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EFFICACY OF SOME HERBICIDES ON WEED GROWTH AND YIELD OF POTATO IN CLIMATIC CONDITIONS OF BARSA COUNTY

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Abstract

Weed control is an important factor for a successful potato crop. The objectives of current study were to assess the effect of herbicides and their rates of application on weeds and the crop. Test results come from a field experiment conducted between 2020–2021 to the National Institute of Research and Development for Potato and Sugar Beet Brasov, Romania. Two factors were tested: factor I - potato variety: Brasovia; factor II - five herbicides to control weeds and a control one variant (V1: Control; V2: clomazone+pendimenthalin 2.0 l/ha; V3: clomazone+ pendimenthalin 1.8 l/ha; V4: Sencor 0.9 l/ha; V5: Proman 3 l/ha; V6: Challenge 4 l/ha). The experiment was laid out in randomized complete block design with three replications. Herbicides were applied as preemergence. The weed community included Chenopodium album, Amaranthus spp., Echinochloa crus-galli, Abutilon theophrasti, Polygonum spp., Falloppia convolvulus. In both years the reported effectiveness for all registered weeds was good and very good, over 85-90% of the control and all variants treated by herbicides significantly influenced the increase in potato yield in comparison with the control variants.

Key words*: efficacy, herbicide, potato, weed control, yield.*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food crops in the world. In volume of crop production, potato ranks fourth following wheat, maize, and rice in the world. It is regarded as a high-potential food security crop because of its ability to provide a high yield of high-quality product per unit input with a shorter crop cycle (mostly < 120 days) than major cereal crops, like maize, sorghum etc. (Adane et al., 2010; Kebede et al., 2016).

Weed infestation decrease the quality and quantity of potato tubers via decreasing size, weight and number of tubers (Arnold et al., 1998). Competition affects considerably the shape, size and function of competing species (Mondani et al., 2011).

Competition between potatoes and weeds should be minimized from planting to the time of canopy closure, 6 to 7 weeks later. Weeds that emerge after row closure usually will not compete with the potato crop so long as the canopy is uniform and dense. Crop uniformity and density is determined by the stature of the variety and the uniformity of plant spacing (Hermeziu et al., 2020).

Jan et al. (2004) reported that chemical weed control increased potato yield significantly and was found to be the least expensive giving the highest marginal rate of return (14.17%) compared to other weed control measures.

Among weed management practices, chemical weed control is easy, effective and time saving method. Labor cost has increased tremendously during the last few years, which has made the manual weeding almost impracticable (Khan et al., 2009).

Substantial scientific reports are now available that show that the time of weed control is as important as the weeding itself. Delayed weeding until late stages could result in irreversible damage due to weed competition (Zimdahl 1987; Karimmojeni et al., 2014).

MATERIALS AND METHODS

Experiments were carried out at the National Institute of Research and Development for Potato and Sugar Beet Brasov, Romania, in 2020-2021. The soil was cambic chernozeum with 6.6 pH, humus 4.68% and clay 27%. The pre-crop in both years was wheat.

The field experiments each year were set up in random block, 3 replicate plots with 4 rows each with 11 plants. The size of elementary plot was 9 m^2, with the distance 75/30 cm. Fertilizer, NPK 15-15-15, was applied at 1000 kg/ ha rate in both years before potato planting.
A Romanian potato variety Brasovia was planted in 2020, April 6 and in 2021, May 3.
Herbicide used were: V1: Control (untreated); V2: clomazone+pendimethalin - 2.0 l/ha; V3 clomazone+pendimethalin) - 1.8 l/ha; V4: Sencor (metribuzin 70%)) - 0.9 l/ha; V5: Proman (500 g/l metobromuron - 3.0 l/ha; V6: Challenge (600 g/l aclonifen) 4.0 l /ha. Herbicides were applied on 30 April 2020 and 19 May 2021 respectively and assessments were made 20,37 and 54 days after application. Herbicides were applied with a knapsack sprayer with 10 l capacity (nozzle type TJ 11002). The weeds species, growth stages and population level were recorded by counting the number of individual species in 4 x 0.25 m^2. Statistical analysis was done using factorial analysis of variance (ANOVA), the statistical and rating differences between mean values was performed by LSD test.
The harvest was performed in 2020, September, 10 and respectively 2021, October 4.

