Germination and phenological phases of sorghum under saline soil conditions

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Abstract. Young sorghum seedlings face significant challenges in saline soils, often failing to survive the germination phase due to their low tolerance to salt stress and external adverse conditions. This article explores the developmental stages of sorghum in relation to soil salinity levels, focusing on optimal conditions for germination and early growth. Key findings highlight the importance of timely leaching of harmful salts and precise irrigation management to support seedling establishment. Notably, reducing irrigation frequency from four to three times under water-scarce conditions proves detrimental to sorghum growth in saline soils. The study provides valuable insights into improving sorghum cultivation in salt-affected environments. The outcomes prove that in order for sorghum seedlings to grow well in saline soils, it is not advisable to reduce irrigation from 4 to 3 in water shortage conditions.

1 Introduction

In agriculture, the maintenance of agricultural crops begins with the formation of full hectares. When a full hectare is formed from the planted seed, the farmer is satisfied. The damage of salt in the normal growth and development of sorghum in the conditions of saline soils is very strong. The salt in the soil has a strong effect on the growth and development of the plant at the beginning. Because during this period, young sprouts are resistant to salt and external negative effects. Therefore, it is important to wash off harmful salts in time and set the watering regime correctly. When these activities are carried out correctly in the existing soil, good conditions are created for the growth and development of the plant. This indicates the relevance of this topic [1-7].

The root network of sorghum is a tap root, the main part of which develops in the arable layer of the earth, and some roots penetrate to a depth of 2.5 m. The stem is straw-like, 0.5-7 m tall, 2-3 m on average, the inside of the stem is filled with porous parenchyma tissue. The leaves are wide, 20-25. A tuber, 15-60 cm long, produces 2 spikes at the ends of the lateral branches, one of which forms a fruit, pollinated from the side.

It consists of studying the resistance of the "Qarabosh" variety of sorghum grown on saline lands to the effects of salt, the rules of salt washing and one-gallon and seasonal irrigation of sorghum, and their scientific justification.

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2 Materials and Methods.

The research was carried out at the farm "Bekzafarlik Khorvadoril" of Babur SFU in the direction of animal husbandry in the Aq Oltin district of the Syrdarya region. The field experiment was conducted in 9 options, 4 repetitions. The options are arranged in one tier. The length of the building is 50 m. Each option is obtained for 8 rows, i.e. one return of the seeder (50x5.6-280 m^2). The total area of each plot is 280 m^2, the estimated area is 140 m^2. Based on this, the total area of the experiment was 10,080 m^2, and the calculated area was 5,040 m^2.

In the implementation of field experiments on agricultural crops, the methods "Methodology of conducting field experiments" developed by the author Dospekhov B.A and "Methodology of field experiments" developed by Nurmatov Sh were used [4, 5].

The field experiment was carried out in the following options:

In options 1-3, the soil salinity was not washed away. Sorghums were irrigated at 70-80-75%; 70-80-70%; 70-70-70% compared to soil moisture limit (SML);

In options 4-6, soil salinity was washed in November. Sorghums were irrigated at 70-80-75%; 70-80-70%; 70-70-70% compared to SML;

In options 7-9, soil salinity was washed away in February. Sorghums were irrigated at 70-80-75%; 70-80-70%; 70-70-70% compared to SML.

Studies have also been conducted on other plant species at these irrigation rates [1, 2, 3].

When sorghum is planted in rows, 14 kg/ha is the norm. The row spacing is 60 cm. The plant spacing is 15 cm.

In order to determine the agrochemical parameters of the soil of the experimental field mixed soil SML samples were taken from 0-30 and 30-50 cm soil layers by envelope method from 5 points of the field. Before planting, soil SML samples were taken in the 0-30 cm and 30-50 cm layers of the plowed and under plowed layers to determine the amount of NPK, general and mobile forms, humus and sent to the laboratory for analysis (4, 5). The volume weight of the soil is determined according to irrigation procedures in every 10 cm layer at depths of 0-50 cm. The water permeability of the soil was determined using special cylinders in the spring and after harvesting.

