

RESPONSE OF MAIZE YIELD AND YIELD COMPONENTS TO TILLAGE SYSTEM AND PLANT POPULATIONS

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ABSTRACT

A field study was conducted at the experimental farm, College of Agriculture, Abu-Ghraib (Alternative site), Baghdad , Iraq, during the spring and fall seasons of 2017, to evaluate the effects of tillage systems (zero tillage T1, Surface tillage T2, normal tillage T3) and three plant populations (66666 D1, 57143 D2, 50000 D3) on yield and it's Components of two maize (*Zea mays* L.) cultivars (Maha V1 and Fajr V2). The layout of the experiment was split split plot design with three replications, Results were revealed that the zero tillage (T1) was superior to surface and normal tillage in weight of 300 grains both seasons spring and fall. Also the same treatment was the best in ears number plant⁻¹, plant height and grains yield (6.92) ton.ha⁻¹ . the increase in plant density leds to increase in leaf area, weight of 300 grains and grains yield 4.97 ton.ha⁻¹ wich obtained from (D1).while The treatment of (D2) was superior in plant height in spring and fall seasons. Cultivar Maha (V1) was superior to cultivar Fajr 1 (V2) in some chracters, including plant height and the leaf area, the weight of 300 grains and grains yield, (6.70 ton.ha⁻¹). Also the interaction treatments varied among them, the interaction (D2 × T1) gave the highest plant height reached 148.53 cm in fall season, Different mazie traits were differed due to different types of interaction

Keywords: zero tillage, grain yield, plant height, leaf area, interaction, cultivars

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استجابة حاصل الذرة الصفراء ومكونات الحاصل لنظم الحراثة والكثافة النباتية

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باحث

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المستخلص

نفذت تجربة حقلية في حقول كلية الزراعة- جامعة الانبار الموقع البديل (ابو غريب) خلال العروتين الربيعية والخريفية لعام 2017. بهدف دراسة تأثير نظم الحراثة (ثلاث انظمة: بدون حراثة (T1) وحراثة سطحية (T2) وحراثة اعتيادية (T3)) وثلاث كثافات نباتية (66666 (D1) و57143 (D2) و50000 (D3)) في نمو وحاصل صنفين من الذرة الصفراء (مها (V1) وفجر 1 (V2)). باستخدام ترتيب الالواح المنشقة - المنشقة وفق القطاعات الكاملة المعشاة وثلاث مكررات أظهرت النتائج تفوق معاملة الزراعة بدون حراثة (T1) على معاملي الحراثة السطحية والحراثة الاعتيادية (T2 و T3) في وزن حبة للعروتين الربيعية والخريفية، وتفوقت في العروة الخريفية ايضا في ارتفاع النبات وعدد عرايص النبات وحاصل الحبوب (6.92 طن هـ⁻¹). وادت الزيادة في الكثافة النباتية الى زيادة في المساحة الورقية ومعدل وزن الحبة وحاصل الحبوب الذي بلغ 4.97 طن هـ⁻¹ عند الكثافة النباتية العالية (D1) وتفوقت الكثافة النباتية المتوسطة (D2) في صفة ارتفاع النبات للعروتين الربيعية والخريفية. واختلفت الاصناف فيما بينها في عدة صفات وتفوق الصنف التركيبي مها (V1) على الصنف فجر 1 (V2) في بعض الصفات منها ارتفاع النبات والمساحة الورقية ومعدل وزن الحبة وحاصل الحبوب (6.70 طن هـ⁻¹). اختلفت صفات الذرة الصفراء باختلاف التداخل.

الكلمات المفتاحية: بدون حراثة، حاصل الحبوب، ارتفاع النبات، مساحة ورقية، التداخل، أصناف

