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EFFECT OF PLANTING DATE AND PLANT SPACING ON ONION (*Allium cepa.* L.) YIELD UNDER RAIN-FED IN SEMI-ARID CONDITIONS OF JORDAN

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By
A. Y. Mahadeen

Plant Production Department, Faculty of Agriculture, Mu'tah University, Al-Karak, Jordan

ABSTRACT

A field experiment was carried out during 2006/2007 growing season at the Agricultural Research Station, Mu'tah University, Jordan, to study the effect of planting date and plant spacing on onion yield under rain-fed in semi-arid conditions of Jordan. Treatments were arranged in a split plot design with 3 replicates. The main plots were assigned for planting on (Dec. 1, Dec. 15, Jan. 1, Jan. 15 and Feb. 1), while the sub-plots were assigned for plant spacings (10, 15, 20 and 25 cm).

Onion bulb yield and bulb weight were decreased with delaying planting date. The highest yield was produced with the earliest planting date (Dec. 1). Neck thick diameter, bulb diameter and bulb height were significantly decreased with delaying planting. Wide plant spacing reduced onion bulb yield, but it significantly increased individual bulb weight, neck thickness and bulb diameter. In general, maximum onion bulbs yield (23.71 ton ha $^{-1}$) was obtained from early planting date with the closest plant spacing. In conclusion, the best onion yield in terms of quantity and bulb characters was obtained when onion transplants were planted on Dec. 1 or Dec. 15 at the closest plant spacing under semi-arid conditions.

Key words: *Allium cepa L., bulb characters, bulb yield, onion, planting date, plant spacing.*

1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops worldwide and in Jordan. Onion ranks first in terms of area and production amongst the bulb crops in the world. Also, it is produced in a wide range of climatic conditions throughout the world. Due to the rapid increase in local consumption and world demand, there is a need to increase the productivity of onion bulbs to meet this demand.

The productivity of onion crop is strongly influenced by a number of environmental factors including the cultural practices such as time of planting data (Daymond *et al*., 1997) and plant density (Khan *et al*., 2003). Proper spacing ensures optimum plant growth through adequate utilization of moisture, light, spacing and nutrients (Weerasinghe and Fordham, 1994). Also, onion is highly sensitive to temperature and photoperiod, so planting date is considered a critical importance in determining onion yield. A number of studies in the world has shown that onion production can be improved through appropriate cultural practices (Weerasinghe and Fordham, 1994; Daymond *et al*., 1997; Khan *et al*., 2003). Overwintered onion crop is exposed to a great seasonal fluctuation of temperature and photoperiod, both having a strong influence on onion growth. The yield potential of onion plant depends on the extent of vegetative growth attained before bulbing commences (Brewester *et al*., 1977; Madisa, 1994; Gonzalez *et al*., 1997; Derawadan *et al*., 2002; Adekpe *et al*., 2007; Al-Moshileh, 2007). Yet, the available data obtained under different agroclimatic conditions, though valuable, can not be adopted for local conditions. Therefore, this study was designed to find out the optimum planting dates and plant spacing for maximum onion yield under semi-arid conditions of Jordan.

2. MATERIAL AND METHODS

A field experiment was conducted at the Agricultural Research Station, Mu'tah University, Jordan, during the growing season of 2006/2007. The experiment was performed on a sandy clay loam soil with the following characteristics: pH 7.78, electrical conductivity (EC) 1.28 ds/m, total $CaCO_3$ 32%, organic matter 1.63%. The region has a Mediterranean climate (semi-arid, with cold rainy winters and hot dry summers) with annual mean rainfall of 350 mm, most of the rain fall occurs from December to February.

The treatments consisted of five planting dates at about two week interval (Dec. 1, Dec. 15, Jan.

