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Influence of *Diflufenican* the Herbicide on Some Biological Traits of Bulgarian Common Bean Cultivar Plovdiv 15M

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Abstract

Three-year trials (2006-2008) were conducted in order to determine the influence of the herbicide *diflufenican* (trade name – Pelikan 50 CK) on certain biological traits of Bulgarian common bean cultivar Plovdiv 15 M. The herbicide was applied in the doses of 200, 250 and 300 ml/ha after the sowing and before the growth of the plants. It has been found that the traits related to the height of the plant, number of fruit-yielding branches, pods and seeds, mass of the seeds and average length of 10 pods per plant were influenced by different doses of the herbicide, by the year and the interaction between these two factors. A 300 ml/ha dose treatment differs most from other variants in the conducted clustering as a result of its strong influence on the traits: number of seeds, fruit-yielding branches and mass of the seeds per plant. The highest stability indices have been obtained for the traits related to the mass of the pods per plant, which showed greater stability regarding the treatment with the herbicide.

Key words: biological traits, diflufenican, herbicides, *Phaseolus vulgaris* L.

Introduction

Today, pesticides are used at large scale and are considered an important part in modern systems for growing of crops, mainly due to direct benefits - primarily economic that they create 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 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 as 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 by 16% (Soltani et al. 2008).

The aim of this study was to investigate the effect of the action of *diflufenican* herbicide (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 10 to 15 April, and trials were done by the block method in four replicates. Fighting weeds was carried out using soil herbicide *diflufenican* by the following schedule:

A. Control (K1) - untreated and not trenched area;
2. Industrial control (K2) - untreated area with 2-3 hoeing;
3. *Diflufenican* - 200 ml / ha;

4. *Diflufenican* - 250 ml / ha;
5. *Diflufenican* - 300 ml / ha.

The 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 biometrical analysis was performed on 50 plants of each variant after harvesting, on the following parameters: plant height, height of betting on the first pod, number of fruit branches and seeds per plant, mass of pods with seeds, average length of 10 pods.

The data obtained were analysed in terms of the condition that the more variable the trait, the greater the influence was in the total genotypic variability. ANOVA, Principal Component Analysis (Philippeau, 1990) and clustering of variants were performed, depending on the quantitative traits studied (Ward, 1963).

Results and discussion

Results, presented in Table 1 and 2, show that plant height for all the variants was highest in 2006.

No difference in plant height, in both control variants, was found in the three years of the study.

It is noteworthy that in 2006 and 2008 the treatment with the *diflufenican* herbicide in 250 ml/ha dose resulted in increasing plant height in comparison to the controls and treatment with other applied doses of the herbicide. There were no warranted differences in all variants compared to the control (K1).

The height of betting on the first pod was a relatively permanent trait that was not affected much by growing conditions (Svetleva, 2003). In our study, the exception was 2007 when the control (K1) showed relatively lower scores compared to the other variants. It was evident in our study that this trait was not significantly influenced by the application of *diflufenican* .

Traits - mass of plant with pods, number of fruit-yielding branches, pods and seeds per plant as well as mass of seeds per plant were crucial for the formation of the yield (Svetleva, 2003).

Our study showed that the number of fruit-yielding branches remained constant during the three years of investigations. This means that it was not significantly affected by the environmental conditions and treatment with application of the herbicide.

It is noteworthy that the number of seeds per plant varies more than the number of pods per plant. The average length of 10 pods per plant is a conservative trait, which depends more on the genotype of the plants than on the environmental conditions and the herbicide applied.

Tab. 1. Biometrical evaluation of some quantitative traits in common bean cultivar Plovdiv 15 M after application of the herbicide *diflufenican* in the period 2006 – 2008

Biometrijska evaluacija nekih kvantitativnih karakteristika sorte graha Plovdiv 15 M nakon primjene herbicida diflufenikana u periodu od 2006-2008. godine

