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Insecticidal Protection Effectiveness Reduces Pest Populations and Increases Spring Wheat Yield in Northern Kazakhstan Agroecosystems Study

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ABSTRACT

Spring wheat productivity in Northern Kazakhstan is closely linked to the ecological stability of agroecosystems, where pest outbreaks significantly limit yield formation under favorable climatic conditions. This study aimed to evaluate the effectiveness of insecticidal protection in reducing pest abundance and increasing spring wheat yield within regional agroecosystems. Field microplot experiments were conducted in 2024 on the Aina cultivar under the conditions of the Akmola region. The treatments included lambda-cyhalothrin-based insecticide applied at rates of 0.075 and 0.1 L/ha, compared with an untreated control and a reference product. Pest populations were assessed before and after treatment, and grain yield was measured under standard agronomic conditions. The results demonstrated high biological efficiency of insecticidal application within the agroecosystem. At the 0.1 L/ha rate, pest suppression reached up to 98.7% for wheat thrips, 97.7% for flea beetles and leafhoppers, 96.2% for cutworms, and up to 100.0% for stem pests. Insecticidal protection led to yield increases of 3.4–3.7 c/ha (28.5–31.0%) compared with the control. No negative effects on non-target organisms or operator health were observed, indicating ecological safety under the studied conditions. The findings confirm the importance of targeted insecticidal protection for maintaining agroecosystem balance and enhancing the productivity of spring wheat in Northern Kazakhstan.

Keywords: *Spring wheat, Biological efficiency, Ecological protection, Cereal crop pests*

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INTRODUCTION

One of the main cereal crops in the Republic of Kazakhstan that ensures food security is spring wheat (Zotova *et al*., 2024). Hazardous insects are one of the biotic and abiotic elements that significantly reduce productivity in Northern and Central Kazakhstan (Kantarbayeva *et al*., 2017; Ospanova *et al*., 2018; Aidarbekova *et al*., 2022). A promising path for crop production in northeastern Kazakhstan is the cultivation of spring wheat in the Pavlodar region, which is marked by a sharply continental climate and soil moisture deficit (Pukhovskiy & Shilova, 2016). Wheat exhibits high resistance to environmental stress factors and maintains productivity under the arid conditions typical of the studied region. Spring wheat productivity is influenced by factors other than ecological and geographic zone features (Yang *et al*., 2014; Hýsek *et al*., 2019; Gultyaeva *et al*., 2021). The phytosanitary state of crops and seedlings is also a significant factor affecting yield levels (Mustarin *et al*., 2021; Logachev & Goncharov, 2024; Yskak *et al*., 2026).

One of the most effective components of integrated plant protection remains the use of insecticides. Modern insecticidal products are characterized by high biological activity, selectivity of action, and the possibility of application at low consumption rates (Pretty & Bharucha, 2015; Toleuova *et al*., 2025). The structure of pesticide use and their effectiveness in protecting agricultural crops depend on climatic factors, soil conditions, and pest phenology, which directly affects the optimal choice of preparation, timing, and frequency of treatments to achieve economic thresholds of harmfulness (Tudi *et al*., 2021).

In this regard, studying the effect of insecticidal protection on pest populations and the yield of spring wheat is a relevant area of scientific research and has important practical significance for improving grain production efficiency and the sustainability of agroecosystems (Knutson *et al*., 2018; Cherkasova *et al*., 2024).

MATERIALS AND METHODS

Research work on evaluating pesticide effectiveness was conducted on production fields of LLP "Manshuk-AE," located in the Tselinograd district of the Akmola region.

The Aina variety of spring wheat was the subject of the investigation. The row method was used for sowing. The medium-depth, medium-loamy, dark chestnut soil in the experimental plot had a pH of 6.8 and a humus level of up to 3.0%. Spring wheat, the second crop following fallow, was the previous crop. Chemical weeding was done prior to seeding (Carter *et al*., 2024; Eriksson *et al*., 2024; Sahu & Tiwari, 2024). May 25 was the date of sowing. With a 15-cm row spacing, 3.0 million viable seeds were sown per hectare.

