Uluslararası Tarım Araştırmalarında Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Agricultural Research 2019, Vol. 3 (4), 601-610
https://doi.org/10.29329/ijiaar.2019.217.6

Original article

After-effect of Foliar-Applied Herbicides for Broad-leaved Weeds on the Primary Germ Length of Cotton Seeds (*Gossypium Hirsutum* L.)

Teodora Barakova [a,*], Grozi Delchev [b], Neli Valkova [a] & Stoyan Georgiev [a]

[a] Field Crops Institute, 6200, Chirpan, Bulgaria
[b] Department of Plant Production, Faculty of Agriculture, Trakia University, 6000, Stara Zagora, Bulgaria

Abstract

The trial was carried out during 2013-2015, with twelve cotton cultivars (*Gossypium hirsutum* L.). Influence of herbicides Bazagran 480 SL (bentazone), Pulsar 40 (imazamox) and Express 50 VG (tribenuron-methyl) was studied. These herbicides were used during the budding stage of cotton. The herbicide Bazagran 480 SL has the highest phytotoxicity on the primary germ length of seeds of cotton cultivars Chirpan-539 and Trakia and the lowest on cultivar Natalia. The herbicide Pulsar 40 has the highest phytotoxicity on the primary germ length of seeds of cotton cultivar Dorina and the lowest on the cultivars IPK-Veno and Viki. The herbicide Express 50 VG has the highest phytotoxicity on the primary germ length of seeds of the cotton cultivar Chirpan-539 and the lowest on the cultivars Helius and Trakia. From the viewpoint of cotton growing technology, technologically the most valuable are all cultivars, by foliar treatment with herbicide Bazagran 480 SL. Technologically the most valuable are cultivars Viki, IPK-Veno, Boyana and Natalia by foliar treatment with herbicide Pulsar 40. Technologically the most valuable are cultivars Helius, Trakia, Viki, Avangard and Nelina by foliar treatment with herbicide Express 50 VG. These variants combine high primary germ lengths and high stability of this index during the different years.

Keywords: Cotton, Herbicides, Foliar treatment, Cultivars, Primary germ length.

Received: 31 August 2018 * **Accepted:** 18 September 2019 * **DOI:** https://doi.org/10.29329/ijiaar.2019.217.6

* **Corresponding author:**

Teodora Barakova, Field Crops Institute, 6200, Chirpan, Bulgaria.
Email: tedi_mendeva@abv.bg

INTRODUCTION

Cotton is one of the most valuable crops for Bulgaria. Problem in contemporary farming is secondary weed infestation of crop (Boz, 2000; Bukun, 2004). The competition of weeds leads to a decrease in the cotton plants height, the number and length of the fruit twigs, the number of boxes per plant and the yield (Salimi, 2006; Cardoso, 2011). In the application of vegetative antibroadleaved herbicides in conventional technology, there are often manifestations of phytotoxicity (Vargas and Wright, 1994; Ashok, 2006). The fight against secondary weed infestation is extremely difficult and must look for new approaches and herbicides technology for growing cotton, which are efficacy and selective to crop (Gao, 2005).

The aim of this research is to investigate the after-effect of foliar-applied herbicides for broad-leaved weeds on the primary germ length of cotton seeds (Gossypium hirsutum L.).

Material and Methods

The investigation was carried out during 2013-2015, with twelve cotton cultivars - Chirpan-539, Helius, Trakia, Viki, Filipopolis, IPK-Veno, Boyana, Avangard, Natalia, Darmi, Dorina and Nelina (*Gossypium hirsutum* L.). The experiment was conducted under the block method, in 4 repetitions; the size of the crop plot was 20 m^2. For the control was used the standard for Bulgaria cultivar Chirpan-539.

Influence of herbicides Bazagran 480 SL (bentazone) – 1.5 l/ha, Pulsar 40 (imazamox) – 1.2 l/ha and Express 50 VG (tribenuron-methyl) 50 g/ha was studied. The herbicides were used during the budding stage of cotton. These foliar herbicides were treated after the herbicidal combination Dual gold 960 EC (S-metholahlor) – 1.2 l/ha + Goal 2 E (oxifluorfen) – 1.2 l/ha, which is applied after sowing before emergence for controlling of primary weed infestation in cotton. Spraying is done with a knapsack sprayer with a working solution 300 l/ha.

