# RESEARCH REGARDING PROBLEM WEEDS IN POTATO CROP IN SOUTHERN ROMANIA

Raluca-Monica Cristea[1,2]*, Daniel Jalobă[1,2], Valentin-Marius Ciontu[1,2], Marga Grădilă[1]

[1]Research – Development Institute for Plant Protection, 8 Ion Ionescu de la Brad Blvd, 013813, Bucharest, Romania

[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, 011464, Bucharest, Romania

**Abstract**

*Potato* (*Solanum tuberosum* L.) *is considered to be one of the most competed crop by weeds. They may cause great losses, reducing the yield by 20-35%, consume large amounts of water and nutrients, decrease the effectiveness of treatments against diseases and pests and mechanized harvesting becomes difficult or impossible. The observations and assessments carried out aimed at deciding the problem weeds in the potato crop against which prevention and control measures must be effectively applied. The research targeted the monitoring and mapping of weeds in potato crops in Dâmbovița, Prahova and Călărași counties, in Romania. 30 determinations per hectare were conducted during 2020-2021, using the metric frame and the observations focused on density (number of plants/m$^2$), participation (% in which each species is involved in the whole weed infestation), frequency (% in which each species was found in the observation points), class (pteridophytes, monocotyledonous, dicotyledonous) and the life span of each species (ephemeral, annual, biennial, weeds that can overwinter, perennials). The results obtained marked that the problem weeds in potato crops are usually perennial species difficult to control. Thus, among the dicotyledonous weeds, the species of Cirsium arvense, Sonchus arvensis and Convolvulus arvensis were identified as problem weeds, and among the monocotyledonous weeds, Sorghum halepense and Agropyron repens. Also in Lunguleț, due to the monoculture, the species Equisetum arvense, Ambrosia artemisiifolia and Symphitum officinalis created special problems for control, in Călărași county at Dâlga Cannabis ruderalis and in Prahova, Polygonum convolvulus and the Xanthium species. Even annual species, when they find favorable conditions for growth and development, are causing troubles: Chenopodium album, Polygonum aviculare, Echinochloa crus-galli. It has also been noted the increasing presence of invasive species: Ambrosia, Erigeron, Veronica, Xanthium.*

**Keywords:** *potato, problem weeds, perennial weeds, invasive species*

## 1. INTRODUCTION

Due to its high biological and nutritive value, potato is one of the most important crop in the world being at the same time one of the most competed crop by the weeds, especially in the early stages of vegetation. Potato crop involves much expenses it can be profitable only if high and quality yields are obtained. Although in Romania the potato is sown on large areas, the average productions obtained per hectare are lower compared to those obtained in other countries. 84 thousand hectares were cultivated with potatoes with a total yield of 1378 thousand tons in 2021 (National Institute of Statistics, 2022). Weeds are a major problem in potatoes crop in Romania. Large distance between rows, the use of manure and fertilizers, the long period from planting to plant emergence, slow preliminary growth of potato plants create favourable conditions for an early emergence of weeds long before the appearance of potato plants (Mukherjee et al. 2012; Barbaś 2015; Soren et al. 2018). The most critical period of crop-weed competition is first 4-6 weeks after planting when the crop must be kept free from weeds (Budoi & Penescu 1996; Týr 2008; Hermeziu et al. 2018). Weed control as early as possible is the main goal in potato production because weeds emergence simultaneously as the potato crop or a week later can cause higher crop losses than weeds that appear 3 or more weeks later (Nelson & Thoreson 1981; Felix et al. 2008). Weeds in potato crops are difficult to be fought, as the early stages of vegetation of potato plant overlap the rainy intervals of May and June, when only a small number of

