# THE INFLUENCE OF THE DIFFERENT TILLAGE SYSTEMS ON THE ABUNDANCE OF PESTS IN THE SOY CULTURE, IN THE CONDITIONS OF THE TRANSYLVANIA PLAIN

*Felicia Cheţan[1], Felicia Mureşanu[1], Dana Malschi[1], Cornel Cheţan[1], Loredana Suciu[1,2]*

[1]Agricultural Research and Development Station Turda, Cluj County, Romania,
[2]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 400372, Romania

Correspondence address,
[2]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca,
3-5 Manastur Street, Cluj-Napoca, 400372, Romania
E-mail: felice_fely@yahoo.com

**Abstract**: The agro-ecological conditions of the area, in particular the changes of the microclimate related to global warming, as well as the changes of the culture technologies, constitute a diversity of factors that influence the level of the populations of pests. The research carried out at ARDS Turda in 2018 and 2019 aimed to find out the dependence link between the soil processing mode and the climatic conditions on the abundance of pests and soybean yield. The soybean yield is influenced by climatic conditions and soil tillage system. The application of unconventional soil tillage systems to soybean cultivation favors the abundance and frequency of the attack of *Tetranychus urticae* and *Vanessa cardui.*

***Key words****: soybean, clime, pests, tillage system, yield*

## INTRODUCTION

Soy is of great economic importance due to its many uses, grains with a high protein content 34-39%, fats 19-20% and vitamins (A, D, E). From ground grains milk, flakes, cheese, chocolate, sauces, biscuits, coffee, candies, macaroons and cakes are prepared. This is also used for the preparation of bread (4-5% mixture with wheat flour) or as an addition to flour lysates for enrichment in lysine. Soybeans are also used in the paints, varnishes, glycerin, soaps, lecithin, rubber and printing ink industries. In animal feed, soybeans, after degreasing, are used in the composition of the combined feed, the value of the shrimp increases if the highest percentage of shells is eliminated, before or after oil extraction. Also, the whole plant can be used as feed in various forms: green, dry or silage (https://www.cartiagricole.ro/cultura-soiei/). Being a leguminous plant which enters into a symbiosis relationship with nitrogen-fixing bacteria (the species *Bradyrhizobium japonicum*), soy is a good precursor for most crops, leaving large amounts of nitrogen in the soil, and can also be used as a green fertilizer (Muntean et al., 1995). Pesticides have led to increased labor productivity comparable to industrial productivity, but being foreign to the ecosystem, especially under abusive conditions can become dangerous by inducing residues in ecosystems as well as in products that go on the food chain. On the other hand, worldwide, if these products were not used it would lead to losses of up to 14% due to pests (Davidescu et al., 1992).

Particularly interesting and important for the production of safe and ecological food and feed products, for limiting environmental pollution, for protecting and preserving the biodiversity of agroecosystems, are the benefits of practicing soy culture, with complex technologies combining the most suitable systems for the soil conservation, integrated pest management, chemical and biological methods (Malschi, 2009; Malschi et al., 2018). The economic growth of soybean production can be achieved by applying appropriate agricultural techniques and practices, which protect the environment (Malschi et al., 2007, 2015;

Mureşanu et al., 2014, 2018) by exercising careful control of imputations and production costs and judicious choice of biological material for sowing (Cheţan & Cheţan, 2014). The use of soybean varieties with the insertion of the first stems more than 12 cm from the soil level is one of the problems related to limiting harvest losses and research in the field of plant improvement from ARDS Turda, led to the creation of varieties with the insertion point at 14-19 cm from the soil level, adapted to the new environmental conditions, suitable for mechanized harvesting, capable of producing, in the context of current climate change, productions high and stable (Mureşanu et al., 2010, 2012).

