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The agrophysical properties effects in syderation used short-row sowing on soil

Yunus Kenjaev[1*], *Razzak* Aripov[2]

[1]National University of Uzbekistan named after Mirzo Ulugbek, 4 University Street, 100174 Tashkent, Uzbekistan
[2]Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnology, 77 Mirzo Ulugbek, 140103 Samarkand, Uzbekistan

Abstract. In short-term cotton-crop rotation fields agrophysical features was achieved improvement by sowing pure rape, peas + rape, peas + rape + chick peas are 22–32 tons of biomass per hectare of land is sown in the fall. In particular, when peas + rape, peas + rape + chick peas are used as siderites, macroaggregates in the topsoil increase by 7.87–8.73% and in the subsoil by 3.35–3.50%, when water-resistant aggregates are planted with gooseberry (55.82%) and pea when mixed with rapeseed and peas (56.7%), and increased soil fertility. As a result, the decrease in soil volume had a significant effect on the increase in water permeability and soil moisture more than 2%. The highest moisture content was observed in the mixture of peas + rape + chick peas as a siderite, and when rapeseed was used in its pure form. Sideration has resulted in an increase in organic humus in the soil and an optimal retention of moisture.

1. Introduction

The importance of soil as the main means of agricultural production in the national economy is determined by its fertility, which is formed during the process of soil formation and is expressed as the sum of all the properties of the soil. Consequently, along with the formation of soil fertility, the necessary factors and conditions for plants emerge. Therefore, it is important to maintain and increase soil fertility, both in ancient and modern farming systems.

Scientists have used a variety of measures to improve soil fertility, including soil tillage, fertilizers and various reclamation measures, proper irrigation, erosion control, crop rotation, the use of siderites, and soil improvement. have managed to increase.

Authors of the work [1] recommend growing soybeans as an intermediate crop in cotton-alfalfa crop rotation systems, especially in weak soils. At the same time, it is noted that the roots and stalks left in the shade increase soil fertility and have a positive effect on the yield of subsequent crops.

According to, many problems in agriculture can be solved by the widespread use of intermediate crops in crop rotation. First of all, crop rotation plays an important role in increasing the type and number of microorganisms in the soil. This is because when a plant is planted in the same area, specific diseases and weeds increase, which negatively affects the microbiological processes in the soil [2].

When intermediate crops are planted, microbiological processes are accelerated and soil fertility is restored as a result of organic matter and root separation.

In researches, the amount of humus under the action of siderites is 0.26–0.41% in the driving layer in comparison with the non-controlled variant, mobile phosphorus 18.3–36.7 mg/kg, exchangeable potassium 14–45 mg/kg, nitrogen nitrate an increase of 1.8–4.2 mg/kg was found. Sideration has been scientifically proven to reduce soil mass from 1.27 to 1.19 g/cm^3, increase porosity by 6–11%, increase the number of earthworms by 7–8 times, improve soil structure, and increase potato growth and productivity [3].

In order to increase soil fertility, alfalfa in saline lands, legumes (mosh, soybeans, beans, peas) and intermediate crops, in particular rapeseed, perko, rye, vetch are used as secondary crops in non-saline soils, it is recommended to drive the peas into the soil as a siderite [4-23].

*Corresponding author: ykenjayev@bk.ru

From the above, it is important to use intermediate crops as siderites to increase soil fertility. However, the effect of siderites on soil fertility, i.e. agrophysical properties, has not been studied in short-crop rotations. In this regard, a number of studies in this area are theoretically and practically relevant.

In order to solve this problem, in recent years, large-scale research experiments have been carried out, which include the following tasks: identification of crops suitable for use as siderites in areas free of grain in the summer; to prove the effect of cultivated and buried mass on the agrophysical properties of the soil.

2. Materials and Methods

Conducting field experiments, planting, caring for crops, harvesting and analysis of the generally accepted Uzbek Botanical Research Institute, (1986); The methods of the Uzbek Cotton Research Institute (2007) were used.

In order to implement the set tasks, the field experiments were conducted on the grassland-gray soils of the farm “Avliyotepalik Ismail MAL” of Ishtikhon district of Samarkand region (2017–2019 years).

