Rational measures of agromelioration on grey soils

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Abstract. In the conditions of grey soils in the south of Kazakhstan, the soil is degraded due to irrational use of irrigated land and non-compliance with agro-reclamation works in its order, as well as excessive irrigation of medium-saline soil, it negatively affects crop yields. In addition, on medium-saline soils, winter plowing is carried out only to a shallow depth of 30-32 cm. Mainly on grey soils, with timely and intensive soil treatment, it is preferable, since the degree of bulk mass of gray soils in a stable indicator is 1.28-1.30 g/cm^3. If agrotechnological measures are carried out incorrectly, i.e. it affects the increase in soil density and its salinization, which negatively affects the growth and productivity of agricultural crops. In conditions of decreasing soil fertility, scientists of our scientific institution have carried out experimental work to identify the effects of effective agro-reclamation measures on irrigated saline lands, based on the rational use of irrigated agriculture in the south of Kazakhstan. The first issue that hinders the development of agricultural crops and the regulation of the condition of the rooting layer of plants in the soil is soil salinization and measures to combat them, since this issue is very relevant in conditions of increasing irrigated agriculture intensity.

1 Introduction

The territory of the Turkestan region is located in the south of the desert zone, which makes the issue of agromelioration of saline lands in the region very relevant. The main causes of soil salinization in this region are an increase in the groundwater level above their possible depth and their progressive evaporation, as a consequence, the redistribution of salt reserves, accompanied by their accumulation in the upper layers of soils.

Farmers growing cotton in the southern region need changes in cotton growing, consisting of radical innovative technologies. That is, producers of "white gold" need

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scientific and practical recommendations to achieve high results with the use of new intensive methods to increase soil fertility and cotton productivity.

Unfavorable factors affecting salinization in conditions of water scarcity are, for example, a non-functioning vertical drainage well, as a result of which soil salinization occurs, and a low level of agrotechnology and cotton crop rotation occurs in agrotechnological order.

Development of agriculture remains one of the key problems. The state of the industry directly affects the country's food security. The industry is in dire need of advanced technological solutions, the President noted in his message [1].

In this regard, one of the most important problems of cotton-growing farms of the Turkestan region is the need for deep introduction of new efficient and affordable water-resource-saving technologies into production to improve the reclamation condition of irrigated lands.

Standard deep tillage in combination with soil loosening play a role in the destruction of the plow sole and a decrease in the volume density of the soil, which can increase the capacity of the soil to retain moisture, as well as reduces surface evaporation and promotes the effective use of soil moisture and reduces crop yield losses [2,3].

As a rule, the application of deep loosening methods to the soil is used to reduce the density of the arable horizon root layer for intensive plant growth, this is due to the fact that the roots of crops deeply rooted in the deep soil layer are provided with soil moisture in the deep layer. This effective measure reduces soil compaction, increases humidity and improves the agrophysical conditions of the soil by increasing the infiltration rate. In conditions of water resources scarcity, deep tillage technologies are carried out once every 3 years and as a result has a great impact on increasing the productivity of irrigated lands, as well as the yield of cotton and grain crops [4-6].

2 Materials and Methods

All laboratory analyses and phenological observations were carried out in accordance with the methodology for cotton culture [7].

In the research work, a new domestic cotton variety Maktaaral 4017 was grown, its development and productivity were monitored.

Based on this experiment, the following types of scientific work were carried out: determination of the soil horizon bulk density, soil samples were taken and analyzed from the soil layers in which the roots of cotton take root.

Variants based on tillage using various soil agromeliorations were studied at the experimental site (Table 1).

Table 1. Scientific work schedule.

N o.	Variants.	Fertilizer.		Fertilization, kg, l/ha			
		N	P	basic treatment	budding	flowering phase	fruiting
				P	LHF (liquid humic fertilizer)	Biological fertilizers	
1	Conventional technology	120	80	80	-	-	-
2	Deep soil loosening and biofertilizers	100	60	60	2.0	2.0	3.0
3	Laser soil leveling and biofertilizers	100	60	60	2.0	2.0	3.0

4	Deep loosening. Laser soil leveling	100	60	60	2.0	2.0	3.0

3 Results and Discussion

In the course of this work, it was noticed that the agrophysical condition of the soil improved due to deep tillage.

The results of studies conducted at the experimental site showed that under the effect of deep tillage, the agrophysical properties of light gray soils significantly change. Soil compaction was determined in fields sown with cotton.

When determining the soil density, it was found that soil density in deep soil layers is 15-20% higher than in the upper horizons.

According to the first option, i.e. in a field cultivated by conventional technology, the degree of soil density was high, for example, in a layer of 0-10 cm, soil compaction was 1.35 g/cm^3 in spring, 1.39 g/cm^3 in a layer of 10-20 cm and 1.41 g/cm^3 in a layer of 20-30 cm. At the end of the growing season, it was found that the soil density was above a stable level, that is, by autumn, the soil density was high, for example, in a layer of 0-10cm - 1.36 g/cm^3, 10-20 cm - 1.37 and 20-30 cm – 1.46 g/cm^3 (Table 2).