Year	Variant Trait	K 1	K 2	Herbicide *diflufenican* in doses: 200 ml/ha	250 ml/ha	300 ml/ha
2006	Height of plant, cm	77,87	77,90 $^{n.s.}$	77,02 $^{n.s.}$	87,07 $^{n.s.}$	80,35 $^{n.s.}$
2007		68,85	68,72 $^{n.s.}$	69,42 $^{n.s.}$	70,90 $^{n.s.}$	72,27 $^{n.s.}$
2008		72,92	73,17 $^{n.s.}$	73,22 $^{n.s.}$	79,45 $^{n.s.}$	76,42 $^{n.s.}$
2006 2007 2008	$GD_{5\%}$ = 28,64 $GD_{1\%}$ = 39,60 $GD_{0,1\%}$ = 54,74		$GD_{5\%}$ = 9,67 $GD_{1\%}$ = 13,37 $GD_{0,1\%}$ = 18,49		$GD_{5\%}$ = 16,36 $GD_{1\%}$ = 22,63 $GD_{0,1\%}$ = 31,28	
2006	Height of betting on the first pod, cm	8,17	8,00 $^{n.s.}$	7,57 $^{n.s.}$	7,90 $^{n.s.}$	7,55 $^{n.s.}$
2007		8,55	10,97 $^{++}$	10,55 $^{++}$	9,22 $^{n.s.}$	9,12 $^{n.s.}$
2008		8,20	9,47 $^{+}$	9,10 $^{n.s.}$	8,57 $^{n.s.}$	8,37 $^{n.s.}$
2006 2007 2008	$GD_{5\%}$ = 1,49 $GD_{1\%}$ = 2,06 $GD_{0,1\%}$ = 2,85		$GD_{5\%}$ = 1,32 $GD_{1\%}$ = 1,82 $GD_{0,1\%}$ = 2,52		$GD_{5\%}$ = 1,12 $GD_{1\%}$ = 1,56 $GD_{0,1\%}$ = 2,15	
2006	Mass of plant with pods, g	20,10	24,90 $^{n.s.}$	18,25 $^{n.s.}$	21,35 $^{n.s.}$	17,62 $^{n.s.}$
2007		47,85	66,47 $^{n.s.}$	72,85 $^{+}$	71,77 $^{+}$	64,92 $^{n.s.}$
2008		33,97	43,20 $^{n.s.}$	43,52 $^{n.s.}$	44,12 $^{n.s.}$	46,55 $^{n.s.}$
2006 2007 2008	$GD_{5\%}$ = 16,96 $GD_{1\%}$ = 23,45 $GD_{0,1\%}$ = 32,42		$GD_{5\%}$ = 21,11 $GD_{1\%}$ = 29,20 $GD_{0,1\%}$ = 40,36		$GD_{5\%}$ = 14,27 $GD_{1\%}$ = 19,74 $GD_{0,1\%}$ = 27,28	
2006	Number of fruit-yielding branches	7,25	9,65 $^{n.s.}$	7,47 $^{n.s.}$	9,87 $^{n.s.}$	7,10 $^{n.s.}$
2007		7,37	9,25 $^{n.s.}$	8,80 $^{n.s.}$	7,87 $^{n.s.}$	8,82 $^{n.s.}$
2008		7,30	9,47 $^{n.s.}$	8,10 $^{n.s.}$	8,85 $^{n.s.}$	7,92 $^{n.s.}$
2006 2007 2008	$GD_{5\%}$ = 5,92 $GD_{1\%}$ = 8,19 $GD_{0,1\%}$ = 11,32		$GD_{5\%}$ = 2,70 $GD_{1\%}$ = 3,74 $GD_{0,1\%}$ = 5,17		$GD_{5\%}$ = 3,17 $GD_{1\%}$ = 4,39 $GD_{0,1\%}$ = 6,06	

Note: $GD_{5\%}$ (+), $GD_{1\%}$ (+ +), $GD_{0,1}$ (+ + +), n.s. - less than GD $_{5,0\%}$

With few exceptions, there were not warranted differences between the two controls (K1 and K2) and the application of *diflufenican* herbicide in different doses.

Of the conducted investigations (Tables 1 and 2), it was evaluated that application of the *diflufenican* herbicide at 200, 250, 300 ml/ha doses had no significant influence on the studied biometrical traits of common bean.

Based on the conducted ANOVA analysis (Table 3), it was shown that the height of betting on the first pod and mass of the plant with pods per plant were more strongly influenced by the interaction between variants of treatment and the years of growing. In all other traits: plant height , number of fruit-yielding branches, pods and seeds, mass of seeds per plant and average length per 10 pods were influenced by the application of *diflufenican* herbicide, the year of cultivation and the interaction between these indicators.

