

STUDY ON THE ACTION AND EFFICIENCY OF MIXES OF FOLIAR FERTILIZERS AND HERBICIDES IN THE WHEAT AND CORN CROPS

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Abstract

Liquid fertilizer, in the current period, represents an important share for agricultural crops. From the research of the herbicides used worldwide it is ascertained that in most of the cases mixes of products are used to obtain a wide action range. Usually mixes of herbicides and complementary action are used, thus obtaining products having a wide action range which enables their use in various fields. The use of the herbicide mixes has important technical and economic benefits: the number of crops treatments are significantly diminished, therefore of the equipment, manpower, thus obtaining important diminishment of the energy consumption.

Key words: fertilizer, foliar, herbicide.

INTRODUCTION

Taking into consideration the technical and economic benefits, we studied the possibility to obtain fertilizing compositions with herbicide mixes. In Romania, mixes made up of the acid 2.4D (2,4-dichlorophenoxyacetic acid) and Dicamba (3,6-dichloro-2-methoxybenzoic acid) manufactured and traded under the name of Ceredin Forte is homologated and licensed to be used by ALCHIMEX S.A. Specialists estimate that the assimilation and industrialization of liquid fertilizers constitutes one of the most important achievements in the field of fertilizers, due to the technical and economic advantages it presents (Akelah, 1996; Hall et al., 1994). These mixtures allow for a single operation to carry out a complex treatment: fertilisation, herbicide, insectification etc., which constitutes great technical and economic advantages (Horrihan et al., 2002; Matson et al., 1998; Mogul et al., 1996).

MATERIALS AND METHODS

To obtain a wide action range we used a mix of 2.4 D (28%) and Dicamba (35%) as dimethylamine (DMA). This systemic herbicide is absorbed by plants both by the root system and by the leaves (Muraviev et al., 1998).

The biochemical mechanism used by Ceredin to destroy the weed resides in deranging the growth processes and inhibiting the development of the root system.

CEREDIN FORTE is used to fight and control weeds in the corn, wheat, rye, barley, two row barley and oat crops (when the plant has 2-5 leaves). It is also used in the springtime during the twinning phase until the formation of the second node and the weeds are in the rosette phase (namely they have 2-6 leaves); consumption 2 l/ha for corn, wheat, barley; 1,5 l/ha for the two-row barley and barley.

Table 1. Main species of weeds destroyed by the CEREDIN type herbicide

Name of the weed		Control rate	
Common name	Scientific name	2,4-D	CEREDIN
Yarrow (milfoil)	<i>Archillea millefolium</i>	**	***
Corn cockle	<i>Agrosterma githago</i>	0	****
Mayweed / wild chamomile	<i>Anthemis</i> sp.	**	****
Wild bishop	<i>Biofora radians</i>	0	***
Heart-padded hoary-cress	<i>Cardania draba</i>	**	****
Shepherd's-purse	<i>Capsella bursa pastoris</i>	***	****
Creeping thistle	<i>Cirsium arvense</i>	***	****
Convolvulus	<i>Convolvus arvensis</i>	**	***
	<i>Descurania sophia</i>	***	****
Field (common) horsetail	<i>Equisentum arvense</i>	***	****
Cleavers	<i>Gallium aparine</i>	0	****
Chamomile	<i>Matricaria chamomilla</i>	0	****
Matricaria	<i>Matricaria inodora</i>	0	****
Corn poppy (corn rose)	<i>Papaver rhaeas</i>	0	***
black-bindweed	<i>Polygonum convulvulus</i>	**	****
pale persicaria	<i>Polygonum laphthiofolium</i>	**	****
Sheep's (red) sorrel	<i>Rumex acetosella</i>	**	***
Austrian fielddress	<i>Rorippa austriaca</i>	**	***
Corn Sow thistle, (Dindle, Field Sow Thistle, Gutweed, Swine Thistle)	<i>Sonchus arvensis</i>	**	****
	<i>Sonchus oleraceans</i>	**	***
Common chickweed	<i>Stellaria media</i>	0	**
Field Penny-cress	<i>Thalasp arvense</i>	***	****
Corn (common) speedwell	<i>Veronica arvense</i>	0	****
Veronica	<i>Veronica hederifolia</i>	0	****
Common vetch	<i>Vicia angustifolia</i>	**	***
Tufted (cow) vetch	<i>Vicia cracca</i>	**	***
Hairy (tiny) vetch	<i>Vicia herusta</i>	**	***
Hungarian vetch	<i>Vicia pannonica</i>	**	***
Field pansy	<i>Viola arvensis</i>	**	***

LEGEND:

0 = inefficient; ** = the weeds are approximately 50% destroyed; *** = the weeds are approx. 75% destroyed; **** =the weeds are approx. 100% destroyed.

