Growth and development of *Kochia prostrate* (L.) Schrad in the extraordinary year in the north desert of Atyrau region in Kazakhstan

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Abstract. A system of agriculture is being developed to accumulate and preserve moisture in soil strips (5-10 cm wide, 5 cm deep, repeated every 50-55 cm in virgin soil untouched by vegetation), treated by surface raking of the loose seedbed layer to form a solid compacted bed, where an ideal condition for seed germination is created. With a favorable combination of weather and climatic conditions, this variant provides an optimal fullness of seedlings and a fairly high fruit-bearing weight of 3.9 t/ha on average for four years, including 4.8 tons in 2019. However, in extraordinary 2019-2020 crop year with extremely low precipitation (2.7 times lower than average annual norms), with the warm winter and spring (100 more than the average annual norm), incredibly intense droughts and dust storms (average of 18-19 days a month vs 4-5 mean annual norm) wind erosion dominated and dictated terms everywhere: furrows, sown with seeds of Summer Cypress were completely covered with drifts of dust with a thickness of 2-3 cm, under which the seedlings could not break through to the surface of the soil and died. In the cultivar keeping nursery, where seeds were sown directly without tillage and 15 PCs/m² of seedlings were obtained only in the dust-inspired areas that make up one third of the area (400 m²).

1. Introduction
This year the winter turned out to be extraordinarily warm, which was the reason for the incredible phenomenon: against the earlier established early spring simultaneous germination, seedlings in the variety conservation nursery appeared rhythmically (undulating) during a long term period - from March, 4 to May 9, 2010. By explaining the nature of this phenomenon, it becomes possible to postpone the sowing of the *Kochia prostrate* from early winter to next April, so *Kochia prostrate* is re-sowed on soils grooves degraded by wind erosion, covered with dust in winter and early spring. This is a new direction of agrotechnical struggle with wind erosion and the development of degraded desert lands.

The determining factor, which ultimately ensures the success of phytomelioration in the desert, is the problem of obtaining stable seedlings over years and in space. First of all, compared with seeds of forage
grasses, Kochia prostrate seeds are much smaller and thinner, therefore it is impossible to cover them to the required depth and maintain the seeding rate with existing sowing units in modern conditions.

Secondly, Kochia prostrate (L.) Schrad. seeds cannot tolerate the slightest sinking below 0.3-0.5 cm, while the upper sowing layer of the soil is constantly subjected to wind erosion - the winds not only take away seeds with soil particles, but at the same time, drying the latter contributes to the formation of hard soil crust, impenetrable by seedlings of the bar, which die in the soil itself, without having made its way to its surface. The winds, depending on the roughness of the fields and the exposure of the slopes, have a local effect: in some places the soil dries up to form a hard soil crust, in other places mounds with an abundance of seeds are formed, introduced by the wind from other places, which ultimately determines the diversity of seedlings and productivity.

That is why, more than 88 years after the first successful sowing, carried out by the Professor P. P. Beguchev [1], on the advice and constant support of academician I.V. Larin, attempts to introduce the Kochia prostrate (L.) Schrad into production were unsuccessful [2], although the scientific sowing is not interrupted until today. In modern conditions, the Kochia prostrate (L.) Schrad in the Republic of Kazakhstan is not cultivated outside the experimental scientific plots.

Science has not yet developed a reliable barrier against wind erosion, which once and for all leaves its consequences, therefore, the study of new technological methods that ensure the Kochia prostrate sprouts that is stable over the years and in space is stated to be major importance of the research.

The aim of the research is to study the influence of the external environment on age-related changes and adaptive reactions of Kochia prostrate (L.) Schrad in the northern desert of the Atyrau region.

Research objectives are to study the germination and fruit-and-feed productivity of Kochia prostrate (L.) Schrad, depending on the prevailing agrometeorological and edaphic conditions in the anomalistic year.

