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EFFECT OF TILLAGE TIMES, LASER LEVELING AND CHEMICAL WEED CONTROL ON GROWTH AND YIELD OF *ZEA MAYS* L. VAR. DRAKMA

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Abstract

A field experiment was carried out in one of the agricultural fields of the Diyala Governorate Iraq during the autumn season of 2018-2019, the study effect of the number of tillage times, leveling type with interaction methods weed control on the growth and yield of maize crop variety Drakma. The study was carried out according to Randomized Complete Block Design (RCBD) using split-plot design arrangement with three replicates, the main plots included the number of tillage times, while the sub-plots included the leveling methods (traditional and precise by laser), whereas the sub-sub-plots included five control treatments (comparison, without weed and chemical, weeding, chemical + weeding). The results showed that the two-time tillage exceeded significantly in the plant height characteristic by 231.76 cm, and total grain yield of 11.32 ton.ha^{-1}. As for the precise leveling, it also significantly exceeded at all the studied characteristics over the traditional leveling, as it achieved the highest height of 226.76 cm, the weed dry weight was reduced to 105.21 g.m^{-2} and the total grain yield of 10.65 ton.ha^{-1}. As for the control treatments, they significantly affected most of the studied characteristics, where the control + weeding treatment exceeded in achieving the highest height of 227.5 cm, the lowest weed dry weight of 47.38 g.m^{-2} and the highest yield of 11.55 ton.ha^{-1}. Moreover, control treatments differed significantly among them, as the (without weed and chemical) treatment was superior by giving the highest yield of 10.63 ton.ha^{-1} respectively, in general, two-time tillage, precise leveling, and weed control achieved the best results compared with the comparison treatment.

Key words : Tillage, Precise leveling, Chemical control, Weeding, Maize (*Zea mays* L.).

Introduction

Maize *Zea mays* L. is one of the most important crops in the world as it is used directly in human feeding and its grains are used in the production of poultry and livestock diets (Barnes, 2007). Furthermore, it considers as one of the bio-ethanol sources (Lorenz, 2009), where its plant residues are used in manufacture papers, plastics and alcohol (Kebede and Anbasa,2017); the maize crop importance resulted from it contains a good percentage of carbohydrates, proteins, and vitamins (Dhugga,2007). Despite the importance of this crop, productivity per unit area is still low at a rate of 4,535 ton.ha^{-1} (Central Statistical Organization, 2019), which is below the required level (FAO,1998). In addition, the local yield rate is very low compared to the global production rate, which was 11.07 ton.ha^{-1} (USDA, 2019). Among the most important reasons for the low productivity is the lack of interest in soil and crop service operations, especially weed control operations that compete with the crop on growth requirements, directly affect the vital activities of the crop, and thus crop degradation and decline (Al-Jubouri *et al.*, 1985). The critical period for weed competition for maize crop between 2-7 weeks after planting and this causes a large loss in the yield amounted to 37% (Shrestna *et al.*, 2019; Barua *et al.*, 2019), and in some cases, the losses reached 18% - 85% (Jagadish *et al.*, 2016). Besides, the weed causes difficulty in harvesting and crop service (Zanin *et al.*, 1986), where one of the most important methods used to control the weed is to follow the method

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of precise leveling to the field, which achieves the best germination rate per unit area. As well as, it ensures regular and equal irrigation, which is reflected positively on the yield (Al-Wokaa, 2018), and there has been an increase in the yield of up to 40% when applying precise leveling technology using lasers (Hashimi *et al*., 2017). Chemical control achieved high results in controlling weed and reducing the cost of agriculture due to its ease of use and its positive role in improving the yield and its quality (Mehmeti *et al*., 2012). The mechanical control of the weed accompanying maize crop proved a role in reducing the weed percentage per unit area. As it is considered one of the environmentally friendly methods, but it should be repeated more than once and difficult to do in the advanced times of plant life and the weed may grow again, especially perennials (Al-Wokaa 2019 and Al-Saeedi, 2000). Accordingly, the study aimed to identify the effect of the number of tillage times, precise leveling, chemical control and mechanical weeding n the growth and yield of maize crop variety Drakma.