The CEREDIN FORTE herbicides are used to fight and control the weeds of the straw cereals; consumption 1 l/ha of crop.

In Table 1 there are the main species of weeds destroyed by the 2.4D acid and the CEREDIN type products (2.4-D and Dicamba).

From the data presented in Table 1 it clearly comes out that the CEREDIN products have a wider herbicide range than 2.4-D, therefore they were selected to make the mix of fertilizers and pesticides.

We may obtain concentrated emulsions of liquid foliar fertilizers and Ceredin, using emulsifier as thickening agents and dispersing agents. We decided that we may obtain compositions of chemical fertilizers as concentrated emulsion using liquid fertilizers (including foliar) and Ceredin, having the composition below:

- 100-129 g Ceredin;
- 300-350 g solution of foliar liquid fertilizers;
- 20-25 g emulsifier NF-10 (as thickening agent);
- 2.0-2.5 g polyvynilic polyvynil alcohol with GH = 88-92% (as dispersing agent).

To obtain a stable in time concentrated suspensions (in which no separations or sedimentations of products as sediment occur), to the obtained compositions we added various jellifying agents.

We used jellifying agents of the polysaccharide class and polyacrylamide solutions in concentrations of 0.1-0.5% compared to the total weight of the mix.

The Ceredin products are applied post-emergent, during the vegetation when the air temperature is of minimum 7°C, tending to be higher. The Ceredin type herbicides have a wide action range, therefore they are used to fight and control more than 200 species of annual and perennial dicotyledonous weeds, including those resistant to the action of the 2.4 D acid (in the mix two herbicides with complementary action are used, which determines a convenient widening of the action range). Liquid compositions of foliar fertilizers and Ceredin are used as concentrated suspensions. The suspension is made by inserting the Ceredin, the emulsifier and the dispersing agent into the fertilizer solution, by agitation, at 30-75°C. The obtained concentrated suspensions have been analyzed from the point of view of the stability of the active products (herbicides) they are made of. After 30-45 days from the making the diminution of the active products' (2.4 D acid and Dicamba) concentrations was no longer found. As a conclusion, we may obtain concentrated suspensions of liquid fertilizers and Ceredin type fertilizers with appropriate physical-chemical stability in time. The solid mixes (as granules) made up of chemical fertilizers and Ceredin type herbicides were made by depositing the herbicides in solution on the fertilizers granules and eliminating humidity by means of a warm air current. On the grounds of the theoretical and technical-economic reasons as well as of preliminary investigations, we reached the conclusion that liquid compositions of foliar fertilizers and Ceredin may be obtained as concentrated suspensions.

RESULTS AND DISCUSSIONS

I.C.P.P. (Research Institute of Corn Crops) tested the herbicide on experimental lots cultivated with Flamura variety wheat. The first treatment was carried out in April and the second one in May. The mix of herbicide fertilizer was sprayed using the manual pump. The observations were made 30 and 60 days after the treatment. The experiments were made in dryness conditions (high temperatures and absence of rain). As standard substance we used the Ceredin Forte herbicide. During the tests we also monitored the effect of the

fertilizer on the way the plants develop and on the increase of the seeds production.

The results of testing the herbicide efficiency of the mix of fertilizer and Ceredin Forte are presented in Table 2.

The Cereals and Technical Plants Research Institute (I.C.C.P.T.) of Fundulea made the tests on the selection and efficiency (E) of post-emergent application of the mix of foliar liquid fertilizer and Ceredin Forte at a dose of 5.0 l/ha for the wheat crops (Hodosan, 2007). The treatments was carried out when the plants had 2-3 internodes and the dicotyledonous weeds had more than 4-6 leaves. To apply the mix we used 400 l of water/ha. The experiments were carried out in unfavorable weather conditions: prolonged dryness, high temperatures (35-41°C), extremely small quantity of rain.