In the last 62 years since the evolution of the climatic conditions in Turda was monitored, from the data collected at the Turda Meteorological Station (1957-present), a heating process was observed that felt more intense after 2007 (Ignea, 2017). The multiannual average for 62 years was 9.1°C. The number of years in which the annual average temperature had values below 9°C was 25 years, 25 years with temperature 9°C and over 9°C and 12 years in which annual average values of temperature above 10°C, especially in the last eight years (2012-2019). The highest annual average temperature values are attributed to 2014 (11.1°C) and 2018 (11.2°C). The evolution of the rainfall regime was uneven and no dominant trend was observed, the multiannual amount for 62 years was 531 mm, the number of years in which rainfall was below 500 mm was 24 years, over 500 mm in 21 years, over 600 mm were recorded in 13 years and in four years rainfall was over 700 mm. The highest rainfall of the whole period, 816.8 mm were recorded in 2016.

If, from the point of view of the protection of the soybean crop, the first thing we think about in the chapter on pests is the red mite *Tetranychus urticae*, in the last four years at the end of June and the beginning of July in the Turda area, it has been reported the omission of bricks or butterflies *Vanessa cardui*, which, if not acted upon to stop it, can leave the crop without leaves. The ruderal caterpillars are the main host for the scabies, which requires their control, especially those on the edge of the soil where the larvae can first appear and then spread in the culture, in the form of attack in glass. Under the climatic conditions in Romania, the pest presents three generations a year, and the greatest abundance occurs in June and July. More recent studies have shown that the high level of precipitation favors the deposition of the bridge and the larval development (www.scdaturda.ro, 2016, 2018).

The researches aimed to find out the dependency link between the soil processing mode and the climatic conditions on the abundance of pests and the soybean yield realization.

## MATERIALS AND METHODS

The researches were carried out in 2018-2019 at the Turda Agricultural Development Research Station (ARDS) located from a physical-geographical point of view in the Transylvanian Plain. The experience was organised on a haploid chernozem (SRTS, 2012): 56.07% clay, coarse sand 0.73%, porosity 58%, density 1.13 g/m$^3$, SIC texture, with the following indices (MESP, 1987): pH 7.8, humus 3.49%, total nitrogen 0.207%, 65 ppm phosphorus, potassium 400 ppm, 0.7% carbonates, values determined at 0-28 cm depth (OSPA Cluj). The experimental field was included in a rotation of three years: soybean - winter wheat - maize. The biological material was represented by the Felix soybean variety (maturity group 00, created at ARDS Turda).

Experimental factors: A - the soil tillage system: $a_1$ -classical (CS), in the autumn plowed with the Kuhn Huard Multi Master 125T at 28 cm depth + preparation of the germinating bed in spring with the rotary harrow HRB 403D + sowing + fertilizing; $a_2$ - conservative *minimum tillage* (MT), the soil scarified in autumn with the Gaspardo Pinocchio chisel at 28 cm depth + preparation of the germinating bed in spring with the rotary harrow

HRB 403D + sowing + fertilizing; $a_3$ -conservative *no tillage* (NT) direct sowing + fertilized. B - the year (climatic conditions): $b_1$-2018, $b_2$-2019.

The sowing was done with the Gaspardo Directa 400 machine at a height of 65g.g./$m^2$, the distance between rows 18 cm, the depth of incorporation of the seed 5 cm. Mineral (basic) fertilization was performed with $N_{32}P_{32}K_{32}$ a.s./ha (concomitant with sowing) + foliar fertilization with 2.0 l/ha NPK type fertilizer + microelements (8:32:4 + Fe, Mn, Zn, humic acids), applied concomitant with the phytosanitary treatments.

Weed control was carried out in two phases: preemergent with 0.35 l/ha produced on the basis of *metribuzin* 600 g/l + 1.5 l/ha produced on the basis of *S-metolachlor* 960 g/l and postemergent with 1.0 l/ha produced on the basis of *imazamox* 40 g/l + after 4 days 1.5 l ha was applied based on *propaquizafop* 100 g/l.

For control of *T. urticae* was applied 0.8 l/ha *propargite* acaricide and for control of *V. cardui* was applied 0.2 l/ha *tiacloprid* insecticide. The crop phytosanitary status was established according to the degree of attack (GA% = F x I/100).

