

The Efficiency Of Different Methods In Controlling Potato Weeds And Their Effect On Some Traits Of Potato Tuber Yield

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Abstract

A field experiment was conducted in one of the agricultural fields in Nineveh province to study the effect of weeds control methods on the potato crop in the autumn season 2020-2021, represented by manual, chemical, and mechanical control, with three dates (50, 50 + 100 and 100%) of the percentage of potato tubers germination with the presence of a control treatment (without counter), The results showed that all control methods led to an increase in the percentage of control based on the dry weight of the weeds and the number of weeds that were eliminated in compared with the control treatment (without control), but in varying proportions, and that all control methods were expensive when compared with the control treatment. (without counter), Where manual control was twice as expensive due to the large number of workers involved in the control work, while mechanical control gave the lowest value of control costs, but it was useless in the quantitative yield traits. Chemical control was less expensive than manual control, and it was noted that all control methods led to an increase in the total number of tubers per plant compared to the control treatment (without control), As for the marketable plant yield and the total yield, the mechanical control gave a yield close to that of the control treatment (without control). While manual and chemical control recorded for the second date the highest total yield of tubers (ton. ha⁻¹).

Keywords: potato weeds, potato tuber yield, *Solanum tuberosum* L.

Introduction

Potato (*Solanum tuberosum* L.), belonging to the Solanaceae family, is one of the most important crops in the world due to its abundant yield, cheap productivity, and diversity of growth under different conditions, and despite the fact that the environmental conditions in Iraq. It may be suitable for the growth of the crop, but the productivity of the crop is low compared to Arab countries such as Egypt. The reason for this is the lack of care by farmers in the servicing operation's crop, especially in the field of weeds controlling, where the weeds cause heavy losses that sometimes lead to the loss of the entire crop and thus depends on the density of the weeds and the quality of the weeds prevalent in the field. Most of the researchers confirmed that the weeds cause great losses in the total yield, ranging from 30-50%, the loss of half of the yield may sometimes reach more than 70% (Al-Ziyadi and Al-Shati, 2010). The competition from the bush to the potato crop for light, water, and nutrients is not only limited to productivity but also affects the quality of the tubers. Where the weeds help in the appearance of holes and distortions in the potato tubers and may also contribute to the production of

tubers of small size and unwanted during marketing, which causes heavy losses to the farms, and some weeds secrete toxic substances that may cause the destruction of the crop and the weed is a suitable habitat for many agricultural pests, insects, and viruses that may contribute significantly to the decline in productivity in terms of quantity and quality. Zollinger (2000). Among the other damages caused by the weed is the increase in the costs of agricultural operations through preparing the land and using agricultural machinery and pesticides to control it (Al-Jawadi, 1999). In order to measure the percentage of control on the basis of dry weight, Sultan et al. (2015) explained that there is an increase in the percentage of dry weight of the weeds in mechanical controlling, and thus the lowest percentage of control was recorded compared to chemical control using the pesticide cramezone. Manual control can also give a higher percentage of control on the basis of dry weight than chemical control, especially when using the control twice, Poddar et al. (2017) and Gupta et al. (2019), Many researchers also emphasized that manual control is very expensive, especially when it is conducted in two stages or more, and needs up to (25) workers per hectare, while chemical control by bag big sprayer needs approximately two workers per hectare to conduct the control properly. While mechanical control needs only one factor per hectare, the tractor driver Aldahol (2006) and Shehata et al. (2019), and there can be an increase in the total yield of tubers when using manual control twice compared to chemical control methods using Paraquat Kepede et al. (2016). The aim of the research is to know the best system and best date for controlling the autumn potato weeds in Nineveh province, and to indicate the costs of those systems used in the weeds control, and to know the best total yield of the potato crop through the systems used in the controlling.

Materials and methods

The tubers were cultivated on 9/9/2020, the Dutch Riviera cultivar, and were cultivated on the Furrow, the distance between one and another is 75 cm, at a depth of 10-12 cm, and the distance between one tuber and another was 25 cm. The experiment was conducted in a simple experiment system with a design of randomized complete blocks with three replicates, and independent comparisons were made between the treatments (groups), and after recording the data, it was statistically analyzed and the averages were compared using Duncan's multinomial test at a probability level of 0.05.