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INTRODUCTION

Tillage is one of the most important processes in the field, it has an important role in improving the physical properties of the soil, also to create a suitable seedbed, and helps to increase the radical growth which leads to increase the vegetative growth due to fracture of layers under soil surface (7,27). The traditional pattern of agriculture has a unstable impact on increasing the exposure of soil to erosion, especially in the semi-arid areas, as well as working to move the weed seeds and make them in places more suitable for germination. Therefore, a number of researchers had found modern agricultural systems, including Zero Tillage which is characterized as an agricultural system that eliminates all tillage operations and prepares a seed bed by opening a line to place the seed in the soil. The agricultural systems in a number of countries were use a this system of cultivation of crops without tillage because of its many benefits, notably reducing the effort and time required for tillage, reducing the use of machinery (6). In order to achieve the best productivity of the maize crop, the best method of tillage should be chosen with the best suitable plant density to increase the grain yield. About 40% of the increase in maize yield is due to the improvement of agricultural processes which included the plant density and fertilizers. The plant needs to be cultivated with optimum plant density to enabling it to make more efficient use of available nutrients and water in the soil, exploitation of light with higher efficiency and other factors, the optimum plant density plays a major role in the expression of cultivar of its characters and its higher yield. The aim of this study is to estimat the best tillage system and plant population for grain yield and its components of maize cultivars.

MATERIALS AND METHODS

A field study was conducted at the experimental farm, College of Agriculture, Abu-Ghraib (Alternative site), Baghdad , Iraq, during the spring and fall seasons of 2017 to evaluate the effects of zero tillage systems and three plant population on roots, yield and it's Components of tow Maize (*Zea mays* L.) cultivars. using split split plot design according to the Randomized Complete Block

Design (RCBD) with three replications, The tillage systems (zero tillage, surface tillage, normal tillage) which symbolize (T1, T2, T3) occupies the main plots for both seasons, the (distance between rows 60cm included 6 rows, 70cm included 5 rows, 80cm included 4 rows) occupied the sub-plots which symbolize (D1, D2, D3) respectively, length of every row 3.5m, while sub-sub plots contained two synthetic cultivars Maha and Fajr (V1, V2) respectively. Soil was prepared and divided into three replications.

- Zero tillage: rows were made using a manual machine to create seeds holes.
- Surface tillage: Use only spring harrow to create a create lines and seeds holes.
- Normal tillage using moldboard plow, softening, leveling of soil.

Random samples were taken from the experimental soil before planting to estimate some chemical and physical properties, also samples of irrigation water were taken to estimate the salinity ratio in irrigation water in the laboratories of the General Directorate for Agricultural Research, Ministry of Agriculture. The dimensions of experimental units (3.5×4 m) with area (14m^2). The distance between the plants of (25) cm, which achieved a plant density of (50000, 57143 and 66666 plants, plant.ha^{-1}) respectively. The soil of the experiment was fertilized with 400 kg.ha^{-1} Dap (N18% and P 18%) which added before planting, Nitrogen fertilizer as urea (46% N) was added, using 300 kg.ha^{-1} by three doses, the first dose at planting, while the second dose when the plant height was 30 cm and the third dose added at the flowering stage (18) The stem corn (*sesame criteca*) added to was conducted using the liquid diazinon, 6 liters.ha^{-1} (60% active material) with two doses, the first one after 20 days of planting while the second dose applied after 15 days of first dose in fall and spring seasons (19). The results were analyzed statistically as analysis of variance using the statistical program GenStat according to the split split plot design. The means were compared and using the least significant difference (L.S.D) at 5% level.

RESULTS AND DISCUSSION

Plant height (cm): Results of Table 1 indicate that there are significant differences between

plant height under different tillage systems in spring and fall seasons. The normal tillage (T3) gave the highest plant height reached 160.32 cm compared to the surface tillage and zero tillage (T1, T2) in spring season, which were 151.26 and 149.89 cm respectively. These results in agreement with results of other researchers (13) and (26), they reported that different tillage systems had a significant effect on the plant height of maize crop. Results of the fall season, were the opposite of the spring season, where the plants of zero tillage (T1) was higher (145.41 cm) and significantly different compared to the other tillage treatments, the normal tillage (T3) had the lowest plant height (126.61 cm), while the surface tillage (T2) had 138.3 cm. and this results in agreement with results of Haddadi (11), he Results in Table 1 shows significant differences between the plant height according to the plant density in both seasons. The plant population 57614 plant.ha⁻¹ (D2) had the highest plant height which was 161.05 and 139.88 cm in spring and fall seasons, respectively. While the highest plant population (D1) gave lowest plant height (144.92 cm) in spring season, while in fall season the (D3) treatment had lowest value (135.06 cm), which didn't differed significantly when others compared to the high plant population (D1). These results in agreement with results of (2 , 24). The results of the same table shows significant differences between the varieties in spring season only. The cultivar Maha (V1) had the highest plant height (155.18 cm) compared to the cultivar Fajr 1 (V2), which had lowest (152.47 cm). This is due to the genetic variances between cultivars this results in agreement with results of other researchers (17 , 22) Interaction treatments between tillage system and plant population shows significant differences in plant height in both seasons. The interaction between plant population (D2) and tillage system (T3) gave the highest plant height (171.60 cm) in spring season, while in the fall season the interaction plant density (D2) with zero tillage (T1) had the highest value of plant height (148.53 cm). The interaction between the tillage system and cultivars were also significant in this character in fall season only. The highest value of plant height obtained

