

ESTABLISHMENT OF OPTIMAL PERIOD OF HERBICIDES APPLICATION FOR WINTER WHEAT AND ITS IMPORTANCE FOR WEED CONTROL AND YIELD

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Abstract

In order to determine with maximum accuracy the optimal herbicide treatment period for winter wheat, a trial field was organized at Moara Domneasca by the Agrotechnical Department, Faculty for Agriculture between 2008-2009.

The soil type is reddish brown, pH value 6.7, organic material content 2.6% and clay content over 40%. Five herbicides were tested and their effect was compared with a check field where no herbicides were used, known as standard. The following herbicides were studied:

- *Dicopur D (2.4 D) dosage 1 litre/ha;*
- *Dicopur Top (2.4 D + dicamba) dosage 1 litre/ha;*
- *Buctril universal (bromoxinil) dosage 1 litre/ha;*
- *Mustang (florasulam + 2.4 D) dosage 0.5 litre/ha;*
- *Kingstar 75 WG (tribenuron methyl) dosage 0.020 kg/ha.*

These herbicides were applied in four different stages of development for the wheat plants as follows:

- *the first treatment was made during the tillering period (stage D-F; Keller & Baggiolini scale) (Figure 1);*
- *the second treatment was made at the end of the tillering and the beginning of the first inter-node formation (stage F-H);*
- *the third treatment was made at the stage of 2-3 internodes (stage H-J);*
- *the fourth treatment was made at the stage of buds, before emerging of the live (stage J-L).*

The experiment was made by the method of divided patches with two factors, in four replications, having the harvested plot of 10 square meters, with 2 factors:

The factor A was period of treatment with herbicides;

The factor B was type of herbicides.

The winter wheat variety cultivated was Boema, produced by INCDA Fndulea.

The herbicides were applied mixed with 250 liters water/ha.

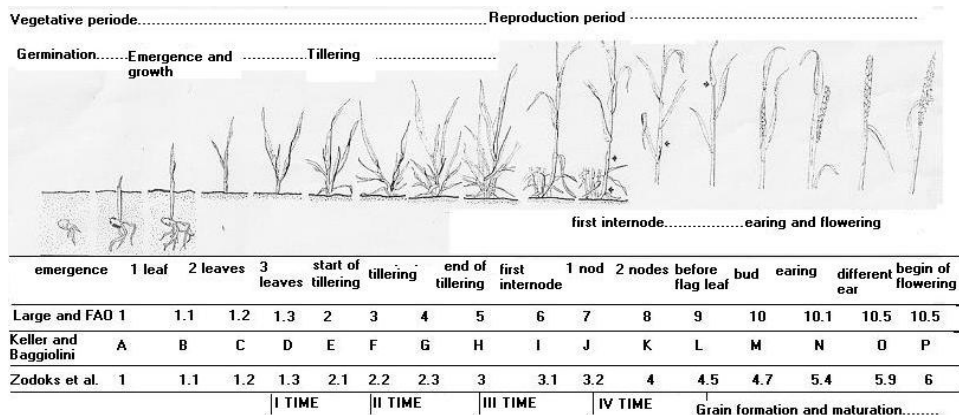


Fig. 1. Development stages of winter wheat and setting of application periods

There have been made measurements regarding the weeds before the treatment with herbicides, they were repeated after 30 days and before harvesting.

The measurements were made by counting the weeds by different species and by weighting the dried weeds in kg/ha.

There have been made measurements regarding the selectivity of the herbicides on wheat plants following the EWRS (European Weed Research Society) notes, by measuring the density per square meter, by counting the number of spikes on the ears, by counting the number of thin beans, by MMB and by yield.

The analysis of the data concluded that the appliance of herbicides in the second period, that is at the end of the tillering period and at the stage of first inter-node formation, efficiency was very good and the yield was the highest.

The earlier or the later the application moment of the treatment, compared to this optimal period, the less effect was obtained as regards weed control and the less yield was harvested.

INTRODUCTION

In Romania, in the past 10 years, due to the lack of financial resources, these research works, although very important for the agricultural practice, were less approached. The fact that Romania has become a member of the European Community was the reason why sorts, hybrids and even technologies were adopted without a prior and thorough research. In our country are used today varieties from all over the world (especially Europe and USA, but also from Asia and Australia) and this leads to massive yield reductions due to the lack of adaptability to the local conditions. Well known are the severe droughts from the past years that led to low wheat yields. Not the last factor that contributed to diminished yields was the

improper usage of herbicides (sometimes too early, other times too late) or the miss choice from the range of herbicides on the market.