The field experiments were carried out in the conditions of old irrigated, cultivated, meadow-gray soils with average sand and groundwater depth of 3–4 m. Field experiments were conducted in 9 variants and 4 repetitions. The area of each pile in the experiment was 240 m^2 (length 50 m, width 4.8 m), the calculated area was 120 m^2, and the piles were systematically arranged in a single layer. Peas “Asia 2001” variety, chick peas – promising K-295 (chick peas (nigretum) feed), Rapeseed Regina, Barley's “Temur” and Soy’s “Dostlik” varieties were selected as siderite crops for the experiment. Field and production experiments, sowing, care, harvesting and analysis of crops were carried out in accordance with the manuals “Methods of field experiments”. “The methodical manual “Methods of agrochemical, agrophysical and microbiological research in water cotton fields” (1963) was used in the implementation of agrophysical analysis. The mean error of the data obtained in the field experiments was analyzed mathematically statistically using Microsoft Excel.

3. Results and Discussion

3.1. Sideration into soil granules and water impact on the share of resistant aggregates

One of the important agronomic properties that determine soil fertility and crop yield is its granularity. Although the impact of soil properties on soil physical properties, tillage measures, soil water and air regimes and overall fertility, and plant productivity has been extensively studied by national and foreign scientists, Samarkand region's grassland-grass soils have been replaced by short-term cotton-growing. The effect of siderite crops on soil granularity has not been studied in grain-free areas.

After siding, samples of 0–30 and 30–60 cm layers of soil were taken from the experimental field in accordance with the experimental work program at the beginning and end of the cotton vegetation in the spring and the granularity, ie aggregate fractions, were analyzed.

In the analysis, the share of 0.25–5 mm macro aggregates at the beginning of the cotton vegetation after sideration was 4.8–8.73% higher in the 0–30 cm layer of soil in other variants than in the controlless siderite variant. The highest differences were observed in goose rapeseed and pea, as well as in mixed plantings with pea rapeseed.

In the 30–60 cm layer, the proportion of macroaggregates differed from that in the driving layer, reaching 65.08% in the non-control siderite variant, and in the variants using siderites, this figure ranged from 62.21 to 68.58%. In the 30–60 cm layer of the soil, its share was lower than in the control-siderite variant in the case of pure peas, peas and barley. This is due to the low biomass of legumes and peas, and the fact that the root of barley is a poplar root, as the formation of the structure is associated with the spread of plant roots in the soil and the amount of humus in the soil [7, 22, 24, 25].

The proportion of 0.25–5 mm macro aggregates in the 0–30 cm and 30–60 cm layers of the soil is the highest in the variant planted with a mixture of pea rapeseed and peas as a siderite (3.50–8.73% according to the layers). A relatively high proportion of macroaggregates was noted in variants planted with pea rapeseed, pea barley, mixed with barley soybeans, and rapeseed pure.

In addition to macro-aggregates, micro-aggregates of 0.25 mm to 0.05 mm have a special place in soil fertility. The favorable share of micro-aggregates in the soil structure ensures high crop yields in the gray soils of Central Asia, and in soils with a large number of micro-aggregates less than 0.25 mm, air exchange deteriorates. Such soils are easily pollinated when wet and compacted when dry [25].

In the experiment, it was found that the micro-aggregates in the 0–30 cm layer of the soil were 18.18–23.63% of the variants, and 0.02–5.45% less in the variants of siderite crops than in the control siderite variant. The effect of pure barley as a siderite was negligible.

In general, when sown with pea rapeseed and peas or with rapeseed and pea, rapeseed, pea pureed and mixed with barley soybeans, the proportion of macroaggregates larger than 0.25 mm in the soil driving layer increased, resulting in water-resistant soil aggregates. This is because organic humus and soil particles combine to form structural soil

