

EFFECT OF GREEN MANURE APPLICATION ON SOIL FERTILITY, GROWTH, DEVELOPMENT AND YIELD OF COTTON IN TYPICAL SANDY LOAM SEROZEM SOIL CONDITIONS OF UZBEKISTAN

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Abstract. It is discussed on effect of green manure application on changes of agro physical and agrochemical properties of serozem soils of Zaravshon walley of Uzbekistan. Several varieties of field crops such as typhoon, pea, and rye were used as a green manure. Field and laboratory investigations showed an improvement of physical, chemical and biological soil properties, as well as on better growth, development and yield of cotton plants under influence of green manure.

Key words: green manure, serozem, light serozem, typical serozem, meadow serozem, agro physical, agrochemical, cotton, nutrient.

Introduction. Nowadays, the most important problem of land husbandry in condition of intensive agriculture is concluded in extended restoration of soil fertility. But in the same way, creation of limitless balance of the nutrients in soil-plant system is one of factors of the potential fertility of the soil and its humus content is considered as significant index of soil fertility.

Local and international experiences show that systematic increase of the soil fertility and productivity of the field crops is possible under constant application of organic and mineral fertilizers in required rates. Increasing of the soil fertility by cotton growing is one of the main chains for increasing of the yield of cotton plants. Commonly accepted agro technical mean for realization of this problem is proper implementation of crop rotation in combination with application of mineral fertilizers, land cultivation, and irrigation. In this regards, it needs to point out that in many cases, it requires not only to restore a lost value of soil fertility due to improper application of heavy agricultural machinery and irrigation, but continuously reproduce soil organic matter by application both organic fertilizers and green manure.

Field crops grown as a green manure are broadly used in countries of the Europe and Asia and attract great attention, as one of the effective agro technical mean of increasing of the soil fertility. Arable areas which are free from main crops are used for green manure farming. Green manure is cultivated during the rest periods of summer and althorn. In order to create optimal satisfied requirements of plants in significant environmental factors, creation of optimal temperature, aerial and nutritional regimes, it needs to improve an agro physical and water physical conditions of soil, which is considered as a key role in optimal decomposition processes of incorporated organic materials. (Oripov, 1983)

As it is well known crops for green manure grown as intermediate ones vastly mitigate the diurnal fluctuations of soil

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temperature at spring period. Their root systems penetrate deeply into soil horizons, raises water holding capacity which positively causes to soil water balance and at the end, in result of decomposition of 50-60 tons of vegetation materials it is relised more than 10-15 tons of carbon dioxide. Several authors pointed out on positive effect of green manure application to the growth development and productivity of field crops. Application of green manure improved soil biological, physical and chemical characters (Mac Rae R.J, G. R. Mehuys G.R. (1985), Davis J.R., Huisman O.C., Everson D.O., Schneider A.T. Sorensen L.H. (1999), Davis J.R., Huisman O.C., Everson D.O., and Schneider A.T. (2001), Conklin A.E., Erich M.S., Liebman M., Lambert D., Gallandt E.R. 2002. Jennifer Miller.(2004), [Elfstrand S., Båth B., Mårtensson A. \(2007\)](#), [S. Hedlund K, Mårtensson A. \(2007\)](#), [Zhang M.K. Fang \(2007\)](#). This group of researchers also showed the role of the organic fertilizer in improvement of the structure of soil, in particular, increasing its water penetration, water holding capacity, buffering, reduction of the bulk density due to enrichment by humus. At the same time, it is increased consolidated ability of soil to withstand the destructive action of water and winds.

Under application of green manure it is incorporated a lot of growth agents, vitamins, hormones which are essential compounds for soil inhabited microorganisms.

Several researchers pointed out a dissolving influence of the root system of crops on soil phosphates, in particular, it was stated that rye, oats, mustard grown on sandy soils capable to transform indissoluble phosphoric compounds into absorbed nutrient forms (Marupov, 2003, Oripov, 1983, Khalmanov, 2017, 2019) Authors recommend to use such crops in green manuring. Green manure cultivation as an intermediate crop positively influences to soil fertility. According to A. MARUPOV (2003) plowing in a aboveground biomass of rye and mustards have increased soil organic matter content from 0.175 to 0.296%.