The yield data obtained were statistically processed by analyzing the variance (PoliFact, 2015) and establishing the limit differences (LSD, 5%, 1%, 0.1%).

The climatic conditions for 2018-2019 period (Turda Weather Station, longitude 23; 47; latitude 46; 35; altitude 427 m) are shown in Figure 1.

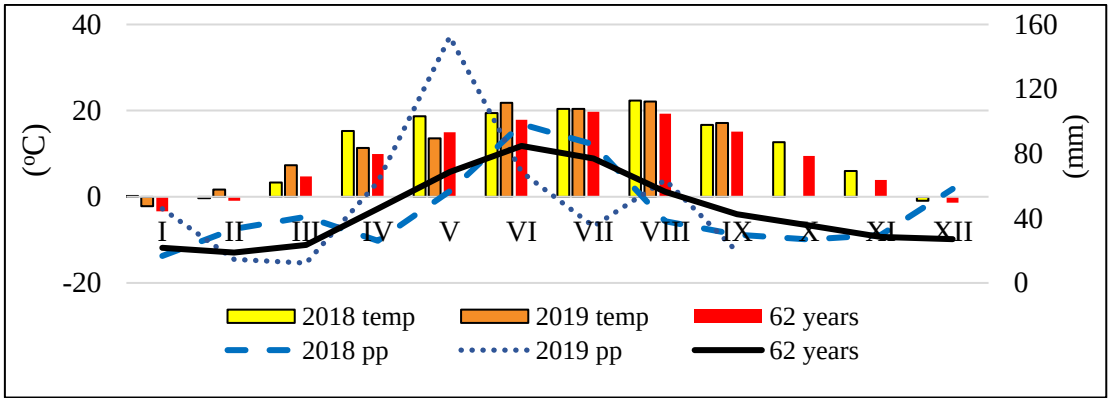


**Figure 1.** The thermal and rainfall regime, during 2018-2019 at ARDS Turda

The abundance of the *T. urticae* adults and the frequency of the attack (F%) in the soybean culture, realized on a number of 150 leaves in each soil tillage system, classical plow (CS), minimum chisel (MT) and no tillage (NT), is shown in Figure 2.

Analyzing the weather data for the period of July when the pest attack manifests (20.4°C in 2018 and 2019), it was found that in these experimental years, the average monthly temperature exceeded the multiannual monthly average over 62 years (19.7°C) with a deviation of 0.7°C. Even if from the point of view of the rainfall regime we cannot talk about a precipitation deficit in July 2018, in 2019 there were only 35 mm, which coincided with the high temperatures, and thus favorable conditions were created attack of the mite. In CS, the abundance of mite in the two experimental years has values between 2930-3329 adults/150 leaves and a frequency of 60.1 - 68.3%, in the MT system the abundance was 2987-3415 adults/150 leaves with the frequency 63.4-69.8% and in the system NT were 3035-3556 adults/150 leaves with a frequency of 64.8-75.2%.

The unconventional soil tillage systems (MT and NT) favor both the abundance of the pests and the frequency of the attack, we consider that this is mainly due to the presence of the vegetal mulch (vegetal debris) left after the harvest of the preceding plant (in this case maize),

this polyphagous pest finding favorable conditions for wintering. Rising temperatures prolonged drought, uneven distribution of rainfall and soil tillage systems (unconventional) in the Turda area represented favorable conditions for intensely manifesting the harmful *T. urticae* to soybean culture in the two experimental years.

