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ВЕСТНИК

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
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NAS RK is pleased to announce that Bulletin of NAS RK scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of Bulletin of NAS RK in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential multidiscipline content to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабаршысы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабаршысының Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді мультидисциплинарлы контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Вестник НАН РК» был принят для индексирования в Emerging Sources CitationIndex, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Вестника НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному мультидисциплинарному контенту для нашего сообщества.

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THE EFFECT OF PRE-SOWN PRIMING OF BARLEY SEEDS IN THE SOLUTIONS OF DIFFERENT SALTS IN THE COMBINATION WITH DIATOMITE ON ALLANTOIN CONTENT IN ROOTS SEEDLINGS UNDER SALINE CONDITIONS

Abstract. Pre-sown priming of barley seeds in diatomite suspension in the combination with the solutions of biological important elements strongly increased their germination under saline conditions. For maximal seed germination and content of the potential antioxidantallantoinin seedling roots under salinity it was necessary the priming in the presence of diatomite, KNO_3 and Na_2MoO_4. Role of nitrate and molybdate in maximal formation of allantoin by explained in vivo cooperations of molybdenum-containing enzymes of nitrate reductase (NR) and xanthine dehydrogenase (XDH) in the conditions of salinization. For finding out of role of diatomit further researches are required.

Thus, pre-sowing treatment of plant seeds in a combination of diatomite suspension with solutions of biologically important elements dramatically increases the stability of seed germination in saline conditions. Pre-sowing seed treatment by priming is an environmentally friendly and cheap technology of pre-sowing seed treatment for saturation with important elements, which allows to do without fertilization on huge surface. This will provide the plants with important elements from the germination stage to full maturity.

Key words: diatomite, barley seeds, allantoin, pre-sown priming, nitrate reductase, xanthine dehydrogenase, salt tolerance.

The relevance of the topic. Today the application of new and unconventional methods to increase the resistance of cultivated plants to adverse environmental conditions in agriculture is told more and more. And first of all we are talking about diatomites-sedimentary rock consisting of shells of diatoms [1]. Diatomite is considered as a source of soluble silica, which plays an important role in the formation of soil fertility, increasing the productivity of plants and their resistance to diseases [2,3]. However, the mechanism of diatomites in plant resistance to adverse environmental conditions has not been sufficiently studied yet.

Plant resistance to salinization is determined by a variety of biochemical pathways that promote water retention and / or assimilation, protect chloroplast functions, and maintain ionic homeostasis. The main pathways include those that lead to the osmotic synthesis active metabolites, specific proteins and certain free radical purification enzymes that control the ion flow and water and control the level of oxygen radicals. The ability of plants to detoxify radicals under salinization is probably the most important condition for their resistance to this stress. Many salt-tolerant species accumulate metabolites that play an important dual role as protectors against radicals [4]. One of these metabolites are uric acid (urate) and allantoin. These substances are formed as metabolic intermediates of purine catabolism. Our early studies have shown the involvement of purine catabolism in plant protection from stress [5]. When oxygen radicals are neutralized, urate is converted to allantoin, allantoin to allantoic acid.

It is well known that the key enzyme of purine catabolism is xanthine dehydrogenase (XDH), which converts xanthine or hypoxanthine (products of adenine and guanine oxidation) into a potential antioxidant

– uric acid. Last enzyme uricase or under strong oxidative stress (i.e., in the presence of a high concentration of ROS in the cell) oxidizing turns into allantoin. Allantoin is also a strong antioxidant that neutralizes ROS in the cell (in this case, it is converted to allantoic acid). Thus, these purine catabolism products are potential antioxidants. On the other hand, as it has been established before, that tropical legumes and some other plants use allantoin and allantoic acid (i.e. ureides) as the main transport and spare forms of nitrogen. Recently, allantoin has been shown that activates the production of abscisic acid (ABA), thereby stimulating the expression of stress-related genes and increasing the tolerance of plant seedlings to abiotic stress. These studies suggest a possible link between purine catabolism and stress hormone homeostasis (ABA) and highlight the potential importance of allantoin in these interactions [6]. *Arabidopsis thaliana* was used as a model system to study the effect of salt stress on allantoin metabolism. In different concentrations of NaCl in plant seedlings, an increased content of allantoin and a reduced allantoate were found. Treatment of seedlings with NaCl resulted in the expression of genes involved in allantoin biosynthesis [7]. Thus, depending on plant growth and development conditions, urate and allantoin may play an important role in nitrogen metabolism and in stress protection. However, the effect of diatomite on purine metabolism (i.e. on the formation of ureides) in plant cells under various environmental conditions has not been studied at all.

