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INFLUENCE OF SOIL TILLAGE SYSTEM ON WEEDING, PRODUCTION AND SEVERAL PHYSIOLOGICAL CHARACTERISTICS OF PEA CROP

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Abstract

Pea is a plant sensitive to weeding, during the first stages of vegetation, with a high risk of losing the production should an integrated plan of controlling weeding is missing. The production obtained depends on one hand on the soil characteristics and the microclimate in the area, but also on the tillage system applied, the biological material used and its capacity to adapt, including recent climate changes. Thermal stress and high temperatures affect the physiological and biochemical processes from the plants, their research being necessary in relation to the technology applied. The paper presents the influence of the soil tillage system (conventional and minimum tillage) and of the experimental years 2015-2016 (differentiated as climate conditions) upon the degree of weeding, physiological characteristics and production of the pea crop. After having applied the two soil tillage systems, a number of 12 species of weeds was determined, and the annual dicotyledonous weeds are the biggest weeding source. The application of the minimum tillage system leads to a smaller production by 88 kg/ha, representing 97.7% of the conventional system, in the case of main production and 1643 kg/ha (79%) in the secondary production. The determination made upon pea plants and upon the most important crop weeds (Chenopodium album and Xanthium strumarium) led to different results for each physiological parameter. When applying the minimum tillage system, the values of the physiological parameters were lower for the pea crop and higher for Chenopodium album and Xantium strumarium than the values recorded in conventional soil tillage system. The CO_2 assimilation rate was 17.89 µmol.$m^{-2}s^{-1}$ at the conventional system and 16.15 µmol.$m^{-2}s^{-1}$ at the minimum tillage system, and the average efficiency values of using water in photosynthesis were 3.32 µmol mol^{-1} at the conventional system and 2.77 µmol.mol^{-1} at the minimum tillage system.

Key words*: soil tillage, weeding, physiological parameters, production, pea.*

INTRODUCTION

Pea has several characteristics and useful advantages for its introduction in agricultural crop rotations: it is a plant tolerant to different environment conditions; it is suitable for different types of soil; as it is a vegetable, it can fix atmospheric nitrogen into the soil; it has a short period of vegetation. Due to the reduced competition capacity with weeds, especially during the first development stages, pea has a high risk of losing the production upon weeding (Karkanis et al., 2016).
Weeds affect efficiency but also the quality of the production obtained, pea is sensitive to weeding during the whole period of vegetation (Patel et al., 2003). Thus, ensuring constant and quality productions supposes adequate control of weeds. Physical and mechanical control of weeds from pea crops has certain specific limitations (Khan et al., 2004). The use of herbicides can be a useful alternative in fighting weeds by eliminating hoeing and necessary working time and it is essential in the case of conservative systems, with minimum tillage and no-tillage. The chemical strategies of fighting weeds may comprise herbicides with pre-emergent and post-emergent application.
The production obtained depends on one hand on the soil characteristics and microclimate in the area, but also on the technological system applied, crop rotations, fighting diseases, weeds and pests, biological material used and the fertilization level (Dobre et al., 2008; Rusu, 2014). The production differences by applying different soil tillage systems results from choosing the best variant for certain pedo-climate conditions (Rusu et al., 1999; Gus et al., 1995). The application of the minimum tillage system at pea crop, under the conditions from the Transylvanian Plain determined a production 204 kg/ha smaller compared to the

conventional system (Simon and Rusu, 2016). The research of the conservative soil tillage systems targets both nationally and internationally, both productivity aspects, water preserve, carbon management etc., but also aspects related to physiological and biochemical processes in plants, in relation to the technology applied (Liu et al., 2016).

Global climate changes are determined by the increase of CO_2 level in the atmosphere. The CO_2 concentration grew from 280 ppm in 1950 up to 385 ppm now (by approximately 38%) (IPCC, 2014). Adapting to climate changes supposes the creation of new vegetal genotypes with large ecological plasticity to ensure: crop stability; long resistance against the attack of pathogen agents, pests, weeds; improved quality by high content of active biological substances, valuable for the nutrition and health of animals and humans.