The other research (Georgescu et al., 2016; Mureşanu & Tărău, 2013) also showed the influence of climatic conditions on appearance of this pest in soybean culture, the high temperatures in July (23-25.1°C) correlated with the lack of precipitation or insufficient quantities, offer the favorable conditions for manifesting the attack. Harvest losses due to pests are between 3-21%, but in some cases they can reach 70% or even compromise the crop (Paulian et al., 1977; Bărbulescu, 2001 cited by Georgescu et al. (2016); Jinga & Lupu, 2014). The studies in 2006-2013 at ARDS Secuieni on soybean crop (Trotuş et al., 2014), mention that out of 10 species harmful to the culture identified in the area of Moldova, the highest frequency of 45.6%was recorded by the species *T. urticae.*

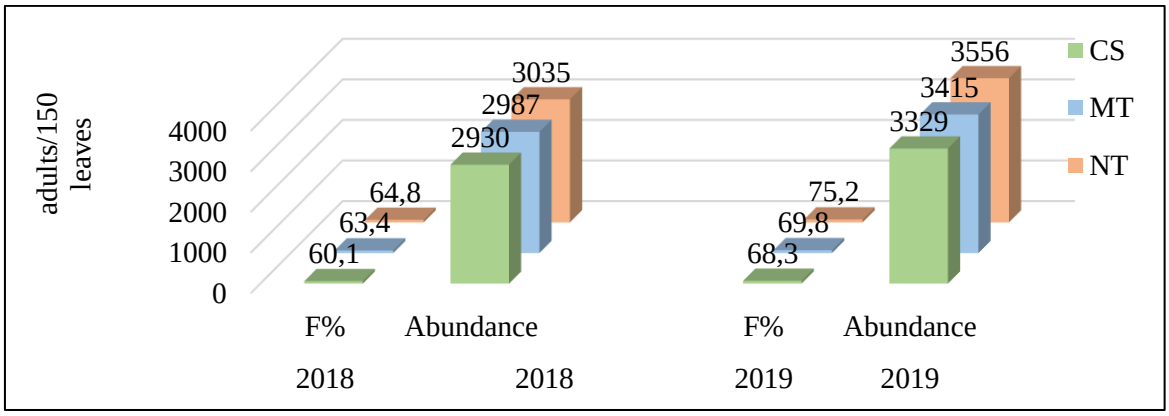


**Figure 2.** Frequency of attack *Tetranychusurticae* (F %), 2018-2019 at ARDS Turda

From the data obtained in ten surveys carried out in each soil tillage system (Figure 3), it can be observed that in soybeans in the classical system (CS), the frequency of the attack of *V. cardui* registered the lowest values, 10.3% in 2018 and 15.5% in 2019, compared to unconventional MT and NT systems. The application of the minimum tillage technology, led to an increase of 11.2% respectively 16.6% and in NT 11.5%, 17.9%. The average difference registered is between 1.0-1.8% in favor of the classical system (CS).