The value of pre-sowing seed priming. For normal growth and development of agricultural crops of seeds, rapid germination and pecking is of great importance, therefore, pre-sowing priming of seeds is important. Priming is an effective technology to achieve rapid and simultaneous seed development, high growth energy, resulting in a good harvest. This is a simple and cheap method of soaking, in which the seeds are partially moistened to the point where the metabolic processes required for germination have already begun, but germination has not yet occurred. The seeds are dried to almost their original dry weight.

Harris and others (2007) report that pre-sowing seed priming leads to better corn formation, growth, early flowering, increases its resistance to unfavorable environment and, accordingly, increases yield [8]. A good yield of many crops is associated with pre-sowing seed priming, which leads to accelerated early and more uniform growth, moreover, it is a cheap technology [9]. These positive effects are influenced by factors such as plant species, priming environment, priming duration, temperature, storage conditions and others.

Khan and others (2009) evaluated the results of pre-sowing seed priming in a solution of different NaCl concentrations for early growth and concluded that seed priming in NaCl is a better treatment compared to control variants [10]. Priming improves seed germination in the field, in this respect potassium nitrate (KNO3) is a promising substance. The time and speed of seed germination, priming in KNO3, shows better results compared to other treatments [11]. Seeds of rape culture treated with osmopriming (in KNO3 and NaCl) when grown in the field showed that salt priming, especially priming in KNO3, reduces germination time and increases the length of seedlings compared to untreated seeds [12]. Seed priming in K2SO4 and KCl shows good potency for increasing germination, hatching, growth and yield of wheat grain [13].

Materials and methods of research. For our research, we used barley ("Tselinnaya" sort) which is more resistant to salinization in Kazakhstan. Before growing barley seeds were sterilized in 0, 5% solution of potassium permanganate (10 minutes). To determine the germination of barley seeds, samples of 100 seeds were taken, placed in Petri dishes on wet filter paper, and left at the temperature of 20-25°C in a thermostat for 12 hours. Sprouted seeds was daily counted and results recorded during 10 days, determined the number of sprouted grains, which will be an indicator of the percentage of germination of the tested seeds. All variants were carried out in 3 repetitions. Statistical processing of data groups was carried out in the application ANOVA. The significance of the differences was estimated by p-value ($p \le 0.05$).

Method for determination of allantoin. To 100 µl plants sample (in our case roots) add 100 µl 0.5 M NaOH and 200 µl bidistilled water and boil at 100°C for 8 minutes. Then cool to 0°C for 4-5 minutes. The cooled mixture is added 100 µl 0.65 M hydrochloric acid and boiled again at 100°C for 4 minutes. After cooling, 100 µl of 0.4 M phosphate (Na2HPO4-KH2PO4) buffer pH-7.0 and 100 µl of 18 mm phenylhydrazine are added to the mixture. Further, at 0°C temperature, 500 µl of concentrated hydrochloric acid is added to the mixture. For the development of staining, 100 µl of 50.6 mm K-FeCy (potassium ferricyanide) is added and left at room temperature for 15 minutes. To remove possible sediment centrifuged at room temperature 10 min at 10 000g. Measured absorption of transparent supernatant at 535 nm wavelength spectrophotometer [7].

Research results. We studied the effect of pre-sowing priming of barley seeds in increasing concentrations of mM solutions of NaCl, KNO3, Na2MoO4, KH2PO4 and in diatomite suspension (variant 7 in table 1). The suspension mixture was obtained by adding diatomite in an increasing ratio of 1g, 5g, 10g, 15g, 20g, 25g / per 100 ml of H2O.

Priming of seeds in these solutions was carried out for 24 hours at a temperature of 7ºC in the dark. Then the seeds extracted from the solutions were washed several times with distilled water and left at room temperature until completely dried (another 24 hours). After drying, the seeds were grown at room temperature on filter paper moistened with distilled paper and placed in Petri dishes. Initial untreated seeds and seeds after priming in distilled water (variants 5 and 6) served as germination controls. On the seventh day, the number of seedlings was counted (it should be noted that the seedlings in each variant were uneven in length). The results of these experiments are presented in table 1.

