ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)

2021 • 3

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

БАЯНДАМАЛАРЫ

ДОКЛАДЫ
НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

REPORTS
OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN

PUBLISHED SINCE JANUARY 1947

ALMATY, NAS RK

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
БАЯНДАМАЛАРЫ **2021 • 3**

«Қазақстан Республикасы Ұлттық ғылым академиясының баяндамалары»
ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» Республикалық қоғамдық бірлестігі (Алматы қ.). Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ93VPY00025418** мерзімдік басылым тіркеуіне қойылу туралы куәлік.
Тақырыптық бағыты: *наноматериалдар алу, биотехнология және экология саласындағы бірегей зерттеу нәтижелерін жариялау.*
Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.
Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28; 219 бөл.; тел.: 272-13-19, 272-13-18
http://reports-science.kz/index.php/en/archive

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

ДОКЛАДЫ **2021 • 3**

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

Доклады Национальной академии наук Республики Казахстан»
ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)
Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы). Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ93VPY00025418,** выданное 29.07.2020 г.
Тематическая направленность: *публикация оригинальных результатов исследований в области получения наномате-риалов, биотехнологии и экологии.*
Периодичность: 6 раз в год. Тираж: 300 экземпляров
Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28; ком. 219; тел. 272-13-19, 272-13-18
http://reports-science.kz/index.php/en/archive

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

REPORTS
OF NATIONAL ACADEMY OF SCIENCES OF THE
REPUBLIC OF KAZAKHSTAN

2021 • 3

Reports of the National Academy of Sciences of the Republic of Kazakhstan.
ISSN 2224-5227
ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)
Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).
The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ93VPY00025418,** issued 29.07.2020.
Thematic scope: *publication of original research results in the field of obtaining nanomaterials, biotechnology and ecology.*
Periodicity: 6 times a year.
Circulation: 300 copies.
Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19, 272-13-18
http://reports-science.kz/index.php/en/archive

Address of printing house: ST «Aruna», 75, Muratbayev str., Almaty.

REPORTS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
ISSN 2224-5227
Volume 3, Number 337 (2021), 46 – 52 **https://doi.org/10.32014/2021.2518-1483.47**

UDC631.811.98
IRSTI 68.35.49

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EFFECT OF THE COMPLEX HIGH MOLECULAR FERTILIZER STRESSTOP ON THE YIELD AND BIOCHEMICAL COMPOSITION OF POTATO TUBERS

Abstract. This article discusses the methods and standards for the use of complex high molecular fertilizer StresStop on potatoes in the conditions of the Akmola region. The article deals with the influence of the complex high molecular fertilizer StresStop on the yield, marketable qualities and biochemical composition of potatoes, depending on the norms of its application and the phase of development of potato plants. During the phase-by-phase treatment with StresStop fertilizer, at the doses recommended by the manufacturing institutions, the content of dry matter, starch and vitamin C in potato tubers changes, while the content of toxic elements in potatoes does not change significantly.

A significant effect of a complex high molecular fertilizer on potato yield was determined. The greatest increase in the potato yield +9.1 t / ha in comparison with the control variant was provided by spraying the variant treated with 0.01% StresStop solution in the full germination + flowering phase, where the yield was 17.5. The use of a complex high molecular fertilizer contributes to an increase in the yield, commodity and quality indicators of potatoes, while the study showed that the content of toxic elements in potatoes does not change significantly.

Key words: Potato, complex high molecular fertilizer, yield, marketability, biochemical composition.

Introduction. Potatoe is the most important food, fodder and commercial crop. Potato tubers are a valuable food product; they are also used to feed livestock and to produce alcohol, starch, and molasses [1]. Western Siberia and Northern Kazakhstan have a large area of potatoe fields, the most important food and fodder crop [2].

Potato is a raw material in the industrial production of starch, alcohol, chips, and the output of the finished product or its quality depends on the starch content in the tubers. Therefore, when accepting potatoes for processing, not only their quantity but also their starch content is taken into account. Fruits and vegetables are of particular value as sources of vitamins, primarily vitamin C (ascorbic acid). The daily requirement of the individual for vitamin C is 50-100 mg, and with heavy physical labor even more. It should be noted that vitamin C cannot accumulate in the body, so it should be consumed all the year round [3]. Currently, various types of organic, mineral growth fertilizers are used to increase the yield, marketable and qualitative indicators of various plant crops [4, 5, 6, 7], including potatoe [8].