RESULTS AND DISCUSSIONS

In 2020 during the vegetation period (April - August) the average monthly temperatures were close to normal, only 0.7°C higher than MAA. Between April 1 and August 31, the total rainfall was less with 8.6 l/m^2 than the MAA but the distribution of precipitation was very uneven. A very low volume in April but an excess of rainfall in May made it difficult to carry out the activities in good conditions. In 2021 in the same period the average monthly temperatures were much close to normal, only 2.2°C higher than MAA but the rainfalls was less with 36.9 l/m^2 than the MAA.
The weather conditions in particular years had a significant impact on weed infestation (Table 1). The highest number of weeds, before row closure as well as before tuber harvest, was found in 2020 which was characterized by uneven distribution of rainfall and temperatures (Figure 1).

Table 1. Weeds present in the field to NIRDPSB Brasov (2021-2022)

Common name	Scientific name	EPPO code
Fat-hen	*Chenopodium album*	CHEAL
Pigweeds	*Amaranthus* spp.	AMARE
Cockspur	*Echinochloa crus-galli*	ECHCG
Velvetleaf	*Abutilon theophrasti*	ABUTH
Knotweed	*Polygonum* spp.	POLG
Wild buckweed	*Falloppia convolvulus*	POLCO

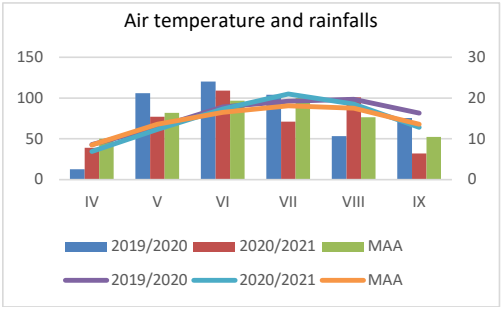

Figure 1. Air temperature and rainfalls during the experiment

Chenopodium album (CHEAL) evaluated in experience reached a population of 23.2 ind./m^2 at the first assessment in 2020 and 22.3/m^2 at the first assessment in 2021 in the untreated variant (control).
There were statistically significant differences between variants. The lowest values were observed in the Challange variant (1.2 kg/ha). In the case of *Amaranthus* spp. (AMARE) the control variant reached a population of 16.7 ind./m^2 at the first assessment in 2020 and 15.5 ind./m^2 at the first assessment in 2021 and *Echinochloa crus-galli* (ECHCG) 14.9 ind./m^2 at the first grading in 2020 and 12.7 ind./m^2 at the 2021 assessment.
Abutilon theophrasti (ABUTH) was assessed as reaching a population of 50 ind./m^2 in the control variant in 2020 and 5.8 ind./m^2 in 2021 and *Fallopia convolvulus* (POLC) recorded 11.6 ind./m^2 at the first assessment in 2020 and 11.2 ind./m^2 at the assessment in 2021. In the case of *Polygonum* spp. (POLG), the control variant reached a population of 11.3 ind./m^2 at the first assessment in 2020 and 12.7 ind./m^2 at the first assessment in 2021. There are statistically significant differences between variants (Table 2).

Table 2. Effectiveness of different herbicides in potato weeds control (I assessment)