Amount of microorganism and their productivity has a direct correlation with soil fertility. Broad application of pesticides negatively caused on to soil microbiological activities. During the last 20-30 years in long-term irrigated serozem soils of Central Asia the number of microorganism reduced for three-four times, the number of protozoo decreased tenfold, rain worms practically did not remain (B.A, Zimovec, 1988)

1. Materials and methods.

1.1. Green manure crops. The field crops for green manure were planted in autumn time, in a second decade of October of

The sowing rate for rye was 80 kg/ha, pea – 50 kg/ha, and typhoon – 4 kg/ha. At the spring time crops for green manure were fertilized by nitrogen of 100 kg/ha. After maturing time aboveground biomass were grinded with using special implement KIR-1.5 and plowed in to soil to the depth of 40 cm with using two tiered plow.

1.2 Experimental setup. The field experiments were installed on meadow and typical light serozem soils in farmlands of Samarkand and Navoi provinces of Uzbekistan.

Field experiments were conducted in four replicates, with 28 subplots in total. The size of each subplot was 240 m² (50x4.8m). agro physical, agro chemical and biological characters of soil were determined by commonly accepted methods, described in proceedings of cotton growing research institute (2007). Soil samples were taken from three places of each subplots, before plowing in and at the end of august to the depth of 0-20 and 20-40 cm respectively.

Soil water content was determined by balance methods. Soil humus content was determined with using Tyurins methods which is modified Walkley-Black method, total nitrogen on Kieldal, nitrate nitrogen on Granwald Liege, removable phosphorus on Machigin.

The fungi were determined in a Chapec media, bacterium –on meat pepton agar, actinomycetes on starch-ammonium agar, dinitrifiers of Giltay media.

All field observation was performed according to methods developed by Research institute of cotton growing (2007). The total yield was determined by cuttings from each subplots.

2. Results and discussions. It was stated that for better growth and development of cotton plants during different phase of growth it needs to maintain constantly optimal soil moisture content. The optimal soil moisture

creates the best conditions for normal growth, development of cotton plants with early ripening. Field and Laboratory analyses of soil moisture showed that application of green manure has improved a soil water properties(table.1)

In case of control treatment of field experiment in a depth of 0-20cm it was 12.0%, in 0-40cm it was 14/5%, but application of green manure increased the soil moisture up to 14.7- 15.2 and 18.1-18.8% respectively.

Table.1

Soil water content under application of green manure

(in % to absolute dry soil)

	Treatments	Before plowing in		Before first irrigation		Before last irrigation	
		Layers, cm					
		0-20	20-40	0-20	20-40	0-20	20-40
1	Controle	16,4	18,8	12,6	14,1	12,0	14,5
2	Pea	14,5	17,3	14,0	17,6	14,8	18,2
3	Rye	14,3	17,7	13,7	17,4	14,7	18,1
4	Typhon	15,1	17,2	13,9	17,8	14,7	18,2
5	Pea-Rye	14,0	17,5	14,2	18,4	15,0	18,5
6	Typhone-Rye	14,2	17,7	14,5	18,2	14,9	18,3
7	Typhone-Pea-Rye	14,6	17,4	14,7	18,7	15,2	18,8

The increase of soil humus content due to green manure application caused positively to aggregate composition of soil and favored to improvement of physical characteristic of arable layer, decreases the bulk density of soil. Investigation showed that highest bulk density of soil samples (tabl.2) is noted on treatment without organic fertilizers (control) herewith both in upper (0-20) and in under-stratums layers plowing in of green biomass noticeably reduce the bulk density of soil.