1, Jan. 15 and Feb. 1), and four inter-plant spacings (10, 15, 20 and 25 cm). The experiment consisted of 20 treatments and 3 replicates in a split plot design. The main plots were arranged for different planting dates, while the sub-plots were arranged for plant spacings. The total area of each plot was 12 m^2 which consisted of 4 rows 3 m long and 0.5 m apart. The soil was prepared for planting by plowing, disking and leveling. Total amount of decomposed animal manure (3 tons ha^{-1}) and triple-super phosphate (300kg ha^{-1}) were added during land preparation (late November) for all treatments. Seeds of onion (Giza 20 cv.) were sown 2 months before each planting date. Seeds were sown in polyester trays filled with peat moss and perilite (3:1 ratio) and watered as necessary. Onion transplants of 60 day old were planted in respective to planting date and according to the different treatments of plant density which mentioned previously. Weed control were done manually by traditional hoe. Recommended agricultural practices were followed in the experimental fields throughout the growing season. Bulbs were harvested (June, 15) when the leaves turned yellowish green and had started withering. The bulbs were kept on the open floor to cure for three days. Ten bulbs from each treatment were taken randomly to determine the bulb character measurements. Total yield per hectare, average weight of bulb, bulb diameter, neck diameter and bulb height were recorded. Data were subjected to analysis of variance (ANOVA) by MSTAT-program and means were separated using Duncan's Multiple Ranges Test (DMRT) with $P<0.05$ (Lentner and Bishop, 1993).

3. RESULTS AND DISCUSSION

3.1. The separate effects of planting date and plant spacing on onion

Data of the separate effects of planting date and plant spacing on onion yield, average bulb weight, neck thick diameter, bulb diameter and bulb height are presented in Table (1). Planting date significantly ($P< 0.05$) affected the yield of onion and the average bulb weight. There was significant ($P< 0.05$) decline on onion yield per hectare and average bulb weight with delaying the time of planting. The highest yield (17.09 ton ha^{-1}) was produced with the earliest planting date (Dec. 1), while the lowest yield (3.95 ton ha^{-1}) was produced with the latest planting date (Feb. 1). Determined, average bulb weight had similar trend. The largest bulb weight (126 gm) was obtained with the earliest planting date (Dec. 1), while the smallest bulb weight (33 gm) was obtained with the latest planting date (Feb. 1). In general, bulb characters as neck thick diameter, bulb diameter and bulb height were significantly ($P< 0.05$) decreased with delaying planting date from Dec. 1 to Feb. 1. The latest planting date showed the lowest onion yield and the smallest bulb weight may be due to the short period allowed for growth. Such results confirm the findings of many researchers (Madisa, 1994; Rizk *et al*., 1996; Gonzalez *et al*., 1997; Derawadan *et al*., 2002; Bhuiya *et al.*, 2003; Adekpe *et al*., 2007; Al-Moshileh, 2007). They reported that late planting date resulted in lower yield and smaller bulbs and thick necks as compared with early date. Also, Brewester *et al.* (1977) reported that sowing date was critical in determining yields of over wintered onion crop. According to Brewester *et al*. (1977) the plants must be sufficiently large to survive the winter and to establish a large leaf canopy early in spring. It means that onion plant must attaine higher vegetative growth in early planting, which possibly leads to the development of larger bulbs and higher yield.

Table (1): The separate effects of planting date and plant spacing on cured bulb yield, average bulb weight and bulb characters of onion grown under rain-fed in semi-arid conditions.

Treatment	Bulb yield (ton ha^{-1})	Average bulb weight (gm $bulb^{-1}$)	Neck thick diameter (cm)	Bulb diameter (cm)	Bulb height (cm)
Planting date					
Dec. 1	**17.09 a**	**126 a**	**0.70 a**	**7.3 a**	**5.79 a**
Dec. 15	**13.96 ab**	**97 b**	**0.53 b**	**7.0 a**	**5.40 b**
Jan. 1	**13.46 b**	**97 b**	**0.35 c**	**6.4 b**	**5.38 b**
Jan. 15	**9.15 c**	**59 c**	**0.27 cd**	**5.8 c**	**5.02 c**
Feb. 1	**3.95 d**	**33 d**	**0.25 d**	**5.0 d**	**4.85 c**
Plant spacing (cm)					
10	**16.69 a**	**74 c**	**0.35 c**	**6.0 b**	**5.19 a**
15	**11.49 b**	**77 c**	**0.41 b**	**6.1 b**	**5.20 a**
20	**9.74 c**	**89 b**	**0.44 b**	**6.5 a**	**5.40 a**
25	**8.97 c**	**103 a**	**0.48 a**	**6.4 a**	**5.36 a**

*****Means having different letters within each column of each factor are significantly different at 5% level of probability according to DMRT

