

The influence of rotation crops and intercrops on cotton productivity

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Abstract Basing on obtained data, we can conclude that for normal growth of cotton-plant, for strong and resistant plants, for high quantity of yield branches and their unripe cotton bolls it is expedient to plant cotton-plants in the rotation system of cotton-plant – wheat after leguminous – grain and other intercrops. High and good quality cotton yield was produced when cotton-plant was sown in the system 1:2 winter wheat + rotation crop (soy bean):cotton-plant, after winter wheat + rotation crop (soy bean) 2:1, winter wheat + rotation crop (soy bean):winter wheat + rotation crop (soy bean)+intercrop (oats + green peas + rye): cotton-plant.

Key Words: winter wheat, rotation crop, cotton-plant, soy bean, intercrop, green peas, rye, oats, cotton fiber, productivity.

1. INTRODUCTION:

In recent years in the world agriculture and farming a greater attention to biological attributes of crops and proper application of appropriate agro-technologies to soil and climate conditions have enabled to achieve fertility features improvement of lands, to economize mineral fertilizers and fuel as well for obtaining abundant and best quality crop yield, to reduce cotton production costs and prices through cultivating rotation crops (soy-bean, bean, mung bean, pea, green peas, lentil) in fallow lands after winter wheat depending on the results of creating widely the advanced resource-saving technologies which improve and protect soil ecology.

Soil fertility is directly linked with scientifically based norm of mineral fertilizers, their ratio, use of organic fertilizers, wide application of rotation system, creating land and water resource-saving advanced agro-technologies in the farming. Today's prior tasks on the creation of short rotation and successive sowing systems in irrigated lands in the farming are to draw great attention to the cultivation of leguminous-grain crops, grain and vegetable crops which can keep and improve soil fertility, provide daily needs of people for food products, to introduce these crops to short successive sowing systems as rotation and intercrop, consequently, to increase efficacy of land use.

In our republic considering soil-climatic conditions a particular attention has been drawn in recent years to increase soil fertility through rotation sowing of agricultural crops, to use lands rationally and to cultivate rotation crops in fallow lands after wheat and to use widely intercropping system too.

Alfalfa leaves the most stubbles in the soil, but according to today's requirements it is expedient to cultivate annual leguminous crops after winter wheat for keeping soil fertility in good condition [2].

In the roots of one bush of soy bean sown rotation there are around 400 pieces of bacteria and their dried mass makes 1,2-2,4 grams [5].

It was defined that in the roots of main crop – pea there are 14-15 grams of biological nitrogen [7]. One of biological attributes of intercrops is their organic residues (roots and stubbles) left in the soil. The occurrence of organic residues in soils depends on plant type, which serves to enrich and save soil reserve [10, 11].

By surveys it was identified that in the rotation system 2:1 (winter wheat + rotation crop – mung bean: winter wheat+ rotation crop – mung bean +intercrop – rye :cotton plant) only after winter wheat left, rotation and intercrops totally 12,43-16,80 tons of roots and stubbles were left per ha, in 1:1:1 (winter wheat + rotation crop – mung bean +intercrop – triticale : soy bean: cotton plant and winter wheat + rotation crop – mung bean : cotton plant: soy bean) system 12,09-16,09 tons of roots and stubbles were left in the fields. In the result of rotting and decomposition of some part of this residue the mass of tillage and under tillage layer of typical virgin, bare and meadow-alluvial soils decreases by 0,02-0,04 g/cm³, and relatively increases the quantity of water resistant aggregates by 2,4-3,7 %, water retention of soil according to soil types raises to 2,1-14,3 %; 2,5-3,0 %; 6,5-14,2 % relatively[9].