During the study, the effectiveness of the preparation against a complex of harmful organisms was evaluated. The main wheat pests targeted in the trials were wheat thrips (*Haplothrips tritici* Uzel), striped flea beetle (*Phyllotreta vittula* L.), striped leafhopper (*Psammotettix striatus* L.), gray grain cutworm (*Apamea anceps* Schiff.), sunn pest (*Eurygaster integriceps* Put.), Hessian fly (*Mayetiola destructor* Say), and cereal stem flea beetle (*Chaetocnema hortensis* Geoff.). For wheat thrips, striped flea beetles, and striped leafhoppers, RAPTOR 10% EC was tested at an application rate of 0.1 L/ha and compared with the standard product BREAK, IU, at the same rate and with an untreated control. For gray grain cutworm and sunn pest, RAPTOR 10% EC was applied at 0.075 L/ha and compared with BREAK, IU, at 0.075 L/ha and with an untreated control. For Hessian fly and cereal stem flea beetle, RAPTOR 10% EC was tested at two application rates, 0.075 and 0.1 L/ha, in comparison with BREAK IU at the corresponding rates and with an untreated control.

Type of experiment (field – registration (small-plot), area of experimental plots, number of replications)

Field-registration (small-plot), plot area 48 m², fourfold replication.

Type of sprayer, working solution application rate

Crop treatment was carried out using a manual backpack sprayer PATRIOT PR 420WF-12. The working solution rate was 200 L/ha.

Methodology for accounting harmful organisms

Counts were conducted according to the "Guidelines for conducting production trials of pesticides in the Republic of Kazakhstan," Astana, 2006, and in accordance with the "Rules for conducting registration (small-plot and production) trials and state registration of pesticides in the Republic of Kazakhstan," Astana, 2015 (Guidelines for conducting production trials of pesticides in the Republic of Kazakhstan, 2006).

Methodology for yield accounting

During small-plot trials, the effectiveness of the insecticide RAPTOR 10% EC (lambda-cyhalothrin, 100 g/L) against thrips and a complex of pests on spring wheat was evaluated. The experiments were carried out with fourfold replication; the number of thrips was recorded using the sweep net method before treatment and on the 3rd, 7th, and 14th days after application of the preparations. Yield was determined by sampling sheaves and threshing from 1 m² plots in fourfold replication (Iftode *et al*., 2024; Mayer *et al*., 2024; Adams & Hayes, 2025; Cai *et al*., 2025; King *et al*., 2025; Okello *et al*., 2025; Romero *et al*., 2025; Sousa *et al*., 2025).

Yield data were adjusted to 100% purity and 14% standard grain moisture according to GOST and recalculated in centners per hectare (Amantayev *et al*., 2025).

In 2024, weather conditions in terms of temperature developed in such a way that for all months except May there was an excess of long-term average data. The hottest month was August; the average monthly temperature was 22.2°C, with a norm of 20°C (an excess of 2.2°C). In terms of precipitation, an excess was observed in May (by 42 mm), June (4 mm), and August (43 mm). The total amount of precipitation from April to May amounted to 249.5 mm, with a norm of 183 mm (an excess of 66.5 mm). The weather conditions of the 2024 growing season were extremely favorable for the development of harmful organisms **(Table 1)**.

Table 1. Meteorological indicators of the growing season of agricultural crops in the Tselinograd district of the Akmola region

Month	Temperature during the growing season	Long-term average	Deviation from long-term average	Precipitation during the growing season	Long-term average	Deviation from long-term average
April	9.1	6.3	+2.6	21.5	22.0	−0.5
May	12.3	14.6	−2.2	76.0	34.0	+42.0
June	21.8	19.7	+2.1	46.0	42.0	+4.0
July	21.8	20.8	+1.0	29.0	54.0	−25.0
August	22.2	20.0	+2.2	74.0	31.0	+43.0