Thermal stress and high temperatures affect the physiological and biochemical processes in plants: they accelerate the ongoing of phenological phases; the vegetation period is shortened; leaf surface and radiation are reduced; reduction of biomass; decrease of growth of terminal roots (T> 35°C), which have a higher sensitivity compared to the air part to daily temperature fluctuations; production is affected more by short episodes of really high temperatures than by the average growth of temperature in the area (Yeboah et al., 2016).

The paper presents the results of the researches made under the conditions from the Agricultural Research and Development Station Turda (ARDS Turda), situated in the Transylvanian Plain, the influence of the soil tillage system upon weeding, the production and certain physiological characteristics at pea crop.

MATERIALS AND METHODS

The researches were made during 2015-2016, on a vertic Phaeozem type of soil (SRTS, 2012), with neutral pH, clayey-loamy texture, average humus content, good supply of mobile phosphorus and potassium.

Pea was sowed in the third decade of March, with a quantity of 100 seeds per 1 m^2, with a distance among lines of 18 cm, with Gaspardo Directa 400 sower.

The experimental factors were:

Factor A - The soil tillage system:

a_1- The conventional tillage system (CS) which includes plowing 25 cm deep after the harvest of the preceding crop and the soil processing with rotary harrow before sowing;

a_2-The minimum tillage system (MT) with chisel 30 cm deep after the harvest of the preceding crop and the soil processing with rotary harrow before sowing.

Factor B - experimental years: b_1-2015, b_2-2016.

The biological material was an afila pea genotype: Tudor. The pea was cultivated on a 3 year rotation crop system, the preceding plant was winter wheat.

After sowing a pre-emergent herbicidation was done with Gliphosate (4 l/ha) in all three systems. The control of monocotyledonous and dicotyledonous weeds per vegetation was done with Tender (1.5 l/ha), Pulsar (1.0 l/ha) and Agil (1.0 l/ha) herbicides in the rosette phenophase of dicotyledonous weeds and 3-4 leaves at monocotyledonous.

For the protection of pea crops against pests, in the stage of beginning of blooming, a treatment with the insecticide Calypso (0.1 l/ha) was made and ten days after blooming the treatment was repeated.

The determination of the number of weeds was made by using the meter frame ($0.25m^2$) before the harvest of the pea crop.

For the determination of physiological parameters CIRAS-3 leaf gas analyzer was used, which determines several physiological and environment indicators, the method is non-destructive for the plants. The determinations were made both for plants and for weeds during blooming-formation of pea pods and an average of these determinations was made. The results obtained were statistically processed by the method of analyzing the variant and establishing the limit differences (DL, 5%, 1% and 0.1%) (PoliFact, 2015).

The climate conditions during 2015 and 2016 are presented in table 1. The average of multi-annual temperatures during the last 60 years was 9^0C and the sum of rainfall was 520.6 mm. The average of temperatures recorded in the vegetation period at pea crop during the two research years (2015-2016) is higher than the multiannual average by 1.1^0C in 2015 and by 1.2^0C in 2016, being considered warm years.

The sum of rainfall was lower in the first trimester of 2015, pea reacting negatively to the spring drought; in 2016 rainfall was higher than the multiannual average, being considered a very rainy year. Although in 2015 rainfall was higher than the multiannual average, its absence in the best moments for the formation of the production (blooming-pod formation) resulted in the decrease of the production. In 2016 temperatures and rainfall recorded were beneficial for the pea crop, the productions obtained are the result of interaction among favourable climate conditions.

Table 1. Thermal and rainfall regime during the vegetation period of pea crop,Turda 2015-2016

Year		Month					Average/sum
		March	April	May	June	July	
Air temperature (^{0}C)	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 60 years	4.5	9.9	15.0	17.8	19.7	13.4
Rainfall (mm)	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 60 years	19.3	44.4	67.1	83.4	72.9	57.4

RESULTS AND DISCUSSIONS

In the experimental years 2015 and 2016 after having applied the two soil tillage systems (conventional and minimum tillage), 12 species of weeds were determined (Table 2); the biggest number is determined in 2016; their number is influenced by the favourable environment conditions. Out of the total of species recorded, only 3 species were found in the two years and in the two soil tillage systems, these weeds: *Chenopodium album, Setaria glauca, Xanthium strumarium,* are considered problem weeds on the fields from ARDS Turda, as they are hard to fight in the vegetable crops, especially in the case of minimum tillage systems.

