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BIOLOGICAL AND ECONOMIC EFFECTIVENESS OF INSECTICIDES AGAINST POTATO PESTS IN THE CONDITIONS OF AKMOLA REGION

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The article presents the results of a study on the effect of insecticides on potato yield and determines the biological effectiveness against the Colorado potato beetle and the economic effectiveness of insecticides on potatoes.

The research tests were placed at the experimental field of Kokshetau Experimental Production Farm LLP, Akmola region. The research was carried out on potato culture, the Shagalaly variety, approved for use in the Akmola region since 2008. At the first spraying on the biological effectiveness of insecticides, that is, the death of the larvae of the Colorado beetle, the maximum indicator was observed in the variant of the experiment with the insecticide YUKAZ-7, the efficiency was 96 %. The biological efficiency of the standard Break, M.E. (0.05 l/ha) was maximum of 92,2%, on average for 3 records – 89.7% (1-spraying).

During the second spraying of potatoes with insecticides, the highest biological efficiency of 93.7% was observed in the variant using YUKAZ-7 (0.05 l/ha), on average 90.9%. The lowest biological efficiency index of 83.5% was observed in the variant with the use of Regent (0.025 kg/ha).

Key words: potato; meteorological indicators; insecticides; colorado potato beetle; biological efficiency; economic efficiency; yield.

БИОЛОГИЧЕСКАЯ И ХОЗЯЙСТВЕННАЯ ЭФФЕКТИВНОСТЬ ИНСЕКТИЦИДОВ ПРОТИВ ВРЕДИТЕЛЕЙ КАРТОФЕЛЯ В УСЛОВИЯХ АКМОЛИНСКОЙ ОБЛАСТИ

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В статье приведены результаты исследования по влиянию инсектицидов на урожайность картофеля, определены биологическая эффективность против колорадского жука и хозяйственная эффективность инсектицидов на картофеле.

Научно-исследовательские испытания были размещены на опытном поле ТОО «Кокшетауское опытно-производственное хозяйство», Акмолинской области. Исследования проведены на культуре картофель, сорт Шагалалы, допущен к использованию в Акмолинской области с 2008 г.

При первом опрыскивании по биологической эффективности инсектицидов, то есть гибели личинок колорадского жука, максимальный показатель наблюдался в варианте опыта с инсектицидом ЮКАЗ-7, к.э. составила 96,0 %. Биологическая эффективность эталона Брейк, м.э. (0,05 л/га) максимально составляла 92,2%, в среднем за 3 учета – 89,7 % (1-опрыскивание).

При втором опрыскивании картофеля инсектицидами наибольшая биологическая эффективность 93,7 % наблюдалась в варианте с применением ЮКАЗ-7, к.э.0,05 л/га, в среднем 90,9%. Наименьший показатель биологической эффективности 83,5 % наблюдался в варианте с применением Регент 0,025 кг/га, в в среднем за 3 учета –87,3%.

Наибольшую хозяйственную эффективность показали инсектициды Фипромакс в.д.г. – урожайность составила 21,8 т/га.

Ключевые слова: картофель; метеорологические показатели; инсектициды; колорадский жук; биологическая эффективность; хозяйственная эффективность; урожайность.

АҚМОЛА ОБЛЫСЫ ЖАҒДАЙЫНДА КАРТОП ЗИЯНКЕСТЕРІНЕ ҚАРСЫ ИНСЕКТИЦИДТЕРДІҢ БИОЛОГИЯЛЫҚ ЖӘНЕ ШАРУАШЫЛЫҚ ТИІМДІЛІГІ

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Мақалада картоптың өнімділігіне инсектицидтердің әсері келтірілген, Колорадо қоңызына қарсы инсектицидтердің биологиялық тиімділігі және картоптағы инсектицидтердің шаруашылық тиімділігі анықталған.

Инсектицидтердің ғылыми-зерттеу сынақтары Ақмола облысы, "Көкшетау тәжірибелік-өндірістік шаруашылығы" ЖШС тәжірибе алаңына орналастырылды. Зерттеулер картоп дақылына, Шағалалы сортына жүргізілді, ол Ақмола облысында 2008 жылдан бастап пайдалануға рұқсат етілді.

