Turkish Journal of Agricultural and Natural Sciences
Special Issue: 1, 2014

TÜRK
TARIM ve DOĞA BİLİMLERİ
DERGİSİ

TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

www.turkjans.com

Effectiveness and Selectivity of the Herbicide *Diflufenikan in Common Bean*

Maya DIMITROVA*, Dotchka DIMOVA, Diana SVETLEVA, Tonya GEORGIEVA, Ivan POPOV

Agricultural University – Plovdiv
12 „Mendeleev" str, 4000 Plovdiv, Bulgaria
*Corresponding author: mayadimitrova30@yahoo.com

Abstract

During the period from 2006 to 2008 we conducted a number of experiments at the experimental base of the Agricultural University – Plovdiv in order to establish the effectiveness and selectivity of the new herbicide *diflufenikan* (trade name – Pelikan 50 CK). The prevailing types of weeds in the experimental fields were annual late-spring weeds. The herbicide preparation was selective for common bean Bulgarian cultivar Plovdiv 15 (grade 1 on the scale of EWRS) in doses of 200, 250 and 300 ml/ha. The effect of the herbicide on the annual dicotyledonous weeds was the greatest for the variant Pelikan 50 CK – 300 ml/ha and during the three years of the experiment it reached 90-94% compared to the control K1 and when doses of 200 and 250 ml/ha were applied, the effectiveness reached 82%-84% respectively. In 2007 the effect of the herbicide was the lowest due to the severe drought in April and the high density of the annual gramineous weeds was not affected by application of the herbicide.

Key words: *diflufenikan*, effectiveness, herbicide, *Phaseolus vulgaris* L., selectivity

Introduction

Today pesticides are used in large scale and are considered an important part in modern systems for growing of crops, mainly due to the direct benefits - primarily economic, that they created for the benefit of farmers. Pesticides are used to boost the yield, they make production more profitable and the deliveries - more secure. Among the most commonly used types are: insecticides - to combat insects, herbicides - to fight the weeds, fungicides - to combat yeast, fungus, mildew and others.

Pesticides affect fundamental processes in living organisms and can cause adverse effects on non-target organisms, human health and the environment. Despite the existing regulatory framework, undesirable amounts of certain pesticides can be found in the environment, especially in soil, air and water, as well as in food products (so-called "pesticide residues"). Recent scientific discoveries show that some pesticides, even in very small amounts, are able to impair the functioning of the endocrine system.

White bean is not a strong competitor with weeds, and weed interference can result in large yield losses in the crop (Malik et al. 1993; Chikoye et al., 1995). Weeds also interfere with harvest efficiency and may stain white bean, resulting in reduced market value (Burnside et al., 1998; Bauer et al., 1995; Urwin et al., 1996). Therefore, weed management is very important for profitable white bean production.

Several herbicides commonly used in dry bean (Phaseolus vulgaris) production have been reported by growers and other researchers to be phytotoxic to adzuki bean (Powell et al., 2004). Sikkema et al., 2006 found that dimethenamid caused up to 37% visual injury and reduced plant height, shoot dry weight and yield 27, 59 and 52%, respectively. S-metolachlor caused up to 34% visual injury and reduced plant height, shoot dry weight and yield 27, 48 and 48%, respectively. Clomazone caused 53% visual injury and reduced plant height, shoot dry weight and yield 47, 84 and 78%, respectively. Imazethapyr caused up to 6% visual injury; however, this injury was transient with no adverse effect on plant height, shoot dry weight, seed moisture content and yield of adzuki bean. Based on these results, dimethenamid, S-metolachlor and clomazone applied pre-emergence (PRE) do not have an adequate margin of crop safety for use in adzuki bean at the doses evaluated. However, imazethapyr applied PRE has an adequate margin of crop safety for weed management in adzuki bean production in Ontario at the doses evaluated.

Bentazon applied once or twice (to simulate a spray overlap in the field) at 840 g ai/ha and imazethapyr applied at 37,5 g/ha caused minimal injury (6% or less) in pinto and SRM bean and had no adverse effect on plant height, shoot dry weight, seed moisture content, and yield. Imazethapyr applied twice at 37,5 and all single and repeat applications containing 75 or 150 g/ha caused 15 to 44% injury to dry bean. These injuries were persistent and reduced plant height by as much as 21% and shoot dry weight by as much as 34%, but caused no adverse effect on maturity and yield, except for imazethapyr applied twice at 150 g/ha, which delayed maturity and reduced yield 16% (Soltani et al. 2008).