These are the reasons for which we consider this research issue very important, the conclusions should establish the best period of herbicide treatment for the winter wheat crops in order to get the maximum for the weed control, and the maximum of yield. The farmers should also become more familiar to the proper usage of herbicides, should understand the risks of early or late applications of the treatments.

MATERIAL AND METHODS

The trial field was organized in the fields of the Faculty of Agriculture from Moara Domneasca between 2008-2009, on a brown-reddish soil, with a pH value of 6.4 and a organic material content of 2.6%.

Five herbicides were tested:

- Dicopur D (600 g/l 2.4 D) dosage 1 litre/ha;
- Dicopur Top (344 g/l 2.4 D+120 g/l dicamba) dosage 1 litre/ha;
- Buctril universal (280 g/l bromoxinil + 280 g/l ester 2,4D) dosage 1 litre/ha;
- Mustang (6.25 g/l florasulam + 300 g /l acid 2.4 D) dosage 0.5 litre/ha;
- Kingstar 75 WG (tribenuron methyl 75%) dosage 0.020 kg/ha.

These dosages were the ones used for the registration of these herbicides in Romania.

There were made four treatments in four different stages of development of the wheat plants (Zadoks et al and Keller et. Baggiolini scale, Figure 1):

- the first application was made during the tillering period (stage D-F), the weeds were undeveloped, with 2-3 leaves, some of the weeds were in different stages of emerging;
- the second application was made at the end of the tillering and formation of the first inter-node (stage F-H), all the weeds are emerged and have 4-6 leaves and are 2-4cm high, it is considered the optimal period;
- the third application was made at the stage of 2-3 internodes (stage H-J) and the weeds were 10-14 cm high;
- the fourth application was made at the stage of buds, before emerging of the flag (stage J-L) and the weeds were 25-30 cm high or more.

The trial field was organized by the divided patches method in four replications, the area of the plot being 10 square meters. The quantity of water used for the tests was 250 litres.

Measurements regarding the selectivity of the wheat plants and the efficiency on weeds using the EWRS scale (European Weeds Research Society-Table 1).

Table 1

EWRS Scale used for measurement of efficacy and selectivity of herbicides

EWRS NOTES	Efficacy on weeds	EWRS NOTES	Selectivity on wheat
1	Destroyed weeds 98-100%	1	Wheat plants destroyed 1-2%
2	Destroyed weeds 80-95%	2	Wheat plants destroyed 5-15%
3	Destroyed weeds 75%	3	Wheat plants destroyed 25-30%
4	Destroyed weeds 50%	4	Wheat plants destroyed 30-40%
5	Destroyed weeds 30-50%	5	Wheat plants destroyed 40-60%
6	Destroyed weeds 20-25%	6	Wheat plants destroyed 60-70%
7	Destroyed weeds 15-20%	7	Wheat plants destroyed 70-80%
8	Destroyed weeds 5-10%	8	Wheat plants destroyed 80-95%
9	All species of weeds developed resistance	9	Wheat plants destroyed 100%

Measurements were made before harvesting regarding the infestation with weeds by weighting the dried plants.

Measurements were made for plant density on square meter, number of ears, number of spikes in ear, number of kernels in ear, number of thin beans in ear, MMB and yield per ha.

All the experiments were evenly fertilized with complex fertilizers that provided a balanced nutrients support for the plants and diseases and pests were fought against with the same products.

As regards the climate for the period 2008-2009, the weather was favorable for wheat cultures. The lack of rainfall in autumn determined an unevenly emerge of the wheat plants, but the situation was compensated in spring due to the sufficient rainfalls.

The variety cultivated was Boema, produced by Fundulea Insitute.

RESULTS AND DISCUSSION

The level of infestation with weeds species in the experiment was a normal one and the dominating weeds were the following (Table 2).

Table 2**Species of weeds registered in the trial field of Moara Domneasca in 2008-2009**

Annual dicotyledonous			Perennial weeds		
No.	Species	Number /m ²	No.	Species	Number /m ²
1	Stellaria media	14.0	1	Cirsium arvense	5
2	Sinapis arvensis	10.0	2	Convolvulus arvense	5
3	Fumaria sleicleri	10.0	3	Sonchus arvense	4
4	Galium aparine	8.0	4	Polygonum aviculare	4
5	Polygonum convolvulus	7.0			
6	Capsela bursa pastoris	5.0			
7	Chenopodium album	5.0			
8	Thlaspi arvense	2.0			
9	Papaver rhoeas	1.5			
10	Veronica hederifolia	8.0			
	Total	10 species		Total	4 species

The results obtained in weed control are shown in Table 3. The analysis of these results emphasizes the fact that the best effect on weed control is obtained for the second period of the application that corresponds to the phase when the weeds reach their full growth (four leaves stage) and also the wheat plants reach their full growth. The application made in the first period when the wheat plants are tillering and the weeds were not entirely emerged reduced the weed control compared to the second period or a new infestation with weeds took place after the application.