Research goal:

- Identification of the effectiveness of applying complex high molecular fertilizer Stresstop to potatoe tubers.

Objectives:

- study the effect of application of complex high molecular fertilizer StresStop depending on the norms of its application and the phase of development of potato plants on the biochemical composition;
- study the effect of application of complex high molecular fertilizer Stresstop depending on the norms of its application and the phase of development of potato plants on the yield, marketability.

Materials and methods. The object of the study is Nevsky released variety of potatoes in Akmola Oblast. This variety is created by crossing Veselovsky and Katadin variety. The bush is well foliated. The stem is green. The leaves are dark green, penetrating, venation pattern is coarse. Lobes have long stalks; terminal lobe is rounded with heart-shaped base; lobes are mostly angular. Lobing is average.

Flowering is significant, but short. Buds are large; bells are dark green. Flowers are white, large with long pointed tips, sometimes forming berries. Tubers are white, rounded and round-oval. Eyes are medium-deep and numerous. The flesh is white, slightly darker on the cut.

The variety is good for early potatoes in fallow land and under irrigated conditions. In the field, potatoes are affected by blight, viral diseases, scab.

The storability of tubers is good, however, their dormant period is short, early awakening of tuber

eyes [9]. The advantage of the variety: stable yield and relatively weak damage. The variety is resistant to cancer, relatively resistant to viruses, stem rot, moderately resistant to blight and scab. Very poorly tolerates breaking of sprouts before planting [10].

Field experiments were conducted in 2020 at «Kokshetau experimental-production farm» LLP, in the Republic of Kazakhstan, Akmola Oblast, Zerenda district.

Technological measures were carried out in accordance with the recommendations and methods of the experimentation [11, 12]. Field experiments were carried out in a 3-fold replication. Farming techniques in the experiments is zonal. Experimental plot area is 100 m2, the placement of plots is randomized. Forecrop is black fallow. Soil - ordinary chernozem, mechanical composition - heavy loam. The potatoes were planted on May 11, 2020.

The experimental design included the following options:

1 - control (water);

2 -Treatment with 0.005% of StresStop solution in the phase of full sprouts;

3 - Treatment with 0.005% of StresStop solution in the phase of flowering;

4 - Treatment with 0.005% of StresStop solution in the phase of full sprouts + flowering;

5 -Treatment with 0.01% of StresStop solution in the phase of full sprouts;

6 - Treatment with 0.01% of StresStop solution in the phase of flowering;

7 - Treatment with 0.01% of StresStop solution in the phase of full sprouts + flowering;

Laboratory analysis of the biochemical composition of potatoe tubers was conducted in the research laboratory of «National Center of Expertise and Certification» JSC Akmola branch, Kokshetau.

Potato varieties treated with complex high molecular fertilizer StresStop, depending on the rates of its application and the phase of plant development, were studied in the laboratory of «National Center of Expertise and Certification» JSC. The laboratory also studied the content of mass fraction of dry matter, mass fraction of starch, nitrates, vitamin C, as well as toxic elements: lead, cadmium, arsenic, mercury.

Regulation of application:

Nevsky potato variety was treated with 0.005% and 0.01% solution of complex high molecular fertilizer StresStop in the phases of full sprouting and flowering.

Stres Stop is a complex high molecular fertilizer. Immunomodulator of root system development. Adaptogen. Contains: amino acids, auxins, bactericides, biofungicides, vitamins, gibberellins, humins, peptides, phytohormones, fulvates, N, P, K, Ca, S, Cu, Mn, Zn, Mg, B, Fe, Na. Produced with commercial worms and a complex symbiosis of insects, fungi, bacteria, microorganisms that revive the yield and fertility of tired degraded soils and closed greenhouse soils. Improves the development of strong root, lateral and adventive sprouts. Has a powerful adaptive effect during the relocation of seedlings. Increases the population of nitrogen-fixing and phototrophic bacteria. Increases the availability of micro- and macronutrients in the soil. Strengthens immunity, resistance to disease and pests. Improves gas exchange of the root system, absorption of minerals. Increases the indicators of nutrients, vitamins, proteins, sugars, oils. Improves the process of ovary formation. Improves taste, color and marketable appearance. Increases yield and storage time of fruits. A means of prevention of ascochytosis, bacteriosis, root rot, blight, smut, spot disease, wilting, mildew, black stem [13].

