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EFFICACY AND SELECTIVITY OF HERBICIDES TO CONTROL WEEDS IN CHICKPEA CROP AT MOARA DOMNEASCĂ, ROMANIA

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ABSTRACT

This paper presents the data regarding the control of weeds in chickpea crop. The observations and determinations aimed the selectivity and efficacy of some simple, complex or associated herbicides, applied pre- and post-emergent, in order to determine their influence on the production yield. The chickpea crop was strongly infested with mono and dicotyledonous species, including perennial species that are difficult to control (Cirsium, Convolvulus, Sonchus). The best results were obtained in the experimental variants in which the pre-emergent treatments were followed by post-emergent treatments. Perennial species were not sufficiently controlled. The herbicide Pulsar 40 (imazamox, 40 g/l) showed phytotoxicity, the harvest being delayed and the production lower.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is considered to be the most important dried legume, widely cultivated worldwide in more than 55 countries (Varshney et al. 2017). In the structure of crops for grain, in terms of importance, it ranks fourth after soybeans (*Glycine max* L. Merr.), peas (*Pisum sativum* L.) and beans (*Phaseolus vulgaris* L.).

It is cultivated on approximately 15 million ha worldwide, of which approximately 90% (13.5 million ha) are present in Asia alone. According to FAO data (https://www.fao.org/faostat/en/#data/QCL), in Europe chickpeas were grown on average between 2017-2021 on 525 thousand ha, of which 1231 ha were sown in Romania in 2017. Yet there is an increasing trend in the areas occupied by chickpeas all over the world.

In the chickpea crops, one of the most important yield limiting factors is represented by ineffective weed management. Being a plant with slow growth in the early period and not having an imposing stature, chickpea is very sensitive to weed infestation, which can cause yield losses of over 75% (Yadav et al. 2019, Singh et al. 2020, Chaudhary et al. 2005, Cojocaru & Marin 2022). Effective herbicides are absolutely necessary for the control of mixed weed flora.

There are very few approved herbicides for chickpea cultivation in Romania and there are no herbicides with post-emergence application for dicotyledonous weeds and none for perennial dicotyledonous weeds

(https://aloe.anfdf.ro/) as bindweed (*Convolvulus arvensis* L.), perennial thistle (*Cirsium arvense* L. Scop.) and perennial sowthistle (*Sonchus arvensis* L.).

The research carried out aimed to test the selectivity and efficacy of some simple, complex or associated herbicides, applied pre and post-emergent to the chickpea crop, determining their influence on the production yield.

MATERIAL AND METHODS

The research was carried out in 2022, in the Experimental Didactic Field of the Faculty of Agriculture within the University Agronomic Sciences and Veterinary Medicine of Bucharest, at Moara Domnească, Ilfov County. The experience was located on the geographical coordinates: 44°50'13.07" North latitude and 26°24'94.51" East longitude. The soil is reddish preluviosol type, characterized by a loamy-clay texture, with a moderately acidic pH around 5.4 and 5.6, with a reduced humus content of a maximum of 2.4% (Mihalache et al. 2010).

The chickpea crop was sown with the Burnas variety after the oat crop, at 50 cm between rows, with a density of around 40 plants/m^2, at a sowing depth of 4-5 cm. The agrotechnical practices consisted of autumn plowing at a depth of 25 cm and working with the cultivator in the spring.

Regarding precipitation, the year 2022 was extremely dry compared to the multiannual average recorded in Romania, at Moara Domnească (local weather station) an average of 324.7 mm was recorded throughout the year. Yet during the growing season, chickpeas received only 180.6 mm. This plant is not very pretentious to the amounts of rain if it is distributed favorably (Kirnak et al. 2017). Having in April 71,5 mm offered a favorable first growth start for the crop.

The experimental variants, together with the doses and periods of application, are presented in Table 1.