Инсектицидтердің биологиялық тиімділігі бойынша бірінші бүрку кезінде, яғни Колорадо қоңызының дернәсілдің өлімі, ең жоғары көрсеткіш ЮКАЗ-7 инсектицидімен тәжірибе нұсқасында байқалды, 96 % құрады. Брейк (0,05 л/га) эталонының биологиялық тиімділігі, барынша 92,2% құрады, орташа алғанда (3 рет есепке алу)– 89,7 % (1-бүрку).

Картопты инсектицидтермен екінші рет бүрку кезінде нұсқада ең үлкен биологиялық тиімділік ЮКАЗ-7 0,05 л/га инсектицидін қолдану кезінде байқалды, 93,7%, орташа 90,9%. Биологиялық тиімділіктің ең төменгі көрсеткіші 83,5 т/га Регентті (0,025 кг/га) қолданумен нұсқада байқалды, орташа алғанда 3 рет есепке алу кезінде -87,3%.

Шаруашылық тиімділігі жағынан ең жоғары өнімдік 21,8 т/га Фипромакс в.д.г. инсектициді нұсқасы көрсетті.

Түйінді сөздер: картоп; метеорологиялық көрсеткіштер; инсектицидтер; колорадо қоңызы; биологиялық тиімділігі; шаруашылық тиімділігі; өнімділік.

Introduction. Potato is the most important food, fodder and industrial crop grown in the Akmola region, with a yield in the region of 120.4 centners per hectare in 2015. Annually, the yield decreases from a complex of harmful objects, among which the Colorado potato beetle is the most dangerous. In this regard, when cultivating potatoes, it is necessary to provide for a set of measures aimed at reducing the number of the Colorado potato beetle to an economically imperceptible level. Particular attention should be paid to the introduction into production of productive resistant or relatively resistant potato varieties with various mechanisms of resistance to the phytophage, which will ensure not only long-term control of the density of pest populations, but also reduce crop losses. This does not exclude the possibility of using insecticides from new, promising chemical groups [1. p. 24; 2. p. 123; 3. p. 165; 4. p. 32; 5. p.186].

Potatoes in the field and storage are damaged by many harmful insects. More than 60 species of pests specific to this crop, as well as polyberries, have been noted on potatoes. Leaves and stems are damaged by the Colorado potato beetle, red-headed shanks, aphids, cicadas, bugs, thrips.

Currently, a dangerous pest is the Colorado potato beetle (Leptinotarsa desemlineata Say). Until 1985, it was a quarantine pest in Kazakhstan. The first foci of the Colorado potato beetle in our country were found in the northern regions, and since 1987 it has acquired the significance of a mass pest. In addition to

potatoes, the Colorado potato beetle causes great harm to the main vegetable crops of the nightshade family (tomato, eggplant, pepper), as well as industrial crops (tobacco).

The pest colonization in the field is 70-100% with a population of 15-30 larvae per bush. The length of the Colorado potato beetle is 9-11 mm, its body is oval, convex, reddish yellow in color, very similar in shape to a ladybug. There are 10 longitudinal black stripes on the wings, the anterior dorsum with eleven black spots, one of them in the center, similar to the Roman U [6. p.19; 7. p.32; 8. p.105].

The research aim is to study the biological and economic effectiveness of insecticides in the conditions of the Akmola region.

The research objects were insecticides YuKAZ-7, k.e. (lambda-cyhalothrin, 100 g/l); Break m.e. 0.05 l/ha; Fipromax w.d.g. (0.02-0.025 kg/ha); Regent 0.025 kg/ha.

Research materials and methods. Small plot tests of insecticides were placed on the experimental field of Kokshetau Experimental Production Farm LLP, Akmola region.

The studies were carried out on the potato culture, the Shagalala variety, approved for use in the Akmola region since 2008.

The predecessor of the potato is spring wheat. In autumn, autumn plowing was carried out to 27-30 cm, in spring – pre-planting cultivation of the field. Mineral fertilizers were applied under potatoes in the norm N90P60K75. Potatoes were planted in the 2nd decade of May. Row spacing - 70 cm, seed potato planting rate – 3.5 t/ha. Measures for plant care: watering, loosening row spacing, hilling, pest control.