from interaction (T1 x V2) which was 147.02 cm compared to interaction (V1 x T3), which gave lowest value (128.12 cm). Also the results of Table 1 reveal to significant differences between the plant cultivars and plant density, the interaction of (V2 x D2) gave the highest value of plant height (167.18 cm) in spring season, while in fall season the treatment of (V1 x D2) had the highest value of this character. The third order had a significant effect in both seasons, The highest value of plant height was 177.73 cm in spring season obtained from the interaction (V2 x D2 x T3) while, in fall season the interaction (V1 x D2 x T2) had the highest plant height.

Leaf area (cm²)

The leaf area of the plant affected significantly by tillage systems in spring and fall seasons spring. Results of Table 2 shows that the highest leaf area obtained from the normal tillage (T3) which reached 4787 cm² compared to the surface tillage (T2) and zero tillage (T1) treatments, which had a leaf area 4406 and 4101 cm² in spring season respectively. Fall season treatment (T2) gave the highest mean of the leaf area (3826 cm²) and different significantly from other tillage treatments, which showed no significant differences between them. This in agreement with the results of (10 , 13), showed they that the leaf area affected by tillage systems and didn't agree with (16) results of explain superiority of the zero tillage treatment to other tillage treatments. Table 2 other researcher leaf area shows a significant increases in the leaf area of plant with an increase in plant population. The highest plant population (D1) had highest leaf area 3804 cm². The plants at the (D2) recorded the lowest leaf area 3480 cm² in fall season only. This is in agreement with results of (1 , 4). While the plant population didn't affect significantly in this character in spring season. Cultivars differed significantly in leaf area in spring and fall seasons. The cultivar (V2) was superior in spring season and had 4681cm², which differed from maha cultivar (V1) that gave 4182 cm². The cultivar Maha (V1) was superior by giving the highest mean of this character 3702 cm² compared to other cultivars (V2), which gave 3584 cm². These results in agreement with results of other researcher (5 , 21). The interaction between

the tillage systems and plant population showed significant differences in the leaf area, The lowest plant population (D3) with normal tillage system (T3) had the highest value of leaf area (5069 cm²) in spring season. While, in the fall season, the interaction (D3 x T2) had the highest leaf area (4010 cm²). It was noted through the results of the same Table that there was a significant effect from the interaction between the systems of tillage and the cultivars in both seasons. The cultivar Fajr1 (V2) with normal tillage (T3) gave the highest average of leaf area (4977 cm²) in spring season, the interaction (V1 x T2) had the highest average of this character (4092 cm²). The interaction had a significant effect on leaf area, the interaction (V2 x D3 x T3) produced the highest average of leaf area reached 5518 cm² in spring season, while the interaction (V1 x D3 x T2) gave the highest value of leaf area (4579 cm²) in fall season.

Number of ears plant⁻¹

Results in Table 3 shows that the tillage systems had a significant effect on the number of ears per plant in fall season only. The treatment of zero tillage (T1) produced highest number of ears plant (1.543), while (T2) produced the lowest of this character (1.305 ear plants⁻¹), these results in agreement with the results of other researcher (26), they found significant differences in the number of ears plant⁻¹ according to different tillage systems. The lowest plant population (D3) had highest value which had (1.482.plants⁻¹) in fall season only compared to treatment of (D2) that produced 1.28 . These results in agreement with results of other researcher (1 , 12), which found a significant effect of different plant population in the number of ears plant⁻¹. The varieties didn't differ significantly in the number of ears plant⁻¹ in both seasons and these results in agreement with results of Alnasseri (5). The same Table shows that the interaction between the tillage systems and the plant population was significant in this characters in fall season only. The lowest plant population (D3) under the zero tillage treatment (T1) gave the highest value of ears number plant⁻¹ (1.740). Results of the Table shows that the interaction between plant population and cultivars had a significant effect on this character, the interaction (V1 x

D1) give the highest number of ears plant⁻¹ (1.668).

