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THE EFFECT OF PRE-SOWING HARDENING OF SEEDS ON CERTAIN YIELD TRAITS OF DIFFERENT SPRING WHEAT VARIETIES

Sh. Yunuskhanov, Z.L. Abdurazakova, *S.K. Meliev, M.R. Mardonova, T.A. Bozorov

Institute of Genetics and Plants Experimental Biology, Academy of Sciences of Uzbekistan, Tashkent Region, Kibray district, Yukori-Yuz
**e-mail: meliev.sodir@mail.ru*

Summary

A study was conducted to investigate the effect of pre-sowing seed hardening on certain yield traits of eleven spring wheat accessions from the CIMMYT collection (Eswyt-1 to Eswyt-11) and two local wheat varieties, E'zoz and Qayraqtosh, under irrigated and non-irrigated conditions. The results showed that, based on the effect of pre-sowing hardening, the studied wheat accessions could be classified into three main groups: positive, neutral, and negative, in both irrigated and non-irrigated conditions. In some accessions, pre-sowing treatment exhibited an indifferent response under irrigated conditions, whereas under non-irrigated conditions, most accessions demonstrated an increase in the studied traits compared to the control variants.

Keywords: *hardening, seeds, wheat, grain, spike, control, moisture*

Introduction. The yield of agricultural crops depends on favorable agroecological conditions and sufficient water availability. In most regions of Central Asia, agriculture is impossible without irrigation, as crops suffer from water shortages and drought. In desert areas, air temperatures often reach **45°C.** Water deficiency is one of the main limiting factors affecting crop yield. Studies have shown [1,2] that water scarcity is a major factor restricting agricultural productivity, and its impact on global crop losses significantly exceeds losses caused by other biotic and abiotic factors. Plant life processes occur through the continuous absorption and utilization of water. A lack of water in plants leads to disruptions in physiological processes, including slowed cell division, inhibited growth, suppressed photosynthesis, increased respiration, and accelerated breakdown of organic compounds. These disturbances become more severe as cellular dehydration intensifies [3]. In the search for ways to increase agricultural production under modern agroecological stress conditions, one of the most important directions is the development of strategies that enhance plants' ability to withstand various extreme environmental factors, regardless of growing conditions. Strengthening plant resilience to such stressors will contribute to the transition toward a sustainable agriculture strategy.

High-quality wheat seed material is one of the key factors influencing both the quality and quantity of the harvest. One of the simplest methods to improve seed quality and increase grain yield is pre-sowing seed treatment. A wide range of pre-sowing treatment methods has been developed and proposed for implementation.The method of pre-sowing hardening of seeds against drought, developed by **P. A. Henkeland, S. S. Kolotovain 1934–1936** [4], involves soaking the seeds in water at a specific seed-to-water ratio, followed by drying them back to their original moisture content. When the soaked seeds swell and slightly germinate, they are spread in a thin layer and dried, essentially simulating drought conditions. The physiological and biochemical basis of this method is that seed germination activates enzymes, leading to an increase in metabolic activity, which can be directed in a desired way at this stage. When seeds are dried back to their original moisture content—effectively undergoing artificial drought—deep physiological changes occur in the embryo, leading to the development of new traits in the emerging plant. These traits are characteristic of plants with enhanced drought resistance.

Plants grown from such seeds exhibit xeromorphic morphological traits, which correlate with greater drought tolerance. The positive effects of pre-sowing seed soaking in solutions of various salts and chemical compounds, followed by drying, have also been studied in the works of other researchers [5]. Such treatments have been found to enhance growth and development processes in subsequent stages.

In the present study, research was conducted to examine the effect of pre-sowing seed hardening against drought on certain quantitative traits of eleven spring wheat accessions from the CIMMYT collection and two local varieties.

Materials and Methods. The study utilized seeds from eleven spring wheat accessions from the CIMMYT collection (Eswyt-1 to Eswyt-11) and two local wheat varieties, *E'zoz* and *Qayraqtosh*. Hardening was performed according to the method described in [4], by soaking the seeds in tap water in a thermostat at **24°C** for **24 hours**, followed by drying the germinated seeds at room temperature.The experiments were conducted at the experimental field of the Institute in **Durmen, Kibray District, Tashkent Region.** Sowing was carried out in early March. In the irrigated experiments, in addition to natural rainfall (which occurred three times), irrigation was applied four times.