Weeds	CHEAL	CHEL	AMARE	AMARE	ECHCG	ECHCG	ABUTH	ABUTH	POLCO	POLCO	POLG	POLG
Data	20,05.20	8.06.21	20,05.20	8.06.21	20,05.20	8.06.21	20,05.20	8.06.21	20,05.20	8.06.21	20,05.20	8.06.21
Control (untreated)	23.2a	22.3a	16.7a	15.5a	14.9a	12.7a	5.0a	5.8a	11.6a	11.2a	11.3a	12.7a
Clomazone+ pendimenth 2.0	2.0c	3.8b	1.9bc	2.7b	1.7bc	0.7bc	2.1b	1.8b	2.1bc	2.3bc	2.2b	2.9b
Clomazone+ pendimenth .1.8	3.8b	2.0c	2.5b	2.1b	2.2b	1.9b	2.7b	2.6b	2.9b	2.2bc	2.0bc	1.9bc
Sencor	1.8cd	1.3cd	1.4bc	1.7b	0.9cd	2.6b	1.7b	1.1b	1.9bcd	1.1cde	1.4bc	0.7d
Proman	1.3cd	1.3cd	1.1bcd	0.4c	1.2bcd	1.1bc	0.4c	0.2c	1.2cde	0.9de	1.2bcd	1.2cd
Challange	1.3cd	0.8cd	0.9cd	0.2c	0.6d	0.5bc	0.2c	0.0c	0.9de	0.4e	1.0cd	1.1cd
LSD (P =.05)	1.73	1.49	0.25	0.25	0.17	0.20	0.21	0.19	0.20	0.20	0.19	0.18
Standard Deviation	1.19	1.69	0.17	0.19	0.12	0.10	0.14	0.15	0.14	0.12	0.13	0.11
CV	3.2	1.97	4.28	3.48	8.96	7.45	9.82	8.8	8..82	7.9	9.88	8.9

Means followed by same letter do not significantly differ (P =.05, Student-Newman-Keuls)

To the second assessment *Chenopodium album* (CHEAL) reached a population of 21.7 ind./m^2 at in 2020 and 22.3 ind./m^2 in 2021 in the untreated variant (control).

There were statistically significant differences between variants.

In the case of *Amaranthus* spp. (AMARE) the control variant reached a population of 9.8 ind./m^2 in 2020 and 11.8 ind./m^2 in 2021 and *Echinochloa crus-galli* (ECHCG) 10.8 ind./m^2 in 2020 and 11.0 ind./m^2 at the 2021 assessment. *Abutilon theophrasti* (ABUTH) was assessed as reaching a population of 10.0 ind./m^2 in the control variant in 2020 and 8.9 ind./m^2 in 2021.and *Fallopia convolvulus* (POLC) recorded 8.9 ind./m^2 in 2020 and 9.3 ind./m^2 in 2021.

In the case of *Polygonum* spp. (POLG), the control variant reached a population of 11.8 ind./m^2 in 2020 and 9.5 ind./m^2 in 2021. There are statistically significant differences between variants (Table 3).

Table 3. Effectiveness of different herbicides in potato weeds control (II assessment)

Weeds	CHEAL	CHEAL	AMARE	AMARE	ECHCG	ECHCG	ABUTH	ABUTH	POLCO	POLCO	POLG	POLG
Data	6.06.20	25.06.21	6.06.20	25.06.21	6.06.20	25.06.21	6.06.20	25.06.21	6.06.20	25.06.21	6.06.20	25.06.21
Control (untreated)	21.7a	22.3a	9.8a	11.8a	10.8a	11.0a	10.0a	8.9a	8.9a	9.3a	11.8a	9.5a
clomazone+ pendimenth 1.8 l	2.5bc	2.1b	2.0b	1.5b	0.0b	1.7b	0.0b	0.0b	1.9cd	2.5b	0.0b	0.0b
clomazone+ pendimenth 2.0 l	3.2b	1.4bc	2.0b	1.5b	0.0b	1.4bc	0.0b	0.0b	2.9b	2.0bc	0.0b	0.0b
Sencor	1.5cd	0.7cd	1.3bc	0.8bc	0.0b	0.4de	0.0b	0.0b	1.6bc	1.7bc	0.0b	0.0b
Proman	1.2cd	0.4d	0.8cd	0.5bc	0.0b	0.0e	0.0b	0.0b	1.0cd	0.4e	0.0b	0.0b
Challange	0.5de	0.7d	0.8cd	0.5bc	0.0b	0.2de	0.0b	0.0b	0.7d	0.6de	0.0b	0.0b
LSD (P =.05)	3.28	2.73	0.97	0.47	0.73	1.22	1.43	1.01	0.19t	6.59	1.34	4.60
Standard Deviation	2.25	2.25	0.67	0.32	0.50	0.83	098	0.69	0.13t	4.51	0.92	3.15
CV	30.09	28.8	34.29	26.72	31.86	29.77	28.32	25.74	13.09	5.65	7.31	3.77

