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EFFECT OF AMELIORANT AND FERTILIZERS ON SOIL FILTRATION PROPERTIES, PLANT WATER REGIME, AND FERTILITY UNDER NATURAL CONDITIONS

Saribek B. Galstyan
Shushi University of Technology
7, V.Vagharshyan Str., Stepanakert, RA
galstyan.saribek@mail.ru
ORCID iD: 0000-0001-6728-7817
Republic of Artsakh

Hovhannes V. Tokmajyan
Shushi University of Technology
7, V.Vagharshyan Str., Stepanakert, RA
tokmajyan.hovhannes@gmail.com
ORCID iD: 0000-0002-2315-7233
Republic of Armenia

Nver A. Mikayelyan
Shushi University of Technology
7 V.Vagharshyan, Stepanakert, RA
nver211@yandex.ru
ORCID iD: 0000-0002-2536-501X
Republic of Artsakh

Hovsep A. Ohanyan
Shushi University of Technology
7, V.Vagharshyan Str., Stepanakert, RA
hovsep.ohanyan1995@mail.ru
ORCID iD: 0000-0002-4122-6423
Republic of Armenia

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Abstract

The effect of the PMM polymer-mineral additive on enhancing the filtration properties of the soil, increasing the drought resistance of plants, and increasing the yield of agricultural crops was investigated in post-forest brown, stony, calcareous, medium-thick soils of the foothill zone. The influence of the introduction of the "PMM" additive, both separately and together with fertilizers, on the dynamics of changes in moisture and dissolved nutrients in the soil layer, the amount of water evaporated from a unit of leaf area per unit of time was revealed. The experiments revealed that these agrotechnical practices help to create a favorable

environment, rich in nutrients and moisture, in the upper horizon of arable land (0–15 cm), which is essential for increasing crop yields.

Key words: land, filtration, fertilizer, crop yield, moisture, transpiration, nutrients, topsoil differentiation

Intriduction

Due to soil and air drought, crop losses and yield decline have increased over the past few years. This is the result of both the adverse conditions caused by global warming and the decline in precipitation as well as the absence of measures to mitigate them. Anthropogenic events aimed at combating the drought of the Earth are mainly associated with the structure of the soil. Structured soils that simultaneously contain air and water effectively manifest crucial soil properties required for the growth and development of crops. Natural structuring is not a property shared by all soils, though. Obtaining structural soil frequently necessitates additional work. There are numerous established techniques for enhancing soil structure, including the use of organic fertilizers, incorporating perennial cereals and grasses into crop rotations, treating soil under specific moisture conditions, etc. However, the outcomes of using these techniques to restore the soil structure are insignificant. Therefore, it is important to look for quicker and more efficient ways to enhance the soil's physical characteristics. The answer can be sought, in particular, under circumstances where any soil-improving material is introduced (in our case, polymer-mineral filler "PMM"). In addition to serving as a source of nutrients, mineral fertilizers are also well known for helping plants become more drought resistant. Numerous physiological studies on the black soils of the mountain meadows in RA were conducted between 1981 and 1983. The macroelements "NPK" and the timing of their introduction into the soil were studied for their effect on the amount of hard – and - weakly bound water in the leaves of winter wheat and triticale, the density of cell juice, the holding capacity of the leaves, water deficit, and other features.

According to the study's findings, fertilizers had a greater impact than the control group on the wet and dry mass of the first floor's leaves as measured from the ear. The results of transpiration studies demonstrated that complete "NPK" fertilizers made it easier for plants to intensify their growth in addition to those that had only received phosphorus-potassium fertilizer prior to sowing [1].

As an ameliorant improving the water properties of the soil, "PM" polymer mineral additive created in M.V. Lomonosov State Moscow University was investigated under laboratory conditions. [2, 3].

Drought-induced stress is considered a major yield limiting factor, especially for drought-sensitive plants. Drought resistance primarily depends on the shallow root system [6].

From 2011 to 2018, tests were performed on four cultures in Argentina. Various agrotechnical procedures were carried out in between the sowings during the summer sowing – application of cover plants along with or without applying compost and fertilizer. From 2015 to- 2018 the total amount of biomass produced, the yield, and the water use effectiveness were determined .

The highest water use efficiency was observed in the crop rotation of oats with soybeans-maize-sunflower-wheat. According to the same indicator, wheat with soybean sub-sowing-soybean-soybean-wheat succession was in the last place, with the highest frequency of soybean harvest.

«The Faculty of Agricultural and Forest Sciences, J. Hirschhorn (34°52' LS, 57°58' LO)», conducted research of cultural plants rotation which revealed how differently they used water.

The option using cover crops and compost had a high water use efficiency of 10.85%, a total biomass of 3.64%, and an average grain yield [4].

The application of organo-mineral fertilizers - a mixture of sulfur, compost and potassium humate in the ratio 2:10:1, under conditions of irrigation deficit can be a practical decision to compensate the negative impact of water stress on the cucumber crop. An experimental study conducted in 2014 leads to this conclusion. [5]. Depending on the level of quality deterioration and the availability of water, salinization becomes a serious problem that reduces productivity, even in soilless farming systems. Therefore, new strategies are needed to improve the salt resistance of plants in these systems [7].

Conflict setting

Using the information above as a base, the task is to examine the effect of separate and combined application of various amounts of polymeric mineral additive (PMM), an ameliorant that enhances the water properties of the soil, on the water-physical properties of the soil and some physiological properties of winter and spring crops in short-rotation crop rotations carried out under the conditions of minimal cultivation soils, which is due to their drought resistance.

Research Results

Research work was carried out in two stages - field and laboratory vegetation experiments.

