Study on the influence of sideration on soil density and porosity

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Abstract. It was achieved to improve agro physical properties of soil by forming of 22.41-52.92 t/ha green biomass of pea, chickpea, rape and barley when sown as green manure as well as tilling it into soil in summer July 10 wheat freed areas, and autumn October 10 cotton freed areas. It was determined that the mass of soil before the first irrigation of cotton in 0-20 cm tilling layer of soil with green manure applied variant was 0.06-0.08 g/cm^3; 0.03-0.08 g/cm^3 and it was less 0.05-0.07 g/cm^3; 0.03-0.08 g/cm^3 in 20-40 cm of soil layer relatively to control-without green manure variants. In its turn, it creates best and favorable condition of branching root system of cotton-plant and will be achieved to get high and quality yield.

1. Introduction

To increase systematically of soil fertility and use of its potential for further development of crop cultivation is a topical issue. Whereas, after independence of our republic, radical reforms were carried out in the country, as a result of organization of farmers' specific peculiarities of farm management especially those related to the introduction of modern short-term varieties, the solution to this problem plays an important role in theoretical and practical aspects.

The scientists, in the field of soil fertility, have developed a variety of activities and methods, including land treatment, use of fertilizers and various ameliorative activities, proper irrigation, erosion control, rotation system, use of green manure, enhancing soil fertility by implementing many activities, such as improved soil ecological state [1, 2].

According to Mirzajonov [3], the mass of the soil determines its hydrometric, air and microbiological states. Green manure (green fertilizers) optimizes its overall state. When green manure is crushed with hard disk and tilling into soil, agro physical, agrochemical and biological properties of soil are improved and the productivity of the cotton will grow by 2.8-4.5 s depending on green manure types.

The experiments were conducted by Ernazarov [4], Kholikov [5] and other researchers, which showed that the use of intercrops radically improved physical and mechanical properties of the soil, reduced mass and soil humidity content. According to Kholikov [6], when tilling intercrops in spring, they positively impact on agrochemical and agro physical properties of the soil, the soil fertility changes and the yield of the next crops increases. The root system of green manure crops and stirred of green mass also positively impact on the physical properties of the soil.

First of all, the deep-rooted system leads to a reduction the mass of soil, the water retaining increases in 75m^3 in barley for 3 hours, 88 m^3 in rye, 124 m^3 in rape and accelerate of microbiological processes and restores soil fertility [7-12].

The rotting process of organic compounds is extremely important in the occurrence of productivity and in the process of soil aggregates formation and a number of researchers have covered this issue [7-12]. It is recommended that alfalfa is to be planted in salinity and pulse (mung, soya, bean, chick peas) in desalinized areas as double crops and intercrops like, rape, perko, rye, vika, peas are preferable to till into the soil as green manure in rotation system of cotton growing complex [7-13].

Besides that, in some parts of irrigated farm lands of our republic it is observed a breakdown of soil aggregates, erosion, breaking down of the soil aggregations, humus-freed, erosion, pollution with heavy metals, radio nuclides, pesticides and others. To prevent these negative states, it is very important to develop natural technology systems of restoring and increasing of soil fertility.

In addition, the use of intercrops and their utilization as green manure to improve soil fertility plays a crucial role.

When the ground part of the intercrops is harvested, over 10tons of stalk, root and leaf residues are stirred per hectare when the soil tills, as a result soil fertility and its agro physical characteristics will improve.