RESULTS AND DISCUSSION

Table 2 summarizes the biological effectiveness of RAPTOR 10% EC against three major spring wheat pests, namely wheat thrips, striped flea beetle, and striped leafhopper, under the same experimental design. RAPTOR 10% EC and the standard product BREAK, IU, were both applied at a rate of 0.1 L/ha and compared with an untreated control under fourfold replication. Before treatment, pest abundance in all variants was comparable, indicating uniform infestation of the experimental plots. After application, both insecticides provided a rapid and pronounced reduction in pest numbers. Against wheat thrips, the biological effectiveness of RAPTOR 10% EC reached 77.4% on the 3rd day, 88.6% on the 7th day, and 98.7% on the 14th day after treatment, while the standard product showed similarly high values of 78.2%, 89.4%, and 99.3%, respectively. Against the striped flea beetle, RAPTOR 10% EC achieved 79.5%, 86.4%, and 97.7% effectiveness, which was practically identical to BREAK, IU (79.7%, 86.7%, and 97.7%). In the case of the striped leafhopper, RAPTOR 10% EC provided 78.1%, 87.5%, and 97.7% control, whereas the standard treatment resulted in 78.6%, 88.1%, and 97.6% effectiveness. In the untreated control, pest abundance remained stable or increased during the observation period. Overall, RAPTOR 10% EC demonstrated consistently high biological activity and was not inferior to the standard product in the control of all three pests (Darwish & Nasser, 2024; Essah *et al*., 2024; Ghati *et al*., 2024; Hsiao *et al*., 2024; Jabin & Guthrie, 2025; Jagsi *et al*., 2025; Moyo & Dlamini, 2025; Ramirez *et al*., 2025).

Table 2. Biological effectiveness of RAPTOR 10% EC against pests of spring wheat

Pest	Treatment	Before treatment	Day 1	Day 3	Day 7	Day 14	Reduction at final assessment, %
Wheat thrips, pcs./10 sweeps	RAPTOR 10% EC – 0.1 L/ha	74.3	-	16.8	8.5	1.0	98.7
	BREAK, IU – 0.1 L/ha (standard)	73.3	-	16.0	7.8	0.5	99.3
	Control (untreated)	74.5	-	75.3	79.5	91.0	-
Striped flea beetle, pcs./m²	RAPTOR 10% EC – 0.1 L/ha	75.5	15.5	10.3	1.8	-	97.7
	BREAK, IU – 0.1 L/ha (standard)	75.3	15.3	10.0	1.8	-	97.7
	Control (untreated)	75.0	75.8	84.0	95.8	-	-
Striped leafhopper, pcs./stem	RAPTOR 10% EC – 0.1 L/ha	3.2	0.7	0.4	0.1	-	97.7
	BREAK, IU – 0.1 L/ha (standard)	3.2	0.7	0.4	0.1	-	97.6
	Control (untreated)	3.2	3.3	3.4	3.6	-	-

Table 3 presents the biological effectiveness of RAPTOR 10% EC against the gray grain cutworm in spring wheat crops. The insecticide was compared with the standard product and the untreated control under fourfold replication.

Table 3. Biological effectiveness of the insecticide RAPTOR 10% EC against the gray grain cutworm in spring wheat crops

Experimental variant (name, application rate)	Replication	Number of larvae per 10 ears, pcs.			Reduction of caterpillars the day of accounting, %	
		before treatment	on day of accounting		on day of accounting	
			3	7	3	7
RAPTOR 10% EC – 0.075 L/ha	1	14	3	1	-	-
	2	13	4	1	-	-
	3	15	5	0	-	-
	4	11	2	0	-	-
	Avg.	13,3	3,5	0,5	73,6	96,2
BREAK, IU – 0.075 L/ha (standard)	1	12	5	1	-	-
	2	16	2	0	-	-
	3	10	2	0	-	-
	4	13	4	1	-	-
	Avg.	12,8	3,3	0,5	74,5	96,1
Control (untreated)	1	14	12	15	-	-
	2	11	15	13	-	-
	3	16	13	14	-	-
	4	13	16	17	-	-
	Avg.	13,5	14,0	14,8	-	-

