

Investigation of soil tillage practices and weed control methods on Zea may farms in North West of Iran

Abstract

In order to study the influence of tillage methods on weed control in corn (single cross 704), an experiment was conducted in Miandoab research station for 3 years from 2014- 2017. The design of experiment was split plot based on random block designed. Main factor was two tillage method with chisel and mould board plow in 25 cm depth and weed control methods as sub factor in 4 level were: chemical control with using of 2 L /ha (Cruz) Nicosulfuron (4% S.C), mechanical control with 2 times cultivation between rows in 2 and 8 leaves stage of corn, control treatment without weeds (with 3- hand weeding) and control treatment with weeds. Analysis of variance results indicated that the effect of tillage methods on corn yield was not significant. Average of corn yield in different tillage methods were 9.422 and 9.148 respectively but the effect of control methods was significant at 1% level. Means comparison by Duncans multiple range test showed that chemical control and hand weeding respectively with 11.285 and 10.85 were placed in a same group but mechanical control and without control respectively with 8.654 and 6.357 were placed in another groups. Analysis of variance results indicated that the effect of Tillage methods on density of common purslane and barnyard grass was significant at 1% level but on the other weeds, tillage method didn't show any effect on their density. Average of density of barnyard grass during 3 years with mould board plow and chisel were 43/083, 12 respectively and average of density of common purslane with mould board plow and chisel were 6/917 and 14/5 respectively and they were placed in separated group by using of Duncans multiple range test.

Main weeds of experiment were:

- I. Red root pigweed (*Amaranthus retroflexus*)
- II. Lambsquarters (*Chenopodium album*)
- III. Common purslane (*Portulaca oleraceae*)
- IV. Barnyard grass (*Echinochloa crus-galli*)
- V. Field bindweed (*Convolvulus arvensis*)

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Introduction

Nowadays discusses about fuel usage optimizing are very noticeable and the most of investigated projects are conducted in order to offering methods and useful techniques, for better consumption of energy resources. Soil practices are the most important operations of agricultural performance which have generally dedicated more than 50% of whole consumed energy for crop production. So, applying various methods of plowing will be an effective movement in reducing energy consumption in agricultural activities. Applying Reversible ploughs in comparing with slender ploughs, for the primary soil practices, needs more energy and is time consuming. However, in these methods the soil moisture is evaporated much more, and its texture will be destroyed and therefore soil is exposed to windy erosion. With continuing applications of ploughs, the soil surface will be disturbed that result in forming the plowing pans in constant depth of soil reducing the penetration and extension of plant roots. In other hand, the slender ploughs have less control on weeds.¹ Studying the alternative planting system of corn and soybean for a period of 10 years, has found that plowing system by reversible ploughs with neglecting the kinds of alternative plants,

has been resulted in producing the maximum crop yield. In none of the soil practices systems neither ordinary nor protective one, in the mentioned period, any reduction has been observed in crop yield.² This demonstrates that, the minimum soil practices systems do not cause any reduction in crop yield. The effect of year on operation in both ordinary and protective soil practices was not significant. In continues plantings of corn, the applying reversible plough in soil practices, has the maximum investment retention, while in corn-soybean alternative plantings, applying the slender plough, has showed the most investment retention. This study has demonstrated that the protective soil practice system could perform without any noticeable losses in investment retention and significant increase in chemical pesticides applications,³ had reported that in comparing the soil practices methods on silt-loam soils, the yield of corn in without soil practices system was 8.4 tons per hectare in the first year, and soil practices with reversible plough and slender plough resulted in 10.5 and 9.3 tons per hectare, respectively. In the second years, the effect of soil practices on corn bean operation was not significant, therefore, protective soil practices (slender one or none) have been recommended for sloping fields.⁴