The aim of this study was to investigate the effect of the action of herbicide *diflufenikan* (trade name - Pelican 50 CC) on some biological traits in Bulgarian common bean variety Plovdiv 15 M.

Materials and Methods

Three-year trials (2006-2008) with Bulgarian common bean cultivar Plovdiv 15 M were conducted. Sowing was carried out during the period April 10 to 15, and attempts were down by the block method in four replicates. Fighting on weeds was carried out with soil herbicide *diflufenikan* (trade name – Pelikan 50 CK) by the following schedule:

1. Control (K1) - untreated and not trenced area;
2. Industrial control (K2) - untreated area with 2-3 hoeing;
3. *Diflufenikan* - 200 ml / ha;
4. *Diflufenikan* - 250 ml / ha;
5. *Diflufenikan* - 300 ml / ha.

Herbicide was imported after sowing before germination of the crop. This treatment was done with a knapsack sprayer with a working solution 300-400 l/ha. The efficiency of herbicides was studied under the conditions of natural weeding, taking into account the composition of the weeds and their density. The selectivity of the preparations was evaluated on the grounds of the 9-point scale of EWRS (point 1 - no damages on the crops, point 9 - the crops have been completely damaged).

Obtained data were analyzed in terms of the condition that the more variable was the trait, greater power of his influence in the total genotypic variability, was. ANOVA, Principal Component Analysis (Philippeau, 1990).

Results and Discussion

The herbicide *diflufenikan* is a selective, soil and leaf herbicide. It inhibits the synthesis of carotenoids. It is mainly absorbed by the germs and among the sensitive types severe chlorosis occurs followed by necrosis and death of the plants.

During the period from 2006 to 2008, we studied the selectivity of the herbicide *diflufenikan* in

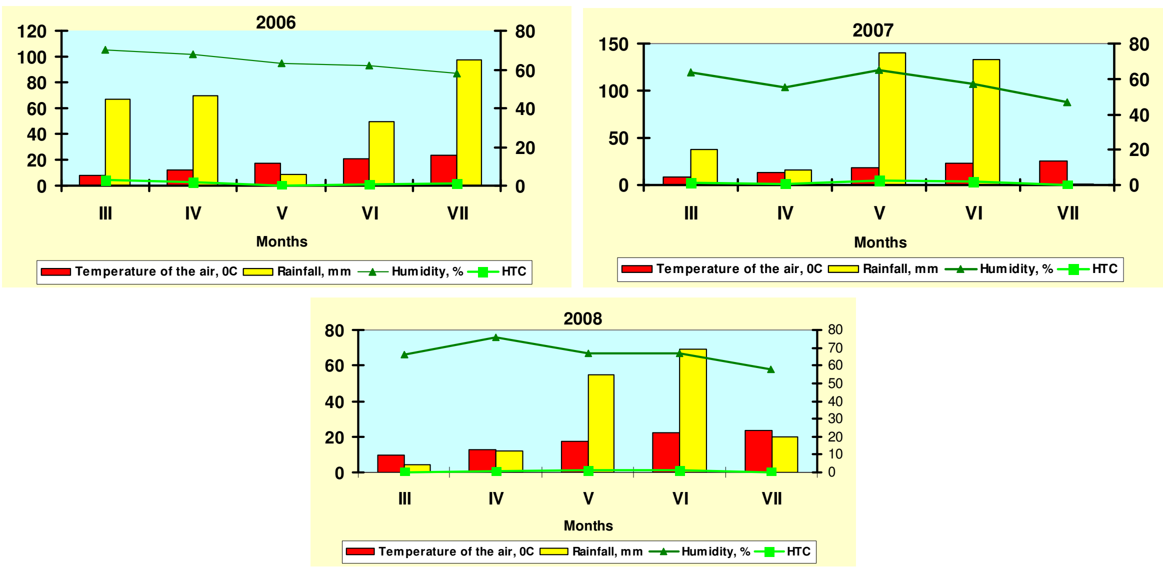

Figure 1. Meteorological elements in the period 2006-2008

doses of 200, 250 and 300 ml/ha in Bulgarian common bean cultivar Plovdiv 15M and registered it on the grounds of the EWRS scale (for grade 1 – there were no damages on the cultivated plants, for grade 9 – the plant was totally damaged). On the 3rd, the 7th and the 20th days after the treatment, we discovered no signs of phytotoxicity of the beans – grade 1 of the EWRS scale. Later, by the end of the vegetation, no phytotoxicity was detected despite the various weather conditions during the years.