The study of the experiment included 10 treatments as follows:-

1- control treatment (without control).

2- Manual control (A1B1): It includes the first date (control when the percentage of germination of potato tubers reaches 50%).

3- Manual control (A1B2): It includes the second date (control when the percentage of germination of potato tubers reaches 50% and 100%).

4- Manual control (A1B3): It includes the third date (control when the percentage of germination of potato tubers reaches 100%).

5- Chemical control (A2B1): It includes the first date (control when the percentage of germination of potato tubers reaches 50%).

6- Chemical control (A2B2): It includes the second date (control when the percentage of germination of potato tubers reaches 50% and 100%).

7- Chemical control (A2B3): It includes the third date (control when the percentage of germination of potato tubers reaches 100%).

8- Mechanical control (A3B1): It includes the first date (control when the percentage of germination of potato tubers reaches 50%).

9- Mechanical control (A3B2): It includes the second date (control when the percentage of germination of potato tubers reaches 50% and 100%).

10- Mechanical control (A3B3): It includes the third date (the control when the percentage of germination of potato tubers reaches 100%).

Before conducted the cultivation process, the soil was plowed with moldboard plows, and the organic fertilizers were spread by the animal manure spreader (HARMANIS). After that, smoothing and leveling machines were used in the field. After that, the potato was mechanically planted by the two-line planter on 9/9/2020, Compound fertilizers (NPK) were sprayed at the same time as the cultivation, and the fixed sprinkler irrigation system was used to conducted irrigation operations for the crop, and it was conducted on 10/11/2020. All control methods where the percentage of germination of the potato crop was 50%, and the second control was conducted on 10/18/2020 when the percentage germination reached 100%. The Axe was used to conducted manual control, and the bag big sprayer with a capacity of 16 liters was used, which contains a mixture of water and paraquat pesticide (2 liters of pesticide + 400 liters of water). 1 hectare for chemical control, While mechanical cultivators were used with three shares as mechanical control. The potato planter used AYDIN PULLUK, which works with only one line and a working width of 60 cm.

The following traits were studied:

1- The percentage of control based on the dry weight of the weeds %

The following equation was used and approved by Yadav et al (2015).

$$WCE = \frac{DWC - DWT}{DWC} \times 100$$

where:

WCE: control percentage based on weed dry weight %, DWC: weed dry weight in control treatment g, DWT: weed dry weight in weed control treatments (g).

2- Number of weeds eliminated (m^2):

The following equation was used:

Number of weeds eliminated (m^2) = Number of weeds in (Control) treatment in (m^2) -

Number of weeds remaining in weeds control treatments in (m^2)

3- Control costs for each treatment

It was calculated by the worker's wages per day for each of the control methods used in the research.

4- Total number of tubers (tuber. plant⁻¹):

The total number of tubers per plant was calculated using the following equation:

$$\text{Total number of tubers (tuber. plant}^{-1}\text{)} = \frac{\text{Total number of tubers}}{\text{The number of plants from which the sample was taken}}$$

5- Product of the marketable plant yield:

It was calculated using the following equation:

$$\text{the marketable plant yield} = \frac{\text{Marketable tubers yield}}{\text{The number of plants from which the marketable yield was taken}}$$

6- The total yield of tubers (ton. ha⁻¹):

Nine samples were taken for each experimental unit and the average yield per plant was taken using the following equation:

$$\text{Total yield} = \text{total yield per plant} \times \text{number of plants/ha}$$

Results and discussion

The control percentage based on the dry weight of the weeds:

