

PRODUCTIVITY OF GRAIN SORGHUM AT APPLICATION OF POST-EMERGENCE HERBICIDES

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During the four-year field experiments, the influence of post-emergence herbicides such as Peak, Prima and Grantox on the phytosanitary state of grain sorghum crops and the formation the grain productivity of plants was established. It was found that the applied chemicals did not affect the main stages of ontogenesis by sorghum plants. The use of the active ingredient of Prima and Grantox led to decrease the linear growth of plants. The height of sorghum plants with increasing the application dose of Prima decreased from 101.7 to 98.5 cm. When increasing the dose of Grantox, the toxic effect of the active ingredient on sorghum plants increased, as a result their height decreased significantly from 103.1 to 98.1 cm.

With regard to the Peak herbicide, the plant height increased from 105.5 to 107.9 cm with increasing of application doze. Due to the use of the application dose of 20 g/ha, the highest grain yield of sorghum was obtained (4.04 t/ha). It is only 0.22 t/ha less compared to the variants where weeds were removed manually. These results indicate a significant effect of the Peak herbicide on weeds and weak phytotoxicity against sorghum plants.

The activation of tillering with a slight decrease in the number of panicles was observed when using Prima herbicide. All studied herbicides were characterized by high efficiency against dicotyledonous weeds: Grantox – 78.0–86.2 %, Prima – 75.4–83.1 %, Peak – 80.6–89.3 %. Despite the different phytotoxic effect on plants, grain productivity of grain sorghum increased due to the application of post-emergence herbicides compared to plots with natural weed infestation: Prima – by 0.66–0.92 t/ha, Grantox – by 0.60–0.97 t/ha, Peak – by 1.02–1.40 t/ha. Based on the research, it was found that the application of Peak herbicide in dose of 15–20 g/ha at the 4–5 leaf stage of sorghum was safest for plants and the most effective for the control of dicotyledonous weeds.

Key words: grain sorghum, growth and development, weeds, herbicide, yield.

Due to global climate change on the planet, significant differences also occur in the arid steppe regions of Ukraine. Cases of prolonged rainlessness during the growing season have become more frequent, which causes soil and air droughts, dry winds, and very low relative humidity.

One of the crops most adapted to arid conditions is grain sorghum (*Sorghum bicolor*

L.). The prospectivity of growing grain sorghum compared to traditional cereals is extremely high drought and heat resistance, tolerance to weather and soil conditions, consistently high yields, and multifaceted use [1, 2]. At the present stage, the development and improvement of existing elements of cultivation technology is one of the main factors in increasing the yield of sorghum.

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The characteristic of sorghum is the damped growth of plants in the beginning of the growing season, for this reason it does not compete with weeds and reduce the productivity. But the greatest damage is caused by weeds that emerge earlier or simultaneously with the sprouts of grain sorghum. They strongly suppress the crops at the beginning of the growing season. No noticeable effect of weeds on sorghum yield is observed if weed control measures are taken during this period [3].

It is possible to obtain the yield increase of 9–14 % and achieve reduction of ecological load on the environment due to observance of scientifically substantiated agrotechnical measures of protection of crops against weeds without herbicides [4]. However, as a result of harrowing sorghum crops, even if all the requirements of this agricultural measure are met, some plants are damaged (or even destroyed): during the first harrowing – on average by 19–20 %, the second – by 5–7 %. In the case of double harrowing, the plant density is reduced by 20–30 %. Therefore, chemical protection methods play an important role in weed control of the field crops [5].

Some researchers believe that sorghum is identical in its biological characteristics and sensitivity to herbicides to maize, so the of weed control system for it is the same [6]. However, numerous studies by domestic and foreign scientists have shown that sorghum is more sensitive to herbicides and requires a slightly different problem solving approach of their proper use [7].

Aim. To establish the efficiency of post-emergence herbicides and find out the features of their influence on the growth, development and formation of sorghum grain productivity.

Materials and Methods. Field research was performed during 2011–2014 in the fields of the Erastivka Experimental Station of the Institute of Agriculture of the Steppe Zone of NAAS (now the Institute of Grain Crops of NAAS). Due to the zonal distribution, this area belongs to the northern part of the Steppe zone with insufficient and unstable moistening and arid weather conditions.

The soils of the experimental site are ordinary low-humus heavy loam chernozems. The content of humus in the arable layer of the soil is 3.5–4.0 %, gross nitrogen – 0.23–0.26, phospho-

rus – 0.11–0.12 and potassium –2.0–2.5 %. The reaction of the soil solution is neutral (pH of the water extract is 6.5–7.0). Predecessor – winter wheat. The object of study was grain sorghum of Dniprovskiy 39 variety. The field trial scheme: control 1 (natural weed infestation), control 2 (manual weeding) and herbicides: Peak (active ingredient: 750 g/kg prosulfuron), Prima (6.25 g/l florasulam + 452.5 g/l 2-ethylhexyl ether 2.4-D), Grantox (500 g/l MCPA as the sodium, potassium and dimethylamine salts). The herbicides were used in accordance with the manufacturer recommendations: in the minimum, average and maximum doses at the 4–5 leaves stage of grain sorghum.