days allow the farmers to work their lands, because of soil moisture (Uremis et al. 2009). Therefore, weeds may cause great damage, often reducing yields by 20-35% even when tillage practices were performed as well as possible by machineries (Tripathi et al. 1989; Monteiro et al. 2011; Yadav et al. 2015; Shehata et al. 2019). The decrease in production is due to the consumption of large amounts of water and nutrients by weeds and the development of imbalances in plant nutrition. Weeds decrease the effectiveness of treatments against diseases (especially late blight) and pests (Zimdahl 2007; Uremis et al. 2009). In weed – infested potato fields the harvest become difficult or almost impossible (Hoza et al. 2015; Pszczółkowski et al. 2020). Weed competition could also affect quality of potato tubers and nutritional content. The presence of weeds during the whole growing season reduced tuber dry matter, protein and starch content (Arora et al. 2009) and tuber diameter (Hidayat et al. 2013), relative to hand weeding treatment. Finally, all these matters lead to the increase of production costs (Roder et al. 2009; Boydston 2010). Soon after planting, weeds with early emergence appear, less sensitive to temperatures. During the emergence stage or immediately after the emergence of the potato plants, there are also thermophilic and perennial weeds that can prolong their competition until harvest. Potato weed control must be addressed both mechanically and chemically. An effective weed management program takes into account the current type of weeds, crop rotation, cultivation technology, available herbicides and the competitive capacity of the potato crop. Until crop emergence stage, harrowing, hoeing and re-hilling are priorities. By using herbicides one can obtain potato yields approximately equal to those obtained by mechanical maintenance of the crop. As herbicidal effect is not long - lasting (usually 40-60 days), it is better that herbicides should be applied a few days before potato emergence, in order to control weeds until July - August, without no other interventions (Șarpe 1987). In practice, however, it often happens that the period of emergence coincides with a rainy period and therefore herbicides cannot be applied. The segetal flora that infests is various and constantly modifying and adapting itself depending on the crop technologies applied by farmers and the pedoclimatic conditions (Nikolić et al. 2013). Most harmful weeds which infest potato crop, endangers yield and causes serious control problems, they are called "problem weeds". Most of them are perennial species which reproduce themselves both by seeds and by vegetative organs, which reach a high density per $m^2$ sometimes as an effect of the occurrence of herbicide resistance phenomenon, too. (Berindei 1985; Frîncu 1980, 1995, 1996; Ianoși 2002; Ianoși & Boțoman 2004). In this context, this paper presents data regarding problemtic weeds within potato crop against which prevention and control measures must be effectively applied. The main objectives considered were: the determination of the segetal flora, the establishment of the degree of weeding and the identification of the dominant weed species from the potato crops studied.

## 2. MATERIALS AND METHODS

The research targeted the monitoring and mapping of weeds in potato crops in Dâmbovița, Prahova and Călărași counties, during 2020–2021. 30 determinations per hectare were conducted, using the metric frame and the observations focused on density (number of plants/$m^2$), participation (% in which each species is involved in the whole weed infestation), frequency (% in which each species was found in the observation points), class (pteridophytes, monocotyledonous, dicotyledonous) and the life span of each species (ephemeral, annual, biennial, weeds that can overwinter, perennials). The measurement of weeds was made by using a metric frame, recording the number of weeds per square (Berca 2004; Chirilă 2001; Slonovski et al. 2001; Hoza et al. 2015). The potatoes crops in which the assessments were performed, were cultivated by private farmers according to their own technologies. At Lunguleț, Dâmbovița county, 3 waterings were applied with a rate of 800 liters on hectare. For each field, landfills of weed infestation have been done and they present both general data on the location, the soil type, the previous crop etc. Each sampling point was established by going through the field in 1-2 diagonals according to the number of specified samples. At the final stage, the data obtained from all the analysed samples were centralised. Finally, the weeds were distributed in density categories in descending order to identify the dominant species and the problem weeds, the results obtained by mapping being an important tool in taking the most appropriate weed control measures in a crop.

## 3. RESULTS AND DISCUSSION

The weeds flora in the studied potato crops differs from location to location depending on the type of soil, climatic conditions, cultivation technology, previous crop, altitude, etc. During the period from planting to potato emergence, the annual weeds with early spring germination usually appear, but the soil humidity and the higher and higher temperatures also stimulate the start of the perennial species in vegetation. Thus, at Lungulețu where monoculture is usually practiced or interposed with cabbage growing (one year cabbage, 1 year potato) and where irrigation was applied, 22 weed species with an average density of 194/m$^2$ plants were identified which were divided into 4 categories depending on density (Table 1). Thus, the first category with a density higher than 20 plants/m$^2$ included the species: *Setaria glauca* (L.) P. Beauv. and *Chenopodium album* (L.). The second category had a density between 10-20 plants/m$^2$, being found the following species: *Equisetum arvense* (L.), *Ambrosia artemisiifolia* (L.), *Symphytum officinale* (L.), *Echinochloa crus-galli* (L.) Pal. Beauv. and *Cirsium arvense* (L.) *Scop.*

