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SELECTIVITY AND EFFECTIVENESS OF HERBICIDES APPLIED TO CHICKPEAS CULTURE UNDER THE CONDITIONS OF S.C.D.A. TELEORMAN

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Abstract

Chickpea (Cicer arietinum L.) is known to be sensitive to many chemicals and therefore the use of herbicides for the control of dicotyledonous weeds is limited. The research was conducted in 2019-2020 at A.R.D.S. Teleorman, with different applied herbicide associations being studied. The research focused on the selectivity and effectiveness degrees for the control of monocotyledonous and dicotyledonous, annual and perennial weeds, by applying combined herbicides treatments. From the analysis of the 12 variants, the experimental variant with the association of herbicides Gardoprim Plus Gold 500 SC (4.0 l) + Merlin Flex (0.3 l). Applied during pre-emergence phase, this solution registered a higher efficiency, of 96-99%, for both monocotyledonous (Avena fatua; Echinochloa crus-galli; Setaria spp.) and dicotyledons (Amaranthus retroflexus; Chenopodium album; Chenopodium polyspermum; Hibiscus trionum; Polygonum convolvulus; Sinapis arvensis) weeds. In the embodiments Gardoprim + Merlin 500 SC Plus Gold Flex Flex Leopard 50 EC + Merlin, there is a chemical weed control that significantly exceeded, provided statistically the untreated control and with production increases between 115-246 kg/ha.

Key words*: chickpeas, herbicides, weeds, control, efficacy.*

INTRODUCTION

Chickpeas (*Cicer arietinum* L.) is considered a crop with low labor consumption, and its production requires fewer inputs compared to cereals.

Chickpeas are widely grown around the world and serve as a multifunctional crop.

It plays a significant role in improving soil fertility by fixing atmospheric nitrogen. After harvesting, it leaves a substantial amount of residual nitrogen in the soil for the forerunner cultures and adds an amount of organic matter to maintain and improve soil health and fertility.

Saves the cost of entering fertilizers, not only for chickpeas, but also for subsequent cultures.

In the period 1990-2012, chickpeas had a slight recovery, being cultivated on areas that reached up to about 10 thousand ha, mainly in the south of the Romanian Plain, Banat, Moldova and Dobrogea, the most areas being found in the culture structure of agricultural research stations (Sturzu et al., 2012).

It is known that chickpeas (*Cicer arietinum* L.) are sensitive to many herbicides and therefore the options for using herbicides for weed control are limited.

Ratnam et al. (2011) conducted a study between 2006-2007 and 2008-2009 at RARS, Lam Farm, Guntur, to find out the most suitable integrated practices for weed control in chickpeas. The results indicated that weed control treatments significantly reduced the density and dry weight of weeds in chickpeas culture. Post-emergence application of imazetapir 63 g/ha caused 20% damage to chickpeas plants.

In Romania, chickpeas are a "niche" culture, whose proportion in the structure of agricultural plants is low, but increasing, due to its advantages: the crop is made with relatively low costs, obtains economic productions, having a high content of protein substances (23.6-31.2%).

Agricultural systems that include legumes increase soil fertility and prevent erosion and desertification, are of major interest in many

countries around the world, leading to increased plant productivity (Egamberdieva et al., 2014).
Increasing the yield in chemical control may depend on the appropriate use of moisture, nutrients, light and sowing density of chickpeas, in the absence of competition with weeds, as shown by experimental data obtained by Arya (2004) and Patel et al., 2006.
The best weed control in chickpeas was obtained by applying pendimethalin and trifluralin (Hassan et al., 1995).
Another study shows that weeds produce a loss of chickpea yield of 40-90% (Solh and Pala, 1990).
Simultaneous and rapid growth of weeds with chickpeas plants leads to severe competition for light, moisture, space and nutrients, which leads to a drastic reduction in yield. Production losses ranged between 40 and 94% (Bhan and Kukula, 1987).
To date, not enough weed control strategies have been found, so the main purpose of the research is to establish and extend weed control strategies in chickpeas culture, by selecting and testing an assortment of selective herbicides with increased effectiveness, environmentally friendly.
Weeds competition affects space, air, water, light and nutrients in culture plants. Moreover, they increase production costs, favour the attack of pests and plant diseases, decrease the quality of agricultural production and reduce soil fertility. Harvest losses are due to weeding (45%), pest attack (30%), disease attack (20%) and other causes (5%) (Rao, 1983). Effective control increased chickpeas production by 97%, and the first 4-6 weeks after sowing were the most critical period for competition in weed control (Ahlawat et al., 1981).
Singh and Sharma reported in 2013 that pendimethalin is an effective herbicide applied in pre-emergence (0.50-0.75 kg/ha) to control annual dicotyledonous weeds in chickpeas culture. They also reported that the application of oxyfluorfen (0.25 kg/ha) in pre-emergence is effective for the management of dicotyledonous weeds, especially for *Medicago* sp. from central India. The reduction of chickpea production due to the presence of weeds in proportion of 75% was also observed by Chaudhary et al. (2005).
Whish et al. (2002) highlighted the fact that with the increase of weed density, a loss of chickpea production and a decrease of production components were reported. Even low weed densities (<10 m^2 plants) caused a large reduction in production (by about 50%) and higher production losses at longer distances between plant rows.