They also suggested that, in corn planting in plowing by reversible plough, due to decreasing the useful graining of soil, total soil prosier and fertility, showed decline in comparing to protective soil practices,⁵ have declared that application of slender plough in a period of 5 years in autumn season, resulted in 5% losses in comparing to reversible one,⁶ after investigating the six methods of soil practices, have found that, in duration of 3 years, only none-soil practice systems had less performance than the other systems According to the reports of⁷ soil practices by slender plough caused the equal yield as soil practices by reversible plough. Soil practices by reversible plough need low fuel, energy (40%) and are time-consuming. Janzen HH⁸ according to his economic studies has found that, the application of slender plough has better and more direct investment retention than the other methods⁹ announced that the external specific germ and soil cone index was more in soil practice via slender plough than reversible one. Also, resistance of soil in fewer slopes to penetrating has showed more increases in reversible soil practice than slender one⁶ have reported that the effect of soil practice on resistance of soil to penetrating in silt-loam soil was limited to plowing layer (about 23 cm), and cone index in depths was less than 23 cm for all treatments, and it was less than 2 mega Pascal¹⁰ had reported that the protective soil practice systems, allows to elevating the moist contact of soil, reducing soil temperature and external high specific germ in comparing to ordinary soil practices. In sloppy fields, with good drainage and low organic materials, the protective soil practice methods showed equal crop yield or more, compared to the ordinary soil practices in corn beans planting. In a field with weak drainage and low organic materials and weak soil structures, protective soil practices with taking time showed improved soil structure, in a way that the organic matters and soil grains increased. The corn yield has improved with time and often was more than the ordinary soil practices³ have mentioned that the low depth soil practices systems in comparing to soil practices systems by reversible ploughs are results in:

- I. Increase in external specific germ in low layers of soil
- II. Increase in organic matters of soil, which promotes increasing the water holding ability of soil and grain resistance
- III. Increasing earthworm's populations that allows to promoting the water penetration into soil, and decreasing the erosion and soil washings.

Griffith DR, et al.,⁶ has reported that, by lesser intensity of soil practices, we would obtain the maximum resistance closer to soil level, and for reversible plough the maximum depth to cone index was greater than slender one and the maximum resistance to soil practices via slender plough was about 22-25 cm and in soil practices via reversible plough it was limited to 23-40 cm¹¹ has reported that the decreasing rates of external specific germ after soil practices via reversible plough were 22%, whereas it was about 17% after slender plough¹² has demonstrated that, the external specific germ of soil is not significantly affected by the kind of soil practices, but it is affected by depth changing, and the variations of external specific germ is significant have declared that among the different methods of soil practices especially in depths of 8-16 cm, significant differences ($P < 0.05$) between the both slender and reversible systems has been observed¹³ has reported that the cone index is affected by the kinds and depths of soil practices. Also the difference in external specific germ across soil depths and kind of soil practices were significant. Base plowing was observed in all the treatments except for the soil practices by slender plough¹⁴ have announced that applying herbicides and cultivators between rows, 2-4 weeks after germination of corn

increased economically crop performance and they observed an accretive yield and better weeds control.

Helgason BL et al.,¹⁰ following their researches have declared that, after mechanical controls of weeds the density of weeds was 41% which was more than in chemical controls, but the decrease of corn yield in mechanical way was only 22%. However, in comparing with chemical control of weeds in rows by using herbicides, the weeds density was 8% more, but the only 1% loss was observed in crop yield. Weeds control was the most beneficial effect of useful plowing. Different experiments has demonstrated that in the soils without weeds, the yield of product in plowed fields any significant increase in crop yield have been not observed. Corn is a kind of plants that have more growth in high temperature and light, but have low growth in low temperatures. So, this would be more sensitive in beginning of its growth, whenever the weather in not suitable for this purpose, it would be more sensitive to weeds.⁹ The researches which have conducted for estimating the weeds damages had demonstrated that, its damage level in German is 45%, in Russia is 30%, in Indonesia is 50%, and in USA is about 41% up to 86%.⁴