Results. Sowing of grain sorghum in 2012–2013 was carried out at the end of the first ten-days of May, and in 2011–2014 – at the beginning of the second ten-days of the same month High air temperatures contributed to the full emergence of sorghum sprouts for 8–9 days after sowing. The period from full emergence of sprouts to 4–5 leaves stage continued 18 days, to the tillering stage – 24 days. Stem elongation was observed 29 days after sowing, panicle earing – for 44 days. The duration of the "sprouts - flowering" period was 54 days. The end of milky ripeness and the beginning of wax one was observed at 72th day. The period of "sprouts – full maturity" in more favorable weather conditions in 2011 and 2013 was 106 days. In 2014, adverse weather conditions at the end of the growing season led to some reduction in its duration. Thus, the period of "sprouts - full maturity" was 97 days. In the most adverse hydrothermal conditions of 2012, there was a decrease in its duration, respectively, the period of "sprouts – full maturity" was 84 days. No relationship was established between the growth rate and development of sorghum plants and the application of chemicals.

Plant height characterizes the growing conditions. The accounting showed that the highest sorghum plants (108.4 cm) were in plots with manual weeding without the use of chemicals. In control 1 (without herbicides), the height of sorghum plants was 99.9 cm. In variants with the herbicides, the best conditions for the growth and development of sorghum plants were at the Peak application. Its phytotoxic effect on sorghum plants was weaker compared to other studied herbicides, at the same time the

plant height was 105.5–107.9 cm. Prima herbicide was characterized by greater phytotoxic effect. The height of sorghum plants decreased from 101.7 to 98.5 cm with increasing its dose. In the case of increasing the dose of Grantox herbicide, the toxic effects of the active ingredi-

ents increased, while the plant height of the sorghum decreased significantly – from 103.1 to 98.1 cm (Table 1).

When growing grain sorghum, it is important to take into account the biological feature of this crop as the tillering ability.

1. Plant height and coefficient of productive tillering grain sorghum at herbicide application (average for 2011–2014)

Variant		Plant height at full maturity stage, cm	Tillering coefficient	
			general	productive
Control 1 *		99.9	2.3	1.26
Control 2 **		108.4	2.7	1.35
Peak	10 g/ha	105.5	2.3	1.29
	15 g/ha	106.3	2.5	1.30
	20 g/ha	107.9	2.7	1.31
Prime	0.4 l/ha	101.7	3.2	1.09
	0.5 l/ha	99.3	3.5	1.05
	0.6 l/ha	98.5	3.6	1.02
Grantox	0.7 l/ha	103.1	2.3	1.16
	1.2 l/ha	100.2	2.4	1.15
	1.7 l/ha	98.1	2.7	1.12

* Natural weed infestation ** Manual weeding

This feature of grain sorghum plants in most cases has a negative meaning, because the side shoots (often with immature panicles) make it difficult to harvest.

During the study of the action of herbicides revealed some features of their effect on sorghum plants. Thus, in the experimental plots with the application of the Peak herbicide, the coefficient of general tillering was 2.3–2.7, productive – 1.29–1.31. With increasing dose of Grantox, there was an increase in general tillering – 2.3–2.7 and a decrease in productive one – 1.16–1.12. When applying Prima, there was a significant increase in the number of side shoots, the coefficient of general tillering was 3.2–3.6, and productive – 1.09–1.02. In plots with manual weeding (control 2), these indicators were 2.7 and 1.35, respectively.

Weather conditions at the beginning of the sorghum growing season favored to the germination of weeds. The accounting of weeds at the time of herbicides application (4–5 leaves stage of sorghum) showed that their number was 21.8–24.5 pcs/m². In terms of species, the most numerous were common ragweed (*Ambrusia artemisiifolia* L.) – 52 %, redroot pigweed (*Amaranthus retroflexus* L.) – 27 %, lamb's quarters (*Chenopodium album* L.) – 12 %, yellow foxtail

(*Setaria pumila* L.) – 9 %. The herbicides reduced weed infestation, but their efficiency varied (Table 2).

It should be noted that the effect of the studied herbicides is aimed only at dicotyledonous plants, so after the application of these herbicides was dominated by cereal type of weed infestation.

The efficiency of weed control by Prima and Grantox was almost the same in both quantitative and weight indicators.