Number of grains ear⁻¹

Table 4 shows that there are significant differences in the number of grains ear⁻¹ under effect of different tillage systems. The normal tillage (T3) exceeded by producing the highest 361.3 grains.ear⁻¹ which was significantly different from zero tillage (T1) but it has not any significant differences from (T2). The surface tillage treatment (T2) in fall season was superior compared to the other tillage treatments by producing highest number of seeds ears⁻¹ (468.4 grains ear⁻¹), this results in agreement with results of Zamir (26) who found a significant difference in the number of grains ear⁻¹ under effect of different tillage treatments. The interaction (D2 x T3) produced the highest of this character (392.1) in spring season. but the interaction (D3 x T2) the highest this characters amounted to 503.0 grains.ear⁻¹ in fall season. As show Table 4, the effect of the interaction between tillage systems and the cultivars in fall season only, the interaction (V2 x T2) produced the highest average of this character amounted to 506.4 grains ear⁻¹ , the interaction of the two factors of plant population and varieties have significantly affected to this character in both seasons, the of (V2 x D1) gave the highest value of the grains per ear reached 361.2 grains ear⁻¹, the interaction of (V1) under the same high plant population (D1) produced the highest average of this character amounted to (461.9 grains ear⁻¹.) The interaction of the studied factors was significant, the interaction (T3 x D2 x V2) produced highest (416.7 grain.ear⁻¹) in spring season, while the triangular interaction treatment (T1 x D1 x V1) produced the highest average reached 480.3 grain ear⁻¹ in fall season.

Weight of 300 grains (gm)

Results in Table 5 shows that the tillage systems affected significantly the weight of 300 grains. The zero tillage was superior to normal tillage and surface tillage which gave highest weight of 300 grains (55.04 and 59.76 gm) in both seasons respectively. The normal tillage treatment recorded the lowest value of this character reached 45.07 and 52.98 gm in both seasons respectively. These results in agreement with results of Alizadeh, Zamir (3 ,

26). As for the plant population, the increase in grain weight was found by increasing the plant population. The highest plant population (D1) produced the highest weight of 300 grains (52.20 gm) in spring season followed that low plant population (D3) which produced 50.86 gm. As for the fall season, the plant population factor did not significantly affect in this character. Results in Table 5 revealed that the varieties differed significantly in fall season only. The V1 cultivar was superior compared to V2 with an average 58.5 and 54.39 gm in both seasons respectively. The results of the fall season in agreement with results of other researcher (20 , 23) they found significant differences in the weight of the grain among different cultivars. The results of the spring season, revealed that cultivars have not effect on this character significantly, this results in agreement with results of nouri and abadi (25) didn't find significant differences between the cultivars in this characters. As for the interaction between tillage systems and plant population, it has a significant effect on this character in both seasons. The low plant population (D3) under the treatment of zero tillage (T1), produced the highest rate of weight of 300 grains reached 59.68 and 62.52 gm in both seasons respectively. The treatment of normal tillage (T3) with plant density (D2) was achieved 42.75 gm in spring season and the same treatment (T3) but with high plant population (D1) gave of 51.43 gm in fall season. The interaction between plant population and varieties had a significant effect on the weight of the grain in fall season only. The cultivar (V1) under the medium plant population (D2) recorded the highest weight of 300 grains reached 59.80 gm in fall season only. The third order interaction had a significant effect on the weight of 300 grains in spring season only. The interaction (V2 x D3 x T1) gave the highest weight of 300 grains was 60.33 gm, while the interaction treatment (V1x D2 x T3) gave 40.37 gm only.

