Preliminary Study on the Effect of Certain Weed Control Strategies on the Weed Seed Banks in the Soil

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Abstract

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Regular studies of soil seed banks can give a lot of information about different weed species that persist in experimental fields, and help for planning different weed management strategies. In this work, two field experiments in a randomized complete block design (RCBD) were carried out at Giza Farm Station located at Giza Governorate, Egypt, to evaluate the effect of certain weed control strategies on the weeds' species seed bank in the soil during the summer season of the years 2021 and 2022. To determine all weed species in the soil seed bank, both the emergence method and extracted seeds method were used. Ten weed control treatments were applied in the experiment including 6 herbicide treatments using different combinations and 3 hoeing treatments (1, 2 and 3 times), in addition to the untreated control treatment. After application of treatments, soil samples were taken at depths of 5 cm and 15 cm from the soil surface, to study weed seedbank distribution in the soil and identify the species present. Results obtained indicated that the emergence method has given less seedling number than of the seed extraction method, and horizontal distribution in soil seed bank at zero time showed high significance at P≥ 0.01 between the experimental replicates for most weed species and their total, whereas the vertical distribution of the soil seed bank showed no significant difference between the two depths of 5 and 15 cm for all weed species except those of *Setaria virids* and *Ipomoea eriocarpa*. It can be concluded from this study that the implemented control strategy based on applying pre- and post emergence herbicides and hoeing treatments in two subsequent seasons summer seasons significantly reduced the soil seed bank of all identified weed species and their total.
Key words: Weed management, weed seedbank, herbicides, *Setaria viridis* and *Ipomia eriocarpa*.

Introduction

Applications of different weed management strategies are essential for successful economical plant crop production. In this context, knowing of the soil weed seed-bank represents an essential starting point for any integrated weed management program, as it provides a powerful tool for predicting future weed infestations. Direct seed extraction technique of soil samples was used to recognize the abundance of weed species and their seed density in the soil (*Sharshar et al.,* 2022). Among different methodologies, seed germination (SG) and seed physical extraction (SPE) were used to determine the seed bank composition (Haring & Flessner, 2018). The extraction method gives the higher weed species seeds number, frequency and diversity, compared to seedling emergence method, (Hussain *et al.,* 2017). The shifting from conventional to conservation agricultures has led to shifting of dynamic change in weed species, and their population and diversity (Gandía *et al.,* 2022). In no tillage system, weed seed banks were found to be accumulated in the top soil layer 0–5 cm, while in plowing system, most weed seeds were displaced to deeper layers of 5–10 and of 10–20 cm and their seed banks found to be three times less than those in no tillage system (Feledyn-Szewczyk *et al.,* 2020), in addition the seed bank dynamics varied significantly between soil layers and among plots with high and low infestation levels (Chadha *et al.,* 2022). Zhang *et al.* (2021) found that total weed seed bank and their population dynamics were reduced by 51%, and the dominant grassy weed population density was reduced by 53% compared to those determined at the start as a result of applying weed management program for 6 years. They also stated that integrated weed management method could reduce the number of herbicide applications by half and reduce costs and labor by 30%. Although herbicides can significantly cut down on the seed density (Ge *et al.,* 2018), however, alternative and additional weed management tactics are required to reduce the soil weed seed-bank (Dey *et al.,* 2018; Schwartz-Lazaro & Copes, 2019).

Finally, the aim of the present study is to demonstrate the impact of weed seed-bank and to provide information for perspective research regarding weed management strategies, and/or in presenting recommendations to transform weed management into cost-benefit assessments.

Materials and Methods

During the two consecutive summer seasons of 2021 and 2022, two field experiments were conducted at the Giza Agricultural Experimental Station of the Agricultural Research Center (ARC), Giza governorate. The purpose of these experiments was to assess the impact of specific weed control treatments on the soil seed bank of weed species.
The applied weed control treatments that include different tested herbicides, hand hoeing and untreated plots were distributed in a completely randomized block design

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(RCBD) with four replicates for each as follows: T1= Pendimethalin, known commercially as stomp extra 45.5% CS pre sowing at the rate 3.6 l/ha; T2= Isoxaflutole 22.5% + Theincarbazone-methyl 9%+ Cyprosulfamide (safener) 10% SC, known commercially as adengo extra 46.5% SC pre - sowing at the rate 360 cm^3/ha; T3= Metribozin, known commercially as marine el-nasr 70% WG pre-sowing at the rate 720 g/ha; T4= Foramsulfuron sodium 3.35% +Iodosulfuron methyl – sodium 0.11% +Thiencarbazone-methyl 1.07%, known commercially as Maister Power 4.25% OD post emergence at the rate 1.2 l/ha; T5= Foramsulfuron known commercially as Equip 2.25% OD post emergence at the rate 1.8 l/ha; T6= Bromoxanil 10%+terbuthylazine 25%, known commercially as Monster 35% SE, at the rate 1.2 l/ha; T7= Hand hoeing thrice after 15, 30 and 35 days after sowing (DAS); T8= Hand hoeing twice after 15 and 30 DAS; T9= Hand hoeing once after 15 DAS; T10= Un-weeded control (weed check).

In winter season of 2021/2022, all plots of the experimental area were sown with clover and weeds were controlled by applying the herbicide bentazon 48% SL at the rate of 1.8 l/ha using CP3 knapsack sprayer equipped with one nozzle boom with water volume of 480 l/ha.

Weed seed bank sampling at zero time, before application of weed control treatments

After preparation of soil seed bed for sowing maize crop, the experimental area was divided into eight longitudinal slices of 30 m long and 4 m wide. Each slice (column) was divided into five plots (rows) plus 10 m were left as a border on the two sides of the maize experiment, and the total area for each plot was 14 m² (3.5 m long × 4 m wide).

From each plot, forty samples were collected following an X shape, of which, twenty samples were obtained from a depth of 5 cm, and twenty samples from a depth 15 cm to form a sample unit that represent each plot. Samples were then mixed and homogenized, then split to a subsample of one kg and 100 g each. Finally, the soil weed seed bank was determined four times during the two seasons (before and after application of weed control treatments), using the following methods.

The germination test for weed seed method

At zero time, before applying weed treatments, the emergence test of weed seed bank was carried out using seedling emergence method, where one kg of the soil sample was placed in trays. The one kg of soil sufficiently filled fifty hills of the germination tray then irrigated on 15Th April to simulate maize crop sowing date during the 2021 season. Trays were irrigated when needed to maintain the original moisture level during the germination test, and the numbers of weed species seedling/soil sample were recorded. Cumulative germination was determined for each soil sample after emergence of all seedlings of weed species at zero time and the number of seedling/m^2 was calculated.

After application of weed control treatments during the 1st and 2nd seasons

After application of weed control treatments and harvesting of maize crop in the 1st season (2021), the 1st soil sample was taken to evaluate the effect of applied weed control treatments on soil weed seed banks flow during the 1st season. Collected samples were subjected to the steps previously described above, and irrigation started in November 2021, then irrigated as needed.

In the 2nd season (2022), the same described technique of seedling emergence method was carried out before sowing the maize crop and prepared samples were first irrigated on the 10th of June 2022, then irrigated as needed.

After the harvest of maize crop, the 2nd soil sample after application of weed control treatments was collected and handled as described above and irrigated for the first time on 15Th September 2022. Finally, the effect of these treatments on soil weed seed bank flow during the two seasons was evaluated.

Extract method

100 g of the soil sample was used to determine the number of weed seeds. The soil sample was placed in sieves with different mesh sizes, cleaned by washing under tap water, then screened by the sieving method (extract method). The weed seeds detection was carried out after their cleaning and identification based on their size, shape and weight using a video microscope and a magnifying lens. Finally, the seed count per 100 g of soil was estimated per one square meter as follows:

Number of weed seeds in one meter square = number of weed seeds in 100 g soil sample×10×39.5

After harvesting the maize crop in the 1st season, the experimental field area was prepared for cultivation with clover crop during the winter season 2021/2022. As a result of weather changes, some annual summer weeds species such as *Ipomoea* sp., *Trianthema portulactastrum* and *Setaria viridis* appeared during the winter season one month after clover sowing date was investigated. This area was previously cultivated with the winter crops tomatoes and sweet potato during 2020/2021 season and with clover during 2021/2022 season. In the summer season of 2022, tillage of field experimental area was conducted and seed bed for maize crop was prepared. The experimental area was then divided into eight slices with five plots each, as done in the 1st season. Two samples were taken one before sowing maize crop and the other after the harvest of maize crop. The experimental area was divided into 40 plots of 14 m^2 each (3.5 m long × 4 m wide). Each plot included five rows. Maize cv. single cross 178 was chosen and sowed on one ridge at the rate of 2 grains /hill and 25 cm between the hills, and thinned later to one plant/hill before adding the first dose of Nitrogen fertilizer and/or the first irrigation.