2. Materials and methods

The main method of research is field [3,4]. The calculation of the number of seedlings (3 times repeat, m²) and the yield of the fruit mass (2 times repeats, 10 m²) was carried out in the nurseries of variety conservation and pre-propagation of Kochia prostrate, which were laid annually against the background of shallow furrowing of the soil in the cultivation nursery, direct sowing without tillage in the nursery of variety conservation. The repeatability of nurseries is two-fold, the area is 400 m² (variety preservation) and 0.25 ha (breeding nursery). Sowing is to be carried in the underground in 2020 (in November) with a rate of 1.5 million PCs/ha wide-row method (60 cm).

3. Research results

As it was noted in previous works, [5] the continuous tillage of the soil for Kochia prostrate (L.) Schrad does not provide uniform germination over the entire field, both in space and in time. And as an alternative, a raking of the fertile layer 5 cm to the side (depth 5 cm) has been proposed and studied.

Indeed, in this variant, optimal germination was obtained (data from 2018 and 2019), however, in 2019-2020, the germination of Kochia prostrate was not uniform in the experimental nurseries.

In the winter and spring of 2019-2020 agricultural year, there were extremely unfavorable conditions for the growth of Kochia prostrate (L.) Schrad seedlings both in terms of moisture and temperature conditions, especially in the nature of wind activity. In the six months from November 2019 to April 2020, only 33.6 mm of precipitation fell, which is 2.7 times less than the average annual norm (89.5 mm). The air temperature was 10° warmer, and the relative humidity in March and April dropped to 48% and 46% against 75.8 and 69.3 of normal years. The number of days with strong winds above 15-20 m/s for three months (February-April) was 3.5 times more than the average annual norm (18.5 against 5.5 days).

The violent activity of the wind had a major negative impact on obtaining optimal seedlings, which in the conditions of a warm winter provoked premature thawing of the soil. As a result, the open, loosely bonded soil surface uncovered by snow was subjected to wind erosion and the grooves were covered
with aeolian sediments, and the seeds were buried under a thick layer of dust (2-3 cm), so there were no shoots of Kochia prostrate (L.) Schrad.

In another experiment, seedlings were obtained in 1/3 of variety conservation nursery area. Unlike previous experience, Kochia prostrate (L.) Schrad was sown directly on the open surface of the soil without cultivation. The shoots appeared mosaically, only on inspired dust accumulations, on the rest of the bare and densely cemented part of the area the shoots did not germinate. In the dust deposits, seedlings in the amount of 15 pcs / m² appeared rhythmically (wave-like) from March 4 to May 10, only in those places where the seeds were covered with a thin layer of dust, 0.5-1 mm thick.

The seedlings appeared in the following terms (as a percentage of the total number of seedlings (100%): the first wave before March 4-5 in the amount of 5%, the second respectively in March 15-April 09 – 28%, the third - April 13-22 (42%), the fourth - April 24-28 (23%), the fifth - April 30-May 10 (2%).

From the first decade of March to May 9 the moisture content of the near-sown soil layer where the seeds were placed decreased within the limits of:

- March, 4-5 for 10% of the maximum-field moisture capacity of the soil,
- March, 15-April, 09 - below or just above the rupture of the capillary bond,
- April 13-22 - up to fresh, i.e. within barely available moisture,
- April 24-28-from fresh to dry, in the zone of inaccessible moisture,
- April 30-May 02 - within the maximum hygroscopicity of the soil.

The majority of seedlings were obtained from March 15 to April 27 (97%), during relatively long time - 42 days.

The further from the time of snowmelt or rain shoots appear, the more likely they are to die, especially those plants that appear on loose deposits of 2-3 cm deep dust. In such conditions, they died in the rosette phase, i.e. in the phase of the real three pairs of leaves after 8-10 days, the percentage of plant mortality at this time was 80-100%. Mostly plant seedlings, appeared after April, 20-25 fell out.

Otherwise, Kochia prostrate (L.) Schrad seedlings that sprouted from seeds on a moist, dense bed of soil without cover or poorly covered by the thickness of the seeds with mulch behave, survive totally in such conditions.