Results and Discussion. The conducted study revealed that the examined wheat varieties exhibited higher quantitative trait values under irrigated conditions compared to non-irrigated conditions (Table 1). The wheat accessions were categorized into different groups based on their response to pre -sowing seed hardening under varying irrigation conditions (Table 2).Under irrigated conditions, the accessions Eswyt-3, Eswyt-5, Eswyt-9, Eswyt-11, and the variety Qayraqtosh exhibited a positive response to pre-sowing hardening. Accessions Eswyt-2, Eswyt-4, and Eswyt-6 showed a neutral response, while accessions Eswyt-1, Eswyt-6, Eswyt-7, Eswyt-8, Eswyt-10, and the variety E'zoz displayed a negative response.Under non-irrigated conditions, accessions Eswyt-2, Eswyt-3, Eswyt-4, Eswyt -8, Eswyt-10, and the variety E'zoz demonstrated a positive response. Accessions Eswyt-6, Eswyt-7, Eswyt-8, Eswyt-9, Eswyt-11, and the variety Qayraqtosh exhibited a neutral response, whereas accessions Eswyt-1, Eswyt-5, Eswyt-9, Eswyt-10, and the varieties E'zoz and Qayraqtosh showed a negative response to pre-sowing seed treatment.

Table 1. Minimum and Maximum Values of Certain Traits in the Studied Wheat Accessions Under Different Irrigation Systems During Pre-Sowing Hardening

Trait	Irrigated		Non-Irrigated	
	Control	WithHardening	Control	WithHardening
NumberofSpikes (pcs.)	12,05-15,33	12,67-15,40	11,45-13,25	10,53-14,00
SpikeWeight (g)	1,73-2,38	1,76-3,35	1,42-1,80	1,31-2,37
NumberofGrains (pcs.)	26,95-42,77	27,60-40,80	24,22-33,60	24,23-37,35
GrainWeight (g)	1,28-2,14	1,30-1,73	1,00-1,73	0,96-1,53
1000-Grain Weight (g)	33,44-66,25	40,73-59,78	34,40-51,49	31,04-47,51

Some accessions exhibited a positive response to pre-sowing hardening under normal irrigation conditions, particularly Eswyt-3 and Eswyt-5. In contrast, Eswyt-1 did not show any positive impact of seed hardening on its yield-related traits, while Eswyt-2 exhibited an increase in grain number under non-irrigated conditions. A similar pattern was observed in other wheat accessions.The 1000-grain weight among the studied accessions ranged from 39.1 g (Eswyt-2) to 65.3 g (Eswyt-7). Wheat yield depends on the number of spikes, grain count, and 1000-grain weight.

A positive effect of pre-sowing hardening on 1000-grain weight under irrigated conditions was observed in accessions Eswyt-1, Eswyt-4, Eswyt-5, Eswyt-6, Eswyt-9, Eswyt-11, E'zoz, and Qayraqtosh, while a negative effect was noted in Eswyt-3, Eswyt-7, Eswyt-8, and Eswyt-10.Under non-irrigated conditions, a positive effect of hardening was observed in Eswyt-6, Eswyt-7, Eswyt-8, Eswyt-10, Eswyt-11, and E'zoz, whereas a negative effect was found in Eswyt-1, Eswyt-3, Eswyt-5, Eswyt-9, E'zoz, and Qayraqtosh.The number of grains increased under irrigated conditions after seed hardening in Eswyt-3, Eswyt-5, Eswyt-10, and Eswyt-11, but decreased in Eswyt-1, Eswyt-7, Eswyt-8, and Eswyt-9.Under non-irrigated conditions, a positive effect on grain number was observed in Eswyt-2, Eswyt-3, Eswyt-4, Eswyt-8, Eswyt-9, Eswyt-11, E'zoz, and Qayraqtosh, while a negative effect was noted in Eswyt-5, Eswyt-6, and Eswyt-10. The obtained data indicate that pre-sowing seed treatment had an indifferent effect on certain accessions under irrigated conditions. However, under non-irrigated conditions, most accessions showed an increase in quantitative traits compared to the control.A similar pattern of neutrality and indifference to pre-sowing seed hardening was also observed in studies conducted on various cotton varieties [6].In the Eswyt-1 accession under irrigated conditions, all studied traits, except for 1000-grain weight, were higher compared to non-irrigated conditions. However, in the hardened variants, these traits were reduced compared to the control.For Eswyt-2, these traits remained almost unchanged.In Eswyt-3, under irrigated conditions, all traits except for 1000-grain weight increased in the hardened variant. A similar trend was observed under non-irrigated conditions, although there was a slight decrease compared to the irrigated trials.For Eswyt-4, under irrigated conditions, no significant differences were observed between the control and hardened variants. However, under non-irrigated conditions, the hardened variants showed higher values compared to the control.In Eswyt-5, the hardened seeds exhibited higher values under irrigation compared to the control, whereas under non-irrigated conditions, the hardened variants had relatively lower values than the control.The Eswyt-6 accession displayed indifference to pre-sowing hardening in both irrigated and non-irrigated conditions.For Eswyt-7, a slight decrease in the hardened variant was observed under irrigated conditions. However, under non-irrigated conditions, there were no differences between the control and hardened variants, except for 1000-grain weight, which increased in the hardened samples. Similar results were obtained for Eswyt-8. In Eswyt-9, under irrigated conditions, a slight decrease in trait values was observed, except for 1000-grain weight, which increased in the hardened variant. Under non-irrigated conditions, no significant differences were found between the control and hardened variants.The Eswyt-10 accession showed indifference between control and hardened variants under irrigated conditions. However, under non-irrigated conditions, an increase was observed only in 1000-grain weight.For Eswyt-11, a slight increase in traits was noted in the hardened variant under irrigated conditions, while no significant differences were observed under non-irrigated conditions. In the E'zoz variety, no major differences were observed between studied variants under irrigated conditions. However, under non-irrigated conditions, some traits increased in the hardened variant, although 1000-grain weight significantly decreased. In the Qayraqtosh variety, no significant differences were observed between control and hardened variants.