Materials and Methods

A field experiment was carried out in one of the agricultural fields of the Diyala Governorate/Hibhib District during the autumn season of 2018-2019, to study the effect of the number of tillage times, leveling type and weed control methods on the growth and yield of maize crop variety Drakma. The study was carried out according to Randomized Complete Block Design (RCBD) using a split-plot design arrangement with three replicates, with three factors. The first one is two-level tillage (one-time tillage, two-time tillage), the second factor is the two-level leveling method (traditional leveling, precise leveling using a laser), and the third factor is the different control treatments, which are five (comparison, without weed, chemical, weeding, chemical + weeding). The area of one experimental unit was 90 m^2 (3 m x 30 m), planted with plant density (66666.66) plant.ha^{-1}, the distance between one hole and another was 20 cm and between lines 75 cm. The date of planting was on 20/7/2019, while the chemical control process was then carried out using a 400-liter Turkish sprinkler (Kobra) using chlordane herbicides according to the concentration recommended by the manufacturing company, where the (chemical) treatment was sprayed in addition to (chemical treatment + weeding). Then, the field was irrigated immediately after planting and chemical control, where the irrigation continued according to the plant's need. However, the experiment land was fertilized with nitrogen fertilizer and phosphate according to the recommended quantities, as the compound fertilizer (18 N% and P 18%) was added in one batch at a rate of 400 kg.ha^{-1} at planting, while the urea fertilizer (46 N%) was added at an average of 300 kg.ha^{-1} in three batches. The first batch was at planting, the second is when plants reach a height of 30 cm and the third was at the beginning of the flowering stage (Jeyad and Sahuki 2011). The shares (cultivator 6 sweeps) was used in weeding process and was adjusted by leaving 10 cm on each side of plant lines at a speed of 6 km/hour, while the weed was identified as shown in Table 1 and its density was calculated using the squares method as mentioned in (Al-Wagga, 2012). The experiment was harvested on 11/10/2019, and ten plants were taken from the two intermediate lines in the experimental unit randomly to study the following characteristics:

1. Plants height: Once the flowering process is completed, the plant's height was measured using a graduated tape measure from the stem portion above the soil surface to the upper end of the male inflorescence (tassel) (Sahuki, 1990).
2. Dry weight per meter of weed at harvest (g / m^2): as the weed was cut at the soil surface level from an area of one square meter of the experimental unit and placed inside perforated bags and air-dried for two weeks with continuous stirring to ensure drying until the weight constant (Al Ketbi, 2006).

Table 1: Types of companion weed to the maize crop for the autumn season 2019-2020.

Common name	English name	Scientific name	Family	Life cycle
Amaranthus	Pigweed amaranth	*Amaranthus retroflexus* L.	Amaranthaceae	Winter annual
Sword-grass	Cogon grass	*Imperata cylindrica* L.	Poaceae	Perennial
Common reed	Common reed	*Phragmites australis*	Poaceae	Perennial
Wild cherry	Ground cherry	*Physalis angulate* L	Solanaceae	Winter annual
Cressa cretica	Salt Cresse	*Cressa ceretica* L.	Convolvulacea	Winter annual
Alhagi maourum	Prickly alhagi	*Alhagi maurorum Medic.*	Papilionaceae	Perennial
Betavulgaris	Wild beets	*Beta vulgaris* L.	Chenopodiaceae	Winter annual
Wild lettuce	Prickly lettuce	*Lactuca scariola* L.	Compositae	Winter annual
Bind weed	Field Bind Weed	*Convolvolus arvensis* L.	Convolvulacea	perennial