Table 4 presents the results of the field experiment evaluating the biological effectiveness of RAPTOR 10% EC against the sunn pest in spring wheat crops. The tested insecticide was compared with the standard treatment and the untreated control (Essah *et al*., 2024; Formiga *et al*., 2024; Hsiao *et al*., 2024; Iftode *et al*., 2024; Adams & Hayes, 2025; Jagsi *et al*., 2025; King *et al*., 2025; Mishra *et al*., 2025; Romero *et al*., 2025; Yu *et al*., 2025).

Table 4. Biological effectiveness of the insecticide RAPTOR 10% EC against sunn pest in spring wheat crops

Experimental variant (name, application rate)	Replication	Number of larvae per 1 m²			Reduction of caterpillars the day of accounting, %	
		before treatment	on day of accounting		on day of accounting	
			3	7	3	7
RAPTOR 10% EC – 0.075 L/ha	1	2,9	0,7	0,1	-	-
	2	3,1	0,8	0,0	-	-
	3	2,8	0,5	0,0	-	-
	4	2,7	0,4	0,1	-	-
	Avg.	2,9	0,6	0,1	79,1	98,3
BREAK, IU – 0.075 L/ha (standard)	1	2,5	0,7	0,0	-	-
	2	2,9	0,5	0,0	-	-
	3	2,6	0,4	0,0	-	-

	4	3,0	0,7	0,1	-	-
	Avg.	2,8	0,6	0,0	79,1	99,1
Control (untreated)	1	2,8	2,7	3,1	-	-
	2	2,7	3,0	2,8	-	-
	3	3,1	2,9	3,2	-	-
	4	2,6	3,3	3,4	-	-
	Avg.	2,8	3,0	3,1	-	-

Table 5 shows the biological effectiveness of RAPTOR 10% EC against Hessian fly in spring wheat crops at two application rates. The results are compared with those of the standard product and the untreated control.

Table 5. Biological effectiveness of the insecticide RAPTOR 10% EC against Hessian fly in spring wheat crops

Experimental variant (name, application rate)	**Replication**	**Average number of larvae per linear meter of row, pcs.**				**Reduction, %**		
		before treatment	**Per day after treatment**					
			3	**7**	**14**	**3**	**7**	**14**
RAPTOR 10% EC – 0.075 L/ha	1	3,3	1,0	0,5	0,1	-	-	-
	2	3,1	1,2	0,8	0,2	-	-	-
	3	3,5	1,1	0,6	0,1	-	-	-
	4	3,2	0,7	0,5	0,4	-	-	-
	Avg.	3,3	1,0	0,6	0,2	69,5	81,7	93,9
RAPTOR 10% EC – 0.1 L/ha	1	3,6	0,9	0,6	0,2	-	-	-
	2	3,1	1,1	0,4	0,0	-	-	-
	3	3,2	0,8	0,7	0,1	-	-	-
	4	3,3	1,0	0,3	0,0	-	-	-
	Avg.	3,3	1,0	0,5	0,1	71,2	84,8	97,7
BREAK, IU – 0.075 L/ha	1	3,0	0,9	0,5	0,2	-	-	-
	2	3,4	0,9	0,7	0,1	-	-	-
	3	3,1	1,1	0,7	0,3	-	-	-
	4	3,2	0,9	0,4	0,1	-	-	-
	Avg.	3,2	1,0	0,6	0,2	70,1	81,9	94,5
BREAK, IU – 0.1 L/ha	1	3,4	1,1	0,3	0,0	-	-	-
	2	3,5	0,8	0,7	0,1	-	-	-
	3	3,1	1,0	0,5	0,1	-	-	-
	4	3,3	0,9	0,5	0,0	-	-	-
	Avg.	3,3	1,0	0,5	0,1	71,4	85,0	98,5
Control (untreated)	1	3,1	3,1	3,5	3,4	-	-	-
	2	3,5	3,4	3,3	3,6	-	-	-
	3	3,1	3,6	3,6	3,9	-	-	-
	4	3,3	3,4	3,7	3,7	-	-	-
	Avg.	3,3	3,4	3,5	3,7	-	-	-

Table 6 presents the biological effectiveness of RAPTOR 10% EC against the cereal stem flea beetle in spring wheat crops. The insecticide was evaluated at two application rates in comparison with the standard treatment and the untreated control.