Table 1

The experimental variants for weed control to chickpea crop, 2022

No.	Experimental variants	Active substance content	Dose	Applying time
V1	Untreated	-	-	-
V2	Ut.2 - manually hoeing	-	-	-
V3	Ut.3 - mechanical plows	-	-	-
V4	Challenge 600 SC	600 g/l, aclonifen	4 l/ha	Preem.
V5	Dual Gold 960 EC + Merlin Flexx	960 g/l, s-metolachlor + 240 g/l, isoxaflutole + 240 g/l, cyprosulfamide (safener)	1.5 l/ha + 0.25 l/ha	Preem.
V6	Gardoprim Plus Gold 500 SC	312,5 g/l s-metalochlor + 187,5 g/l terbuthylazine	4.5 l/ha	Preem.
V7	Gardoprim Plus Gold 500 SC + Merlin Flexx	312,5 g/l s-metolachlor +187,5 g/l terbuthylazine + 240 g/l, isoxaflutol + 240 g/l, cyprosulfamide (safener)	4.5 l/ha + 0.25 l/ha	Preem.
V8	Gardoprim Plus Gold 500 SC + Merlin Flexx	312,5 g/l s-metolachlor + 187,5 g/l terbuthylazine + 240 g/l, isoxaflutol + 240 g/l, cyprosulfamide (safener)	4.5 l/ha + 0.18 l/ha	Preem. Postem.
V9	Lentagran 45 WP + Pantera 40 EC	450 g/kg, pyridate + 40 g/l, quizalofop-p-tefuryl	1.2 kg/ha+ 1 l/ha	Postem.
V10	Dual Gold 960 EC + Pulsar 40	960 g/l, s-metolachlor + 40 g/l, imazamox	1.5 l/ha 0.8 l/ha	Preem. Postem.

The trials were placed in randomized blocks design, in 3 replications that included 10 experimental variants, with an experimental plot area of 21 m^2 (3,5 width x 6 length). In order to have a clearer picture regarding the efficacy of crop weeding on production, in addition to the untreated variant, two more variants were evaluated: manually hoeing, which completely eliminated the weeds (Ut. 2) and the variant with two mechanical plows, which is practicated in organic agriculture (Ut.3). The determination of weed species and percentage of soil coverage in the untreated were carried out at the time of application of the post-emergent herbicides, when the chickpea crop was in the stage of about 10 cm height. The degree of selectivity of the herbicides was determined, have being done 7, 14 and 28 days after the application of the treatments and it was established according to the EWRS scale, rated visually at each date of the efficacy assessments on a 1-9 scale (1: no visible injury; 9: dead plant). The estimated visual assessment of the percentage of infestation with monocot and dicot weeds was carried out, to establish their dominance before and 14, 21 and 48 days after the treatment. At the time of harvesting, weed biomass (grams of dry matter) and the percentage between monocots and dicots were determined. The experimental data were calculated and interpreted based on the analysis of the variance (Săndoiu 2020).

RESULTS AND DISCUSSIONS

The observations and determination carried out in the experimental plots, showed that the most numerous were dicotyledonous weeds, among these there are perennial dicotyledons such as: *Convolvulus arvensis* (L.), *Cirsium arvense* (L.) Scop., *Sonchus arvensis* (L.) and annual dicotyledons as *Chenopodium album* (L.), *Amaranthus retroflexus* (L), *Polygonum aviculare* (L.), *Solanum nigrum* (L.), *Polygonum convolvulus* (L.) sin. *Fallopia convolvulus* (L.) A. Löve, *Galium aparine* (L.). There were determinated other dicotyledonous species, too, but in a lower density (< 2 plats/m^2) they were: *Rumex* spp., *Daucus carota* (L.), *Portulaca oleracea* (L.), *Thlaspi arvense* (L.), *Xanthium* spp., *Erigeron annuus* (L.) Persoon, *Plantago major* (L.), *Capsella bursa-pastoris* (L.) Medicus. Annual monocotyledonous weeds were fewer in number of species, but they have a higher degree of soil surface cover: *Setaria* spp, *Echinochloa crus-galli* (L.) P.Beauv., volunteer *Avena sativa* (L.) and *Digitaria sanguinalis* (L.) Scop (Figure 1).