Results and discussions. Improving the quality of products is an important indicator of the growth of efficiency of social production [14]. The concept of «quality» of potatoes, fruits and vegetables is complex and dynamic, it includes all the physical, chemical, technological and nutritional properties of products. These properties can be classified according to three main criteria that define the concept of «quality» of fruit and vegetable products: external (marketable) characteristics, technical characteristics, as well as biological and nutritional value.

External (product) characteristics of products. These characteristics are defined by existing state standards, technical specifications and other normative documents based on the following criteria: shape, size, volume, weight, color, cleanliness, freshness, sanitary condition, skin elasticity [15].

Studies of the biochemical composition of potatoes after the treatment with complex high molecular fertilizer, depending on the rates of its application and the phase of plant development showed the following results (Table 1).

Table 1 - Effect of StresStop complex high molecular fertilizer on the biochemical composition of potatoes

№.	Name	Replication	Mass fraction of dry matter, %	Mass fraction of starch, %	Nitrates: mg/kg, max	Vitamin C, %
1	Control (water)	I	23.6	16.3	138	13.8
		II	22.4	16.9	142	14.6

		∑	46	33.2	280	28.4
		$\sum_{ave.}$	23	16.6	140	14.2
2	Treatment with 0.005% of StresStop solution in the phase of full sprouts	I	24.0	18.6	159	15.1
		II	23.0	18.1	158	16.2
		∑	47	36.7	317	31.3
		$\sum_{ave.}$	23.5	18.35	158.5	15.65
3	Treatment with 0.005% of StresStop solution in the phase of flowering	I	23.9	17.3	152	14.6
		II	22.8	17.6	155	15.8
		∑	46.7	34.9	307	30.4
		$\sum_{ave.}$	23.35	17.45	153.5	15.2
4	Treatment with 0.005% of StresStop solution in the phase of full sprouts + flowering	I	24.2	19.8	161	17.1
		II	24.2	19.6	174	17.6
		∑	48.4	39.4	335	34.7
		$\sum_{ave.}$	24.2	19.7	167.5	17.35
5	Treatment with 0.01% of StresStop solution in the phase of full sprouts	I	24.4	20.1	169	16.2
		II	23.5	19.4	167	17.5
		∑	47.9	39.5	336	33.7
		$\sum_{ave.}$	23.95	19.75	168	16.85
6	Treatment with 0.01% of StresStop solution in the phase of flowering	I	24.2	18.1	162	15.3
		II	23.2	18.6	166	16.9
		∑	47.4	36.7	328	32.2
		$\sum_{ave.}$	23.7	18.35	164	16.1
7	Treatment with 0.01% of StresStop solution in the phase of full sprouts + flowering	I	24.5	22.6	173	18.6
		II	24.6	22.6	177	19.8
		∑	49.1	45.2	350	38.4
		$\sum_{ave.}$	24.55	22.6	175	19.2

The study of the composition of potato samples treated with complex high molecular fertilizer StresStop showed that the dry matter content in all variants was at the level with the control sample.

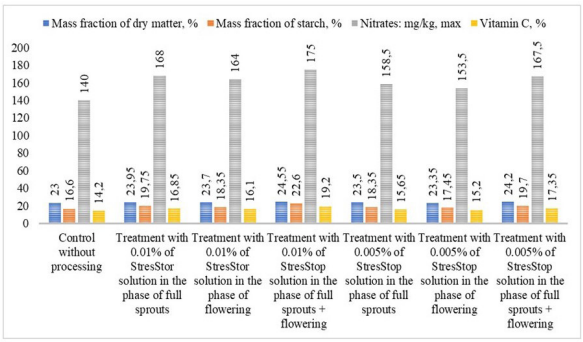
The content of the mass fraction of starch in the variant treated in the phases of full sprouts + flowering with 0.01% StresStop solution showed the highest result of 22.6%, exceeding the control sample by 6.0%. The variant treated in the phases of full sprouts + flowering with 0.005% solution of StresStop was 19.7%.