In laboratory conditions it was investigated the length of the primary germ of cotton seeds. The index is reported in centimeters (*cm*). The primary germ length was reported for 100 seeds per each variant (25 seeds per 1 replication) of twelve cultivars of cotton. The seeds are taken from cotton plants treated during the vegetation with the respective herbicides. Primary germ length was reported on day 7.

The statistical processing of the data was done according to the method of analyses of variance (Shanin 1977; Barov, 1982; Lidanski 1988). The stability of herbicides and cultivars for length of the primary germ with relation to years was estimated using the stability variances σ_i^2 and S_i^2 of Shukla (1972), the ecovalence W_i of Wricke (1962) and the stability criterion YS_i of Kang (1993).

Results and Discussion

Secondary weed infestation with annual and perennial broadleaf weeds is a huge problem for the cotton fields. To combat these weeds are made 3-4 hands hoeing with hoes. They are very heavy, labor intensive, and greatly increase the cost of cotton production. Until now, this has made conventional cotton production unprofitable and it could not compete with cheap GMO cotton produced in the major cotton-producing countries outside Europe. For the first time in the world, cotton cultivars resistant to herbicides Basagran 480 SL (bentazone), Pulsar 40 (imazamox) and Express 50 VG (tribenuron-methyl) have been established. These cultivars are Bulgarian and have been created in the Field Crops Institute, Chirpan. They produce high and stable yields of raw cotton, cotton fiber and cotton seeds over the years (Barakova and Delchev, 2016; Barakova, 2017). The use of the herbicides bentazone, imazamox and tribenuron-methyl in cotton provides complete control of late spring annual broadleaf weeds *Xanthium strumarium* L., *Amaranthus retroflexus* L., *Amaranthus albus* L., *Amaranthus blifoides* W., *Chenopodium album* L., *Solanum nigrum* L., *Datura stramonium* L., *Polygonum aviculare* L., *Abutilon teophrasti* Medic., *Portulaca oleracea* L., *Polygonum aviculare* L., *Hibiscum trionum* L., *Tribulus terrestris* L.

The herbicides imazamox and tribenuron-methyl also provide complete control of the perennial broadleaf weeds *Cirsium arvense* Scop. and *Convolvulus arvensis* L. (Barakova, 2017).

The obtained results are of great importance not only for Bulgaria and Romania, but also for the other countries producing cotton in the European Union - Greece, Italy, Spain and Portugal, who cannot use genetically modified cotton cultivars. This requires a study of the quality indicators of the fiber and seeds of these genetically improved cultivars resistant to herbicides.

The herbicide Bazagran 480 SL applied during cotton vegetation, mean for the investigated period, has the highest phytotoxicity on the primary germ length of the seeds from cultivars Chirpan-539 and Trakia (Table 1). At both cultivars is measured the lower value of the indicator compared to the other cultivars – 4.5 cm. The lowest is the action of Bazagran on cultivar Natalia – 6.4 cm. This is due to the smaller phytotoxicity of the herbicide on the germ length of this cultivar. Cultivars Chirpan-539 and Trakia are characterized as the most sensitive to the herbicide Bazagran 480 SL and cultivar Natalia - the most resistant to this herbicide.

The herbicide Pulsar 40 has the highest phytotoxicity on the primary germ length of the seed from cultivar Dorina – 2.7 cm. Tested cultivars it is defined as the most sensitive to this herbicide. Cultivars IPK-Veno and Viki have the biggest primary germ length compared to the other cultivars, respectively – 4.4 cm and 4.3 cm. Pulsar influences the less on these cultivars.

The herbicide Express 50 VG has the highest phytotoxicity on the primary germ length of the seed from cultivar Chirpan-539 – 3.7 cm. Cultivars Helius and Trakia have the biggest primary germ length, respectively – 5.2, 5.3 cm. Express influence the less on this cultivars. Cultivar Chirpan-539 is the most sensitive to this herbicide in terms of the primary germ length.

Analysis of variance for length of the primary germ of cotton seeds (Table 2) shows that the years have the biggest influence on the variation of primary germ – 45.9 % of the total variation. The strength of influence of herbicides is 17.4 % and the strength of influence cultivars is 5.0 %. The influence of years, of herbicides and of cultivars on the variation of the investigated trait is statistically very well proven at $p \leq 0.01$. There is an interaction between herbicides and meteorological conditions of years (AxB) – 2.3 %, between cultivars and meteorological conditions of years (AxC) – 7.9 %, and between cultivars and herbicides (BxC) – 13.2 %. They are very well proven at $p \leq 0.1$. There is interaction between three experiment factors (AxBxC) – 5.9 %. It also is very well proven at $p \leq 0.1$.

