INFLUENCE OF THE TILLAGE SYSTEM ON THE DEGREE OF WEEDING IN PEAS CULTURE AT ARDS TURDA

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Abstract. *Weeds were, are and will be a big problem for crops, they affect and act in all conditions in all areas of the globe. The most significant sources of weed infestation of crops include weeds seeds deposited in soil and agricultural practices applied (Gruber and Clauplein, 2009). Tillage, or the absence of tillage, can affect weed population. The experimental factors were: factor A - the experimental years: A_1-2014, A_2-2015, A_3- 2016; factor B - Tillage system: B_1-Conventional tillage system included ploughing at 25 cm depth after harvest of the previous crop and processing with rotary harrow before sowing; B_2-Minimum tillage system involved the use of a chisel at 25 cm depth after harvest of the previous crop and processing with rotary harrow before sowing; B_3-No tillage system included the direct sowing. The experiment was conducted in the period 2014-2016 at the Agricultural Research-Development Station Turda. Immediately after sowing it was made one treatment with Gliphosate (4l/ha) in the three systems. Monocotyledonous and dicotyledonous weeds control was made after emergence of the crop with Tender (1.5 l/ha), Pulsar (1.0 l/ha) and Agil (1.0 l/ha) herbicide in a weeds rosette phenophase. After emergence of the crop in all three years, were recorded, by numerical method, 12 weed species, of which only 4 were found in all three years (Chenopodium album, Polygonum convolvulus, Setaria glauca, Xanthium strumarium). Before harvesting the crop in 2014-2016 period, were recorded 13 weed species, of which only 3 were found in all three years (Chenopodium album, Setaria glauca, Xanthium strumarium). Every year most species were found in the minimum tillage system, with 13 weeds/m^2 compared to the conventional tillage system, the difference being very significant. The pea yield obtained in 2016 is higher and lower in 2015 with very significant differences compared to average years. In minimum tillage system weed seeds get in the top layer of soil, where to find germination conditions, resulting in a high degree of weeding.*

Key words: *peas, tillage system, weed, yield.*

INTRODUCTION

Weeds were, are and will be a big problem for all crops, they affect and act in all conditions, in all areas of the globe. Yield losses due to weed infestation lands can reach up to 80%. The number and weight of weeds as well as their species diversity depend on the measures control applied and the method and period of cultivating.

Tillage is the mechanical manipulation of the soil and plant residues to prepare a seedbed for crop planting (SHRESTHA ET AL, 2006), is often used as a weed control system. The most significant sources of weed infestation of crops include weeds seeds deposited in soil and agricultural practices applied (GRUBER AND CLAUPLEIN, 2009). The density and content of the weed seed reserve in the soil varies according to the soil tillage (CARDINA EL AL, 1991).

Tillage modifications have a significant effect on weed emergence and weed seed distribution in the soil profile (TORRESEN ET AL., 2003). Tillage, or the absence of tillage, can affect weed, pest and diseases population. In zero-till systems, weed seeds remain on the soil surface, the mortality of these seeds is higher than for seeds buried in the soil. The most

important benefits of tillage are: it loosens soil, enhances the release of nutrients from the soil for crop growth, kills weeds, and regulates the circulation of water and air within the soil (REICOSKY AND ALLMARAS, 2003).

As reported by RUSU ET AL. (2013) the diversity of the seed reserve grows from the mouldboard plough, to disk, chisel and no-tillage, which had the biggest seeds reserve, crop rotation and soil tillage continue to remain one of the most important measures with high efficiency in fighting weeds.

The main feature of the minimum tillage is keeping plant debris on the soil surface which prevents water evaporation from the soil and penetration weed seeds in the soil layer.

MATERIAL AND METHODS

The experiment was conducted in the period 2014-2016 at the Agricultural Research-Development Station Turda (ARDS), on soil type vertic faeozem, pH neutral, with loam-clay texture, medium humus content, good supply in mobile phosphorus and potassium.

Pea was sown in the third decade of the March in the quantity of 100 seeds per 1 m^2, with the distance between rows 18 cm with Gaspardo Directa 400 drills.

The experimental factors were: factor A - the experimental years: A_1-2014, A_2-2015, A_3-2016; factor B - Tillage system: B_1-Conventional tillage system included ploughing at 25 cm depth after harvest of the previous crop and processing with rotary harrow before sowing; B_2-Minimum tillage system involved the use of a chisel at 25 cm depth after harvest of the previous crop and processing with rotary harrow before sowing; B_3-No tillage system included the direct sowing.