3. Weight 500 g grain after ear threshing manually using a sensitive balance device at a moisture content of 15.5.
4. Total grain yield (ton.ha^{-1}): The yield of one plant was calculated in grams, and then the total yield in ton was calculated at the standard humidity 15.5% according to the following equation:

grain yield (ton.ha^{-1}) =

$$\frac{\text{Average grain yield per plant (g)} \times \text{plant density}}{1000000}$$

Results and Discussion

The effect of the number of tillage times, leveling type and control methods on the characteristic of plant height

The results in table 2 showed a significant effect of the number of tillage times on the characteristic of plant height, where the two-time tillage achieved the highest average plant height reached 231.76 cm, while the one-time tillage achieved the lowest average plant height was 204.43 cm, which was consistent with (Abdul Amir *et al.*, 2010). The leveling factor had a significant effect, as the precise leveling gave the highest average plant height of 226.76 cm, while the traditional leveling achieved the lowest plant height was 209.43 cm, these results are consistent with (Naresh R.K *et al.*, 2014). It was also noted from the same Table that there were significant differences between control treatments, as the chemical control + weeding treatment achieved the highest height of the plants amounted to 227.5 cm, followed by without weed treatment of 225.58 cm high, while the comparison without control treatment gave the lowest height of 202.33 cm. This confirms the importance of controlling the weed that competes for the crop for space and growth requirements, and that reducing weed leads to a decrease in this competition, which encouraged the corn plant to grow, which was reflected positively on the plant height and this is consistent with (Al-wagaa *et al.*, 2019). The Table also shows a significant interaction in the number of tillage times with leveling in the two methods, where the two-time tillage treatment with precise leveling achieved the highest average height of 242.80 cm, while the one-time tillage treatment with traditional leveling gave the lowest height of 198.13 cm. Furthermore, it was observed that the interaction between the number of tillage times and the control treatments had a significant effect on the plant height. As the two-time tillage, treatment was superior with the chemical control + weeding treatment and gave the highest height of 240.33 cm, whereas, the one-time tillage treatment with the comparison treatment without control gave the lowest height was 188.00 cm. It was also observed that the interaction between the leveling method and the control treatments has a significant effect, as the precise leveling treatment was superior with the control + weeding treatment and achieved the highest height of 235.5 cm, while the traditional leveling treatment with the comparison gave the lowest height of 192.33 cm. The Table also shows a triple significant interaction, as the two-time tillage treatment with the precise leveling and the control + weeding treatment achieved the highest height of 251.33 cm, while the one-time tillage treatment with the traditional leveling and the comparison treatment gave the lowest height of 179.66 cm.

The effect of the number of tillage times, leveling type and control methods on the characteristic of the dry weight of the companion weed the maize crop g / m^2

The results in table 3 showed a significant effect of

Table 2: The effect of the number of tillage times, leveling type and control methods on the characteristic of plant height for maize plant variety Drakma.

Tillage systems	Leveling method	Control treatments					Tillage X leveling	Tillage effect	Leveling effect
		Chemical + weeding	Chemical	Without weed	Weeding	Comparison			
Two-time tillage	Precise leveling	251.33 a	248.33 b	250.33 a	235.66 c	228.33 d	242.8a		
	Traditional leveling	229.33 d	225.33 e	228.00 d	216.00 g	205.00 k	220.73 b		
One-time tillage	Precise leveling	219.66f	214.33 h	216.66 g	206.66j	196.33l	210.73 c		
	Traditional leveling	209.66i	203.66 k	207.33j	190.33 m	179.66 n	198.13 e		
Tillage X control treatments		240.33 a	236.83 c	239.16 b	225.83 d	216.66 e		231.76 a	
		214.66f	209.00 h	212.00 g	198.50i	188.00j		204.43 b	
Leveling X control treatments		235.5a	231.33 c	233.5b	221.16 d	212.33 h			226.76 a
		219.5e	214.5g	217.66f	203.16i	192.33j			209.43 b
Control treatments effect		227.5a	222.91 c	225.58 b	212.16 d	202.33 e			

* The values of averages followed by the same letter for each characteristic are not significantly different at the significance level of 5%.