**Table 1.** Weed flora in potato crops Lungulețu, 2021

| Species | Average no./m$^2$ | P (%) | F (%) | Family | Order | Life period |
|---|---|---|---|---|---|---|
| Weeds with density: >20 plants/m$^2$ | | | | | | |
| *Setaria glauca* | 40 | 20.6 | 100 | *Poaceae* | *Poales* | annual monocots |
| *Chenopodium album* | 20 | 10.3 | 93.3 | *Amaranthaceae* | *Caryophyllales* | annual dicots |
| Weeds with density: 10-20 plants/m$^2$ | | | | | | |
| *Equisetum arvense* | 16 | 8.2 | 86.6 | *Equisetaceae* | *Equisetales* | perennial |
| *Ambrosia artemisiifolia* | 12 | 6.2 | 80.0 | *Asteraceae* | *Asterales* | annual dicots (i) |
| *Symphytum officinale* | 12 | 6.2 | 76.6 | *Boraginaceae* | *Polemoniales* | perennial dicots |
| *Echinochloa crus-galli* | 11 | 5.7 | 80.0 | *Poaceae* | *Poales* | annual monocots |
| *Cirsium arvense* | 11 | 5.7 | 73.3 | *Asteraceae* | *Asterales* | perennial dicots |
| Weeds with density: 5-10 plants/m$^2$ | | | | | | |
| *Polygonum convolvulus* | 10 | 5.1 | 63.3 | *Polygonaceae* | *Caryophyllales* | annual dicots |
| *Convolvulus arvensis* | 9 | 4.6 | 60.0 | *Convolvulaceae* | *Solanales* | perennial dicots |
| *Sorghum halepense* | 8 | 4.1 | 53.3 | *Poaceae* | *Poales* | perennial monocots (i) |
| *Amaranthus retroflexus* | 8 | 4.1 | 53.3 | *Amaranthaceae* | *Caryophyllales* | annual dicots |
| *Sonchus arvensis* | 6 | 3.1 | 43.3 | *Asteraceae* | *Asterales* | perennial dicots |
| *Brassica oleracea* | 6 | 3.1 | 36.6 | *Brassicaceae* | *Brassicales* | annual dicots |
| Weeds with density: 2-5 plants/m$^2$ | | | | | | |
| *Veronica persica* | 5 | 3.0 | 10.0 | *Plantaginaceae* | *Lamiales* | biennial dicots (i) |
| *Polygonum aviculare* | 4 | 2.0 | 10.0 | *Polygonaceae* | *Caryophyllales* | annual dicots |
| *Sonchus oleraceus* | 4 | 2.0 | 6.6 | *Asteraceae* | *Asterales* | annual dicots |
| *Stellaria media* | 2 | 1.0 | 6.6 | *Caryophyllaceae* | *Caryophyllales* | annual dicots |
| *Sinapis arvensis* | 2 | 1.0 | 3.3 | *Brassicaceae* | *Brassicales* | biennial dicots |
| *Capsella bursa-pastoris* | 2 | 1.0 | 3.3 | *Brassicaceae* | *Brassicales* | biennial dicots |
| *Arctium lappa* | 2 | 1.0 | 3.3 | *Asteraceae* | *Asterales* | biennial dicots |
| *Euphorbia cyparissias* | 2 | 1.0 | 3.3 | *Euphorbiaceae* | *Malpighiales* | perennial dicots |
| *Calamagrostis epigeios* | 2 | 1.0 | 3.3 | *Poaceae* | *Poales* | perennial monocots |

*(i) - invasive species in Romania

The third category had a density 5-10 plants/m$^2$, being found the following species: *Polygonum convolvulus* (L.), *Convolvulus arvensis* (L.), *Sorghum halepense* (L.) Pers., *Amaranthus retroflexus* (L.), *Sonchus arvensis* (L.) and *Brassica oleracea* (L.). The last category included weed species with a low density (2-5 plants/m$^2$). The invasive species *V. persica* (Poir.) but also the perennial species *E. cyparissias* (L.) and *C. epigeios* (L.) were noted in this category. In order to highlight the most problematic weeds and to choose the best control strategy, the weed species identified in the potato crops from Lungulețu were distributed on botanical groups according to the density and the percentage of participation of each species (Figure 1). Aspects regarding the weeds present in the experimental field from Lungulețu are presented in figure 2.