3 Results and Discussion

In 2019, sorghum seed germination observations are presented in Table 1 below. For observation, a distance of 16.6 meters was taken from each plot. Germination of young sorghum seedlings was monitored every 2 days from 8-10 days after sowing seed.

In particular, the second observation was conducted on 05.06.2019. During the observation on 05.06.2019, 48 plants germinated in the control option without soil salinity washing. This was 41% of the plants that should germinate. Also, in options 2 and 3, where the soil salinity was not washed, the number of seedlings that germinated during this period was equal to 48.

In options 4, 5, 6, which soil salinity were washed in November, the number of sprouted seedlings at this time was 67 and made 58% of the total sprouting plants.

In the experiment, the number of sprouted seedlings in options 7, 8, 9, which soil salinity were washed in February, was 60, which was 52% of the total sprouting plants.

The third observation in the experiment was carried out on 08.05.2019. At the time of this observation, 71 plants germinated in the control option without soil salinity washing. This was 61% of the plants that should have germinated. Also, in options 2 and 3 without soil salinity washing, the number of seedlings that sprouted during this period was equal to 71 (Table 1). In options 4, 5, 6, which soil salinity were washed in November, the number

of sprouted seedlings at this time was 81 and made 70% of the total number of plants that should sprout.

In the experiment, the number of seedlings germinated in options 7, 8, 9, which soil salinity was washed in February, was 78, which was 67% of the total number of plants that should germinate. The fourth observation in the experiment was conducted on 10.05.2019. During this observation, 89 plants sprouted in the control option, which soil salinity was not washed. This was 77% of the plants that should sprout. Also, in options 2 and 3, in which the soil salinity was not washed, the number of seedlings sprouted during this period was equal to 89.

In options 4, 5, 6, which soil salinity were washed in November, the number of sprouted seedlings at this time was 100 and made 86% of the total number of sprouted plants.

In the experiment, the number of sprouted seedlings in options 7, 8, 9, which soil salinity was washed in February, was 92, which was 79% of the total sprouting plants.

The fifth observation in the experiment was conducted on 12.05.2019. At the time of this observation, 95 plants sprouted in the control option, which soil salinity was not washed. This was 82% of the plants that should sprout. Also, in options 2 and 3, which soil salinity were not washed, the number of seedlings sprouted during this period was equal to 95.

In options 4, 5, 6, which soil salinity were washed in November, the number of sprouted seedlings at this time was 114 and made 98.7% of the total sprouting plants [6, 7].

In the experiment, the number of seedlings germinated in options 7, 8, 9, soil salinity was washed in February was 106, which was 92% of the total number of plants that should germinate.

The sixth observation in the experiment was conducted on 16.05.2019. No bruising was observed in the control option that soil salinity was not washed during this observation period. The total number of sprouted plants was 95, or 82% of the plants that were supposed to sprout, 18% did not sprout at all.

In options 4, 5, 6, which soil salinity were washed in November, the number of sprouted seedlings at this time was 111 and made 95.6% of the total sprouting plants. We accepted this indicator 100%. In the experiment, in options 7, 8, 9, where soil salinity was washed in February, the number of seedlings that sprouted was 104, which was 91.2% of the total number of plants that should sprout (Figure 1).