Table.2 Effect of green manure on to bulk density of soil (g sm³)

	Treatments	Soil layers, cm	Time of determination		
			10.05.	1.07.	1.10
1	Controle	0-20	1,29	1,37	1,45
		20-40	1,38	1,45	1,51
2	Pea	0-20	1,30	1,34	1,36
		20-40	1,37	1,42	1,45
3	Rye	0-20	1,30	1,35	1,39
		20-40	1,38	1,43	1,46
4	Typhon	0-20	1,27	1,33	1,34

		20-40	1,36	1,40	1,42
5	Pea-Rye	0-20	1,27	1,33	1,34
		20-40	1,36	1,40	1,42
6	Typhone-Rye	0-20	1,30	1,34	1,35
		20-40	1,36	1,41	1,43
7	Typhone-Pea-Rye	0-20	1,28	1,30	1,32
		20-40	1,37	1,40	1,39

In our experiments application of green manure promoted the decrease of soil bulk density index in soil layer of 0-20 cm to 1.39 - 1.32, in subsoil layer of 20-40cm to 1.46-1.39 g/cm³ against control without green manure application of 1.45-1.51g/cm³ respectively.

Under application of green manure on serozem soils the difference between control and green manure applied treatments were as in layer 0-20 cm to 0.06 - 0.13 g/cm³ in layer 20-40 cm to - 0.06 - 0.12 cm³. The best result was obtained in the seventh treatment.

The significant role of the organic fertilizer as a nutrient for plants is well-known. . The nutritive value of green manure depends both on quantity of aboveground biomass and its chemical composition.

The basic characteristic to which green manure can effect is variation of soil humus, nitrate nitrogen, mobile phosphorus and exchangeable potassium contents.

From the table 3 we can see that lowest soil humus content was observed in a treatment without green manure application as compared to other treatments with application of green manure.

Organic fertilizers have positive effect on soil microorganisms. Application of organic fertilizers can increase a number of microorganisms for many times. This data correlates with amount of applied biomass and its chemical composition. Under plowing is of 32.2 – 47.7 tons per ha of green biomass it was accumulated highest numbers of bacterium (table.4).

The most active period of the growing of the numbers of microorganism in soil is a period of the blossom and fruiting of cotton plants (June-July). Especially the last treatment where combined mixture of different crops applied as a green manure, caused to increase a number of soil microorganisms significantly.

Table 3. Effect of green manure on nutrients content in soil at the end of vegetation period

	Treatment	Soil layer cm	Meadow serozem			Typic serozem			Light serozem		
			Humus, %	Mobile nitrogen	Mobile phosphorus	Humus, %	Mobile nitrogen	Mobile phosphorus	Humus, %	Mobile nitrogen	Mobile phosphorus
1	Control	0-20	1,28	17,3	36,0	0,91	9,0	31,4	0,83	7,2	24,2
			1,15	12,5	26,5	0,76	6,1	16,2	0,73	4,2	19,9

2	Pea		1,31	21,1	41,3	0,95	15,1	36,0	0,88	10,2	27,9
		0-20-40	1,18	17,6	34,4	0,79	10,7	24,7	0,77	8,4	24,2
3	Rye		1,32	20,2	42,6	0,95	14,3	36,2	0,87	9,6	27,6
			1,18	17,1	35,3	0,79	9,9	25,4	0,76	8,1	23,5
4	Typhon		1,32	19,4	39,7	0,95	13,2	34,0	0,87	9,2	27,1
			1,18	16,8	34,8	0,79	9,4	25,1	0,76	7,5	23,0
5	Pea-Rye		1,32	23,0	42,3	0,96	16,9	36,7	0,89	11,3	28,8
			1,19	19,1	37,7	0,80	11,7	29,3	0,77	9,2	25,3
6	Typhon e-Rye		1,32	22,4	41,1	0,97	16,1	36,4	0,88	10,7	28,4
			1,19	18,2	36,8	0,80	11,0	29,0	0,77	8,8	24,8
7	Typhon e-Pea-Rye		1,33	24,2	42,9	0,97	18,3	37,4	0,89	12,2	29,9
			1,20	20,4	38,4	0,81	14,1	30,1	0,78	9,8	25,7

Table 4 The number of microorganisms in soil under application of green manure (1g dry soil, average for 2004-2006)