Table 3: The effect of the number of tillage times, leveling type and control methods on the characteristic of dry weight of the companion weed the maize crop g / m^2 variety Drakma.

Tillage systems	Leveling method	Control treatments					Tillage X leveling	Tillage effect	Leveling effect
		Chemical + weeding	Chemical	Without weed	Weeding	Comparison			
Two-time tillage	Precise leveling	38.82 i	75.02 h	0.00 k	91.21 g	426.02 b	126.21 b		
	Traditional leveling	73.94 h	100.03 g	0.00 k	139.62 e	475.30 a	157.78 a		
One-time tillage	Precise leveling	24.06 j	45.62i	0.00 k	92.13 g	259.20 d	84.20 d		
	Traditional leveling	52.70 i	70.49 h	0.00 k	121.33 f	351.45 c	119.19 c		
Tillage X control treatments		56.38 e	87.52 d	0.00 g	115.42 c	450.66 a		142.00 a	
		38.38 f	58.06 e	0.00 g	106.73 c	305.32 b		101.70 b	
Leveling X control treatments		31.44 f	60.32 e	0.00 g	91.67 d	342.61 b			105.21 b
		63.32 e	85.26 d	0.00 g	130.48 c	413.38 a			138.49 a
Control treatments effect		47.38 d	72.79 c	0.00 e	111.07 b	377.99 a			

* The values of averages followed by the same letter for each characteristic are not significantly different at the significance level of 5%.

the number of tillage times on the characteristic of weed dry weight, where the one-time tillage achieved the lowest weed dry weight was 101.70 g / m^2, while the two-time tillage achieved the highest weed dry weight reached 142.00 g / m^2, this differs from what (Al-Jawadi,1999) mentioned. The leveling factor had a significant effect, as the precise leveling gave the lowest weed dry weight of 105.21 g / m^2, while the traditional leveling achieved the highest weed dry weight was 138.49 g / m^2. The reason may be attributed to the fact that a good leveling reduces the weed growth, which is one of the modern scientific methods in reducing the growth and proliferation of the weed and this is consistent with what (Rickman, 2002) indicated. It was also noted from the Table that there were significant differences between control treatments, as the without weed treatment achieved a significant effect amounted to 0 g / m^2, while the comparison without control treatment achieved the highest weed dry weight reached 377.99 g / m^2, this is consistent with (Khazali *et al.*, 2019). The Table also shows a significant interaction in the number of tillage times with leveling in the two methods, where the one-time tillage treatment with precise leveling achieved the lowest weed dry weight of 84.20 g / m^2, while the two-time tillage treatment with traditional leveling gave the highest weed dry weight amounted to 157.78 g / m^2. Moreover, it was observed that the interaction between the number of tillage times and the control treatments had a significant effect on the characteristic of weed dry weight. As the two-time tillage and the one-time tillage treatments were superior with the without weed treatment and gave the lowest weed dry weight reached 0 g / m^2, whereas, the two-time tillage treatment with the comparison treatment without control gave the highest weed dry weight was 450.66 g / m^2. The interaction between the leveling method and the control treatments has a significant effect, as the precise and traditional leveling treatments were superior with the without weed treatment and achieved the lowest weed dry weight reached 0 g / m^2, while the traditional leveling treatment with the comparison gave the highest weed dry weight reached 413.38 g / m^2. The same Table also shows that there was a triple significant interaction, as the without weed treatment in all treatments achieved the lowest weed dry weight of 0 g / m^2, while the two-time tillage treatment with the traditional leveling and the comparison treatment gave the highest weed dry weight amounted to 475.30 g / m^2.