The applications made in the third and fourth period reduced even more the weed control due to the development of the weeds far over 15-40 cm high, their foliar mass being consistent. Among the products, the best results in weed control were obtained for the second application with Dicopur Top (more than 96%) and Kingstar (more than 98%) followed by Mustang (95%) and Bucril Universal (95%). A less effective product was Dicopur D based on 2.4 D, as the low efficacy for certain species of weeds as Convolvulus avense, Galium aparine, Veronica hederifolia and Papaver rhoeas is known.

As regards the selectivity of the herbicides for the wheat plants, the reduced effect was registered for the second application (Table 3). Herbicides like Dicopur D, Dicopur Top and Mustang affected the wheat plants especially on the third and fourth application; the number of ears, MMB and the number of thin beans emphasize this conclusion. It is known the fact that herbicides based on 2.4 D and Dicamba applied later than the beginning of stem forming lead to pollen sterility.

As regards the effects of different herbicides on productivity, they are shown in Table 4.

Table 3

Influence of application period and type of herbicides on weed control for winter wheat Boema (Moara Domneasca; 2008-2009)

Herbicides	Dosage (l, kg/ha)	Weed control			
		EWRS NOTES	Weight of weeds (kg/ha)	Weed control (%)	Selectivity (EWRS) NOTES
First application – beginning of tillering					
Untreated	STANDARD	8.0	2351	MT	MT
Dicopur D	1.0	2.5	796	66	1.1
Dicopur Top	1.0	1.5	278	90	1.1
Buctril Univ.	0.8	1.7	410	83	1.0
Mustang	0.5	2.0	311	87	1.0
Kingstar 75	0.02	1.0	215	91	1.0
Second application – end tillering and first inter-node (considered optimal stages)					
Untreated	MT	0	2411	MT	MT
Dicopur D	1.0	2.0	510	84	1.6
Dicopur Top	1.0	1.5	105	96	1.1
Buctril Univ	0.8	1.0	215	95	1.0
Mustang	0.5	1.0	210	95	1.0
Kingstar 75	0.02	1.0	100	98	1.0
Third application – 2-3 inter-nodes					
Untreated	MT	9.0	2451	MT	MT
Dicopur D	1.0	3.0	1002	70	2.0
Dicopur Top	1.0	1.5	471	89	2.5
Buctril Univ	0.8	2.0	510	79	1.5
Mustang	0.5	2.0	670	76	2.0
Kingstar 75	0.02	1.5	310	89	1.5
Fourth application – bud stage (before appears the flag leaf)					
Untreated	MT	8.0	2456	MT	MT
Dicopur D	1.0	3.5	1040	68	2.8
Dicopur Top	1.0	1.5	650	74	3.5
Buctril Univ	0.8	2.5	615	75	2.5
Mustang	0.5	2.0	710	71	3.0
Kingstar 75	0.02	1.5	501	80	1.5

Table 4

Influence of different periods of application and different herbicides on some productivity elements for winter wheat cultures - Boema (Moara Domneasca 2008-2009)

Herbicides	Dosa ge (kg, l/ha)	Number of ear/-s	Number of sterile ears	Number of beans/ ear	No. of thin beans in ears	Weigh of kernel in ear (gr)	Density (Pls/m ²)	MMB (gr)
First application – Beginning of tillering								
Untreated	MT	18.9	1.0	52	8	1.56	510	49.5
Dicopur D	1.0	17.9	2.8	49	9	1.53	508	47.2
Dicopur Top	1.0	18.1	3.2	49	10	1.38	509	46.2
Buctril Univ	0.8	18.2	2.4	50	6	1.51	512	47.9
Mustang	0.5	18.1	3.4	52	4	1.57	519	48.0
Kingstar 75	0.02	18.1	2.7	53	2	1.58	549	49.15
Second application – End of tillering, first inter-node								
Untreated	MT	18.9	1.0	50	6	1.53	508	49.9
Dicopur D	1.0	18.7	2.8	51	8	1.58	511	50.3
Dicopur Top	1.0	18.5	3.5	50	8	1.49	509	49.8
Buctril Univ	0.8	18.9	2.0	52	3	1.57	510	50.1
Mustang	0.5	18.6	1.5	53	4	1.51	511	50.4
Kingstar 75	0.02	18.5	2.0	53	3	1.53	515	50.7
Third application – 2-3 inter-nodes								
Untreated	MT	18.1	1.8	52	5	1.48	511	47.7
Dicopur D	1.0	18.4	6.5	43	8	1.15	510	40.2
Dicopur top	1.0	18.3	6.5	40	11	1.01	509	39.5
Buctril Univ	0.8	18.2	2.7	49	4	1.38	501	46.9
Mustang	0.5	18.1	3.5	46	5	1.30	508	45.7
Kingstar 75	0.02	18.4	3.1	49	6	1.39	507	46.9
Fourth application – bud stage								
Untreated	MT	18.5	1.8	51	5	1.49	510	47.1
Dicopur D	1.0	18.6	4.9	38	10	0.86	507	34.2
Dicopur top	1.0	18.5	9.5	30	16	0.76	506	30.2
Buctril Univ	0.8	18.4	3.8	45	7	1.28	511	41.5
Mustang	0.5	18.1	5.7	39	11	1.20	504	40.9
Kingstar 75	0.02	18.2	4.3	40	8	1.30	501	45.8