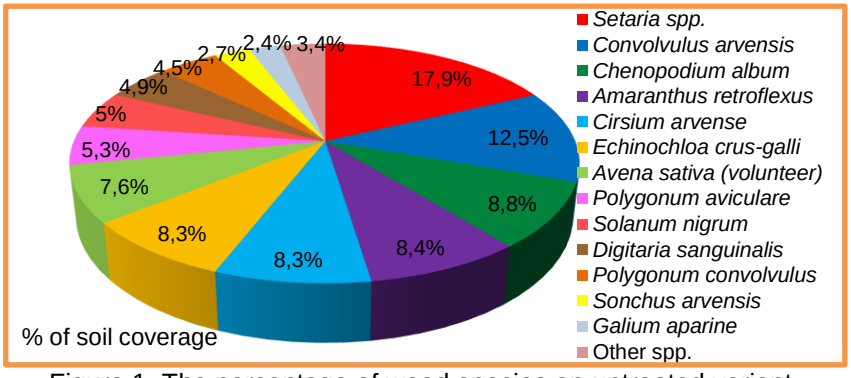

Figure 1. The percentage of weed species on untreated variant

Among these, the species with the highest degree of soil coverage is

Setaria spp in percentage of 17,9%, followed by the species that represents the highest problem in chickpea crop *C. arvensis* with 12,5%. Another perennial dicotyledonous species, *C. arvense*, also stands out with a rather high percentage of soil coverage of 8,3%, the rest of the species having a degree of coverage between 8,8 and 2,4%.

Regarding the selectivity of the herbicides applied to the chickpea crop in 2022, there was noted that only the experimental variants (V10) with Pulsar 40 applied post-emergence showed phytotoxicity phenomena. EWRS scores were 4, 4 and 3 across the three post-treatment observation periods. The chickpea plants stagnated in growth and the leaflets shriveled, so the crop was delayed and the production was lower.

The results of the efficacy of the weed control measures in the chickpea crop and of the weed biomass taken at harvest are presented in Table 2. The results show that compared to untreated, the degree of weed control increased, in all variants by more than 65%. The best values were recorded in experimental plot where Gardoprim Plus Gold 960 EC have been applied in pre-emergence + Merlin Flexx applied in post-emergence (V8) of 90,3%, followed by Gardoprim Plus Gold 500 SC + Merlin Flexx applied in pre-emergence (V7) of 89,7% and Dual Gold 960 EC + Merlin Flexx applied in pre-emergence (V5) of 85,3%. Variants 4, 6 and 9 did not give satisfactory results and in V10 the presence of phytotoxicity, which delayed the crop, leads us to state that this is a less accepted variant for weed control.

Regarding the biomass of the weeds taken at harvest, it is found that in untreated plot 226 g.d.m./m^2 were recorded. Herbicide treatments greatly reduced weed biomass to values between 25 – 81 g.d.m./m^2, the most satisfactory variants were 8, 7 and 5 where Merlin Flexx herbicide was applied post-emergence or pre-emergence in combination with Gardoprim Plus Gold 500 SC or Dual Gold 960 EC.

Table 2

Efficacy of weed control measures in chickpea crop, 2022

No.	Experimental variants	Degree of control (%)				Biomass of weeds	
		14	21	48	Aver-	g.d.m.	% mono.
		days			age	/m^2	/dico.
V1	Untreated	0	0	0	0	226	59/41
V2	Ut.2 - manually hoeing	100	100	100	100.0	-	-
V3	Ut.3 - mechanical plows	72	67	60	66.3	78	75/25
V4	Challenge 600 SC	69	64	62	65.0	81	22/88
V5	Dual Gold 960EC + Merlin Flexx	86	86	84	85.3	36	13/87
V6	Gardoprim Plus Gold 500 SC	68	64	63	65.0	63	11/89
V7	Gardoprim Plus Gold 500 SC + Merlin Flexx	89	90	90	89.7	28	8/92
V8	Gardoprim Plus Gold 500 SC + Merlin Flexx	90	91	90	90.3	25	6/94
V9	Lentagran 45 WP + Pantera 40 EC	73	64	63	66.7	71	5/95
V10	Dual Gold 960 EC + Pulsar 40	85	83	80	82.7	22	7/93