The testing took place in the wheat field of Flamura 85 variety and the assessment of the herbicide efficiency was carried out 14 and 28 days after the treatment. Furthermore, the efficiency tests of the mix of fertilizer and Ceredin Forte in the corn crops were carried out by the scientific researchers within the Research Institute of Corn Crops (I.C.P.P.) of Bucharest. The experiments were made in conditions of high rate of weeds (the number of weds reached even 107 plants/m²). On the grounds of the theoretic and technical – economic reasons as well as of preliminary investigations, we studied the possibility to realize compositions of foliar fertilizers and CEREDIN as concentrated suspensions.

The observations were made 30 and 60 days after the treatment.

The results of the tests of the herbicide efficiency of the mix of fertilizer and Ceredin Forte in fighting and controlling the weeds of the corn crops are presented in Table 4. Weeds represent a major threat to crop production (Ahmad, 2021; Gandini, 2020; Hodosan, 2007; Shavit et al., 1997).

The weeds present in the wheat crop (Table 3) when the treatment was made were:

- *Galium* (Gal.)
- *Papaver* (Pap.)
- *Anthemus* (Anth.)
- *Cirsium* (Cirs.)
- *Convulsuvus* (Conv.)
- *Veronica* (Ver.)
- *Delphinium* (Delph.)

Table 2. The herbicide efficiency of the mix of foliar fertilizer and Ceredin Forte in fighting the wheat crops weeds

Product	30 days after the treatment						60 days after the treatment					
	Dicotyledonous		Monocotyledonous		Total		Dicotyledonous		Monocotyledonous		Total	
	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)
Untreated sample	10	-	8.5	-	18.5	-	8	-	5.5	-	13.5	-
Fertilizer + Ceredin Forte 4 l/ha	2	80	2	76.5	4	78.4	3	62.5	2	63.7	5	63
Ceredin Forte 1 l/ha (standard)	1	90	0	100	1	94.6	2	75	1.5	72.7	3.5	74.1

Table 3. Results of the herbicide activity efficiency of the mix of foliar fertilizer and Ceredin Forte in the wheat crops (ICCPT-Fundulea)

Product	Dose l/ha	Application cleaning	Efficiency		Average yield		Species of uncontrolled weed (according to the dominance)
			14 days	28 days	kg/ha	(%)	
Untreated	-	-	0	0	3200	100	Gal., Pap., Anth., Cirs., Conv., Ver., Delph.
Ceredin Forte (standard)	1.0	Post-treatment	90	90	3546	111	Conv., Gal., Delph.
Ceredin Forte+ Foliar fertilizer	5.0	Post-treatment	90	90	3520	110	Conv., Gal., Delph.

Table 4. The results of the herbicide action efficiency of the mix of fertilizer and Ceredin Forte in the corn crops

Product	30 days after the treatment						60 days after the treatment					
	Dicotyledonous		Monocotyledonous		Total		Dicotyledonous		Monocotyledonous		Total	
	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)	No. of plants/m ²	E (%)
Untreated sample	2.5	-	1.5	-	4	-	0.5	-	1	-	1.5	-
Un-weeded sample	17.5	-	80	-	97.5	-	21.5	-	88.5	-	107	-
Fertilizer + Ceredin Forte 4l/ha	0	100	27.2	66	27.2	72.2	5.5	74.5	22	74.3	27.5	74.3
Ceredin Forte 1l/ha	3.5	80	25	68.8	28.5	70.8	2.5	88.4	26	69.6	28.5	73.4

The weeds present in the corn crop when the treatment was made are mentioned below. As standard herbicide Ceredin Forte was used.

Annual dicotyledonous:

- *Amaranthus retroflexus*
- *Chenopodium album*
- *Galisonga parviflora*
- *Polygonum* spp.
- *Portulaca oleracea*
- *Solanum nigrum*
- *Sonchus oleraceus*

Perennial dicotyledonous:

- *Cirisium arvense*

- *Convolvulus arvensis*

Annual monocotyledonous:

- *Setaria* spp.
- *Echinochloa crus-galli*

The toxicity to mammals of the CEREDIN products is moderate, the average lethal doses (DL₅₀) being of 305-320 mg/kg of live weight. These herbicides pertain to the toxicity group III. DL₅₀ for mammals of 2,4-D is of 350-360 mg/kg, the amine salt of 2,4 D has DL₅₀=980-1200 mg/kg (low toxicity). For mammals, Dicamba has DL₅₀ = 1200-1300 mg/kg (low toxicity).

