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Influence of Organo-Mineral Fertilizers on Nitrogen Regime and Winter Wheat Yield in Crop Rotation on Dry Zones of Uzbekistan

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ABSTRACT: With many years of stationary experience on a semi-atmospheric precipitation flat-hilly dry zone of Uzbekistan with typical gray soils, it was studied the various doses effect of organic fertilizers (10, 20 and 30 t/ha) in combination with 40 kg/ha of phosphorus fertilizers, introduced before the pure steam rise on the mineral nitrogen dynamics (NO_3 and NH_4) and the winter wheat yield varieties "Tezpishar" in the grain-and-row crop rotation link - pure steam-wheat-wheat. It was found that the highest nitrate and ammonia nitrogen content in the 0-60 cm soil layer was observed in years favorable for atmospheric moisture in the variants with 20 and 30 t/ha of organic fertilizers introduction (C manure) in the initial growing season stages - tillering and booting. At the same time, NO_3 content prevailed over NH_4.The soil water-nutritional regime improvement contributed to an increase in the grain wheat yield in 4.7-9.0 c/ha range (104-223%) to permanent wheat without fertilizers use.

I. INTRODUCTION

In specific soil and climatic conditions, Uzbekistan rainforests, all agro-technological measures effectiveness, in particular the use of organic mineral fertilizers primarily depends on the precipitation amount and distribution during the winter grain crops growing season. The soil water regime in all zones in the dry republic belongs to the non-leaching type [1,3,5]. In this regime, the soil is soaked only to a certain depth and atmospheric precipitation moisture does not merge with the underlying soil horizons moisture, which are fed by groundwater.

The studies carried out back in the 60-70s of the last century have established the optimal doses, terms and methods of applying organic and mineral fertilizers for grain crops cultivated outside the grain-fallow crop rotation [5].

For a fertilizer system development in grain-fallow crop rotation, it is necessary to study the nutrients dynamics in soil and plants, the amount of their use by various precursors and their transformation in the “soil - fertilizer - harvest” system. Previously, such studies on the republic dry land were extremely weak (Yunusov M.Yu., 1972).

II. RESEARCH METHODOLOGY, SCHEME AND CONDITIONS.

In this regard, the studies were carried out in a semi-precipitated plain - hilly zone dry with typical gray soils, where the arable horizon (0-22 cm) contains 0,058-0,085% humus, 0,06-0,08% nitrogen, 0,10-0,14% phosphorus and 1,4-1,6% potassium, HB is16-18%, specific gravity is 1,0 g/cm^3, bulk weight is 1,25-1,30 g/cm^3.

In 2009-2013, field experiments were laid in a stationary experiment, laid down in 1960 according to the following scheme:

1) **Wheat monoculture without the mineral fertilizers introduction;**
2) **Pure steam-wheat-wheat - without fertilizers;**
3) **Pure steam with 10 t/ga of manure addition + P_{40} P40 under the plow when lifting pure steam;**
4) **Pure steam + 20 t/ga of manure + P_{40} under plow;**
5) **Pure steam + 30 t/ga of manure + P_{40} also under plow;**
6) **Chickpea - P_{40} under before plowing under the plow – wheat;**
7) **Alfalfa 4 years standing + P_{40} - 4 years in a row wheat;**
8) **Wheat monoculture with $N_{40}P_{40}K_{40}$ introduction annually.**

During research years, we used semi-rotted cattle manure, phosphorus in the ammophos, potassium forms in the potassium chloride form.

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International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 2 , February 2021

In 2-5 variants, in spring, when the growing season of winter wheat was resumed, nitrogen fertilization was carried out at 40 kg/ha dose in the ammonium nitrate form. The humus content was determined according to I.V. Tyurin, total nitrogen according to Kjeldahl, total phosphorus according to B.P. Machigin and total potassium according to P.V. Protasov, nitrate nitrogen according to Granvald-Lyazh, ammonia nitrogen with Nessler's reagent.