Bush quantity of soy bean plant depends on soil-climatic conditions and needed 300-400 thousand/ha pieces of late and late-medium matured varieties, 500-600 thousand/ha of medium and early matured varieties, 700-800 thousand/ha of fast matured varieties. For one hectare sowing norm of late and medium matured variety is equal to 350-500, medium and early matured variety - 550-650 and fast matured variety - 750-850 thousand pieces/ha. The quantity of seeds depends on seed largeness and sown from 40-60 kg to 120-140 kg per ha [1].

Rotation crops sown after winter wheat leave roots and stubbles in the soil, keep its fertility, improve its agrophysical, agrochemical, meliorative and ecological condition [8].

2. MATERIALS AND METHODS:

Field experiments were conducted in 2001-2004 under the short rotation system, as control variants during 3 years in 1:1 system (cotton plant + winter wheat), in 1:2 system (winter wheat + cotton plant + cotton plant), in 1:2 system (winter wheat + soybean + cotton plant + cotton plant), in 1:2 system (winter wheat + rotation crop – oats + green peas + cotton plant + cotton plant) and in 2:1 system (winter wheat + rotation crop – soy bean) + winter wheat + rotation crop – soy bean + intercrops – oats + green peas + rye + cotton plant the impact of 2, 3 and 4 crops combined sowing systems on soil fertility and cotton plant productivity was determined. The experiments were carried out in a particular place and time (in two fields), involving 5 variants according to systems, each plot made 240 m², in three repetitions and total area was 4,5 ha.

Productivity determination obtained on the base of experimental variants and repetitions was analyzed by dispersion method [2].

Agrochemical [4] and agro-physical [3] attributes of soil of experimental field were identified according to standard methods.

3. RESULTS AND DISCUSSION:

Considering the obtained data, it was observed that winter wheat and soy bean which was sown after wheat as a rotation crop influenced on plant quantity of cotton plant positively. In the second year of experiment (the first field) abundant plant density was observed in the 3rd variant at the end of practice period in the rotation system 1:2, winter wheat : cotton plant : cotton plant, and made 87,5 thousand/ha. According to the data obtained at the end of practice period of cotton plant (variant-5) which was cultivated after spring intercrops, the highest indication of plant dying consisted 4,5 %. Consequently, after intercrops involvement (oats + green peas + rye) it was observed that during practice period plants quantity reduced 2,7 % more in the first cultivation of cotton plant compared to control variant due to influence of organic residues left after intercrops. However, after intercrops in the second year of cultivation of cotton plant (variant-5) they influenced on plant density effectively, at the end of practice period the quantity of died plants made only 2,2 %.

Regarding the data from the 2nd field of research, it was observed that plant density of cotton plant consisted 85,8 thousand/ha in control variant at the end of practice period of initial years of research (2002), quantity of died plants was equal to 4,7 %, in the 2nd-3rd years these indications changed relatively to 86,8 thousand/ha; 3,6 %; 85,1 thousand/ha; 5,55 %. When the cotton plant cultivated in winter wheat stubble slope (variant-3) in 2003 this indication showed 88,3 thousand/ha; 1,9 %; in 2004 87,7 thousand/ha, 2,6 % relatively. When it was sown in the first year after soy bean which was sown in wheat stubble the quantity of died plants was 4,8; 5,5 %. But when cotton plant was sown in this variant in the second year plants dying indication showed the least level 2,0 %. Generally saying, the quantity of died plants consisted average 3,0 % at the end of practice period of experiment compared to the beginning of practice period.

According to the data on the impact of short rotation systems on cotton plant growth and development, in 2002 when cotton plant was cultivated in the first year after rotation crops soy bean and intercrops in the 3, 4, 5th variants of experiment the highest indication was noted in the 4th variant in the system 1:2, winter wheat + rotation crop (soy bean): cotton plant: cotton plant, the height of main stalk (1.08) was 87,1 cm relatively, yield branches were 13,4 pieces, quantity (1.09) of unripe cotton bolls was 10,5 pieces.