The pest against which the products have been tested is the Colorado potato beetle (Leptinotarsa decemlineata Say).

The experimental plot soil is ordinary chernozem, heavy loamy in texture. The topsoil contains about 4.0% humus; 0.2-0.25% total nitrogen; 0.15-0.17% of gross phosphorus. The content of mobile phosphorus is 25-30 mg/kg, exchangeable potassium is 400-450 mg/kg. The reaction of the soil solution is close to neutral, pH 7.2-7.3. The volumetric mass of the soil is 1.0-1.1 kg/cm3.

The scheme of experience is presented as follows:

1) Control (without processing)
2) YUKAZ-7, k.e. - 0.05 l/ha (test preparation)
3) Break, m.e. - 0.05 l/ha (reference)
4) Fipromax w.d.g. (0.02-0.025 kg/ha)
5) Regent 0.025 kg/ha

Type of experiment: field - registration (small plot), the area of the experimental plot - 63 m2 (4.2 m x 15 m). The repetition of experience - 4-fold. Continuous processing of plantings of potatoes was carried out with insecticides YUKAZ-7, k.e. (lambda-cyhalothrin, 100 g/l); Break m.e. 0.05 l/ha; Fipromax w.d.g. (0.02-0.025 kg/ha); Regent 0.025 kg/ha. Method of application of the drug - 2-fold spraying during the growing season.

To spray plantings of potatoes with insecticides under test against the Colorado potato beetle, a GRINDA backpack sprayer with a capacity of 4 liters was used. The consumption rate of the working fluid is 200-300 l/ha.

In the hilly-flat zone of the Akmola region, meteorological conditions play a decisive role in the growth and development of potato plants. The main feature of the climate is its sharp continentality, which is manifested by a large amplitude of fluctuations in air temperature, dryness of the air and an insignificant amount of precipitation in some years.

The main meteorological indicators - precipitation and temperature conditions - show that the conditions for the development of potato plants in 2021 are satisfactory. The air temperature in May was 12.4°C, and 7.8 mm of precipitation fell (Table 1). The air temperature in June exceeded the long-term average by 0.2 °C. Precipitation in June was 40.2 mm (Table 1). The air temperature in July, 20.6°C and in August, 16.7°C, was at the level of long-term average data (Table 1). An insignificant amount of precipitation in July (40.2 mm) and August (28.0 mm) negatively affected the accumulation of the crop and the passage of such phases of potato development as budding and flowering. During the growing season (May-August), 110.7 mm of precipitation fell (Table 1).

Meteorological indicators for the growing season of 2021 are shown in Table 1.

Table 1 – Meteorological data for the growing season 2021

Meteorological indicators	Сроки (декады, годы)	Months						Average (sum) for the growing season.
		April	May	June	July	August	September	
Air temperature 0,	I decade	+1,6	+12,4	+14,6	+23,3	+21,4	+14,5	14,6
	II decade	+5,3	+17,8	+19,5	+17,2	+18,7	+10,6	14,9

C	III decade	+7,6	+21,2	+17,5	+21,3	+19,5	+4,7	15,3
	average month	+4,8	+17,1	+17,2	+20,6	+19,9	+9,9	14,9
	rennial	+4,4	+11,9	+17,0	+20,1	+16,7	+10,5	13,4
Atmospheric precipitation, mm	I decade	-	5,0	5,0	6,0	17,5	6,7	8,0
	II decade	-	0,6	18,0	3,7	2,0	0,3	10,9
	III decade	9,2	2,2	2,5	0,5	9,5	7,2	5,2
	um. per month	9,2	7,8	25,5	40,2	28,0	14,2	20,8
	rennial.	22,7	35,0	42,4	66,7	36,2	26,1	38,2

The weather conditions of the growing season in 2021 were noticeably different compared to the average long-term data. The peculiarities of the meteorological conditions of the current year are the small amount and uneven distribution of precipitation, sharp fluctuations in air temperature in the spring and summer. It should also be noted an insignificant amount of precipitation in the phase of tuberization, which had an adverse effect on crop yields.