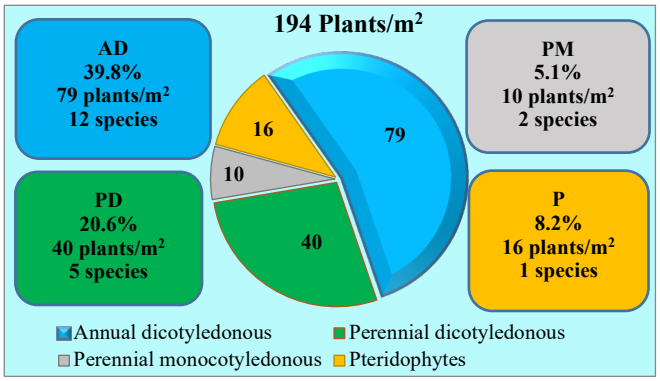



**Fig. 1.** Distribution of weed species by botanical groups at Lungulețu N: 44° 35'811"; E: 25°41'385"



**Fig. 2.** Problem weeds in potato at Lungulețu

Analyzing the presented data, it results that the dominant weeds are represented by the annual dicotyledonous, which included 12 species with a density of 79 plants/m$^2$ and with a participation percentage of 39.8% in the general weed infestation of potato crops from Lungulețu. The presence of the species *C. album*, *P. convolvulus*, *A. artemisiifolia* and previous crop *B. oleracea* (as volunteer) can be noticed. Usually, only a few weed species dominate the population in each agroecosystem (Johnson & Kent 2002) and, consequently, only a relatively small number of species within potato crop are considered problematic weeds (Diallo & Johnson 1997). The real problem weeds are mono and dicotyledonous perennial species and horsetail from pteridophytes, weeds that are difficult to control for which fewer herbicides are approved. The attributes that distinguish such species are: high competitiveness, the ability to form a large number of seeds, the ability to quickly form new populations, the ability to recover quickly after the execution of a control work (hoeing, weeding), combine a high frequency with a high ecological plasticity especially in the case of annual species or combine long lasting root structures with a high rate of multiplication in the case of perennial species.

These weeds are also considered, according to which specific weed control decisions are taken in a crop (Grădilă et al. 2021).

In the potato crops in Pietroasele, Prahova county, due to drought and avoidance of monoculture (potato crops being included in a suitable crop rotation), were present only 14 species of weeds with an average density of 88 plants/m$^2$. As the degree of weed infestation didn`t exceed 18 plants/m$^2$, the identified weed species were divided into 3 density categories. Thus, the first category with a density > 10 plants/m$^2$, included drought-resistant weed species *Sorghum*, *P. convolvulus*, *Cirsium* and *Xanthium* species. The second category had a density between 5-10 plants/m$^2$, being found the following species: *Setaria* spp. (L.) P. Beauv., *C. arvensis* (L.), *Cardaria draba* (L.) Desv. and *Lamium purpureum* (L.). Among the weeds included in the third category with a density ranging between 2-5 plants/m$^2$, the presence of the species *Viola arvensis* (Murray), *Sinapis arvensis* (L.) and *Conyza canadensis* (L.). Cronquist, an invasive species in Romania, was noted (Table 2). Analyzing the presented data, it was concluded that the problematic weeds were the perennial dicotyledonous species (*Cirsium*, *Convolvulus*) and the perennial species *S. halepense* (L.) of monocotyledonous, an invasive species in the cultures of our country that had a density of 18 plants/m$^2$ and a participation percentage of 20% at the general weed infestation of potato crops in Pietroasele, Buzău county.

*P. convolvulus* (L.) and *Xanthium* species (L.) were identified as problem weeds, including the invasive species *Xanthium italicum* (Moretti). In recent years, it has been found that the invasive species causes increasing damages to crops, with the success of this plant provided by some biological particularities (Grădilă & Jalobă 2018).