Grains yield (ton.ha⁻¹)

Results in Table 6 indicate that there were no significant differences between the different tillage system treatments on the grains yield in

spring season. The T1, T2 and T3 gave 4.17, 4.32 and 4.13 ton ha⁻¹ respectively, This is a very positive and important result because it could help to us to choose a system of zero tillage, where the cost of material and effort is very low, which means higher economic returns for farmers. While in fall season the tillage systems affected on grain yield. The grains yield which obtained from (T1) was the 6.92 tons ha⁻¹ while the total yield of T2 was 6.31 tons and did not differ significantly from (T1). The treatment (T3) had the lowest average (5.86 ton ha⁻¹). The reason for this increase in grains yield due to the superiority of zero tillage in the some yield components such as the number of ears plant⁻¹ (Table 4) and weight of 300 grains (Tables 5). The results of the spring season in agreement with results of other researcher (14 , 24) Results of fall season, they in agreement with the results of Borrás and Echarte (8) they concluded that the zero tillage system achieved the highest average of grains yield per unit area. Table 6 shows that the increase in plant population led to an increase in grains yield in both seasons. The increase in plant population from D3 to D1 increased grain yield from 3.56 to 4.97 ton ha⁻¹ in spring season, from 5.25 - 8.31 ton ha⁻¹ in fall season. These results in agreement with results of Hamdan, Ijaz (12 , 15) they reported that the difference in plant population led to significantly affects the grains yield. As for the cultivars, there are no significant differences among them in the grains yield in spring season, while in fall season. They differed significantly. These results in agreement with results of Kabululu, Marques (20 , 23). The interaction between tillage systems and plant density was not significant in both seasons in grains yield. The interaction between plant population and cultivars didn't had significant differences in spring season only. while in the fall season, the effect of the interaction between the plant population and the cultivars was significant in the values of the grains yield, the interaction treatment (V1 x D1) gave the highest grains yield of reached 9.85 ton ha⁻¹.

Table 1. Effect of tillage systems and plant populations to plant height (cm) of two maize cultivars

Spring season								Fall season						
Tillage systems	synthetic cultivars	Plant population			T × V	Plant population			T × V					
		D1	D2	D3		D1	D2	D3						
T ₁	V ₁	152.9	144.2	154.7	150.6	146.1	144.5	140.7	143.8					
	V ₂	145.7	168.2	133.4	149.1	147.2	152.5	141.3	147.0					
T ₂	V ₁	130.2	155.0	169.0	151.4	134.2	157.4	132.3	141.3					
	V ₂	135.5	155.6	162.1	151.0	130.4	132.9	142.4	135.2					
T ₃	V ₁	156.0	165.4	168.8	163.4	129.8	129.8	124.6	128.1					
	V ₂	149.0	177.7	144.8	157.2	124.4	122.0	128.8	125.0					
T X D	Tillage system	Plant density			Mean of Tillage systems	Plant density			Mean of Tillage systems					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	T ₁	149.3	156.2	144.1	149.8	146.6	148.5	141.0	145.4					
	T ₂	132.9	155.3	165.5	151.2	132.3	145.1	137.3	138.3					
Mean of D	T ₃	152.5	171.6	156.8	160.3	127.1	125.9	126.7	126.6					
		144.9	161.0	155.5		135.3	139.8	135.0						
D x V	V	D			Mean of V	D			Mean of V					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	V ₁	146.4	154.9	164.2	155.1	136.7	143.9	132.5	137.7					
	V ₂	143.4	167.1	146.8	152.4	134.0	135.8	137.5	135.8					
L.S.D	T	D	V	T*D	T*V	D*V	T*D*V	T	D	V	T*D	T*V	D*V	T*D*V
	7.5	3.1	2.6	7.6	N.S	4.3	9.0	4	3.4	N.S	5.6	4.7	4.7	8.0

Table 2. Effect of tillage systems and plant populations to leaf area (cm²) of two maize cultivars

