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DYNAMICS OF FERTILITY ELEMENTS OF ALLUVIAL - MEADOW SALINE SOILS IN EXPERIMENTAL PLOT UNDER MELILOTUS

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Abstract. The paper presents the results of seasonal dynamics of nutrients in alluvial meadow saline soils in experimental area under fodder crop melilot. Conducted experiments on manure background with application of humic-adaptogen drug PA 2-1 are characterized by increase of their fertility. In soil nitrate mode a clear dependence on the phase of cultivated melilot crop has been observed. A significant amount of mobile phosphorus and exchangeable potassium has been observed in spring. During the summer period a gradual decrease in concentration of these elements has been observed. At the end of the summer a gradual increase in concentration of nutrients has been observed. Nutrient elements concentration in all variants of the experiment is higher in arable horizon of pilot area.

Keywords: topsoil, manure, drug-adaptogen, nitrate mode, mobile phosphorus, exchangeable potassium.

INTRODUCTION

In recent years, under the influence of the existing natural- climatic conditions and as a result of irrational use of arable land by peasant and private farms, due to destruction of irrigation systems and deterioration of ameliorative condition, sharp increase of secondary saline and junk soils has been observed. Uncontrolled economic activity leads to alienation of soils from biological cycle, besides this, imperfect farming systems reduce the level of soil fertility, which is primarily determined by humus status, including soil carbon reserves. Also soil agrophysical and water properties are significantly worsening.

The effective method of improving nutritional regime is their planting with perennial grasses. The application of organic and mineral fertilizers is also desirable in this case.

With application of manure, soil receives all macro-and micronutrients necessary for plants, soil water and thermal properties, soil structural properties and, accordingly, resistance to formation of crust after watering are improving. Furthermore, a large number of microorganisms are introduced into soil with manure which decompose organic matter of manure and soil and thereby convert nutrients into a form which is accessible for plants.

The experiments of scientific institutions of Kazakhstan have determined high responsiveness of fodder and vegetable crops to organic and mineral fertilizers, which are extensively cultivated in irrigated conditions. In this regard, the research on seasonal dynamics of mobile nutrients directly under fodder crops in irrigated area taking into account availability of nutrients in soil represents scientific and practical interest and relevance. Therefore, the research on the effect of organic fertilizers on productivity of forage crops with application of humic preparation-adaptogen PA 2-1, depending on availability of soil nutrients is of interest to agricultural producers.

OBJECTS AND METHODS

The research works were conducted on alluvial- meadow saline soils in Makhambet irrigation area. By natural reclamation zoning this area refers to the Old Ural-Baksay Sokolinsky delta-sea plain. It is located on both sides of the river Urals.

It has formed as Novobogatinsk regression phase of Hvalynski sea [1]. This –is old delta maritime (Novo-Caspian) very flat plain, it is broken by numerous canals with steep banks (up to 3 m depth) and flat extensive depressions of former spills and dried estuaries. The plain is complicated by hydrochloric elevations (Chernorechenskoye, Novobogatinskoe), most of which have a flat surface. The depth of groundwater – 2,5-4,5 m, mineralization - 24-53 g/l, and it has chloride. The capacity of water-bearing argillaceous rocks with sand layers of Khvalyn-Khazar sands - from 3-4 to 20 m, clay of Apsheron tier, opening is at a depth of 15-25 m south of the village Makhambet in 14 km [2]. Most of the territory is composed of late Khvalyn clays and heavy loams or underlying sands or layered medium loams. Prisorochinsk meadows are composed of layered medium loams.

The main background is meadow saline-saline marsh clay soils, containing 2,4 % of humus, absorbed sodium at depth of 50 cm - 6-12 % of the amount, calcareous from the surface salinity to 30-50 cm - weak, deeply - strong and very strong, chloride -sulfate and sulfate-chloride. Meadow coalescent soils on flat wide depressions are significantly spread. They contain 3 % humus, weak salinization, deep salinization, but after flooding in the summer and autumn, the salts are pulled to the surface (1 %). Filtering from surface – 1,5 m/day and 15 cm in dense fusion horizon – 0,02-0.04 m/day. One meter soil layer contains 18 gypsum and 1567 t/ha of carbonates. Meadow deep saline medium loamy soils occur in Sorochinsk meadows and Naryn plain. In recent years, meadow soils began desertification.