MATERIALS AND METHODS

The research took place in the years 2019-2020, at A.R.D.S. Teleorman, being studied the combinations and associations of herbicides applied to chickpea culture. The experiment was located on a soil of chernozem vertric type with good fertility (over 3.1% humus, clay content over 42% in the horizon 0-24 cm, pH -> 5.9), using the variety of chickpeas Burnas. The forerunner plant was wheat. The experiment was performed according to the method of randomized blocks, with a plot area of 25 m^2, in four repetitions.
The calculation and interpretation of the results was made based on the analysis of the variance of the experiments placed in the subdivided plots (Săulescu and Săulescu, 1967).
Research has shown the degree of selectivity and effectiveness in controlling annual and perennial monocotyledonous and dicotyledonous weeds by applying herbicide treatments in combinations and combinations (Table 1).
Good seed germination and the appearance of plants are important preconditions for a successful cultivation, and soil temperature and humidity are important factors for their achievement in optimal parameters.
In optimal conditions of humidity and temperature, chickpea seeds quickly absorb water and germinate in a few days, provided that the temperatures are > 0°C. Chickpeas will not germinate in soils below 0°C.
In terms of water, in 2019, chickpeas benefited from 376.6 mm of rainfall over the entire vegetation period, being 76.6 mm more than the crop's requirements for humidity, but their distribution was unfavourable to chickpeas.

Table 1. Experimental variants in chickpea culture. ARDS Teleorman, 2019 - 2020

No. variant	Active substance content	Dose g.s.a./ha	Herbicide treatment	Period of application
V1	Unhoeing	-	Control – untreated	
V2	2 mechanical hoeing	-	Untreated control 2 mechanical hoeing	
V3	50 g/l quizalofop-p-ethyl isoxaflutole 240 g/l Cyprosulfamide (safener): 240 g/l	1.20 l/ha 0.15 l/ha	Leopard 50EC + Merlin Flex	Postem.
V4	960 g/l S-Metolachlor isoxaflutole 240 g/l Cyprosulfamide (safener) 240 g/l	1.50 l/ha + 0,20 l/ha	Dual Gold 960EC+ Merlin Flex	Preem.
V5	960 g/l S-Metolachlor isoxaflutole 240 g/l Cyprosulfamide (safener) 240 g/l	1.20 l/ha + 0.30 l/ha	Dual Gold 960 EC + Merlin Flex	Preem.
V6	312.5 g/l S-metolachlor 187.5 g/l terbutylazine	4.0 l/ha	Gardoprim Plus Gold 500 SC	Preem.
V7	312.5 g/l S-metolachlor 187.5 g/l terbutylazine isoxaflutole 240 g/l Cyprosulfamide (safener): 240 g/l	4.0 l/ha + 0.20 l/ha	Gardoprim Plus Gold 500 SC + Merlin Flex	Preem.
V8	312.5 g/l S-metolachlor 187.5 g/l terbutylazine isoxaflutole 240 g/l Cyprosulfamide (safener): 240 g/l	4.0 l/ha + 0.300 l/ha	Gardoprim Plus Gold 500 SC + Merlin Flex	Preem
V9	312.5 g/l S-metolachlor 187.5 g/l terbutylazine pyridate 450 g/kg	4.0 l/ha + 1.0 l/ha + 1.0 l/ha	Gardoprim Plus Gold 500 SC + Lentagran+ Lentagran	Preem. Post. I Post. II
V10	960 g/l S-metolachlor aclonifen	1.5 l/ha + 2.5 l/ha	Dual Gold 960EC + Challenge 600 SC	Preem.
V11	960 g/l S-metolachlor 40 g/l imazamox	1.5 l/ha + 0.7 l/ha	Dual Gold 960EC+ Pulsar 40	Preem. Post.
V12	960 g/l S-metolachlor metribuzin 700 g/kg	1.5 l/ha + 0.3 l/ha	Dual Gold 960EC + Sencor 600 SC	Preem.