The sowing dates were 15th April 2021 and 10th June 2022. Phosphorus fertilizer was added with land preparation at the rate of 150 kg P_2O_5 per acre in the form of calcium super phosphate (15.5% P_2O_5), and potassium was added at the rate of 50 kg/acre in the form of potassium sulfate (48% K_2O). Nitrogen fertilizers were applied in the form of urea (46.5% N) at the rate of 80 kg N/acre, in two equal portions; the 1st portion was after thinning as previously mentioned and before the first irrigation, and the 2nd one was before the second irrigation. Other agricultural practices of maize were applied as recommended.

Seed and seedlings count/m^2

Seeds and seedlings count were made at the following stages: (i) after seed bed preparation and before maize sowing experiment, (ii) after harvest of maize crop experiment and before plowing of the experimental field. The number of *Ipomoea* sp./m^2 seedlings in the next winter season one month after sowing clover crop at the same experimental field area was determined to estimate the losses in soil weed seed bank before the second season. Soil weed seed bank losses (%) after the application of each weed control treatment, compared to number of weed seed/m^2 of each treatment at zero time before application of weed control treatments were determined as follows:

$$\text{Weed seed bank losses (\%)} = \frac{\text{no. of weed seed bank before application} - \text{no. after application of treatment}}{\text{no. of weed seed bank before application weed control treatments}} \times 100$$

Statistical analysis

All data were statistically analyzed according to the analysis of variance (ANOVA2) for the randomized complete block design with four replicates as mentioned by (Gomez & Gomez, 1991) by means of "MSTATC" computer software package, and significance between the means was based on LSD at P=0.05.

The effects of different factors on the abundance of grassy weed species seeds, broadleaf species and their total presented in the soil were analyzed by Multi-way ANOVA. Linear models to investigate the main effects of time when soil sample was taken, weed control treatments and soil depth, and the two and three-way interactions were conducted. Finally, the interaction effects, differences between levels within a given factor were further separated using SPSS Statistics, version 17.

Results and Discussion

Information about weed seed banks in cultivated lands help the sustainable improvement of different weed management programs and in the increase of crops production, and decrease in environmental pollution due to massive application of chemical herbicides. To assess the size of weed community in the soil, two methodologies, germination test and seed extraction, can be used.

In this work, the effect of ten treatments (T1 to T10), including untreated weedy check (T10), were evaluated on soil seed bank as follows: the pre-emergence herbicide Pendimethaline 45.5% CS at the rate 3.6 l/ha (T1), Isoxaflutol 22.5%+Theincarbazone-methyl 9% SC Cyprosulfamide (safener) 10% SC at the rate 360 ml/ha (T2), Metribozin 70% WG at the rate 720 g/ha (T3) , and the post-emergence herbicides Foamsulfuron 3.35% + Iodosulfuron methyl-sodium 0.11% + Thiencarbazone-methyl 1.07% OD at 1.2 l/ha (T4), Foramsulfuron 2.25 OD at 1.8 l/ha (T5), and Bromoxynil 10% + Terbuthylanine 25% SE at 1.8 l/ha (T6) , were individually or sequentially applied with mechanical, hand hoeing thrice (T7), hand hoeing twice (T8) and hand hoeing once (T9), for controlling weeds in maize plantation during the summer season. whereas, the herbicide bentazon was used in clover plantation during the winter season, and showed to be an effective way to manage weeds, when compared to the untreated weedy check (T10).

Results obtained indicated that the composition of soil seed banks profile in the experimental sites were as follows: *Setaria virids* about 28.59 % and *Echinocloa colonum* 15.35%, family Poaceae (Gramineae); *Portulaca oleracea* 25.98 %, family Portulaceae; *Trianthema Portulactastrum* 22.43%, family Aizoaceae; and *Ipomoea eriocarpa* 7.66%, family Convolvulaceae.

Vertical and horizontal distribution of soil seed bank in experimental field at zero time in 2021 and 2022 seasons

Table 1 summarizes the results of the two used methodologies (seed extraction and emergence methods) assessing weed species in soil seed banks. Fewer weed seedling number/m^2 were found by the emergence method than those number of weed seeds/m^2 obtained by extraction methods of soil seed bank that reached 98.64% at 5 cm and 98.90 % at 15 cm soil depth.

The statistical analysis of horizontal distribution of soil seed banks obtained data from seed extraction and emergence methods indicated that the difference of concentrations of most annual weed species as well as total broad leaved, grassy and total weeds were significant at P=0.01, between the experimental replicates (Ri). The highest density of grassy weeds such as *S. virids*, *E. colonum* and the total grassy weeds was found at 5 cm depth in (R1) and were 402.9 seedling/m^2, 7702.5 seeds/m^2 and 588.55 seedling/m^2, respectively, and 161.95 seedling/m^2, 9085 seeds/m^2 and 323.9 seedling/m^2, respectively in (R2). The density of *I. eriocarpa* as broad leaved weed was found to be 4649 seeds/m^2 and 75 seedling/m^2 in R3 and 4892 seeds/m^2 and 234.9 seedling/m^2 in R4. The *Euphorbia geniculate* density was higher R3 and R4, which reached 31.6 and 3.95 seedling/m^2, respectively. Finally, the highest density of total annual weeds was found in R2 and R3 and reached 53522.5 and 47941seeds/m^2, respectively.The vertical distribution of soil seed bank obtained using the extractions method at 5 cm depth showed that most of weed species and total annual weeds were significantly different at P=0.01, however, at depth of 15 cm, few weed species such as *E. geniculate* were significantly higher at P=0.01 at R1 and R3, where the number of seeds/m^2 reached 632 and 474, respectively, whereas data obtained by the emergence method indicated that the difference of all weed species in field experiment replicates were highly significant at soil depth of 5 and 15 cm, except those for *E. colonum* which was not significantly different at the same depth. The *S. virids* was significantly different at P=0.05, whereas *T. Portulacastrum* and *P. Oleracea* were not significantly different at 5 cm soil depth. It can be concluded that horizontal weed seed distribution was not significantly affected by traditional plowing during seed bed preparation in both maize summer season and clover winter season. To the contrary, vertical distribution was significantly affected. These results agree with those previously reported (Chadha *et al.,* 2022; Sharshar *et al.,* 2022; Feledyn-Szewczyk *et al.,* 2020).

The relative importance value of weed species seed bank found by the extraction method was 35 % for *T.*

portulactastrum and *P. oleraceae*, 13% for *S. viridis*, 5% for *E. colonum* and 7% for *I. eriocarpa* (Table 1).

Results obtained indicated that the horizontal distribution of soil weed species seed bank have highly significant for *E. colonum* at 5 cm soil depth, and for *I. eriocarpa* at both 5 and 15 cm soil depth, and was significantly different with *E. colonum* at 15 cm soil depth, and total annual grassy weeds at 5 cm depth, with *P. oleraceae* at 5 cm and with *Amaranthus* and *Euphorbia* at 15 cm. In addition, it showed non-significant differences in the vertical weed seed bank distribution except for *E. colonum* seed concentration at 15 cm and *I. eriocarpa* at 5 cm soil depth. Such results could be due to seeds characteristics that enabled their movement during the plowing of the experimental field (Table 1, Figure 1). These findings are in agreement with a previous report (Haring & Flessner, 2018) who stated that the soil weed seed-bank populations give potential for predicting future weed infestations. In addition, shifting from conventional agriculture to conservation agriculture can cause a shift in weed dynamic, population density and diversity. Finally, in no-tillage systems, most weed seeds accumulate in the topsoil layer (0–5 cm), whereas in the plowing system, most weed seeds move to deeper soil layers (5–10 and 10–20 cm (Feledyn-Szewczyk *et al.,* 2020). In addition, the soil seed bank dynamics varied significantly among plots according to different soil depths and infestation levels (Chadha *et al.,* 2022).

Table 1. Species composition of weed seed banks in the experimental field before sowing maize crop, vertical distribution and seed density (seeds or seedling/m^2) during the first 2021 and 2022 seasons vertical and horizontal distribution, seed density (seeds or seedling /m^2).