Spring season								Fall season						
Tillage systems	synthetic cultivars	Plant density			T × V	Plant density			T × V					
		D1	D2	D3		D1	D2	D3						
T ₁	V ₁	4867	3784	3336	3996	3269	3689	3410	3456					
	V ₂	3851	4262	4504	4206	4104	3321	3732	3719					
T ₂	V ₁	4306	4267	3283	4859	3776	3921	4579	4092					
	V ₂	5801	4602	4175	4859	3680	3558	3442	3560					
T ₃	V ₁	4367	4805	4621	4598	4574	2983	3117	3558					
	V ₂	4518	4895	5518	4977	3425	3406	3592	3474					
T X D	Tillage systems	Plant density			Mean of tillage systems	Plant density			Mean of Tillage systems					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	T ₁	4359	4023	3920	4101	3686	3505	3571	3587					
	T ₂	5053	4434	3729	4406	3728	3740	4010	3826					
Mean of D	T ₃	4443	4850	5069	4787	3999	3194	3354	3516					
		4618	4436	4240		3804	3480	3645						
D x V	V	V			Mean of V	D			Mean Of V					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	V ₁	4513	4285	3747	4182	3873	3531	3702	3702					
	V ₂	4723	4587	4732	4681	3736	3428	3588	3584					
L.S.D	T	D	V	T*D	T*V	D*V	T*D*V	T	D	V	T*D	T*V	D*V	T*D*V
	363	N.S	153	507	364	347	583	124	187	109	276	163	N.S	347

Table 3. Effect of tillage systems and plant populations to Number of ears plant (ear.plant⁻¹) of two maize cultivars

		Spring season						Fall season						
Tillage systems	synthetic cultivars	Plant density			T × V	Plant density			T × V					
		D1	D2	D3		D1	D2	D3						
T ₁	V ₁	1.300	1.267	1.400	1.322	1.433	1.277	1.747	1.486					
	V ₂	1.467	1.200	1.200	1.289	1.367	1.700	1.733	1.600					
T ₂	V ₁	1.333	1.267	1.200	1.267	1.687	1.000	1.377	1.354					
	V ₂	1.200	1.200	1.200	1.200	1.000	1.000	1.767	1.256					
T ₃	V ₁	1.400	1.400	1.200	1.333	1.883	1.263	1.133	1.427					
	V ₂	1.333	1.400	1.200	1.311	1.487	1.483	1.133	1.368					
T X D	Tillage systems	Plant density			Mean of Tillage systems	Plant density			Mean of Tillage systems					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
Mean of D	T ₁	1.383	1.233	1.300	1.306	1.400	1.488	1.740	1.543					
	T ₂	1.267	1.233	1.200	1.233	1.343	1.000	1.572	1.305					
	T ₃	1.367	1.400	1.200	1.322	1.685	1.373	1.133	1.397					
D x V	V	Plant density			Mean of V	Plant density			Mean of V					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
		V ₁	1.344	1.311		1.267	1.307	1.668		1.180	1.419	1.422		
	V ₂	1.333	1.267	1.200	1.267	1.284	1.394	1.544	1.408					
L.S.D	T	D	V	T*D	T*V	D*V	T*D*V	T	D	V	T*D	T*V	D*V	T*D*V
	N.S	N.S	N.S	N.S	N.S	N.S	N.S	0.11	0.11	N.S	0.180	N.S	0.14	0.238

Table4. Effect of tillage systems and plant populations to Number of grains ear (grain.ear⁻¹) of two maize cultivars

		Spring season						Fall season						
Tillage systems	synthetic cultivars	Plant density			T × V	Plant density			T × V					
		D1	D2	D3		D1	D2	D3						
T ₁	V ₁	278.0	314.1	262.4	284.8	480.3	406.0	374.3	420.2					
	V ₂	339.0	282.7	234.1	285.3	442.5	348.3	365.3	385.4					
T ₂	V ₁	385.0	282.7	378.0	348.6	478.3	378.0	435.0	430.4					
	V ₂	337.5	380.0	375.3	364.3	429.3	519.0	571.0	506.4					
T ₃	V ₁	306.3	367.6	377.7	350.5	427.0	420.7	412.8	420.2					
	V ₂	407.2	416.7	292.1	372.0	384.9	449.7	444.9	426.5					
T X D	Tillage systems	Plant density			Mean of Tillage systems	Plant density			Mean of Tillage systems					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
Mean of D	T ₁	308.5	298.4	248.2	285.1	461.4	377.2	369.8	402.8					
	T ₂	361.3	331.3	376.7	356.4	453.8	448.5	503.0	468.4					
	T ₃	356.8	392.1	334.9	361.3	405.9	435.2	428.8	423.3					
D x V	V	Plant density			Mean of V	Plant density			Mean of Cultivars					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
		V ₁	323.1	321.4		339.4	328.0	461.9		401.6	407.4	423.6		
	V ₂	361.2	359.8	300.5	340.5	418.9	439.0	460.4	439.4					
L.S.D	T	D	V	T*D	T*V	D*V	T*D*V	T	D	V	T*D	T*V	D*V	T*D*V
	32.9	N.S	N.S	42.2	N.S	33.2	57.8	31.1	N.S	N.S	49.8	34.8	38.5	63.2