The results in table (1) indicate that the control percentage based on the dry weight of the weeds at the first date recorded significant differences between the control systems, where the manual control treatment at the first date (A1B1) recorded the highest significant value and amounted to (92.10%), which differed significantly with the treatment of Mechanical control (A3B1) which recorded (60.73%), While it did not differ significantly with the chemical control treatment for the same date (A2B1), which recorded (81.57%), the reason for the existence of significant differences between the manual and mechanical control treatment at the first date is that the mechanical control leaves lines (between share) untreated where the weeds is It continues to grow, and this has led to an increase in the dry weight of the weeds, and consequently a decrease in the control percentage when mechanical control, and this was confirmed by Johnson and Frick (2002) and (Al-Adab, 2006). As for the control percentage based on the dry weight of the weeds at 50% + 100% of the percentage germination of the potato crop (the second date), the results showed that there is a significant difference between the manual and chemical control at the second date (A1B2 and A2B2) with the mechanical control at the second date (A3B2). and were (99.07, 98.77 and 36.07)%, respectively. Hence, we note that the second date (twice) recorded a higher rate of control than the first date (once) for manual and chemical control, since hoeing or spraying chemical pesticides for one time does not give clear results in controlling the weeds because the effect of the control may decrease on time and the recurrence of The control will lead to the weakening of the weeds significantly and manual control twice is better than chemical control twice, due to the emergence of some weeds resistant to the pesticide used, and this was confirmed by Al-Jubouri et al (1985) and Sultan and Barwary (2008) and the reason for the existence of significant differences between manual control and mechanical control is due to the fact that the two-time control of the mechanical control system has contributed significantly to an increase in the number of bushes (such as Garden Grass), and thus the dry weight of the weeds has increased, and thus the percentage of control is reduced, and this is what Sultan et al. (2015). It is clear from the results that the highest control percentage the based on the dry weight of the weeds at 100% of the percentage germination of the potato crop reached (97.63%) in the chemical control treatment at the third date (A2B3), which did not differ significantly with the manual control treatment at the third date (A1B3), where recorded (95.17%) and the treatment of chemical and manual control at the third date (A1B3 and A2B3) differed significantly with the treatment of mechanical control at the third date (A3B3), which recorded 38.37 %. The method of manual control and the method of chemical control were close and did not give significant differences, this is what was indicated by (Al-Dahool, 2006), while the mechanical control

method recorded the lowest relative difference with the rest of the treatments due to the increase in the dry weight of the weeds.

The number of weeds eliminated (m²):

The results of the number of weeds that were eliminated (m²) at 50% of the germination rate of the potato crop (first date) in Table (1) indicate that there is no significant difference between the manual control treatment and the chemical control treatment for the first date, which were recorded (170.6) weed.m⁻² and they differed significantly with the mechanical control treatment for the same date, where it was recorded (116.6) weed.m⁻², We note that manual and chemical control was highly effective in eliminating weed density and this was confirmed by Poddar et al. (2017) and Abadi (2010). As for the mechanical control, it was useless in control weed, because it cannot reach the roots of the deep weeds, and it cuts the roots of the rhizome weeds, causing an increase in its spread, and this is in agreement with (Vasilakoglou et al., 2013). The results also showed that the number of weeds that were eliminated (m²) at 50% + 100% of the percentage germination of the potato crop (second date). The treatment of manual and chemical control twice gave the highest significant difference in the trait of the number of bushes that were eliminated and they differed significantly with the mechanical control treatment for two times, where these treatments were recorded respectively (103.8, 110.1 and 39.9) perch.m⁻². The reason is that paraquat has contributed significantly to reducing weed density, as confirmed by Ebadi (2010) and Ibade and Mohammed (2020). The results of the number of weeds that were eliminated (m²) at 100% of the percentage germination of the potato crop (the third date) showed the effectiveness of manual and chemical control, where it is noted that the two treatments of manual and chemical control at the third date gave the highest significant values in this trait, which were recorded (107.1 and 107.1). 95.8) weed.m⁻²,

and they differed significantly with the mechanical control for the third date, which recorded (31.8) weed.m⁻², and the reason for this is that manual control was very effective in eliminating the weed and the chemical control by using the pesticide Karamexone has contributed to the killing and extermination of the growths of the bush, as for the mechanical control .It showed a decrease in the number of weeds that were eliminated due to the presence of weeds such as the Garden Grass, which was able to restore its vegetative growth very quickly, and this is what was indicated by (Sultan et al., 2015).