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As well as extensive scientific research on the effectiveness of intercrops have been done in Uzbekistan.
This activity has been continued by Khalikov. It is fully important to use of natural factors that improves soil fertility during the development of measures, to keep the ecological balance of the former cotton fields and to restore soil fertility. During the development of these measures, a great attention should be paid to green manure for the first place in Central Asian condition [4].
Introduction of cereals intercrops and double crops into rotation system play an important role in maintaining the ecological position of the soil. Because the root residues of these varieties spread widely into the deep soil and serve natural drainage, and this improves the soil fertility and allows growing consistently abundant, quality and inexpensive products [14]. It helps not only to increase soil fertility but enables to grow abundant, quality and inexpensive products. In particularly, the root of the cereal crops is fibrous root, they are placed in tilling part of the soil, and because of placing widely and thickly from the subterranean the water and small quantities of nutrient will vapor low as well as harmful salt comparatively to tap root plants.
In irrigated condition, more than 10-12 tons of organic matter will be collected per hectare in tilling part of the soil when rotated cereals, corn, alfalfa, cotton, pulse and other crops.
Leguminous crops collect 300-400 kg of biological nitrogen and other nutritious elements per ha and improve the soil physical and microbiological activities [15].
The world scientists as well as our republican leader research institute centers' experiments confirm, it is purposeful to increase soil fertility systematically and normally apply to mineral fertilizers and supply it into the soil mapping correspondingly. The services of the scientists on increasing soil fertility were highly appreciated by Commonwealth of Independent States [16]. Green manure crops play a great role to develop farming and the main resource and source in European and Asian countries agriculture [4].
In Central Asia, Kazakhstan- including in Uzbekistan, it is said that the organic matter positively influences on soil fertility, harvest and quality as well [5]. CIS and foreign scientists state that intensively decreasing of humus quantity is being expected in tilling layer of the cotton fields. The soil fertility is not to be able to restore by applied measures but this problem can be solved by using of plant residues and organic matters [7-12].
In the republican crop rotation recommendations [5], it is said that alfalfa, pulse and other legume crops should be15-20% and that is for intercrops at least 10 % in the composition of the crops based on rotation system and its contribution, properly placement of crops and improving types, ratio and rationally adapting of rotation system continually restore soil fertility.
It is obviously above-mentioned analysis, it is specifically emphasized to use rationally of organic and green manure, especially application of intercrops as green manure to improve meliorative state and fertility of the soil in rotation crop system. However, the solution of the issue has not been studied sufficiently in the pasture-virgin soil condition of Samarkand region, besides that, it has also not studied the influence of green manure on soil fertility and its agro physical, agrochemical and agro biological properties in short -term rotation system.
For this point of view, it is a very important task to carry out theoretical and practical research investigations on this trend.

2. Materials and Methods

The methods by Uzbekistan plant growing institute (1986); Uzbekistan cotton-growing scientific research institute (1981, 2007) were used while conducting field experiments, planting crops, growing, harvesting and analyzing.
The field experiments were conducted for 5 variants and 4 repetitions in the formerly irrigated, cultured, average sandy as for mechanical component and the subterranean level was 3-4 m deep pasture-virgin soil condition in Samarkand region.
For per seedbed surface in the experiment was 240m² (the length was 50m, width was 4.8 m) in 120 m² area and the seedbeds were placed systematically in one circle.
The samples which included in the state list "K-295" (fodder nigretum) for fodder chick pea, "Osiyo-2001" for pea, "Loris" autumn variety and "Viking-BNIIMK" for spring variety of rape, "Temur" for barley were taken and sown in different times (summer and autumn)
Methodical manual such as "Methods of agro chemical, agro physical and agro biological research in irrigated cotton areas" was used to perform agro physical analysis [17].
In the experiment the following *agrophysical analysis* have been done:
- by Kachinski method [17] on mass of soil volume (g/cm³) in 0-20, 20-40 cm layer for 4 repetitions after green manure in cotton vegetation period before the first and last irrigation;
-with the help of pycnometer in 0-20, 20-40 cm of soil layer for 4 repetitions of comparative mass(g/cm³) after green manure of cotton vegetation period, before the first and last irrigation;
-by accounting mass of soil volume and comparative mass according to soil porosity (%) in first and last irrigation period of cotton vegetation;

3. Results and Discussion

Besides, it is important to be favorable condition for well growth and develop of agricultural crop in the soil layer which the primary root spread.

Therefore, it theoretically and practically important, to identify suitable green manure type and change mass of soil volume under the green manure which were sown in wheat and cotton freed areas in short-term rotation system.

According to a number of carried results that the mass of soil is admitted one of the most determining factor of soil fertility.

Muhammadjanov and Zokirov [18] stated that when the mass of soil was 1.2-1.3 g/cm^3 the yield of cotton was 70.7-60.1g for per plant and when it was low 1.4-1.5 g/cm^3 the yield was 48.6-46.0 g.

The density of soil was over 0.1 g/cm it decreased the wheat yield in 6 s/ha and for corn it was 15-25 s/ha, when the density was equaled to 1.5 g/cm^3 the cotton yield decreased 40%.