The effectiveness of the herbicide on the 20th, the 45th and the 60th days after its application during the years has been shown in tables 1, 2 and 3. The rainfall up to the 45th day after the application of the preparation is extremely important for its effect on the soil (Figure 1).

In 2006, May and June were very dry – the total quantity of the rainfall was 58,4 mm compared to the average quantity for these months over the years – 128 mm (figure 1). The highest density during the 1st registering of the control sample was that of *Chenopodium album* L. – 15 plants/m^2, *Xanthium strumarium* L., *Amaranthus retroflexus* L. and *Abutilon theophrasti* L. – 11 plants/m^2 (Table 1). The density of these kinds increased during the 2nd and the 3rd registering. It reached 18 plants/m^2 for *Amaranthus retroflexus* L., for *Chenopodium album* L. it was 21 plants/m^2 and for *Xanthium strumarium* L. and *Abutilon theophrasti* L. it was 15 and 19 plants/m^2 respectively. The other types of weeds like *Datura stramonium* L. and *Solanum nigrum* L. have lower density. The density of *Echinochloa crus-galli* L. also increased and reached 10 plants/m^2 in the control sample. The effect of the herbicide *diflufenikan* on the existing annual plants during the 1st registering is the highest in a dose of 300 ml/ha – 84% in the control sample, followed by variant 4 (a dose of 250 ml/ha) – 75% and the variant with the lowest dose (a dose of 200 ml/ha) – 76%. During the second registering on the 45th day after the application, the effect of the herbicide decreased in all three doses and varied from 76% to 56%. The rainfall during that period of time, like the previous one, was light and this explained the similar herbicide effect of the separate variants.

In July there was a significant quantity of rainfall which extended and enhanced the soil effect of the herbicide (97,3 mm). During the third registering (on the 60th day), the effectiveness of *diflufenikan* varied from 42% to 58%.

In 2007 there was significant drought and in April the quantity of the rainfall was 15,3 mm but during the following two months, which are crucial for the soil effect of the herbicide, the total quantity of rainfall was 272,7 mm (Figure 1).

During the 1st registering (17.05.2007) the density of the weeds was not very high owing to the drought – 34 plants/m^2 in the control sample. The effect of the herbicide was the greatest in variant 5 – 74% and *diflufenikan* in a dose of 250 ml/ha controls the annual weeds – 59% and in a dose of 200 ml/ha – 53% (Table 2). In 2007 the highest density was registered for *Amaranthus retroflexus* L.- 12 plants/m^2, *Abutilon theophrasti* L. –10 plants/m^2 and *Xanthium strumarium* L. – 8 plants/m^2. On the 45th day after the application of the herbicide - at the end of May, the situation was completely different because there was 139,9 mm of rainfall. The density of the annual weeds increased and in the control sample it reached 133 plants/m^2. The effect of the herbicide was unsatisfactory and varied from 39% to 46%. This can be explained considering the fact *diflufenikan* does not control annual wheat weeds (in this case *Echinochloa crus-galli* L., which shows high density in all the treated variants – from 20 to 23 plants/m^2) and has a weaker effect on the kinds *Abutilon theophrasti* L., *Datura stramonium* L. and Amaranthus *retroflexus* L.

During the 3rd registering, owing to the large quantity of the rainfall, the density of the weeds increased and reached 189 plants/m^2 in the control sample. The effect of the herbicide varied from 52% to 66%. There is no significant difference regarding the effectiveness of the herbicide in the doses of 250 and 300 ml/ha. Considering the fact that *diflufenikan* does not control perennial weeds, so far we have been discussing only the effect it has on the annual kinds. The polycarp kinds found in the experimental areas are *Sorghum halepense* L., *Convolvulus arvensis* L., *Cirsium arvense* L. and *Cynodon dactylon* L., whose density is different during the years (2006 – up to 11 plants/m^2, 2007 – up to 42 plants/m^2 and 2008 – up to 144 plants/m^2).