Alluvial-meadow saline soil is characterized by high humus concentration. In the whole area humus concentration is very low (Table 1). Only in the upper layer of 0-10 cm humus concentration is 2,17 % and is in gradation - 2, that is, low.

Table 1 - Chemical properties of alluvial-meadow saline soil

Depth of sample, cm	Humus, %	Gross nitrogen, %	Mobile forms, mg/kg of soil			CO_2	pH
			$N_{hydro.}$	P_2O_5	K_2O		
0-10	2,17	0,140	25,3	26,0	410	3,54	8,26
10-20	0,93	0,098	22,2	23,0	380	4,09	8,10
20-40	0,65	0,082	20,8	20,0	338	3,86	8,17
40-50	0,31	0,070	-	-	-	3,31	7,96
50-80	0,72	0,062	-	-	-	3,78	7,91
80-130	0,79	0,056	-	-	-	3,96	7,99
130-200	0,28	0,042	-	-	-	3,15	8,09

Total humus is found throughout the explored soil profile. Stretching of humus profile through the entire soil thickness is caused by the process of removal of humus in terms of high alkaline reaction of soil solution. The character of distribution in soil profile is not quite even. Gross nitrogen concentration is characterized by relatively low from 0,098 to 0,140 % in the upper layers, in deep layers ross nitrogen decreases. The quantity of mobile forms of nitrogen in soil profile varies between 20,8-25,3 mg/kg soil. Availability of mobile nitrogen is very low. Availability of mobile forms of phosphates is medium. Availability of mobile forms of potassium is high. The carbonate concentration in soil profile increases from 3,54 to 4,09 %.

Concentration of gypsum is not high and varies from 0,068 to 0,088 %. There is some correlation between concentration of carbonates and gypsum.

This is due to soil hydromorphic features and exudative type of salinity. Bulk weight of these soil horizons vary from 1,06 to 1,26 g/cm^3. The rate of absorption in the first meter of soil is 1,15 m/day. Filtration coefficient – 0,748 m/day. Salinity of alluvial meadow saline soils is observed in depth of 20 cm and further in soil profile. On this soil we have conducted field experiment on the effect of manure in combination with humic preparation adaptogen PA 2-1 on seasonal dynamics of nutrients during growing season of fodder crop white "Arkas" melilot. The land plot intended for experiments was divided into two equal portions of 900 m^2. 1,8 m of manure was applied on one side, on the other side manure was not applied, that means they remained as control. On these backgrounds the effectiveness of drug-adaptogen PA 2-1 on growth and development of melilot forage crop has been explored. Experiment was conducted in triplicate according to experimental scheme. Area of plots 50 m^2. The experiment scheme is shown in Table 2.

Table2 – Experimental plot scheme

№ of variant	Crop	Background without manure	№ of variant	Crop	Background with manure
1	Melilot	Control	4	Melilot	PA 2-1 + spraying
2		PA 2-1	5		Control
3		PA 2-1 + spraying	6		PA 2-1

According to the scheme of experiment, soil samples from depth of 0-20 and 20-40 cm have been selected for NPK nutrient concentration.

Field, morphological and specialized techniques were used in the research. For the analysis of soil substance composition, common soil science analytical research methods were used as described by E.V. Arinushkina [3] in guide for general soil analysis. In selected soil samples the following was determined: nitrate nitrogen by method of Granville-Lyazhu, mobile phosphorus by Machigin method, exchangeable potassium by Machigin method in Grabirov's modification.

RESULTS AND DISCUSSION

Here is some information on the nature of legume crop Melilot white "Arkas", *Melilotus* (Kaz. tuyezhonyshka.) - biennial, rarely annual herbaceous plant which refers to the legume family.

Sown forage grasses are of great importance in field forage production. Their green mass is used to produce different types of feed. Perennial grasses accumulate a lot of organic matter in soil, loosen it, increase its resistance to water and wind erosion. Besides, leguminous grasses, accumulate nitrogen in soil.

