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# Studying the effect of preplanting tillage on the germination and forage productivity of *Kochia prostrata* in the northern desert of Kazakhstan

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**Abstract.** The earlier studies about the efficiency of the main tillage showed that at the overall tillage for *Kochia prostrata* sowing do not guarantee the uniform germination throughout the field, both in space and in time. It is due to the unsatisfactory water-physical conditions of the subsurface soil where seeds lie. Taking it into account, a farming system is being developed. It is aimed at accumulating and preserving moisture in the soil strips (10-15 cm wide, repeated in 45-50 cm in the virgin soil), treated with a help of the method of a surface excavation of a loose soil layer with the formation of a solid compacted bed where seeds of *Kochia prostrata* are placed. The research results showed a high efficiency of harvesting the upper loose soil layer in strips with a width of 10-15 cm to a depth of 5-8 cm with the creation of a highly compacted solid seed bed, without conducting basic soil cultivation. In this variant, the optimum completeness of seedlings and a rather high yield of forage by fodder mass of *Kochia prostrata* were obtained 3.12 g / ha on average over three years. Earlier, before the development of this research, *Kochia prostrata* with annual sowing provided only 2 years of full-fledged germination from five years of sowing. Then as a result of the conducted research, a number of years providing full-fledged germination has reduced to 4 years of sowing.

## 1. Introduction

One of the plants that are not implanted in the production of feed plants remains to be *Kochia prostrata*. Since the first day it was planted on the area of 2.0 thousand hectares in 1936 by Professors P.P. Beguchaev and B.I. Anfinogentov, sufficient time has passed [1]. Since then, *Kochia prostrata* has been studied in the entire arid zone of the former the USSR (the RSFSR, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan) by several, or it would be better to say by hundreds, of scientific research institutions and experimental stations.

The territories with *Kochia prostrata* are negligible. Over the 83 year period, it was introduced in the republic on the territory of 0.2–0.3 million hectares [2]. By comparison, the introduction areas of grain crops in the republic at first plowing up virgin lands for 10 years is about 41.8 million hectares in the USSR, including 25.4 million hectares in Kazakhstan [3].

In any farming system, soil tillage is of the primary importance. In relation to the main cultivation of *Kochia prostrata* in the desert zone, experimental scientists have explicitly established the efficiency of



plowing with waste plows on loamy soils, or loosening with flat-cutting tools in developing sandy soils. Cultivating technologies of *Kochia prostrata* were developed on the basis of techniques borrowed from the tillage of grain crops in the northern part of Kazakhstan.

That is, a technology of tillage grain crops and perennial grasses was tested in cultivating a perennial such a semi-wood, subshrub plant as *Kochia prostrata*. But they completely overlooking the fact that *Kochia prostrata* is a semi-woody plant; in biology it is close to trees than grain and forage crops. [4]

This is the main error. It became clear soon that *Kochia prostrata* does not sprout annually, but about 2 times out of five years of sowing and then flaps in space; in one place there are full-fledged sprouts, and in another place they are absent.

This fact in itself unambiguously points to the unjustified and inexpedient nature of deep cultivation to a depth of 20-22 cm for sowing *Kochia prostrata* until technological methods will be developed that ensures its full annual sprouts.

It implies that the development of technological methods that ensure the optimum field germination of *Kochia prostrata* in space and in time is of great importance to all other methods of tillage *Kochia prostrata*. This is the relevance of the work.

The goal of the research is development of preplanting technological methods of soil tillage in the cultivation of *Kochia prostrata*, providing its annual full seedlings during the five-year period of planting. It is the study of field germination and forage productivity of black clay *Kochia* depending on the emerging agrometeorological and edaphic conditions.

## **2. Materials and methods of research**

The main research method is field [5]. The counting a number of seedlings (3 times repeating per sq.m<sup>2</sup>) and crop yields (2 times repeating per sq.m<sup>2</sup>) was carried out in seed plots of preliminary *Kochia prostrata* breeding, that were laid annually in the previous year's as a winter crop (in November), for five consecutive years since 2005.

The repetition of seed plots is double; the area is 0.25-0.3 ha. Moreover, in 2015 and 2018, experiments with a winter crop were carried out to study the influence of meteorological conditions and preplanting soil cultivation on germination and fruiting and forage productivity of *Kochia prostrata*; the diagram is given in the description of research results. Sowing as a winter crop was carried out (in November) on the soil surface with a norm of 1.5 million pieces per 1 hectare of zero tillage, wide-row (60 cm) method with embedding of seeds by rolling in the soil.