To evaluate the yielding of pea cultivated in the three tillage systems we are studied one genotype of afila pea: Tudor. Pea was grown in a crop rotation for 3 years, the precursory plant being winter wheat.

Immediately after sowing it was made one treatment with Gliphosate (4l/ha) in the three systems. Monocotyledonous and dicotyledonous weeds control was made, after emergence of the pea crop, with herbicides Tender (1.5 l/ha), Pulsar (1.0 l/ha) and Agil (1.0 l/ha) in a weeds rosette phenophase.

For pea protection against pests, at the early flowering stage of plants it was made a treatment with Calypso (0.1 l/ha) insecticide and at the 10 days after early flowering it was made another treatment.

Determination of the weed species it was made with metric frame, by numerical method, in every plot and the results achieved were elaborated statistically with the method of analysis of variance and setting up the Least Significant Difference - LSD - (5%, 1%, and 0.1%) (ANOVA, 2015).

The climatic condition of the years 2014 - 2016 were presented according to the Weather Station Turda (Table 1). During the last 59 years, the annual means of temperature were 9^0C and total amount of precipitation were 520.6 mm. Average temperatures recorded in the months during the growing crop of peas, in the two years is greater than the average on 59 years with 1.4^0C in 2014, is characterized as being the hottest of the last 59 years, with 1.1^0C in 2015 the year being considered a hot year, and with 1.2^0C in 2016 considered a hot year.

Rainfalls amount in 2014 was higher than the average on 59 years, being considered a rainy year, the rainfalls was low during the first half of the year 2015, the peas suffered from the drought installed during spring, in 2016 the rainfalls was higher than the average on 59 years, being considered a very rainy year. In 2015 rainfall was lower than in 2014, and their

absence in optimum moments for culture development has resulted in significant loss of yielding. In 2014 and 2016 the temperatures and rainfall were beneficial to the crop of peas, the yield being the result of the interaction optimum climatic conditions.

Table 1

Thermic and pluviometric regime in the vegetation period of pea culture, Turda 2014-2016

Years		Months					Average/ amount
		March	April	May	June	July	
Air temperature (^{0}C)	2014	8.8	11.4	15.1	18.5	20.4	14.8
	2015	5.5	9.6	15.8	19.4	22.3	14.5
	2016	5.9	12.4	14.3	19.8	20.5	14.6
	Average 59 years	4.5	9.9	15.0	17.8	19.7	13.4
Precipitation (mm)	2014	23.1	72.0	66.2	48.4	144.4	354.1
	2015	12.8	32.2	66.0	115.7	52.2	278.9
	2016	47	62.2	90.4	123.2	124.9	89.5
	Average 59 years	19.3	44.4	67.1	83.4	72.9	57.4

Source: Weather Station Turda

RESULTS AND DISCUSSION

The degree of weeding spring is higher, this is due to the adaptability of weeds to harsh environmental conditions to plant crops. Weed spectrum, time of occurrence, degree of weeding and methods of combating in differently influence yield (Cheţan et al., 2015).

In our experience, after emergence of the crop in all three years, were recorded, by numerical method, 12 weed species, of which only 4 were found in all three years (*Chenopodium album, Polygonum convolvulus, Setaria glauca, Xanthium strumarium*) (*Table 2*).

The number of weeds species recording in the classical system, after pea emergence, is 11 weeds species, at the conservative tillage systems application their number decrease to 8 weeds species in minimum tillage respectively 10 species in no tillage system. In a research by Cheţan et al. (2014) in classical system attended by a total of 24 species of weeds, annual dicotyledonous weeds being present in all the experimental variants with participation from 1-100%, *Xanthium strumarium* presented the most common species and the weeds species existing in minimum tillage it was result 21 species, the most common are: *Xanthium strumarium* and *Hibiscus trionum*, in second place are yearly monocotyledonous *Setaria glauca* and *Echinochloa crus-galli* in soya culture at ARDS Turda. Investigation by Tuesca et al. (2001) demonstrated increased weed infestations on plots with ploughing system and a reduced number and weight of weeds in the no tillage system.