Soil seed bank (various seeds which are stored in soil) is the most important origin of weed attacks in most of the plowed field. Soil practices by destroying the soil structure, affected directly the seeds bank. Soil practices follow the herbicides usage, with decreasing indirectly the seed production of plants, would affect the gene bank. This kind of operations, would affected the seed bank characteristics such as seeds number, their growth ability, seeds dormancy, and combination of species. Changes in seed bank characteristics are often lead to change in species combinations and varying in flora of weeds. The soil practice methods are influenced the lifelong and desperations of seeds in vertical profile of the soil. In plowing by reversible plough, the weed's seeds are disspreading more uniformly in all plowed layers of soil than by slender plough. In plowing by slender ploughs the seeds are concentrated near to the soil level. Changes in the soil practice system methods from traditional system to protective one would leads to some changes in weed species combinations, in which germination of weeds species would show a resistance against the weeds controlling practices.⁴ The results of several studies have demonstrated that the effects of soil practices on species combinations are different, and mostly depend on the planting systems and its duration. Tremblay G¹⁵ has performed an experiment in order to evaluate the effects of primary soil practices (plowing by slender and reversible plough), secondary soil practices (cultivator application) and herbicides application on controlling of weeds, changing the population of weeds species, storing seeds in soil during the period of three years. In this study the alternative plants were: continuous planting of corn for 3 years (CN), continuous planting green bean for 3 years (PB), and planting of sugar bean for 2 years and corn in third year (SB). By comparing the slender plough with reversible plough, they have demonstrated that the seeds of weeds after plowing by slender plough have more dispersed to near of soil level than plowing by reversible plough. Some densities of annually weeds' seeds after plowing by slender plough have showed a high amount of seeds in seed bank during three years period. The most important species that have showed notable increase are mentioned in bellow:

Chenopodium album, *Amaranthus retroflexas*, and for SB alternatives, *Eragrostis cilianesis*, *Solanum sarrachoides*

Reversely, the seeds density in plowed plates by slender plough in SB plant system has rapidly decreased in *Kachia scoparia* species. Cultivator applying in comparing with not applying, leads to decline

the seeds bank density in soil. Using herbicides in controlling weeds on each planting sequence do not causes changes in density of weed species which makes resistance to herbicides. Seeds of *S. sarrachoides* in alternative planting of PB were more highlighted and the seeds of *K. scoparia*, *A. retroflexus*, *Chenopodium album* in SB alternative planting were very remarkable. Grover KK, et al.,³ have investigated the effects of tillage and herbicides on weeds flora combinations in irrigated planting system. In this research, the effects of primary soil practices (plowing by slender and reversible plough) cultivator applications between rows, different levels of herbicides in changes of weeds were evaluated on three alternative irrigated planting for 5 years. The alternative plantings were: corn continues planting for 5 years (CN), green bean continues planting for 3 years and planting corn after green bean for 2 years (PB), sugar bean planting for 2 years and corn for 3 years (SB). Total density of weeds for PB alteration were 1 to 245, for SB was 100 to 209 and, for CN was 2 to 190 weeds per square during 5 years of studies. Density inductions in plowed treatments were not significant by reversible plough. Total observations in each alternative showed that during the last year in alternative planting of CN, *Setaria viridis*, in PB alternative, *A. retroflexus*, *S. sarrachoides*, and in SB alternatives, *A. retroflexus*, *S. viridis*, were more prevalent.¹⁶ Differences in weeds species due to alternative planting were only observed in treatments with primary soil practices by slender plough. Furthermore, density of *A. retroflexus* has been reduced because of alternative planting and plowing by slender plough with high amounts of chemicals application. Using cultivator in units was more effective in destroying the weeds species combinations than the none-treatment plates. In this study, only during the drought period occurred in July 1994, the plowing has remarkably affected the germination of *A. retroflexus*. Temperature and moisture of the soil in 2.5cm deeps had been measured and evaluated and demonstrated that, plowing has not any significant effect on them.