The earlier the plants germinate, the higher their growth. by May 2, the height of plants sprouted in March and the first half of April reached 2-5 cm, and some up to 10-12 cm, while those sprouted later than April, 20-25 remained in the rosette phase without advancing in growth above 1-2 mm.

There is a direct proportional relationship between the growth of Kochia prostrate plant in the first and second years and subsequent years of life. The more favorable the soil and weather conditions of the first and second year of its life, the better the plants of Kochia prostrate (L.) Schrad grow and develop in the subsequent years of their life. The worse these conditions are in the first and second years of life, the worse the growth and development is in the subsequent years.

This is evidenced by data on the growth and development of the first year of life in the conditions of contrasting moisture in 2015, 2018, 2019 and 2020, respectively, seeding were carried out in November 2014, 2017, 2018 and 2019.

In 2015, the annual precipitation rate (136.4) was 54.4 mm less than the average monthly norm (189.8 mm), but in 2016, in the second year of Kochia prostrate life, precipitation fell 2 times more than the norm. The high availability of precipitation in the second year of life determined the high productivity of the plant in the subsequent years of its life, despite the fact that in some years the precipitation height did not exceed 100.5 mm of precipitation per year (2018). At the same time, the fruit-and-feed productivity of Kochia prostrate by year was respectively (t / ha) 1.8, 4.9, 4.2 and 4.8 starting from the second (2016) to the fifth year (2019).

In 2018, the first year of the plant life, only 100.5 mm of precipitation fell, which is 89.3 mm lower than the average annual norm. In this highly arid year, its germination rate was 18 PCs / m² against the background of raking the upper fertile soil layer to the side. However, in conditions of lack of nutrients,
despite the fact that moisture conditions were favorable for the growth and development of Kochia prostrate (L.) Schrad of the second year (in 2019 there was 227.2 mm of precipitation, that was 37.4 mm more than normal) the denutrition has drastically affected the Kochia prostrate (L.) Schrad yield, comprising 0.8 t/ha, which is 2 times less the yield the same plant of the second year (2016), but provided with nutrients in sufficient quantities.

It should be noted that the growth and development of Kochia prostrate in the first year of life proceeded in a peculiar way on the basis of upper fertile soil layer raking aside (2018 and 2019). In this variant, where the upper 0-5 cm layer of soil is wide, the depth was also 5 cm aside shifted to place the seeds on a solid soil bed in order to abundant shoots. The goal was justified, against this background, full-fledged germination is really provided both in the acutely arid (100.5 mm) 2018, and in the wetter (227.2 mm) 2019, respectively experiencing 18 and 15 PCs/m². However, against the same background, Kochia prostrate (L.) Schrad plants in 2019 experienced a lack of nutrients and they did not advance in the growth of 8-10 cm, at a height of 8-10 cm, they could not form sufficiently strong supporting axial organs, such as a trunk with a sufficient supply of wood.

In conditions of insufficient development of wood, the plants of the first year life switch to a haloresistant metabolism, the vast majority of plants develop weak emaciated single stems that resemble the axial organs of halophytes, its leaves are not dissected from the stems, but are their continuation. Such weak and sickly plants is totally out in the middle of June, not joining in the phase of flowering.

4. Discussion
Two opposite opinions have been established about Kochia prostrate wood in science. Some believe that wood in Kochia prostrate (L.) Schrad is formed in old age and is a consequence of its senile degeneration, i.e., an undesirable process in its development [6], others, on the contrary, claim (Nechaeva, 1974) that “Annual growth, depending on meteorological conditions, is the most stable in plants with a well-developed woody part (trees, shrubs)” [7]. Our research shows that previously the formation of wood with sufficiently strong axial skeletal organs during the juvenile growth period, i.e. before the flowering phase, is one of the adaptive reactions of the Kochia prostrate (L.) Schrad as a representative of a semi-wood life form, which ensures its successful growth and fruiting in harsh desert conditions.