Costs of control operations (\$.ha⁻¹):

The results in Table (1) indicate that the costs of the manual control treatment at the second date (twice) gave the highest costs among the costs of the control systems, where it was recorded (184.54) dollars per ha⁻¹. This is due to the large number of workers engaged in weeds eliminated operations. Their total number reached (26.94) workers. 1 hectare, Followed by the manual control treatment on the third date, which amounted to \$ (123.71). ha⁻¹ and the number of workers was (18.06) workers. hectare-1, and the manual control treatment was recorded at the first date (107.27). Hectare-1 and the number of workers was (15.66) workers .ha⁻¹. Here, we note that manual control twice was expensive and difficult, and this was confirmed by Uremis et al. (2009), but it was very effective in eliminating the weeds, and this was indicated by Bawazir and Shuaib (2013), Kebede et al. (2016), Poddar et al. (2017), and EL-Metwally and EL-Wakeel (2019) ,As we note in the table that the treatment of manual control on the third date was higher than the treatment of manual control on the first date, due to the increased bush density on the third date. Chemical control gave less costs than manual control, as it was recorded on the first date (27.38) \$.ha⁻¹, recorded on the second date (53.03) \$.ha⁻¹, and recorded on the last date (29.85) \$.ha⁻¹. The reason for this discrepancy in the costs of chemical control for the first and second dates is the increase in the number of workers in the process of spraying the pesticide on the weeds, where the number of workers on the first date was (1.4) workers. 1 hectare, while the number of workers in chemical control twice was (2.63) workers. 1- There are also other costs added to the costs, such as

the rental of the sprayer and the spraying of Paraquat pesticide for the second time. The difference in the costs of the first date from the costs of the third date is due to the increase in the number of workers, which were (1.64) workers. 1 hectare of this increase was due to the increase in the density of the weed. It is noted that the costs of chemical control are lower than the costs of manual control and were of good productivity, and this was confirmed by Al-Dahool (2006) and Shehata et al. (2019). The mechanical control treatment was recorded on the first date (21.91) \$.ha⁻¹, on the second date (43.82) \$.ha⁻¹, and on the last date (21.91) \$.ha⁻¹. We note that there is a discrepancy between the first date and the second date, due to the repetition of the control process an increase in the costs of renting the tractor and machine with the tractor driver's fee. There is a discrepancy in the cost values between the second date and the third date for the same reason above, and from here we note that manual and chemical control is better than mechanical control and this is what Al-Allaf (2006) indicated. However, mechanical control recorded the lowest costs among the control systems.

Table (1) Effect of weed control systems and dates on the percentage of control, the number of weed and the costs of the control process in the autumn potato crop

control costs (\$.ha ⁻¹)	weeds that eliminated at 100% weed.m ²	weeds that eliminated at 50% weed.m ²	The percentage of control at 100% of the germination of the potato crop	The percentage of control at 50% of the germination of the potato crop	Treatments	No
0.00	0 d	0 d	0.00 c	0.00 c	Control	1
107.27	61.8 b	170.6 a	97.40 a	92.10 a	A1B1 Manual control first date	2
184.54	103.8 a	168.6 a	99.07 a	85.20 ab	A1B2 Manual control second date	3
123.71	107.1 a	26.0 c	95.17 a	0.43 c	A1B3 Manual control third date	4
27.38	104.8 a	170.6 a	97.23 a	81.57 ab	A2B1 Chemical control first date	5
53.03	110.1 a	164.0 a	98.77 a	76.27 ab	A2B2 Chemical control second date	6
29.85	95.8 a	33.0 c	97.63 a	15.33 c	A2B3 Chemical control third date	7
21.91	25.1 c	116.6 b	43.07 b	60.73 b	A3B1 Mechanical control first date	8
43.82	39.9	100.6	36.07	24.07	A3B2	9

	c	b	b	c	Mechanical control second date	
21.91	31.8 c	10.0 cd	38.37 b	5.83 c	A3B3 Mechanical control third date	10

*The averages with the same letters within the same column do not differ significantly according to Duncan's polynomial test under the 0.05 probability level.