For Bondarev, Dimo and others point of view [19], when the mass of soil is over 0.01g/cm^3 for optimal indicator, the grain productivity decreases 0.35-0.6 s/ha and that is for potato productivity 1.0-2.0 s/ha.

It is known from most research results, the density of soil should be about 1.25-1.35 g/cm^3 to grow and develop well of cotton, wheat, barley, oats, sugar beet.

The microbiological and air properties will be favorable in these positions of soil. As most researches show that each crop requires the best compact soil consolidation. When density is over from reasonable indicator, it negatively influences on the plant and its productivity decreases as well. As Muhammadjonov [18] says, the density of soil is the most essential indicator of soil and all physical indicators depend on the density.

In conducted experiments, having taken 0-20 and 20-40 cm of soil layer and analyzed in order to determine the effect of green manure types on mass of soil. The soil mass changes were observed in (0-40 cm) tilling layer after green manure, before and latter irrigation of cotton-plant. It was defined with the help of cylinder in the field condition by taking a naturally unbroken sample from soil mass in tilling layer of soil.

The recording results to define the mass of soil tilling layer were shown by two tables.

Before the first irrigation of cotton–plant the mass of soil was 0.06-0.08 g/cm^3; 0.03-0.08 g/cm^3 with green manure variants in 0-20 cm of soil layer compare with control-without green manure, it was low 0.05-0.07 g/cm^3; 0.03-0.08 g/cm^3 in 20-40 cm in soil layer.

It is apparently, the mass of soil was larger in 0.20 cm of surface layer than the bottom layer of 20-40 cm.

Maximum reduction of mass of soil in soil tilling layer was (1.19-1.22 g/cm^3; 1.20-1.23 g/cm^3 or 0.08-0.07 g/cm^3; 0.08-0.06 g/cm^3) in rape sown green manure variant relatively to control- variant without green manure.

Much increasing of mass soil in tilling layer was recorded (1.20-1.23 g/cm^3; 1.24 and 1.24 g/cm^3) in barley purely sown relatively and the mass of soil decreased 0.07-0.06 g/cm^3; 0.07-0.07 g/cm^3 relatively to control- variant without green manure.

Minimum increasing of mass of soil in (0-20 and 20-40 cm) soil tilling layer was recorded (1.20-1.25 g/cm^3; 1.25-1.27 g/cm^3) in rape green manure sown, it decreased 0.08-0.07 g/cm^3; 0.07-0.07 g/cm^3 comparatively to control-without green manure before the last irrigation of growth period.

Minimum increasing of mass of soil in tilling layer was recorded (1.24-1.26 g/cm^3; 1.26-1.28 g/cm^3) in barley as green manure crop sown (Table 1).

Thus, the mass of soil increased in tilling layer before the first and last irrigation of cotton- plant in control variant without green manure and in variants with green manure decreasing of mass of soil was found.

This principle was also recorded in pea and chick pea variants, and the mass of soil was identified considerably decreasing before the first irrigation in compare with control variant without green manure [20, 21].

The maximum decreasing (1.19-1.22 g/cm^3 and 1.20-1.23 g/cm^3; 1.23-1.25 g/cm^3 and 1.24-1.26 g/cm^3) of the mass of soil was recorded for rape and barley green manure variants in (0-20 and 20-40 cm) tilling layer and it became known average decreasing in barley variant 0.07 and 0.06 g/cm^3; 0.07 and 0.07 g/cm^3 control variant relatively.

The increasing the mass of soil (1.28-1.32 g/cm^3 and 1.32 and 1.34 g/cm^3) was observed in tilling layer before the last irrigation of cotton growth period. When rape applied as green manure, it was the least (1.20-1.25 g/cm^3 and 1.22-1.26 g/cm^3) average for 3 years. Minimum mass of soil was (1.21 and 1.26 g/cm^3 also 1.26 and 1.28 g/cm^3) defined barley as manure sown before latter of irrigation in tilling layer relatively.

Generally, maximum decreasing of the mass of soil was in rape and barley purely sown as green manure variant comparatively, there were not any changes due to irrigation. When applied green manure good density forms to grow well and branching of the root of cotton. In the experiment the comparative mass of soil was also determined with the mass of soil. The comparative mass was 2.63g/cm^3 in the ground part of 0-20cm layer and in 20-40 cm layer it was 2.70 g/cm^3. As well as, summer and autumn green manure impact on the porosity also studied.