Table 1 – Effect of pre-sowing priming of barley seeds in different concentrations of mineral salt solutions and diatomite suspension (in g / 100 ml) on their germination

A salt solution for priming	Concentrations of salt solutions for priming, mM						
	0	25	50	75	100	125	150
NaCl	–	72%	74%	76%	76%	74%	70%
KNO_3	–	72%	72%	76%	76%	75%	75%
Na_2MoO_4	–	72%	72%	73%	73%	69%	65%
KH_2PO_4	–	71%	72%	73%	73%	72%	70%
Water	71%	–	–	–	–	–	–
Seeds without priming (control)	64%	–	–	–	–	–	–
Suspension of diatomite	–	*1 g	*5 g	*10 g	*15 g	*20 g	*25 g
Germination (%)	–	73%	75%	78%	78%	78%	78%

As can be seen from table 1, compared with dry barley seeds (variant 6), their pre-sowing priming in distilled water significantly improved seed germination (variant 5). Priming seeds in solutions of these salts further increased their germination. Maximum seed germination was observed after priming in solutions of KNO3 and NaCl in the range of their concentration of 75-100 mM. Priming in a suspension of diatomite containing above 10 g/100 ml H2O showed the highest germination of barley seeds. The effect of priming in solutions of molybdenum and phosphate on seed germination was insignificant.

Further, we conducted experiments to study the effect of pre-sowing priming of seeds in solutions of NaCl, nitrate, molybdenum, phosphate in combination with a suspension of diatomite on the growth and development of barley seedlings and the content of allantoin in the roots of 10-day seedlings (table 2).

Table 2 – Effect of pre-sowing priming on barley seeds in diatomite suspensions (DTM) containing salts of some biologically important elements on their germination and formation of allantoin in them

Pre-sowing seed processing	Germination medium	Number of germinated seeds, pieces	Average weight (mg) of one 10-day seedling	Allantoin content in the roots of 50 seedlings (mcg/g dry weight)
1	2	3	4	5
Seeds without pre-processing	Water	76%	253±0,34	5.6±0,21
	80 mM NaCl solution	49%	165±0,33	6.2±0,31
	80 mM NaCl solution + DTM	62%	221±0,25	6.7±0,15
Water	Water	70%	293±0,22	5.8±0,25
	80 mM NaCl solution	50%	178±0,44	6.8±0,31
	80 mM NaCl solution + DTM	72%	272±0,14	7.7±0,18
Suspension of diatomite (DTM)	Water	80%	298±0,15	6.9±0,35
	80 mM NaCl solution	62%	205±0,25	7.6±0,33
	80 mM NaCl solution + DTM	77%	273±0,34	8.2±0,12

Table 2 continuation

1	2	3	4	5
75 mM KNO_3	Water	76%	302±0,42	6.9±0,07
	80 mM NaCl solution	66%	208±0,31	8.8±0,09
	80 mM NaCl solution + DTM	75%	278±0,41	9.2±0,21
Suspension of DTM + 75 mM KNO_3	Water	80%	321±0,21	7.1±0,34
	80 mM NaCl solution	68%	212±0,15	8.9±0,18
	80 mM NaCl solution + DTM	80%	282±0,18	10.4±0,20
75 mM Na_2MoO_4	Water	79%	318±0,17	7.0±0,31
	80 mM NaCl solution	57%	223±0,31	8.9±0,42
	80 mM NaCl solution + DTM	80%	273±0,14	9.2±0,44
DTM + 75 mM Na_2MoO_4	Water	80%	318±0,16	7.2±0,41
	80 mM NaCl solution	72%	232±0,18	9.0±0,32
	80 mM NaCl solution + DTM	79%	298±0,19	10.4±0,33
DTM + 75 mM Na_2WO_4	Water	75%	298±0,20	7.0±0,35
	80 mM NaCl solution	67%	226±0,24	7.9±0,36
	80 mM NaCl solution + DTM	76%	278±0,23	8.4±0,36
0.5 M KNO_3+ 75mM Na_2MoO_4	Water	83%	325±0,51	7.2±0,27
	80 mM NaCl solution	73%	253±0,41	9.2±0,27
	80 mM NaCl solution + DTM	82%	322±0,32	9.7±0,29
0.5 M KNO_3+ 75mM Na_2WO_4	Water	72%	320±0,34	7.0±0,12
	80 mM NaCl solution	65%	280±0,36	6.7±0,18
	80 mM NaCl solution + DTM	78%	312±0,12	7.2±0,31
75 mM KH_2PO_4	Water	79%	321±0,09	6.9±0,25
	80 mM NaCl solution	67%	275±0,10	9.5±0,17
	80 mM NaCl solution + DTM	80%	315±0,15	10.2±0,09
DTM + 0.5 M KNO_3 + 75 mM Na_2MoO_4	Water	83%	325±0,21	8.2±0,15
	80 mM NaCl solution	73%	283±0,28	18.2±0,19
	80 mM NaCl solution + DTM	82%	322±0,05	26.4±0,13
ДТМ +KNO_3+ Na_2MoO_4+ KH_2PO_4	Water	84%	332±0,25	7.6±0,21
	80 mM NaCl solution	75%	268±0,31	18.6±0,22
	80 mM NaCl solution + DTM	83%	321±0,21	28.8±0,21
DTM + KNO_3+ Na_2WO_4+ KH_2PO_4	Water	79%	320±0,23	7.0±0,25
	80 mM NaCl solution	71%	260±0,41	9.8±0,21
	80 mM NaCl solution + DTM	78%	315±0,35	11.3±0,26