Table 1. After-effect of foliar-applied herbicides for broad-leaved weeds on the primary germ length of cotton seeds, cm (2013-2015)

Herbicides	Cultivars	2013	2014	2015	Mean
Bazagran	Chirpan-539	3.5	6.4	3.5	4.5
	Helius	5.1	5.1	3.9	4.7
	Trakia	5.0	5.1	3.4	4.5
	Viki	5.6	5.6	3.7	5.0
	Filipopolis	5.6	5.7	3.2	4.8
	IPK-Veno	5.4	5.5	2.8	4.6
	Boyana	5.6	5.7	4.1	5.1
	Avangard	6.4	6.5	3.6	5.5
	Natalia	7.2	7.3	4.6	6.4
	Darmi	6.0	6.0	3.2	5.1
	Dorina	5.0	5.1	4.0	4.7
	Nelina	6.0	6.1	3.2	5.1
Pulsar	Chirpan-539	3.7	4.9	3.7	4.1
	Helius	4.6	4.6	3.0	4.1
	Trakia	4.4	4.4	2.9	3.9
	Viki	4.8	4.9	3.1	4.3
	Filipopolis	4.6	4.7	2.3	3.9
	IPK-Veno	4.8	4.9	3.5	4.4
	Boyana	4.6	4.7	3.2	4.2
	Avangard	4.0	4.1	2.2	3.4
	Natalia	4.8	4.9	2.7	4.1
	Darmi	4.0	4.0	3.3	3.8
	Dorina	2.8	2.5	2.8	2.7
	Nelina	3.5	2.4	3.5	3.1
Express	Chirpan-539	3.0	5.2	2.9	3.7
	Helius	6.0	6.3	3.4	5.2
	Trakia	6.0	6.2	3.6	5.3
	Viki	5.0	4.9	2.7	4.2
	Filipopolis	4.4	4.4	2.8	3.9
	IPK-Veno	4.0	4.1	3.4	3.8
	Boyana	4.7	4.8	2.7	4.1
	Avangard	4.7	4.8	3.0	4.2
	Natalia	4.4	4.6	2.5	3.8
	Darmi	4.1	4.2	3.4	3.8
	Dorina	4.1	4.2	3.6	4.0
	Nelina	5.0	5.0	2.7	4.2

LSD, cm:

F.A $p \leq 5\% = 0.08$ $p \leq 1\% = 0.1$ $p \leq 0.1\% = 0.2$

F.B $p \leq 5\% = 0.08$ $p \leq 1\% = 0.1$ $p \leq 0.1\% = 0.2$

F.C	p≤5%=0.1	p≤1%=0.2	p≤0.1%=0.3
AxB	p≤5%=0.1	p≤1%=0.2	p≤0.1%=0.3
AxC	p≤5%=0.3	p≤1%=0.4	p≤0.1%=0.5
BxC	p≤5%=0.3	p≤1%=0.4	p≤0.1%=0.5
AxBxC	p≤5%=0.5	p≤1%=0.7	p≤0.1%=0.9

Table 2. Analyses of variance of studied factors for the primary germ length

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean square
Total	215	293,1	100	-
Tract of land	1	0.1	0.1	0.01
Variants	107	286.3	97.6	2.7***
Factor A - Years	2	134.7	45.9	67.3***
Factor B - Herbicides	2	50.9	17.4	25.5***
Factor C - Cultivars	11	14.6	5.0	1.3***
Interaction AxB	4	6.8	2.3	1.7***
Interaction AxC	22	23.2	7.9	1.1***
Interaction BxC	22	38.7	13.2	1.8***
Interaction AxBxC	44	17.3	5.9	0.4***
Pooled error	107	6.8	2.3	0.06

*p≤5% **p≤1% ***p≤0.1%

Based on proven herbicide x year interaction and cultivar x year interaction, it was evaluated stability parameters for each variant for primary germ length of cotton seeds with relation to years (Table 3). It was calculated the stability variances σ_i^2 and S_i^2 of Shukla, the ecovalence W_i of Wricke and the stability criterion YS_i of Kang.