When treated with complex high molecular fertilizer only in the phase of full sprouts or flowering, regardless of the doses of application, the starch mass fraction content was at the same level.

The carried out experiments showed that the use of complex high molecular fertilizer compared with the control variant leads to a slight increase in nitrate content, but the nitrate content in potato tubers for all variants was at the level of LOC.

The variants treated with complex high molecular fertilizer exceeded the control variant in vitamin C content. The highest vitamin C content (19.2%) was observed in the variant treated with 0.01% StresStop solution in the phases of full sprouts + flowering, which is 5.0% higher than in the control variant. The variant treated with 0.005% StresStop solution in two phases also showed increased Vitamin C content - 17.35%.

Thus, the highest efficiency was shown in the variants where the potato was treated with 0.005% in the phase of full sprouts + flowering and with 0.01% of StresStop solution in the phase of full sprouts + flowering. The quality indicators of the treated potato tubers increased, that is, the content of dry matter, starch and ascorbic acid.



Picture 1 - Effect of StresStop complex high molecular fertilizer on the biochemical composition of potatoes

The results of laboratory analysis showed the quantitative content of toxic elements isolated in potato tubers treated with a complex high molecular fertilizer StresStop depending on the norms of its application and the phase of plant development (Table 2).

Table 2 - Effect of complex high molecular fertilizer StresStop on the content of toxic elements in potatoes

№	Name	Replication	Toxic elements: mg/kg, max			
			Lead	Cadmium	Arsenic	Mercury
1	Control (water)	I	0.079	0.0061	Less than 0.02	Less than 0.0025
		II	0.080	0.0061	Less than 0.02	Less than 0.0025
		∑	0.159	0.0122		
		$\sum_{ave.}$	0.0795	0.0061		
2	Treatment with 0.005% of StresStop solution in the phase of full sprouts	I	0.080	0.0061	Less than 0.02	Less than 0.0025
		II	0.083	0.0069	Less than 0.02	Less than 0.0025
		∑	0.163	0.013		
		$\sum_{ave.}$	0.0815	0.0065		
3	Treatment with 0.005% of StresStop solution in the phase of flowering	I	0.080	0.0063	Less than 0.02	Less than 0.0025
		II	0.081	0.0063	Less than 0.02	Less than 0.0025
		∑	0.161	0.0126		
		$\sum_{ave.}$	0.0805	0.0063		
4	Treatment with 0.005% of StresStop solution in the phase of full sprouts + flowering	I	0.080	0.0056	Less than 0.02	Less than 0.0025
		II	0.086	0.0071	Less than 0.02	Less than 0.0025
		∑	0.166	0.0127		
		$\sum_{ave.}$	0.083	0.00635		
5	Treatment with 0.01% of StresStop solution in the phase of full sprouts	I	0.081	0.0063	Less than 0.02	Less than 0.0025
		II	0.084	0.0065	Less than 0.02	Less than 0.0025
		∑	0.165	0.0128		
		$\sum_{ave.}$	0.0825	0.0064		
6	Treatment with 0.01% of StresStop solution in the phase of flowering	I	0.080	0.0063	Less than 0.02	Less than 0.0025
		II	0.081	0.0065	Less than 0.02	Less than 0.0025
		∑	0.161	0.0128		
		$\sum_{ave.}$	0.0805	0.0064		
7	Treatment with 0.01% of StresStop solution in the phase of full sprouts + flowering	I	0.081	0.0062	Less than 0.02	Less than 0.0025
		II	0.081	0.0069	Less than 0.02	Less than 0.0025
		∑	0.162	0.0131		
		$\sum_{ave.}$	0.081	0.00655		

When spraying with complex high molecular fertilizer the potatoes in the phases of development of full sprouts + flowering, the concentration of lead, cadmium, arsenic and mercury does not change significantly. In the control sample, lead content was 0.0795 mg/kg, its maximum content was observed in the sample with spraying of 0.005% StresStop solution in the phase of full sprouts and flowering, and it was 0.083 mg/kg, which does not exceed LOC.

The amount of cadmium in the control sample was 0.0061 mg/kg, and in samples using a complex high molecular fertilizer it was higher by 0.0002....0.0004 mg/kg

The content of arsenic and mercury was at the same level, both in the control variant and in variants treated with high-organomineral fertilizer, and it was less than 0.02-0.0025 mg/kg, respectively.