In field conditions, the formation of wood and other substances (lignin, cellulose) that give plants strength and resistance against adverse environmental conditions is visually determined in a simple and affordable way: haloresistant plants are easily unwound around the fingers several times, while the stems do not break, and the stems with developed wood, on the contrary, do not unwound, but break with a crash. This operation can be performed weekly, starting from the end of May until fruit formation, i.e. until mid-September.

Attention is drawn to the fact that, in spite of the established scientific opinion that Kochia prostrate (L.) Schrad requires increased humidity within the lowest moisture content of the soil, observed immediately after snow or rain, in the extra-arid 2019-2020 year, the largest number of seedlings (97%) were obtained in soils where the moisture content of the near-sown soil layer varied from breaking the capillary bond to maximum hygroscopicity.

The second important point is the completeness of seedlings formation in time this extraordinary year indicates the possibility of advancing the period of sowing of Kochia prostrate from sub-winter and winter time to spring, if sufficient moisture is provided. The possibility of extending the period of Kochia prostrate sowing from the time of snowmelt to April 20 determines the economic efficiency of sowing operations, but in the case of wind erosion, when the furrows are filled with sediment in winter, re-sowing of Kochia prostrate (L.) Schrad is to be provided.

The possibility of extending Kochia prostrate sowing period until April, 20 allows us to review measures to combat wind erosion and suggest a re-seeding agrotechnical method for developing disturbed land. Among the measures to combat soil erosion, along with re-seeding of Kochia prostrate, it is possible to include the use of frequent irrigation with a low rate of aerosol mobile installations in order to prevent the blowing of soil particles together with flying Kochia prostrate seeds, since
moistened soils are less exposed to the destructive force of the wind. It is necessary to take into account that the harmful effects of wind erosion occur once in 8-10 years, and the winds can not destroy the crops of twigs twice a year, no matter how strong they are.

As the academician N. T. Nechayeva (1954) rightly notes, “plant growth and the process of barkhan sands overgrowth goes better on the broken Sands of the Badkhyz tract than in the South-Eastern Kara-Kum [8]. This can be explained by soil features: The Badkhyz Sands are richer in dust particles and probably nutrients than Karakum Sands. Obviously, not only the lack of moisture, but also the lack of nutrition in the sand makes it difficult for them to quickly overgrow” (Gael, 1952) [9].

The research we conducted fully confirmed the data obtained by academician N. T. Nechaeva. Lack of nutrition has a detrimental effect on the growth, lag behind in development, can not form skeletal supporting organs, as a result, prematurely fall out in mid-June. The conclusions we have obtained in the course of research are quite consistent with the previously established conclusions of other researchers that the Kochia prostrate (L.) Schrad is a nitrogen-loving plant. This was known as early as in 1968 [10] from the research by E. V. Rothschild and others [11].

5. Conclusion
Summing up the above said, we can formulate the following conclusions:

- Kochia prostrate (L.) Schrad as a representative of a semi-wood life form urgently needs intensive care in the first two years of their life. During this period, it must be provided with sufficient nutrition and hydration, which is achieved by applying certain doses of fertilizers and using aerosol humidification.
- In an intensely well-groomed plant, the skeletal part with a developed woody one is formed before flowering, only plants with a highly developed wood finish the vegetation in the first year with fruit formation at a height of 30-35 cm. These intensively groomed plants continue to grow in winter, forming winter leaves, nutrients of which are intensively reutilized in the spring by more powerfully developed young formations – large leaves, abundantly provided with the necessary dose of nutrients. Intensive care of the first and second year Kochia prostrate (L.) Schrad is a guarantee of high productivity for the subsequent years, regardless of the prevailing weather and meteorological conditions.
- small furrows with a 5 cm. width and depth and the upper fertile layer at the place of seeding, not only serve as a marker for accurate seeding, fertilizing and directing water droplets along them, but also create a solid soil bed that provides optimal germination.
- re-seeding and watering of Kochia prostrate (L.) Schrad in April can completely resist the harmful effects of wind erosion.

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