Stability variances (σ_i^2 and S_i^2) of Shukla, which recorded respectively linear and nonlinear interactions, unidirectional evaluate the stability of the variants. These variants which showed lower values are considered to be more stable because they interact less with the environmental conditions. In the present case this means that the observed effect of the treatment with the corresponding herbicides will be constant in different years. Negative values of the indicators σ_i^2 and S_i^2 are considered 0. At high values of either of the two parameters - σ_i^2 and S_i^2, the variant are regarded as unstable. At the ecovalence W_i of Wricke, the higher are the values of the index, the more unstable is the variant.

On this basis, using the first three parameters of stability, it is found that by foliar treatment with herbicide Bazagran 480 SL stable are cultivars Helius, Trakia, Viki and Boyana. By treatment with herbicide Pulsar 40 stable are cultivars Helius, Trakia, Viki, Natalia and by treatment with herbicide Express 50 VG stable are cultivars Filipopolis, Boyana, Avangard and Natalia. Other variants have high instability - values of stability variance σ_i^2 and S_i^2 of Shukla and ecovalence W_i of Wricke are the highest and mathematically proven. The reason for this high instability is greater variation in primary germ lengths during years of experience as weather conditions affect those most. At part of them there is instability from linear and nonlinear type - proven values σ_i^2 and S_i^2. At another part of them, instability is a linear type - proven values σ_i^2, the values of S_i^2 are not proven.

To evaluate the complete efficacy of each herbicide should be considered as its effect on primary germ length of cotton seeds and its stability - the reaction of cotton to this variant during the years. Valuable information about the technologic value of the variant give the stability criterion YS_i of Kang for simultaneous assessment of length of the primary germ and stability, based on the reliability of the differences in primary germ length and variance of interaction with the environment. The value of this criterion is experienced that using nonparametric methods and warranted statistical differences we get a summary assessment aligning variants in descending order according to their economic value.

Table 3. Stability parameters for the variants for after-effect of foliar-applied herbicides for broad-leaved weeds on the primary germ length of cotton seeds with relation to years

Herbicides	Cultivars	$\bar{x}$	σ_i^2	S_i^2	W_i	YS_i
Bazagran	Chirpan-539	4.5	3.9**	7.7**	7.3	16+
	Helius	4.7	0.2	0.01	0.3	28+
	Trakia	4.5	-0.01	-0.01	0.01	25+
	Viki	5.0	0.04	0.04	0.1	32+
	Filipopolis	4.8	0.4**	0.02	0.8	23+
	IPK-Veno	4.6	0.7**	0.04	1.3	18+
	Boyana	5.1	-0.03	-0.04	0.03	35+
	Avangard	5.5	1.0**	0.05	1.9	30+
	Natalia	6.4	0.7**	0.04	1.3	31+
	Darmi	5.1	0.9**	0.1	1.7	25+
	Dorina	4.7	0.3*	-0.01	0.5	24+
	Nelina	5.1	1.0**	0.05	1.9	26+
Pulsar	Chirpan-539	4.1	1.3**	1.3**	2.5	5
	Helius	4.1	0.06	0.03	0.04	11
	Trakia	3.9	0.02	0.02	0.08	9
	Viki	4.3	-0.08	0.01	0.01	20+
	Filipopolis	3.9	0.3**	0.02	0.6	-3
	IPK-Veno	4.4	5.9**	-0.08	0.1	23+
	Boyana	4.2	2.1**	-0.06	0.07	16+
	Avangard	3.4	9.7**	0	0.05	0
	Natalia	4.1	0.1	0.01	0.3	15+
	Darmi	3.8	0.7**	-0.05	1.3	-7
	Dorina	2.7	2.5**	0.07	4.7	-10
	Nelina	3.1	2.7**	1.3**	5.2	-9
Express	Chirpan-539	3.7	2.7**	4.7**	5.2	-2
	Helius	5.2	0.8**	-0.01	1.6	28+
	Trakia	5.3	0.5**	-0.06	0.9	29+
	Viki	4.2	0.2*	0.1	0.5	14+
	Filipopolis	3.9	0.06	0.02	0.04	6
	IPK-Veno	3.8	0.7**	-0.01	1.4	-6
	Boyana	4.1	0.08	0.02	0.2	11
	Avangard	4.2	-0.08	0.01	0.01	16+
	Natalia	3.8	5.8	-0.01	0.1	2
	Darmi	3.8	0.6**	-0.01	1.1	0
	Dorina	4.0	0.9**	-0.01	1.7	2
	Nelina	4.2	0.2*	0.07	0.6	15+

Generalized stability criterion YS_i of Kang, taking into accounts both the stability and value of primary germ length gives a negative assessment of cultivars Filipopolis, Darmi, Dorina and Nelina, treated by Pulsar 40, and Chirpan-539, IPK-Veno, Boyna, treated by Express 50 VG. They are characterized as the most unstable and with low values.