Means followed by same letter do not significantly differ (P =.05, Student-Newman-Keuls)

Chenopodium album (CHEAL) to the last assessment reached a population of 21.7 ind./m^2 in 2020 and 22.2 ind./m^2 in 2021 in the untreated variant (control). There are statistically significant differences between variants. The lowest values were observed in Challange (1.2 kg/ha) and Proman (3.0 l/ha) variants. In the case of *Amaranthus* spp. (AMARE) the control variant reached a population of 11.8 ind./m^2 in 2020 and 12.2 ind./m^2 in 2021 and *Echinochloa crus-galli* (ECHCG) 10.8 ind./m^2 in 2020 and 10.0 ind./m^2 at the 2021 assessment. *Abutilon theophrasti* (ABUTH) was assessed as reaching a population of 9.5 ind./m^2 in the control variant in 2020 and 8.2 ind/m^2 in 2021. *Fallopia convolvulus* (POLC) recorded 10.5 ind./m^2 in 2020 and 8.2 ind./m^2 at the

assessment in 2021. In the case of *Polygonum* spp. (POLG), the control variant reached a population of 10.8 ind./m^2 in 2020 and 7.7 ind./m^2 in 2021. To the last assessment *Echinochloa crus-galli, Abutilon theophrasti, Polygonum* spp. in treated variants were not present. There are statistically significant differences between variants (Table 4).

Table 4. Effectiveness of different herbicides in potato weeds control (III assessment)

Weeds	CHEAL	CHEAL	AMARE	AMARE	ECHCG	ECHCG	ABUTH	ABUTH	POLCO	POLCO	POLG	POLG
Data	23.06.20	12.07.21	23.06.20	12.07.21	2.06.20	12.07.21	23.06.20	12.07.21	23.06.20	12.07.21	23.06.20	12.07.21
Control (untreated)	21.7a	22.2a	11.8a	12.2a	10.8a	10.0a	9.5a	8.2a	10.5a	8.2a	10.8a	7.7a
Clomazone + pendimeth. 1.8 l	1.5bc	1.5b	1.5b	1.0b	0.0b	0.0b	0.0b	0.0b	1.4bc	0.0b	0.0b	0.0b
Clomazone+ pendimeth 2.0 l	1.9b	1.5b	1.5b	1.0b	0.0b	0.0b	0.0b	0.0b	2.1b	0.0b	0.0b	0.0b
Sencor	0.6c	0.5b	0.8bc	1.0b	0.0b	0.0b	0.0b	0.0b	0.7cd	0.0b	0.0b	0.0b
Proman	0.1d	0.0c	0.5bc	0.1bc	0.0b	0.0b	0.0b	0.0b	0.4d	0.0b	0.0b	0.0b
Challange	0.1d	0.0c	0.5bc	0.1bc	0.0b	0.0b	0.0b	0.0b	0.7d	0.0b	0.0b	0.0b
LSD (P =.05)	2.73	2.28	1.14	1.18	1.22	0.89	1.01	0.91	0.16	0.51	0.47	0.75
Standard Deviation	1.87	1.55	0.78	0.80	0.83	0.60	0.69	0.62	0.11	0.51	0.32	0.62
CV	13.8	11.56	11.46	18.8	19.77	11.6	15.74	11.6	12.46	10.5	16.72	11.6

Means followed by same letter do not significantly differ (P =.05, Student-Newman-Keuls)

No potato injury was observed with any herbicide treatments at NIRDPB Brasov in 2020 and 2021.

In 2020 to the control variant was the lower yield of tubers in the largest size (50-60 mm) category (17.06 t/ha) compared to herbicide-treated plots (differences being between 7.32 and 11.78 t/ha). To the medium category (40-50 mm) the highest yield was to the Sencor variant (21.98 t/ha) and the lowest to Challange variant (17.03 t/ha) (Table 5).