The effect of the number of tillage times, leveling type and control methods on the characteristic of weight 500 grain/g

The results in table 4 showed a significant effect of the number of tillage times on the characteristic of weight 500 grain, where the two-time tillage achieved the highest weight was 165.16 g, while the one-time tillage achieved the lowest weight reached 135 g. As the tillage method plays an important role in improving the yield components of any agricultural crop (Tekhanov, 1997). The leveling factor had a significant effect, as the precise leveling gave the highest weight reached 157.68 g, while the traditional leveling achieved the lowest weight was 143.14 g, this is consistent with (R.K.Naresh *et al.*, 2014). It was also noted from the Table that there were significant differences between control treatments, as the chemical control + weeding treatment achieved the highest weight amounted to 160.14 g, followed by without weed treatment of 158.39 g. The comparison without control treatment achieved the lowest weight reached 134.46 g, this is consistent with (Abdullahi *et al.*, 2016) stated, that chemical and mechanical treatments resulted in maximum grain yield compared to the comparison treatment. The Table also shows a significant interaction in the number

Table 4: The effect of the number of tillage times, leveling type and control methods on the characteristic of weight 500 grain/g variety Drakma.

Tillage systems	Leveling method	Control treatments					Tillage X leveling	Tillage effect	Leveling effect
		Chemical + weeding	Chemical	Without weed	Weeding	Comparison			
Two-time tillage	Precise leveling	184.09 a	180.51 c	183.30 b	166.48 f	156.02 h	174.08 a		
	Traditional leveling	170.63 d	163.14 g	168.10 e	146.49 k	132.87 p	156.24 b		
One-time tillage	Precise leveling	149.31 i	144.79 l	147.73 j	135.72 n	128.89 r	141.29 c		
	Traditional leveling	136.53 m	131.76 q	134.45 o	127.32 s	120.08 t	130.03 d		
Tillage X control treatments		177.36 a	171.83 c	175.70 b	156.48 d	144.44 e		165.16 a	
		142.92 f	138.28 h	141.09 g	131.52 i	124.48 j		135.66 b	
Leveling X control treatments		166.70 a	162.65 c	165.52 b	151.10 e	142.45 g			157.68 a
		153.58 d	147.45 f	151.27 e	136.90 h	126.90 i			143.14 b
Control treatments effect		160.14 a	155.05 c	158.39 b	144.00 d	134.46 e			

* The values of averages followed by the same letter for each characteristic are not significantly different at the significance level of 5%.

of tillage times with leveling in the two methods, where the two-time tillage treatment with precise leveling achieved the highest weight of 174.08 g, while the one-time tillage treatment with traditional leveling gave the lowest weight amounted to 130.03 g. Furthermore, it was observed that the interaction between the number of tillage times and the control treatments had a significant effect on the average yield. As the one-time tillage and the two-time tillage treatments was superior with the chemical control + weeding treatment and gave the highest weight reached 177.63 g, whereas, the one-time tillage treatment with the comparison treatment without control gave the lowest weight was 124.48 g. It was also observed that the interaction between the leveling method and the control treatments has a significant effect, as the precise leveling treatment was superior with the chemical control + weeding treatment and achieved the highest weight reached 166.70 g, while the traditional leveling treatment with the comparison gave the lowest weight reached 126.90 g. The Table also shows that there was a triple significant interaction, as the two-time tillage treatment with traditional leveling in the control + weeding treatment achieved the highest weight amounted to 184.09 g, while the one-time tillage treatment with traditional leveling with comparison treatment gave the lowest weight was 120.08 g.