Plant spacing had significant ($P< 0.05$) effect on bulb yield per ha (Table 1). It is evident that increasing plant spacing from 10 to 20 cm significantly ($P< 0.05$) reduced bulb yield, while further increase to 25 cm did not cause additional reduction in bulb yield of onion. The highest yield (16.69 ton ha $^{-1}$) was recorded at 10 cm spacing, whereas the lowest yield was recorded at 20 and 25 cm spacing. Furthermore, wide plant spacing had significantly ($P< 0.05$) increased individual bulb weight, neck thickness and bulb diameter, but had no effect on bulb height. Planting of onion at 20 and 25 cm spacing produced larger bulbs compared with planting at 10 and 15 cm spacing. The present results agreed with the findings of many researchers (El-Habasha *et al*., 1985; Weerasinghe and Fordham, 1994; McGeary, 1985; De Visser and Van Den Berg, 1998 Kanton *et al*., 2003). They reported that total onion yield was increased as the plant spacing decreased and average bulb weight as well as bulb diameter increased with increased the plant spacings. In general, the increase in onion bulb yield per unit area under the higher plant densities might be due mainly to the increase in number of bulbs in unit area (El-Gamili, 1996; El-Habasha *et al*., 1985; Islam *et al*. 1999; Khan *et al*., 2003). In addition, with wide distance, the competition between onion plants are minimized and consequently encouraged the capacity of onion plants in building metabolites and increased both diameter and weight of bulb (El-Gamili, 1996). Onion plants grown at the wide spacing received more soil water, mineral and solar radiation under less interplant competition which promoted vigorous growth resulting in positive bulb traits (Khan *et al*., 2003).

3.2. The interaction effects of planting date and plant spacing on onion

Data of the interactive effects of planting date and plant spacing on onion yield and average bulb weight are presented in Table 2. Maximum onion bulbs yield (23.71 ton ha $^{-1}$) was obtained from early planting date (Dec. 1) with closer plant spacing (10 cm). On the other hand, the lowest onion bulbs yield was obtained from the latest planting date (Feb. 1) with plant spacing more than 10 cm. In general, within each planting date, each increase in plant spacing resulted in a reduction in onion bulbs yield. Moreover, bulb yield was decreased when planting date was delayed at all plant spaces. On contrary to bulb yield, average bulb weight significantly ($P< 0.05$) increased with increasing plant spacing within each planting date. To produce higher yield in onion, onion transplants had to be planted at early time (Dec. 1) which allowed development of large vegetative parts (Madisa, 1994; Gonzalez *et al*., 1997; Derawadan *et al*., 2002; Bhuiya *et al*., 2003; Al-Moshileh, 2007). The present results agree with earlier findings of (El-Gamili, 1996; El-Habasha *et al*., 1985; Islam *et al*. 1999; Khan *et al*., 2003). They indicated that the production of high onion bulb yield per unit area under the high plant densities is attributed mainly to the increase in the number of bulbs in unit area.

Data of the interactive effects of planting date and plant spacing on bulb diameter, neck thick diameter and bulb height are presented in Table 3. Bulb diameter, neck thick diameter and bulb height were significantly ($P< 0.05$) higher when transplants were planted on Dec. 1 at all plant spaces and on Dec. 15 at 25 cm plant spacing compared with other treatment combination. The

Table (2): The interaction effect of planting date and plant spacing on cured bulb yield and average bulb weight of onion grown under rain-fed in semi-arid conditions.

Planting date	Plant spacing (cm)			
	10	15	20	25
	Cured bulb yield (ton ha $^{-1}$)			
Dec. 1	23.71 a*	17.83 c	13.91 de	1.291 c
Dec. 15	17.33 c	16.08 cd	11.33 efg	1.108 efgh
Jan. 1	20.50 b	12.25 efg	11.50 efg	9.59 fghi
Jan. 15	14.42 ef	8.50 hi	8.17 i	7.50 i
Feb. 1	9.50 ghi	2.77 j	3.78 j	3.75 j
	Average bulb weight (gm bulb $^{-1}$)			
Dec. 1	105 de	124 bc	131 ab	147 a
Dec. 15	89 efg	107 cde	114 bcd	145 a
Jan. 1	98 ef	82 fg	97 def	114 bcd
Jan. 15	47 hj	50 ij	64 hi	75 gh
Feb. 1	34 jk	24 k	37 jk	36 jk

*Means having different letters within each interaction of each parameter are significantly different at 5% level of probability according to DMRT

Table (3): The interaction effect of planting date and plant spacing on bulb characters of onion grown under rain-fed in semi-arid conditions.