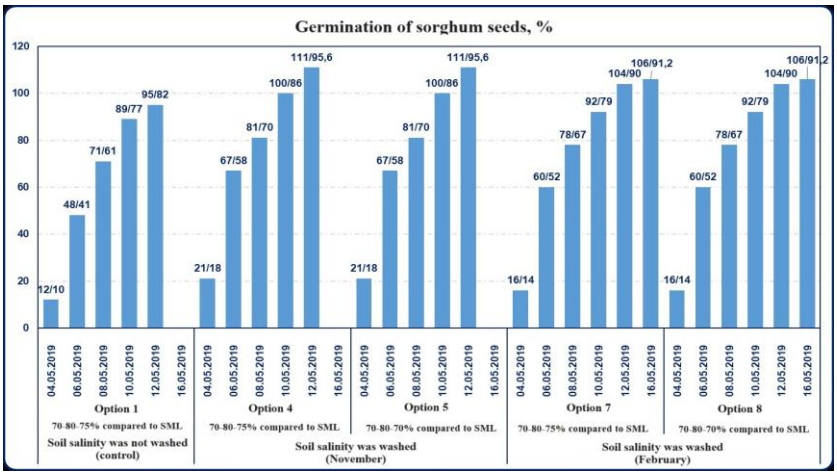

Fig. 1. Monitoring the germination of sorghum seeds. (Sorghums were planted on 25.04.2019)

Note: The number above the decimal line is the number of plants germinated, the number below is the percentage of germination.

In 2020, observation of sorghum seed germination was carried out from the beginning of seedling germination to the formation of a full hectare. In this research year, as in 2019, observation of seedling germination was carried out for the six times. In particular, the first observation was on 08.05.2020, and the remaining observations were conducted every 2 days after that. In the formation of seedlings in 2020, the amount of precipitation was 18-30% more than in 2019, and it created a little more natural moisture reserve in the soil and accelerated the germination of young seedlings. We are not wrong to say that in options 4, 5, 6 washed in February and in options 7, 8, 9 washed in February, certain laws were preserved and it showed its effect until the formation of seedlings (Figure 2).

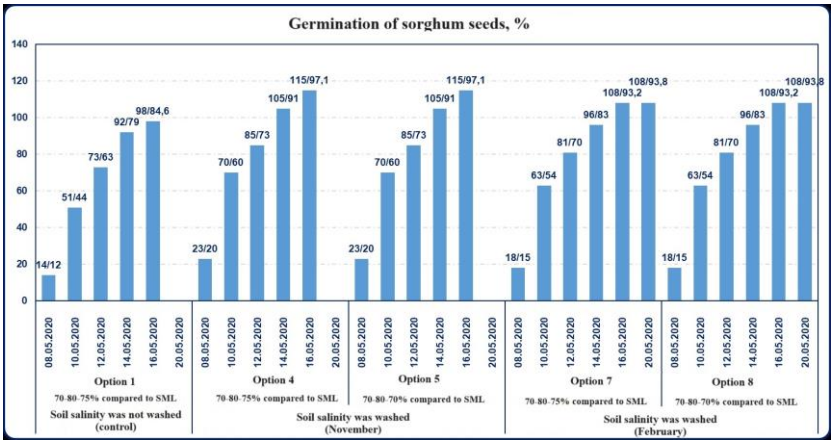

Fig. 2. Monitoring the germination of sorghum seeds. (Sorghums were planted on 04.30.2020)

Analysis of the results of monitoring the dynamics of the 2021 sorghum seed review also noted that data were obtained close to those of 2019-2020. However, it should be noted here that atmospheric precipitation during the growing season in 2021 was 18-31% less than in the previous two years. This had a subtle effect on the soil moisture reserve and, in turn, on the wilting of young seedlings. In particular, in 2021, the number of seedlings that did not sprout in the control option was 19%, in options 4, 5, 6 washed in November, 3.3%, and 7.6% in options 7, 8, 9, washed in February. It can be seen from these analyzes that, the worst acceptor of soil salinity is considered to be the period of youth-emergence of this plant. During this period, even a small amount of salt in the soil is enough to kill it.

Phenological observations were made in the following order. In the experimental options, the seedlings that entered the phase of accumulation according to the plot were calculated in a specific area unit.