## **3. Results of research**

Meteorological and edaphic environmental conditions have a direct impact on the *Kochia prostrata* germination; therefore, consider the information about the germination of *Kochia prostrata* in connection with the specifically established weather conditions during the sowing season 2015-2019.

### *3.1. Seed plots of preliminary breeding in 2014 year of sowing*

In 2015, the snow completely melted on 17 March. After snowmelt, the first rain with snow fell on 21 and 22 of March. Daytime air temperature is not lower than +7, + 10°C, and nighttime is 1-2° C. The annual rainfall rate is 136.4 mm, which is 53.4 mm less than the average annual multiyear rainfall (189.8). On 23 March, 2015, the optimum germination of black clay *Kochia prostrata* (22 pcs / m<sup>2</sup>) was obtained.

In 2014, black clay *Kochia prostrata* was sown by zero tillage on three-phones: 1) on medium loamy bound highly compacted soil formed by raking loose surface layer and 2) plowed soil and 3) plots of 100 m<sup>2</sup> on slightly loosened soil, plots 100 m<sup>2</sup>, repeated three times. The optimal *Kochia prostrata* sheds were obtained on medium loamy bound densely compacted soil (up to 22 pcs / m<sup>2</sup>), and on unbound loosened soil, sprouts were thinned and the thrones grew flakes is less than 1 pc / 1 sq. m. (average of three definitions - 0.33 pcs / m<sup>2</sup>). Looking ahead, it should be noted that shoots obtained on loosened soils and subsequently have a growing height of not more than 4 cm (at the end of the first and second years). Plants at this height cannot provide a productive mass.

Kochia prostrate plants, sown on clayey, tightly compacted soils, on the other hand, reach a height of 15–16 cm in the first year, and a number of stems in one bush was 6–8; with a number of 4 pieces per 1 square meter before winter. Thus, when the year is secured by precipitation in the spring and when temperature conditions are favorable, Kochia prostrate provides full-fledged seedlings, despite the fact that the year as a whole is dry. In 2016, favorable conditions were both in terms of precipitation and temperature conditions for the growth and development of black clay Kochia prostrate of the second year. Precipitation fell almost 2 times more than the norm during the vegetation period (March-June), which contributed to the production of up to 1.8 t / ha of forage products, and in the third year (2017) it provided for fruit and vegetables up to 4.9 t, and the fourth year it was 4.2 t / ha . In average it was 3.12t / ha.

That is, with the guarantee of heat and moisture in the first and second years, the Kochia prostrate plants of the third year were less responsive to inadequate precipitation in both the third (188.6 mm) and fourth (100.5 mm) years. For it, precipitation and a favorable temperature regime in the first and second years are very important.

### *3.2. Seed plot of the prebreeding of the 2015 sowing year*

Snow fell on 15 February 2015. Shoots of Kochia prostrate in the amount of 40.5 pcs / sq. m. appeared a week after snowmelt. The air temperature after snowmelt in the afternoon did not fall below 10–11 °C until the emergence of shoots. During the year, 353.1 mm of precipitation fell. It is almost 2 times higher than the average multiyear norm and their distribution in months was even.

Kochia prostrate seedlings with such abundant rainfall a year were soon silenced by weeds such as Atriplex. As a result their height at the end of the first year of life barely reached 1–2 cm; such weak stems completely dropped out in the second year.

### *3.3. Seed plot of the preliminary breeding of the sowing 2016 year*

During the year, 188.6 mm of; it corresponds to the average annual rainfall. During two spring (March-April) months precipitation fell 20.2 mm; it was by 11.4 mm less than precipitation compared to the average norm for some years (31.6 mm). Snow fell in 2017 from March 2–3, and, the daytime temperature reached 11–12 °C from March 4 to March 12. It hadn't not rained until 12 March, when 6.2 cotyledons of Kochia prostrate were grown in wetted soil areas, and in most of the territory (1.15 ha), seedlings did not appear due to premature early drying and the formation of a solid soil crust of the near-surface layer of the soil where the seeds were.

### *3.4. Seed plot of the preliminary breeding of the sowing 2017 year*

The autumn-winter conditions of 2017–2018 were characterized by a warm and dry autumn and it was little snow in winter. During the year, 100.5 mm of precipitation fell; it is 89.3 mm below the average one for some years. The height of snow cover before thawing snow (25 February, 2018) did not exceed 2–5 cm. From 26–27 of February, the air temperature rose to + 8 °C, with a minus temperature at night. Such a sharply contrasting temperature regime lasted until 25 March, when the first cotyledons of Kochia prostrate appeared. Moreover, the seedlings appeared massively (18 pcs./m) only in dry places.