Weed species	Soil samples depth (cm)	Seed density	CV (%)	Seedlings density	CV (%)
2021					
Echinochloa colonum	5	6566.870**	35.81	152.075	60.05
	15	6280.500	49.86	108.633	51.71
Setaira viridis	5	13874.380	37.07	206.389**	56.97
	15	10055.870	44.56	124.425*	82.31
Total annual grassy weeds	5	20441.250**	25.74	358.464**	38.76
	15	16336.375*	35.16	233.058**	50.35
Ipomea eriocarpa	5	3906.000	36.13	81.438**	79.11
	15	2508.250	46.55	30.088**	129.44
Portulaca oleracea	5	11780.880	34.87	91.850	99.95
	15	9963.880	45.63	23.700**	113.86
Trianthema portulacastrum	5	10891.880	26.56	96.775	97.29
	15	7880.250*	33.61	102.688**	66.64
Amaranthus and *Euphorbia*	5	979.600	68.89	9.880**	209.41
	15	651.750**	70.47	15.800**	152.90
Total annual broad-leaved weeds	5	26578.750	21.65	279.938	66.47
	15	20352.375	25.50	172.275*	52.05
Total annual weeds	5	47020.000**	12.61	638.401	36.70
	15	36688.750**	17.83	405.332**	42.50
2022					
Echinochloa crusgalli	5	1261.500**	36.25	277.000**	61.25
	15	1517.000*	52.12	270.000	96.41
Setaria viridis	5	3268.630	74.03	256.000**	65.57
	15	3349.250	70.70	201.980	99.48
Total annual grassy weeds	5	4530.130*	55.92	533.000**	54.93
	15	4866.250	47.79	471.980*	70.79
Ipomea eriocarpa	5	1501.000**	32.19	57.000*	101.31
	15	770.250**	92.84	0.000	0.00
Portulaca oleracea	5	8710.750*	44.20	312.000**	55.97
	15	7451.380	42.79	396.000	66.52
Triaanthem	5	9933.700	28.07	68.000	92.59
	15	9177.000	37.19	121.000	113.00
Amaranthus and *Euphorbia*	5	79.000	263.52	24.000	149.42
	15	651.750**	70.47	74.000	110.48
Total annual broad-leaved weeds	5	20145.450	28.87	461.000*	45.10
	15	17398.630	27.70	577.000*	55.27
Total annual weeds	5	24675.580	31.14	994.000**	42.89
	15	22264.880	23.59	1048.970*	53.57

** Significant at P=0.01 and * Significant at P= 0.05.

Results presented in Table 1 and Figure 1 indicated that *S. virids* was more present than *E. colonum* as grassy weed in the experimental field in 2021, and the distribution of both weeds at zero times before application of weed control treatments, with coefficient of variation of 37.07, 49.86 and 37.07, 44.56% at 5 and 15 cm soil depth, respectively. The *T. portulacastrum* and *P. Oleracea* seed bank count were also found to be more than those of *I. Eriocarpa* and *E. geniculata* seed bank in the experimental field. The distribution of *T. Portulacastrum*, *P. oleracea*, *I. eriocarpa* and *E. geniculata* at zero time before applying weed control treatments have coefficient of variation (CV) of 26.56, 33.61, 34.87% and 45.63, 36.13, 46.55, 267.80 and 221.43% at 5 and 15 cm soil depth, respectively. These differences in distribution due to the relationship between weed seed bank and location and distribution of weed species in the plot area, could probably be related to the effect of applied weed control treatments during the previous cultivated crops. The number of seed at soil depth of 5 cm did not differ much compared to those obtained from soil sample taken from soil depth of 15 cm before application of weed control treatments, which is probably due to the effect of plowing of the experimental field area and preparation of seedbed for sowing maize crop. These results are in agreement with those previously reported (Gandía *et al.,* 2022; Hussain *et al.,* 2017; Zhang *et al.,* 2021).

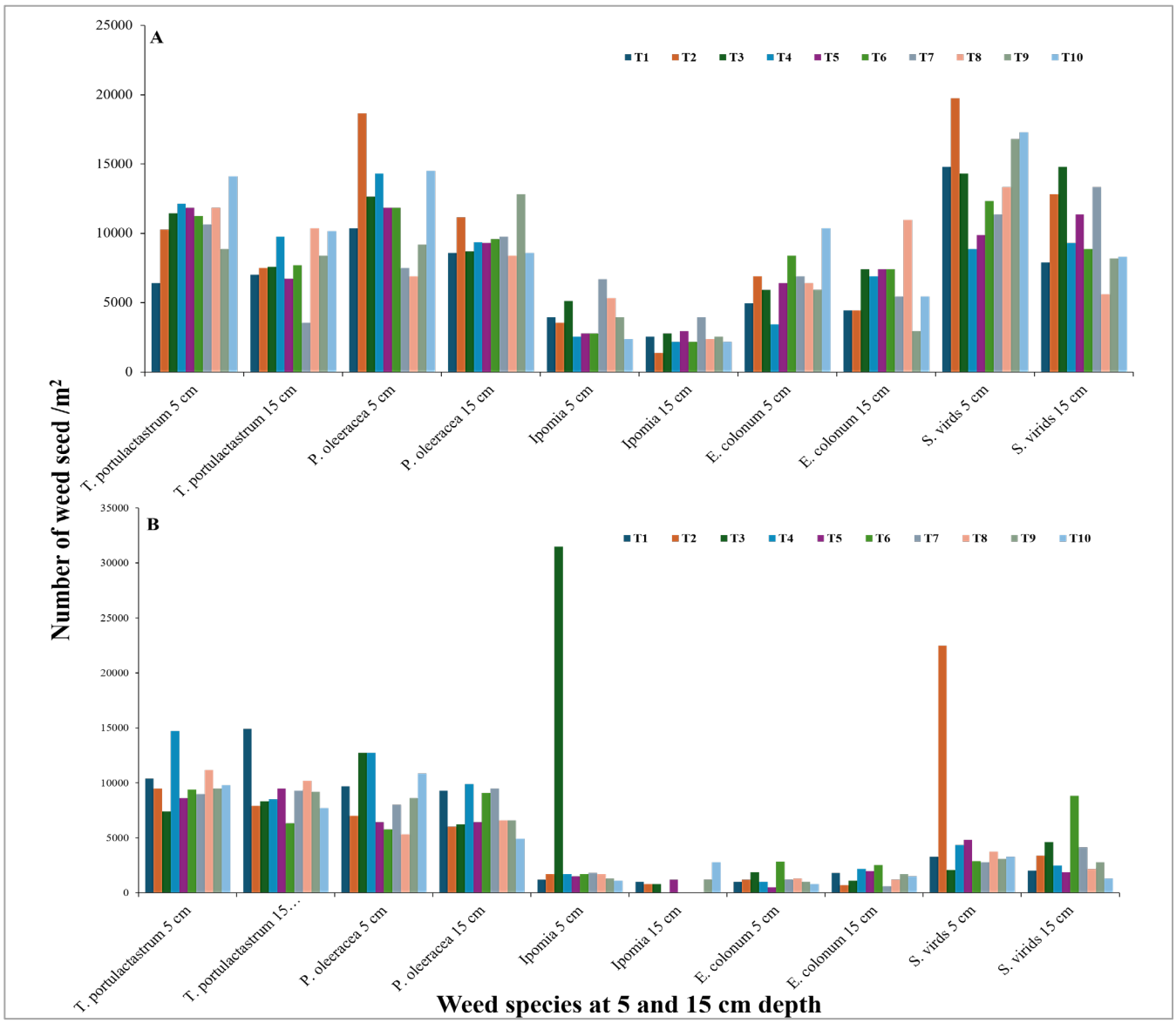


Figure 1. Number of seed bank weed species detected in tested soil samples at zero time during the 2021 (A) and 2022 (B) seasons.

T1= Pendimethaline 45.5% CS at the rate 3.6 l/ha, T2= Isoxaflutol 22.5% + Theincarbazone-methyl 9% SC Cyprosulfamide (safener) 10% SC at 360 cm^3/ha, T3= Metribozin 70% WG at 720 g/ha, T4= Foamsulfuron 3.35%+Iodosulfuron methyl-odium 0.11%+Thiencarbazone-methyl 1.07% OD at 1.2 l/ha, T5= Foramsulfuron 2.25 OD at 1.8 l/ha[1], T6= Bromoxynil 10%+Terbuthylanine 25% SE at 1.2 l/ha, T7= Hand hoeing thrice, T8= Hand hoeing twice and T9= Hand hoeing once, and T10= weedy check (untreated).

Effect of weed control treatments on number of weed seeds in soil seed bank samples during 2021 and 2022 seasons

Figure 2 shows that after the application of weed control treatments for the 2021 season, the soil seed banks of *S. virids* at soil depth of 5 cm was more than those at depth of 15 cm in the un-weeded control (T10) and in some other treatments (T3, T5, T7, T8 and T9) and T9 of *E. colonum* due to reduced treatment's effect on this weed species. In addition, the tested soil sample was taken after harvesting of maize with no plowing of the experimental plot area was carried out, which could explain reasons for which the weed seed bank was more concentrated at the soil depth of 5 cm.

All applied weed control treatments were found to reduce the number of weed seed bank of *S. viridis* and *E. colonum* and their total grassy weeds more than before application. The percent of decline in seed bank after application of weed control treatments in T1, T2, T4, T5 and T7 reached more than 70%, whereas in T3, T6, T8, T9 and T10 only 46.87, 61.78, 68.23, 42.3 and 19.02% losses were obtained for *S. viridis* seed bank, respectively.

Figure 2 shows that after the application of weed control treatments for the 2022 season, S. *virids* seed banks were more than those of *E. colonum* seed bank in the experimental field (Figure 2). *S. virids* and *E. colonum* had a high coefficients of variation around 74.03%, 70.70% and 36.25%, 52.12% at 5 and 15 cm soil depth, respectively, which is not normal distribution due to the relationship between weed seed bank and location of weed species grown in the unit area. The seed bank reduction after application of treatments T1, T2, T7 was more than 60%, whereas treatments T3, T4, T5, T6, T8 and T9 produced a reduction in seed bank of *S. viridis* of around 10.29, 36.23, 42.65, 13.61, 59.79 and 45.76% respectively. All weed control treatments gave more than 90% reduction in the seed bank of *E. colonum*, except T10 (the unweeded control), compared to the mean of soil seed banks before application of weed control treatments.