The studies were carried out according to generally accepted methods: “Methodology of the field experiment” [9. p.88-101]; "Guidelines for conducting registration tests of herbicides, defoliants, desiccants and plant growth regulators" [10 p.8].

Registration tests of insecticides against the potato pest (Colorado potato beetle) were carried out according to the "Guidelines for conducting registration tests of insecticides, acaricides, biological products and pheromones in crop production" (Almaty-Akmola, 1997) [10. p.12].

The insecticide is tested against larvae and adults (adult beetles) with a population of at least 10 larvae of II-III instars per 1 bush. Pest counts are carried out before insecticide treatment (test and reference) and after treatment on day 3, day 7 and day 14. The biological effectiveness of the insecticide is calculated by the formula: E \u003d 100 x (1 - (Ta x sv) : (Tv x ca), where E is the effectiveness of the drug in% of the control (adjusted decrease); Tv is the number of living individuals before treatment in the experiment ; Ta - the number of live individuals after treatment in the experiment; sv - the number of live individuals in the control in the preliminary account; ca - the number of live individuals in the control in subsequent counts.

Accounting for the potato crop was carried out by a continuous method from the entire area of the registration plot according to 4 repetitions of the registration (small-plot) experiment.

Research results. The Colorado potato beetle has played a large role in the creation of the modern pesticide industry, with hundreds of chemicals tested against it. High selection pressure, together with a natural tendency to adapt to toxic substances, eventually led to a large number of insecticide-resistant populations of the Colorado potato beetle [11. p. 140; 12. p.395]. The biological effectiveness of pesticides is the result of using the pesticide in the field, which is expressed in terms of death, reduction in the number of harmful organisms or the degree of damage by them to protected plants (%) [13. p.23].

The results of our research on the biological effectiveness of insecticides against the Colorado potato beetle on potatoes are shown in tables 2-3, economic efficiency - in table 4.

Table 2 – Biological effectiveness of insecticides against the Colorado potato beetle, 2021 (first spray)

Experience options	Repeatability of experience	The number of larvae of the Colorado potato beetle per 1 bush on the day of registration, individuals				Decrease in the number on the day of registration,%		
		before processing	3-day	7-day	14-day	3-day	7-day	14-day
Control (no processing)	1	15	17	20	24			
	2	14	16	19	23			
	3	11	13	17	20			
	4	19	20	23	27			
	Average	**14,75**	**16,5**	**19,75**	**23,5**	-	-	-
Processing YuKAZ-7 k.e. 0.05 l/ha (test drug)	1	17	2,3	2,1	1,5			
	2	18	1,8	1,5	0,8			
	3	14	1,4	0,9	0,5			
	4	17	2,0	1,6	1,3			
	Average	**16,5**	**1,87**	**1,52**	**1,03**	**89,6**	**92,8**	**96,0**
Break, m.e. 0.05 l/ha (reference)	1	13	1,5	0,8	2,1			
	2	16	1,7	1,4	2,6			
	3	18	3,0	2,2	3,5			
	4	14	2,4	2,0	1,9			
	Average	**15,25**	**2,15**	**1,60**	**2,52**	**87,4**	**92,2**	**89,6**

Fipromax w.d.g. (0.02-0.025 kg/ha)	1	20	3,0	1,8	1,3			
	2	17	2,5	1,5	1,2			
	3	15	2,0	1,9	1,4			
	4	16	1,6	1,0	0,8			
	Average	**17,0**	**2,27**	**1,55**	**1,17**	**86,6**	**90,9**	**93,1**
Regent 0.025 kg/ha	1	17	2,7	2,4	1,7			
	2	15	2,5	2,3	1,5			
	3	16	2,6	1,7	0,8			
	4	14	1,8	1,2	0,5			
	Average	**15,5**	**2,4**	**1,9**	**1,1**	**84,5**	**87,7**	**92,9**

To determine the biological effectiveness of pesticides, a control plot (without treatment) is left on part of the field; accordingly, under laboratory conditions, colonies (groups) of harmful organisms that are not treated with pesticides are isolated. Accounting is carried out according to repetitions (accounting sites, accounting trees or shrubs, samples of leaves or cut plants, etc.) [14. p.30].