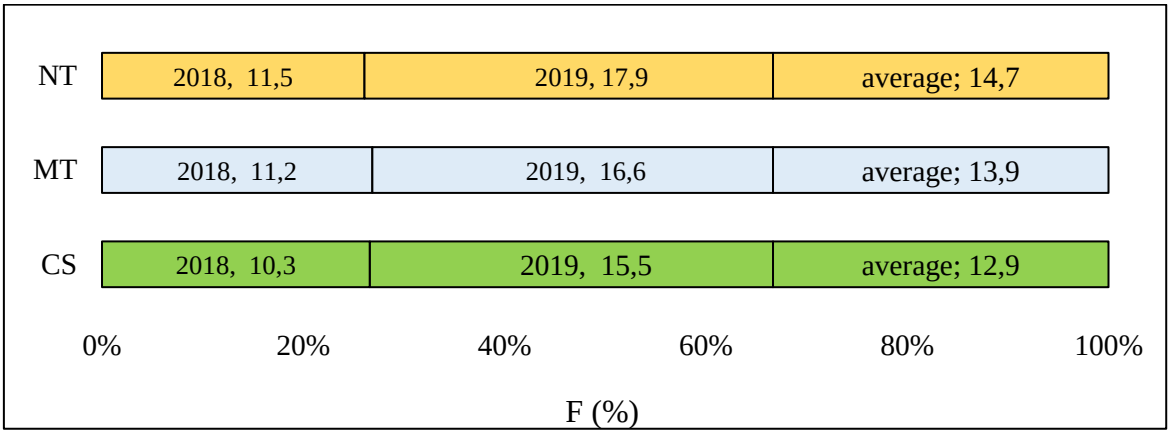


**Figure 3.** Frequency of attack *Vanessa cardui* (F %), 2018-2019 at ARDS Turda

Within agro-ecosystems, soybean cultivation offers a place of development and refuge in the summer months, for a variety of harmful and auxiliary species useful, especially for the species of entomophagous arthropods and pollinating (Malschi, 2009; Malschi et al., 2018). In the experimental plots, the abundance of the useful fauna of arthropod entomophagous epigeous could be highlighted, demonstrating their ecological importance in limiting pests and maintaining them at low levels in soybean culture. In the annual structure of the entomophagous, the major weight of the carabids (78.59%) is observed, followed by the predatory spiders (8.12%), the different pollinating Hymenoptera, especially bees and ants (7.83%), Coccinellidae (2.76%), Syrphidae (1.2%) (Figure 4).

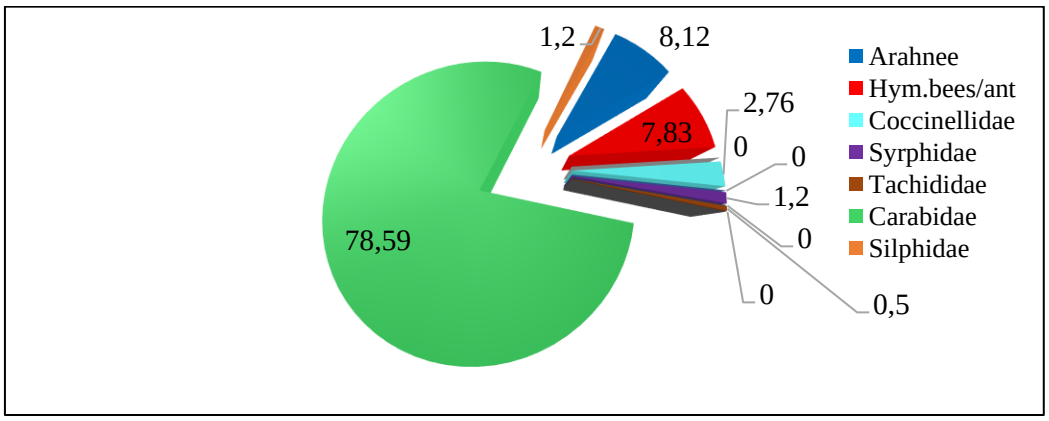


**Figure 4.** Annual structure of useful fauna of entomophagous arthropods and soybean pollinating (collected in yellow vessels with water), ARDS Turda 2019

Experimental variants of soil work induce a different dynamics of pest species. From the data in Figure 5, we notice the great abundances of the pests in classical system, with plow and in conservative system NT. In addition to the positive agronomic effects, conservative systems contribute to increasing the abundance and conservation of entomophagous and pollinator auxiliaries in agro-ecosystems. Soybean is a culture that preserves and argues for the biodiversity of entomophagous useful in the summer months, and also provides niches for feeding and shelter of phytophagous, both harmful to soy and migratory from other crops.