* Germinated seeds were weighed together with roots and leaves.

Thus, the results of our experiments show an increase in the germination of barley seeds after priming in aqueous solutions. A relatively high seed germination was observed after priming of the suspension of diatomite, containing molybdate, nitrate and phosphate. Accordingly, the mass of seedlings in these variants was greater. The maximum mass of seedlings was observed after priming in a nitrate-containing solution. Pre-sowing priming of seeds in aqueous solutions and cultivation in media containing NaCl and diatomite significantly increases the content of allantoin in the roots of 10-day seedlings. Pre-sowing priming of barley seeds in diatomite suspensions containing nitrate, molybdenum and phosphate and growing them in a saline environment with diatomite dramatically (almost 3 times) increased the formation of allantoin in the roots of seedlings. However, pre-sowing priming of seeds in suspensions, in which tungstate was added instead of molybdenum, did not increase the formation of allantoin in the roots of seedlings under saline conditions. It is well known that the chemical analogue of molybdenum-tungsten is also easily embedded in the active center of molybdenum enzymes. However, in this case, the enzymes become inactive. As a result of the obtained results, it can be assumed that during pre-sowing priming in a solution of molybdenum and nitrate, the ions of these salts accumulate in barley seeds. During germination, these ions are transported from the seeds to the roots and leaves of the seedlings and activate the enzymes nitrate reductase (NR) and xanthine dehydrogenase (XDH). Nitrate reductase (NR) as an inducible enzyme is synthesized only in the presence of nitrate in the cell. As mentioned above, the combined actions of these enzymes lead to increased urate biosynthesis. Urate in conditions of oxidative stress is converted into allantoin, ie during salinization, urate molecules are oxidized by oxygen radicals to form allantoin. Since allantoin is also a strong antioxidant, we do not exclude its oxidation by radicals to form allantoic acid.

Currently, three of the four molybdenum-containing proteins are well studied in plants: xanthine dehydrogenase (XDH), nitrate reductase (NR), aldehyde oxidase (AO) and sulfite oxidase (SO). Nitrate assimilation is a fundamental process in the plant Kingdom and therefore the enzyme HP, which restores nitrate, is seen as a limiting factor in the growth, development, protein formation and final yield of plants. AO catalyzes the conversion of abscisic aldehyde to the corresponding phytohormone abscisic acid (ABA). It is known that adverse environmental factors cause the synthesis of phytohormone adaptation- ABA. For example, when the leaves of mesophytic plants are subjected to drought stress, within 4 hours, the level of ABA increases up to 50 times. Thus, ABA plays an important role in plant resistance to adverse environmental factors [14].

In all molybdenum-containing enzymes of plants, the main component in the active center is the so-called "molybdenum cofactor". The molybdenum atom binds to this cofactor i.e. the molybdenum-cofactor complex is directly involved in the catalytic reactions of these enzymes. However, the molybdenum factor is synthesized together with the apoenzyme molecule and it does not depend on the presence of molybdenum, i.e. in the absence of molybdenum, the place of this metal in the active center will be empty and the molybdenum-free enzymes lose their activity. Therefore, the lack of molybdenum in the growth medium leads to a decrease in the activity of these enzymes. Under in vivo conditions with a high concentration of tungsten, a chemical analogue of molybdenum, this metal easily replaces molybdenum in the active center and as a result these enzymes become inactive [15].