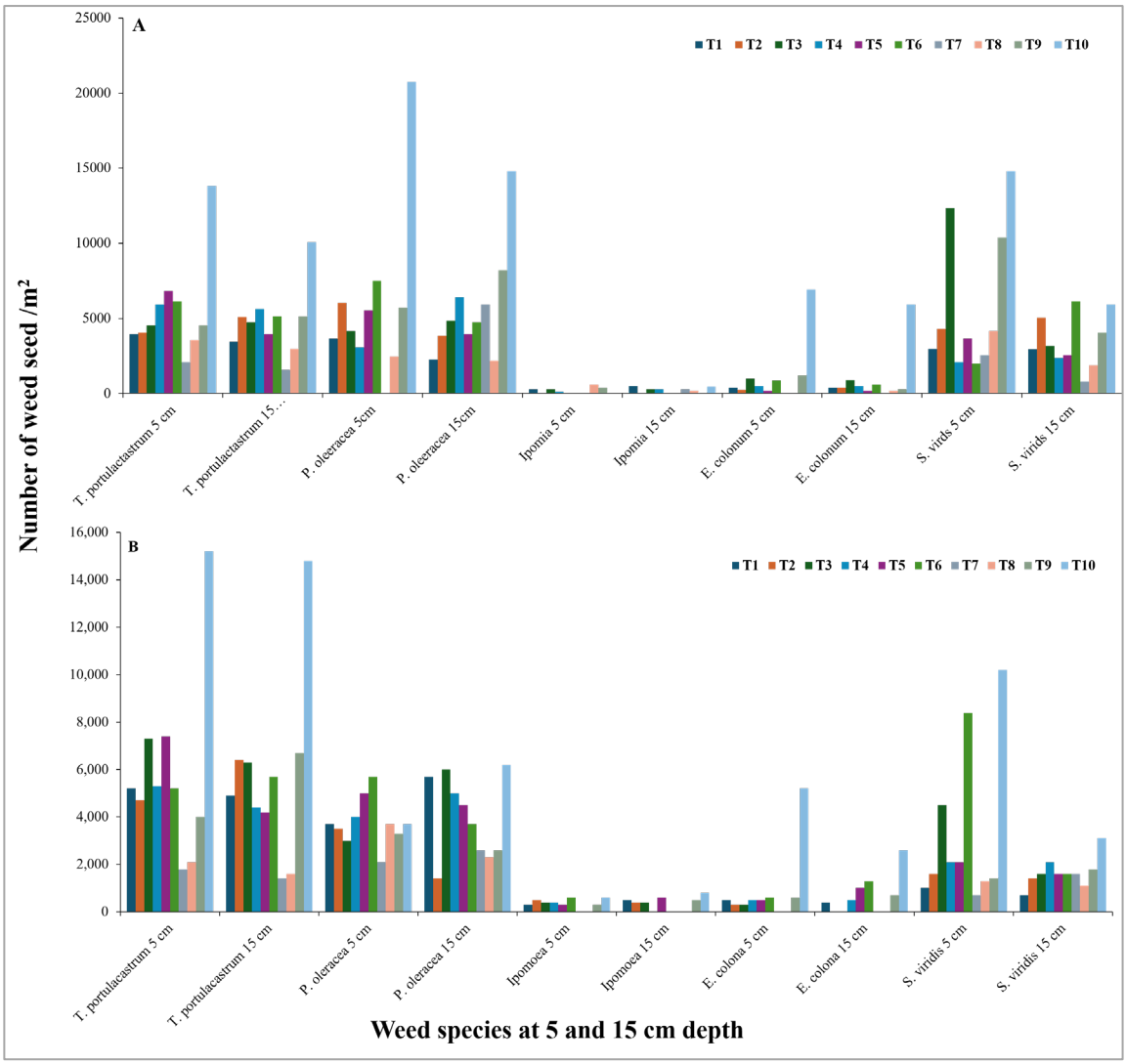


Figure 2. Effect of weed control treatments on the number of weed species seed banks during 2021 (A) and 2022 (B) season.
T1= Pendimethaline 45.5% CS at the rate 3.6 l/ha, T2= Isoxaflutol 22.5% + Theincarbazone-methyl 9% SC Cyprosulfamide (safener) 10% SC at 360 cm^3/ha, T3= Metribozin 70% WG at 720 g/ha, T4= Foamsulfuron 3.35%+Iodosulfuron methyl-odium 0.11%+Thiencarbazone-methyl 1.07% OD at 1.2 l/ha, T5= Foramsulfuron 2.25 OD at 1.8 l/ha^1, T6= Bromoxynil 10%+Terbuthylanine 25% SE at 1.2 l/ha, T7= Hand hoeing thrice, T8= Hand hoeing twice and T9= Hand hoeing once, and T10= weedy check (untreated).

These results could be due to the effect of weed control treatments on the emergence and development of seedling and growth of *S. virids* and *E. colonum* leading to reduction in number and production of new seed banks. All weed control treatments reduced the number of *T. portulacastrum*, *P. oleracea, L.* and *I. eriocarpa, E. geniculata* and the total of broad-leaf weeds compared to before application. These results were in agreement with those reported previously (Dey *et al.,* 2018; Ge *et al.,* 2018; Schwartz-Lazaro & Copes, 2019; Zhang *et al.,* 2021). In the case of *E. colonum,* all weed control treatments produced more than 80% decline in its seed bank count in 2021, compared to the un-weeded control treatment (T10) and to the soil seed banks calculated means before application of weed control treatments (at zero time) during 2021 season. These results could be due to the effect of applied weed control treatments on emergence, development and growth of both grassy *S. virids* and *E. colonum*, leading to reduction and inhibition of density and growth and subsequently, reduction of their seeds' yield and decrease in their density in the soil seed bank due to the effect of weed treatments which had an effect on the germination and growth of the dominant weed species (Dey *et al.,* 2018; Schwartz-Lazaro & Copes, 2019, Zhang *et al.,* 2021).

Data presented in Figure 3 and Table 2 show the effect of weed control treatments on the number of soil weed species' seeds and their total seed bank count after harvesting the maize crop in the first season, as compared to those obtained before applying the different weed control treatments in 2021 season, and the reduction rate occurred due to such application.

In 2022, results obtained indicated that treatments T1, T2, T4, T5 and T7 produced more than 70% decline in seed bank, whereas treatments T3, T6, T8, T9 and T10 caused around 46.87, 61.78, 68.23, 42.3 and 19.02% reduction in *S. virids* seed bank (Figure 3). All weed control treatments caused more than 80% decline in *E. colonum*, contrary to the unweeded control (T10), which showed increase in its soil seed bank compared to the primary analysis of its seed bank before sowing maize crop in the 2nd season of 2022. These results could be due to the effect of weed control treatments on the emergence and development of seedlings and growth of *S. virids* and *E. colonum* which caused the reduction in the number and production of new seed banks.

The results obtained showed that the weed control treatments significantly reduced the total annual grassy, broad leaved and total annual weed seed bank in 2021 season, compared to their numbers before application (Table 2). In addition, treatments T3 and T9 caused less reduction in total grassy weed seed bank around 59.07 and 53.06%, respectively, compared to counts before application.

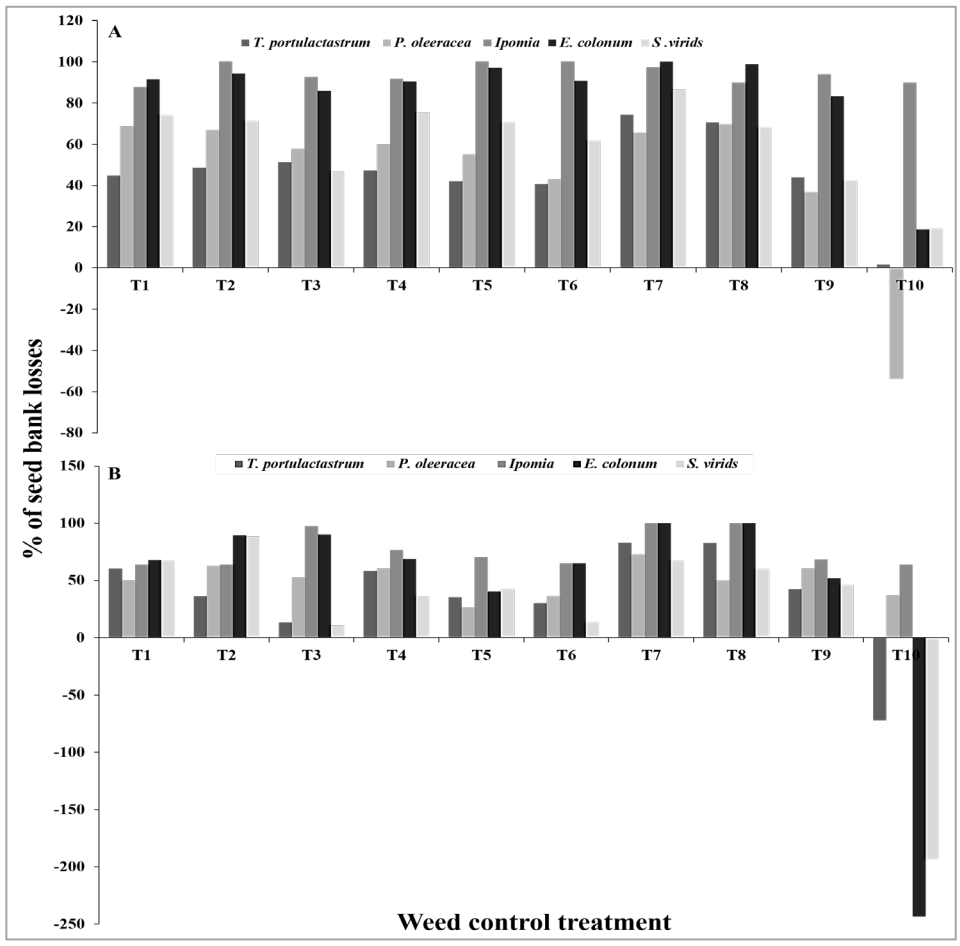


Figure 3. The reduction rate (%) in weed species after application of the weed control treatment compared to the number obtained before application of weed control treatments during the 2021 (A) and 2022 (B) seasons.