Insecticide YuKAZ-7, k.e. (lambda-cyhalothrin, 100 g/l), registrant company –LLP "UKAZ Group", Kazakhstan, when tested on potatoes at a rate of 0.05 l/ha against the pest (Colorado potato beetle) showed a fairly high efficiency.

Biological efficiency, i.e. the death of larvae of the Colorado potato beetle from the use of the insecticide YuKAZ-7, k.e. was maximum 96.0%, and on average for 3 counts – 92.8% (data of the first spraying are given). Biological efficiency of the Break standard, m.e. (0.05 l/ha) maximum was 92.2%, on average for 3 surveys – 89.7% (data of the first spraying are given).

Biological efficiency of the Break standard, m.e. (0.05 l/ha) maximum was 92.2%, on average for 3 surveys - 89.7% (1-spraying).

Decrease in the number of Colorado potato beetle larvae on the day of registration when using the insecticide Fipromax v.d.g. (0.02-0.025 kg/ha) was 93.1%, on average for 3 surveys – 90.2% (1-spraying).

The biological effectiveness of the insecticide Regent 0.025 kg/ha – 92.9%, on average for 3 counts – 88.4% (1-spraying).

Table 3 – Biological effectiveness of insecticides against the Colorado potato beetle, 2021 (second spray)

Experience options	Repeatability of experience	The number of larvae of the Colorado potato beetle per 1 bush on the day of registration, individuals				Decrease in the number on the day of registration,%		
		before processing	3-day	7-day	14-day	3-day	7-day	14-day
Control (no processing)	1	15	16	19	25			
	2	18	20	24	27			
	3	13	15	18	22			
	4	17	19	21	26			
	Average	**15,75**	**17,50**	**20,50**	**25,00**	-	-	-
Processing YuKAZ-7 k.e. 0.05 l/ha (test drug)	1	16	2,3	2,1	1,5			
	2	14	1,8	1,5	0,8			
	3	16	1,4	0,9	0,5			
	4	19	2,0	1,6	1,3			
	Average	**16,25**	**1,87**	**1,52**	**1,03**	88,49	90,6	93,7
Break, m.e. 0.05 l/ha (reference)	1	18	2,5	2,0	1,7			
	2	11	2,4	2,1	1,6			
	3	19	1,9	1,6	1,1			
	4	17	2,1	1,5	0,9			
	Average	**16,25**	**2,22**	**1,8**	**1,32**	86,3	88,9	91,9
Fipromax w.d.g. (0.02-0.025 kg/ha)	1	13	1,9	1,0	2,0			
	2	15	2,3	2,0	2,1			
	3	12	2,7	1,4	0,7			
	4	13	1,5	0,9	1,5			
	Average	13,25	**2,1**	**1,32**	**1,57**	84,1	90,0	88,1
Regent 0.025 kg/ha	1	14	1,3	2,3	1,5			
	2	16	2,7	2,1	1,0			
	3	11	2,6	1,2	0,2			
	4	10	1,8	1,0	1,6			
	Average	**12,75**	**2,1**	**1,65**	**1,07**	83,5	87,0	91,6

During the second spraying, the highest efficiency was observed in the variant with the use of the YuKAZ-7, k.e. 0.05 l/ha insecticide, where the number of the Colorado potato beetle decreased to 93.7%, on average 90.9%. The lowest indicator of biological efficiency was observed in the variant with the use of Regent 0.025 kg/ha 83.5, on average for 3 counts – 87.3%.

For potatoes, the pest is most dangerous during the periods of budding and flowering. Potato crop losses are often more than 30%. Due to the rapid adaptation of the beetle in a wide range of environmental conditions, a high level of its abundance and harmfulness on potatoes is now observed annually at all points of the continuous distribution zone, and often in foci near the northeastern border of the species range [15. p.43-54; 16. p.206-210].

According to the authors, the world level of development of plant protection is currently focused on increasing plant resistance to pests, maximizing the use of the natural forces of agrocenoses, expanding the use of biological methods, and the rational use of chemicals [17. p.218-221; 18. p.15-16].