CONCLUSIONS

After the tests made at I.C.P.P. Bucharest, the following conclusions were drawn:

- a) the mix of fertilizer-Ceredin Forte provides a satisfactory control of the wheat crops weeds;
- b) the herbicides efficiency of the composition fertilizer-Ceredin Forte was comparable to the one of the substance used as standard (Ceredin Forte); the differences related to the herbicide efficiency of the mix of fertilizer-Ceredin Forte and the one recorded for the standard substance are in the limits of the specific errors of the statistic calculations;
- c) in the evaluation of the tests results we must take into consideration the dryness conditions of the experiments (unfavorable: high temperatures, absence of rain) etc.;
- d) because of the unfavorable weather conditions the data recorded on the effects of the fertilizers on the yield increase did not enable evaluations; yet the stimulating effects of the fertilizer on the plant development during vegetation were highlighted by a more intense coloration of the leaves representing the proof of the photosynthesis processes stimulation; moreover, we also noticed as a positive effect of the fertilizer, a higher resistance of the plants to the dryness.

As a conclusion, we assert that the mix of fertilizer and Ceredin Forte provides an adequate control of the weeds in the wheat crops.

After the tests carried out at I.C.C.P.T Fundulea, the following conditions were drawn:

- a) the herbicide efficiency of the mix of foliar fertilizer and Ceredin Forte is satisfactory (88-90%), comparable to the efficiency of Ceredin Forte used as standard substance 14 days after the treatment and equal 28 days after (both products had a herbicide efficiency of 90%). As well, the selectivity of the mix fertilizer + herbicide was similar to the one of the standard product;
- b) in the assessment of the herbicide efficiency we must take into account two determining factors:
 - b.1.) the treatment was far too late compared to the vegetative state of the weeds (the dicotyledonous weed had more than 4 – 6 leaves; the species *Convulus*, *Galium*, *Papver* and *Delphinium* were 10-15 cm tall; in this

stage of weeds' vegetative development, the efficiency of the herbicides is significantly reduced;

- b.2.) the assessment of the fertilizer's influence on the production of berries was not possible because of the dryness conditions of the experiments 28 days after the treatment, on the areas treated with mix of fertilizer Ceredin and those treated with Ceredin Forte (standard substance), the weeds totally dried out; given the circumstances, the yields increases for each separate case did not significantly differentiate (the treatment with the mix of fertilizer + herbicide recorded a 110% increase and for the lots treated with standard substance the yield increase was of 111%).

Using mixes of herbicides and fertilizers we obtain synergic effects between the components of those compositions, which is materialized in superior crops compared to the crops obtained when these products are separately used.

The mix of fertilizer – herbicide is very efficient on the mono and dicotyledonous weeds of the corn crops. As well, the toxicity of these mixes to mammals is moderate, pertaining to the toxicity group III.

For the corn crops, after the tests made within I.C.P.P. Bucharest, the following conclusions were drawn:

- a) the efficiency of the herbicide action of the mix of fertilizer and Ceredin Forte was similar to the one of the product used as standard (Ceredin Forte); both the mix of fertilizer – herbicide as well as Ceredin Forte are highly efficient on the dicotyledonous and monocotyledonous weeds;
- b) the assessment of the results of the herbicide efficiency of the mix of fertilizer with herbicide must take into consideration two important issues:
 - b.1.) the experiments were made in a period when certain weeds were in more advanced vegetative states, when they are more resistant to the herbicide action of Ceredin;
 - b.2.) the testing was carried out in conditions of extremely high weed rate (107 plants/m²);
- c) the conditions of the experiments (non irrigation) did not allow definite assertions related to the effects of the fertilizers on the yield increase.
- d) Ceredin products have moderate toxicity in mammals

As an overall conclusion, we believe that the herbicide efficiency and selectivity of the mix of foliar fertilizer and Ceredin Forte were similar to those recorded when using Ceredin Forte herbicide as a standard substance for both the wheat crops and the corn one.

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