The study of the effect of complex high molecular fertilizer on the content of toxic elements in potatoes showed that in variants treated with high-organomineral fertilizer in different concentrations and the control variant does not change significantly.

Thus, based on the obtained results, the complex high molecular fertilizer StresStop, used to treat potatoes in the phases of development of full sprouts and flowering, does not affect the content of toxic elements in the conditions of Akmola Oblast.

Studies of the yield after the treatment with complex high molecular fertilizer, depending on the rates of its application and the phase of plant development showed the following results (Table 3).

Table 3 - Effect of complex high molecular fertilizer StresStop on the yield of potatoes

Variant	Yield, t/ha	Deviation from the control	Marketability, %
Control (water)	8.1	-	89
Treatment with 0.005% of StresStop solution in the phase of full sprouts	9.6	+1.5	91
Treatment with 0.005% of StresStop solution in the phase of flowering	9.3	+1.2	77
Treatment with 0.005% of StresStop solution in the phase of full sprouts + flowering	13.9	+5.8	87
Treatment with 0.01% of StresStop solution in the phase of full sprouts	14.5	+6.4	90
Treatment with 0.01% of StresStop solution in the phase of flowering	12.7	+4.6	81
Treatment with 0.01% of StresStop solution in the phase of full sprouts + flowering	17.5	+9.1	84

As a result of the research, it was determined that treatment with complex high molecular fertilizer has a positive effect on potato yields. In all studied variants there was an increase in yield compared to the control variant. In the variant treated with 0.005% of StresStop solution at the phases of full sprouts + flowering, the yield was 13.9 t/ha, which exceeds the control sample by 5.8 t/ha. In the variants treated with 0.005% of StresStop solution in the phase of full sprouts and 0.005% of StresStop solution in the flowering phase, the yield was approximately at the same level.

The highest yield of potatoes was shown by the variant treated with the complex high molecular fertilizer StresStop in the phases of full sprouts + flowering with a solution concentration of 0.01%, which amounted to 17.5 t/ha. This exceeds the control variant by 9.1 t/ha. The highest marketability (91%) is noted in the variants treated with 0.005% of StresStop solution in the phase of full sprouts and 0.01% StresStop solution in the phase of full sprouts - 90%.

Conclusions. Thus, the highest efficiency was shown in the variants where the potato was treated with 0.005% in the phase of full sprouts + flowering and with 0.01% of StresStop solution in the phase of full sprouts + flowering. The quality indicators of the treated potato tubers increased, that is, the content of dry matter, starch and ascorbic acid.

At the same time, the complex high molecular fertilizer StreStop, used to treat potatoes in the phases of development of full sprouts + flowering, does not affect the content of toxic elements in the conditions of Akmola Oblast.

The highest marketability is noted in the variants, treated with 0.005% of StresStop solution in the phase of full sprouts - 91% and 0.01% of StresStop solution in the phase of full sprouts - 90%. The highest yield of potatoes was shown by the variant, treated with complex high molecular fertilizer StresStop in phases of full sprouts + flowering with concentration of 0,01%, which amounted to 17,5 t/ha.

The use of complex high molecular fertilizer contributes to improving the yield, marketability and qualitative indicators of potatoes, and as the study showed the content of toxic elements in potatoes are not significant. In this regard, the authors consider it advisable to continue research work on the cultivation of potatoes, treated with complex high molecular fertilizer StresStop, depending on the norms of its application and the phase of plant development.

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STRESSTOP КЕШЕНДІ ЖОҒАРЫ МОЛЕКУЛЯРЛЫ ТЫҢАЙТҚЫШТЫҢ КАРТОП ТҮЙНЕКТЕРІНІҢ ӨНІМДІЛІГІ МЕН БИОХИМИЯЛЫҚ ҚҰРАМЫНА ӘСЕРІ