Tab. 2. Biometrical evaluation of some quantitative traits in common bean cultivar Plovdiv 15 M after application of the herbicide *diflufenican* in the period 2006 – 2008

Biometrijska evaluacija nekih kvantitativnih karakteristika sorte graha Plovdiv 15 M nakon primjene herbicida diflufenikana u periodu od 2006-2008. godine

Year	Variant / Trait	K 1	K 2	Herbicide *diflufenican* in doses: 200 ml/ha	250 ml/ha	300 ml/ha
2006	Number of pods per plant	10,00	13,35 $^{n.s.}$	10,25 $^{n.s.}$	13,22 $^{n.s.}$	9,82 $^{n.s.}$
2007		11,30	14,55 $^{n.s.}$	13,40 $^{n.s.}$	12,67 $^{n.s.}$	13,77 $^{n.s.}$
2008		10,62	13,92 $^{n.s.}$	11,80 $^{n.s.}$	12,95 $^{n.s.}$	11,77 $^{n.s.}$
2006	$GD_{5\%}$ = 7,96		$GD_{5\%}$ = 4,92		$GD_{5\%}$ = 4,47	
2007	$GD_{1\%}$ = 11,02		$GD_{1\%}$ = 6,80		$GD_{1\%}$ = 6,18	
2008	$GD_{0,1\%}$ = 15,23		$GD_{0,1\%}$ = 9,40		$GD_{0,1\%}$ = 8,55	
2006	Number of seeds per plant	29,82	39,47 $^{n.s.}$	28,90 $^{n.s.}$	35,10 $^{n.s.}$	27,10 $^{n.s.}$
2007		33,87	44,27 $^{n.s.}$	44,27 $^{n.s.}$	38,15 $^{n.s.}$	46,72 $^{n.s.}$
2008		31,85	41,85 $^{n.s.}$	36,57 $^{n.s.}$	36,60 $^{n.s.}$	36,90 $^{n.s.}$
2006	$GD_{5\%}$ = 27,48		$GD_{5\%}$ = 15,21		$GD_{5\%}$ = 16,08	
2007	$GD_{1\%}$ = 38,01		$GD_{1\%}$ = 21,04		$GD_{1\%}$ = 22,24	
2008	$GD_{0,1\%}$ = 52,54		$GD_{0,1\%}$ = 29,08		$GD_{0,1\%}$ = 30,75	
2006	Mass of seeds per plant, g	10,10	15,00 $^{n.s.}$	8,30 $^{n.s.}$	10,20 $^{n.s.}$	10,35 $^{n.s.}$
2007		8,10	9,77 $^{n.s.}$	9,60 $^{n.s.}$	7,92 $^{n.s.}$	11,52 $^{n.s.}$
2008		9,05	12,35 $^{n.s.}$	8,92 $^{n.s.}$	8,30 $^{n.s.}$	10,90 $^{n.s.}$
2006	$GD_{5\%}$ = 12,35		$GD_{5\%}$ = 4,00		$GD_{5\%}$ = 5,75	
2007	$GD_{1\%}$ = 17,09		$GD_{1\%}$ = 5,54		$GD_{1\%}$ = 7,95	
2008	$GD_{0,1\%}$ = 23,62		$GD_{0,1\%}$ = 7,65		$GD_{0,1\%}$ = 10,99	
2006	Average length per 10 pods, cm	8,12	8,15 $^{n.s.}$	7,95 $^{n.s.}$	7,92 $^{n.s.}$	7,95 $^{n.s.}$
2007		7,92	7,90 $^{n.s.}$	7,67 $^{n.s.}$	7,75 $^{n.s.}$	8,20 $^{n.s.}$
2008		8,02	8,00 $^{n.s.}$	7,77 $^{n.s.}$	7,82 $^{n.s.}$	8,07 $^{n.s.}$
2006	$GD_{5\%}$ = 1,23		$GD_{5\%}$ = 0,70		$GD_{5\%}$ = 0,74	
2007	$GD_{1\%}$ = 1,70		$GD_{1\%}$ = 0,97		$GD_{1\%}$ = 1,03	
2008	$GD_{0,1\%}$ = 2,36		$GD_{0,1\%}$ = 1,34		$GD_{0,1\%}$ = 1,42	

Note: $GD_{5\%}$ (+), $GD_{1\%}$ (+ +), $GD_{0,1}$ (+ + +), n.s. - less than $GD_{5,0\%}$

The main objective of any breeding program is the creation of cultivars combining high productive potential and good quality characteristics under different environmental conditions, and resistance to diseases, pests and weeds. Of particular importance are newly created cultivars that have high plasticity and stability, which can be a good indicator for determining future yields and quality (Dimova et al., 2006). As the Allard and Bradshaw (1964) showed cultivars, which manifested good genotypic productivity under different climatic conditions, are characterised by greater general flexibility.