A previous study [7] showed that under unfavorable conditions with limited water availability, all studied cotton varieties experienced a sharp decline in productivity, but this decline was not proportional.

The yields of Tashkent-I and Express-I varieties decreased significantly, whereas I75-F and I08-F varieties were more adaptive to unfavorable conditions. The adaptive abilities of these varieties were inherited by first-generation hybrids.Another study [8] noted that pre-sowing treatment of seeds using P.A. Henkel's method [4] did not produce positive results, which could be attributed to agroecological cultivation conditions. Numerous studies have confirmed that the location where seeds are grown also influences their sowing quality [9-11].

Thus, our study on pre-sowing hardening of spring wheat seeds demonstrated that some varieties responded positively to different irrigation regimes, while others remained neutral or showed a negative response to such treatment.

Table 2. Some Quantitative Traits of Spring Wheat Under the Influence of Pre-Sowing Hardening

Wheat Varieties	Irrigation Conditions	Indicators ControlHardening	NumberofSpikes (pcs.)	SpikeWeight (g)	NumberofGrains (pcs.)	GrainWeight (g)	1000-Grain Weight (g)
Eswyt -1	Irrigated	control	14,40±0,20	2,04±0,05	34,65±0,45	1,48±0,08	42.71
		Hardening	12,90±0,50	1,81±0,08	29,85±1,25	1,30±0,07	43,55
	Non-Irrigated	control	12,40±1,20	1,44±0,07	24,27±0,57	1,00±0,09	41,20
		Hardening	10,94±0,64	1,35±0,12	24,60±2,50	0,96±0,08	39,02
Eswyt -2	Irrigated	control	14,50±1,10	2,38±0,47	39,00±2,50	1,74±0,36	44,62
		Hardening	13,85±1,25	2,28±0,11	38,50±2,30	1,70±0,05	44,16
	Non-Irrigated	control	12,10±0,50	1,60±0,29	29,15±1,55	1,14±0,25	39,11
		Hardening	12,50±1,33	1,87±0,13	34,30±2,33	1,36±0,10	39,65
Eswyt -3	Irrigated	control	12,05±1,05	1,73±0,47	26,95±1,65	1,28±0,34	47,50
		Hardening	13,75±0,05	2,17±0,13	34,00±1,40	1,57±0,07	46,18
	Non-Irrigated	control	11,45±0,65	1,58±0,15	25,40±1,60	1,13±0,12	44,49
		Hardening	12,30±0,87	1,81±0,26	30,57±2,38	1,34±0,20	43,83
Eswyt -4	Irrigated	control	14,53±0,18	2,20±0,13	37,50±1,80	1,69±0,09	45,07
		Hardening	14,65±0,25	3,35±1,40	37,40±1,00	1,73±0,01	46,26
	Non-Irrigated	control	11,65±0,15	1,46±0,03	26,85±2,05	1,08±0,05	40,22
		Hardening	14,00±1,00	2,37±0,35	37,35±3,57	1,53±0,25	40,96
Eswyt -5	Irrigated	control	13,63±0,51	1,93±0,21	35,10±1,84	1,45±0,13	41,31
		Hardening	14,13±0,64	2,13±0,11	37,33±1,64	1,62±0,08	43,40
	Non-Irrigated	control	12,40±0,10	1,80±0,01	33,60±1,30	1,73±0,37	51,49
		Hardening	11,53±0,22	1,31±0,10	24,23±1,98	0,98±0,07	40,45
Eswyt -6	Irrigated	control	13,23±0,29	1,81±0,12	31,67±1,64	1,29±0,08	40,73
	Non-Irrigated	Hardening	12,67±1,24	1,80±0,14	31,77±2,89	1,32±0,10	41,55
	Irrigated	control	12,00±0,00	1,42±0,10	26,45±0,95	1,01±0,07	38,19
	Non-Irrigated	Hardening	11,30±0,53	1,44±0,09	25,83±1,44	1,05±0,07	40.65