None of these cultivars receive negative evaluation by foliar treatment with herbicide Bazagran 480 SL. According to this criterion, the most valuable technologically appears foliar treatment with herbicide Bazagran at all studied cultivars. The most valuable technologically appears cultivars Viki, IPK-Veno, Boyana and Natalia by foliar treatment with herbicide Pulsar. Cultivars Helius, Trakia Viki, Avangard and Nelina have the highest evaluation by foliar treatment with herbicide Express. They combine relatively high primary germ lengths of cotton seeds with high stability during the different years of the investigation.

Conclusions

The herbicide Bazagran 480 SL has the highest phytotoxicity on the primary germ length of seeds of cotton cultivars Chirpan-539 and Trakia and the lowest on cultivar Natalia.

The herbicide Pulsar 40 has the highest phytotoxicity on the primary germ length of seeds of cotton cultivar Dorina and the lowest on the cultivars IPK-Veno and Viki.

The herbicide Express 50 VG has the highest phytotoxicity on the primary germ length of seeds of the cotton cultivar Chirpan-539 and the lowest on the cultivars Helius and Trakia.

From the viewpoint of cotton growing technology, technologically the most valuable are all cultivars, by foliar treatment with herbicide Bazagran 480 SL.

Technologically the most valuable are cultivars Viki, IPK-Veno, Boyana and Natalia by foliar treatment with herbicide Pulsar 40.

Technologically the most valuable are cultivars Helius, Trakia, Viki, Avangard and Nelina by foliar treatment with herbicide Express 50 VG. These variants combine high primary germ lengths and high stability of this index during the different years.

REFERENCES

Ashok, Y. (2006). Integrated control of weeds in cotton. Environ. Ecol., 24 S (Special 3A), 883-885.

Barakova, T. (2017). Development of elements of integrated weed control in cotton vegetation and testing of cotton genotypes (Gossypium hirsutum L.) for resistance to herbicides, Doctoral dissertation. Chirpan.

Barakova, T. and G. Delchev (2016). Selectivity and stability of vegetation-applied herbicides at cotton (Gossypium hirsutum L.). Agric. Sci. Technol., 8 (2), 121-126.

Barov, V. (1982). Analysis and schemes of the field experience. NAPO, Sofia, 668.

Boz, O. (2000). Determination of weed flora, distribution and density of weed species occurring in cotton growing in Aydin. Turkey Herbology Dergisi, 3, 10-16.

Bukun, B. (2004). Critical periods or weed control in cotton in Turkey. Weed Res., 44, 404-412.

Cardoso, G. D. (2011). Critical periods of weed control in naturally green coloured cotton BRS Verde. Ind. Crop. Prod., 34, 1198-1202.

Gao, X. H. (2005). The effect of different mixed herbicides in controlling weeds. China Cotton, 32, 19-23.

Kang, M. (1993). Simultaneous selection for yield and stability: Consequences for growers. Agron. J., 85, 754-757.

Lidanski, T. (1988). Statistical methods in biology and agriculture, Sofia, 376.

Salimi, H. (2006). Determination of the critical period of weed control in cotton fields (*Gossypium hirsutum* L.). Appl. Entomol. Phytopath., 74 (1), 35-37.

Shanin, Yo. (1977). Methodology of the field experience. BAS, 384.

Shukla, G. (1972). Some statistical aspects of partitioning genotype - environmental components of variability. Heredity, 29, 237-245.

Vargas, R. and S. Wright (1994). Nightshade control with phrithiobace (Staple) in California. Proceedings Beltwide Cotton Conferences, San Diego, California, USA, 1689-1691.

Wricke, G. (1962). Über eine Methode zur Erfassung des ökologischen Straks breiten Feldersuchen. Pflanzenzurecht, 47, 92-96.