Table5. Effect of tillage systems and plant populations to weight of 300 grains (gm) of two maize cultivars

		Spring season						Fall season						
Tillage systems	synthetic cultivars	Plant density			T × V	Plant density			T × V					
		D1	D2	D3		D1	D2	D3						
T ₁	V ₁	59.67	47.63	59.03	55.44	61.83	60.07	66.10	62.67					
	V ₂	56.30	47.30	60.33	54.64	57.07	54.57	58.93	56.86					
T ₂	V ₁	42.30	53.84	51.00	49.05	54.33	63.37	53.90	57.20					
	V ₂	56.67	54.53	48.13	53.11	63.37	59.93	44.60	55.97					
T ₃	V ₁	52.40	40.37	44.00	45.59	54.30	55.97	56.63	55.63					
	V ₂	45.87	45.13	42.67	44.56	48.57	54.73	47.70	50.33					
T × V	Tillage systems	Plant density			Mean of Tillage systems	Plant density			Mean of Tillage systems					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	T ₁	57.98	47.47	59.68	55.04	59.45	57.32	62.52	59.76					
	T ₂	49.48	54.19	49.57	51.08	58.85	61.65	49.25	56.58					
	T ₃	49.13	42.75	43.33	45.07	51.43	55.35	52.17	52.98					
Mean of D		52.20	48.13	50.86		56.58	58.11	54.64						
D × V	V	D			Mean of V	D			Mean of V					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	V ₁	51.46	47.28	51.34	50.03	56.82	59.80	58.88	58.50					
	V ₂	52.94	48.99	50.38	50.77	56.33	56.41	50.41	54.39					
L.S.D	T	D	V	T*D	T*V	D*V	T*D*V	T	D	V	T*D	T*V	D*V	T*D*V
	1.88	1.30	N.S	2.32	N.S	N.S	5.14	4.04	N.S	2.31	5.30	N.S	4.02	N.S

Table 6. Effect of tillage systems and plant populations to grains yield (ton.ha⁻¹) of two maize cultivars.

		Spring season						Fall season						
Tillage systems	synthetic cultivars	Plant density			T × V	Plant density			T × V					
		D1	D2	D3		D1	D2	D3						
T ₁	V ₁	4.34	3.75	3.64	3.91	9.80	5.72	6.26	7.26					
	V ₂	5.73	4.02	3.53	4.43	7.50	6.37	5.86	6.58					
T ₂	V ₁	4.93	3.85	3.95	4.24	9.93	4.66	5.13	6.57					
	V ₂	4.90	4.98	3.32	4.40	6.14	5.39	6.62	6.05					
T ₃	V ₁	4.91	3.48	3.69	4.03	9.82	4.94	4.07	6.27					
	V ₂	5.00	4.48	3.23	4.23	6.64	6.14	3.54	5.44					
T × V	Mean of Tillage systems	Plant density			Mean of Tillage systems	Plant density			Mean of Tillage systems					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	T ₁	5.03	3.89	3.59	4.17	8.65	6.05	6.06	6.92					
	T ₂	4.91	4.41	3.63	4.32	8.04	5.03	5.88	6.31					
	T ₃	4.96	3.98	3.46	4.13	8.23	5.54	3.80	5.86					
Mean of D		4.97	4.09	3.56		8.31	5.54	5.25						
D × V	V	D			Mean of V	D			Mean of V					
		D ₁	D ₂	D ₃		D ₁	D ₂	D ₃						
	V ₁	4.73	3.69	3.76	4.06	9.85	5.11	5.15	6.70					
	V ₂	5.21	4.49	3.36	4.35	6.76	5.97	5.34	6.02					
L.S.D	T	D	V	T*D	T*V	D*V	T*D*V	T	D	V	T*D	T*V	D*V	T*D*V
	N.S	0.53	N.S	N.S	N.S	N.S	N.S	0.77	0.91	0.51	N.S	N.S	1.06	N.S

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