	Treatment	Bacterium			Fungi			Actinomycetes		
		10/05	20/08	10/10	10/05	20/08	10/10	10/05	20/08	10/10
1	Controle	84	161	233	79	64	56	86	225	343
2	Pea	302	438	1100	104	125	143	341	705	917
3	Rye	283	416	1080	97	114	130	312	682	856
4	Typhon	267	378	1020	91	108	112	275	593	786
5	Pea-Rye	333	514	1301	121	145	168	401	820	1080
6	Typhone-Rye	315	486	1205	110	139	151	365	773	997
7	Typhone-Pea-Rye	383	594	1640	143	167	185	430	890	1130

Application of organic biomasses positively influenced to growth and development of cotton plants. Field measurements of the rate of growth of cotton plans has shown that application the organic fertilizers before of the blossom there was not observed a significant difference in the height of main steam of cotton plants. The main

differences on steam growth are become visible starting from second decade of June, and later on starting from July, these differences are more intensive.

Green manure application in the scheme of typhoon+pea+rye had more stable effect on main steam growth, where cotton plant steams were taller on 12.7 -14.7 cm as compared to control treatment, where green manure were not applied.(table.5)

Table.5 Effect of green manure to growth and development of “Omad” cotton plants variety in meadow serozem soils of Uzbekistan (2006-2009)

	treatment	Main steam growth, cm	Number of simpodias	Number of bulbs	Wilting,%	
					total	strong
					01.09	01.09
1	Control	80,9	13,6	10,9	17	5
2	Pea	89,8	15,3	13,5	7	2
3	Rye	86,6	15,2	12,9	8	1
4	Typhon	83,6	15,1	12,6	9	1
5	Pea-Rye	92,0	15,4	13,8	6	-
6	Typhon-Rye	90,1	15,3	14,2	6	-
7	Typhon-Pea-Rye	95,6	15,7	14,7	4	-

The same relationship was observed in the typic and light serozem soil conditions. Better nutritional status of soil under green manure application had effect on the quantities of simpodial branches as well as cotton bulbs as compared to unfertilized control treatment.

Table.6 Effect of green manure application to the yield of cotton (tons/ha)

	Treatments	Meadow serozem	Typic serozem	Light serozem
1	Control	3,28	3,09	2,80
2	Pea	3,97	3,69	3,25
3	Rye	3,83	3,58	3,20
4	Typhon	3,76	3,50	3,15
5	Pea-Rye	4,05	3,77	3,30
6	Typhon-Rye	4,00	3,71	3,26
	Typhon-Pea-Rye	4,20	3,97	3,42
		LSD_{05-0,35t/ha}	LSD_{050,27t/ha}	LSD_{05-0,29t/ha}

	P%=3,1	P % = 1,4	P%=2,7
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Application of organic fertilizers creates enhanced conditions for mineral nutrition and causes to growth, development and productivity of cotton. .(table.6)

There was obtained an additional yield as 0.48 – 0.92 t/ha due to application of green manure. The highest yield was obtained in a treatment where mixture of different herbage such as Typhon-Pea-Rye were incorporated which allowed to obtain an additional yield of cotton as 0.77-0.92 t/ha as compared to control.

Discussion.

Scientific research on the effects of citrate fertilizers on the soil properties and the growth and development of cotton was conducted in cotton growing farms of the Republic of Uzbekistan in the 1960s and 1970s. The climatic conditions and soil fertility of the soil were relatively high, and the species composition of sider plants and cotton varieties were different. In our study, the effects of a new side rat seed mix with a separate, green pea and rye mix were studied based on microbiological analyzes and the positive effects of the soil on the agrophysical and agrochemical properties of the soil and the positive effect of cotton on the type of “Omad” of the crop.

Conclusions. On the basis of obtained results it was possible to conclude a positive effect of green manure application to growth development and yield of cotton in irrigated serozem soil conditions. Application of green manure positively caused to improve a microbiological activity of soil microorganisms. Green manure creates better nutritional regime on supply of plant with bioavailable mineral elements for field crops.

Application of green manure in a different scheme allowed to obtain an additional yield of cotton such as 0.48-0.92 t/ha.

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