The effect of a number of tillage times, leveling type and control methods on the characteristic of grain yield (ton.ha^{-1})

The results in table 5 showed a significant effect of the number of tillage times on the characteristic of grain yield, where the two-time tillage achieved the highest grain yield amounted to 11.32 ton.ha^{-1}, while the one-time tillage achieved the lowest grain yield reached 8.91 ton.ha^{-1}, this is agreed with (Abdul Amir *et al.,* 2010) results. The leveling factor had a significant effect, as the precise leveling gave the highest grain yield reached 10.65 ton.ha^{-1}, while the traditional leveling achieved the lowest grain yield was 9.58 ton.ha^{-1}, this is consistent with (Hashimi *et al.,* 2017). It was also noted from the same Table that there were a significant differences between control treatments. As the chemical control + weeding treatment achieved the highest grain yield amounted to 11.55 ton.ha^{-1}, followed by without weed treatment of 11.23 ton.ha^{-1}, while the comparison without control treatment achieved the lowest grain yield reached 7.83 ton.ha^{-1}. This gives a clear indication that the weed works to continuously absorb nutrients throughout the growing season, which in turn reduces the simplest growth ingredients needed for the maize and this is embodied in the comparison treatment (S.Ramesh, 2019). The Table also shows a significant interaction in the number of tillage times with leveling in the two methods, where the two-time tillage treatment with precise leveling achieved the highest grain yield of 12.15 ton.ha^{-1}, while the one-time tillage treatment with traditional leveling gave the lowest grain yield amounted to 8.68 ton.ha^{-1}. Moreover, it was observed that the interaction between the number of tillage times and the control treatments had a significant effect on the average yield, as the two-time tillage treatment was superior with the chemical control + weeding treatment and gave the highest grain yield reached 13.06 ton.ha^{-1}. Whereas, the one-time tillage treatment with the comparison treatment without control gave the lowest grain yield was 7.10 ton.ha^{-1}. It was also observed that the interaction between the leveling method and the control treatments has a significant effect, as the precise leveling treatment was superior with the chemical control + weeding treatment and achieved the highest grain yield reached 12.20 ton.ha^{-1}, while the traditional leveling treatment with the comparison gave the lowest

Table 5: The effect of the number of tillage times, leveling type and control methods of grain yield for maize plant variety Drakma.

Tillage systems	Leveling method	Control treatments					Tillage X leveling	Tillage effect	Leveling effect
		Chemical + weeding	Chemical	Without weed	Weeding	Comparison			
Two-time tillage	Precise leveling	14.04 a	12.80 c	13.73 b	10.98 g	9.19 k	12.15 a		
	Traditional leveling	12.08 d	11.35 f	11.78 e	9.29 k	7.93 o	10.49 b		
One-time tillage	Precise leveling	10.36 h	9.29 k	9.84 i	8.71 m	7.51 p	9.14 c		
	Traditional leveling	9.72 ij	9.08 l	9.59 j	8.29 n	6.70 q	8.68 d		
Tillage X control treatments		13.06 a	12.07 c	12.75 b	10.14 d	8.56 g		11.32 a	
		10.04 d	9.19 f	9.72 e	8.50 g	7.10 h		8.91 b	
Leveling X control treatments		12.20 a	11.05 c	11.78 b	9.85 g	8.35 i			10.65 a
		10.90 d	10.21 f	10.69	8.79 h	7.31 j			9.58 b
Control treatments effect		11.55 a	10.63 c	11.23 b	9.32 d	7.83 e			

* The values of averages followed by the same letter for each characteristic are not significantly different at the significance level of 5%.

grain yield reached 7.31 ton.ha^{-1}. The Table also shows that there was a triple significant interaction, as the two-time tillage treatment with traditional leveling in the control + weeding treatment achieved the highest grain yield amounted to 14.04 ton.ha^{-1}, while the one-time tillage treatment with traditional leveling with comparison treatment gave the lowest grain yield was 6.70 ton.ha^{-1}.

Conclusion

From the result of the investigation being concluded to repeated tillage, tolerance, precision and control chemical herbicides crosses made their superiority in grain yield under high plant and increase the leaf area relevant to the largest number of cereal bars and weight of 500 seeds per plant and number of grains in the from. Critical differences were noted, in terms of effect of repeat tillage, Soil settlement and control methods, especially herbicides with Mechanical cutting weed**.**

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