As mentioned above, adverse environmental conditions such as salinity, drought and cold cause oxidative stress, i.e. increased formation of reactive oxygen species (ROS). Molybdenum enzymes NR and XDH play an important role in ROS neutralization. When nitrate is reduced, NR + uses NADH as an electron donor (after the reaction, NADH is converted to oxidized NAD+). In the enzymatic reaction, XDH uses NAD+ as an electron acceptor. In other words, the more nitrate is assimilated, the more NAD+ is formed and XDH activity increases, i.e. more antioxidants are formed-uric acid and allantoin. These antioxidants, restoring ROS, increase the resistance of plants to salinity [16]. It was convinced that fertilizing pea seedlings with nitrate as a source of nitrogen increases their salt resistance [17]. Thus, plant molybdenum enzymes play a key role in plant resistance to salinization. And their activity depends on the sufficiency of molybdenum in the soil. According to the results of long-term studies of the Institute of soil science of the Academy of Sciences of the Republic of Kazakhstan, the content of molybdenum in our soils is 3-5 times less than the critical concentration (0.1 mg Mo/kg for temperate soils) necessary for normal growth and development of plants. Therefore, pre-sowing saturation of plant seeds with molybdenum solution should provide plants with this metal for the entire period of growth and development.

Thus, pre-sowing treatment of plant seeds in a combination of diatomite suspension with solutions of biologically important elements dramatically increases the stability of seed germination in saline conditions. Pre-sowing seed treatment by priming is an environmentally friendly and cheap technology of pre-sowing seed treatment for saturation with important elements, which allows to do without fertilization on huge surface. This will provide the plants with important elements from the germination stage to full maturity.

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АРПАНЫҢ ДӘНДЕРІН СЕБЕР АЛДЫНДА ӘРТҮРЛІ ТҰЗДАРДЫҢ ЕРІТІНДІЛЕРІНДЕ ДИАТОМИТТПЕН БІРЛЕСЕ ПРАЙМИНГТЕУДІҢ ӨРКЕНДЕРДІҢ ТАМЫРЛАРЫНДАҒЫ АЛЛАНТОИННЫҢ МӨЛШЕРІНЕ ТҰЗДАНУ ЖАҒДАЙЫНДА ТИГІЗЕТІН ӘСЕРІ

Аннотация. Ауыл шаруашылығы дақылдарының қалыпты өсуі мен дамуы үшін тұқымдардың тез өсуі мен сіңірілуі үлкен маңызға ие, сондықтан тұқым праймингінің маңызы зор. Прайминг-тұқымдарды жылдам және бір мезгілде дамытуға, жақсы өнімге әкелетін жоғары өсу энергиясына қол жеткізу үшін тиімді технология. Бұл тұқымдарды өсіру үшін талап етілетін метаболикалық процестер басталғанша ішінара ылғалданған кезде оңай және арзан суландыру әдісі. Тұқымдар бастапқы құрғақ салмаққа дейін кептіріледі.

Біз арпа тұқымдарының праймингінің NaCl, KNO3, Na2MoO4, KH2PO4 ерітінділерінің өсу концентрацияларындағы және диатомит суспензиясының әсері зерттелді (1-кестеде 7-нұсқа). Суспензиялық қоспаны диатомитті қосу кезінде 1г , 5г, 10г 15 г, 20г, 25 г / 100 мл H2O өсу қатынасында алынған. Арпаның құрғақ тұқымдарымен салыстырғанда тазартылған судағы олардың алдын ала праймингі тұқымның өнуін едәуір жақсартты. Аталған тұздардың ерітінділеріндегі тұқым праймингі олардың өнгіштігін одан әрі арттыра түсті. 10 г / 100 мл H2O жоғары болатын диатомит суспензиясындағы Прайминг арпа тұқымдары-ның ең жоғары өнгіштігін көрсетті. Молибдат және фосфат ерітінділерінде тұқымдардың өнгіштігіне прайминг әсері шамалы болды.