**Table 2.** Weed flora in potato crops Pietrosele, 2021

| Species | Average no./m$^2$ | P (%) | F (%) | Family | Order | Life period |
|---|---|---|---|---|---|---|
| Weeds with density: >10 plants/m$^2$ | | | | | | |
| *Sorghum halepense* | 18 | 20.5 | 86.6 | *Poaceae* | *Poales* | perennial monocots (i) |
| *Polygonum convolvulus* | 12 | 14.1 | 60.0 | *Polygonaceae* | *Caryophyllales* | annual dicots |
| *Cirsium arvense* | 10 | 11.4 | 76.6 | *Asteraceae* | *Asterales* | perennial dicots |
| *Xanthium species* | 10 | 11.4 | 63.3 | *Asteraceae* | *Asterales* | annual dicots |
| Weeds with density: 5-10 plants/m$^2$ | | | | | | |
| *Setaria species* | 6 | 6.8 | 63.3 | *Poaceae* | *Poales* | annual monocots |
| *Convolvulus arvensis* | 6 | 6.8 | 60.0 | *Convolvulaceae* | *Solanales* | perennial dicots |
| *Cardaria draba* | 5 | 5.6 | 43.3 | *Brassicaceae* | *Brassicales* | perennial dicots |
| *Lamium purpureum* | 5 | 5.6 | 33.3 | *Lamiaceae* | *Lamilales* | annual dicots |
| Weeds with density: 2-5 plants/m$^2$ | | | | | | |
| *Viola arvensis* | 3 | 3.4 | 26.6 | *Violaceae* | *Malpighiales* | annual dicots |
| *Sinapis arvensis* | 3 | 3.4 | 16.6 | *Brassicaceae* | *Brassicales* | biennial dicots |
| *Trifolium pratense* | 2 | 2.2 | 10.0 | *Fabaceae* | *Fabales* | perennial dicots |
| *Taraxacum officinale* | 2 | 2.2 | 6.6 | *Asteraceae* | *Asterales* | perennial dicots |
| *Digitaria sanguinalis* | 2 | 2.2 | 6.6 | *Poaceae* | *Poales* | annual monocots |
| *Veronica hederifolia* | 2 | 2.2 | 6.6 | *Plantaginaceae* | *Lamiales* | biennial dicots |
| *Conyza canadensis* | 2 | 2.2 | 6.6 | *Asteraceae* | *Asterales* | annual dicots (i) |

The distribution of weed species by botanical groups in Pietroasele potato crops is shown in figure 3 and aspects regarding the weeds present in the experimental field are presented in figure 4.

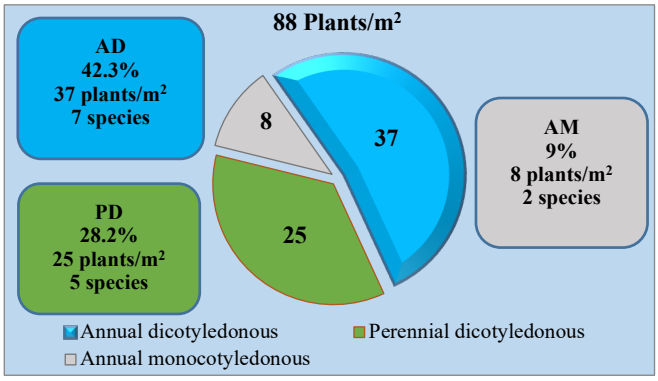



**Fig. 3.** Distribution of weed species by botanical groups at Pietroasele (Buzău) N: 45° 04'205"; E: 26°34'909"



**Fig. 4.** Problem weeds in potato at Pietroasele

The vitality of *P. convolvulus* (L.) species is ensured by the voluble stem with which it clings to the crop plants, the extensive root system, the great power of competition and the staggered germination of the seeds (Grădilă & Jalobă 2020). In the potato crops in Dâlga, Călărași county, there were 12 species of weeds with an average density of 106 plants/m$^2$. The first category with a density >10 plants/m$^2$, included the following weed species*: P. convolvulus* (L.), *C. album* (L.), *Solanum nigrum* (L.), *C. arvensis* (L.) and *Cannabis ruderalis* (Janisch.). Among the weeds included in the second category, the presence of the perennial species *Agropyron repens* (P. Beauv.) sin. *Triticum repens* (L.) sin. *Elymus repens* (L.), a species with mixed breeding by seeds and rhizomes difficult to control that grows on almost all soil types but especially on more fertile, compact soils, rich in nutrients (Table 3).