The weeding observations showed that the weed species that created major problems and did not respond to the action of herbicides were the perennial dicotyledons (bindweed and perennial thistle). Following the percentage between monocotyledons and dicotyledons in the variants with herbicides, we found that the biomass of weeds it is in favor of dicotyledons, on average being 10,3 for monocotyledons and 89,7 for dicotyledons. Due to the fact that 2022 was an extremely dry year and affected all agricultural crops, in chickpea in the untreated variant the production was 622 kg/ha and in Ut. 2 (manually hoeing) the production was 1557 kg/ha (Table 3). But applying manually hoeing is not a solution for chickpea growers. Instead, the application of mechanical plows can be applied in organic agriculture but also in conventional agriculture and supplemented with herbicide treatments. Moreover, when two mechanical plows were carried out, the production was 1,012 kg/ha (Ut. 3). The other variants, with herbicides, gave yields from 1,312 to 752 kg/ha. The highest yields were recorded when pre- and post-emergent treatments were applied, in V8 being 1312 kg/ha, 210,9% higher than untreated, and at V7 with the production of 1283 kg/ha, 206,3% higher than untreated, followed by V5 with 1173 kg/ha respectively 188,6% more compared to untreated. The differences from the untreated variant show that all weed control variants gave statistically proven increases in production. The differences from Ut. 2 (manually hoeing) show highly significant negative values. This shows that on lands heavily infested with perennial dicotyledonous weeds (*C. arvensis* and *C. arvense*), such as the one at Moara Domnească, we still do not have a solution for a weed-free chickpea crop and we will have to test other associations of herbicides. The differences from Ut. 3 (mechanical plows) effectively bring out variants 8, 7 and 5 with very significant and distinctly significant productions.

Table 3

Chickpea crop yields, 2022

No.	Experimental variants	yields		Difference from the untreated (kg/ha)		
		kg/ha	%			
V1	Untreated	622	100.0	Ut. 1	-935^{ooo}	-390^{ooo}
V2	Ut.2 manually hoeing	1557	250.3	935***	Ut. 2	545***
V3	Ut.3 mechanical plows	1012	162.7	390***	-545^{ooo}	Ut. 3
V4	Challenge 600 SC	786	126.4	164**	-771^{ooo}	-226^{oo}
V5	Dual Golg 960 EC + Merlin Flexx	1173	188.6	551***	-384^{ooo}	161**
V6	Gardoprim Plus Gold 500 SC	995	160.0	373***	-562^{ooo}	-17
V7	Gardoprim Plus Gold 500 SC + Merlin Flexx	1283	206.3	661***	-274^{ooo}	271***
V8	Gardoprim Plus Gold 500 SC + Merlin Flexx	1312	210.9	690***	-245^{ooo}	300***
V9	Lentagran 45 WP + Pantera 40 EC 40 EC	854	137.3	232**	-703^{ooo}	-158^{oo}
V10	Dual Gold 960 EC + Pulsar 40	752	120.9	130*	-805^{ooo}	-256^{ooo}

LSD 5% = 69.4 kg/ha; LSD 1% = 137.3 kg/ha; LSD 0,1% = 249.6 kg/ha.

Thus with the help of herbicides we can obtain higher yields than by mechanical weed control. The use of the herbicide Merlin Flex (240 g/l isoxaflutole + 240 g/l cyprosulfamide) applied pre- and postemergence in treatments

associated with other herbicides (Gardoprim Plus Gold 500 SC or Dual Gold 960 EC) currently represents a solution to obtain good chickpeas productions.

CONCLUSIONS

The year 2022 was an extremely dry year for the Moara Domnească area, which affected all agricultural crops, including the chickpea.

The results regarding the selectivity of the herbicides applied to the chickpea showed that the herbicide Pulsar 40 showed phytotoxicity, the crop was delayed and the production was lower.

The results of the efficacy of the weed control measures showed that the degree of weed control increased in all variants by over 65%. The highest values were recorded in V8 with 210,9% followed by V7 with 206,3% and V5 with 188,6% compared to the untreated.

Application of the herbicide Merlin Flex pre- and post-emergence in combination and association with Gardoprim Plus Gold 500 SC and Dual Gold 960 EC determined to obtain distinctly significant and very significant productions.

The presence of perennial dicotyledonous weeds creates big problems for the chickpea crop and the herbicides tested did not give satisfactory results.

Mechanical plows associated with the application of the herbicides Gardoprim Plus Gold 500 SC or Dual Gold 960 EC with Merlin Flexx can be a viable solution in the success of a chickpea crop.

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