Table 5. Influence of herbicides on yield 2020

Product	YLDCAT1 50-60 mm size tubers (t/ha)	Dif. (t/ha)	Sign.	YLDCAT2 40-50 mm size tubers (t/ha)	Dif. (t/ha)	Sign.	YLDCAT3 28-40 mm size tubers (t/ha)	Dif. (t/ha)	Sign.
Untreated ckeck	17.06	-	-	19.18	-	-	1.30	-	-
Clomazone +pendimeth 1.8 l	26.39	9.33	ns	19.02	-0.16	ns	1.39	0.09	ns
Clomazone+ pendimeth 2.0 l	24.38	7.32	ns	19.23	0.21	ns	1.71	0.32	ns
Sencor	28.83	11.78	ns	21.98	2.74	ns	1.90	0.19	ns
Proman	26.42	9.37	ns	20.70	-1.28	ns	2.10	0.20	ns
Challange	28.36	11.30	ns	17.03	-36.67	ns	2.12	0.02	ns

DL5% = 14.93 t/ha; DL5% = 8.16 t/ha; DL5% = 1.27 t/ha;
DL1% = 20.56 t/ha; DL1% = 11.19 t/ha; DL1% = 1.74 t/ha;
DL0.1% = 27.99 t/ha; DL0.1%= 15.23 t/ha; DL0.1% = 2.37 t/ha.

Regarding the yield, in 2021, highest value was obtained to V6 (Challange) (24.78 t/ha) and the lowest to the V5 (Proman) variant (22.2 t/ha). To the control variant was the lower yield of tubers in the largest size (50-60 mm) category (4.89 t/ha) compared to herbicide-treated plots To the medium category (40-50 mm) the highest yield was to the Control variant (16.19 t/ha) and the lowest Clomazone + pendimethalin 1.8 l variant (14.66 t/ha) (Table 6).

Table 6. Influence of herbicides on yield 2021

Product	YLDCAT1 50-60 mm size tubers (t/ha)	Dif. (t/ha)	Sign.	YLDCAT2 40-50 mm size tubers (t/ha)	Dif. (t/ha)	Sign.	YLDCAT3 28-40 mm size tubers (t/ha)	Dif. (t/ha)	Sign.
Untreated ckeck	4.89	-	-	16.19	-	-	1.73	-	-
Clomazone +pendimeth 1.8 l	6.12	1.23	ns	14.66	-1.53	ns	1.92	0.19	ns
Clomazone +pendimeth 2.0 l	4.94	0.06	ns	16.12	-0.07	ns	1.90	0.17	ns
Sencor	6.18	1.29	ns	15.20	-0.99	ns	2.16	0.42	ns
Proman	6.03	1.14	ns	14.73	-1.46	ns	1.46	-0.28	ns
Challange	7.83	2.94	ns	15.41	-0.78	ns	1.54	-0.19	ns

DL5% = 3.88 t/ha; DL5% = 4.39 t/ha; DL5% = 0.74 t/ha;
DL1% = 5.32 t/ha; DL1% = 6.02 t/ha; DL1% = 1.02 t/ha;
DL0.1% = 7.24 t/ha; DL0.1% = 8.19t/ha; DL0.1% = 1.38 t/ha.

The productions obtained in 2021 are lower than in 2020. The spring precipitations determined a later planting and the temperatures during the vegetation period (July-August) negatively influenced the development of the plants.

CONCLUSIONS

The results showed that no phytotoxic effect of any herbicide was observed on the potato crop. The tuber yield was influenced due to different treatments. The yield of potato tuber in 2020 was recorded highest (52.71 t/ha) under Sencor 0.9 l/ha treatment. The lowest tuber yield

(37.53/ha) was obtained in control variant. In 2021 the yield of potato tuber was recorded highest (28.8 t/ha) under mixture Clomazone+pendimethalin 2.0 l/ha treatment. The lowest tuber yield (22.2 t/ha) was obtained in Proman 3 l/ha. The weather conditions in the studied years influenced the weeds infestation degree and the obtained yield.

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