Planting date	Plant spacing (cm)			
	10	15	20	25
	Neck thick diameter (cm)			
Dec. 1	0.63 b	0.65 b	0.70 ab	0.83 a
Dec. 15	0.43 cd	0.58 bc	0.55 bc	0.55 bc
Jan. 1	0.35 de	0.33 def	0.35 de	0.38 de
Jan. 15	0.15 g	0.28 defg	0.33 def	0.33 def
Feb. 1	0.18 fg	0.23 efg	0.28 defg	0.33 def
	Bulb diameter (cm)			
Dec. 1	6.9 bc	7.3 ab	7.3 ab	7.6 a
Dec. 15	6.5 cd	7.0 ab	7.2 ab	7.3 ab
Jan. 1	6.4 cd	6.2 d	6.5 cd	6.4 cd
Jan. 15	5.2 fg	5.7 ef	6.3 d	6.0 de
Feb. 1	5.3 fg	4.4 h	5.3 fg	4.9 gh
	Bulb height (cm)			
Dec. 1	5.65 abc	5.70 abc	5.70 abc	6.10 a
Dec. 15	5.00 def	5.43 bcde	5.45 bcd	5.73 ab
Jan. 1	5.73 ab	5.25 bcdef	5.45 bcd	5.08 cdef
Jan. 15	4.78 f	4.83 def	5.40 bcd	5.08 cdef
Feb. 1	4.80 ef	4.79 ef	4.98 def	4.83 def

*****Means having different letters within each interaction of each parameter are significantly different at 5% level of probability according to DMRT.

competition between onion plants at wide spacing are minimized and consequently encouraged the capacity of onion plants in building metabolites and increased both diameter and weight of bulb as mentioned earlier by several researchers (El-Gamili, 1996; Khan *et al*., 2003). Also, Onion plants grown at the wide spacing received more soil water, mineral and solar radiation under less interplant competition which promoted vigorous growth resulting in positive bulb traits (Khan *et al*., 2003).

In conclusion, the maximum yield of onion in the closet spacing was due to the highest number of plants which led to the highest yield. But the size of bulb in the closet spacing was small. The best onion yield in terms of quantity and quality was obtained when onion transplants were planted on Dec. 1 or Dec. 15 at closed spacing (10 cm) under semi-arid conditions of Jordan.

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تأثير مواعيد ومسافات الزراعة على محصول البصل تحت ظروف الزراعة المطرية في المناطق شبه الجافة من الأردن

عاطف ياسين محادين

قسم الإنتاج النباتي - كلية الزراعة - جامعة مؤتة - الكرك -الأردن

ملخـص

أجريت التجربة في محطة البحوث الزراعية - كلية الزراعة- جامعة مؤته خلال موسم 2007/2006 لدراسة تأثير خمسة مواعيد للزراعة وثلاثة مسافات على محصول البصل وصفاته. رتبت المعاملات في تجربة القطع المنشقة وبثلاث مكررات.

أدى تأخير موعد الزراعة عن 15 كانون الأول إلى نقص كمية حاصل البصل ومتوسط وزن البصلة الواحدة، حيث تم الحصول على أعلى محصول عند الزراعة في 15 كانون الثاني. كما أدى تأخير موعد الزراعة إلى نقص سمك عنق البصلة وقطرها وارتفاعها. بينما أدت الزراعة على مسافات واسعة إلى تقليل حاصل البصل، كما أدت إلى زيادة متوسط وزن البصلة الواحدة وزيادة سمك عنق البصلة وقطرها. وبصورة عامة فانه تم الحصول على أعلى محصول من البصل (23.71 طن/هكتار) لوحدة المساحة نتيجة الزراعة في مواعيد مبكرة وعلى مسافات ضيقة.

ويمكن الاستنتاج من خلال هذه الدراسة بأنه للحصول على أعلى إنتاجية يفضل زراعة أشتال البصل خلال كانون الثاني (1 أو 15 كانون الثاني) وعلى مسافات زراعة قصيرة.

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