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Efficiency of Herbicides and Fungicides in Cultivation of Soybeans in The Context of Farming of the Forest-Steppe in Trans-Volga Region.

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ABSTRACT

Soy is a valuable and promising food crop for Russia, but the acreage of this crop are limited by a low agrotechnology and lack of the plant protection system against weeds and diseases. Our studies have shown that in the absence of herbicidal treatment the number of weeds is very high that is associated with low competitiveness of soy. Therefore, the use of herbicides is an effective practice of plant protection against weeds, especially application of preparations containing imidazolinone (Pivot, Pulsar and their mixtures). Lack of herbicidal treatment reduced yielding capacity of soy in 36-59%. A reliable increase of soy yield is noted with the use of fungicide Optimo which amounted to 0,1 t/hectare.

Keywords: soy, herbicides, fungicides, weeds, efficiency of plant protection

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INTRODUCTION

Soy is a valuable food and commercial crop. Its role, from the agrotechnical point of view, is high, crop rotation links with bean crops should be considered as "genetically associated with crop rotation" and it weakens a negative influence of sowing subsequent grain crops, it reduces rot affection of roots [1]. The soy acreage share remains low in the structure of sown acreages of agricultural enterprises in the Volga region. It is connected with a high cost intensity of cultivation technology and lack of experience of its cultivation [2].

Cropping power of soy is determined by a complex of controlled and uncontrolled factors among which there are, certainly, temperature , moisture content, mineral nutrients supply and protection of plants against weeds [3, 4]. At the initial stages of development soy poorly competes with weeds and due to lack of proper protection of crops its cropping power considerably decreases. Weed plants cause the main damage to a soy harvest before the phase of primordial leaves – 1-2 ternate leaves of crops. The critical period of injuriousness of weeds in crops of soy lasts 14-20 days [5, 6, 7]. Therefore, to increase yielding capacity it is very important to carry out timely weed control measures, especially in early periods of crop development.

Plants of soy are susceptible to fungi diseases. In spite of the fact that in the setting of Trans-Volga region the spread of diseases is insignificant, development of rust, black stem, Fusarium blight and other diseases occur in some years [8]. All this causes necessitate the study and selection of effective remedies of plant protection of soy against weeds and diseases.

Objective of this work: to assess efficiency of herbicides and fungicides in cultivation of soy in the context of farming of the Trans-Volga forest-steppe of Russia.

Research technique

Soy is cultivated in a grain and fallow crop rotation: complete fallow – winter wheat – barley - soy. A predecessor is barley, sowing was made in the last decade of April with the seeding rate of 0,6 million seeds/hectare. The main tillage of the soil was carried out according to the scheme: soil disking on 8-10 cm + plowing on 25-27 cm, during the spring period - early-spring harrowing and pre-seeding cultivation on 4-6 cm. The soil of the experimental plot - leached chernozem of medium thickness, average loam.

In the experiment the systems of soy protection were studied allowing to control various levels of field weed infestation. The following herbicides – Galaxy Top, Bazagran, Aramo, Pulsar and Pivot were applied (factor A). Besides, fungicide Optimo was studied (factor B). The area of the plot is 600 sq.m. Replication is triple.

Course of the experiment:

1. Control (without herbicides)
2. Bazagran - 2,0 l/hectare + 1,5 l/hectare of Aramo
3. Galaxy Top - 1,5 l/hectare + 1,5 l/hectare of Aramo
4. Pulsar - 1 l/hectare
5. Pulsar -0,5 l/hectare + Pivot of 0,4 l/hectare
6. Pivot -0,8 l/hectare
7. Optimo -0,5 l/hectare
8. Bazagran - 2,0 l/hectare + 1,5 l/hectare of Aramo + Optimo of 0,5 l/hectare
9. Galaxy Top - 1,5 l/hectare + 1,5 l/hectare of Aramo + Optimo of 0,5 l/hectare
10. Pulsar - 1 l/hectare + Optimo of 0,5 l/hectare
11. Pulsar - 0,5 l/hectare + Pivot of 0,4 l/hectare + Optimo of 0,5 l/hectare
12. Pivot- 0,8 l/hectare + Optimo of 0,5 l/hectare.