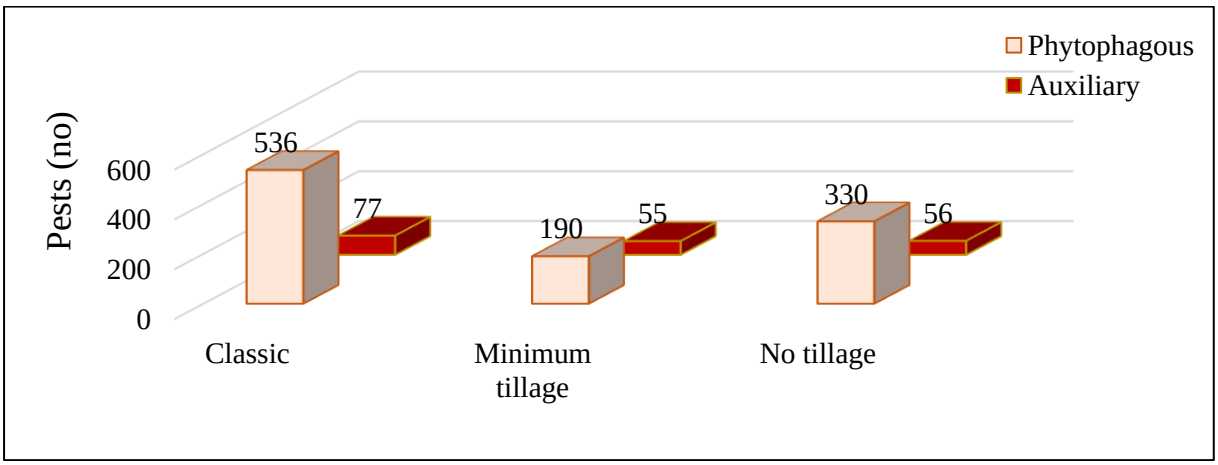


**Figure 5.** Abundance of phytophagous and auxiliary arthropods from soybean culture (captured in yellow vessels with water), ARDS Turda 2019

The data in Table 1 showed the influence of tillage system factor in the soybean crop formation. The difference in yield between the three systems CS (2927 kg/ha), MT (2791 kg/ha) and NT (2563 kg/ha) suggests that soybean is suitable for the technology with minimal works (MT), the difference from the control being only 136 kg/ha, but it is less suitable for cultivation in system without works (NT) with a difference of 364 kg/ha compared to the classical system and 228 kg/ha compared to the minimum system. It seems that under the pedo-climatic conditions specific to the Turda area, soybean cultivation involves at least minimal tillage (MT), the choice of NT variant significantly reducing the yield. The experience was established on fertile soil, but also with the possibility of the rapid compaction when passing large agricultural aggregates, or when effectuated the mechanical works in high humidity conditions, due to the high clay content (56.07%).

**Table 1.** The influence of the soil tillage system factor on the soybean yield, 2018-2019

| A-system | Yield (kg/ha) | % | Differences | Signification |
|---|---|---|---|---|
| $a_1$ CS | 2927 | 100 | 0 | Ct. |
| $a_2$ MT | 2791 | 95 | -136 | - |
| $a_3$ NT | 2563 | 88 | -364 | 0 |
| LSD (p 5%) = 307; LSD (p 1%) = 509; LSD (p 0.1%) = 756. | | | | |

For soybean, in generally, 10-15 June and 15-20 August are critical periods for water (formation of reproductive organs, flowering and grains) and the lack or insufficiency of water lead to low yields. The reduced precipitation during these periods, especially in 2019, have placed their mark on soybean yield, achieving only 2543 kg/ha with a difference of 218 kg/ha compared to the control (2760 kg/ha). Also, soybean yield in 2019 was also affected by hail (06/22/2019), which, although of short duration, due to a strong wind, perforated and removed part of the soybean leaf. Compared with 2019, an important role on the yield was played by the precipitation recorded during June-August 2018 (the amount was 222 mm) and the lower level of pests, the yield being 2978 kg/ha (significant positive influence). Compared to the control (the average of the years) the yield differences were ± 218 kg/ha. Although in the two experimental years the soybean yields were below 3000 kg/ha, the biological material chosen in this experiment, Felix variety has a high yield potential, responds favorably when good conditions are met from the point of climatic view, exceeding 3000 kg/ha, both in cultivation in the classical system and in the minimum system (Cheţan et al. 2017, 2019).

