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Research Article
Effect of New Tillage System and Soil Moisture Content on Some Onion Engineering Properties

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Abstract

Background and Objective: In Egypt, onion is an important and economical crop it needs good seedbed preparation to achieve the optimum growing conditions. The present investigation aimed to study the effect of using different seedbed preparation methods on some engineering properties of onion which affect its quality and yield. **Materials and Methods:** The experiments were carried out during the agricultural season of 2015-2016 in Giza governorate. Onions (*Allium cepa*) L. Beheri (red) cultivar were transplanted manually at late December, 2015 in the winter planting season under surface irrigation. Two main treatments were compared. First treatment includes three tillage systems: The new combined machine (NCM), conventional method system (TM) and no tillage treatment (NT). Second treatment was done with three different soil moisture contents at plowing (SMC), $SMC_1 = 9.5\%$, $SMC_2 = 18\%$, $SMC_1 = 23\%$, respectively. Data were analyzed by one-way ANOVA using SAS. **Results:** The obtained results showed clearly that all engineering properties of onion bulb had a positive response with tillage systems: The lowest geometric mean diameter D_{mg} (cm) and arithmetic mean diameter D_{am} were obtained under using NCM. On the other hand, the highest value was obtained under NT. The highest cross- section area A_{CS} and the lowest one were obtained in NT system and NCM, respectively. The increase in soil moisture stress in the root zone has a depressive effect on cross- section area A_{CS}. Shape index showed adverse effect where the highest value 0.81 was obtained under 9.5% soil moister content. The lowest of A_{CS} and shape index were obtained under q_2 and q_3, respectively. The volumes of bulb onion were affected with soil moisture content where increasing soil moisture content decreased volumes of bulb onion. **Conclusion:** All engineering properties of onion bulb had a positive response with tillage systems.

Key words: Tillage method, seedbed preparation conditions, soil moisture content, engineering properties, onion, clay loam soil

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Onion (*Allium cepa*) is the 5th most-valuable vegetable crop produced[1]. In Egypt, onion ranks the 4th after cotton, rice and citrus as an export crop. Three of the most popular cultivars (Giza 6 (white), Beheri (red) and Giza 20 (yellow)) of onion are grown in Egypt[2]. Onion is grown in Egypt in the winter loop, as solo or loaded on winter crops. Hassan *et al.*[3] showed that the total cultivated area of onions is about 28.28 thousand feddans, represents an area of solo onions about 63.2% and the average for the period (2007-2012). Onion requires a well seedbed preparation, especially when grown from seeds that are planted directly into the soil[4]. There are some factors that have been shown to have affected the productivity of onions, the most important of which are the quality of onions, the quality of the cultivars and the distance between the plants, as well as the damage caused by soil problems, various insects, traditional diseases and viral or nontraditional diseases. The plowing system refers to sequential processes in a particular order, which is the most historical invention. It was used in certain fields to prepare the seedbed and resulted in a significant increase in the productivity of the onion crop. Traditional tillage involves primary tillage to break and turn the soil followed by secondary tillage to obtain seedbed for sowing or planting[5,6].

Combined machines mean assembling of two or more different machines to do different tasks in one trip. Javadi and Hajiahmad[7] mentioned that using combined equipment and reducing the number of passes is getting popular due to its effect decreasing time, increasing efficiency and decreasing costs. Design and development of combined machine were considered in both primary and secondary tillage operations from about hundred years ago. The present investigation aimed to study the effect of a combined machine as new tillage technique and soil moisture content on some engineering properties of red onion.