In the 3rd variant of experiment in rotation system 1:2, winter wheat : cotton plant : cotton plant these parameters showed relatively 84,6 cm, 13,1 pcs, 10,2 pcs, while in control variant showed 78,8 cm, 12,7 pcs, 9,3 pcs relatively.

Another positive influence of rotation crops leguminous-grain crops and particularly intercrops studied in the research was observed in the second year of cultivation of cotton plant under standard systems of rotation. On the base of obtained data, it should be noted that the height of cotton plant of control variant experiment consisted 79,0 cm, quantity of yield branches - 12,3 pcs, unripe cotton bolls were 8,7 pcs (1.09), in the second year of cotton plant cultivation after winter wheat these parameters (variant-2) were 86,3 cm; 12,9 pcs and 10,3 pcs relatively, while in variant-3 cultivation of cotton plant after winter wheat in the second year indications showed 89,6 cm, 13,4 pcs and 10,9 pcs, in the cultivation of cotton plant after winter wheat + rotation crop (soy bean) in the second year (variant-4) indications were 91,3 cm, 14,1 pcs and 11,2 pcs, when winter wheat was cultivated together with rotation and intercrops during two years under rotation system 2:1 and then cotton plant was cultivated (variant-5) the height of cotton plant made 90,4 cm, yielding branches were of 14,5 pcs, quantity of unripe bolls was 12,2 pcs (1.08) and opened bolls were of 5,2 pcs (1.09).

According to facts of the 2nd field, the cotton plant sown after winter wheat under system 1:2 (variant-3) had normal growth and development in the 1st year, at the end of practice period its height consisted 87,7 cm, quantity of yield branches was 12,8 pieces, unripe bolls - 10,8 pcs, while in cotton plant the variants (variants-4, 5) in which cotton plant was sown after intercrops combination with three components (oats + green peas + rye) which were also sown after soy bean in the stubbles of winter wheat, the height of cotton plant showed 94,8-95,8 cm at the end of practice

period, quantity of yield branches 13,8-14,0 pcs, unripe bolls-(1.09) 11,6 -12,3 pcs, including 4-3,7 pcs of opened bolls, compared to control variant unripe bolls quantity was observed to be 2,2-2,9 pcs more.

Wilt damaging stage of cotton plant in its stalk joints was noted in the first days of July, August, September and October months of practice period. Regarding the data in 2002, wilt damaging level of cotton plant in rotation variants of experiment consisted around 8,6-12,5 % according to facts of October month. In control variant this indication was 24,5 %. Therefore, the cultivation of cotton plant in the first year after rotation crops legumes-grain crops and intercrops has decreased its wilt disease damaging level by 64,8-98,9%.

In 2003, in the 2nd variant when cotton plant was sown after winter wheat, in 1:1 system, cotton plant : winter wheat : cotton plant and in the 5th variant, in 2:1 rotation system, winter wheat + rotation crop (soy bean): winter wheat + rotation crop (soy bean)+intercrop (oats + green peas + rye) : cotton plant it was observed and its indication made 10,0 % relatively.

Table 1

Mean productivity of cotton plant in short rotation system by fields, centner/ha

Variants	Experimental variants	In 2001 (1-field)	In 2002 (2-field)	mean	In 2002 (1-field)	In 2003 (2-field)	mean	In 2003 (1-field)	In 2004 (2-field)	mean
1	Cotton plant (control)	34,9	33,5	34,0	33,4	33,5	33,4	31,2	31,4	31,3
2	1:1:1, cotton plant : winter wheat	34,4	34,7	34,5	-	-	-	36,5	33,7	35,1
3	1:2, winter wheat : cotton plant : cotton plant	-	-	-	36,2	36,3	36,2	35,8	35,1	35,4
4	1:2, winter wheat + rotation crop (soy bean) : cotton plant : cotton plant	-	-	-	36,6	37,8	37,2	37,4	37,4	37,4
5	2:1, winter wheat + rotation crop (soy bean): winter wheat + rotation crop (soy bean) + intercrop (oats + green peas + rye) : cotton plant	-	-	-	-	-	-	40,8	38,5	39,6