**Table 2.** The influence of the year on the soybean yield, 2018-2019

| B-year | Yield ( kg/ha) | % | Differences | Signification |
|---|---|---|---|---|
| Average | 2760 | 100 | 0 | Ct. |
| $b_1$2018 | 2978 | 108 | 218 | * |
| $b_2$ 2019 | 2543 | 92 | -218 | 0 |
| LSD (p 5%) = 166; LSD (p 1%) = 304; LSD (p 0.1%) = 677 | | | | |

At soybean culture, the costs of materials (seeds, fertilizers, pesticides) being necessary, the reduction of soil works (as number and intensity) remains a source of growth of economic efficiency (Cheţan et al., 2016). The yield results obtained constitute an important scientific fund for the implementation of technologies appropriate to the area in which the researches were carried out, the unconventional systems of soil work being alternatives to the system with the plowing, for the conservation of the soil properties and the protection of the environment.

## CONCLUSIONS

The climatic conditions, the high temperature correlated with the lack of precipitation between June and August offer favorable conditions for the manifestation of the *Tetranychus urticae* attack.

In the cultivation of soy in the classical system, the frequency of the attack *Vanessa cardui* recorded the lowest average value of 12.9% compared to the minimum tillage variant 13.9% and no tillage 14.7%.

Soybean responds less favorably to cultivation in the no tillage system. In the two experimental years, the average recorded production was lower by 364 kg/ha compared to the classical system and 228 kg/ha compared to the minimum tillage system, which is also correlated with the greater abundance of pests in conservative systems compared to the classical system.

Based on the results obtained, we recommend the cultivation of soy in the minimum tillage system as an alternative to the classic system.

In the formation of the productions, a major role belongs to the climatic conditions, the reduced precipitations of the period May-August corroborated with the high temperatures, that persisted for a long time had a negative impact on the soybean harvest.

## ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI-UEFISCDI, PN-III-P1-1.2-PCCDI-2017-0056, within PNCDI III (Project SWEETCONOMY).

## REFERENCES

CHEŢAN, F., CHEŢAN, C. (2014). Cultivarea soiei în sistemul de agricultură conservativ şi rolul ei în protejarea mediului. *Simpozion National Folosirea îngrăşămintelor minerale şi organominerale în agricultură*, 7 oct 2013, Lucrări stiinţifice Bucureşti, Ed.AGRIS -Revistele agricole SRL, Bucureşti.

CHEȚAN, F., CHEȚAN, C., MUREȘANU, F. (2016). Stabilirea influenţei tehnologiei de cultivare a soiei asupra solului, producţiei şi eficienţa economică în zona Turda. *Simpozion Economie Agrara si Dezvoltare Rurala - Realitati si Perspective pentru Romania*, Bucureşti, editia 7, 124-129.

CHEȚAN, F., CHEȚAN, C., ȘIMON, A., DEAC, V. (2017). Influența sistemului de fertilizare și de lucrare a solului asupra conservării apei în sol și producției la cultura de soia la S.C.D.A. Turda. *Anale I.N.C.D.A. Fundulea, Agrotehnica culturilor*, 85.

CHEŢAN F., CHEŢAN, C., MUREŞANU, F., MALSCHI, D., SUCIU, V., BĂRDAŞ, M. (2019). Relaţia dintre condiţiile climatice, sistemul de lucrare a solului şi gradul de îmburuienare al culturii de soia, în zona Turda. *Ghid XXIX simpozion Factori și procese pedogenetice din zona temperată*, Iaşi septembrie 2019. Ed. Universităţii „Alexandru Ioan Cuza" Iaşi, 125-140.

DAVIDESCU, D., CALANCEA, L., DAVIDESCU V., (1992). Protecţia chimică în agricultură, Editura Ceres, Bucureşti.

GEORGESCU, E., CANĂ, L., GĂRGĂRIŢĂ, R., RÂŞNOVEANU, L. (2016). Cercetări privind combaterea păianjenului roşu comun (*Tetranycus urticae*) la cultura de soia, în sud-estul țării. *Anale I.N.C.D.A. Fundulea,* 84.

IGNEA., M. (2017). 60 de ani de observaţii meteorologice în folosul cercetării agricole, la SCDA Turda. *Agricultura Transilvană*, 27, 15-21.