Table 1 (continued)

Eswyt -7	Irrigated	control	13,03±0,11	2,10±0,13	32,30±2,07	2,14±0,86	66,25
	Non-Irrigated	Hardening	12,87±0,62	2,02±0,06	30,13±0,84	1,49±0,06	49,45
	Irrigated	control	11,15±0,55	1,64±0,07	27,20±0,70	1,20±0,04	44,12
	Non-Irrigated	Hardening	11,22±0,52	1,64±0,12	26,47±1,76	1,21±0,09	47,51
Eswyt -8	Irrigated	control	13,83±0,62	2,00±0,20	35,30±3,13	1,49±0,14	42,21
	Non-Irrigated	Hardening	12,90±1,07	1,83±0,48	32,33±2,76	1,35±0,33	41,76
	Irrigated	control	12,60±0,20	1,50±0,11	29,25±1,45	1,06±0,11	36,24
	Non-Irrigated	Hardening	11,90±0,33	1,63±0,07	30,23±0,76	1,20±0,07	39,70
Eswyt -9	Irrigated	control	13,95±0,80	2,23±0,07	34,03±2,42	1,58±0,04	46,43
	Non-Irrigated	Hardening	12,83±0,04	1,76±0,08	27,60±1,07	1,65±0,61	59,78
	Irrigated	control	11,45±0,25	1,50±0,03	24,95±0,25	1,00±0,03	40,08
	Non-Irrigated	Hardening	11,83±0,64	1,54±0,05	26,30±1,47	1,02±0,04	38,78
Eswyt -10	Irrigated	control	14,80±0,73	2,16±0,11	34,68±3,22	1,61±0,10	46,42
	Non-Irrigated	Hardening	13,90±0,33	2,22±0,09	36,87±0,42	1,67±0,06	45,29
	Irrigated	control	12,00±0,30	1,58±0,02	28,75±0,65	1,15±0,01	40,00
	Non-Irrigated	Hardening	10,53±0,51	1,48±0,16	24,80±1,53	1,11±0,14	44,76
Eswyt -11	Irrigated	control	15,33±0,62	1,99±0,18	37,87±2,18	1,51±0,16	39,87
		Hardening	15,40±0,33	2,27±0,07	39,93±1,98	1,71±0,05	42,83
	Non-Irrigated	control	13,25±0,85	1,59±0,05	30,55±0,75	1,19±0,00	38,95
		Hardening	13,75±0,35	1,73±0,15	33,40±1,90	1,29±0,10	38,62
E'zoz	Irrigated	control	14,23±0,69	2,28±0,31	37,50±2,93	1,64±0,17	43,73
		Hardening	12,87±1,71	2,00±0,44	34,23±3,22	1,51±0,33	44,11
	Non-Irrigated	control	11,75±0,05	1,73±0,09	32,30±0,70	1,30±0,06	40,25
		Hardening	12,33±0,16	1,51±0,12	34,47±1,36	1,07±0,11	31,04
Qay-raqtosh	Irrigated	control	14,77±0,18	2,01±0,15	42,77±2,89	1,43±0,14	33,44
		Hardening	14,73±0,36	2,17±0,07	40,80±1,87	1,59±0,00	39,00
	Non-Irrigated	control	12,10±0,40	1,48±0,19	31,40±2,80	1,08±0,16	34,40
		Hardening	12,33±0,16	1,51±0,12	34,47±1,36	1,07±0,11	31,04

Thus, our study on pre-sowing hardening of spring wheat seeds demonstrated that some varieties responded positively to different irrigation regimes, while others remained neutral or showed a negative response to such treatment.