The average number of total tubers (tuber. plant⁻¹):

It is noted from the results in Table (2) that the manual control treatment at the first date and the chemical control treatment at the second date gave the highest significant values in the total number of tubers per plant, amounted to (5.945 and 5.890) tubers. Chemical control at the third date, which recorded (4,056) tuber.plant⁻¹, and the mechanical control treatment at the third date, which gave (4.167) tuber.plant⁻¹, and the control treatment (without control), which gave the lowest value in this trait and was (3.112) tuber. plant⁻¹. While no significant differences were observed between the rest of the treatments. The reason for the excelled of the manual control treatment at the first date is the low effect of the weeds with potato plants, which means that the bush is less competitive for the crop for water, light and nutrients, so this treatment is very effective and this is what was indicated by Poddar et al. (2017). The chemical control at the second date also had the highest significant value due to the lack of weeds competition for the crop due to spraying chemical pesticides twice, and this was confirmed by Sultan and others (2015). clear with control treatment. This was confirmed by Momany et al. (2016), and the reason for the low value of the control treatment is due to the large number of weeds that contribute to reducing the number of tubers per plant, and this was confirmed by Zarzecka et al, 2020)

marketable yield of the plant (kg):

The results in Table (2) indicate that the manual control treatment at the second and third dates and the chemical control treatment at the second date gave the highest significant values in the marketable plant yield and recorded (0.859, 0.792 and 0.800) kg, respectively, and these treatments differed significantly with the manual control treatment. For the first appointment and the chemical control treatment for the first and third appointments, it also differed with all mechanical control treatments and with the control treatment also, which recorded (0.273) kg, We note that one of the best effective methods to control the weeds is the manual control twice, which led to an increase in the marketable plant yield, and this was indicated by Bawazeer and Shuaib (2013) and Kebede et al. (2016), while the control of pesticides was less effective. The reason for this is due to the emergence of weeds resistant to the pesticide used and this was confirmed by Sultan and Barwary (2008). and the mechanical control treatment was close to the control treatment.

Total yield (tons. ha⁻¹):

It is noted from the results in Table (2) that the manual control treatment at the second date (twice) recorded the highest significant values in the total yield, reaching (31.262) tons. hectare-1 and differed significantly with the treatment of manual control at the first date, where it differed significantly with Chemical control treatment at the first appointment, as well as it differed with all mechanical control treatments (all appointments), It also differed with the comparison treatment (without control), which recorded the lowest significant value in this trait and amounted to (10.025) tons. hectare-1, and no differences were observed with the manual control treatment at the third date and the chemical control treatment at the second date

(twice). We note from the table that the manual control twice was effective in increasing the productivity of the total crop, and this was confirmed by Kebede et al(2016), and that the chemical control was twice as close to the manual control twice, and this was indicated by Al-Dahol (2006), and that all methods of control (manual and chemical) and mechanical) has led to an increase in the total yield of tubers and this is what was concluded (Momany et al., 2016).

Table (2) The effect of weed control systems and dates on the quantitative yield traits of the autumn potato .crop

Total yield (tons. ha-1)	marketable yield of the plant (kg)	Total number of tubers(tuber. plant-1)	Treatments	No.
d10.025	d0.273	c3.112	Control	1
bc25.656	bc0.709	a5.945	A1B1 Manual control first date	2
a31.262	a0.859	ab4.944	A1B2 Manual control second date	3
ab28.664	ab0.792	ab5.445	A1B3 Manual control third date	4
c23.756	c0.647	ab4.890	A2B1 Chemical control first date	5
ab29.196	ab0.800	a5.890	A2B2 Chemical control second date	6
bc25.162	bc0.687	bc4.056	A2B3 Chemical control third date	7
d13.824	d0.372	ab5.00	A3B1 Mechanical control first date	8
d11.863	d0.297	abc4.611	A3B2	9

			Mechanical control second date	
d11.244	d0.288	bc4.167	A3B3 Mechanical control th date	10

* The averages with the same letters within the same column do not differ significantly according to Duncan's polynomial test under the 0.05 probability level.

Conclusions

Through this research, we can conclude that manual and chemical control was positively effective in eliminating the weeds and reducing their dry weight, thus increasing the percentage of control. Also, the manual and chemical control twice led to an increase in the marketable plant yield and the total yield, while the mechanical control once or twice did not prove effective in this, but on the contrary, it was very close to the comparison treatment (without control).

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