Table 5

Influence of different periods of treatment and type of herbicides on Boema winter wheat yield – trial field (Moara Domneasca 2008-2009)

Herbicides	Dose (l, kg/ha)	Yield			
		kg/ha	%	Difference (kg/ha)	Significance
First application – beginning of tillering					
Untreated	MT	2750	MT	MT	-
Dicopur D	1.0	3210	117	460	***
Dicopur Top	1.0	3220	117	470	***
Buctril Univ	0.8	3150	115	400	**
Mustang	0.5	3250	118	500	***
Kingstar 75	0.02	3300	120	550	***
Second application – end of tillering, first inter-node					
Untreated	MT	2796	MT	MT	-
Dicopur D	1.0	3220	115	424	***
Dicopur Top	1.0	3415	122	619	***
Buctril Univ	0.8	3400	122	604	***
Mustang	0.5	3390	121	594	***
Kingstar 75	0.02	3450	123	654	***
Third application – 2, 3 inter-nodes					
Untreated	MT	2786	MT	MT	-
Dicopur D	1.0	2605	94	-181	
Dicopur Top	1.0	2590	93	-196	
Buctril Univ	0.8	3157	113	371	**
Mustang	0.5	2560	103	162	
Kingstar 75	0.02	3296	118	510	***
Fourth application – bud stage					
Untreated	MT	2730	MT	MT	-
Dicopur D	1.0	2400	88	-330	00
Dicopur Top	1.0	2398	87	-332	00
Buctril Univ	0.8	2780	102	50	
Mustang	0.5	2490	98	-240	
Kingstar 75	0.02	3008	110	278	

LSD5% = 286 kg/ha

LSD1% = 310 kg/ha

LSD0.1% = 415 kg/ha

The analyses of the results lead to the following conclusion:

Applied in the second period all the herbicides have the best effect on weeds and the wheat plants are less affected, thus being formed the most ears, the highest number of beans in ear, the highest density, the lowest number of thin beans and a very good MMB.

The earlier or the later we apply the treatment with respect to this second period, the effect is a negative one for all elements of productivity, especially for the herbicides Dicopur D, Mustang and Buctril Universal.

The high number of thin beans obtained for the third and fourth periods for Dicopur D (8-10), Dicopur Top (8-15), Mustang (4-11) reveal the fact that for these herbicides and for these periods the process of floral organs genesis takes place and, the pollen becomes sterile. Also the weeds have a long period for growth and they severely compete with the wheat plants for nutrients, water and vegetation factors.

The results regarding the influence of herbicides applied in different periods to the beans yield are shown in Table 5.

It is very clear, analysing the results, that the best yield is obtained when herbicides were applied in the second period. Applied later, the treatment leads to the decrease of the yield, especially for Dicopur D (-181 kg/ha for the third period and -330 kg/ha for the fourth period); Dicopur Top (-196 kg/ha for the third period and -332 kg/ha for the fourth period) and Mustang (-240 kg/ha for the fourth period). The analysis of the results displayed in figure no. 5 shows the fact that the product based on Tribenuron methyl can be applied until the fourth period with no effect on the yield, but it is not advisable to wait until this period as weeds compete for the nutrients and water with the wheat plants.

CONCLUSIONS

The results obtained after the application of herbicides in different periods led to the following:

1. When herbicides were applied in the second period, all the herbicides had the best effect in weed control and the best selectivity (tolerance) for the wheat plants;
2. The highest yields were obtained when herbicides were applied in the second period (end of tillering-forming of the first inter-node). The application made later, until the bud stage led to big losses of yield and had negative effect on productivity factors;
3. The herbicides that contain 2,4 D, dicamba or esters of these chemicals can be applied only in the second period (end of tillering - forming of the first inter-node). After this period, some other products based on other active substances must be used – for example Tribenuron methyl;
4. That does not affect the yield and the productivity elements.

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