In this case, the soil porosity was accounted and average 3 years analyzed. The soil porosity was high before the irrigation in 0-20cm of layer rape and barley applied variants, 54,6-55,4% and 55.2-56.0% comparatively to control

variants, in 20-40cm of layer it was 53.4-54.2 and 54.1-54.9 while before the latter irrigation in 0-20 cm of layer it was 55.2-55.6% and 54.9-55.3% or in 20-40 cm layer it made up 53.4-54.2% and 53.0-53.5%.
Maximum porosity was in rape and chick pea variants relatively. Providing the soil porosity in the norm improves the soil erosion and allows developing root growth when green manure applied. It provides to get high qualitative yield of cotton (Table 1). Therefore, to sow pea, chick pea, rape and barley are favorable green manure in summer wheat freed area and autumn cotton freed areas and the cotton that have been grown in these areas, provides with high qualitative yield.

Table 1. The impact of green manure on the mass of soil (2016-2018 ss)

№	Experiment variants	Before the first irrigation						Before the last irrigation					
		Layer of soil, cm											
		0-20			20-40			0-20			20-40		
		d, g/cm^3	T, %	Tae, %	d, g/cm^3	T, %	Tae, %	d, g/cm^3	T, %	Tae, %	d, g/cm^3	T, %	Tae, %
Summer green manure													
1	Control variant without green manure	1.27	51.9	24.3	1.29	51.9	24.4	1.28	52.2	29.3	1.32	50.7	27.7
2	Pea	1.21	54.9	25.2	1.24	53.7	21.8	1.22	54.5	30.1	1.27	52.6	24.2
3	Chick pea	1.21	54.9	26.4	1.24	53.7	20.0	1.22	54.5	28.8	1.27	52.6	22.1
4	Rape	1.19	55.6	27.3	1.22	54.5	19.7	1.2	55.2	28.3	1.25	53.4	21.5
5	Barley	1.2	55.2	25.1	1.23	54.1	22.6	1.21	54.9	30.3	1.26	53	24.7
Autumn green manure													
1	Control variant without green manure	1.31	52.4	21.7	1.33	51.6	17.3	1.32	52.0	30.4	1.34	51.3	28.5
2	Pea	1.28	53.5	21.3	1.3	52.7	17.2	1.29	53.1	29.2	1.31	52.4	23.4
3	Chick pea	1.28	53.5	20.7	1.29	53.1	17.2	1.3	52.7	27.2	1.32	52.0	20.7
4	Rape	1.23	55.3	18.6	1.25	53.4	21.5	1.25	53.7	21.5	1.27	52.6	24.2
5	Barley	1.24	54.9	21.3	1.26	53	24.7	1.26	54.2	22.4	1.28	53.5	25.2

4. Conclusions

The mass of soil was 0.06-0.08 g/cm^3; 0.03-0.08 g/cm^3 in 0-20 cm layer of soil before the first irrigation of cotton-plant with green manure applied version in compare with control variant without green manure, that was 0.05-0.07 g/cm^3; 0.03-0.08 g/cm^3 low in 20-40 cm of soil layer. This enables a good condition to branch of the cotton root.
The porosity of the soil before the first irrigation was high for rape and barley applied versions on 0-20 cm layer and made up 55.6-56.4 and 55.2-56.0% relatively to control variant and or in 20-40 cm layer it was 54.5-55.3% and 54.1-54.9%, before the last irrigation it was 55.2-55.6% and 54.9-55.3% on 0.20 cm of layer, 53.4-54.2% and 53.0-53.5% on 20-40 cm of layer.
High porosity was in pea and chick pea versions relatively to. In general, to till and stir the biomass into the soil 35-40 cm deep which have been taken by sowing of pea, chick pea, rape and barley purely as green manure provides to improve the structure of the soil, decrease of mass and to be favorable of porosity and the soil grainy as well as increases the fertility in wheat freed area in summer and cotton freed area in autumn by short-term cotton-wheat rotation. Consequently, to get high, qualitative yield of cotton will be achieved after application of green manure.

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