In the untreated control option, sorghum entry into the tillering phase and the number of tillered plants were delayed among the years of the experiment. In this case, the number of plants grown in the control option was 10 plants in the first observation, i.e. on 16.05.2019, in the option soil salinity washed in November, this indicator was 16, and in the option soil salinity washed in February, this indicator was 13. On 05.06.2019 and 10.06.2019, when the last observations were made, the total number of germinated plants was 56% of the number of plants that should be germinated in the non-salt-washed control option. 80% in the November soil-salinity-washed options and 69% in the February soil-salinity-washed options. The data obtained in 2020 and 2021 also confirm these data (Table 1, Figure 3).

Table 1. Monitoring sorghum grass entering the tillering phase (2029 year)

Option	Soil moisture before irrigation in % compared to SML.	Sorghum tillering %											
		16.05.2019		20.05.2019		25.05.2019		30.05.2019		5.06.2019		10.06.19	
Soil is not washed (control)	70-80-75	12	10	32	28	43	37	71	61	92	79,2		
Soil is not washed	70-80-70	12	10	32	28	43	37	71	61	92	79,2		
Soil is not washed	70-70-70	12	10	32	28	43	37	71	61	92	79,2		
Soil is washed (November)	70-80-75	18	16	55	47	74	64	91	78	105	91,2		
Soil is washed (November)	70-80-70	18	16	55	47	74	64	91	78	105	91,2		
Soil is washed (November)	70-70-70	18	16	55	47	74	64	91	78	105	91,2		
Soil is washed (February)	70-80-75	15	13	51	44	64	55	84	72	99	85,6	99	85,6
Soil is washed (February)	70-80-70	15	13	51	44	64	55	84	72	99	85,6	99	85,6
Soil is washed (February)	70-70-70	15	13	51	44	64	55	84	72	99	85,6	99	85,6

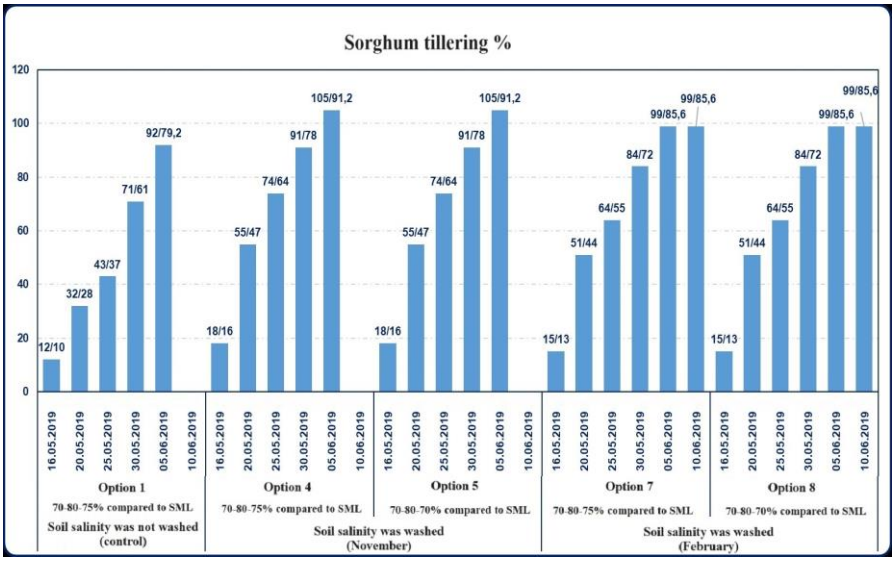

Fig. 3. Monitoring sorghum grass entering the tillering phase. (Sorghums were planted on 25.04.2019)

The above rule was also preserved when the sorghum moved to the next tubering or tubering and bud formation phases. It should be noted here that during the sorghum vegetation, the soil moisture before irrigation was 70-80-75% compared to SML, and the number of plants that produced tubers and buds in the options that were watered 5 times during the growing season, the soil moisture before irrigation was 70-80- 70% and 70-70-

70% and irrigated 3-4 times during the growing season was higher than the options. It is known that the salt in the soil has a negative effect on the early development of the plant. But it will show its negative effects until it is completely washed out of the soil. Instead, in options 7, 8, 9, where soil salinity was washed in February, 18 out of every 100 plants in the plot (number of plants in 16.6 p. meters) for the budding and fruiting phases. The fact that 20 of them were not fully included can be a clear evidence. (Table 2. Figure 4).