The new environment conditions created by the conservative soil tillage technologies determines the change almost entirely of the weed spectrum, the species adapted to loosening soils are replaced by the species adaptd to more compact soils (Dobre et al., 2008).

The number of weeds from the pea crop was higher in 2016 when the quantity of water in the soil was bigger and the weed seeds germinated better than in 2015; the lack of water from the soil influenced negatively the number of growing weeds (Simon et al., 2016); the differences appear also in the case of tillage systems (Tabel 3); the number of pea plants is bigger in the conventional system, the field was better covered and the weeds couldn't develop like in the minimum tillage system. The annual dicotyledonous weeds are the biggest weeding source, the greatest number of weeds (9) is determined in 2016 in the minimum tillage system.

Cultivators who take into account the introduction of pea into crop rotation should develop a plan of integrated management of peas, which should take into account the entire life cycle of crops from sowing until after harvest. Proceeding thus, they must take advantage of the cultural, physical and chemical practices in order to reduce the spreading and effect of weeds (Menalled, 2012), the efficient fighting of weeds from agricultural crops being a significant factor of production.

The application of minimum tillage leads to a significant decrease of production of over 88 kg/ha (Table 4), the difference representing 97.7% from the one of the conventional system, in the case of main production and over 1643 kg/ha (79%) in the secondary production. From the experiences made by Marin and colab. (2015) during 2008-2010, at Moara Domnească, it results that in the variants worked with the chisel were obtained productions which represent 98.2-98.5% from the one of the conventional variant.

The climate conditions in the two experimental years (Table 5) influenced differently the grain production, the difference of 2622 kg/ha registered in 2016 being considered as very important compared to the production registered in 2015, when only 2401 kg/ha were obtained. The secondary production was also influenced by the climate conditions, the difference of 3963 kg/ha between the two years being very significant in favour of 2016.

Table 2. Number of weeds/m^2 determined before the harvest of the pea crop

No.	Species of weeds	Conventional system		Minimum tillage	
		2015	2016	2015	2016
1	*Agropyron repens*	-	1	-	-
2	*Amaranthus lividus*	-	1	-	-
3	*Chenopodium album*	1	2	2	2
4	*Echinochloa crus-galli*	-	-	1	-
5	*Hibiscus trionum*	-	-	-	1
6	*Polygonum convolvulus*	-	1	-	-
7	*Rubus caesius*	1	-	-	-
8	*Setaria glauca*	1	1	2	1
9	*Silene noctiflora*	-	1	-	1
10	*Sinapis arvensis*	-	1	-	-
11	*Sonchus asper*	1	-	-	-
12	*Xanthium strumarium*	1	1	2	5
Total, weeds / m^2		5	9	7	10

Table 3. Weeding of the pea crop, Turda 2015-2016

Tillage system	Year	Annual Dicotyledonous	Perrenial Dicotyledonous	Annual Monocotyledonous	Perrenial Monocotyledonous
		No. weeds/m^2	No. weeds /m^2	No. weeds /m^2	No. weeds /m^2
Conventional system	2015	3	1	1	-
	2016	7	-	1	1
Total		10	1	2	1
Minimum tillage	2015	2	-	3	-
	2016	9	-	1	-
Total		11	-	4	-

The determinations made with CIRAS-3 leaf analyzer upon pea plants and the most important weeds from the crop (*Chenopodium album* and *Xanthium strumarium)* led to different results for each physiological parameter.

The intensity of photosynthesis decreases during the reproductive phase, the leaf surface is limited and production suffers significant depreciations due to the hydric stress from the vegetation period of pea crop. The quantity of reserve substances stored in seeds is determined by the efficiency of the photosynthesis process, respectively by the absorption capacity of active photosynthethic radiations.