Table 2. Effect of agro-reclamation measures on changes in soil density.

Soil layer	Experiment variants and indicators of soil density, g/cm^3							
	Conventional technology				Conventional technology			
	at the beginning of the growing season		at the beginning of the growing season		at the beginning of the growing season		at the beginning of the growing season	
0-10	1.35	0-10	1.35	0-10	1.35	0-10	1.35	0-10
10-20	1.39	10-20	1.39	10-20	1.39	10-20	1.39	10-20
20-30	1.41	20-30	1.41	20-30	1.41	20-30	1.41	20-30
0-30	**1.38**	**0-30**	**1.38**	**0-30**	**1.38**	**0-30**	**1.38**	**0-30**

During the experimental work, stable soil density was observed in the upper soil layers in the fields where agromeliorative measures were carried out (0-10 cm.).

Let's take, for example, the second and fourth variants, i.e. when using the technology of deep tillage to a depth of 55 cm, during the initial growing season, in the soil layer 0-10 cm, soil compaction indicators were observed at a stable level - 1.29 - 1.27 g/cm^3.

The change in soil density on average 0-30 cm of the soil layer depending on the implementation of agro-reclamation measures is given (Figure 1).

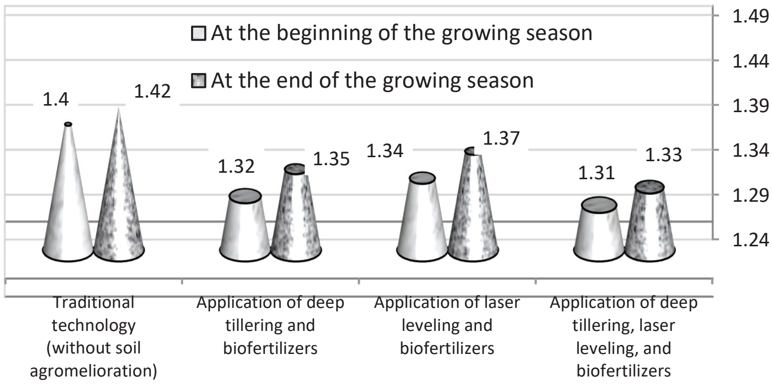

Fig. 1. Seasonal changes in soil density when using agro-reclamation measures, g/cm^3 (0-30cm)

It was found that as a result of deep loosening of the soil to a depth of 55 cm and the use of laser leveling of the soil surface, the degree of soil density decreases. When using complex agro-reclamation measures, the indicators of optimal soil density at the initial stage of experimental work amounted to 1.30 g/cm^3, which is 0.08 g/cm^3 less than the options - without agro-reclamation measures (Figure 1).

The cotton yield depends on the favorable nutrition of plants due to soil moisture and atmospheric conditions. Atmospheric conditions and tillage affect plant phenology and play a vital role as a stressor for plant growth, development, and, ultimately, for the cotton yield [8].

Cotton is considered drought-resistant, so temperatures ranging from 32.2°C to 35°C (90°F to 95°F) are considered almost ideal for growing cotton. Nevertheless, at temperatures below 15.5°C (60°F) or above 37.7°C (100°F), very small changes occur, especially at low soil moisture. The cotton yield is affected by many factors, such as light, precipitation, relative humidity, soil and pests. A warmer environment creates favorable conditions for increasing the growth rate of pests and, thus, reduces the overall productivity of crops. This knowledge creates an urgent need to adapt cotton production to take advantage of the changes while reducing their adverse effects [9-11].

As the results of our research have shown, different rates of fertilizers and agro-reclamation measures had a different effect not only on soil indicators, but also a significant impact on the intensive development of cotton was experimentally established.

The results of phenological observations of cotton against the background of reclamation measures and mineral fertilizers are shown in Table 3.

Table 3. Intensive impact of agro-reclamation measures on cotton development.

Agromeliorative techniques	stem growth, cm		fruit branches, pcs.		fruit elements, pcs.	
Months	VII	VIII	VII	VIII	VIII	IX
Traditional technology $N_{120}P_{80}$	58.0	72.2	7.9	12.0	7.0	7.6
Deep soil loosening $N_{120}P_{80}$ LHF – 2.0. / Biofertilizer BioZZ -2.0 / Biofertilizer WORMic - 3.0	69.2	90.2	10.3	16.0	9.6	9.9
Laser soil leveling $N_{120}P_{80}$ LHF – 2.0. / Biofertilizer BioZZ -2.0 / Biofertilizer WORMic - 3.0	67.0	86.4	9.9	15.4	8.4	9.2

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Deep soil loosening, Laser soil leveling $N_{120}P_{80}$ / LHF – 2.0. / Biofertilizer BioZZ - 2.0 / Biofertilizer WORMic - 3.0	74.3	94.4	10.8	16.6	10.8	11.2

Observations of cotton development on July 1 show that the plants were in the budding and flowering phase in all experiment variants. The growth of the main stem of cotton is in the range of 58.0 - 74.3 cm, the number of fruit branches is 7.9 -10.8 pieces per plant.