Table 2. Monitoring sorghum grass entering the tillering phase (2020 year).

Option	Soil moisture before irrigation in % compared to SML.	Sorghum tillering %											
		24.05.2020		28.05.2020		1.06.2020		5.06.2020		10.06.2020		15.06.2020	
Soil is not washed (control)	70-80-75	14	12	37	32	61	49	85	73	97	84	-	
Soil is not washed	70-80-70	14	12	37	32	61	49	85	73	97	84	-	
Soil is not washed	70-70-70	14	12	37	32	61	49	85	73	97	84	-	
Soil is washed (November)	70-80-75	21	18	61	53	80	69	97	84	108	93	-	
Soil is washed (November)	70-80-70	21	18	61	53	80	69	97	84	108	93	-	
Soil is washed (November)	70-70-70	21	18	61	53	80	69	97	84	108	93	-	
Soil is washed (February)	70-80-75	18	15	57	49	74	64	92	79	101	87	101	87
Soil is washed (February)	70-80-70	18	15	57	49	74	64	92	79	101	87	101	87
Soil is washed (February)	70-70-70	18	15	57	49	74	64	92	79	101	87	101	87

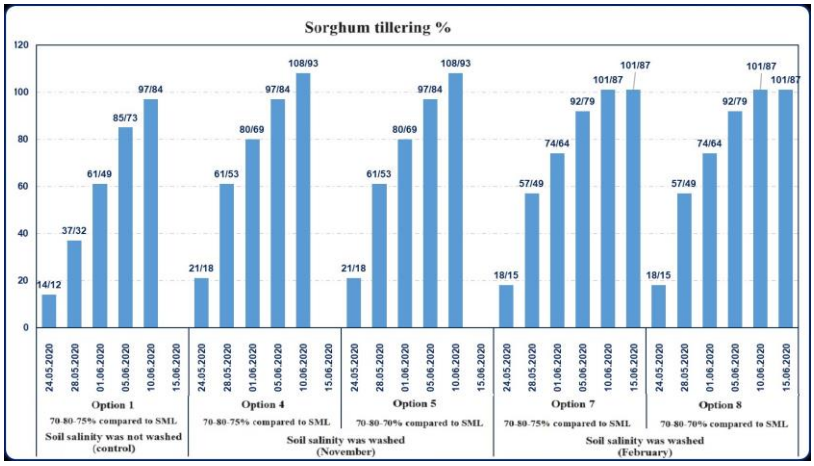

Fig. 4. Monitoring sorghum grass entering the tillering phase. (Sorghums were planted on 04.30.2020).

4 Conclusion

According to the analysis of the conducted scientific research, young plant seedlings are very sensitive to any adverse external effects, because dry matter (sugar and other carbohydrates and proteins) has not yet been formed in the plant. It is very difficult for

young sorghum seedlings to grow and develop well in saline soils, and in most cases, young seedlings die during the germination phase.

Therefore, the salt in the soil has a strong influence on the growth and development of the plant at the beginning. Because during this period, young sprouts are resistant to salt and external negative effects. The article presents interesting information such as the further development of sorghum and the processes of entering phases, based on the permitted level of salt in the soil, when young sorghum seedlings are fully germinated and developed. Based on this, it is important to wash off harmful salts in time and set the watering regime correctly. When these activities are carried out correctly in the existing soil, good conditions are created for the growth and development of the plant. This is the conclusion to be made at the end of the article.

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