Before sowing Melilot, the seeds were treated with drug-adaptogen-PA 2-1 in two percent concentration within three hours, and during vegetation the crops were sprayed with the same drug in dose of 0,04 %. Spraying of crops was done twice during the whole growing season by plant phases. After seed treatment by adaptogen drug PA 2-1 the sowing was done on May 9, 2015. Melilot sprouts appeared on May 17, and on May 24 single leaves emerged, and shoots emerged on June 5th. Melilot entered branching phase on 11 June. On June 30, 2015 first spraying of melilot was done. Repeated sprayings were done on July 15, 2015.

Autumn and spring weather and climatic conditions of 2015-2016 agricultural year have been very favorable for growth and development of melilot

"Arkas". For the first time in the history of Atyrau region, spring period was characterized by increased spring rainfall, which amount was 3,5-4 times higher than average long-term standards, on the background of warm spring this contributed to rapid growth and development of melilot "Arcas". Growth of melilot was observed on 22 March, on 28 April melilot plants began branching, on May 12-18, budding was observed, they entered flowering stage on May 26. Plants of melilot "Arkas" finished fruiting stage on July 10, 2016, about 20 days earlier than average long-term period of its ripening.

The average results of two year period of growth and development of melilot feed crop are presented below (Table 3).

According to Table 3, it should be noted that manure had high efficiency on quantity of germination in spring and plants in autumn, as well as on the height of plants, and among studied methods of use, the same efficiency is noted in treatment of seeds and crop spraying with preparation adaptogen PA 2-1 .

So, on the same variant, both on background of manure and without manure, quantity of seedlings and adult plants in autumn was higher in variant 3 with seed treatment and spraying with drug adaptogen PA 1.2, and then in variant 2 with seed treatment with PA 2-1, compared with control. High plant density and high plant growth resulted in high yield of green mass and hay.

Among melilot varieties, "Arkas" variety has high yield capacity in the first year of life and also in the first year of life, melilot plants are more leafy (49-52 %) than plants of the second year of life.

Crop yield depends on supply of soil with forms of mineral nutrients elements. Concentration of nitrate nitrogen in topsoil was 30,8 mg/kg of soil. In the spring due to the abundant precipitation, nitrate nitrogen compounds as a result of good solubility have been slightly washed out in lower levels [4]. This shows the dynamism of nitrates, and their accumulation is directly depending on soil humidity and aeration, on crop cultivation, tillage and fertilization systems [5]. Concentration of nitrates in soil upper arable layer on background of drug adaptogen PA 2-1 was 36,4 mg/kg, ie, in subsurface layer – 42,0 mg/kg of soil (Table 4).

From Table 4, it should be noted that in the context of seed treatment without manure with seed treatment and spraying of plants with adaptogen drug PA 2-1, their content increased to 39,2 mg/kg of soil. On the background with manure, nitrate concentration was higher than in control variant, compared to the same variant without manure. The same pattern is observed in variants using the adaptogen drug PA 2-1.

Experiments conducted on the background of manure are characterized by increased fertility in comparison with background without manure. There is one specific feature - topsoil contains nitrates less than in subsoil. This is due to mobility of nitrate nitrogen and soil aeration and porosity. Only in variant with seed soaking, as well as in control variant, concentration of nitrate nitrogen became higher in the plow layer. In soil nitrate mode the dependence on cultivated melilot and its development phase is observed. Since melilot relates to the legume family that is in symbiosis with rhizobia, it enriches the soil with nitrogen. In phase of branching and subsequent phases melilot was characterized by increased growth. In this period of growth as a result of energetic consumption of nutrients from soil by melilot, nitrate nitrogen concentration has decreased. At the end of growing season of melilot nitrate concentration has gradually increased.