Table 2

Number of weeds/m^2 after emergence of the pea, Turda 2014-2016

Nr.	Weed species	Tillage system								
		Conventional tillage system			Minimum tillage system			No tillage system		
		Experimental years								
		2014	2015	2016	2014	2015	2016	2014	2015	2016
1	*Agropyron repens*	2	1	-	8	-	-	-	1	-
2	*Amaranthus lividus*	-	-	4	-	-	-	-	-	-
3	*Chenopodium album*	8	4	3	7	5	2	2	2	-
4	*Cirsium arvense*	-	-	-	2	-	-	1	2	-
5	*Echinochloa crus-galli*	1	2	-	4	1	-	-	2	-
6	*Lathyrus tuberosus*	-	1	-	-	-	-	1	1	-
7	*Polygonum convolvulus*	1	1	1	2	3	2	3	3	2
8	*Rubus caesius*	-	1	-	-	-	-	1	-	-
9	*Setaria glauca*	4	1	2	8	2	-	15	2	-
10	*Silene noctiflora*	-	-	3	-	-	-	-	-	-
11	*Sonchus asper*	-	1	-	-	1	-	1	1	-
12	*Xantium strumarium*	1	3	12	13	5	35	5	2	26
Total number of weeds		17	15	25	44	17	39	29	16	28

As can be seen in *table 3* the number of weeds in peas culture was higher in the years 2014 and 2016, when the amount of soil water was higher and weed seeds germinate better than in 2015, when lack of water in the soil negatively influenced the number of weeds emerged. Years 2014 and 2016 were considered good years for pea crop, soil moisture with a very high importance on the number of seeds germinated.

Table 3

The influence of the experimental years on the degree of weeding

Year	Number of weeds/m^2	Difference
Average (control variant)	26.53	-
2014	30.92***	4.39
2015	16.92^{000}	-9.61
2016	31.75***	5.22
LSD (p 5%) 1.75	LSD (1%) 2.66	LSD (p 0.1%) 4.27

A great influence on the number of weeds/m^2 has the soil tillage system, following the application of minimum tillage system and at the application of no tillage system register an increase of weeds number (7 weeds/m^2 at minimum tillage and 13 weeds/m^2 at no tillage application), differences from the conventional tillage system (control variant) being very significant (*Table 4*). In a research by Woźniak (2012) the no tillage system contributed to increase number and weight of weeds in pea compared to the ploughing system. In no tillage system the weed seeds do not reach the ground layer, remain on the soil surface, most of them do not survive over the winter and the number of weeds is lower.

Table 4

The influence of the tillage system on the degree of weeding

Tillage system	Number of weeds/m^2	Difference
Conventional tillage system (control variant)	19.75	-
Minimum tillage system	32.92***	13.17
No tillage system	26.92***	7.17
LSD (p 5%) 2.10	LSD (1%) 2.88	LSD (p 0.1%) 3.93

Climatic conditions from those three experimental years had a great influence on the yield achieved, statistically in 2014 the yield was lower with -69 kg/ha, the difference from the average of the three years (control variant) being very significant negative, in 2015 difference from a control variant (-890 kg/ha) was very significantly negative and in 2016 the yield obtained was higher than control variant with 959 kg/ha, the difference being very significant positive (*Table 5*).

Table 5

The influence of the experimental years on the yield of pea

Year	Yield (kg/ha)	Difference
Average (control variant)	3250	-
2014	3181	-69
2015	2360^{000}	-890
2016	4210***	959
LSD (p 5%) 73	LSD (1%) 110	LSD (p 0.1%) 177

A great influence on the yield has the soil tillage system, following the application of conservative tillage systems register a decrease in yield of -74 kg/ha at application of the minimum tillage system, respectively -1223 kg/ha at application of no tillage system, differences from the conventional tillage system (control variant) is very significant (*Table 6*). The yielding of plants cultivated in no-tillage systems is, generally, slightly lower than of plants from conventional tillage systems. The conservation tillage increases weeds infestation and consequently lowers yield.

Any reduction in tillage intensity or frequency poses serious concerns with regard to weed management, and losses in crop yields as a result of increased weed densities.

Table 6

The influence of the tillage system on the yield of pea

Tillage system	Yield (kg/ha)	Difference
Conventional tillage system (control variant)	3683	-
Minimum tillage system	3608^{00}	-74
No tillage system	2459^{000}	-1223
LSD (p 5%) 53	LSD (1%) 73	LSD (p 0.1%) 99

The total dry weight of weeds in the minimum tillage (319 g/m^2) and conventional tillage (269.8 g/m^2) was higher compared to the no tillage system in the period 2014-2016 and the number of weeds/m^2 is higher in minimum tillage and no tillage, the largest participation with an annual dicotyledonous species followed by annual monocotyledonous species. Perennial monocotyledonous species were found only in the classical tillage system and at the minimum tillage system (*Table 7*).