The un-weeded control (T10) was reduced in grassy soil seed bank due to late maturity of grassy weeds and harvesting of maize crop before the falling of their seeds on the soil. After application of weed control treatments in the 2021 season, the treatments T4, T5, T6 and T9 produced less broad-leaved weed seed bank, around 57.47, 55.44, 48.15 and 47.2 %, compared to numbers of broad-leaved weed seed bank before weed control application. The increase of soil seed bank in the un-weeded control (T10) could simply be due to the fact that some weed species such as *P. oleracea* needs only a short time to complete its life cycle, which contributes to an increase in seed count in the soil. Treatments T3, T4, T5, T6 and T9 caused less reduction in the soil seed bank of total annual weeds after application of weed control, and reached 63.36, 67.54, 68.59, 59.84 and 49.69%, respectively, compared to those before application of treatments. The highest reduction in annual weed soil seed bank was obtained in response to treatment T7 and reached 99.54, 76.57 and 83.29% for grassy weeds, broad-leaved weeds and total annual weeds, respectively. These results were in agreement with those reported earlier (2, 8, 11). In fact, the reduction in weed species density grown during the period of maize summer crop, could be due to the application of the above mentioned treatments that killed weeds before producing their seeds. In addition, removing weeds by three times hand hoeing (T7), increased maize plant competition to weeds, and thus reduced the production of different weed species' seeds.

All weed control treatments significantly reduced total grassy and broad-leaf weed seed bank and the total annual weed seed bank during the 2022 season, compared to the un-weeded check (Table 2) (T10). The un-weeded check (T10) increased the number of soil seed bank around 210.11, 11.65 and 42.43% of grassy, broad-leaf and total number of soil seed bank, respectively, during the 2nd season, compared to soil seed bank before application of weed control treatments during the 2022 season. The highest reduction of grassy, broad-leaved and total weeds were obtained following T7 and T8 treatments (73.86 and 71.66% of grassy weeds, 78.91 and 66.09% of broad-leaved weed and 77.96 and 71.95% of total annual weeds, compared to the soil seed bank before the application of weed control treatments during the 2nd season). T4, T3 and T9 treatments produced the lowest reduction in grassy weed seed banks, T5, T6 and T3 treatments produced the lowest reduction in the number of total weed soil seed bank, compared to the number of soil seed banks before application of weed control treatments. These results could be due to reduction and death of weeds before the production of different weed species' seeds and in line with previous reports (Dey *et al.,* 2018; Ge *et al.,* 2018; Schwartz-Lazaro & Copes, 2019; Zhang *et al.,* 2021).

Results obtained showed that the interaction between soil sample collection time and weed control treatments as well as sample depth had a highly significant effect on seed density of weed seed bank during 2021 season and seedlings density during 2022 season (Tables 3 and 4).

Table 2. Effect of weed control treatments application on the main number of grassy, broad-leaved and total weed seed bank/m^2 during maize cultivation during 2021 and 2022 seasons.

Before application of treatments				After application of treatments			
5.0 cm	15 cm	mean	Treatments	5.0 cm	15 cm	mean	% of seed bank loss
			2021				
Total annual grassy weeds							
19750.00	12343.75	16046.88	T1	3357.50	3330.00	3343.75	79.16
26662.50	17281.25	21971.88	T2	4542.25	5431.00	4986.63	77.30
20243.75	22218.75	21231.25	T3	13331.25	4048.75	8690.00	59.07
12343.75	16195.00	14269.38	T4	2567.50	2863.75	2715.63	80.97
16293.75	18762.50	17528.13	T5	3851.25	2765.00	3308.13	81.13
20737.50	16293.75	18515.63	T6	2861.25	6715.00	4788.13	74.14
718268.75	18762.50	368515.60	T7	2567.50	790.00	1678.75	99.54
19750.00	16590.00	18170.00	T8	4147.50	2073.75	3110.63	82.88
22712.50	11158.75	16935.63	T9	11553.75	4345.00	7949.38	53.06
27650.00	13757.50	20703.75	T10	21725.00	11850.00	16787.50	18.92
-	-	-	$LSD_{0.05}$	6244.55	3957.09		
-	-	-	C.V.	96.52%	97.54%		
Total annual broad-leaved weeds							
20722.50	18170.00	19446.25	T1	8097.50	6221.25	7159.38	63.18
32488.75	20046.25	26267.50	T2	10072.50	8938.50	9505.50	63.81
29215.00	19058.75	24136.88	T3	8986.25	9875.00	9430.63	60.93
29032.50	21330.00	25181.25	T4	9085.00	12343.75	10714.38	57.45
26465.00	18960.00	22712.50	T5	12341.25	7900.00	10120.63	55.44
25872.50	19453.75	22663.13	T6	13627.50	9873.75	11750.63	48.15
24870.00	17281.25	21075.63	T7	2073.75	7801.25	4937.50	76.57
24095.00	21132.50	22613.75	T8	6616.25	5332.50	5974.38	73.58
22018.75	23798.75	22908.75	T9	10862.50	13331.25	12096.88	47.20
31007.50	24292.50	27650.00	T10	34562.50	25347.50	29955.00	-8.34

Before application of treatments				After application of treatments			
5.0 cm	15 cm	mean	Treatments	5.0 cm	15 cm	mean	% of seed bank loss
-	-	-	$LSD_{0.05}$	4223.34	3936.52		
-	-	-	C.V.	39.57%	40.11%		
Total annual weeds							
40472.50	30513.75	35493.13	T1	11455.00	9551.25	10503.13	70.41
59151.25	37327.50	59151.25	T2	14614.75	14369.50	14492.13	75.50
49458.75	41277.50	49458.75	T3	22317.50	13923.75	18120.63	63.36
41376.25	37525.00	41376.25	T4	11652.50	15207.50	13430.00	67.54
42758.75	37722.50	42758.75	T5	16192.50	10665.00	13428.75	68.59
46610.00	35747.50	41178.75	T6	16488.75	16588.75	16538.75	59.84
43138.75	36043.75	39591.25	T7	4641.25	8591.25	6616.25	83.29
43845.00	37722.50	40783.75	T8	10763.75	7406.25	9085.00	77.73
44731.25	34957.50	39844.38	T9	22416.25	17676.25	20046.25	49.69
58657.50	38050.00	48353.75	T10	56287.50	37197.50	46742.5	3.33
-	-	-	$LSD_{0.05}$	8057.84	6121.69		
-	-	-	C.V.	47.00%	44.13%		
				2022			
Total grassy weeds							
4246.25	3803.75	4025.00	T1	1381.25	1145.00	1263.13	68.62
3653.75	4048.75	3851.25	T2	1876.25	1382.75	1629.50	57.69
3950.00	5700.00	4825.00	T3	1718.25	1555.00	1636.625	66.08
5332.50	4641.25	4986.875	T4	2666.25	2666.25	2666.25	46.53
5332.50	3873.75	4603.125	T5	2666.25	2666.25	2666.25	42.08
5703.75	11320.00	8511.875	T6	2835.00	2878.75	2856.875	66.44
3950.00	4740.00	4345.00	T7	691.25	1580.00	1135.625	73.86
5036.25	3326.25	4181.25	T8	1283.75	1086.25	1185.00	71.66
4048.75	4443.75	4246.25	T9	1975.00	2468.75	2221.88	47.67
4047.50	2765.00	3406.25	T10	15497.50	5628.75	10563.13	-210.11
-	-	-	$LSD_{0.05}$	3137.87	1824.67		
-	-	-	C.V.	104.93%	86.24%		
Total broad-leaved weeds							
21231.25	25181.25	23206.25	T1	9125.00	11580.00	10352.50	55.39
18170.00	14713.75	16441.88	T2	9118.75	8578.75	8848.75	46.18
21626.25	15337.50	18481.88	T3	10366.25	13136.250	11751.25	36.42
29131.25	18367.50	23749.38	T4	9316.25	9362.500	9339.375	60.68
16491.25	17083.75	16787.5	T5	12442.50	9875.000	11158.75	33.53
16812.50	15425.00	16118.75	T6	10948.75	9480.000	10214.38	36.64
18757.00	18762.50	18759.75	T7	3915.00	3997.500	3956.25	78.91
18170.00	16756.25	17463.13	T8	5922.50	3848.750	5922.5	66.09
19355.00	16953.75	18154.38	T9	7406.25	10572.50	8989.375	50.48
21710.00	15405.00	18557.50	T10	18992.50	22445.00	20718.75	-11.65
-	-	-	$LSD_{0.05}$	3570.07	3387.04		
-	-	-	C.V.	39.88%	35.88%		
Total annual weeds							
25477.50	28985.00	27231.25	T1	10506.25	12725.00	11615.63	57.34
21823.75	18762.50	20293.13	T2	10995.00	9961.50	10478.25	48.37
25576.25	21037.50	23306.88	T3	12084.50	14691.25	13387.88	42.56
34463.75	23008.75	28736.25	T4	11982.50	12028.75	12005.63	58.22
21823.75	20957.50	21390.63	T5	15108.75	12541.25	13825.00	35.3
22516.25	26745.00	24630.63	T6	13783.75	12358.75	13071.25	46.93
22707.00	23502.50	23104.75	T7	4606.25	5577.50	5091.875	77.96
23206.25	20082.50	21644.38	T8	7206.25	4935.00	6070.625	71.95
23403.75	21397.50	22400.63	T9	9381.25	13041.25	11211.25	49.95
25757.50	18170.00	21963.75	T10	34490.00	28073.75	31281.88	-42.43
-	-	-	$LSD_{0.05}$	4995.65	4477.01		
-	-	-	C.V.	41.83%	38.74%		