The year 2008 was warm and extremely dry during July, August and September. However, in the beginning of the vegetation period (May and June) there was 123,7 mm of rainfall, which is close to the values obtained over the years (128 mm), (Figure 1). The effect of the herbicide in the three tested doses as well as the composition of the weeds are similar to those during the first two years but are higher and vary from 71% to 86% during the 1st registering and from 67% to 72% during the 3rd registering (Table 3).

In Table 4 we have presented the results from the conducted dispersion analyses for the three years of the survey. We assessed the demonstrability of the differences between the tested variants and the control sample and also the field samples regarding the average number of the annual weeds – plants/m^2. Thus, we established the effectiveness of the herbicide *diflufenikan* in common bean cultivar Plovdiv 15 M. During the three years – 2006, 2007 and 2008, the biggest average number of weeds was registered in the control sample, respectively 67,3 plants/m^2, 118,7 plants/m^2 and 62,2 plants. In 2006 the variant that ranked second in terms of number of weeds was variant 3 – *diflufenikan* 200 ml/ha. The

Table 1. Effectiveness of the herbicide *diflufenikan* in common bean, cultivar Plovdiv 15 M, 2006

Variants	Annual weeds in plants/m^2							Total annual	
	Xanthium strumarium L.	*Chenopodium album L.*	*Datura stramonium L.*	*Solanum nigrum L.*	*Amaranthus retroflexus L.*	*Abutilon theophrasti L.*	*Echinochloa crus- galli L.*	plants/m^2	%
I registering – 03.06.									
1	11	15	1	1	11	6	0	45	100
2	3	4	8	7	1	7	0	30	66,6
3	1	7	1	0	0	6	0	15	33,3
4	0	1	2	1	1	6	0	11	24,0
5	0	0	2	1	0	4	0	7	16,0
II registering – 23.06.									
1	11	18	1	2	11	19	9	71	100
2	0	3	2	1	1	5	5	17	23,9
3	5	7	4	1	1	6	7	31	43,7
4	3	5	3	1	1	4	6	23	32,4
5	2	3	2	1	0	3	6	17	24.0
III registering – 17.07.									
1	15	21	1	2	18	19	10	86	100
2	3	1	4	2	2	6	8	26	30,2
3	10	9	5	2	7	8	9	50	58,1
4	7	9	4	1	5	6	8	40	46,5
5	6	8	3	1	5	6	7	36	41,9

Table 2. Effectiveness of the herbicide *diflufenikan* in common bean, cultivar Plovdiv 15 M, 2007

Variants	**Annual weeds in plants/m²**							**Total annual**	
	Xanthium strumarium L.	***Chenopodium album L.***	***Datura stramonium L.***	***Solanum nigrum L.***	***Amaranthus retroflexus L.***	***Abutilon theophrasti L.***	***Echinochloa crus- galli L.***	**plants/m²**	**%**
I registering – 17.05.									
1	8	2	0	2	12	10	0	34	100
2	2	0	3	1	9	9	0	24	70,5
3	1	0	1	1	6	7	0	16	47,0
4	1	0	3	1	2	7	0	14	41,1
5	0	0	0	1	3	5	0	9	26,4
II registering – 28.05.									
1	9	6	10	6	35	41	26	133	100
2	3	4	5	1	31	19	21	84	63,1
3	4	2	8	1	25	18	23	81	60,9
4	2	1	6	0	26	17	21	73	54,8
5	2	2	6	1	23	18	20	72	54,1
III registering – 11.06.									
1	14	7	12	44	38	46	28	189	100
2	6	0	11	25	17	8	14	81	42,8
3	6	6	11	17	28	19	23	110	58,2
4	4	3	6	13	26	18	21	91	48,1
5	5	3	6	14	23	17	21	89	47,1

Table 3. Effectiveness of the herbicide *diflufenikan* in common bean, cultivar Plovdiv 15 M, 2008