Important point hereby is that under rotation sowing systems cotton plant cultivation in the 2nd year didn't cause to increase of wilt disease damaging level. In the 4th variant of experiment under 1:2 rotation system, winter wheat + rotation crop (soy bean): cotton plant: cotton plant in the 1st year the level of wilt disease damage showed 12,5 %, while in the 2nd year of sowing it was 11,7 %, in control variant this indication was 24,7 %. It should be stated that, in these variants at the end of budding stage and flowering period wilt disease was observed around 2,0-5,8 % in cotton plants .

According to the facts from the 2nd field of research, when cotton plant was sown and grown in the first year after winter wheat (variant-3) damage level of wilt disease of cotton plant was equal to 48,8 %, while in the second year of cultivation this indication was identified to be decreased to 46,2 %. In the 4th variant when cotton plant was cultivated in the first year after winter wheat + rotation crop soy bean this indication showed 48,8 % relatively, in the second year of sowing it reduced to 58,8 %. When winter wheat was grown together with rotation crop soy bean and intercrops during two years, then cotton plant was cultivated after them wilt disease of cotton plant reduced to 63,8%.

It can be concluded that, for decreasing wilt disease of cotton plant, provide its healthy development cotton plant was cultivated in the first year in wheat stubble field under the cotton plant – wheat rotation system and by this wilt disease reduction of 64,8 – 48,9 % was achieved, when cotton plant was sown after rotation crop soy bean and intercrops in the first year - 48,9 – 52,2 % while in the second year it reduced by 56,6 – 57,4 %. Generally saying, for prevention of wilt disease of cotton plant and reducing disease level, the significance of the role of sowing rotation crops was proven in this research.

In accordance with rotation sowing system in initial years (in 2001) in the first field of experiment cotton plant was sown in the 1st and 2nd variants. As per obtained data, the productivity of these variants is close to each other, which made relatively 34,9 and 34,4 c/ha. The main results were obtained in 2002 and 2003.

In 2002 under rotation system in the 3rd variant of experiment when cotton plant was sown after winter wheat in the first year, cotton yield consisted 36,2 c/ha, compared to control variant 2,8 c/ha more additional yield was

produced. When cotton plant was cultivated in this variant in the second year the productivity was equal to 35,8 c/ha, additional cotton yield was 4,6 c/ha more than control variant. But it was observed that in the first year cotton productivity was lower by 0,4 c/ha.

When cotton plant was sown in the first year in the 4th variant of experiment under rotation system (1:2) winter wheat + rotation crop (soy bean) : cotton plant : cotton plant, the productivity showed 36,6 c/ha, compared to control variant 3,2 c/ha additional yield was obtained. While the cotton plant was cultivated in this variant in the second year, cotton yield was produced additionally by 0,8 c/ha more compared to the yield of the first year, compared to control variant the yield of 6,2 c/ha was higher.

In the 5th variant under rotation system 2:1, winter wheat + rotation crop (soy bean): winter wheat + rotation crop (soy bean)+intercrop (oats + green peas + rye): cotton plant when the cotton plant was sown successively in two years after winter wheat, soy bean and intercrops with three components (oats + green peas + rye) the productivity of cotton made 40,8 c/ha.

As we analyzed aforementioned data generally, when the cotton plant was cultivated in the first year of experiment after winter wheat (variant-3), additional yield of 2,8 c/ha was obtained more compared to the variant (control) sown annually, when cotton plant was sown in the second year 4,6 c/ha additional yield was produced, cotton plant productivity of the second year was lower than the productivity of the first year. Furthermore, the cotton plant sown in stubble field after soy bean (variant-4) in the first year gave 36,6 c/ha yield, additional yield consisted 3,2 c/ha compared to control variant, in the second year cultivation the productivity showed 37,4 c/ha, while additional yield in this variant made 6,2 c/ha.