Table 6. Biological effectiveness of the insecticide RAPTOR 10% EC against cereal stem flea beetle in spring wheat crops

Experimental variant (name, application rate)	**Replication**	**Average number per 10 sweeps, pcs.**				**Reduction, %**		
		before treatment	Per day after treatment					
			1	3	7	1	3	7
RAPTOR 10% EC – 0.075 L/ha	1	3,8	1,0	0,7	0,2	-	-	-

	2	4,0	1,3	0,4	0,1	-	-	-
	3	3,9	1,2	0,5	0,3	-	-	-
	4	4,2	0,9	0,5	0,2	-	-	-
	Avg.	4,0	1,1	0,5	0,2	72,3	86,8	95,0
RAPTOR 10% EC – 0.1 L/ha	1	3,6	0,7	0,5	0,0	-	-	-
	2	4,1	1,1	0,6	0,0	-	-	-
	3	4,0	0,8	0,4	0,0	-	-	-
	4	3,7	1,2	0,3	0,0	-	-	-
	Avg.	3,9	1,0	0,5	0,0	75,3	88,3	100,0
BREAK, IU – 0.075 L/ha	1	4,1	1,3	0,4	0,4	-	-	-
	2	3,8	1,0	0,6	0,1	-	-	-
	3	4,3	0,9	0,5	0,0	-	-	-
	4	4,0	1,2	0,7	0,2	-	-	-
	Avg.	4,1	1,1	0,6	0,2	72,8	86,4	95,7
BREAK, IU – 0.1 L/ha	1	4,0	0,9	0,3	0,0	-	-	-
	2	3,7	1,1	0,4	0,0	-	-	-
	3	3,9	1,0	0,6	0,0	-	-	-
	4	3,7	0,7	0,4	0,0	-	-	-
	Avg.	3,8	0,9	0,4	0,0	75,8	88,9	100,0
Control (untreated)	1	3,6	3,7	4,1	4,9	-	-	-
	2	3,7	3,9	4,5	5,2	-	-	-
	3	4,0	4,1	4,2	4,8	-	-	-
	4	3,9	3,8	4,4	4,6	-	-	-
	Avg.	3,8	3,9	4,3	4,9	-	-	-

Table 7 shows the effect of RAPTOR 10% EC treatment on spring wheat grain yield. Yield performance is presented for both application rates in comparison with the standard product and the untreated control.

Table 7. Effect of treatment of spring wheat crops with RAPTOR 10% EC insecticide on grain yield

Variant	Yield, c/ha					Deviation from control	
	I	II	III	IV	Cp.	c/ha	%
Control (untreated)	12,1	11,7	12,3	11,6	11,9	-	-
RAPTOR 10% EC – 0.075 L/ha	15,4	15,1	15,5	15,3	15,3	3,4	28,5
RAPTOR 10% EC – 0.1 L/ha	15,6	15,4	15,8	15,7	15,6	3,7	31,0
BREAK, IU – 0.075 L/ha (standard)	15,3	15,4	15,4	15,5	15,4	3,5	29,1
BREAK, IU – 0.1 L/ha (standard)	**15,5**	**15,8**	**15,7**	**15,9**	**15,7**	**3,8**	**31,9**

Observed side effects of the pesticide, including on non-target objects (specify species): note the effect on the skin and respiratory organs of workers handling the preparation. Other negative effects: not noted.