Processing of cotton by traditional technology ($N_{120}P_{80}$), it was revealed that cotton development was low, fewer fruit branches (58.0 pcs/plant) and buds were formed on them.

During the period of plant development in early August, the cotton development differed in growth, for example, where the main stem height with conventional cotton sowing technology averaged 72.2 cm, the number of fruit branches was 7.9 pieces and the number of fruit elements within 7.0 pieces per plant.

On cotton crops, against the background of deep tillage (var. 2) and processing of cotton crops with LHF biofertilizers at the rate of 2.0 l/ha (liquid humic fertilizers) was observed, cotton growth was observed, the cotton main stem height was on average 90.2 cm, the number of sympodia was 16.0 pieces, and the number of boxes was 9.6 pieces per plant.

The fruiting of cotton, in addition to hereditary traits of varieties, is closely related to intensive factors, especially with soil agromelioration and the state of the soil environment.

The growth formation intensity and development of cotton was determined against the background of the use of soil deep tillage and laser planning (var.4), the height of the main stem averaged 94.4 cm, the number of sympodia – 16.6 pieces, and the number of boxes - 10.8 pieces/plant.

As on 01. IX., on cotton crops against the background of deep tillage and cotton crops treatment with LHF biofertilizers – 2.0 l/ha, BioZZ -2.0 l/ha, and biofertilizers WORMic - 3.0 l/ha, the number of boxes was 9.9 pieces/plant (var. 2).

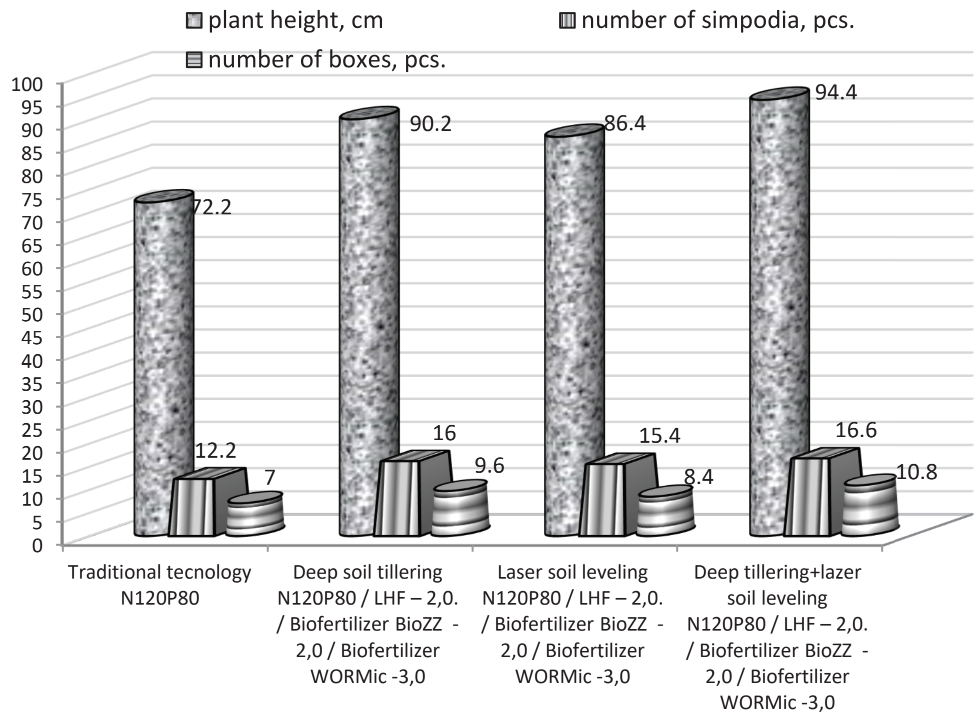

Fig. 2. Height (cm), number of sympodial branches, and cotton boxes (pcs.) – August.

In variant – 3, where laser soil planning was used, and treatment of cotton crops with biofertilizers LHF – 2.0 l/ha, BioZZ - 2.0 l/ha, and WORMic -3.0 l/ha, the number of boxes was 9.2 pieces/plant.

A large accumulation of cotton boxes was determined in option 4, on cotton crops against the background of soil deep tillage and laser planning, the number of boxes is 11.2 pieces/plants (Figure 2).

4 Conclusions

Basically, the degree of grey soil density, compared with other chestnut or chernozems, is higher. Therefore, at the end of the growing season, after harvesting, in the autumn months, it is necessary to intensively loosen the soil to a depth of 55 centimeters.

Intensive application of soil deep loosening with laser leveling, contributes to the formation of an optimal level of arable layer density and intensifies the growth, development, and accumulation of fruit elements of cotton. Quite often, this type of tillage is practiced in areas undergoing secondary salinization of the soil. The technology of complex soil agromelioration reduces the effects of interference in the soil environment, improves the structure, regulates soil bulk density, allows the soil to retain more moisture, and increases cotton yield.

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