Thus, in the first part of the vegetation period the precipitations were quantitatively higher than the multiannual average with (+27.2 mm) in April, (+48.1 mm) in May and (+99.3 mm) in June. During the harvest formation period, there was an accentuated water deficit in July (-27.1 mm) and August (–47.2 mm), a month in which no precipitation was registered (Figure 2).

In 2020, there were excess rainfall in May (+7.8 mm) and June (+11.6 mm) and deficit in April (–21.8 mm), July and August (cumulative –92.9) mm), compared to the multiannual averages of the area (Figure 2).

In July, it can be said that the total drought was installed, only 2.8 mm of rainfall was recorded, the rainfall being practically absent, the deficit of the month being 58.6 mm, and in August 12.6 mm, of which 12.2 mm in the second decade, and the deficit was 34.4 mm.

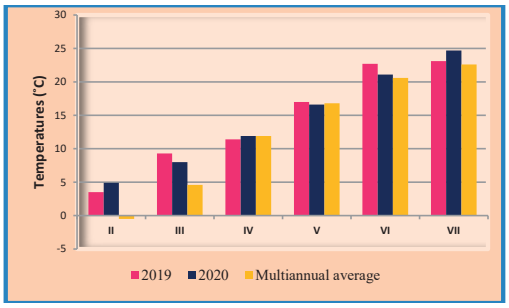

Figure 1. Evolution of average monthly temperatures at ARDS Teleorman 2019-2020

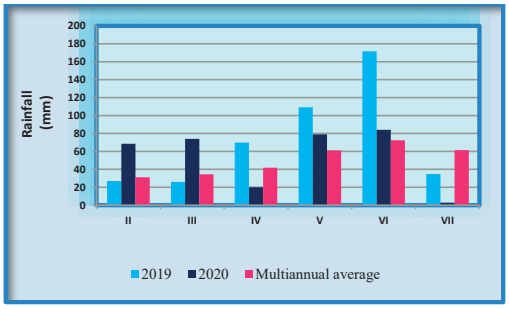

Figure 2. Evolution of rainfall at ARDS Teleorman 2019-2020

The abundant precipitations from May and June 2019, in the presence of relatively high temperatures, had an unfavorable influence on the foliar apparatus through the explosion of foliar diseases, implicitly reducing the assimilation surface of the plants. As a result, the yields obtained are low compared to the genetic capacity, the values of useful agronomic indicators (weight of 1000 seed and hectolitre mass) do not live up to expectations.

The herbicide treatments, mentioned in table 1, were applied: pre-emergent and post-emergent, in the stage of 10-12 cm height at the chickpea plant and the growth stage of monocotyledonous (BBCH 11-14) and dicotyledonous (BBCH 11-15) weeds.

After the application of herbicide treatments, observations were made on the degree of selectivity (%) at intervals of 7 - 14 - 28 days after treatment and the effectiveness of weed control (%) at the interval of 14 and 28 days after treatment.

During the research, specific determinations were made to establish the degree of weeding, weeding characteristics, effectiveness of tested control strategies and herbicide phytotoxicity.

Determinations regarding the weeding characteristics specific to chickpeas in the study area: determination of the annual and average weeding degree (numerical and gravimetric), for chickpeas cultivated in the ARDS Teleorman area.

RESULTS AND DISCUSSIONS

As part of the chickpea experiment located in the experimental field at A.R.D.S. Teleorman, the culture presented a high degree of infestation with annual monocotyledonous and dicotyledonous weeds, depending on the local pedoclimatic conditions, of the years 2019 - 2020.

The most common species of annual monocotyledonous weeds: *Echinochloa crus-galli*, *Setaria* spp., *Avena fatua* and annual dicotyledons: *Amaranthus retroflexus*, *Chenopodium album*, *Chenopodium polyspermum*, *Hibiscus trionum*, *Polygonum convolvulus*, *Sinapis arvensis*, *Stellaria media*, *Veronica* spp., *Xanthium italicum*, as well as perennials: *Cirsium arvense*, *Convolvulus arvensis*, *Sonchus arvensis* (Table 2).

The following problem species were identified on the basis of frequency: *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria spp.*, *Amaranthus retroflexus*, *Chenopodium album*, *Solanum nigrum*, *Hibiscus trionum*, *Polygonum convolvulus*, *Sinapis arvensis*, *Stellaria media, Veronica spp.*, *Xanthium italicum*, *Cirsium arvense*, *Convolvulus arvensis*, *Sonchus arvensis.*

The causes that determined the appearance with frequency and high weight of the above weed species are related to: temporary excess of humidity, short rotations, etc.

