (20.4 g), yield of dry onion bulbs (0.84 $kg.m^{-2}$), dry matter percentages of leaf and bulb (9.6 and 12.9%, respectively) were detected in rainfed high onion population of non-eradicated flowering stalk. Interactions results of 2003-2004 growing season (table, 4) revealed that supplementary irrigated high onion population of weekly eradication interval gave the highest green onions yield (6.64 $kg.m^{-2}$). Whereas, highest bulb fresh weight (60.1 g) was found in supplementary irrigated low onion population of every 2 weeks eradication interval. The highest leaf fresh weigh per plant (256.8 g) , and plant height (84 cm) were observed in supplementary irrigated low onion population of non-eradicated flowering stalks. On the other hand, the lowest green onion yield (2.39 $kg.m^{-2}$) was found in rainfed low onion population of every 2 weeks eradication, while the lowest bulb fresh weight (60.1 g), and leaf fresh weight per plant (106.8 g) were observed in supplementary irrigated high onion population of non-eradicated flowering stalks and non-irrigated high onion population of weekly eradication interval, respectively. From these results we may infer that no apparent responses of onions to either rainfalls and supplementary irrigation, since non-significant yield differences were detected between them. Populations manifested slightly higher responses effect which was obvious on bulb fresh weight and size as they were reduced with high population , however, yield was not affected as it substituted by the high bulb numbers per unit area to give acceptable yield for consumers. Therefore, bolting constitute the main problem facing the production of dry onion bulbs, particularly in fall season, where there were no chose for onion production, but fall season in order to make the height benefit from the rainfall incidences in Mosul. Hence, searching for very bolting causative and overcoming them is crucial. To reduce bolting and its cost, bolting resistant cultivars, planting date and set size should be selected carefully. Corgan, *et al*., (2000) reported that bolting resistant cultivar like NuMex starlit, NuMex Vado, NuMex Luna, and NuMex sandial, plant with a pencil size or smaller can be planted from January, 15^{th}., with out too much bolting. However, bolting susceptible varieties like NuMex bolo, NuMex Jose Fernandez, NuMex Casper, Cammaron, Canady, and most other intermediate and long day varieties. Transplanting should be delayed at least until February, 15^{th}., and plant diameters should be somewhat less than pencil size.

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