Protective measures include the cultivation of the most resistant varieties to the pest, the observance of crop rotations with spatial isolation of plantings of nightshade crops and their return to their original place no more than 1 time in 4 years, the placement of plantings of nightshade crops near forests, groves, meadows and pastures as reserves of natural entomophages pest, pre-harvest destruction of potato tops and thorough harvesting of tubers, the creation of proactive bait plantings of potatoes. When the number of the beetle exceeds the EPV, the use of biological preparations and insecticides of various classes is alternated in order to avoid the formation of pest populations resistant to them. Of all the methods of struggle, the most effective is chemical. It is reliable, simple, relatively little dependent on meteorological conditions. The speed of action of the drugs allows you to get the effect after a few hours, and after 1-3 days, almost complete destruction of the pest is achieved [19. p.167-168; 20. p.33-52].

We considered the economic efficiency of the use of a pesticide, that is, the result of the use of a pesticide in the field, expressed by indicators of the quantity and quality of stored agricultural products.

In our study, insecticides also differed in economic efficiency, that is, in terms of yield and the size of the saved potato crop. When considering the control variant, the potato yield was 14.2 t/ha. The economic efficiency of the YuKAZ-7, k.e. insecticide, was also high - 45.8%. The test preparation ensured the preservation of 6.5 t/ha of potato crop from destruction by the Colorado potato beetle. In the variant with the use of the Regent insecticide, 5.5 t/ha of tubers were saved, here the economic efficiency was 38.7%.

Table 4 – Economic efficiency of insecticides, on potatoes (2021)

Experience options	Repetitions of the field experience (potato yield, t/ha)				Average yield, t/ha	Harvest saved from the pest	
	1	2	3	4		т/га	%
Control (no processing)	13,7	12,3	14,8	16,2	14,2	-	-
Processing YuKAZ-7 k.e. 0.05 l/ha (test drug)	19,2	20,1	22,3	21,4	20,7	6,5	45,8
Break, m.e. 0.05 l/ha (reference)	18,6	19,0	20,4	19,7	19,4	5,2	36,6
Fipromax w.d.g. (0.02-0.025 kg/ha)	22,5	20	23,2	21,5	21,8	7,6	53,5
Regent 0.025 kg/ha	25,2	15,8	16,8	20,9	19,7	5,5	38,7
$lsd_{0,5}$					2,6		

The economic efficiency of the insecticide YuKAZ-7, k.e., was also high – 45.8%. The test preparation ensured the preservation of 6.5 t/ha of potato crop from destruction by the Colorado potato beetle. In the variant with the standard Break, m.e., 5.2 t/ha of tuber yield was preserved (36.6%).

Insecticide YuKAZ-7, k.e. (lambda-cyhalothrin, 100 g/l), registrant company – LLP "YUKAZ Group", Kazakhstan, when tested on potatoes at a rate of 0.05 l/ha against the pest (Colorado potato beetle) showed a fairly high economic efficiency. At the same time, the highest indicator of economic efficiency was observed in the variant of the experiment with the use of the insecticide Fipromax v.d.g. (0.02-0.025 kg/ha), here the yield was 21.8 t/ha, with a saved yield of 53.5%. This is followed by a variant of the experiment with the use of insecticide YuKAZ-7 - 20.7 t/ha, the yield saved from the pest was 6.5 t/ha.

Conclusion. Thus, in the Colorado potato beetle control, the insecticides Fipromax w.d.g. showed the greatest economic efficiency. The highest biological efficiency in the potatoe pest control – the Colorado potato beetle was observed in the variant with the use of the insecticide YuKAZ-7, k.e. 0.05 l/ha 93.7%, on average 90.9%. The lowest indicator of biological efficiency was observed in the variant with the use of Regent 0.025 kg/ha 83.5, on average for 3 counts – 87.3%.

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ИСПОЛЬЗОВАНИЕ КАНАДСКОЙ ТЕХНОЛОГИИ VYTELLE (GROWSAFE) ДЛЯ ОЦЕНКИ РОСТА И РАЗВИТИЯ КАЗАХСКОЙ БЕЛОГОЛОВОЙ ПОРОДЫ

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