The succession of culture and culture-specific technologies in a crop rotation is one of the most effective measures to control weeds, in close connection with the application of treatments.

From the comparative analysis of the average weeding present in the control plots of chickpeas, 14 days after the emergence of the plants, results the obvious role of the need to apply herbicides in weed control in chickpeas, very sensitive to weeds at this stage, through high competition weeds with chickpea plant (Table 2).

Table 2. The structure of the segetal flora from the chickpea culture from ARDS Teleorman, 2019 -2020

No crt	Species	Average pl/m^2		Participation %	
		2019	2020	2019	2020
1.	*Digitaria sanguinalis* (am)	1.0	18.5	0.8	14.7
2.	*Echinochloa crus-galli* (am)	18.0	31.7	14.1	25.2
3.	*Setaria* spp. (am)	18.5	14.5	14.5	11.5
4.	*Amaranthus retroflexus* (ad)	14.5	12.5	11.4	9.9
5.	*Chenopodium album* (ad)	31.7	3.0	24.9	2.4
6.	*Solanum nigrum* (ad)	2.7	1.2	2.1	1.0
7.	*Hibiscus trionum* (ad)	5.5	7.0	4.3	5.6
8.	*Polygonum convolvulus* (ad)	7.2	7.6	6.0	6.0
10.	*Sinapis arvensis* (ad)	0.7	5.5	0.5	4,4
11.	*Stellaria media* (ad)	1.4	1.2	1.1	1.0
12.	*Veronica* spp. (ad)	1.2	2.7	0.9	2.2
13.	*Xanthium italicum* (ad)	7.0	7.6	5.5	6.0
14.	*Cirsium arvense* (ad)	4.6	4.0	3.6	3.1
15.	*Convolvulus arvensis* (pd)	11.0	6.4	8.6	5.0
16.	*Sonchus arvensis* (pd)	2.2	2.4	1.7	2.0
	Total	**127.2**	**125.8**	**100**	**100**
	Annual monocotiles (am)	37.5	64.7	29.4	51.4
	Perennial monocotile	-	-	-	-
	Annual dicotyledonate (ad)	71.9	48.3	56.5	38.3
	Perennial dicotyledonate (pd)	17.8	12.8	13.9	10.1

If effective methods are not applied to control weed weeding in pre-emergence, as it increases, the weeding potential of the crop increases due to the development of annual and perennial monocotyledonous and dicotyledonous species present in chickpea culture.

Under these infestation conditions, the application of herbicides and herbicide combinations has shown good results in controlling the control of monocotyledonous and dicotyledonous weed species, depending on the degree of infestation, the spectrum and the dominance of the species present in the chickpea culture. The influence of climatic conditions (precipitation recorded before and after treatment).

During the experimentation period, the application of herbicide treatments shows a significant control of annual and perennial weed species, in the herbicidal variants, in accordance with the products used compared to the untreated control.

In the years 2019-2020 for the pre-emergence and post-emergence application (Tables 3 and 4) of the new combinations and combinations of herbicides, tested in the experimental field in chickpea culture, the results obtained 14 days after treatment showed superior efficacy (95-99%) for some monocotyledonous weeds (*Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria* spp.) and annual dicotyledons (*Amaranthus retroflexus*, *Chenopodium album*, *Solanum nigrum*, *Hibiscus trionum*, *Polygonum convolvulus*, *Sinapis arvensis*, *Stellicum X*, as.). Exceptions are the annual dicotyledonous weeds *Amaranthus retroflexus*, *Xanthium strumarium*, *Chenopodium album*, *Sinapis arvensis*, *Solanum nigrum*, which showed a lower control effect in the variants treated with the herbicides Dual Gold 960 EC + Sencor 600 SC and Dual Gold 960 EC + P, these registering a lower control effect and the presence of phytitoxicity in the chickpea plant.

In the experimental version treated with the herbicide combination: Gardoprim Plus Gold 500 SC (4.0 l/ha) + Merlin Flex (0.3 l/ha) a superior control efficiency of 96-99% was obtained, both for monocotyledonous weeds and dicotyledonous, annual and perennial.

Analyzing the average results obtained 28 days after treatment, on the effectiveness of the herbicides used (Tables 3 and 4), an optimal level of weed control is found, depending on the control spectrum specific to each product. The Leopard 50 EC variant 1.2 l/ha postem + Merlin Flex 0.150 l/ha, applied post-emergence, achieves a high efficacy on dicotyledonous weeds, with a very good degree of control of (92-98%).