**Table 3.** Weed flora in potato crops Dâlga, 2021

| Species | Average no./m² | P (%) | F (%) | Family | Order | Life period |
|---|---|---|---|---|---|---|
| Weeds with density: >10 plants/m² | | | | | | |
| *Polygonum convolvulus* | 25 | 23.5 | 100 | *Polygonaceae* | *Caryophyllales* | annual dicots |
| *Chenopodium album* | 15 | 14.0 | 93.3 | *Amaranthaceae* | *Caryophyllales* | annual dicots |
| *Solanum nigrum* | 14 | 13.2 | 86.6 | *Solanaceae* | *Solanales* | annual dicots |
| *Convolvulus arvensis* | 10 | 9.4 | 83.3 | *Convolvulaceae* | *Solanales* | perennial dicots |
| *Cannabis ruderalis* | 10 | 9.4 | 73.3 | *Cannabaceae* | *Rosales* | perennial dicots |
| Weeds with density: 5-10 plants/m² | | | | | | |
| *Polygonum aviculare* | 8 | 7.5 | 63.3 | *Polygonaceae* | *Caryophyllales* | annual dicots |
| *Agropyron repens* | 6 | 6.0 | 53.3 | *Poaceae* | *Poales* | perennial monocots (i) |
| *Echinochloa crus-galli* | 5 | 4.6 | 43.3 | *Poaceae* | *Poales* | annual monocots |
| *Cirsium arvense* | 5 | 4.6 | 30.0 | *Asteraceae* | *Asterales* | perennial dicots |
| Weeds with density: 2-5 plants/m² | | | | | | |
| *Ranunculus arvensis* | 4 | 3.8 | 13.3 | *Ranunculaceae* | *Ranunculales* | annual dicots |
| *Thlaspi arvense* | 2 | 2.0 | 10.0 | *Brassicaceae* | *Brassicales* | annual dicots |
| *Lathyrus tuberosus* | 2 | 2.0 | 6.6 | *Fabaceae* | *Fabales* | perennial dicots |

The distribution of weed species by botanical groups in Dâlga potato crops is shown in figure 5 and aspects regarding the weeds present in the experimental field are presented in figure 6.

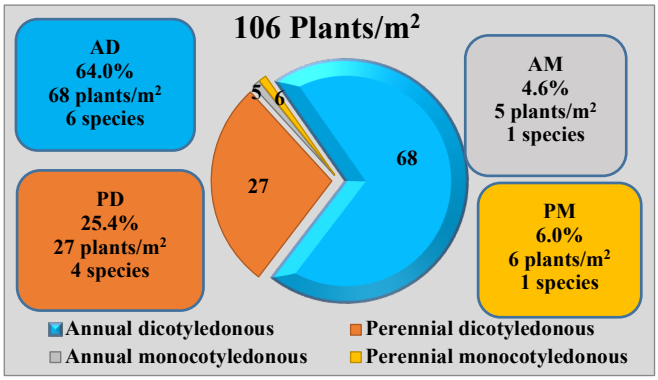



**Fig. 5.** Distribution of weed species by botanical groups at Dâlga N: 44° 28'801"; E: 27°02'966"



**Fig. 6.** Problem weeds in potato at Dâlga

Dominant weeds are represented by annual dicotyledonous species that included 6 species with a density of 68 plants/$m^2$ and a percentage of participation > of 41% in the overall weed infestation of potato crop in Dâlga, Călărași County. Along with *P. convolvulus*, *C. album*, *S. nigrum*, we also identified the wild hemp with a density of 10 plants/$m^2$ and a percentage of 9.4%. In Romania, but also in the neighboring countries, increasing problems are caused by hemp found in cultivated fields and waste areas (Benécs-Bárdi 2002). Some researchers argue that weed hemp is the crop escaped and naturalized while others opinion is that in Romania wild hemp is present spontaneously, too. The research data obtained are similar to those presented in the literature on the fact that while the weed flora for a particular production system can be similar in different agroecological areas, the abundance of individual species may differ substantially (Akobundu & Fagade 1978; Rodenburg & Johnson 2009).

## 4. CONCLUSIONS

Knowledge of segetal flora in potato culture is an important technological sequence in integrated weed control. The obtained data clearly indicated that it is obvious that there is a change in the number and density of weed species according to the location, climatic conditions and culture management. The results obtained marked that the problem weeds in potato crops are usually perennial species difficult to control. Thus, among the dicotyledonous weeds, the species of *Cirsium arvense*, *Sonchus arvensis* and *Convolvulus arvensis* were identified as problem weeds, and among the monocotyledonous weeds, *Sorghum halepense* and *Agropyron repens*. Also in Lunguleţu, due to the monoculture, the species *Equisetum arvense*, *Ambrosia artemisiifolia* and *Symphitum officinalis* created special problems for control, in Călărași county at Dâlga *Cannabis ruderalis* and in Buzău, *Polygonum convolvulus* and the *Xanthium* species (L.). Even annual species, when they find favorable conditions for growth and development, are causing troubles: *Chenopodium album*, *Polygonum aviculare*, *Echinochloa crus-galli*. It has also been noted the increasing presence of invasive species: *Ambrosia, Erigeron, Veronica, Xanthium*.