T1= Pendimethaline 45.5% CS at the rate 3.6 L/ha, T2= Isoxaflutol 22.5% + Theincarbazone-methyl 9% SC Cyprosulfamide (safener) 10% SC at 360 cm^3/ha, T3= Metribozin 70% WG at 720 g/ha, T4= Foamsulfuron 3.35%+Iodosulfuron methyl-odium 0.11%+Thiencarbazone-methyl 1.07% OD at 1.2 L/ha, T5= Foramsulfuron 2.25 OD at 1.8 L/ha, T6= Bromoxynil 10%+Terbuthylanine 25% SE at 1.2 L/ha, T7= Hand hoeing thrice, T8= Hand hoeing twice and T9= Hand hoeing once, and T10= weedy check (untreated).

Table 3. ANOVA analysis for the results obtained on all main effects and their interaction from the mixed models for soil sample times (before or after application of weed control treatments) and depth at which the soil seed banks sample was collected in 2021 and 2022 seasons.

	Seed density		Seedling density	
Factors	**F**	**Prob.**	**F**	**Prob.**
2021				
Sample time	84.049**	0.0027	9.9886	0.0509
Weed control treatments	3.3795**	0.0024	1.5789	0.1452
Soil depth	42.902**	0.0000	2.8634	0.0958
Sample time × weed control	3.3795**	0.0024	0.9944	
Sample time × soil depth	16.577**	0.0001	7.4903**	0.0081
Weed control × soil depth	1.6769	0.1147	1.2827	0.2677
Sample collection time × weed control × soil depth	1.5366	0.1561	0.8329	
2022				
Sample time	7.4504	0.0720	20.5113*	0.0201
Weed control treatments	22.2534**	0.0000	10.7137**	0.0000
Soil depth	3.8663	0.0539	3.3543	0.0720
Sample time × weed control	1.6028	0.1379	2.7541**	0.0100
Sample time × soil depth	2.4054	0.1262	3.4354	0.0687
Weed control × soil depth	1.7956	0.0878	2.1596*	0.0378
Sample collection time × weed control × soil depth	0.8229		2.1035*	0.0431

Table 4. The interaction between the soil sample collection time, weed control treatments and depth of soil sample, on weed seed bank in maize field experiments

Samples collection									
Time	**Soil depth (cm)**	***T. portulactastrum***	***P. oleeracea***	***I. eriucarpa***	**Total broad-leaf weeds**	***E. colonum***	***S. virids***	**Total grassy weeds**	**Total weed seeds**
					Extraction method in 2021				
Before	5	10891.88	11780.88	3906.00	26578.75	6566.88	13874.38	20441.25	47020.00
	15	7880.25	9963.88	2508.25	20352.38	6280.50	10055.88	16336.38	36688.75
After	5	5539.63	5885.50	207.38	11632.50	1128.68	5921.80	7050.48	18682.98
	15	4774.55	5717.68	204.25	10696.48	938.13	3483.10	4421.23	15117.70
					Emergence method in 2021				
Before	5	96.78	91.85	81.44	279.94	152.08	206.39	358.46	638.40
	15	102.69	23.70	30.09	172.28	108.63	124.43	233.06	405.33
After	5	27.68	36.58	61.25	125.50	27.65	123.00	150.65	276.15
	15	44.58	54.4	71.18	170.19	27.65	158.01	185.66	355.85
					Extraction method in 2022				
Before	5	9933.70	8710.75	1501.00	20145.45	1261.50	3268.63	4530.13	24675.58
	15	9177.00	7451.38	770.25	17398.6	1517.00	3349.25	4866.25	22264.88
After	5	5832.00	3804.88	118.50	9755.38	838.75	2420.33	3259.08	13014.45
	15	5657.75	3998.38	631.50	10287.63	641.88	1663.90	2305.78	12593.40
					Emergence method in 2022				
Before	5	68.00	312.00	57.00	461.00	277.00	256.00	533.00	994.00
	15	121.00	396.00	40.00	577.00	270.00	201.98	471.98	1048.98
After	5	222.19	45.43	0.00	267.61	196.51	146.29	342.80	610.41
	15	234.03	26.68	0.00	260.70	133.31	215.93	349.24	609.94

Before= Before application of treatments, After= After application of treatments.

The lowest number of seeds/m^2 and number of seedling/m^2 resulted from the interaction between 15 cm soil sample depth and application of weed control treatments during 2021 and 2022 seasons. These results are due to the fact that weed control treatments affected and killed weed species. The soil samples collected after application of treatments and before tillage, and after harvesting of the maize crop, whereas the soil samples collected before the application of weed control treatments, were collected after the preparation of seed bed for sowing maize crop, and this could explain the presence of more weeds in the weed seed bank at 5 cm depth than those found at 15 cm, which is in agreement with what has been described earlier (Ge *et al.,* 2018).

Effect of weed control treatments groups, T1, T2, T3 as pre-emergence herbicides, T4, T5, T6 as post emergence herbicides, and T7, T8, T9 hand hoeing on the number of weed species in soil seed bank/m^2

Results obtained clearly showed that the highest reduction of total annual soil seed bank resulted from the hand-hoeing treatments in the first season and from pre or post-emergence herbicides in the second season, as well as application of pre-emergence herbicide in the first season and post herbicide in the second one and finally, application of pre-emergence herbicide in the first and second seasons (Figure 4).

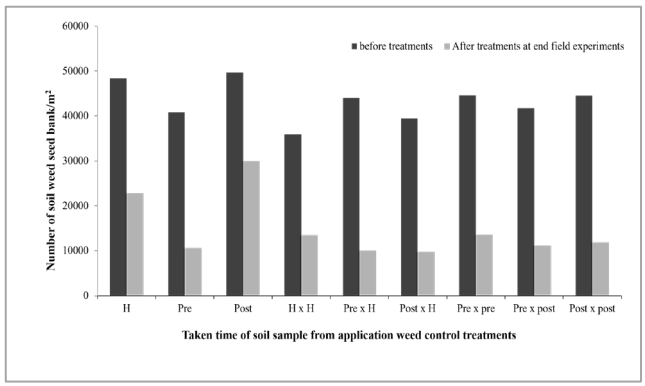


Figure 4. Relationship between numbers of total weed soil seed bank/m^2 at zero time before application of weed control treatments and the effect of weed control treatments in both seasons, H (hand hoeing), pre (pre-emergence herbicide) and post (post emergence herbicide).

Application of weed control for only one season resulted in less reduction in number of soil seed bank by the end of the experiments and harvesting of maize, compared to the initial numbers at zero time, However, application of the pre-emergence herbicide for only one season showed effective control for weeds during the two seasons and thus could be explained by the dominance of sensitive grassy weed species in the experimental field. These results are due to the integrated effect of weed control treatments in reducing all weed species and affected their seeds accumulation in the soil, and some weed species may prevent emergence of other weed species which are naturally late in emergence, whereas some other weed species may be dormant, so they do not appear in the same season. Finally, the emergence rate of *E. colonum* and *S. virids* seed banks when tested under laboratory conditions similar to the maize sowing time, were found to be 54% and 22%, respectively.