Average results obtained for *Amaranthus retroflexus* species, *Chenopodium album*, *Solanum nigrum*, *Hibiscus trionum*, *Polygonum convolvulus*, *Sinapis arvensis*, *Stellaria media*, *Veronica* spp., *Xanthium italicum*, were low (68%), on average over the experimental years in some combinations and combinations, and in the experimental variants treated with the combination of herbicides, Gardoprim Plus Gold 500 SC (4.0 l/ha) + Merlin Flex (0.3 l/ha) pre-emergent and Leopard 50 EC 1.2 l/ha postemergent + Merlin Flex 0.150 l/ha postemergent, a superior control efficiency was registered.

Table 3. Biomass of annual and perennial monocotyledonous and dicotyledonous weeds in chickpeas. ARDS Teleorman, 2019

No. field	The experimental variant	Total weight at harvest (kg/ha)				Monocotyledonous		Dicotyledonous	
						Green weight (kg/ha)	Dry weight (kg/ha)	Green weight (kg/ha)	Dry weight (kg/ha)
		Green weight (kg/ha)	Dry weight			at harvest	at harvest	at harvest	at harvest
			(kg/ha)	%	%				
V1	Control – Untreated	10192	2312	100	1895.1	4152	784	6040	1528
V2	Untreated control 2 - 2 mechanical hoeing	614	122	5.3	100	230	46	384	76
V3	Leopard 50 EC + Merlin Flex	2885	576	24.9	472.1	436	71	2449	505
V4	Dual Gold 960 EC + Merlin Flex	1644	322	13.9	263.9	90	12	1554	310
V5	Dual Gold 960 EC + Merlin Flex	1134	268	11.6	219.7	78	9	1056	259
V6	Gardoprim Plus Gold 500 SC	2247	472	20.4	386.9	71	61	2176	411
V7	Gardoprim Plus Gold 500 SC + Merlin Flex	1074	230	9.9	188.5	50	10	1024	220
V8	Gardoprim Plus Gold 500 SC + Merlin Flex	747	185	8.0	151.6	38	7	709	178
V9	Gardoprim Plus Gold 500 SC + Lentagran +Lentagran	1846	366	15.8	300.0	182	34	1664	332
V10	Dual Gold 960 EC + Challenge 600 SC	2039	441	19.1	361.5	252	50	1787	391
V11	Dual Gold 960 EC + Pulsar 40	2321	500	21.6	409.8	189	34	2132	466
V12	Dual Gold 960 EC + Sencor 600 SC	2682	587	25.39	481.1	330	54	2352	533

Table 4. Biomass of annual and perennial monocotyledonous and dicotyledonous weeds in chickpeas. ARDS Teleorman, 2020

No. field	he experimental variant	Total weight at harvest (kg/ha)				Monocotyledonous		Dicotyledonous	
						Green weight (kg/ha)	Dry weight (kg/ha)	Dry weight (kg/ha)	Dry weight (kg/ha)
		Green weight	Dry weight			at harvest	at harvest	at harvest	at harvest
		(kg/ha)	(kg/ha)	%	%				
V1	Control 1– Untreated	9043	1834	100	2183.3	3943	800	5100	1034
V2	Untreated control 2 - 2 mechanical hoeing	416	84	4.6	100	80	36	336	48
V3	Leopard 50 EC + Merlin Flex	642	130	7.0	154.8	35	7	607	123
V4	Dual Gold 960 EC + Merlin Flex	1460	296	16.1	352.4	210	42.5	1250	253.5
V5	Dual Gold 960 EC + Merlin Flex	1230	233	12.7	277.4	70	14.0	1080	219
V6	Gardoprim Plus Gold 500 SC	1962	398	21.6	473.8	82	16.6	1880	381.3
V7	Gardoprim Plus Gold 500 SC + Merlin Flex	980	199	10.8	236.9	60	12.0	920	186.6
V8	Gardoprim Plus Gold 500 SC + Merlin Flex	536	109	5.9	129.8	26	5.2	510	103.4
V9	Gardoprim Plus Gold 500 SC + Lentagran + Lentagran	1330	270	14.7	321.4	130	26.3	1200	243.4
V10	Dual Gold 960 EC + Challenge 600 SC	1860	377	20.5	448.8	280	56.7	1580	320
V11	Dual Gold 960 EC + Pulsar 40	2260	458	24.9	545.2	60	12.0	2200	446
V12	Dual Gold 960 EC + Sencor 600 SC	2780	1258	68.5	1497.6	380	771	2400	486.8

The average results on the effectiveness of herbicide application obtained at the last evaluation (28 days after treatment) of the experimental variants Dual Gold 960 EC (1.5 l/ha) pre-emergent + Pulsar 40 (0.7 l/ha), showed a low level of control, which led to reinfestations and regenerations caused by the reserve of weed seeds in the soil and the presence of precipitation.