Materials and methods

Present study was conducted in agricultural research center in Miandoab, West Azarbyjan – Iran, with 46°9' longitudes and 36°58' latitudes and 1371 meter high from sea level. This station has dry and semi dry regimes and Mesick thermal regime. Average annual raining is about 286- 330 mm, and its soil structure was silt-loam (river sediments) with pH 8.9 and its electrical conductivity was 1.21 mmhos/cm. Experiments were arranged in randomized complete block design with 4 replications in each of three years. Soil practice treatments and substantial one is included different weeds controlling methods according to the plan. Fertilizer applications were done after

soil analyses results. Corn seeds were planted in 4 rows with 75cm distance from each other, and with 20.5 cm distance between plants in each row. The planting area was 9.225 square meter (harvesting was from 2 middle rows). The spaces between blocks were 4 meter and the spaces between plots were one planting line. Single cross 704 corn seed with 65000 seeds density per hector were sowed by corn planting machine in rows. Chemical controlling treatments was done at 2-4 leaves stage of corn with Cruz (Nicosulfuron 4% EC 2 l/ha) First and second cultivator usage in mechanical controlling treatments were done in 4 and 8 leaves stage of corn plants weed density and dry mass were measured 30days after spraying with herbicides and at the end of experiment before harvesting also density and dry weight of weeds were measured. In soil practiced treatments by reversible plough, plowing by reversible plough was done in 25cm depth in spring, and then disc and leveler were applied and then planting were done. However, plowing by slender plough was done in the same depth and spring plowing was done in 25cm depth by slender plough, and then disc and leveler were applied and then planting were done.

Results and discussion

Effects of soil practice methods on weeds density

As illustrated in Table 1, during the first year of experiment, the main factor of soil practice methods in both slender plough and chisel level in 25cm depth, none of treatments expect of Common purslane has not shown significant effect of the weeds. During the second year of experiment soil practices has not significant effects on weeds density (Table 2), but in third year of experiment the effects were significant ($P<0.05$). Combined analyses of variance showed that the soil practice methods has significant effect on Barnyard grass and Common purslane weeds density ($P<0.01$) (Table 3). According to results, the average of Barnyard grass density in reversible plough and chisel application were 43.083 and 12 plants per square, and the average of Common purslane weeds density in plowing by reversible plough and chisel were 6.917 and 14.5, respectively. Concerning to Red root pigweed, the results were in agreement other studies that investigated the effects of different plowing methods on germination, phonology and density of Red root pigweed. According to their result, although plowing is necessary for germination of most of the weeds, but in the case of amaranth plowing has less importance in prediction of population dynamic and controlling of it. As the results of Oryokot JO et al.,¹⁶ experiments mentioned before, soil practices by slender plough in comparing with reversible plough causes changes in annual weeds density.

Table 1 Analyses and variance of compound operative characteristics

Variance Sources	Freedom degree	Square means			
		Weight 100 gram	Interval of flower to silk flower appearance	Seed yield	Seeds number in rows
Year	2	17.573	0.042	1.968	0.281
Repetition	9	10.385	0.167	3.572	34.941
Tillage Factor	1	1.260 ns	0.167 ns	1.859 ns	10.010 ns
Year* Tillage	2	2.823 ns	0.042 ns	0.479 ns	11.885
Error	9	2.663	0.278	2.197	22.622
Control Factor	3	148.233**	0.083 ns	123.342**	45.594*
Year* Control	6	6.587 ns	0.083 ns	1.097 ns	3.906 ns
Error	54	9.002	0.167	3.173	12.392
Variance Coefficient CV%	-	9.52	18.49	19.18	9.6

Table 2 Analyzes of compound variance of weeds density

Square means						
variance sources	Freedom degree	Field bindweed	Red root pigweed	Lamb squatters	Common purslane	Barnyard grass
year	2	15.221**	2.664	0.43	4.726**	25.858**
Year* repetition	9	0.916	0.554	0.39	0.28	2.396
Tillage factor	1	3.123	2.304	0.002	3.741**	23.586**
Year* tillage	2	1.735	2.048	0.011	0.402	6.057
error	9	0.616	1.343	0.369	0.186	1.581
Weeds Control factor	3	15.993**	43.858**	15.151**	28.418**	103.806**
Year* control	6	2.318	2.575**	0.364	1.761**	8.341**
Control factor* tillage factor	3	0.536	1.067	0.039	2.231**	10.324**
Year* control factor* tillage	6	0.206	0.845	0.205	0.256	1.605
error	54	369	0.409	0.246	0.256	0.935
Variance coefficient CV%	-	37.7	31.99	34.01	27.27	37.54