Herbicides were applied in the phase of 2-3 true leaves of soy, Aramo 45 preparation was applied separately from Galaxy Top and Bazagran.

The vegetative period of 2014 was characterized as droughty, for May-August 118 mm of rainfall fell, in view of the mean value of 181,6 mm for many years, the hydrothermal coefficient (HTC) was 0,52. The

vegetative period of 2015 was close to the mean conditions over many years, for May-August -191 mm, in the first half of the vegetative period (May-June) the HTC fell - 0,46 but July was characterized by excess of moisture and for the period July-August of the hydrothermal coefficient was equal to 1,27.

Biological efficiency, % - perishing of weed plants from herbicides was determined by a formula:

$$C = (A-B) * 100) / A$$

Economic efficiency, t/hectare - a harvest increase from the use of pesticides was calculated:

$$HI = H1-H2$$

Cost efficiency, rub/hectare - a net income from the use of pesticides:

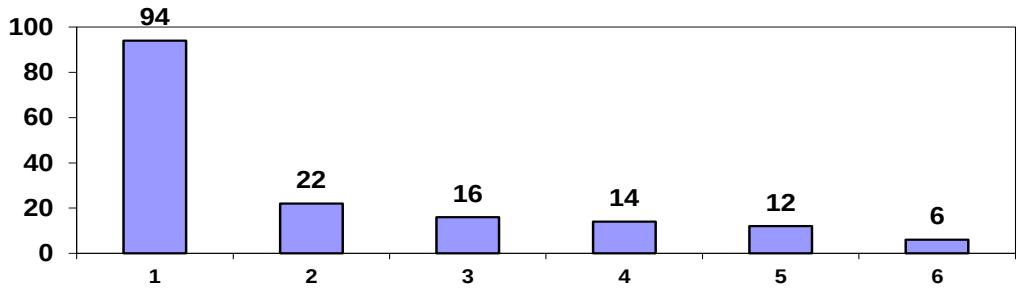
$$NI = CHI-PC$$

where C – biological efficiency, %; A – the quantity of harmful organisms without the use of pesticides (in control), pieces/sq.m; B – the quantity of harmful organisms after the use of pesticides, pieces/sq.m; HI – economic efficiency, t/hectare; H1 – harvest size from a plot where pesticides were applied, t/hectare; H2 – harvest size in control, t/hectare; NI – a net income from the use of pesticides, rub/hectare; CHI – the cost of a harvest increase , rub/hectare; PC – costs for use of pesticides, rub/hectare.

RESULTS AND THEIR DISCUSSION

The market of remedies of soy protection from weeds is represented by a wide range of preparations. On the farms of the region in soy cultivation herbicides of the imidazolin group (Pivot, Pulsar), derivatives of sulfonylurea (Harmonia), bentazone (Bazagran) and other compounds are applied. Preparations are various in different mechanisms of action, objects on which they exert impact, terms of application and duration of protection [8]. For example, preparations containing imidazolinone, along with getting into plants through elevated parts, have a marked soil action that causes their duration of protection. Derivative of sulfonylurea possess outstanding performance, but have no soil action, the same is relevant to the preparations containing bentazone in their composition (Bazagran, Galaxy Top). The wide range of pesticides makes it expedient to conduct researches on their efficiency assessment in specific conditions.

Our researches have shown that in the presence of monocotyledonous and annual dicotyledonous types of weed plants in crops the use of herbicides Pulsar, Pivot, Pivot + Pulsar and Bazagran combined with Aramo, or Galaxy Top with Aramo improved the phytosanitary condition of crops. Before applying the number of weed plants when using these herbicides was at the level of 6-22 pieces/sq.m that is much lower than in control where the number of weeds was 94 pieces/sq.m (fig. 1). The shorfall of soy yield from injuriousness of weed plants, in different variants depending on biological efficiency of herbicides has reached from 36 to 59%.