III. RESULTS AND DISCUSSION

The average long-term amount of atmospheric precipitation during the growing season of winter wheat is 362 mm. Average monthly air temperature is 12.6^{0}C, relative air humidity is 63%. In the 2008/2009 vegetation year, precipitation fell above the norm by 113 mm, at an 8.3^{0}C average monthly air temperature, relative humidity is 69%. The 2009-2010 growing season was the rainiest - 489 mm, at 9.2^{0}C air temperature and air humidity is 66%, the years 2010-2011 were severely arid - a total of 200 mm fell at an average monthly 10.0^{0}C air temperature and a relative humidity is 62%. In the agricultural 2011-2012 vegetation year, the amount of precipitation was 75 mm below the norm. The average monthly temperature was also 1.6^{0}C lower than the norm with high air humidity is 71%. In 2012-2013, precipitation was within the normal range (377 mm), with an average monthly 9.4^{0}C air temperature and air humidity is 70%.

The assimilated forms dynamics study of nitrogen in the 0-60 cm soil layer showed that the highest content of nitrate and ammonia nitrogen was present in favorable atmospheric moisture in 2009 and 2010 at the beginning of the growing season of winter wheat. The nitrate nitrogen content in the soil under wheat in the booting-booting phase following pure vapors fertilized with 10, 20 and 30 t/ha manure of cattle and P_{40} ranged from –12.5; 14.2; 18 mg/kg of soil, which is almost 3-5 times more than in permanent crops without the use of mineral fertilizers. At the same time, NO_3 content prevailed over NH_4 and more than twofold, which indicates a high nitrification capacity of typical sierozem soils.

After two years of winter wheat varieties cultivation "Tezpishar (Fast ripening)" with fertilized clean fallow, in 2011 they were left under clean fallow, but without the organic and mineral fertilizers introduction before they are raised. However, this year was very dry (200 mm) and due to an acute shortage of active moisture in the soil during the entire wheat growing season, microbiological processes were strongly suppressed. As a result, the mobile forms content of nitrogen in the soil began to gradually decrease in subsequent years.

As can be seen from Table 1, the mineral nitrogen content in 0-60 cm soil layer under wheat following the chickpea legume crop was significantly lower during the entire growing season than in the variants with pure fertilized fallow. Such tendency can be traced to a comparatively higher mineral nitrogen content in the soil in the rainy years 2009-2010 during the tillering and booting phase. The nitrogen forms content assimilated by the plant under winter wheat in the alfalfa layer 4 herbage years starting from the second cultivation year according to the seam turnover and subsequent years gradually increased, which is associated with the increasing rates of organic residues mineralization in the soil.

Despite the annual $N_{40}P_{40}K_{40}$ application under permanent wheat, both nitrate and ammonia nitrogen content was at control variant - permanent wheat level without mineral fertilizers. In the typical dry gray soils conditions, improving the soil nitrogen regime under winter wheat by applying organic fertilizers at 10, 20 and 30 t/ha dose before raising pure steam together with 40 kg/ha of phosphorus fertilizers, and carrying out nitrogen fertilization at 40 kg/ha dose in the early spring growing season (tillering) contributed to a significant increase in the winter wheat yield. So, on average, over 4 years with 10, 20 and 30 t/ha of organic fertilizers introduction (manure C) and 40 kg/ha phosphorus before the pure steam rise, the increase in wheat grain yield was 12.0-16.1 c/ha or 164-223% to the control - permanent wheat cultivation without fertilizers (Table № 2).

It should be emphasized that the organic and mineral fertilizers efficiency in the grain-and-row crop rotation links of pure steam-wheat-wheat largely depended on the amount of precipitation, their distribution over the growth and development phases of winter wheat, and on the soil wetting depth. Thus, the highest wheat grain yield was obtained (24.7 c/ha) when sowing 20 t/ha of manure with pure fertilized steam and P_{40} in 2009, when the amount of precipitation exceeded the average long-term norm by 113 mm. In this variant, the increase in grain yield from this organic and mineral fertilizers dose amounted to the control - permanent sowing without fertilizers 14.1 c/ha (234%), and unfertilized clean fallow is 6.8 c/ha (138%).