Table 3 comparing of attributes means in weeds controlling methods in three years of tillage in $p < 0.01$ (seeds yield and 100 gram weight) and in $p < 0.05$ (seeds number in rows)

Weeds controlling	Weight of 100 seeds	Interval of Taji flower to silk flower appearance	Seed yield (t/ha)	Seeds number in rows
Chemical control	32.625 AB	2.208 A	11.29 A	37.625 AB
Manual weeding	34.625 AB	2.167 A	10.85 A	38.042 A
Mechanical control	31.342 B	2.167 A	8.654 B	35.667 BC
None control	28.667 C	2.292 A	6.358 C	35.292 C

Effects of controlling methods on weeds density

Controlling methods on weeds density during three years have significant effects on weeds density in corn field ($P < 0.01$) (Table 4). Comparing the average of weeds density during three years tillage has showed that mechanical controlling without any controlling effect on Barnyard grass, Lambs quarters, Field bindweed, were placed in the same group and chemical controlling and manual weeding with together were placed in another group. Concerning to Barnyard grass, controlling methods were placed in different groups (Table 5). Reviewing the results has demonstrated that the mechanical controlling treatments were 27.41% effective in weeds controlling weed in corn field on Miandoab area, West Azerbaijan province, and this controlling method in comparing with chemical controlling one have resulted in yield loss about 42.01% comparing to chemical controlling treatment (highest yield). Chemical controlling demonstrated the best and

highest weeds controlling in both soil practice methods. Additionally, changing the soil practice system from traditional (reversible plough) to protective system (chisel) caused change in combination of weeds species via germination rate of species seeds in reaction to the different soil practices. These species are mostly included annual weeds in which soil practices caused to gathering seeds of these weeds near to the soil surface by chisel plow, while by reversible plough they dispersed in all over the soil layers, uniformly.

Red root pigweed (*Amaranthus retroflexus*)

Lambsquarters (*Chenopodium album*)

Common purslane (*Portulaca oleraceae*)

Barnyard grass (*Echinochloa crus-galli*)

Field bindweed (*Convolvulus arvensis*)

Table 4 Comparing the weeds density average in weeds controlling methods in three years of tillage in $p < 0.01$

Weed					
Treatment	Barnyard grass	Common purslane	Lambsquarters	Field bindweed	Red root pigweed
None control	27.542 A	10.708 A	4.938 A	6.833 A	12.542 A
Mechanical control	20.458 A	5.292 B	4.208 A	6.167 A	9.292 A
Chemical control	0.542 B	1.458 C	0.292 B	0.365 B	0.708
Manual weeding	0 B	0 D	0 B	0.667 B	0 B

Table 5 comparing the weeds density average in results of cross effects of controlling methods and tillage in three years in $p < 0.01$

Weed					
Treatment	Barnyard grass	Common purslane	Lamb squatters	Field bindweed	Red root pigweed
Reversible + chemical	0.250 D	1.833 D	0.167 A	0.250 A	0.833 A
Reversible + mechanical	28.583 B	3.917 C	4.417 A	4.500 A	7.333 A
Reversible + weed	43.083 A	6.917 B	5.292 A	4.750 A	9.917 A
Reversible + none weeds	0 D	0 E	12:00 AM	0.500 A	12:00 AM
Chisel + chemical	0.833 D	1.083 DE	0.417 A	0.475 A	0.583 A
Chisel + mechanical	12.333 C	6.667 B	4.0 A	7.833 A	11.250 A
Chisel + weeds	12.00 C	14.500 A	4.583 A	8.917 A	15.167 A
Chisel + none weeds	0 D	0 E	12:00 AM	0.833 A	12:00 AM

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None.

Conflicts of interest

The author declares there is no conflict of interest.

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