Number of seedling/m^2 at zero time before application of weed control treatments in 2021 and 2022 season

The emergence test for weed seed bank pointed out that the highest number of seedlings at zero time before application of weed control treatments were for *T. portulacastrium* which reached 300-9900 seedling/m^2, followed by *P. oleracea* (200-980 seedling/m^2 at 15 cm depth), then *I. eriocarba* and *E. colonu* and *S. viridis* (15-30 seedlings/m^2) during the 2021 season. The coefficient of variation was more than 43 to 107 % due to abnormal weed species distribution in the experimental field (Figure 5).

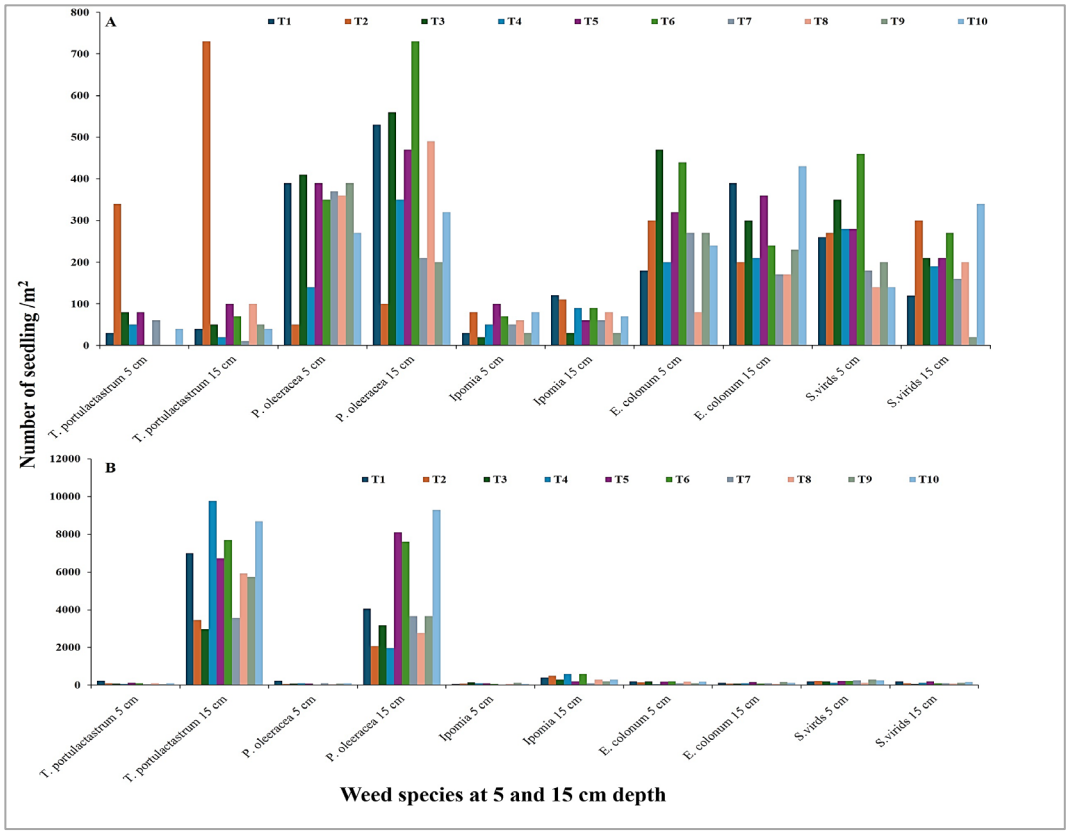


Figure 5. Number of weed species seedlings resulted from soil seed bank samples collected from the weed control treatments site before the application of weed control treatment during the 2021 (A) and 2022 (B) seasons.

In 2022, the highest density of *P. oleracea* seedlings number/m^2 presented at 5 and 15 cm soil depth compared to other weed species, followed by *E. colonum* and *S. viridis* (Figure 5). The *T. portulacastrum* density was higher in T2 treatment site before application of weed control treatments and reached around 750 seedlings/m^2 at 15 cm soil depth and around 350 seedlings/m^2 at 5 cm soil depth, whereas the count of *I. eroicarpa* was less in number of seedlings/m^2 which varied from 20 to 110 seedlings/m^2 (T7).

Number of seedling/m^2 after application of weed control treatments during 2021 and 2022 seasons

(Table 5 and Figure 6) represent statistical analysis showed that all weed control treatments have significantly reduced number of soil weed seed banks of *T. portulactastrum*, *E. colonum, S. viridis* and their total content of annual grassy, total annual broad-leaf and total annual weeds during 2021 summer season (Table 5, Figure 6).

The application of weed control treatments caused significant reduction of all weed species seedling/m^2 compared to before application of weed control treatments at zero time (Figure 6), due to the effect of weed control treatments on production of weed seeds. The highest number of *S. viridis* weed seedlings/m^2 in T10 treatment (un-weeded check) at 5 and 15 cm soil depth was 55 and 39 seedling/m^2, followed by *E. colonum* that gave 36 and 16 seedling /m^2, by *I. eriocarpa*, 22 and 27 seedling/m^2, by *P.oleracea*, 11 and 25 seedlings/m^2, and *T. portulacastrum* 11 and 21 seedling/m^2 for the two-soil depth, respectively. The T7 and T8 treatments caused the highest reduction of all weed species seedlings count, whereas T5, T2, T3 and T9 treatments were less effective on *I. oriocarpa* and *S. viridis* compared to other weed control treatments investigated. The emergence of *S. viridis* was less affected by T8, T5, T1, T9, T6, T3 and T4 treatments and the reduction rate varied from 3.8 to 59.61%. Meanwhile, the T7 treatment was more effective on the same weed species and caused around 100% reduction, whereas T2 and T10 (un-weeded) treatments didn't affect the weed at the end of the first season after the application of weed control treatments compared to before treatment. The *E. colonum* seeds were found to be more sensitive to all the applied weed control treatments that caused reduction of 100%, except for the T9 treatment that was less effective and caused only 9.09% reduction due to application of one time hand hoeing which was not enough to prevent or reduce the weeds grown during the long period of maize crop growth.

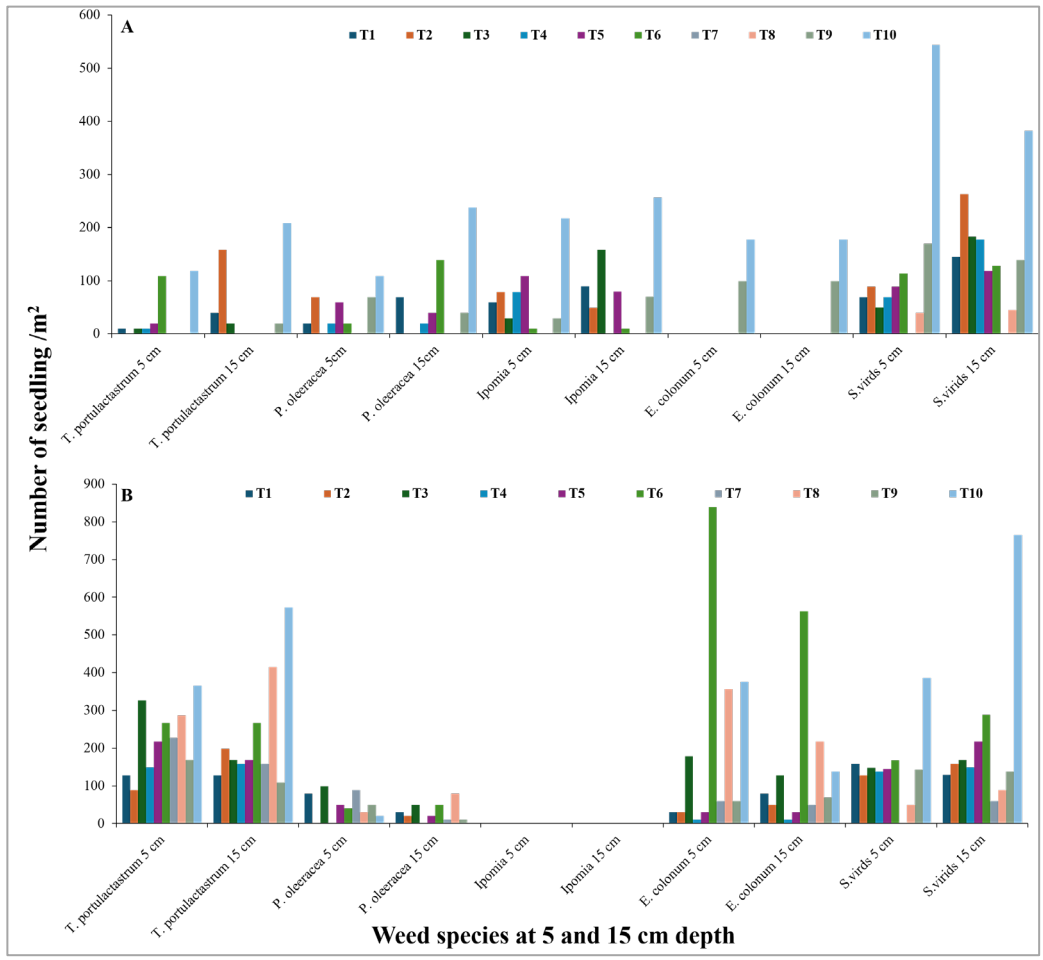


Figure 6. Number of weed species seedling resulted from soil seed bank samples taken after application of weed control treatments 2021 (A) and 2022 (B) seasons.