The efficacy of herbicide treatments applied at this time in the experimental version Gardoprim Plus Gold 50 SC (4.0 l/ha) pre-emergent + Lentagran (1.0 l/ha) postemergent I + Lentagran (1.0 l/ha) postemergent II was 89-95% (Table 5). The treatment was applied depending on the observance of the optimal phase of the chickpea plant, the weed species at the time of treatment, the dominance and spectrum of the two groups of weeds (annual

and perennial monocotyledons and dicotyledons) and the zonal climatic conditions. During the research period, observations were made on the selectivity at 7 - 14 - 28 days from the treatments applied with combined and associated herbicides, to the chickpea culture. In the experimental variant Dual Gold 960 EC (1.5 l/ha) + Chellenge 600 SC (2.5 l/ha), the presence of phytotoxic phenomena manifested temporarily was observed (according to the EWRS scale = 0), for a period of 12-18 days, with stagnation from plant growth and loss of vigor. After 28 days from the emergence of chickpeas, the effectiveness of the tested herbicides was good and very good. Among the combinations of herbicides studied for weed control in chickpeas, the variant (V3) Leopard 50 EC (1.2 l/ha) + Merlin Flex (0.150 l/ha) applied in early post-emergence, together with the variant (V8) Gardoprim Plus Gold 500 SC (4.0 l/ha) + Merlin Flex (0.3 l/ha preem.), Which were appreciated as having very good efficacy, being close as a percentage of control.

Table 5. Degree of weed control according to the treatments applied. A.R.D.S. Teleorman, 2019-2020

No. Var.	Combat / dose variant		Sele-ctivit EWRS	Percentage of weeds controlled Effectiveness (%)			Note EWRS	Appre-ciation
				2019	2020	Average 28 days		
1.	Control – untreated		-	-	-	Mt	***9***	***NS***
2.	Untreated control 2 mechanical hoeing		-	92	94	93^{000}	***3.0***	***B***
3.	Leopard 50 EC + Merlin Flex	1.20 l/ha post 0.15 l/ha post	**1**	92	98	95^{000}	*3.0*	***B***
4.	Dual Gold 960EC+ Merlin Flex	1.5 l/ha preem 0.2 l/ha preem	**1**	94	98,4	96.2^{000}	***2.8***	***FB***
5.	Dual Gold 960 EC + Merlin Flex	1.2 l/ha 0.3 l/ha preem	**1**	95	97	96^{000}	***2.8***	***FB***
6.	Gardoprim Plus Gold 500 SC	4.0 l/ha preem	**1**	89	90	89.5^{000}	***3.7***	***B/S***
7.	Gardoprim Plus Gold 500 SC + Merlin Flex	4.0 l/ha preem 0.2 l/ha preem	**1**	91	93	92^{000}	***3.0***	***B***
8.	Gardoprim Plus Gold 500 SC + Merlin Flex	4.0 l/ha preem 0.3 l/ha preem	**1**	96	99	97.5^{000}	***2.5***	***FB***
9.	Gardoprim Plus Gold 500 SC + Lentagran + Lentagran	4.0 l/ha preem 1.0 l/ha post I 1.0 l/ha post II	**1**	89	95	92^{000}	***3.0***	***B***
10.	Dual Gold 960EC + Challenge 600 SC	1.5 l/ha preem 2.5 l/ha post	**2**	87	89	88^{000}	***3.7***	***B/S***
11.	Dual Gold 960EC+ Pulsar 40	1.5 l/ha preem 0.7 l/ha post	**4**	75	80	77.5^{000}	***4.5***	***NS***
12.	Dual Gold 960EC + Sencor 600 SC	1.5 l/ha preem 0.3 l/ha preem	**1**	86	87	86.5^{000}	***4.0***	***NS***

FB= very good effect; B = good effect; S = satisfactory effect; NS = unsatisfactory

For the comparative analysis of the effectiveness of the tested control variants, the averages of the control percentages recorded for all the observations during the chickpea vegetation were also calculated, with the help of which the combat degree ensured in each experimental combat variant tested can be defined (Table 5).

In 2019 and 2020, the most effective combination of herbicides was Gardoprim Plus Gold 500 SC 4.0 l/ha + Merlin Flex 0.3 l/ha, applied pre-emergently, 10 days after sowing the chickpeas. It had a very good efficacy, due to the precipitation that fell after sowing. In the years with less precipitation, as was the case in 2020, we can speak of a good efficiency in

postemergence at the variant (V3) Leopard 50 EC 1.2 l/ha + Merlin Flex 0.150 l/ha.