According to the results of the small-plot trials, the insecticide RAPTOR 10% EC (lambda-cyhalothrin, 100 g/L) showed biological efficiency at the level of the standard preparation BREAK ME. Against wheat thrips, the efficiency was 94.3%; striped flea beetle, 97.7%; striped leafhopper, 97.7%; gray grain cutworm, 96.2%; sunn pest, 98.3%; Hessian fly, 93.9–97.7%; and cereal stem flea beetle, 95.0–100.0% (for the standard preparation BREAK ME, the efficiency against these pests was 95.5, 97.7, 97.6, 96.1, 99.1, 94.5–98.5, and 95.7–100.0%, respectively).

The yield increase when using RAPTOR 10% EC (lambda-cyhalothrin, 100 g/L), compared with the control, amounted to 3.4 c/ha (application rate 0.075 L/ha) and 3.7 c/ha (application rate 0.1 L/ha).

Proposals to incorporate the tested pesticide into the production trial plan or to continue small-plot trials of the pesticide for one growing season in order to provide clarification and/or account for the lack of harmful organisms or their quantity and level of development below the economic threshold of harmfulness (Ahmed *et al*., 2024; Ashyrov & Lukason, 2024; Cai *et al*., 2025; Guillen & Pereira, 2024; Hodoşan *et al*., 2024; Komov *et al*., 2024; Mayer *et al*., 2024; Okello *et al*., 2025; Romero *et al*., 2025).

The insecticide RAPTOR 10% EC (lambda-cyhalothrin, 100 g/L) was found to be effective based on the small-plot experiment findings. Registrant: It is suggested that LLP "Harvest LTD," China, be added to the plan for carrying out production trials on spring wheat, with application rates of 0.1 L/ha against thrips, flea beetles, and leafhoppers; 0.075 L/ha against gray grain cutworm and sunn pest; and 0.075–0.1 L/ha against cereal flies and stem flea beetles, using a working solution consumption of 200 L/ha during the growing season.

Proposals regarding the practicality of state registration of the pesticide at the tested application rates of the preparation and working solution rates, ongoing registration or production trials for the purpose of clarification, and the rules governing the use of the preparation that is suggested for registration (Dashkevich *et al*., 2022; Yskak *et al*., 2025).

If the results of the small-plot trials are confirmed in production trials, the insecticide RAPTOR 10% EC (lambda-cyhalothrin, 100 g/L). Registrant: LLP "Harvest LTD," China, is recommended to be registered on spring wheat against wheat thrips (*Haplothrips tritici*), striped flea beetle (*Phyllotreta vittula*), and striped leafhopper (*Psammotettix striatus*) at an application rate of 0.1 L/ha; against gray grain cutworm (*Apamea anceps*) and sunn pest (*Eurygaster integriceps*) at an application rate of 0.075 L/ha; and against Hessian fly (*Mayetiola destructor*) and stem flea beetle (*Chaetocnema hortensis*) at application rates of 0.075–0.1 L/ha, by the method of full-cover spraying during the growing season, with a working solution consumption of 200 L/ha, and to be included in the "List of pesticides permitted for production (formulation), import, storage, transportation, sale, and application in the territory of the Republic of Kazakhstan." Number of treatments – 1 (Jeung, 2024; Zielinska & Kowal, 2024; Castellano-Rioja, 2025).

CONCLUSION

The insecticide RAPTOR 10% EC (lambda-cyhalothrin, 100 g/L) showed high and prolonged effectiveness against thrips on spring wheat. Already on the 3rd day after treatment, the number of pests decreased by 77.4%; on the 7th day, by 88.6%; and by, the 14th day, it reached 98.7%, which is comparable to the standard preparation BREAK ME. The preparation also demonstrated high biological efficiency against a complex of pests (flea beetles, leafhoppers, cutworms, sunn pest, and Hessian fly) and provided a yield increase of up to 3.7 c/ha. No side effects on non-target objects or the health of workers were identified. The obtained data confirm the expediency of further production trials and possible registration of the preparation in the Republic of Kazakhstan.

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