Table 4 presents average values and indices of stability (Ysi) of the eight quantitative traits studied in common bean cultivar Plovdiv 15 M after the application of diflufenican herbicide. Based on the results obtained, it can be seen that the ranking varies by studied trait that shows the influence of different treatments on the manifestation of studied traits.

Tab. 3. Influence of treatment with the herbicide *diflufenikan* and years of common bean cultivar Plovdiv 15 M growing

Uticaj tretiranja herbicidom diflufenikanom i godine uzgoja sorte graha Plovdiv 15 M

Indicators / Variants	Years		Variants		Interaction	
	$F_{exp.}$	F_{table}	$F_{exp.}$	F_{table}	$F_{exp.}$	F_{table}
Height of plant, cm	3,20	2,82	2,57	0,50	2,15	0,07
Height of betting on the first pod, cm	21,43	3,20	3,91	2,57	2,15	1,60
Mass of plant with pods, g	93,65	3,20	3,65	2,57	2,15	1,90
Number of fruit-yielding branches	3,20	0,01	2,57	1,11	2,15	0,28
Number of pods per plant	3,20	1,02	2,57	1,19	2,15	0,19
Number of seeds per plant	3,20	2,38	2,57	0,81	2,15	0,31
Mass of seeds per plant, g	5,11	0,32	3,76	1,01	2,93	0,26
Average length per 10 pods, cm	3,20	0,22	2,57	0,47	2,15	0,12

The highest indices of stability were obtained for the mass of plants with pods, which indicates greater stability of this trait to the treatment with the herbicide, applied in three different doses. The height of the plants showed the highest stability after treatment with the herbicide in doses of 250 and 300 ml/ha, while for the other traits the highest indices of stability were shown in the control variants. The most variable were the mass of a plant with pods and number of seeds per plant.

It is known that the success of any breeding work depends on the selection of parental pairs with good combining ability. It is believed that the use of such parents in hybridisation increases the chances of favourable combining in a genotype of the traits defining their productivity.

To determine the genetic distance of used parental aiming prospective planning of hybridisation, cluster analysis is applied (Ward, 1963). For the selection of future parents, however, it is not sufficient to characterise them only as genetically distant. It is necessary to determine whether they are carriers of complementary traits that could contribute to the greatest extent to raising productivity and/ or quality of the hybrid.

The cluster analysis and principal component analysis can be applied for separation of the genotypes by degree of their genetic proximity and identifying some of the main components determining the critical behaviour of important complex traits such as yield and quality. Too often, however, these two analyses are used alone, thus not making full use of information from them.

Tab. 4. Stability of some quantitative traits in common bean cultivar Plovdiv 15 M after application of the herbicide diflufenikan
Stabilnost nekih kvantitativnih karakteristika sorte graha Plovdiv 15 M nakon primjene herbicida diflufenikana