MATERIAL AND METHODS

The experiments were carried out during the agricultural season of 2015-2016 and 2016-2017 in Giza governorate. Onions (*Allium cepa*) L. Beheri (red) cultivar were transplanted manually at late December, 2015 and 2016 in the winter planting season under surface irrigation (furrow irrigation) for all treatments. Onion crop was irrigated and fertilized according to the recommendations during growing season. Two main treatments were compared to study their effect on some onion physical properties. First treatment was three tillage systems conducted at 18% soil moisture content (v/v) at plowing operation and plowing depth of 25 cm:

- The new combined machine (NCM): Chisel plow, picker roller and 2 ridger blades attached with each other by metal rectangular frame.
- Conventional method system (TM): Two passes chisel plow followed by ridger
- No tillage treatment (NT)

Second treatment was operating the new combined implement (NCM) at three different soil moisture content of (SMC), $SMC_1 = 9.5\%$, $SMC_2 = 18\%$, $SMC_1 = 23\%$.

Five samples of onion bulbs were collected from each treatment randomly to study its physical properties and assess treatments effect on it.

Measurements procedure

Dimensions

Geometric mean diameter: Geometric mean diameter (D_{gm}) was calculated according to Mohsenin[8] as followed:

$$D_{gm} = (D_e D_p T)^{0.333}, \text{ cm}$$

Where:

D_e = The equatorial diameter
D_p = Polar diameter
T = Thickness

Arithmetic mean diameter: Arithmetic mean diameter (D_{am}) was calculated according to Mohsenin[8] as followed:

$$D_{am} = \frac{D_e + D_p + T}{3}, \text{ cm}$$

Cross-sectional area: Cross-sectional area (A_{CS}) was calculated according to Mohsenin[8] as followed:

$$A_{CS} = \frac{\pi}{4}\frac{\left(D_e + D_p + T\right)^2}{9}, \text{ cm}^2$$

Shape index: Shape index used to evaluate onion bulbs shape and it is calculated according to Mohsenin[8] as following:

$$\text{Sample index} = \frac{D_e}{\sqrt{D_p \times T}}$$

Volume: The volume (cm^3) was measured using water displacement method according to Bahnasawy *et al.*[2]. Samples

of each treatment were dropped, separately into a 1000 mL measuring cylinder filled with distilled water upto 500 mL. The rise in water indicates the true volume of the bulbs.

Statistical analysis: Data were subjected to analysis of variance (one-way ANOVA) in randomized complete block design as factorial (three factors) and means were separated according to LSD test at 5% significant level, correlation and multiple regressions were estimated after computer's program provided by using the SAS program (Version 8.2)[9].

RESULTS

Main effect of tillage system on engineering properties: The presented data in Table 1 clearly indicate that all engineering properties of onion bulb had a positive response with tillage systems. Whereas, statistical analysis of the obtained data revealed that the differences among the three used systems were significantly at 5% levels for all parameters.

Data in Table 1 indicated that the lowest D_{mg} (cm) and D_{am} value (5.29, 6.23) were obtained under NCM tillage treatment. On the other hand, the highest value (7.0, 7.1) was obtained under NT. The highest cross- section area A_{CS} and the lowest one were (27.75, 23.7 cm^2) obtained in NCM system and NT system, respectively. The obtained data indicated that new combine machine exceeded tillage systems on both shape index and volume of bulb onion. This may be attributed to improving soil characteristics such as aggregate size and good distribution of water and nutrients under new combine machine.

Main Effect of moisture content on engineering properties of onion: As shown in Table 2, the increase in soil moisture content at plowing had depressive effect on cross-section area A_{CS}, where the highest value of 25.25 cm^2 was achieved under 23% soil moisture content. Shape index showed divers effect where the highest value 0.81 was obtained under 9.5% soil moister content. The lowest of A_{CS} and shape index (23.70 cm^2, 0.66) obtained under q_2 and q_3, respectively. The volumes of bulb onion was negatively affected with soil moisture content where increasing soil moisture content decreased volume of bulb onion.