Біздің тәжірибелеріміздің нәтижелері су ерітінділерінде праймингтен кейін арпа тұқымдарының өнуін көрсетеді. Тұқымдардың салыстырмалы түрде жоғары өнгіштігі молибдат, нитрат және фосфат бар диатомиттің суспензияларындағы олардың праймингінен кейін байқалды. Тиісінше, бұл нұсқаларда көптеген пайғамбарлар көп болды. Нитраты бар ерітіндіде праймингтен кейін өскіндердің ең көп массасы байқалды. Су ерітінділеріндегі тұқым праймингі және құрамында NaCl және диатомит бар орталарда өсіру 10 күндік өскіндердің тамырларында аллантоин мөлшерін едәуір арттырады. Құрамында нитрат, молибдат және фосфат бар диатомиттің суспензияларындағы арпа тұқымдарының себу алдындағы праймингі және оларды тұздалған ортада диатомитпен өсіру бірден (3 есе дерлік) өсінділердің тамырларында аллантоиннің түзілуін арттырды. Алайда, молибдаттың орнына вольфраматты қосқан суспензиялардағы тұқым праймингі тұздану жағдайында пайғамбарлардың тамырларында аллантоиннің түзілуін көтермеді. Молибден-вольфрамның химиялық аналогы молибдоферменттердің белсенді орталығына оңай кіретіні белгілі. Алайда, бұл жағдайда ферменттер белсенді емес. Алынған деректердің нәтижесінде молибдат пен нитрат ерітіндісінде прайминг алдында осы тұздардың ионы арпа тұқымында жиналады деп пайымдауға болады. Өсірілген кезде бұл иондар тұқымнан тамыр және өскін жапырақтарына тасымалданады және нитратредуктаза (НР) және ксантиндегидрогеназа (КДГ) ферменттерін белсендіреді. Нитратредуктаза (НР) индуцибельді фермент ретінде жасушадағы нитраттың қатысуымен синтезделінеді. Жоғарыда айтылғандай, бұл ферменттердің бірлескен әрекеттері ураттың жоғары биосинтезіне әкеледі. Тотығу стресс жағдайында Урат аллантоинге айналады, яғни. урат молекуласының тұздануы кезінде аллантоиннің пайда болуымен оттегі радикалдары тотығады. Аллантоин күшті антиоксидант болғандықтан, біз аллантоин қышқылының пайда болуымен радикалдардың тотығуын да жоққа шығармаймыз.

Арпа тұқымдарының егу алдындағы праймингі диатомит суспензиясы биологиялық маңызды элементтердің ерітінділерімен бірге сортаңдану жағдайында тұқымның өсуінің тұрақтылығын күрт арттырады. Сортаңдану және әлеуетті антиоксидант – аллантоин құрамының жоғарылауы жағдайында тұқымдардың ең жоғары өнуі үшін проростоктардың тамырларында in vivo құрамында нитратредуктаза (НР) және тұздану жағдайында ксантиндегидрогеназа (КДГ) молибдені бар ферменттердің өзара әрекеттесуімен түсіндіріледі. Диатомиттің рөлін анықтау үшін одан әрі зерттеулер қажет.

Осылайша, биологиялық маңызды элементтердің ерітінділерімен диатомит суспензиясын біріктіріп өсімдік тұқымдарын себу алдында өңдеу тұздану жағдайында тұқымдардың өсуінің тұрақтылығын күрт арттырады. Прайминг әдісімен тұқымдарды себу алдында өңдеу маңызды элементтермен қанықтыру үшін тұқымдарды себу алдында өңдеудің экологиялық таза және арзан технологиясы болып табылады, бұл үлкен егіс алаңдарында тыңайтқыштарды енгізбестен айналып өтуге мүмкіндік береді. Бұл өсімдікті өсіру сатысынан толық жетілуге дейін маңызды элементтермен қамтамасыз етеді.

Түйін сөздер: арпа дәндері, аллантоин, себер алдындағы прайминг, нитратредуктаза, ксантиндегидрогеназа.

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ЭФФЕКТ ПРЕДПОСЕВНОГО ПРАЙМИНГА СЕМЯН ЯЧМЕНЯ В РАСТВОРАХ РАЗЛИЧНЫХ СОЛЕЙ В КОМБИНАЦИИ С ДИАТОМИТОМ НА СОДЕРЖАНИЕ АЛЛАНТОИНА В КОРНЯХ ПРОРОСТКОВ В УСЛОВИЯХ ЗАСОЛЕНИЯ

Аннотация. Для нормального роста и развития сельскохозяйственных культур семян большое значение имеет быстрое прорастание и проклевывание, поэтому, предпосевной прайминг семян имеет важное значение. Прайминг является эффективной технологией для достижения быстрого и одновременного развития семян, высокой энергии роста, приводящей к хорошему урожаю. Это простой и дешевый метод замачивания, при котором семена частично увлажняются до того состояния, когда метаболические процессы, требуемые для прорастания уже начинаются, но прорастание еще не происходит. Семена высушиваются почти до первоначального сухого веса.