The efficiency of Grantox was 78.0 % at a dose of 0.7 l/ha. In variants with doses of 1.2 and 1.7 l/ha, the level of weeds decreased by 82.0 and 86.2 %, respectively. The application Prima at a dose of 0.4 l/ha caused a decrease in the number of weeds by 75.4 %, and 0.5 and 0.6 l/ha – by 79.5 and 83.1 %, respectively. The highest phytotoxic effect was observed in the Peak herbicide, the number of weeds and their vegetative mass depending on the dose was significantly reduced. Thus, in plots with applied dose of 10 g/ha, there was a decrease in the number of weeds by 80.6 %, 15 g/ha – by 85.9 %, and 20 g/ha – by 89.3 %.

The plant productivity is the main factor that determines the efficiency and feasibility of agronomic techniques. The highest productivity

**2. Weed infestation of grain sorghum and herbicide efficiency
(average for 2011–2014)**

Variant		Number of weeds at the time of herbicide application, pcs/m ²	Number of weeds at the full maturity stage of sorghum, pcs/m ²	Efficiency of herbicides, %	Dry mass of weeds, g/m ²
Control 1 (without herbicides)		23.4	40.7	–	506.3
Peak	10 g/ha	23.9	7.2	80.6	23.3
	15 g/ha	24.1	5.5	85.9	18.2
	20 g/ha	24.2	4.1	89.3	17.0
Prima	0.4 l/ha	23.5	9.6	75.4	41.5
	0.5 l/ha	24.3	8.3	79.5	33.2
	0.6 l/ha	21.8	6.1	83.1	27.7
Grantox	0.7 l/ha	23.3	9.4	78.0	41.7
	1.2 l/ha	24.5	9.1	82.0	37.0
	1.7 l/ha	24.1	6.5	86.2	27.6

of grain sorghum was observed in plots with manual weeding (control 2) – 4.26 t/ha, which is 1.6 times higher than the control variant.

In plots with weed control by chemical means, the highest grain yield of sorghum (4.04 t/ha) was obtained due to Peak herbicide

at a dose of 20 g/ha, which is only 0.22 t/ha less compared to the variants with manual weeding.

The research results revealed a significant effect of the herbicide on weeds and its weak phytotoxicity to sorghum plants.

3. Influence of herbicides on sorghum grain yield (average for 2011–2014)

Variant	Grain yield, t/ha	To control 1		To control 2		
		t/ha	%	t/ha	%	
Control 1 *	2.64	–	–	-1.62	-38.0	
Control 2 **	4.26	+1.62	+61.4	–	–	
Peak	10 g/ha	3.66	+1.02	+38.6	-0.60	-14.1
	15 g/ha	3.78	+1.14	+43.2	-0.48	-11.3
	20 g/ha	4.04	+1.40	+53.0	-0.22	-5.20
Prima	0.4 l/ha	3.56	+0.92	+34.8	-0.70	-16.4
	0.5 l/ha	3.40	+0.76	+28.8	-0.86	-20.2
	0.6 l/ha	3.30	+0.66	+25.0	-0.96	-22.5
Grantox	0.7 l/ha	3.61	+0.97	+36.7	-0.65	-15.3
	1.2 l/ha	3.50	+0.86	+32.6	-0.76	-17.8
	1.7 l/ha	3.24	+0.60	+22.7	-1.02	-23.9
LSD ₀₅ , t/ha		0.14–0.25				

* Natural weed infestation. ** Manual weeding.

The grain productivity of sorghum was 3.56 t/ha when Prima with a dose of 0.4 l/ha was applied. Increasing dose was accompanied by inhibition of growth processes in sorghum plants and a decrease in their productivity (Table 3).

In the case of Grantox, the optimal dose was 0.7 l/ha, while the sorghum grain yield was 3.61 t/ha. When increasing the dose of herbi-

cide, there was an inhibition of growth processes in sorghum plants and a decrease in their grain productivity.

Conclusions

In the course of four years of field research, the efficiency of application of the post-emergence herbicides such as Peak, Prima and Grantox in grain sorghum crops was clarified. It is established that the listed herbicides do not

influence duration of interphase periods of growth and development of sorghum plants. However, when using Prima and Grantox herbicides, there was a weakening of linear growth in plants. At application of Prima, activation of tillering with insignificant decrease in number of panicles was observed. As it turned out, all studied herbicides are characterized by high efficiency against dicotyledonous weeds: Grantox – 78.0–86.2 %, Prima – 75.4–83.1 %, Peak – 80.6–89.3 %. Despite the different phytotoxic

effects of the studied post-emergence herbicides, the productivity of sorghum plants increases due to use: Prima – by 0.66–0.92 t/ha, Grantox – by 0.60–0.97 t/ha, Peak – by 1.02–1.40 t/ha compared to the natural weed infestation. On the basis of the conducted researches, it was established that Peak herbicide is the safest and most effective for the destruction of dicotyledonous weeds at a dose of 15–20 g/ha in 4–5 leaves stage of grain sorghum plants.

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