The climate differences in the two years influence very much the CO_2 assimilation rate for the three plants studied, the highest values are recorded for *Chenopodium album*; the structure of this plant being the element which determines the increase of these values compared to pea, which has a shorter leaf surface.

In the minimum tillage system, the CO_2 assimilation rate is lower in the case of the pea crop than the one from the conventional system, being in direct report with the secondary production; the situation is comparable with the two species of weeds where the assimilation rate is higher in the minimum tillage system (where the leaf surface is also bigger than in the conventional system).

One can notice from table 7 that the average value of the CO_2 concentration from the stomatal cavity is a physiological parameter determined by the favourable environmenmt conditions in 2016. For all three plants studied the CO_2 concentration is bigger, the difference compared to 2015 is very significant. When applying the minimum tillage system, a slow increase of the value of CO_2 concentration at pea crop can be noticed, and in the case of the two plants *Chenopodium album* and *Xanthium strumarium,* the difference compared to the conventional system is distinctly significant.

A big number of weeds can reduce a lot the production being in direct competition for light, moisture and nutrients, also weeds from the crop are an important source of disease and pests.

In 2016 the water reserve was higher than in 2015, as it results from table 8, in the photosynthesis process water is used more efficiently; the difference of average values registered in the two years studied is very significant for all three plants studied.

The more developed radicular and leaf system of *Xanthium strumarium* plants from the minimum tillage system determined an important increase of the efficiency to use water in photosynthesis (WUE) compared to the ones from the conventional system. Pea plants used water more efficiently in the photosynthesis process if they were cultivated in the conventional system, the difference compared to the minimum tillage system is very important.

The intensity of the breathing process and of fixing nitrogen depend on temperature and moisture, thus at high tempratures and relatively low moisture, photosynthesis is reduced and the process of transpiration at leaf level is reduced. From table 9 one can observe that in 2016 the transpiration rate was higher than in 2015 both for the pea crop and for the weeds in the crop. In the conventional system the values of the determinations made for *Chenopodium album* and *Xanthium strumarium* were significantly lower than the ones from the minimum tillage system, and in the case of pea the values were higher in the conventional system, the difference is not statistically ensured.

Table 4. Influence of the soil tillage system upon the pea production, Turda 2015-2016

Soil tillage system	Main production		Secondary production	
	Production (kg/ha)	Dif. ±	Production (kg/ha)	Dif. ±
Conventional system	3756	-	7824	-
Minimum tillage	3668^{00}	- 88	6181^{000}	-1643
DL (p 5%)	40		324	
DL (p 1%)	73		596	
DL (p 0.1%)	163		1320	

Table 5. Influence of experimental years upon the pea production, Turda 2015-2016

Experimental year	Main production		Secondary production	
	Production (kg/ha)	Dif. ±	Production (kg/ha)	Dif. ±
2015	2401	-	5021	-
2016	5023***	+ 2622	8984***	+ 3963
DL (p 5%)	81		110	
DL (p 1%)	123		166	
DL (p 0.1%)	197		266	

Table 6. Influence of experimental factors upon the average values of CO_2 assimilation rate

Experimental factor	Pea		*Chenopodium album*		*Xanthium strumarium*	
	Assimilation ($\mu molm^{-2}s^{-1}$)	Dif. ±	Assimilation ($\mu molm^{-2}s^{-1}$)	Dif. ±	Assimilation ($\mu molm^{-2}s^{-1}$)	Dif. ±
Soil tillage system						
Conventional system	17.89	-	20.16	-	18.63	-
Minimum tillage	16.15^{000}	-1.74	24.75***	+4.59	19.61*	+0.99
DL (p 5%)	0.23		0.85		0.87	
DL (p 1%)	0.42		1.56		1.61	
DL (p 0.1%)	0.93		3.46		3.56	
Experimental year						
2015	16.38	-	20.60	-	15.58	-
2016	17.66***	+1.29	24.31**	+3.71	22.66***	+7.09
DL (p 5%)	0.22		2.04		0.46	
DL (p 1%)	0.33		3.09		0.70	
DL (p 0.1%)	0.53		4.96		1.12	