The average yields obtained are closely correlated with the degree of weed control.

Thus, in 2019, in the case of pre-emergence control, the highest production levels were achieved for Gardoprim Plus Gold 500 SC + Merlin Flex treatments, with a very significant production increase, statistically assured, of 1089 kg / ha compared to Mt. 1 and 76 kg/ha compared to Mt. 2, not statistically insured, and in the case of post-emergence control at the treatments with Leopard 50 EC + Merlin Flex (V3), the increase was very significant, statistically assured, of 791 kg/ha compared to Mt.1 (Table 6).

In 2020, compared to Mt.1, all experimental variants had very significant production increases, statistically assured, and compared to Mt.2 very significant production increase, statistically assured (246 kg/ha) was obtained for the Gardoprim Plus variant Gold 500 SC + Merlin Flex (V8), in post-emergence treatments with Leopard 50 EC + Merlin Flex (V3) obtained a distinctly significant production increase (186 kg/ha). Significant production increase (115 kg/ha) compared to Mt.2 was obtained for Gardoprim Plus Gold 500 SC + Merlin Flex (V7) (Table 8).

Table 6. The influence of herbicide combinations on chickpea yields, SCDA Teleorman 2019

No. crt.	Variant experimental	Average yield kg/ha	Relative yield compared to Mt.1	Relative yield compared to Mt.2	The difference ±Mt.1	The difference ±Mt.2	Significance	
							compared to Mt.1	compared to Mt.2
1	Control –untreated	397	100	28.17	MT	-1013	-	000
2	Untreated control 2 mechanical hoeing	1411	355.03	100	1013	MT	***	-
3	Leopard 50 EC + Merlin Flex	1188	298.99	84.22	791	-223	***	000
4	Dual Gold 960 EC + Merlin Flex	1143	287.58	81.00	745	-268	***	000
5	Dual Gold 960 EC + Merlin Flex	1243	312.84	88.11	846	-168	***	00
6	Gardoprim Plus Gold 500 SC	1060	266.69	75.12	662	-351	***	000
7	Gardoprim Plus Gold 500 SC + Merlin Flex	1191	299.66	84.40	793	-220	***	000
8	Gardoprim Plus Gold 500 SC + Merlin Flex	1487	374.16	105.39	1089	76	***	-
9	Gardoprim Plus Gold 500 SC + Lentagran I + Lentagran II	1207	303.69	85.54	809	-204	***	000
10	Dual Gold 960 EC + Challenge 600 SC	1177	296.31	83.46	780	-233	***	000
11	Dual Gold 960 EC + Pulsar 40	400	100.59	28.33	2	-1011	-	000
12	Dual Gold 960 EC + Sencor 600 SC	851	214.09	60.30	453	-560	***	000

LSD 5% = 92.52 kg/ha LSD 1% = 126.11 kg/ha LSD 0.1% =169.49 kg/ha

Table 7. ANOVA for the influence of herbicide combinations on chickpea yields, ARDS Teleorman

The cause of variability	Analysis of variance			
	SP	GL	s^2	Test F
TOTAL	4.13	35		
Rehearsal	0.07	2		
Variants	4.00	11	3.999	69.98***(3.12)
Error	0.06	22	0.057	

Table 8. The influence of herbicide combinations on chickpea yields, SCDA Teleorman 2020

No. crt.	Variant experimental	Average yield kg/ha	Relative yield compared to Mt.1	Relative yield compared to Mt.2	The difference ± Mt.1	The difference ± Mt.2	Significance	
							compared to Mt.1	compared to Mt.2
1	Control –untreated	564	100	31.94	MT	-1201	-	000
2	Untreated control 2 mechanical hoeing	1765	313.07	100	1201	MT	***	-
3	Leopard 50 EC + Merlin Flex	1950	346.01	110.52	1387	186	***	**
4	Dual Gold 960 EC + Merlin Flex	1680	298.05	95.20	1116	-85	***	-
5	Dual Gold 960 EC + Merlin Flex	1761	312.36	99.77	1197	-4	***	-
6	Gardoprim Plus Gold 500 SC	1520	269.66	86.14	956	-245	***	000
7	Gardoprim Plus Gold 500 SC + Merlin Flex	1880	333.47	106.52	1316	115	***	*
8	Gardoprim Plus Gold 500 SC + Merlin Flex	2010	356.65	113.92	1447	246	***	***
9	Gardoprim Plus Gold 500 SC + Lentagran I + Lentagran II	1620	287.46	91.82	1057	-144	***	0
10	Dual Gold 960 EC + Challenge 600 SC	1710	303.43	96.92	1147	-54	***	-
11	Dual Gold 960 EC + Pulsar 40	870	154.29	49.28	306	-895	***	000
12	Dual Gold 960 EC + Sencor 600 SC	1280	227.14	72.55	717	-484	***	000