Аннотация. Осы мақалада Ақмола облысы жағдайында Stresstop кешенді жоғары молекулярлы тыңайтқыштың картоп дақылын өңдеу кезеңдері мен мөлшерлері қарастырылған. Stresstop кешенді жоғары молекулярлық тыңайтқыштың өндеу мөлшерлеріне және картоп дақылының даму кезеңіне байланысты картоптың өнімділігіне, тауарлық қасиеттеріне және биохимиялық құрамына әсері анықталды. StresStop кешенді жоғары молекулярлы тыңайтқышы мекеменің ұсынған дозасына сәйкес дақылдың әр түрлі даму кезеңдерінде өңдегенде, картоп түйнектерінде құрғақ заттардың, крахмалдың және С витаминінің мөлшері жоғарлайтыны анықталған, сонымен қатар картоптағы улы заттардың мөлшері айтарлықтай өзгермейтіндігі айтылған.

Картоптың өнімділігіне кешенді жоғары молекулярлы тыңайтқыштың айтарлықтай әсері етеді. Картоптың ең жоғары өнімділігін 17,5 т/га толық өну + гүлдену фазаларында концентрациясы 0,01% StresStop өсу реттеуіштерімен өңделген нұсқада байқалды, ол бақылау нұсқасымен салыстырғанда + 9,1 т/га жоғары болды. Ең жоғарғы тауарлық сапа көрсеткіші толық өну фазасында 0,005% StresStop ерітіндісімен өңделген нұсқада - 91% құрады және толық өну фазасында 0,01% StresStop өңдегенде - 90% көрсетті.

Кешенді жоғары молекулярлы тыңайтқышы картоп өнімділігіне, тауарлық және сапалық көрсеткіштерінің жоғарылауына ықпал етеді, сонымен қатар улы элементтердің мөлшері айтарлықтай өзгермейді.

Түйін сөздер: картоп, кешенді жоғары молекулярлы тыңайтқыш, өнімділік, тауарлық, биохимиялық құрамы.

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ВЛИЯНИЕ КОМПЛЕКСНОГО ВЫСОКОМОЛЕКУЛЯРНОГО STRESSTOP НА УРОЖАЙНОСТЬ И БИОХИМИЧЕСКИЙ СОСТАВ КЛУБНЕЙ КАРТОФЕЛЯ

Аннотация. В данной статье рассматриваются способы и нормы применения комплексного высокомолекулярного удобрения Stresstop на картофеле в условиях Акмолинской области. Раскрываются вопросы влияния комплексного высокомолекулярного удобрения Stresstop на урожайные, товарные качества и биохимический состав картофеля в зависимости от норм его внесения и фазы развития растений картофеля. При пофазной обработке удобрением StresStop, в дозах, рекомендованных учреждениями-изготовителями, в клубнях картофеля меняется содержание сухого вещества, крахмала и витамина С, при этом содержание токсичных элементов в картофеле меняется незначительно.

Определено существенное влияние комплексного высокомолекулярного удобрения на урожайность картофеля. Наибольшую прибавку урожая картофеля +9,1 т/га в сравнении с контрольным вариантом обеспечило опрыскивание варианта, обработанного 0,01% раствором StresStop в фазу полных всходов + цветения, где урожайность составила 17,5 т/га. Наибольшая товарность отмечается в вариантах, обработанных 0,005% раствором StresStop в фазу полных всходов – 91% и 0,01 % раствором StresStop в фазу полных всходов – 90%. Самую высокую урожайность картофеля показал вариант, обработанный комплексным высокомолекулярным удобрением StresStop в фазах полные всходы + цветения с концентрацией раствора 0,01%, что составило 17,5 т/га.

Использование комплексного высокомолекулярного удобрения способствует повышению урожайных, товарных и качественных показателей картофеля, при этом, как показало исследование содержание токсичных элементов в картофеле, меняется не значительно.

Ключевые слова: картофель, комплексное высокомолекулярное удобрение, урожайность, товарность, биохимический состав.

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http://reports-science.kz/index.php/en/archive

Редакторы: *М.С. Ахметова. Д.С. Аленов, Р.Ж. Мрзабаева*
Верстка на компьютере *В.С. Зикирбаевой*
Подписано в печать 12.06.2021.
Формат 60х881/8. Бумага офсетная. Печать - ризограф.
8,5 п.л. Тираж 300. Заказ 3.

Национальная академия наук РК 050010,
Алматы.ул. Шевченко, 28, т. 272-13-18, 272-13-19