Table 7. Influence of experimental factors upon the average values of CO_2 concentration of substomatal cavity

Experimental factor	Pea				*Xanthium strumarium*	
	CO_2 concentration (mmol $m^{-2}s^{-1}$)	Dif. ±	CO_2 concentration (mmol $m^{-2}s^{-1}$)	Dif.±	CO_2 concentration (mmol $m^{-2}s^{-1}$)	Dif. ±
Soil tillage system						
Conventional system	298.3	-	286.8	-	348.1	-
Minimum tillage	307.3	+9	305.3**	+18.5	363.78**	+15.6
DL (p 5%) DL (p 1%) DL (p 0.1%)	15.17 27.88 61.78		5.95 10.93 24.21		6.79 12.47 27.62	
Experimental year						
2015	290.9	-	280.1	-	344.9	-
2016	314.9***	+24	311.9**	+31.8	367.0***	+22.1
DL (p 5%) DL (p 1%) DL (p 0.1%)	8.72 13.20 21.20		20.11 30.46 48.93		5.23 7.92 12.72	

Table 8. Influence of experimental factors upon the average values of efficiency of using water in photosynthesis (WUE)

Experimental factor	Pea		*Chenopodium album*		*Xanthium strumarium*	
	WUE (µmol mol^{-1})	Dif.±	WUE (µmol mol^{-1})	Dif.±	WUE (µmol mol^{-1})	Dif.±
Soil tillage system						
Conventional system	3.32	-	4.07	-	1.67	-
Minimum tillage	2.77^{000}	-0.55	4.39	+0.32	1.92**	+0.25
DL (p 5%) DL (p 1%) DL (p 0.1%)	0.07 0.12 0.27		0.37 0.68 1.51		0.14 0.25 0.55	
Experimental year						
2015	2.17	-	3.67	-	1.08	-
2016	3.92***	+1.75	4.79***	+1.12	2.51***	+1.43
DL (p 5%) DL (p 1%) DL (p 0.1%)	0.04 0.06 0.10		0.25 0.38 0.62		0.07 0.10 0.16	

Table 9. Influence of experimental factors upon the average values of transpiration rate at leaf level (E)

Experimental factor	Pea		*Chenopodium album*		*Xantium strumarium*	
	Transpiration (mmol $m^{-2}s^{-1}$)	Dif.±	Transpiration (mmol $m^{-2}s^{-1}$)	Dif.±	Transpiration (mmol $m^{-2}s^{-1}$)	Dif. ±
Soil tillage system						
Conventional system	4.80	-	6.15	-	7.91	-
Minimum tillage	4.73	-0.08	6.59*	+0.44	8.18*	+0.26
DL (p 5%) DL (p 1%) DL (p 0.1%)	0.25 0.45 1.01		0.29 0.52 1.16		0.19 0.34 0.76	
Experimental year						
2015	3.93	-	5.69	-	7.84	-
2016	5.60***	+1.68	7.05***	+1.36	8.25***	+0.41
DL (p 5%) DL (p 1%) DL (p 0.1%)	0.12 0.18 0.29		0.17 0.26 0.42		0.06 0.09 0.14	

CONCLUSIONS

In the experimental years 2015 and 2016 after having applied the two soil tillage systems 12 species of weeds were determined, the biggest number is determined in 2016, their number is influenced by the favourable environment conditions. Out of the total of species recorded, only 3 species (*Chenopodium album, Setaria glauca, Xanthium strumarium)* were found in the two years and in the two soil tillage systems.

The application of minimum tillage systems at pea crop leads to a drop in production, representing 97.7% from the one of the conventional system, in the case of main production and 79% in secondary production.

The climate conditions in the two experimental years influenced differently the production: in 2016 were 2622 kg/ha more than in 2015; the difference is very significant compared to 2015 when 2401 kg/ha were obtained in the main production; in the secondary production the difference of 3963 kg/ha between the two years is very significant in favour of 2016.

The values of the physiological parameters determined in the 2 years were significantly higher in 2016 compared to 2015 both for the pea crop and for the species of weeds, as the climate conditions in this year were favourable for the development of plants.