The grain yield of winter wheat in 2009 and 2010 for pure steam fertilized with 30 t/ha of manure and P_{40} decreased by 2.1 and 1.9 c/ha, respectively, which was associated with partial wheat lodging due to the excessive accumulation large vegetative biomass.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 2 , February 2021

During research years, the organic fertilizers aftereffect continued in subsequent years. The average increase in wheat grain yield for four sowing years for fertilized clean fallow at 10, 20 and 30 t/ha doses of manure and P_{40} was 7.1; 9.0 and 8.8 c/ha, respectively, to the control, unfertilized dry wheat sowing. The grain yield of winter wheat according to chickpea also depended on the soil moisture level by atmospheric precipitation. Thus, the relatively highest grain yield was obtained in a relatively rainy year in 2009, and the smallest - in the severely arid 2010-2011, 13.6 c/ha and the lowest in the dry 2011 - 3.2 c/ha. The reason for the low grain yield of winter wheat after chickpea is the fact that by sowing time the soil from under chickpea and permanent wheat under the prolonged hot and dry summer weather influence is very dry. In our experiments, the moisture soil layer content is 0-20 cm after these predecessors was below the maximum hygroscopicity (MH) is 3.7-5.0%.

Table 1

Dynamics of the nitrogen regime under wheat depending on the precursors and the organo-mineral fertilizers dose, mg/kg of soil, 0-60 cm. Stationary experience

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 2 , February 2021

№	Precursor	Nitrogen forms	2009			2010			2011			2012			2013	
			1	2	3	1	2	3	1	2	3	1	2	3	1	2
1	Permanent sowing of wheat - without fertilizers	$N\text{-}NO_3$	4,8	3,4	3,3	3,5	3,9	3,3	4,2	4,5	3,8	3,6	3,4	3,3	4,2	4,8
		$N\text{-}NH_4$	1,8	2,3	1,4	1,7	2,7	0,6	1,2	2,8	1,8	1,7	2,6	2,4	2,8	3,2
2	Pure uncomfortable steam	$N\text{-}NO_3$	7,6	5,6	3,8	6,3	7,5	5,7	-	-	-	5,3	6,5	4,2	5,0	5,6
		$N\text{-}NH_4$	3,8	4,2	3,2	3,0	3,6	2,8	-	-	-	3,0	4,0	3,0	3,8	3,6
3	Pure fertilized steam 10 t/ga of manure + P_{40}	$N\text{-}NO_3$	9,4	8,0	4,9	8,2	12,5	10,5	-	-	-	8,2	9,2	5,8	6,8	7,2
		$N\text{-}NH_4$	4,3	6,6	4,5	4,2	6,8	4,7	-	-	-	3,4	5,8	4,8	3,2	4,8
4	Pure fertilized steam 20 t/ga of manure + P_{40}	$N\text{-}NO_3$	12,2	8,8	6,5	10,4	14,2	7,9	-	-	-	7,8	9,8	7,2	6,2	7,8
		$N\text{-}NH_4$	5,4	5,8	4,2	3,5	6,8	4,8	-	-	-	5,0	4,8	4,0	3,8	4,8
5	Pure fertilized steam 30 t/ga of manure + P_{40}	$N\text{-}NO_3$	12,4	9,5	6,5	12,3	18,4	10,8	-	-	-	7,9	10,8	6,5	7,5	8,5
		$N\text{-}NH_4$	5,9	6,8	4,5	5,8	7,8	5,6	-	-	-	3,4	5,8	4,2	4,2	4,8
6	Chickpea fertilizer –P_{40}	$N\text{-}NO_3$	4,8	5,6	4,2	-	-	-	3,2	4,2	3,2	-	-	-	4,2	5,6
		$N\text{-}NH_4$	2,3	3,8	1,8	-	-	-	-	2,0	-	-	-	-	1,8	3,2
7	Alfalfa 4 years of standing P_{40} under alfalfa	$N\text{-}NO_3$	5,6	7,7	6,8	7,0	9,5	8,6	3,8	4,8	3,6	7,8	8,2	5,8	4,2	5,8
		$N\text{-}NH_4$	4,8	5,8	3,2	6,0	5,8	4,9	-	2,8	-	4,8	5,2	4,8	3,2	4,0
8	Permanent sowing of wheat $N_{40}P_{40}K_0$ - annually	$N\text{-}NO_3$	4,2	5,2	3,2	5,0	4,8	4,2	3,2	4,2	3,6	4,7	5,3	3,6	4,5	5,2
		$N\text{-}NH_4$	1,8	3,2	1,8	3,0	2,7	-	-	2,8	-	2,0	1,8	-	2,0	3,8