According to the data of the second field of experiment, in control variants in which cotton plant was sown annually the cotton yield consisted 33,5; 33,5; 31,4 c/ha by years (2002, 2003, 2004), in the result of rotation sowing of cotton plant cotton yield reduced year by year. In the variant in which the cotton plant was sown after winter wheat (variant-2) the productivity of cotton showed average 33,7 c/ha, 2,3c/ha more additional yield was produced. Similarly, in the 3rd variant when cotton plant was cultivated after winter wheat in the first year it was 36,3 c/ha, in the second year this indication was lower 35,1 c/ha, it was 1,2 c/ha less than the first year.

In experiment's 4th variant cotton plant was cultivated in the first year after soy bean which was sown in the stubble of winter wheat the indication was 37,8 c/ha, in the second year it was 37,4 c/ha. Apparently, similar data was obtained from the 2nd field of experiment as was in the 1st field, growing cotton plant once a year under rotation system 2:1 after soy bean sown in winter wheat stubbles and also after rotation crop winter soy bean and intercrops with three components (oats + green peas + rye) once a year led to obtaining high yield (38,5) from cotton.

From the data on quality parameters of cotton fiber it is clear that at the end of practice period (in 2003, autumn) in experiment's first field in experimental variants cotton fiber production consisted 34,0-35,5 %, length of fiber 32,4-34,3 mm, micronaire 4,1-4,2, weight of 1000 pieces of cotton seeds 133,5-139,5 gr. It should be stated that the influence of short rotation system on quality parameters of cotton fiber was observed in all rotation systems of experiment. By cotton fiber production and line density the highest point was noted in the 4th variant under rotation system 1:2 winter wheat + rotation crop (soy bean): cotton plant: cotton plant (35,5 %; 175). By fiber length and weight of 1000 pcs of seeds the highest indicator was observed in the 5th variant of rotation sowing (1:2) winter wheat + rotation crop (soy bean) +intercrops (oats + green peas + rye) : cotton plant: cotton plant (33,7 mm; 139,5 gr).

It can be concluded considering the obtained results on the influence of rotation systems on cotton yield and its fiber quality parameters that importance of cultivation of cotton plant under rotation system after winter wheat, rotation crop soy bean and winter wheat, rotation crop soy bean, intercrops with three components (oats+green peas+rye) was proven in order to get best quality fiber from cotton.

4. CONCLUSION:

After rotation system (winter wheat, rotation and intercrops) growing of cotton plant positively influences its growth and development, when cotton plant is cultivated in the first year its main stalk height was 8,3-10,4 cm higher than control variant, yield branches quantity was 0,7-0,9 pcs, unripe bolls quantity was 1,2-2,2 pcs more, in the second year of growing these parameters were relatively 12,3-13,4 cm, 1,7-1,8 pcs; 2,2-2,9 pcs higher.

When cotton plant was sown after winter wheat, rotation and intercrops in the first year under rotation system 2:1, winter wheat + rotation crop (soy bean): winter wheat + rotation crop (soy bean)+intercrop (oats + green peas + rye): cotton plant, then again grown successively within two years after winter wheat, rotation and intercrops, then its highest yield made 40,8 c/ha.

As was proven in the experiment that for normal growth and development of cotton plant, high production of yielding branches and unripe bolls it is expedient to grow cotton plant under short rotation system cotton plant – wheat after rotation crops legumes-grains and intercrops as well. The highest results were obtained when cotton plant was grown under rotation system 1:2, winter wheat + rotation crop (soy bean): cotton plant :cotton plant after winter wheat + rotation crop (soy bean) and under rotation system of 2:1, winter wheat + rotation crop (soy bean): winter wheat + rotation crop (soy bean) + intercrops (oats + green peas + rye) : cotton plant.

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