## ACKNOWLEDGMENTS

We respectfully and gratefully thank to farmers from trials locations who made this study possible.

## REFERENCES

1. Akobundu, IO & Fagade, SO 1978, ”Weed problems of African rice lands”. In ‘‘Rice in Africa’’ (I.W. Buddenhagen and G.J. Persley, Eds.), *Academic Press*, London, pp. 181-192.
2. Arora, A, Tomar, SS & Gole, MK 2009, ”Yield and quality of potato as influenced by weed management practices and their residual study in soil”. *Agric. Sci. Digest.*, vol. 29(2), pp. 39-41.
3. Barbaś, P 2015, ”Ochrona plantacji ziemniaka przed zachwaszczeniem”. *Ziemniak Polski*, vol. 1, pp. 11-17.
4. Benécs-Bárdi, G 2002, ”Taxonomy and morphology of uncultivated hemp (Cannabis sativa L.) as weed in Hungary”. *Acta Botanica Hungarica*, vol. 44, no.1-2, pp. 31-47.
5. Berindei, M 1985, ”Combaterea integrată a buruienilor din culturile de cartof”. Cultura cartofului. (Ghidul fermierului); *Edit. Ceres*, Bucureşti, pp 355.
6. Berca, M 2004, ”Weed Integrated Management”, *Ceres Publishing House*, pp. 534.
7. Boydston, RA 2010, ”Managing weeds in potato rotations without herbicides”. *American journal of potato research*, vol. 87(5), pp. 420-427.
8. Budoi, G & Penescu, A 1996, ”Agrotechnics”, *Ceres Publishing House*, Bucharest, pp. 425.
9. Chirilă, C 2001, ”Biologia buruienilor”, *Edit. Ceres*, Bucureşti, pp. 304.