Variants	**Annual weeds in plants/m^2**								**Totla annual**	
	Xanthium strumarium L.	***Chenopodium album L.***	***Datura stramoniumL.***	***Solanum nigrum L.***	***Amaranthus retroflexus L.***	***Abutilon theophrasti L.***	***Echinochloa crus- galli L.***	***Lactuca serriola L.***	**plants/ m^2**	**%**
I registering – 26.05.										
1	2,8	5,8	2,5	7,5	18,3	4,3	2,4	4.0	47.6	100
2	3,3	4,6	2,1	4,7	12,7	3,6	,35	5.0	39.6	83.1
3	2,0	1,6	0,8	0,7	2,1	2,4	2,0	2.0	13.6	28.5
4	1,7	0,6	0,5	0,1	0,1	2,0	2,4	1.5	8.9	18.6
5	1,1	0,3	0,5	0	0	1,6	2,0	1.0	6.5	13.6
II registering –12.06.										
1	4,2	9,6	3,0	9,0	20,8	4,9	8,5	4.5	64.5	100
2	1,8	2,5	1,0	1,1	3,5	1,2	4,3	1.4	16.8	26.0
3	2,2	2,7	1,8	1,2	2,4	3,0	2,0	2.2	17.5	27.1
4	2,0	1,6	1,4	0,8	1,1	2,3	2,5	2.3	14.0	21.7
5	1,6	0,7	1,1	0,7	0,9	2,0	2,1	1.9	11.0	17.0
III registering – 23.06.										
1	6,3	10,5	3,7	9,5	22,5	5,9	9,4	6.6	74.4	100
2	2,2	2,0	1,5	3,3	4,2	1,8	2,8	1.8	19.6	26.3
3	3,0	3,5	2,6	1,8	2,9	3,8	2,9	4.0	24.5	65.8
4	2,9	2,9	2,6	1,5	2,5	4,1	2,9	3.8	23.2	31.1
5	2,3	1,8	2,5	1,4	2,8	3,9	2,7	3.3	20.7	27.8

Table 4. Effectiveness of the herbicide *diflufenikan* in common bean regarding annual weeds (plants/m^2)

2006				**2007**				**2008**			
Variants	$\bar{x}$	**Difference compared to variant 1**	**Difference compared to variant 2**	**Variants**	$\bar{x}$	**Difference compared to variant 1**	**Difference compared to variant 2**	**Variants**	$\bar{x}$	**Difference compared to variant 1**	**Difference compared to variant 2**
1	67,3	-	43^{+++}	**1**	118,67	-	$55,67^{++}$	**1**	62.17	-	36.87^{++}
3	27.3	-40^{--}	3^{ns}	**3**	69	$-49,67^{-}$	6^{ns}	**2**	25.3	-36.87^{--}	-
4	25.3	-42^{---}	1^{ns}	**2**	63	$-55,67^{--}$	-	**3**	18.5	-43.67^{---}	$-6,8^{ns}$
2	24.3	-43^{---}	-	**4**	59,3	$-59,37^{--}$	$-3,7^{ns}$	**4**	15.4	-46.77^{---}	-9.9^{ns}
5	15.3	-52^{---}	$- 9^{ns}$	**5**	57,3	$-61,37^{--}$	$-5,7^{ns}$	**5**	12.7	-49.47^{---}	-12.6^{ns}
GD $_{P5\%}$ =18,9 GD $_{P1\%}$ =27,5 GD $_{P0,1\%}$ =41,3				**GD $_{P5\%}$ =35,0 GD $_{P1\%}$ =51,6 GD $_{P0,1\%}$ =77,4**				**GD $_{P5\%}$ =17,7 GD $_{P1\%}$ =25,7 GD $_{P0,1\%}$ =38,5**			

lowest density of weeds was established after applying a dose of 300 ml/ha of the herbicide. All the variants have been proven ($P_{1\%}$ and $P_{0,1\%}$) to have lower density of weeds compared to the control sample. When comparing the effect of the herbicide on the field sample (variant 2), we can see that in the untreated and non-weeded variants the number of weeds is higher ($P_{0,1\%}$). There is no significant difference between the treated variants. Although the values of the registered weeding in 2007 and 2008 are different, the general trend for demonstrability of the differences between the two samples is identical.