VARIANTS	Average value of the trait	Ranking of the trait	Correction of the rank	Rank coeffi-cient	Stability Variation	Coeffi-cient of stability	Index of stability (Ysi)
Height of plant, cm							
K1 (control)	72,96	1	- 1	0	- 3,98	0	0
K2 (industrial control)	73,26	3	- 1	2	- 3,40	0	2
Pelikan CK 200 ml/ha	73,23	2	- 1	1	4,24	0	1
Pelikan CK 250 ml/ha	79,14	5	1	6	62,38	- 2	4 +
Pelikan CK 300 ml/ha	76,34	4	1	5	1,00	0	5 +
Height of betting on the first pod, cm							
K1 (control)	8,30	1	- 1	0	3,19	- 4	- 4
K2 (industrial control)	9,48	5	2	7	1,68	- 2	5 +
Pelikan CK 200 ml/ha	9,08	4	1	5	1,73	- 2	3 +
Pelikan CK 250 ml/ha	8,56	3	- 1	2	3,46	0	2 +
Pelikan CK 300 ml/ha	8,34	2	- 1	1	- 0,29	0	1
Mass of plants with pods, g							
K1 (control)	31,23	1	- 2	- 1	295,81	- 2	- 3
K2 (industrial control)	38,04	2	- 1	1	540,62	- 4	- 3
Pelikan CK 200 ml/ha	45,48	5	1	6	178,49	0	6 +
Pelikan CK 250 ml/ha	44,64	4	1	5	- 16,32	0	5 +
Pelikan CK 300 ml/ha	41,44	3	1	4	51,03	0	4 +
Number of fruit-yielding branches							
K1 (control)	7,30	1	- 1	0	- 0,73	0	0
K2 (industrial control)	9,48	5	1	6	- 0,11	0	6 +
Pelikan CK 200 ml/ha	8,12	3	- 1	2	1,62	0	2
Pelikan CK 250 ml/ha	8,85	4	1	5	6,89	- 2	3 +
Pelikan CK 300 ml/ha	7,90	2	- 1	1	3,44	- 2	- 1
Number of pods per plant							
K1 (control)	10,63	1	- 1	0	- 0,61	0	0
K2 (industrial control)	13,94	5	1	6	- 0,42	0	6 +
Pelikan CK 200 ml/ha	11,81	3	- 1	2	1,94	0	2
Pelikan CK 250 ml/ha	12,94	4	1	5	8,23	- 2	3 +
Pelikan CK 300 ml/ha	11,78	2	- 1	1	6,58	- 2	- 1
Number of seeds per plant							
K1 (control)	31,84	1	- 1	0	28,13	0	0
K2 (industrial control)	41,86	5	1	6	15,74	0	6 +
Pelikan CK 200 ml/ha	36,58	3	- 1	2	40,65	0	2
Pelikan CK 250 ml/ha	36,51	2	- 1	1	47,68	0	1
Pelikan CK 300 ml/ha	36,90	4	1	5	155,64	- 2	3 +
Mass of seeds per plant, g							
K1 (control)	9,08	3	- 1	2	- 1,83	0	2 +
K2 (industrial control)	12,38	5	1	6	21,90	- 2	4 +
Pelikan CK 200 ml/ha	8,86	2	- 1	1	11,15	- 2	- 1
Pelikan CK 250 ml/ha	8,80	1	- 1	0	- 0,36	0	0
Pelikan CK 300 ml/ha	10,90	4	1	5	8,40	- 2	3 +
Average length of 10 pods per plant, cm							
K1 (control)	8,02	4	1	5	- 6,02	0	5 +
K2 (industrial control)	8,01	3	1	4	7 ,67	0	0
Pelikan CK 200 ml/ha	7,78	1	- 1	0	2 ,43	0	0
Pelikan CK 250 ml/ha	7,83	2	- 1	1	- 1,33	0	1
Pelikan CK 300 ml/ha	8,07	5	1	6	0,22	- 2	4 +

Joint application of cluster analysis and principal component analysis (Principal Component Analysis - PCA) as complementary methods in the selection process allows to determine what the best combination is between parental couples which would come to obtain results corresponding to the maximum set in the selection program's purposes (Dimova, Bojinov, 2002).

Using cluster analysis, the groups were defined in our investigations, grouping studied variants according to their similarity and distance, taking into account the complex influence of eight quantitative traits analysed in common beans.

The cluster analysis was performed with average data from three years of study.

It is assumed that the various traits that were included in the basis of the cluster analysis with varying severity were involved in the differentiation of the remoteness of different variants. Principal component analysis (PCA) allows determination of varying severity of the traits responsible for separation of different variants in clusters.

Moreover, the higher coefficient of variation of a trait within the investigated group, its power of influence was greater. The principle of the PCA is that if the data includes "n" number of quantitative traits, variants can be presented in maximum in the "n"-dimensional space if all observed traits between them are with a correlation coefficient of zero (Philippeau, 1990). However, since such cases are the exception, rather simple analysis ends with fewer dimensions. Most often new axes are added until they become sufficient to reflect on about 90% of the observed variation in the experience.

In PCA, the first coordinate axis is constructed so that the sum of variance projections of separate traits is to be the greatest. Then the trait with the highest correlation coefficient to this axis will have the biggest share in explaining of the total variation in a population and hence the separation of genotypes in different clusters.

The results of the cluster analysis are shown in Fig. 1. It can be seen that the five variants of treatment were grouped in two cluster groups, treatment with *diflufenican* herbicide in a dose of 300 ml/ha is in a separate cluster group.

Applied alone, the cluster analysis shows the distribution of different variants of treatment and relative distances between them, but does not explain the reasons of obtained clustering.

It was possible to get an idea of the main factors affecting the separation of the variants by application of the principal component analysis (Table 5). In performing this analysis, of the possible eight components corresponding to the studied traits, the analysis was conducted only on the third since the first three components explained 90% of the total variation.

From the eight studied traits, the results of the survey allow to determine those which had most influence on the clustering of the variants. It is noteworthy that the found correlation coefficients of the first component are the highest. Such traits as the number of seeds per plant, mass of the seeds and number of fruit-yielding branches have the highest correlation coefficients with the first principal component; therefore they are with the largest relative weight in the distribution of variants presented in the dendrogram.