LSD 5% = 106.84 kg/ha LSD 1% = 145.62 kg/ha LSD 0.1% =195.71 kg/ha

Table 9. Analysis of variance for the influence of herbicide combinations on chickpea yields, ARDS Teleorman 2020

The cause of variability	Analysis of variance			
	SP	GL	s^2	Test F
TOTAL	7.19	35		
Rehearsal	0.02	2		
Variants	7.08	11	6.385	74.39***(3.12)
Error	0.09	22	0.086	

Figure 3. Plus Gold 500 SC (4.0 l/ha) + Merlin Flex (0.3 l/ha) - 14.05.2019

Figure 4. Untreated control 14.05.2019

Figure 5. Leopard 50 EC (1.2 l/ha) +Merlin Flex (0.150 l/ha)

Table 10. Comparative analysis of chickpea production in weed control variants. S.C.D.A. Teleorman, 2019–2020

No. var.	Combat variant	Average yields kg/ha		Classification	
		2019	2020	2019	2020
V8	Gardoprim Plus Gold 500 SC 4.0 l/ha preem + Merlin Flex 0.3 l/ha preem	**1487**	**2010**	**A**	**A**
V5	Dual Gold 960 EC 1.2 l/ha preem + Merlin Flex 0.3 l/ha preem	**1243**	**1761**	**AB**	**CD**
V9	Gardoprim Plus Gold 500 SC + 4.0 l/ha preem Lentagran + 1.0 l/ha post I + Lentagran 1.0 l/ha post II	**1207**	**1620**	**BC**	**D**
V7	Gardoprim Plus Gold 500 SC 4.0 l/ha preem + Merlin Flex 0.2 l/ha preem	**1191**	**1880**	**CD**	**BC**
V3	Leopard 50 EC 1.2 l/ha postem + Merlin Flex 0.150 l/ha postem	**1188**	**1950**	**D**	**AB**

CONCLUSIONS

The combined herbicides and the association of herbicides, applied pre-emergence and post-emergence to the chickpea culture had a good control effect, highlighting their effectiveness by a single application only, in some variants.

Combined herbicides Gardoprim Plus Gold 500 SC 4.0 l/ha + Merlin Flex 0.3 l/ha applied pre-emergence save the weed culture, with maximum efficiency and very good persistence, by reactivating with rainfall after sowing.

The effectiveness of herbicide application depends on the level of infestation, dominance, weed spectrum, applied dose and climatic conditions, having a high productivity by applying the two mechanical hoeing.

Regarding the effectiveness of weed control in chickpeas, the Leopard 50EC variant (V3) (1.2 l/ha) + Merlin Flex (0.150 l/ha) applied in early post-emergence together with the variant (V8) Gardoprim Plus Gold 500 SC (4.0 l/ha) + Merlin Flex (0.3 l/h preem.), were appreciated as having very good efficacy, being very close as a control percentage registering a superior efficacy of 95-97%, both for weeds monocotyledons (*Echinochloa crus-galli*, *Setaria* spp.) and dicotyledons (*Amaranthus retroflexus*, *Chenopodium album*, *Solanum nigrum*, *Hibiscus trionum*, *Polygonum convolvulus*, *Sinapis arvensis*, *Stellaria media*, *Veronica* spp., *Xanthium italic*, *Sonchus arvensis*), as well as for the resistant ones (perennial dicotyledons: *Convolvulus arvensis*, *Sonchus arvensis*).

When applying the Gardoprim Plus Gold 500 SC + Merlin Flex herbicide combination, a chickpea production of 2010 kg/ha and a very significant increase of 246 kg/ha are obtained, compared to the control with the two mechanical hoeing, in 2020.

The productions made after the application of herbicides are in direct correlation with the degree of weed control, being differentiated according to the degree of infestation, and the effectiveness of herbicide combinations and combinations, have achieved a degree of control of 95-99%, being selective for chickpeas plants.

In the two years of research, the most effective combination of herbicides was Gardoprim Plus Gold 500 SC 4.0 l/ha + Merlin Flex 0.3 l/ha, applied pre-emergently, 10 days after sowing the chickpeas, which were effective very good, due to the precipitation that fell after sowing.

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