aggregates. Many studies have shown that such structural soil aggregates do not decompose under the influence of water and retain their condition for many years [7-13].
It is known that the quality of granules is determined by their water resistance and mechanical strength, as water resistance is a dynamic indicator that varies with changes in temperature and humidity, the activity of microorganisms in the soil, the formation of humus.
Analysis of the formation of water-resistant aggregates under the influence of siderite showed that siderite crops had different effects on the formation of water-resistant aggregates. In all variants studied, the proportion of water-resistant aggregates changed significantly from the initial amount by the end of the growing season. At the beginning of the cotton growing season, when the aggregates were analyzed by fractions, in the studied variants, the aggregates of 5-3 mm size were 15.30–15.70% in 0–30 cm soil layers, while at the end of the growing season the share of aggregates of this size was 16.54–16.72%, an increase of 1.24–1.02%.
An increase in the proportion of water-resistant aggregates with a size of 0.25–3 mm was observed in the analyzed fractions. At the beginning of the growing season, the water-resistant aggregates in the non-controlled siderite experiment were 48.28% in the 0–30 cm layer of soil, and at the end of the growing season they were 28.27%.
The highest rate of water-resistant aggregates was observed in peas + rape + chick pea variant (56.70%), and the highest rate was observed in peas + rape variant (55.82%).
In addition, aggregates smaller than 0.25 mm from the studied fractions were found to be more abundant in the upper layers of the soil at the beginning of the growing season than in the lower layers at the end of the growing season. This is especially true in the non-control side variant. This is due to the fact that as a result of precipitation and irrigation, micro-aggregates are washed into the lower layers of the soil and form a colloidal mass. This means that the use of siderites can maintain and increase the fertility of the soil, as well as increase the share of macro-aggregates and water-resistant aggregates in improving the structural condition. This is a factor in maintaining soil fertility in agriculture.
In general, in short-term cotton-crop rotation fields, rapeseed in the summer grain-free areas, pea with rapeseed, pea with rapeseed and peas in the fall, cultivating and cultivating biomass in the fall to improve soil structure, water-resistant aggregate increase soil granularity and fertility.

3.2. The effect of sideration on the bulk mass (density) and porosity of the soil

For optimal growth and development of agricultural crops, favorable conditions are required in the soil layer, where the main part of the root is spread. In this regard, it is theoretically and practically important to determine the change in soil volume mass and the optimal type of siderite crop under the influence of siderites sown in the summer in the grain-free areas in the field of short-term cotton-grain rotation.
According to the results of numerous studies, the bulk mass of the soil is recognized as one of the factors determining its fertility. According to [24], when the volume volume of the soil is 1.2–1.3 g/cm^3, 70.7–60.1 gr, 1.4–1.5 g/cm^3, the yield of cotton was 48.6–46.0 gr. According to and others, when the mass of soil volume exceeds the optimum value by 0.01 g/cm^3, the yield of cereals is 0.35–0.6 ts/ha, and the yield of potatoes is 1.0 Decreased by 2.0 ts/ha [26].
An increase in soil density of 0.1 g/cm^3 reduced grain yields by 6 ts/ha and corn by 15–25 ts/ha, while cotton yields decreased by 40% when soil density was 1.5 g/cm^3 [24].
According to the results of research conducted by many scientists of the country for good growth and development of cotton, wheat, barley, oats, sugar beet, the soil density should be around 1.25–1.35 g/cm^3 [20, 27]. In these conditions of the soil, its air and microbiological properties are also favorable.
Studies show that each crop requires its own unique, optimal soil compaction. If the soil compaction exceeds this acceptable value, the plant will be adversely affected and its productivity will decrease. As points out, soil density is the most important indicator that characterizes soil, and all physical parameters of soil are related to soil density [21].
In order to determine the effect of the tested siderite crop types on the soil volume mass in the experiment, samples were taken and analyzed from 0–20 and 20–40 cm layers of soil.
After sideration, a change in volume mass was observed in the soil drive layer (0–40 cm) before the first and last irrigation of cotton. In field conditions, the soil volume mass was determined by taking a soil sample from the drive layer that did not disturb the natural state using a cylinder. The results of determining the volumetric mass of the soil driving layer are described in Table 1.
In the variants using siderites, the soil volume mass before the first irrigation of cotton was found to be 0.04–0.07 g/cm^3 and 0.02–0.05 g/cm^3 lower in the 0–20 and 20–40 cm soil layers than in the autumn plowing variant. It can be seen that the volume was greater in the lower 20–40 cm layer than in the 0–20 cm layer of the surface. The maximum decrease in volume mass in the soil driving layer compared to the control-siderite variant (1.20 and 1.24 g/cm^3 or 0.07 and 0.05 g/cm^3) as a siderite in pea rape and peas or in mixed plantings with pea rape observed. A relatively large decrease in soil volume mass in the driving layer (1.21 and 1.24 g/cm^3) was noted when peas and peas were planted in pure form, and a decrease in volume mass from 0.06 to 0.05 g/cm^3 was observed compared to the control-siderite variant.