Correlation coefficients for the second and third component are significantly lower compared with the first component.

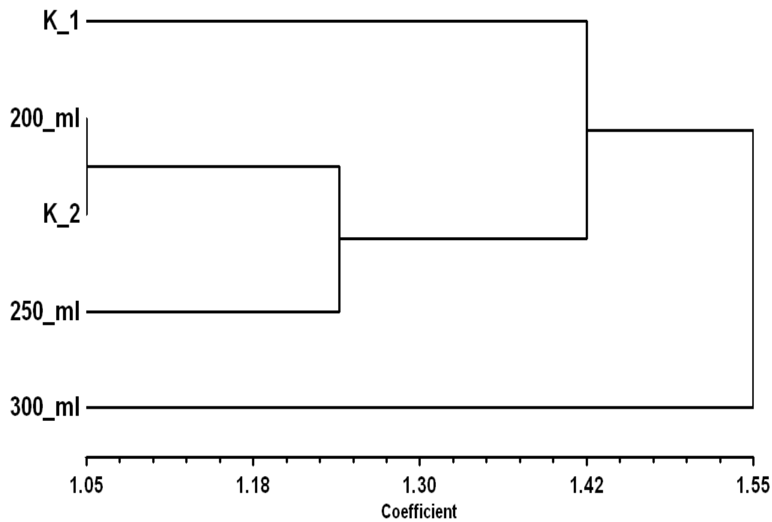

Fig. 1. Clustering of the variants by the Ward method.
Variants: 1) Control (K1), 2) Industrial control (K2),
3) Diflufenican - 200 ml/ha; 4) Diflufenican - 250 ml/ha;
5) Diflufenican - 300 ml/ha.
Klastering varijanti po Ward-ovoj metodi.

Tab. 5. Principal Component Analysis
Analiza glavnih komponenata

TRAITS	Components		
	1	2	3
Variants	0,850	- 0,502	0,087
Height of plant, cm	0,646	0,226	0,728
Mass of plants with pods, g	0,846	- 0,519	0,062
Height of betting on the first pod, cm	0,734	- 0,074	0,675
Number of fruit-yielding branches	0,814	0,459	- 0,166
Number of pods per plant	0,767	0,236	- 0,586
Number of seeds per plant	0,935	0,173	- 0,302
Mass of seeds per plant, g	0,767	0,629	- 0,043
Average length of 10 pods, cm	- 0,566	0,749	0,340

Conclusion

Based on the conducted study, the following conclusions can be drawn:

1. The application of *diflufenican* herbicide at different doses, the year of cultivation and the interaction between these indicators influenced the manifestation of the traits - plant height, number of fruit-yielding branches, number of pods, number of seeds per plant, mass of seeds and average length of 10 pods per plant.

2. The application of *diflufenican* herbicide in a dose of 300 ml/ha differs most from the other variants of conducted clustering as a result of its strong influence on the number of seeds per plant, mass of seeds and number of fruit-yielding branches.

3. The highest indices of stability were obtained for the mass of plants with pods, indicating greater stability of this trait on the application of *diflufenican* herbicide.

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Uticaj herbicida *diflufenikana* na neka biološka svojstva bugarske sorte graha Plovdiv 15M

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Sažetak

Sprovedena su trogodišnja istraživanja (2006-2008. god.) da bi se odredio uticaj herbicida *diflufenikana* (trgovačko ime– Pelikan 50 CK) na neka biološka svojstva bugarske sorte graha Plovdiv 15 M. Herbicid je primjenjivan u dozama od 200, 250 i 300 ml/ha nakon sjetve a prije rasta biljke. Ustanovljeno je da su na osobine vezane za visinu biljke, broj grana sa mahunama, broj mahuna i zrna, masa zrna kao i prosječnu dužinu 10 mahuna po biljci uticale različite doze herbicida, zatim godina uzgoja kao i interakcija ova dva faktora. Tretiranje dozom od 300 ml/ha najviše se razlikuje od drugih varijanti u sprovedenom grupisanju kao rezultat velikog uticaja na sljedeće osobine: broj zrna, grana sa mahunama i masa zrna po biljci. Najviši indeksi stabilnosti dobijeni su za svojstvo vezano za masu mahuna po biljci, koje je pokazalo veću stabilnost u odnosu na tretiranje herbicidom.

Ključne riječi: biološke osobine, diflufenikan, herbicidi, *Phaseolus vulgaris* L.

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