Table 5. Weed species in the experimental field after application of weed control treatments during 2021 and 2022 seasons, their vertical and weed species distribution and seedling density/m^2.

Weed species	Depth of soil sample (cm)	2021		2022	
		Seedling density	CV (%)	Seedling density	CV (%)
Echinochloa crusgalli	5	196.510*	171.65	27.650**	72.74
	15	133.313	181.74	27.650**	72.74
Setaira viridis	5	146.290**	45.91	123.002**	56.36
	15	459.860	142.10	158.013**	42.29
Total annual grassy weeds	5	342.800**	99.75	150.652**	54.97
	15	593.175	135.37	185.663**	33.86
Ipomea eriocarpa	5	0.000	0.00	0.000	0.00
	15	0.000	0.00	71.175	157.22
Portulaca oleracea	5	45.430	177.81	36.575*	128.28
	15	26.675	161.89	54.438*	178.53
Triaanthem	5	222.190	91.63	27.675	240.29
	15	234.025	105.70	44.575*	206.31
Amaranthus and *Euphorbia*	5	0.000	0.00	0.000	0.00
	15	0.000	0.00	0.000	0.00
Total annual broad leaved weeds	5	267.610	82.86	125.500**	73.51
	15	260.700	97.90	170.188**	93.88
Total annual weeds	5	610.410*	70.38	276.152**	45.40
	15	853.875	98.21	355.850**	47.79

** Significant at P=0.01 and * Significant at P= 0.05.

In 2022, results obtained showed that T5 treatment produced the highest number of *E. colonum* seedlings of more than 800 seedlings/m^2 in the soil sample at 5 cm depth and un-weeded check. *S. viridis* density was more than 700 seedling/m^2 in soil samples collected from 15 cm soil depth during the 2022 season, compared to other weed control treatments (Figure 6). The less effect of T5 on *E. colonum* is explained by the fact that this weed emerged and completed its life cycle and produced seeds that constituted its soil seed bank during the 2022 cultivated maize season.

The T10 treatment (un-weeded check) produced more number of *S. viridis* seeds due to competion with other weed species and its ability to reach full maturity with full seeds dropped on the soil enriching the soil seed bank, The highest number of *T. portulacastrum* seeds was obtained in the un-weeded control (T10), *I. eriocarpa* was less in number of seedlings emergence under field experimental conditions after one season of applying weed control treatments due to the integration between weed control treatments and the late maturity of *I. eriocarpa,* that were mowed during harvest of maize crop before full seeds are dropped on the soil. Finally, *P. oleracea* was more affected by weed control treatments (Hussain *et al.,* 2017).

All weed control treatments significantly reduced the number of grassy weed species seedlings, broad-leaf weeds and total weed seed bank by the emergence method at the two-soil depth of 5 and 15 cm during the 2021 season, compared to un-weeded check (Table 5). The *P.oleracea* was affected significantly by weed control treatments in the soil sample depth of 5 and 15 cm, while *T. portulacastrum* was significantly at 15 cm depth in 2022 season.

Control treatments reduced the number of *S. viridis*, total annual grassy weeds seedlings at 5 cm soil depth and significantly reduced *E. colonum* and total annual weed seedling at the same soil depth. *I. eriocarpa*, *Amaranthus* and *Euphorbia* were not counted during the second season due to the integration of weed control treatments in maize crop for two seasons and seed-bed preparation for sowing the winter season-crop (clover). The *I. eriocarpa*, weed continued to emerge during the winter crop (clover) due to extended high temperatures during the months of October and December.

It can be concluded from this study that the seeds distribution of weed species found to be irregular at the beginning of the experiment and before applying different control treatments, as the coefficient of variation (CV) was high (35-70%) and was close to the natural distribution in the stock of weed seeds in the soil due to the fact that the weed species are concentrated in certain spots of the field according to the weed type and on the previously applied weed control treatments in the field. Additionally, the effect of certain weed control treatments in the first season was high before maize sowing because of their effects on grassy weeds such as *Setaria viridis* and *Echinochloa colonum* (L.). Furthermore, the effect of some post-emergence herbicides such as Monster was low on grassy weeds and was not as effective as the pre-sowing herbicides. Finally, based on the present work, it was suggested that special weed control strategies should be formulated for effective reduction of different soil weed seed bank under Giza farm conditions.

In this study, the summer season weed seed bank had five species distributed in the experimental field. The use of herbicides, mechanical processing of soil seed bed preparation during two maize summer seasons, and sowing

clover during the winter season and herbicide application for summer weed species control applied during winter season, and continued high temperatures during September and October, had interactive effects on soil weed seed bank characteristics in maize. Soil weed seed bank under no weed management produced the highest seed density. Considering that the influence of herbicides on weed soil seed bank varied with the mechanical methods used, it is suggested that special weed control strategies should be formulated in such a way to effectively reduce soil weed seed bank of maize experimental plots under Giza farm conditions.

الملخص

أبو ستيت، عز الدين، رجب عبسي، عبدو إسماعيل وعاصم حسن. 2026. دراسة أولية عن تأثير بعض استراتيجيات مكافحة الأعشاب الضارة/الحشائش على مخزون البذور في التربة. مجلة وقاية النبات العربية، 44(3):350–364. https://doi.org/10.22268/AJPP-001418

تساعد الدراسات المنتظمة في توفير كثير من المعلومات التي يمكن الاستفادة منها في دراسة مخزون بذور النباتات غير المرغوبة (أعشاب ضارة/حشائش) في كلٍّ من الأراضي والحقول الزراعية، مما يساعد في تصميم برامج مختلفة لاستراتيجية مكافحتها. تم في هذا البحث إجراء تجربتين حقليتين بتصميم القطاعات العشوائية الكاملة (RCBD) في مركز البحوث الزراعية في محافظة الجيزة، مصر، لتقييم تأثير بعض إستراتيجيات وطرائق مكافحة الأعشاب/الحشائش الضارة المختلفة. استخدمت عشر معاملات على الشكل التالي: تطبيق مبيدات الأعشاب/الحشائش الضارة قبل وبعد الإنبات في المعاملات من الأولى وحتى السادسة، ومعاملات العزيق اليدوي من المعاملة السادسة إلى التاسعة (عزيق ثلاث مرات، ومرتان، ومرة واحدة)، وخصصت المعاملة العاشرة للشاهد (بدون مكافحة). هدفت التجارب إلى دراسة تأثير المعاملات التي أجريت على مخزون بذور وتوزيع بذور الأعشاب/الحشائش الضارة في الحقل الذي طبقت فيه المعاملات، ونفّذت التجارب خلال موسم الزراعة الصيفي للعامين 2021 و 2022. تمت دراسة وتحديد جميع أنواع الأعشاب/الحشائش الضارة الموجودة في عينات التربة المدروسة عند عمق 5 و 15 سم. ولتحديد أنواع بذور الأعشاب/الحشائش الضارة وتوزيعها في التربة، تمّ استخدام كلٍّ من طريقة الإنبات وطريقة استخلاص البذور. أشارت النتائج المتحصّل عليها من عينات التربة، بعد تطبيق طرائق مكافحة الأعشاب/الحشائش الضارة في الحقل، إلى أن استخدام طريقة الإنبات سجلت عدداً أقل من طريقة استخلاص البذور، كوسيلة لدراسة وتتبع بذور الأعشاب/الحشائش الضارة في الحقل، كما أظهر التوزع الأفقي لبنك بذور الأعشاب/الحشائش الضارة الموجودة في التربة عند بداية التجربة معنوية عالية (P=0.01) بين مكررات التجارب لمعظم أنواع الأعشاب/الحشائش الضارة ومجموعها الاجمالي. كما أظهر التوزع الرأسي لبنك بذور الأعشاب/الحشائش الضارة في التربة عدم وجود فروق معنوية في العينات المدروسة عند مستوى عمق 5 و 15 سم لجميع أنواع الأعشاب/الحشائش الضارة التي تمّ تعريفها في عينات التربة، ماعدا نوعين منها هما حشيشة شعر الفار (Foxtail) والإيبوميا (*Setaria viridis* و *Ipomia eriocarpa*). أمكن الاستنتاج بأن الاستراتيجية المنفذة القائمة على تطبيق مبيدات الأعشاب/الحشائش الضارة قبل وبعد الانبات والعزيق أو الطرائق الميكانيكية خلال موسمين متتاليين قد أدى إلى انخفاض كبير في مخزون بذور التربة لجميع أنواع الأعشاب/الحشائش الضارة.

كلمات مفتاحية: إدارة الأعشاب/الحشائش الضارة، بنك بذور الأعشاب/الحشائش الضارة، مبيدات الأعشاب/الحشائش ، *Ipomia eriocarpa* و *Setaria viridis*.

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