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Table 3 - Effect of manure and adaptogen drug PA 2-1 on growth and development of melilot

№	Background	Variants	Quantity of plants item/m²		%	Height, cm	Yield capacity, c/ha		Leaves, %
			In germination	In autumn	Fall down		green mass	hay	
1	A – without manure	Control	161,1	132,5	17,76	145,2	581,67	156,8	50
		Seed treatment with PA 2-1	171	154,2	9,83	147,6	624,27	168,15	51
		Seed treatment + spraying with PA 2-1	171	158,5	7,31	151,,11	663,45	179,0	52
2	B – with manure	Control	165,7	149	10,08	152,2	685,34	180,85	51
		Seed treatment with PA 2-1	180,9	168	7,14	165,3	713,30	192,65	53
		Seed treatment + spraying	180,9	173	4,4	175,3	716,26	202,6	56
		HCP of particular differences, c	-	-	-	-	-	2,5	-
		HCP (A), c	-	-	-	-	-	2,1	-
		HCP (B), c	-	-	-	-	-	2,5	-

This is due to mobility of nitrate nitrogen and soil aeration and porosity. Only in variant with seed soaking, as well as in control variant, concentration of nitrate nitrogen became higher in the plow layer. In soil nitrate mode the dependence on cultivated melilot and its development phase is observed. Since melilot relates to the legume family that is in symbiosis with rhizobia, it enriches the soil with nitrogen. In phase of branching and subsequent phases melilot was characterized by increased growth. In this period of growth as a result of energetic consumption of nutrients from soil by melilot, nitrate nitrogen concentration has decreased. At the end of growing season of melilot nitrate concentration has gradually increased.

According to concentration of mobile forms of phosphorus these soils refer to weak alkaline soils, as the quantity of mobile phosphoric acid in the topsoil at all backgrounds and in all terms of determination, does not exceed 27 mg/kg (Table 4). Insignificant amount of mobile P2O5 in topsoil was 20-33 mg/kg which was observed in May, it has reduced to 13-18 mg/kg in June due to the entry of melilot into branching phase and subsequent phases. In subsurface layer there was even higher decrease (3-10 mg/kg). Since August, there has been observed a gradual increase in available phosphorus concentration in all variants of the experiment, further the increase of mobile phosphoric acid in soil has been observed at the end of the growing season. It should be noted that process of accumulation of phosphoric acid is most intense in plow layer. In subsurface soil layer concentration of phosphorus has significantly decreased.

Favorable water and heat regimes of soil during growing season of melilot plants have created conditions for normal nitrogen soil regime, in spite of relatively low concentration of phosphorus in soil, high yield of melilot was harvest-

Table 4 - Dynamics of mobile nutrients in alluvial-meadow soils of the pilot area (mg/kg of soil) in cultivation of melilot

Back-ground	Experiment vari-ants	Depth cm	N easy hydrolized.			P_2O_5			K_2O			Yield capacity, c/ha	
			Spring	Sum-mer	Autu mn	Spring	Sum-mer	Autu mn	Spring	Sum-mer	Autu mn	Green mass	hay
A with-out ma-nure	Control	0-20	30,8	30,8	39,2	26	13	20	460	390	470	581,67	156,8
		20-40	36,4	28,4	30,8	10	3	13	370	230	340		
	Seed treatment with PA 2-1	0-20	36,4	30,8	39,2	23	13	20	470	400	500	624,27	168,15
		20-40	42,0	25,4	36,4	17	3	10	450	230	340		
	Seed treatment + spraying	0-20	39,2	30,8	36,4	23	15	27	530	460	540	663,46	179,0
		20-40	44,8	25,2	33,6	20	5	13	430	220	370		
B with manure	Control	0-20	36,4	33,6	30,8	20	18	23	540	500	540	685,34	184,85
		20-40	33,6	30,8	28,0	10	6	13	410	300	420		
	Seed treatment with PA 2-1	0-20	44,8	39,2	36,4	23	30	40	530	530	360	713,30	192,65
		20-40	42,0	30,8	33,6	8	10	23	360	300	450		
	Seed treatment + spraying	0-20	36,42	33,6	30,8	33	15	24	580	500	610	716,26	202,6
		20-40	39,2	25,2	33,6	10	5	16	460	300	470		

ed from 581 to 716 c/ha of green mass, and from 156 to 202 c/ha of hay.