10. Diallo, S & Johnson, DE 1997, ”Les adventices du riz irrigue´ au Sahel et leur contro^le”. *Irrigated Rice in the Sahel: Prospects for Sustainable Development* (K. M. Mie´zan, M. C. S. Wopereis, M. Dingkuhn, J. Deckers, and T. F. Randolph, Eds.), WARDA, Dakar, pp. 311-323.
11. Felix, J, Ivany J, Kegode GO & Doohan, D 2008, ”Timing potato cultivation using weedcast model”. *Weed Sci.*, vol. 57, pp. 87-93.
12. Frîncu, G 1980, ”Utilizarea raţională a erbicidelor în cultura cartofului”. Producţia vegetală. *Horticultura*, vol. 4, pp. 18-21.
13. Frîncu, G 1995, ”Aspecte privind posibilitatea reducerii poluării mediului înconjurător, în combaterea chimică a buruienilor din cultura cartofului”, a II-a Conferinţă Naţională pentru protecţia mediului prin metode şi mijloace biologice şi biotehnice, Braşov, pp. 146-152.
14. Frîncu, G, 1996. ”Stadiul cercetărilor privind lucrările de întreținere la cartof cu folosirea erbicidelor.” *Anale*, Institutul de Cercetare și Producție a Cartofului, Braşov, vol. 13, pp. 88-109.
15. Grădilă, M & Jalobă, D 2018, ”Control measures of *Xanthium italicum* - an invasive species in maize crop (Romania) ”. *Acta Oecologica Carpatica*, vol. 11, pp. 73-84.
16. Grădilă, M & Jalobă, D 2020, ”Efficacy of post-emergence herbicide flazulfuron for weed management in stone fruit orchards”. *Agriculture & Food*, vol. 8, pp. 71-80.
17. Hermeziu, M, Moldovan, C, Hermeziu, R & Nitu, S 2018, ”Weeds Control in Potato Crop Using Different Metribuzin Doses”. *Journal of Agricultura*, vol. 1(2), pp. 105-106.
18. Hidayat, H, Hassan, G, Khan, I, Khan, MI & Khan IA 2013, ”Effect of different mulches and herbicides on potato and associated weeds”. *Pak J Weed Sci Res*, vol. 19(2), pp. 191-200.
19. Hoza, G, Enescu, BG & Becherescu, A 2015, ”Research regarding the effect of applying herbicides to combat weeds in quickly-potato cultures”. *Scientific papers-series b, horticulture*, vol. 59, pp. 219-223.
20. Ianoşi, IS 2002, ”Bazele cultivării cartofului pentru consum”. *Editura Phoenix*, Braşov.
21. Ianoși, S & Boţoman, GH 2004, ”Pagube produse de buruieni în cultura cartofului”. *Combaterea buruienilor din culturile de cartof. Edit. Phoenix*, Braşov.
22. Johnson, DE & Kent, RJ 2002, ”The impact of cropping on weed species composition in rice after fallow across a hydrological gradient in west Africa”. *Weed Res.*, vol. 42(2), pp. 89-99.
23. Monteiro A, Henriques I & Moreira I 2011, ”Critical period for weed control in potatoes in the Huambo province (Angola) ”. *Planta Daninha*, vol. 29(2), pp. 351-362.
24. Mukherjee, PK, Rahaman, S, Maity, SK & Sinha, B 2012, ”Weed management practices in potato (Solanum tuberosum L.)”. *Journal of Crop and Weed*, vol. 8(1), pp. 178-180.
25. National Institute of Statistics 2022, Anuarul Statistic al României, <Anuarul statistic al României - serii de timp (CD-ROM) Institutul Național de Statistică (insse.ro)>. https://insse.ro/cms/ro/tags/anuarul-statistic-al-romaniei.
26. Nelson, DC & Thoreson MC 1981, ”Competition between Potatoes (Solanum tuberosum) and Weeds”. *Weed Sci.*, vol. 29, pp. 672-677.
27. Nikolić, L, Ilić, O, Džigurski, D & Ljevnaić-Mašić, B 2013, ”Analysis of weed flora in conventional and organic potato production”. *Biologica Nyssana*, vol. 4(1-2), pp. 9-14.
28. Pszczółkowski, P, Barbaś, P, Sawicka, B, & Krochmal-Marczak, B 2020. ”Biological and agrotechnical aspects of weed control in the cultivation of early potato cultivars under cover”. *Agriculture*, vol. 10(9), pp. 373-383.
29. Rodenburg, J & Johnson, DE 2009, ”Weed management in rice-based cropping systems in Africa”. *Advances in agronomy*, vol. 103, pp. 149-218.

30. Roder, W, Dochen, T, Nidup, K & Dorji, S 2009, ”Weed management challenges in small-holder potato systems in Bhutan”. *Weed research*, vol. 49(3), pp. 300-307.
31. Shehata, SA, Abouziena, HF, Abdelgawad, KF & Elkhawaga, FA 2019, ”Weed control efficacy, growth and yield of potato (Solanum tuberosum L.) as affected by alternative weed control methods”. *Potato Research*, vol. 62(2), pp. 139-155.
32. Soren, C, Chowdary, KA, Sathish, G, & Patra, B.C 2018, ”Weed dynamics and yield of potato as influenced by weed management practices”. *Int. J. Pure App. Biosci.*, vol. 6, pp. 398-408.
33. Șarpe, N 1987, “Integrated Control of Weeds in Agricultural Crops”, *Ceres Publishing House*, Bucharest, pp. 485.
34. Tripathi, B, Singh, CM & Bhargava, M 1989, ”Comparative efficacy of herbicides in potato under conditions of North-Western Himalayas”. *Pesticides*, vol. 23, pp. 37-38.
35. Týr, Š 2008, ”Actual weed infestation of potato crops in Slovakia”. *Acta Herbol*, vol. 17(2), pp. 125-130.
36. Uremis, I, Caliskan, ME, Uludag, A & Caliskan, S 2009, ”Weed management in early season potato production in the Mediterranean conditions of Turkey”. *Bulgarian Journal of Agricultural Science*, vol. 15(5), pp. 423-434.
37. Yadav, SK, Lal, SS, Srivastava, AK, Bag, TK & Singh, BP 2015, ”Efficacy of chemical and non-chemical methods of weed management in rainfed potato (Solanum tuberosum)”. *Indian J. Agric. Sci.*, vol. 85(3), pp. 382-386.
38. Zimdahl, RL 2007, ”Fundamental of weed science” (Third Edition) *Academic Press*, USA., pp. 325.