1-Control, 2-Bazagran+Aramo, 3-Galaxy Top+Aramo, 4-Pulsar 1,0 l/ha, 5-Pivot+Pulsar 0,4+0,5 l/ha, 6-Pivot 0,8 l/ha

Fig. 1 – Number of weeds in crops of soy before harvesting depending on application of herbicides (2014-2015), pieces./m² (mean data in factor A)

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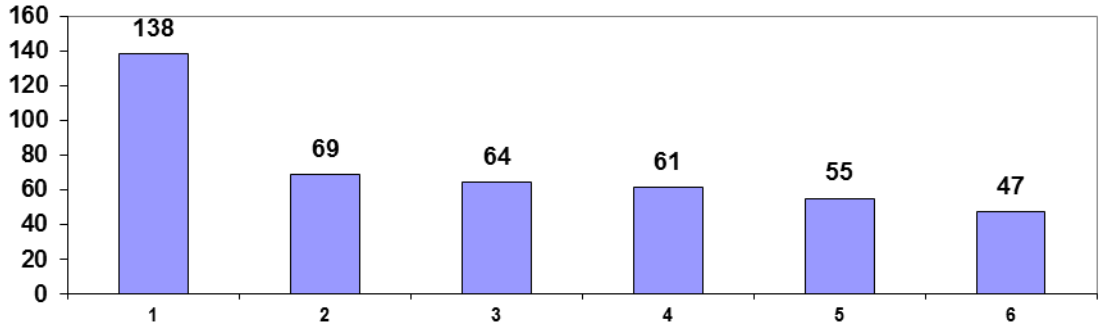
The same picture was seen taking into account the air-dry weight of weeds in the studied variants (fig. 2). In the control variant the air-dry weight of weeds reached 138 g/m^2, in other variants their weight decreased up to 47-69 g/m^2.



1-Control, 2-Bazagran+Aramo, 3-Galaxy Top+Aramo, 4-Pulsar 1,0 l/ha, 5-Pivot+Pulsar 0,4+0,5 l/ha, 6-Pivot 0,8 l/ha

Fig. 2– Air-dry weight of weeds in crops of soy depending on application of herbicides (2014-2015), pieces/m^2 (mean data in factor A)

The floristic structure generally was represented by monocotyledonous weed plants – weed millet (Panicum miliaceum), barnyard millet (Echinochloa crusgalli), gray foxtail (Setaria glauca), green foxtail (Setaria viridis). From dicotyledonous plants - field bindweed (Convolvulus arvensis), redroot amaranth (Amaranthus retroflexus), pigweed (Chenopodium album), Tatar buckwheat (Fagopyrum tataricum), common fumitory (Fumaria officinalis) and others were encountered.

The applied herbicides, optimizing the phytosanitary condition of crops, determined conditions of forming the soy cropping power. On average for 2014-2015 in the control variant, with 94 pieces/sq.m of weed plants the soy yield was 1,29 t/hectare in the variant without fungicide and 1,33 t/hectare with the use of fungicide Optimo. In variants with application of herbicides Bazagran + Aramo and Galaxy Top + Aramo the yielding capacity increased up to 1,65-1,86 t/hectare. With application of imidazolinone based herbicides (Pivot and Pulsar and their mixtures) 2,01-2,12 t/hectare of soy seeds (tab. 1) were harvested.

The efficiency evaluation of fungicide Optimo showed that with its application the yield of soy increased by 0,04-0,19 t/hectare, and on average by 0,1 t/hectare that was a reliable increase (LSD 05 = 0,09).

Thus, in field infestation of soy crops with annual and biannual monocotyledonous and dicotyledonous weed plants the variants treated with imidazolinone based herbicides - Pivot and Pulsar had the greatest harvest increase.