Availability of potassium in soil is high. It should be noted that organic fertilizer affects concentration of exchangeable potassium. On control variants with manure compared with the same variant without manure, exchangeable potassium concentration was higher. The highest concentration of exchangeable potassium has been noted in the topsoil. Preparation PA 2-1 had a significant impact on concentration of exchangeable potassium in all variants. Increased concentration of exchangeable potassium in the top arable layers is associated with high absorption capacity of horizon, as well as with the process of biological accumulation of potassium in accumulative horizons.

The exchangeable potassium concentration in depth of soil profile is reducing. Relatively moderate exchangeable potassium concentration has been observed in the summer months. Gradual increase in exchangeable potassium concentration in all variants of the experiment was observed at the end of the growing season. It should be noted that process of exchangeable potassium accumulation is most intensive in arable layer. In subsurface layer its quantity drastically reduced from 1,3 to 1,5 times. So, in manure application, exchangeable potassium concentration increases.

Humic adaptogen preparation PA 2-1 had a significant impact on exchangeable potassium concentration in all variants.

CONCLUSIONS

1. Seasonal dynamics of nutrients is closely related to vegetation of melilot. Depending on the phase of development of fodder crop the concentrations of nutrients in soil also changed.

2. The highest concentration of mineral nutrient elements was observed on the background of manure with treatment using preparation adaptogen PA 2-1.

3. High efficiency was observed in manure application, seed treatment and

spraying of plants during growing period with preparation adaptogen PA 2-1. At the same time high effective fertility of alluvial meadow saline soils was observed.

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ТҮЙІН

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ТҮЙЕЖОҢЫШҚА ЕГІСТІГІНДЕГІ АЛЛЮВИАЛЬДЫ-ШАЛҒЫНДЫ СОРТАҢДАНҒАН ТОПЫРАҚТАРДЫҢ ҚОРЕКТІК ЭЛЕМЕНТТЕРІНІҢ МАУСЫМДЫҚ ДИНАМИКАСЫ

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Мақалада түйежоңышқа егістігіндегі аллювиальды-шалғынды сортаңданған топырақтардың қоректік элементтерінің маусымдық динамикасы берілген. Көң және адаптоген препаратын қолданғанда топырақтың құнарлылығы артты. Топырақтың нитраттық режимі, онда егілген түйежоңышқаның өсін даму қарқынына байланысты болды. Жылжымалы фосфор мен алмаспалы калийдің жоғарғы көрсеткіштері көктем айларында тіркелінді. Жаз айларында олардың мөлшері біртіндеп азая береді. Жаз айының соңында осы аталған қоректік элементтер біртіндеп арта бастайды. Қоректік элементтердің басым көпшілігі топырақтың жырту қабатында тіркелінді.

Түйінді сөздер: топырақтың жырту қабаты, көң, адаптоген препараты, нитрат режимі, жылжымалы фосфор.

РЕЗЮМЕ

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ДИНАМИКА ЭЛЕМЕНТОВ ПЛОДОРОДИЯ АЛЛЮВИАЛЬНО-ЛУГОВЫХ СОЛОНЧАКОВАТЫХ ПОЧВ ОПЫТНОГО УЧАСТКА ПОД КУЛЬТУРОЙ ДОННИКА

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В статье приводятся результаты сезонной динамики питательных веществ на аллювиально-луговых солончаковатых почвах опытного участка под кормовой культурой донника. Заложенные опыты на фоне навоза с применением гуминового препарата-

адаптогена ПА 2-1 характеризуются повышением их плодородия. В нитратном режиме почвы наблюдается явная зависимость от фазы возделываемой культуры донника. Значительное количество подвижного фосфора и обменного калия отмечено в весеннем сроке. В летний срок наблюдается постепенное снижение содержания этих элементов. В конце лета наблюдается постепенное увеличение содержания этих элементов. Содержание элементов питания во всех вариантах опыта выше в пахотном горизонте опытного участка.

Ключевые слова: пахотный слой почвы, навоз, препарат-адаптогена, нитратный режим, подвижный фосфор, обменный калий.