DISCUSSION

It is clear from presented data that all engineering properties of onion bulb had a positive response with NCM. The NCM system increased soil total porosity and decreased soil compaction[10] that lead to better distribution of water and nutrients in soil and had great effect on onion properties. Some of the advantages and benefits of the agricultural irrigation system were illustrated by signs. By reducing the earth density by Qingjie *et al.*[11]. This resulted in a decrease in pressure in the soil[12]. This resulted in the water movement through the random system of agriculture with references[13] and water use efficiency[11] and higher crop yields[11]. Pierce and Burpee[14] studied the effect of plowing at the site of the study, as well as the assessment of the fertilization system in the case of covering the crop and in the case of tillage without rows on the production of the potato crop Burbank variety during 1985-1988. They found that zone tillage significantly increased total and marketable yields and improved soil physical conditions in the zone of compression of the soil at a depth of 20-30 cm has led to an increase in the productivity of the potato crop of the Propank brand in many years. Kesik and Blazewicz-Wozniak[15] found that the largest vegetative mass of onion produced under the traditional tillage has been in the pre-winter period during soil preparation in the spring.

The main effect of soil moisture content showed that moisture level at plowing had great influence on onion properties. This trend may be due to that the increasing in soil moisture content at plowing compacted the soil which has a

Table 1: Main effect of tillage system on physical properties of onion

Tillage system	Geometric mean diameter, D_{gm} (cm)	Arithmetic mean diameter, D_{am} (cm)	Cross-section area, A_{CS} (cm^2)	Shape index	Volume (cm^3)
New combine machine	5.29^c	6.23^c	27.75^a	0.70^a	148^a
Conventional tillage	6.30^b	6.40^b	25.20^b	0.58^b	145^b
No-tillage	7.00^a	7.10^a	23.70^c	0.53^c	131^c

Treatment with the same latter has no significant different at testing level

Table 2: Main effect of moisture content at plowing on physical properties of onion

Soil moisture content (%)	Geometric mean diameter D_{mg} (cm)	Arithmetic mean diameter D_{am} (cm)	Cross-section area A_{CS} (cm^2)	Shape index	Volume (cm^3)
$\theta_1 = 9.5$	6.28^b	6.35^a	24.25^b	0.81^a	140.50^b
$\theta_2 = 18$	5.92^c	6.23^c	23.70^c	0.70^b	148.00^a
$\theta_3 = 23$	6.35^a	6.30^b	25.25^a	0.66^c	120.50^c

Treatment with the same latter has no significant different at testing level

depressive effect on water and air circulation and fertilizer dissolving in soil. Maw and Mullinix[16] reported that the impact of water management and nutrient management had a significant impact on the quality of post-harvest onion production. And their effect on post-harvest treatments helps the storage quality of onion crop. Onion yield produced under the treatment of low soil moisture and often lose moisture greatly and help to increase the quality of onion crop during the storage period. Subedi *et al.*[17] Some studies were conducted on the effect of soil moisture on onion yield, plant height, number of plant leaves, yield weight and biological production of onion crop. Since the soil moisture affected the above factors and resulted in obtaining the highest yield of onion crop 17.19 t ha^{-1} under the treatment of soil moisture by 100%. Fatideh and Asil[18] indicated that onion crop should be grows in irrigated soil. Drought causes to increase in the leg and on the onion tubers of A and B grade, resulting in increased production quality and storage for long periods.

CONCLUSION

This study focuses on the effect of tillage systems and soil moisture content in plowing operation on some engineering properties of the onion bulbs in Egypt. The presented data clearly indicate that all engineering properties of onion bulb had a positive response with tillage systems. The data indicated that the new combine machine exceeded the other two tillage systems on shape index and volume of bulb onion. Shape index showed divers effect where the highest value 0.81 was obtained under 9.5% soil moister content. The lowest of A_{CS} and shape index obtained under q_2 and q_3, respectively. The volume of bulb onion was affected with soil moisture content at plowing where increasing soil moisture content decreasing volumes of bulb onion.

SIGNIFICANCE STATEMENTS

This study discovered that both the new combined machine and soil moisture content of plowing has significant effect at the 5% level on onion engineering properties. These properties are important concerning onion packaging and processing. Also, this study has contribution for using tractor fuel more efficiently.

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