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ТҰҚЫМДАРДЫ СЕБУ АЛДЫНДАҒЫ ШЫНЫҚТЫРУДЫҢ ЖАЗДЫҚ БИДАЙДЫҢ ӘРТҮРЛІ СОРТТАРЫНЫҢ КЕЙБІР ӨНІМДІЛІК КӨРСЕТКІШТЕРІНЕ ЫҚПАЛЫ

Ш. Юнусханов, З.Л. Абдуразакова, *С.К. Мелиев, М.Р. Мардонова, Т.А. Бозоров

Өзбекстан Ғылым академиясының Генетика және өсімдіктердің эксперименттік биологиясы институты, Ташкент облысы, Қибрай ауданы, Жоқарғы-Жүз

**e-mail: meliev.sodir@mail.ru*

Аңдатпа

Мақалада П.А. Генкель әдісі бойынша егу алдындағы тұқымдарды шынықтырудың СИММИТ халықаралық топтамасына жататын 11 жаздық бидай үлгісі мен жергілікті селекцияның 2-сортының (Эъзоз, Қайрақтас) өнімділік белгілеріне әсері зерттелді. Зерттеулер суармалы және суарылмайтын агроэкологиялық жағдайларда жүргізілді. Тәжірибе барысында тұқымдарды алдын ала шынықтырудың масақтағы дән санына, масақ салмағына, өсімдіктің жалпы өнімділігіне және құрғақшылық жағдайына бейімделу ерекшеліктеріне ықпалы бағаланды. Алынған нәтижелер бидай генотиптерінің шынықтыруға әртүрлі деңгейде жауап беретінін көрсетті, соның негізінде олар оң, бейтарап және теріс реакция топтарына жіктелді. Суармалы жағдайда кейбір үлгілерде өнім көрсеткіштерінің тұрақтануы байқалса, суарылмайтын жағдайда зерттелген үлгілердің басым бөлігінде бақылау нұсқасымен салыстырғанда масақтағы дән саны мен масақ салмағының артқаны анықталды. Бұл тұқымды егу алдындағы шынықтыру тәсілінің құрғақшылыққа төзімділікті арттыруда және жаздық бидайдың өнімділік әлеуетін сақтауда тиімді агротехникалық әдіс бола алатынын көрсетеді.

Түйінді сөздер: *шынықтыру, тұқымдар, бидай, дән, масақ, бақылау, ылғалдылық.*

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ВЛИЯНИЕ ПРЕДПОСЕВНОЙ ЗАКАЛКИ СЕМЯН НА НЕКОТОРЫЕ УРОЖАЙНЫЕ ПРИЗНАКИ РАЗЛИЧНЫХ СОРТОВ ЯРОВОЙ ПШЕНИЦЫ

Ш. Юнусханов, З.Л. Абдуразакова, С.К. Мелиев, М.Р. Мардонова, Т.А. Бозоров

Институт генетики и экспериментальной Академии наук Узбекистана, Ташкентская область, Кибрайский район, г. Юкори-Юз

E-mail: meliev.sodir@mail.ru

Аннотация

В работе проведено исследование влияния предпосевной закалки семян на некоторые показатели урожайности одиннадцати образцов яровой пшеницы из международной коллекции CIMMYT (Eswyt-1 – Eswyt-11), а также двух местных сортов пшеницы — E'zoz и Qayraqtosh. Исследования проводились в различных агроэкологических условиях: при орошении и в условиях дефицита влаги без орошения. В ходе эксперимента оценивалось влияние предпосевной обработки семян на формирование элементов продуктивности растений, включая количество зерен в колосе, массу колоса и общие показатели урожайности. Полученные результаты показали, что реакция исследуемых генотипов пшеницы на предпосевную закалку существенно различалась. На основе характера изменений изученные образцы были условно разделены на три основные группы: с положительной, нейтральной и отрицательной реакцией на обработку как в условиях орошения, так и без орошения. У части образцов предпосевная закалка в условиях орошения не оказала выраженного влияния на показатели продуктивности и характеризовалась нейтральной реакцией. В то же время в условиях без орошения большинство исследованных образцов продемонстрировали увеличение изучаемых показателей по сравнению с контрольными вариантами. Полученные данные свидетельствуют о перспективности применения предпосевной закалки семян в качестве агротехнического приема для повышения устойчивости яровой пшеницы к засушливым условиям и сохранения уровня урожайности.

Ключевые слова: *закаливание, семена, пшеница, зерно, колос, контроль, влажность*

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Authors' contribution. The largest contribution is distributed as follows:

Sh. Yunuskhanov— conceptualization, methodology, and general supervision.

Z.L. Abdurazakova– Data collection and formal analysis.

S.K. Meliev – Investigation, drafting the manuscript, and corresponding with the journal.

M.R. Mardonova –Formal analysis and validation.

T.A. Bozorov – Resources and visualization.

Conflict of interest. The authors declare no conflict of interest.