Note: 1. 1-2 leaves (in autumn);2, Tillering - booting. 3. heading - full ripeness

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Vol. 8, Issue 2 , February 2021

Table 2

The predecessors influence and the organic and mineral fertilizers dose on the wheat grain yield, variety "Tezpishar" (Stationary experience).

№	Predecessor	Grain harvest by year, c/ga					Average c/ha	Increase in yield to control	
		2009	2010	2011	2012	2013		c/ha	%
1	Permanent sowing of wheat - without fertilizers	10,5	10,3	4,8	5,6	5,3	7,3	-	100
2	Pure uncomfortable steam	17,8	14,8	-	8,2	7,4	12,0	4,7	164
3	Pure fertilized steam 10 t/ha of manure + P_{40}	21,8	18,7	-	9,5	7,8	14,4	7,1	197
4	Pure fertilized steam 20 t/ha of manure + P_{40}	24,6	21,7	-	10,2	8,6	16,3	9,0	223
5	Pure fertilized steam 30 t/ha of manure + P_{40}	22,5	19,8	-	12,7	9,3	16,1	8,8	220
6	Chickpea fertilizer –P_{40}	13,6	-	3,2	-	4,7	7,2	-0,1	99
7	Alfalfa 4 years of standing P_{40} under alfalfa	15,6	14,7	5,4	7,8	6,5	10,0	2,7	139
8	Permanent sowing of $N_{40}P_{40}K_0$ wheat - annually	14,8	13,2	5,0	6,8	5,7	9,1	1,8	125
	P, % HCP_{05}, c/ga	1,9 4,0	2,3 5,0	0,8 1,5	0,6 1,4	0,5 1,4			

Note: in 2011 2, 3, 4, 5 options were left for unfertilized clean fallow, option 6 in 2010, 2012 sown chickpea.

With soil moisture below MH, soil particles acquire an exceptionally high adhesion force; therefore, huge traction conditions are spent on plowing such soil, and yet the soil does not crumble, but breaks into large blocks that cannot be crushed even with heavy rollers. Consequently, before the rainy period beginning, the field cultivation from under chickpea and permanent wheat to the accepted 20-22 cm depth is associated with great difficulties.

During the experiment years, 60–20 cm moisture content in the soil layer after plowing alfalfa with a 4-year grass stand was also lower than MH - 4–5%. Therefore, soil cultivation for sowing wheat after these predecessors was carried out after the rainy period beginning - in November and seedlings were obtained in February on opening and warm days. The highest yield of winter wheat grain according to chickpea was also obtained in years with a favorable water regime of the soil.

The grain yield of winter wheat, despite the annual application of $N_{40}P_{40}K_{40}$ mineral fertilizers full dose, largely depended on the amount of moisture in atmospheric precipitation, which is associated with the physical deterioration, water-physical and other properties of typical dry gray soil.

IV. CONCLUSION

Based on the results obtained, one can come to the following conclusions.

1. **Under semi-atmospheric precipitation conditions in the flat-hilly dry zone of Uzbekistan, the most important agro-technological measure is clean steam with the organic fertilizers introduction (C manure) in 10.20 and 30 t/ha doses together with 40 kg/ha phosphorus before raising clean steam under moldboard plowing to 20-22 cm depth.**
2. **Pure vapors fertilized with organic and mineral fertilizers, applied under dump plowing to 20-22 cm depth when they rise, contribute to the nitrogen regime (NO_3, NH_4) the soil improvement under winter wheat;**
3. **The optimal organic fertilizers dose (C manure) is 20 t/ha application together with 40 kg/ha of phosphorus fertilizer. At the same time, the increase in the grain yield of winter wheat for two crop rotations of pure steam-wheat-wheat amounted to an average 9.0 c/ha or 223% to permanent wheat without fertilizers.**

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International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 2 , February 2021

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