Jinga, V., Lupu, C. (2014). Soybean in southern Romania - diseases and pests. *Agricultura Transilvana*, 20, 76-80.

MALSCHI, D., TRITEAN, N., CHEŢAN, C., PACURAR, A., PODAR, I., (2007). Dinamica si importanta entomofaunei daunatoare graului, in conditiile schimbarilor climatice actuale, in centrul Transilvaniei. *Simpozionul national al Societatii Lepidopterologice din Romania*, 18.

MALSCHI, D. (2009). Integrated pest management in relation to environmental sustainability. Part I. Ecological management of wheat pests. *Course notes and practical applications.* Bioflux Publishing House, Cluj-Napoca, 200.
MALSCHI, D., IVAS, D. A., VĂLEAN, A-M, CHEȚAN, F., TRITEAN, N., CHEȚAN, C., PATAKI, I. (2015). Curent importance of wheat pests in the cultural tehnologies of soil no-tillage conservative system and of antierosional agroforestry curtains system, in Transylvania. *The 8th International Symposium "Soil Minimum Tillage System,* Cluj-Napoca, 25-26 June, 2015, 8, 22, 159-169.
MALSCHI, D., TĂRĂU, A.D., VĂLEAN, A-M., ȘOPTEREAN, L., DĂRAB, I. D., KADAR, R., CHEȚAN, F., MUREȘANU, F., CHEȚAN, C., TRITEAN, N. (2018). Wheat pest management under the dynamics of agroecological changes in Transylvania. *Integrated pest management in relation to environmental sustainability*. Bioflux Publishing House Cluj-Napoca, 83 p.
MUNTEAN, L.S., AXINTE, M., BORCEAN, I., ROMAN, G. (1995). *Fitotehnie.* Ed. Pedagogica Bucureşti.
MUREȘANU, E., MĂRGINEAN, R., NEGRU, S. (2010). Soiul timpuriu de soia Felix. *Analele I.N.C.D.A. Fundulea*, 78, 2, Genetica și ameliorarea plantelor.
MUREȘANU, E., MĂRGINEAN, R., ENESCU, T. (2012). Cristina TD şi Mălina TD, soiuri timpurii de soia (Cristina TD and Mălina TD, early soybean cultivars). *Analele I.N.C.D.A. Fundulea*, 80, 1, 89-97.
MUREŞANU, F., TĂRĂU, A. D. (2013). Câteva informaţii privind păianjenul roşu comun (*Tetranychus urticae* Koch) prezent în cultura de soia la SCDA Turda. *Agricultura Transilvană*, 58.
MUREŞANU, F. (2014). Soia în Transilvania, boli şi dăunători. *Agricultura Transilvană*, 76.
MUREȘANU, F., CHEȚAN, F., ȘOPTEREAN, L., MALSCHI, D., VĂLEAN, A.M., MUREȘANU, E., PORUMB, I., CHEȚAN, C., ȘIMON, A., KADAR, R., URDĂ, C., TRITEAN, N. (2018). Tehnologii de aplicare la cultura de soia a sistemului de management integrat cu impact redus asupra mediului, în vederea protejării agrosistemelor. *Sesiunea anuală de comunicări ştiinţifice ICDPP Bucuresti*, 9 noiembrie 2018.
TROTUȘ, E., BUBURUZ, A.-A., POCHIȘCANU, S. F., POMOHACI, T. (2014). Organismele dăunătoare din culturile de soiaşi măsurile de prevenire şi combatere. *Analele I.N.C.D.A. Fundulea*, 82.
***https://www.cartiagricole.ro/cultura-soiei.
***https://www.scdaturda.ro, 2016, 2018.
***MESP (1987). *Pedologic Studies Elaboration Metodology*. Pedologic and Agrochemical Ins. Bucharest. Vol. 1-3.
***SRTS (2012). *Romanian System of Soil Taxonomy*. Ed. Estfalia, Bucharest.
***PoliFact (2015). *ANOVA Test PC program for variant analyses*. USAMV Cluj-Napoca.