The lowest increase in volume mass (1.21 and 1.25 g/cm^3) in the soil drive layer (0–20 and 20–40 cm) before the last irrigation during the growing season was observed when planted in a mixture with pea rapeseed and peas as a siderite. decreased by 0.07 and 0.05 g/cm^3 compared to the siderite-free variant.

The lowest relative increase in soil volume mass in the driving layer (1.22 and 1.26 g/cm^3) was observed when the pea was planted as a siderite crop in pure form and mixed with rapeseed, 0.06 and 0.04 g/cm^3 compared to the control-siderite variant, respectively. It was found that the volume mass per cm^3 decreased.

The lowest relative increase in soil volume mass in the driving layer (1.22 and 1.26 g/cm^3) was observed when the pea was planted as a siderite crop in pure form and mixed with rapeseed, 0.06 and 0.04 g/cm^3 compared to the control-siderite variant, respectively. It was found that the volume mass per cm^3 decreased.

Thus, while the control-siderite variant observed an increase in volume mass in the drive layer before the first and last irrigation of cotton, a decrease in soil volume mass was found in siderite variants.

Table 1. Effect of siderites on soil volume, g/cm^3 (2017–2019 years)

Variants of experience	Growing period of cotton			
	before the first irrigation		before the last irrigation	
	soil layer, cm			
	0–20	20–40	0–20	20–40
Control without sideration	1.27	1.29	1.28	1.30
Peas	1.21	1.24	1.22	1.26
Chick peas	1.21	1.24	1.22	1.25
Rape	1.22	1.25	1.24	1.27
Barley	1.23	1.27	1.25	1.28
Peas+rape	1.20	1.24	1.21	1.26
Barley+peas	1.22	1.25	1.23	1.26
Barley+soy	1.22	1.26	1.24	1.27
Peas + rape + chick peas	1.20	1.24	1.21	1.25
Standard deviation	0.026	0.023	0.026	0.024
Square root of the total number of samples, %	5.20	5,20	5,20	5.20
Standard error	**0.005**	**0.005**	**0.005**	**0.005**

This pattern was also observed in barley + soybean, rapeseed, barley siderites, and it was found that the soil volume mass decreased significantly between 0.05 and 0.03 g/cm^3 compared to the control-siderite variant before the first irrigation of cotton.

Table 2. Effect of siderites on soil porosity (2017–2019 years), %

Variants of experience	Growing period of cotton			
	before the first irrigation		before the last irrigation	
	soil layer, cm			
	0–20	20–40	0–20	20–40
Control without sideration	52.2	51.6	51.7	51.2
Peas	54.3	53.5	53.9	53.0
Chick peas	54.5	53.7	53.8	53.3
Rape	53.8	53.1	53.2	52.4
Barley	53.5	52.5	52.8	52.0
Peas+rape	54.6	53.5	54.2	53.0
Barley+peas	54.1	53.1	53.6	52.8
Barley+soy	53.8	53.0	53.1	52.4
Peas + rape + chick peas	54.6	53.7	54.2	53.3
Standard deviation	0.951	0.884	0.960	0.895
Square root of the total number of samples, %	5.196	5.196	5.196	5.196
Standard error	**0.183**	**0.170**	**0.185**	**0.172**

In the driving layer (0–20 and 20–40 cm) a relatively greater decrease in volume mass with peas rape and as a siderite without mixing with pea rape and peas (1.20 and 1.24 g/cm^3 and 1.21 and 1.26 g/cm^3) was observed at planting, and it was found that the control was reduced by an average of 0.07 and 0.05 g/cm^3 compared to the variant.