Table 7

Number and weight of weeds in pea culture

Tillage system	Year	DA		DP		MA		MP	
		No weeds/m^2	g/m^2	No weeds/m^2	g/m^2	No weeds/m^2	g/m^2	No weeds/m^2	g/m^2
Conventional tillage	2014	5	44.0	-	-	2	13.9	1	15.5
	2015	3	77.7	1	1.7	1	1.8	-	-
	2016	7	113.6	-	-	1	0.5	1	1.1
Total		**15**	**235.3**	**1**	**1.7**	**4**	**16.2**	**2**	**16.6**
Minimum tillage	2014	9	90.2	-	-	3	22.6	2	13.8
	2015	4	48.9	-	-	3	12.8	-	-
	2016	10	118.8	-	-	1	2.5	1	9.4
Total		**23**	**257.9**	**-**	**-**	**7**	**37.9**	**3**	**23.2**
No tillage	2014	6	38.7	1	7.6	4	34.9	-	-
	2015	2	49.7	-	-	3	11.6	-	-
	2016	9	122.6	-	-	1	0.3	-	-
Total		**17**	**211**	**1**	**7.6**	**8**	**46.8**	-	-

Before harvesting the pea crop, in 2014-2016 period, were recorded 13 weed species, of which only 3 were found in all three years (Chenopodium album, Setaria glauca, Xanthium strumarium) they are weed problem in the ARDS Turda area (*Table 8*).

The highest number of weeds/m^2 was registered in the system with minimum tillage, in 2014 (14 weeds/m^2) and the lowest number of weeds/m^2 was recorded in 2015 (5 weeds/m^2) both in the classical tillage system and in no tillage system.

Some other problems associated with reduced tillage include the difficulty in managing perennial weeds, and the successful implementation of a conservative tillage system depends to a good understanding of the dynamics of weed seeds.

The reserve of viable weed seeds present on the surface and in the soil (soil's weed seedbank) is bigher. In no tillage system the highest percentage of weed seeds are located in the top of 2 cm in soil layer and many seeds are destroyed by pests.

Table 8

Number of weeds/m^2 before after of the pea, Turda 2014-2016

Nr.	Weed species	Tillage system								
		Conventional tillage system			Minimum tillage system			No tillage system		
		Experimental years								
		2014	2015	2016	2014	2015	2016	2014	2015	2016
1	*Agropyron repens*	1	-	1	2	-	1	-	-	-
2	*Amaranthus lividus*	-	-	1	-	-	-	-	-	-
3	*Aprea spica-venti*	-	-	-	-	-	-	-	1	-
4	*Chenopodium album*	1	1	2	4	2	2	2	1	2
5	*Echinochloa crus-galli*	-	-	-	1	1	-	-	1	-
6	*Hibiscus trionum*	-	-	-	-	-	1	-	-	-
7	*Polygonum convolvulus*	-	-	1	2	-	-	1	-	-
8	*Rubus caesius*	-	1	-	-	-	-	1	-	-
9	*Setaria glauca*	2	1	1	2	2	1	4	1	1

10	*Silene noctiflora*	-	-	1	-	-	1	-	-	-
11	*Sinapis arvensis*	-	-	1	-	-	-	-	-	-
12	*Sonchus asper*	-	1	-	-	-	-	-	-	-
13	*Xantium strumarium*	2	1	1	3	2	6	3	1	7
Total		6	5	9	14	7	12	11	5	10

CONCLUSIONS

After emergence of the crop in all three years, were recorded, by numerical method, 12 weed species, of which only 4 were found in all three years and before harvesting the crop in 2014-2016 period, were recorded 13 weed species, of which only 3 were found in all three years. The most important weeds recorded in the three tillage systems are *Chenopodium album, Setaria glauca* and *Xanthium strumarium*, weeds problem in the ARDS Turda area.

A great influence on the number of weeds/m^2 has the soil tillage system, following the application of minimum tillage system and at the application of no tillage system register an increase of weeds number.

A great influence on the yield has the climatic conditions and soil tillage system, the reduction in tillage intensity poses serious concerns with regard to weed management, and losses in crop yields as a result of increased weed densities.

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