Нами было изучено влияние предпосевного прайминга семян ячменя в возрастающих концентрациях мМ растворов NaCl, KNO_3, Na_2MoO_4, KH_2PO_4 и в суспензии диатомита (вариант 7 в таблице 1). Суспензионную смесь получали при добавлении диатомита в возрастающем соотношении 1г, 5г, 10г, 15г, 20г, 25г / на 100мл H_2O. По сравнению с сухими семенами ячменя их предпосевной прайминг в дистиллированной воде значительно улучшал всхожесть семян. Прайминг семян в растворах указанных солей еще больше повышал их всхожесть. Максимальная всхожесть семян наблюдалась после прайминга в растворах KNO_3 и. NaCl в диапазоне их концентрации 75-100 мМ. Прайминг в суспензии диатомита, содержащих выше 10 г/100 мл H_2O показал самую высокую всхожесть семян ячменя. Эффект прайминга в растворах молибдата и фосфата на всхожесть семян был незначительным.

Результаты наших экспериментов показывают повышение всхожести семян ячменя после прайминга в водных растворах. Относительно высокая всхожесть семян наблюдалась после их прайминга в суспензиях диатомита, содержащих молибдат, нитрат и фосфат. Соответственно, масса проростков в этих вариантах была больше. Максимальная масса проростков наблюдалась после прайминга в нитратсодержащем растворе. Предпосевной прайминг семян в водных растворах и выращивание в средах, содержащих NaCl и диатомит, значительно повышает содержание аллантоина в корнях 10-дневных проростках. Предпосевной прайминг семян ячменя в суспензиях диатомита, содержащих нитрат, молибдат и фосфат и выращивание их в засоленной среде с диатомитом резко (почти в 3 раза) повышало образование аллантоина в корнях проростков. Однако предпосевной прайминг семян в суспензиях, в которых вместо молибдата добавляли вольфрамат, не повышало образование аллантоина в корнях проростков в условиях засоления. Общеизвестно, что химический аналог молибдена - вольфрам также легко встраивается в активный центр молибдоферментов. Однако в этом случае ферменты становятся неактивными. В результате полученных данных можно полагать, что при предпосевном прайминге в растворе молибдата и нитрата ионы этих солей накапливаются в семенах ячменя. При прорастании эти ионы транспортируются из семян в корни и листья проростков и активируют ферменты нитратредуктазу (НР) и ксантиндегидрогеназу (КДГ). Нитратредуктаза (НР) как индуцибельный фермент синтезируется только в присутствии нитрата в клетке. Как было сказано выше, совместные действия этих ферментов приводят к повышенному биосинтезу урата. Урат в условиях окислительного стресса превращается в аллантоин, т.е. при засолении молекулы урата окисляются кислородными радикалами с образованием аллантоина. Поскольку аллантоин тоже является сильным антиоксидантом, мы не исключаем и его окисление радикалами с образованием аллантоиновой кислоты.

Предпосевной прайминг семян ячменя в комбинации суспензии диатомита с растворами биологически важных элементов резко повышает устойчивость прорастания семян в условиях засоления. Для макси-мальной всхожести семян в условиях засоления и повышения содержания потенциального антиоксиданта – аллантоина в корнях проростков обьясняется *in vivo* взаимодействиями молибденсодержащих ферментов нитратредуктазы (НР) и ксантиндегидрогеназы (КДГ) в условиях засоления. Для выяснения роли диатомита требуются дальнейшие исследования.

Таким образом, предпосевная обработка семян растений в комбинации суспензии диатомита с растворами биологически важных элементов резко повышают устойчивость прорастания семян в условиях засоления. Предпосевная обработка семян методом прайминга представляет собой экологически чистый и дешевой технологией предпосевной обработкой семян для насыщения важными элементами, что позволяет обходится без внесения удобрений на огромных посевных площадях. Это обеспечит растения важными элементами от стадии прорастания до полного созревания.

Ключевые слова: семена ячменя, аллантоин, предпосевной прайминг, нитратредуктаза, ксантиндегидрогеназа.

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