Conclusion

In the experimental areas with common bean during the period from 2006 to 2008, the predominant kinds of weeds belong to the group of annual late-spring weeds - *Xanthium strumarium* L., *Chenopodium album* L., *Datura stramonium* L., *Solanum nigrum* L., *Amaranthus retroflexus* L., *Abutilon theophrasti* L., *Echinochloa crus-galli* L., *Lactuca serriola* L. *Sorghum halepense* L., *Convolvulus arvensis* L., *Cirsium arvense* L. and *Cynodon dactylon* L. have the highest density among polycarp kinds.

The herbicide Pelikan 50 CK (50% *diflufenikan*) is selective for the common bean Bulgarian cultivar Plovdiv 15 M. Its effect on annual dicotyledonous weeds, which are dominant among the plants, in doses of 250 and 300 ml/ha is 88-90% on average for the period of the survey. *Diflufenikan* does not control *Echinochloa crus-galli* L. and its effect on *Abutilon theophrasti.*

References

Allard, R.W., and A.D. Bradshaw, 1964. Implications of Genotype. Environmental Implications in Applied Plant Breeding. Crop. Sci., 503-507.

Bauer, T. A., Renner, K. A., Penner, D. and Kelly, J. D. 1995. Pinto bean (Phaseolus vulgaris) varietal tolerance to imazethapyr. Weed Sci. 43: 417-424.

Burnside, O. C., Wiens, M. J., Krause, N. H., Weisberg, S., Ristau, E. A., Johnson, M. M. and Sheets, R. A. 1998. Mechanical and chemical control systems for kidney bean (Phaseolus vulgaris). Weed Technol. 12: 174_178.

Chikoye, D., Weise, S. F. and Swanton, C. J. 1995. Influence of common ragweed (Ambrosia artemisiifolia) time of emergence and density on white bean (Phaseolus vulgaris). Weed Sci. 43: 375_380.

Dimova, D., B. Bojinov 2002 Application of Cluster Analysis and Principal Component Analysis for evaluation of breeding materials. 50 years Dobrudja Agricultural Institute - Jubilee session "Breeding and Agrotechnology arable crops', 2: 308-312.

Dimova, D., M. Dimitrova, G. Rachovska, 2006 Evaluation by yeilds and stability of promising wheat lines. Studies on field crops, 3 (1): 19-24.

Lubenov, Y. 1987 Integrated systems for combat to weeds. Ed ". Zemizdat" t. 1 p.196-203.

Malik, V. S., Swanton, C. J. and Michaels, T. E. 1993. Interaction of white bean (Phaseolus vulgaris) cultivars, row spacing, and seeding density with annual weeds. Weed Sci. 41: 62 – 68.

Nader Soltani, Robert E. Nurse, Darren E. Robinson, and Peter H. Sikkema, 2008. Response of Pinto and Small Red Mexican Bean to Postemergence Herbicides. Weed Technology: January 2008, Vol. 22, No. 1, pp. 195-199.

Philippeau, G. 1990. In: Principal Component Analyses. How to Use the Results. ITCF, Paris, p. 9.

Powell, G. E, Sprague, C. L. and Renner, K. A. 2004. Adzuki bean: Weed control and production issues. Proc. North Central Weed Sci. Soc. Vol. 59. CD ROM (32)).

Sikkema, P. H., Soltani, N., Shropshire, C. and Robinson, D. E. 2006. Response of adzuki bean to pre-emergence herbicides. Can. J. Plant Sci. 86: 601–604.

Svetleva, D. 2003 Induction of genetic variability and creation of new cultivars of common beans (*Phaseolus vulgaris* L.) by exposure to chemical mutagens. Abstract of dissertation for the award of the degree "Doctor of Agricultural Sciences", Plovdiv.

Urwin, C. P., Wilson, R. G. and Mortensen, D. A. 1996. Responses of dry edible bean (Phaseolus vulgaris) cultivars to four herbicides. Weed Technol. 10: 512_518.

Ward, J.H., 1963 - Hierarchical grouping to optimize ah objective function. Journal of American Statistical Association, 58, pp. 236-244.