In 2017–2018 agricultural year, the experience was carried out on studying the effect of preplanting on the growth and development of black clay Kochia prostrate.

Experience includes three variants:

- Control, without preplanting;
- Partial raking of the surface loose layer to the depth of 5 cm.
- Complete removal of loose soil with the creation of a solid dense bed, where Kochia prostrate seeds are placed. The area of plots is 100 m<sup>2</sup>, repeated three times.

During the experiment, seedlings were obtained: in control it is 0, on the second version it is 1.6, and in the third version it is 8.6 pcs per 1 sq. m. The height of Kochia prostrate plants before leaving for the

winter (November 2018) was 1.6 cm (the second variant) and 15 cm (the third variant) with a number of plants 3-4 pieces per 1 sq. m. The bushiness did not exceed 4-5 stems per plant, and plants in the second variant fell out completely. After overwintering, the safety of *Kochia prostrata* in the third variant in the spring of 2019 was 98%, it began to germinate on 8, April.

### 3.5. Seed plot of preliminary plant breeding in 2018 sowing

The 2019 agricultural year is characterized by almost total absence of snow; its height did not exceed 2–5 cm. Autumn-spring precipitation was at the level of the average multiyear norm (89.5 mm.) 16 days passed after the first rain (16.03) after snow melting (28.02) the air temperature during the day did not fall below + 6–9 °C; a number of seedlings is 12.3 pcs per 1 sq. m. received on 12, March.

## 4. Discussion of the received data and conclusion

*Kochia prostrata* with optimum fullness of germination ensures the production of considerable forage mass. The first year of *Kochia prostrata* is of the most vulnerable period for the growth and development. If the *Kochia prostrata* in the its first year finishes the development cycle with flowering and the formation of a height is more than 15-30 cm and branching to five or six stems in one bush, then it provides a high forage weight regardless of the current weather conditions in the subsequent years. In this regard, the development of agrotechnical measures that ensure the completeness of germination and the required height of plants at the end of the first year of life has a certain priority. Obtaining the required completeness of shoots is associated with several negative factors. This is primarily due to the fact that, it is not possible to obtain a uniform optimum germination of black clay *Kochia prostrata* according to the uneven distribution of snow and soil moistening, as well as the extremely contrasting variation in space and time of the water-physical properties of the subsurface and subsurface layers of the soil, where the seeds lie. [6-8]

For this reason, it is not necessary to consider sowing on a 2017 winter crop out of 5 years of sowing. The main negative effects on the germination of *Kochia prostrata* seeds is the formation of a solid soil crust above and under the seeds. In other words, the soil dries out with the formation of a solid soil crust impermeable to the hypocotyl roots before seeds germinate. This problem can be solved with the help of two agro-hydro technical methods.

Firstly, it is necessary to supplement them with sowing mulch mechanisms that ensure reliable seed cover and create optimal water-physical conditions for seed germination since the existing sowing mechanism cannot fix the required height (0.3-1.0 cm) of mulch. Secondly, it is necessary to develop mobile aerosol and hydraulic unit that will ensure soil moistening in springtime within the field capacity to a depth of 10 cm with a width of 1.5-2.0 cm.

## References

- [1] Balyan G A 1972 *Prutniak prostrate and its culture in Kyrgyzstan* (Frunze: Kyrgyzstan) p 2
- [2] Motoriko M G, Veselovsky V F and Izmailov G F 1983 *Productivity of arid pastures* (Alma-Ata: Kaynar) pp 23-31
- [3] Baraev A I 1975 *Conservation agriculture* (Moscow: Kolos) p 3
- [4] Leontyeva I P 1969 *Introduction to the culture of forage plants to improve semi-desert and desert pastures* (Moscow: Russia) pp 81-7
- [5] Dospekhov B A 1979 *Methods of field experience* (Moscow: Kolos) p 416
- [6] Pryanishnikov S N 1969 *Introduction to the culture of forage plants to improve semi-desert and desert pastures* (Moscow: Kolos) pp 61-4
- [7] Beguchev P P and Leontyeva I P 1975 *Breeding and grazing* (L: Kolos) pp 394-6
- [8] Shamsudinov Z W 2009 Scientific basis and methods for restoring the productivity of degraded arid pastures *Kormovodstvo* **1** 11-7