In the control variant (1.28 and 1.30 g/cm^3) before the last irrigation during the growing season of cotton, an increase in volume mass in the drive layer was observed, on average in three years (1.21 and when applied as a siderite in combination with peas + rape and peas + rape + chick peas) 1.25 g/cm^3) was found to be the lowest. Prior to the last irrigation, a relatively small volume mass (1.24 and 1.28 g/cm^3) in the drive layer was observed when rapeseed and barley were planted as siderites.

In general, for siderite pea in its pure form and when pea with rapeseed and peas or pea in its pure form, the largest decrease in volume mass in the drive layer was observed compared to the control option, and it was observed that it remained virtually unchanged due to irrigation. It was found that the volume mass in the drive layer decreased by 0.07–0.05 g/cm^3 when sideration was applied. When sideration was applied, the roots of the cotton formed a favorable density for good growth, branching.

In the experiment, along with the determination of the volumetric mass of the soil, the specific gravity was also determined. The study found that the specific gravity was 2.63 g/cm^3 in the top 0–20 cm layer of soil and 2.70 g/cm^3 in the 20–40 cm layer. Accordingly, when calculating soil porosity, the average soil porosity in 3 years was 52.2–54.6% in the 0–20 cm layer before the first irrigation, 51.6–53.7% in the 20–40 cm layer, and 0 before the last irrigation. 51.7–54.2% in the 20 cm layer and 51.2–53.3% in the 20–40 cm layer (Table 2).

Therefore, it is convenient to plant peas and peas in pure form in summer and peas in rapeseed and mixed with rapeseed and peas, and high-quality cotton is grown in such areas.

3.3. The effect of sideration on soil moisture

The growth and development of plants, the activity of microorganisms in the soil, all the processes that take place in the soil, the yield of crops depends on the amount of water and moisture in the soil. Along with all the physiological processes that take place in a plant, the close connection of the plant organism with the soil and atmosphere, that is, with the external environment, is due to water. Only when plant cells and tissues are adequately supplied with water do vital processes take place in them. Then the water content in the cell exceeds 80–90% and favorable conditions for cell protoplasm are created [1, 29].

Moisture content of the crop is the main factor determining the yield of cotton. It is known that when moisture in the soil decreases, the osmotic pressure of the soil solution increases and the absorption of water to the roots decreases, water in the plant is used for transpiration, cell sap thickens, concentration increases, physiological processes in tissue are disrupted and productivity decreases.

A number of studies on the impact of various technological measures on soil moisture have been conducted in different soil and climatic conditions of the country [29].

Therefore, analyzes were conducted to study the effect of siderite use on soil moisture and to select suitable siderites in a short-crop cotton crop rotation field.

In our study, a soil sample was taken from the field to determine the moisture content of the experimental field driving layer, and the wet soil sample was dried in a laboratory thermostat at 105 °C for 6 hours.

During the experiment, soil moisture (0–40 cm) was determined before driving siderite crops from the driving layer, before performing the first and last irrigation during the growing season of cotton studied in siderite variants. These figures are described in Tables 3.

The analyzes showed that the siderites had a significant effect on soil moisture.

Humidity (0–20 and 20–40 cm) in the drive layer was 0.5–2.7% and 1.1–5.2% higher in the variants using siderites compared to the control-siderite-free variant before the first irrigation during the cotton growing period.

The highest moisture content (22.1–27.7%) was recorded when planted in a mixture of pea rapeseed and peas as a siderite crop compared to the control-siderite option in the drive layer of soil (0–20 and 20–40 cm) before the first irrigation during the cotton growing season. Relatively high humidity (21.0–26.2%) was observed when rapeseed was sown in pure form as a siderite crop.

Even before the last irrigation of cotton, it was found that the moisture content was highest (21.2–26.4%) when planted in a mixed (0–20 and 20–40 cm) layer as a siderite crop with a mixture of pea rapeseed and peas. Relatively high humidity (20.1–25.5%) was noted for siderite when applied in combination with pea rapeseed and rapeseed in pure form (20.2–25.1%).

Compared to the control-siderite-free variant in the driving layer of the soil, the moisture content increased by 1.9 and 4.4% before the last irrigation when applied as a siderite crop mixed with barley pea.