When applying the minimum tillage system, the values of the physiological parameters were lower for the pea crop and higher for *Chenopodium album* and *Xanthium strumarium* than the values recorded in the conventional soil tillage system.

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REFERENCES

Dobre M., Berechescu C., Susinscki M., Grecu F., Dodocioiu A. M., 2008.Change the spectrum of weeds in no-tillage technology.Soil Minimum Tillage Systems, Ed. Risoprint Cluj-Napoca, 104-106.

Gus P., Sebok P., Mester Al., 1995. Minimum tillage and its influences. Soil Tillage – Present and Future, Cluj-Napoca, (2): 295-300.

Karkanis A., Ntatsi G., Kontopoulou C. K., Pristeri A., Bilalis D., Savvas D., 2016. Field pea in european cropping systems: adaptability, biological nitrogen fixation and cultivation practices. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 44(2): 325-336. doi: 10.15835/nbha44210618.

Khan I.G., Hassan M.I., Khan M.I., Khan I.A., 2004. Efficacy of some new herbicidal molecules on grassy and broadleaf weeds in wheat-II. Pakistan Journal of Weed Science Research,10: 33-38.

Liu C.A., Zhang S., Hua S., Rao X., 2016. Effects of nitrogen and phosphorus fertilizer on crop yields in a field pea-spring wheat-potato rotation system with calcareous soil in semi-arid environments. Spanish Journal of Agricultural Research, 14(2): e1101. doi: 10.5424/sjar/2016142-7347.

Marin D. I., Rusu T., Mihalache M., Ilie L., Nistor E., Bolohan C., 2015. Influence of soil tillage system upon the yield and energy balance of corn and wheat crops. Agrolife Scientific Journal, 4(2): 43-47.

Menalled F., 2012. Integrated management of weeds in dry peas, agriculture and natural resources (weeds). Montana State University. http://ipm.montana.edu.

Patel M.M., Patel A.I., Patel I.C., Tikka S.B.S., Henry A., Kumar D., Singh N.B., 2003. Weed control in cowpea under rain fed conditions. In: Proceedings of the National Symposium on Arid Legumes, for Food Nutrition. Security and promotion of Trade. Advances in Arid Legumes Research. Hisar, India, 203-206.

Rusu T., Gus P., Bogdan I., Mester Al., 1999. Influence of different soil tillage systems upon the yield in the case of winter-wheat crops. In: Systems of Minimum Soil Tillage, Cluj-Napoca, 87-92.

Rusu T., 2014. Energy efficiency and soil conservation in conventional, minimum tillage and no-tillage. International Soil and Water Conservation Research, 2(4): 42-49, doi:10.1016/S2095-6339(15)30057-5.

Rusu T., Bogdan I., Marin D.I., Moraru P.I., A.I. Pop, B.M. Duda, 2015. Effect of conservation agriculture on yield and protecting environmental resources. Agrolife Scientific Journal, 4(1): 141-145.

Sımon A., Rusu T., Chetan C., 2016. Influence of soıl tıllage systems on some characterıstıcs morpho-productıve and yıeld to pea. AgroLife Scientific Journal, 5(1): 194-198.

Simon A., Rusu T., Chetan F., 2016. Influence of the tillage system on the degree of weeding in peas culture at ARDS Turda. Research Journal of Agricultural Science, 48(4): 280-287.

Yeboah S., Zhang R. Z., Cai L. Q., Song M., Li L. L., Xie J. H., Luo Z. Z., Wu J., Zhang J., 2016. Greenhouse gas emissions in a spring wheat-field pea sequence under different tillage practices in semi-arid Northwest China. Nutrient Cycling in Agroecosystems, 106(1): 77-91. doi: 10.1007/s10705-016-9790-1.

IPCC, 2014. Climate Change 2014: Synthesis Report.Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, p. 151.

PoliFact, 2015. ANOVA and Duncan's test pc program for variant analyses made for completely randomized polifactorial experiences. USAMV Cluj-Napoca.

SRTS, 2012. Romanian System of Soil Taxonomy. Ed. Estfalia, Bucharest.