The assessment of contribution of the studied factors (chemical remedies of plants) to the formation of soy yielding capacity, carried out by method of the analysis of variance showed that the greatest contribution belongs to herbicides – 87-88%, 8-10% fell to the share of fungicide, a share of unaccounted factors - 3-4%.

Table 1 – Biologic soy cropping power сои depending on application of herbicides and fungicide Optimo, 2014-2015.

№	Variant	Yielding, t/ha		Deviation from control	In factor A	
		Without fungicide	Оптимо 0,5 l/ha		mean	±
1	Control	1,24	1,33	0,09	1,29	-
2	Bazagran + Aramo 45	1,65	1,84	0,19	1,75	0,46
3	Galaxy Top + Aramo 45	1,75	1,86	0,11	1,81	0,52
4	Pulsar	1,90	1,94	0,04	1,92	0,63
5	Pulsar + Pivot	2,05	2,12	0,08	2,08	0,79

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6	Pivot	2,01	2,10	0,08	2,05	0,76
Mean in factor B		**1,77**	**1,86**	**0,09**	-	-
	LSD_{05}	**0,11**		**0,08**	-	-

A complex assessment of application of plant protection means in a soy cultivation technology showed that herbicides of the imidazolinone group (Pulsar and Pivot) – 85-94% differed in the greatest biological efficiency. This results from the fact that their active ingredients are absorbed by leaves and root system of weeds, they possess long protective soil action unlike other studied preparations. Efficiency of other preparations was at the level of 76-83% (table 2).

Table 2 – Efficiency of pesticide application in crops of soy (average data for 2014-2015)

№	Herbicides and their combinations	Biologic efficiency, %	Economic efficiency, t/ha	Cost efficiency, thousand roubles./1 ha*
Herbicides				
1	Bazagran + Aramo 45	76	0,46	7,10
2	Galaxy Top + Aramo 45	83	0,52	7,60
3	Pulsar	85	0,63	13,2
4	Pulsar + Pivot	87	0,79	17,2
5	Pivot	94	0,76	16,6
Fungicide				
6	Optimo	Registration of diseases was not made	0,10	1,1

** - cost of 1 tonne of soy seeds -25 thousand roubles, expenses were calculated according to the prices of 2016.*

The assessment of economic efficiency (on a yield increase) of the studied herbicides and their tank mixes makes it possible to arrange them in the following row: Bazagran + Aramo 0,46 t/hectare; Galaxy Top + Aramo 0,52 t/hectare; Pulsar 0,63 t/hectare; Pulsar + Pivot 0,79 t/hectare; Pivot 0,76 t/hectare. The assessment of cost efficiency of herbicide application has shown that the harvest increase in a cost estimation has been from 7,10 thousand rub/hectare (Bazagran + Aramo) to 17,2 thousand rub/hectare (Pulsar + Pivot).

Application of fungicide Optimo has provided an increase in 0,1 t/hectare or 1,1 thousand rub/hectare. Not outstanding performance of fungicide on soy yielding capacity is explained by the insignificant spread of diseases in crops.

CONCLUSIONS

1. Soy is a valuable and promising food crop for conditions of the forest-steppe of Trans-Volga region which acreages are limited by a low agrotechnology and absence of the plant protection system against weed plants.
2. Studies have shown that in the absence of herbicidal treatment the number of weed plants reached 94 pieces/sq.m so it was more by 72-88 pieces/sq.m or by 76-94% than in the variants with application of herbicides. Preparations based on imidazolinone (Pivot, Pulsar and their mixtures) were the most effective herbicides in protection of soy against weeds.
3. With a high degree of weed infestation cropping power of soy decreased by 36-59%, and economic efficiency of preparations varied from 0,52 t/hectare (Bazagran + Aramo) to 1,06 t/hectare (Pulsar + Pivot). Cost efficiency of herbicides was from 7,1 (Bazagran + Aramo) to 16,6 thousand rubles/hectare (Pulsar + Pivot).
4. The reliable increase of soy yielding capacity was found with the use of fungicide Optimo which was 0,1 t/hectare, or 1,1 thousand rub/hectare.

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