When barley is sown in pure form as a siderite crop, the soil moisture is 18.8 according to the layers; 22.3%, which was significantly lower than other siderites. This pattern is also observed when pea, pea biomass is used as sideration, after siderites before the first watering of cotton during the growing season in the soil driving layer (0–20 and 20–40 cm) layer moisture for siderite pea and pea when planted in pure 20.6–20.0% and 24.5–24.1%, which was 1.2–0.6% and 2.0–1.6% higher than the control option, respectively.

In general, in our study, it was observed that the moisture in the drive layer was highest before the first and last irrigation of cotton when planted as a siderite crop mixed with pea rapeseed and peas, and rapeseed pure, and soil moisture in the plowed layer was favorable for cotton cultivation. This is because the more humus in the soil, the higher the moisture retention property. When sideration was applied, the accumulation of organic mass in the soil resulted in an acceleration of microbiological activity, resulting in an increase in organic humus in the soil and an optimal retention of moisture. In increasing soil moisture, it was found that siderite crops have a higher chance of retaining moisture in the soil, especially when planting peas mixed with rapeseed and peas or rapeseed and rapeseed in its pure form and used as sideration.

Table 3. Effect of siderites moisture (2017–2019 years) in %

Variants of experience	Before the sideration process 18–24.11		Growing period of cotton			
			before the first irrigation 9–12.06		before the last irrigation 2–5.09	
	soil layer, cm					
	0–20	20–40	0–20	20–40	0–20	20–40
Control without sideration	17.8	19.8	19.4	22.5	17.9	20.4
Peas	20.3	25.5	20.6	24.5	19.6	23.8
chick peas	19.4	24.0	20.0	24.1	18.8	23.5
Rape	21.1	26.6	21.0	26.2	20.2	25.1
Barley	19.2	23.8	19.9	23.6	18.8	22.3
Peas + rape	20.7	27.1	21.2	25.9	20.1	25.5
Barley + peas	20.5	26.5	20.8	25.2	19.8	24.8
Barley + soy	19.9	24.6	20.2	24.1	19.1	22.9
Peas + rape + chick peas	21.5	28.0	22.1	27.7	21.2	26.4
Standard deviation	1.190	2.474	1.276	1.901	1.158	1.994
Square root of the total number of samples, %	5.0	5.0	5.0	5.0	5.0	5.0
Standard error	**0.238**	**0.495**	**0.255**	**0.380**	**0.232**	**0.399**

4. Conclusion

1. When peas + rape, peas + rape + chick peas are used as siderite, macroaggregates in the topsoil increase by 7.87–8.73 and in the subsoil by 3.35–3.5%, when water-resistant aggregates are planted with pea rapeseed (55.82%) and increases its fertility by ensuring that the pea is high when planted in a mixture of rapeseed and peas (56.7%) and provides soil granularity.

In general, water-resistant soil aggregates were formed when the proportion of macroaggregates larger than 0.25 mm in the soil driving layer increased when sown peas with rapeseed and peas or mixed with rapeseed and peas, rapeseed, peas pureed and mixed with barley soybean. The reason is that organic humus and soil particles combine to form gel, i. e. structural soil aggregates. Such structural soil aggregates do not decompose under the influence of water.

2. The use of peas, peas + rape, peas + rape + chick peas as a siderite in areas free of grain in the summer improves the agrophysical properties of the soil, the volume mass before the first irrigation in layers 0–20 and 20–40 cm of soil 0.04–0.07 and 0.02–0.05 g/cm^3, and even at the end of the growing season, if this pattern is maintained, the volume mass is 1.21–1.25 g/cm^3, and favorable conditions are created for the branching of cotton root.

3. Sideration has a significant effect on soil moisture, and before the first irrigation the soil moisture is 0.5–2.7% and 1.1–5.2% higher in the 0–20 and 20–40 cm layer than in the control. The highest moisture content is observed in the mixture of peas + rape + chick peas as a siderite, and when rapeseed is used in its pure form.

In short, when siderite crops are planted in a mixture, the water regime of the soil is improved, precipitation and irrigation water are well absorbed into the soil, the soil layers are uniformly moistened and retain moisture well, creating favorable conditions for plant growth and development.

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