The investigated cultures of short-rotation two-field crop rotation alternated only in time.

Sunflower and corn were the spring crops grown in these fields in the spring of 2021, and wheat and triticale were the fall food and fodder crops planted there after harvest in the autumn.

Field and vegetation experiments were carried out with three repetitions. The following options for applying fertilizers and meliorants were tested.

1. Without ameliorant and fertilization «checker»,
2. P90K60N120,
3. P90K60N90,
4. PMM 1500 kg/ha,
5. PMM 3000 kg/ha,
6. PMM 1500 kg/ha +P90K60N120,
7. PMM 1500 kg/ha + P90K60N90,
8. PMM 3000 kg/ha + P90K60N120,
9. PMM 3000 kg/ha + P90K60N90.

Two doses of fertilizers and an ameliorant were tested on all crop rotation fields, both separately and in combination. Prior to planting, the soil was amended with phosphorus-potassium fertilizers and polymer mineral additive (PMM), and in the spring, nitrogen fertilizers were added as a top dressing. According to the minimum requirements for the cultivation system, the main work involved tilling the soil and caring for the plantings. It is expected that zero tillage will improve the structural quality of the upper soil layer, but continuous zero tillage can lead to physical limitations of the soil.

Structural changes of soil with mechanical composition of sandy loam and clay loam were estimated by various methods of agrotechnical measures.

A minimum set of characteristics for the arable layer has been established, which describes the trends supported by tillage, and the relationship between the stock of organic matter in the soil and its physical characteristics has been clarified. Depending on the method of cultivation and mechanical structure, the capacity of the A horizon of the cultivated soils did not change almost, and the horizon of the uncultivated soil under the same conditions was 4 cm more [9].

Table 1

Dynamics of changes in moisture reserves in sunflower crops depending on the application of fertilizers and ameliorant (%)

№	Option	Observation stages				Average for the growing season
		Emergence of first pair of true leaves	The occurrence of phloem acidity	Flowering	Maturation	
1	Without PMM and fertilizer	26.82	28.45	27.72	19.70	25.67
2	$P_{90}K_{60}N_{120}$	27.08	28.62	27.78	19.75	25.8
3	$P_{90}K_{60}N_{30}$	27.0	28.48	27.79	19.78	25.76
4	PMM- 1500 kg/ha	29.63	31.45	30.67	22.7	28.61
5	PMM - 3000 kg/ha	29.82	31.64	30.69	22.78	28.73
6	PMM - 1500 kg/ha + $P_{90}K_{60}N_{120}$	29.84	32.0	30.92	23.0	28.94
7	PMM - 1500 kg/ha + $P_{90}K_{60}N_{90}$	29.79	32.08	29.48	23.07	28.6
8	PMM- 3000 kg/ha + $P_{90}K_{60}N_{120}$	29.93	32.11	30.5	23.11	28.91
9	PMM- 3000 kg/ha + $P_{90}K_{60}N_{90}$	29.91	32.08	30.76	23.15	28.97

Table 2

Dynamics of moisture reserve change in winter wheat crops depending on fertilizer application and amount of ameliorant application, (%)

№	Option	Observation stages					Average
		Before sowing	Growing of bushes	Ears formation	Maturation	Before harvesting	
1	Without PMM and fertilization	22,48	27,24	27,12	26,18	20,28	24,66
2	P90K60 N120	22,32	28,82	28,44	28,29	22,78	26,13
3	P90K60 N90	22,45	28,79	28,51	28,30	23,03	26,21
4	PMM-1500 kg/ha	21,98	29,72	29,68	29,45	24,33	27,03
5	PMM-3000 kg/ha	22,45	29,78	29,65	29,46	24,14	27,09
6	PMM-1500 kg/ha+P90K60 N120	21,65	31,15	31,43	32,15	25,18	28,31
7	PMM-1500 kg/ha+P90K60 N90	22,32	31,25	31,45	32,18	25,28	28,49
8	PMM-3000 kg/ha+P90K60 N120	22,44	31,27	31,25	31,35	26,25	28,51
9	PMM-3000 kg/ha+P90K60 N90	21,94	32,17	31,15	31,35	26,35	28,59

During the growing season, phenological observations and biometric measurements were made to investigate field productivity, the winter hardiness of spring crops, and overall and effective bushiness. The dynamics of changes in field humidity and nutrients at various stages of plant development were determined in all options and repetitions. The intensity of transpiration was determined using the weight method of Ivanov, and the yield data were mathematically processed using the dispersion analysis method [10].

The data presented below in Tables 1 and 2 show the dynamics of changes in field humidity and mobile nutrient content during different stages of spring and autumn plant development.

Field experiments and laboratory studies also revealed the existence of a relationship between soil moisture and dynamic changes in mobile nutrients content (Table 3).

Table 3

Dynamics of nutrient availability changes to plants in the arable zone depending on fertilizer application and ameliorant use in sunflower crops

Option	Observation stages												Average for the growing season		
	Emergence of first pair of true leaves			The occurrence of phloem acidity			Flowering			Maturation					
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	6.2	3.4	20.3	9.4	6.3	28.0	8.7	5.9	27.6	7.3	3.9	19.4	7.8	4.87	23.82
2	8.9	6.7	28.4	13.3	8.9	34.4	12.7	7.6	32.8	10.5	6.3	30.6	11.35	7.37	31.55
3	8.4	6.5	28.0	13.0	8.7	34.1	12.4	7.4	32.8	10.3	6.3	29.9	11.02	7.22	31.2
4	6.1	3.5	20.4	10.7	7.3	34.0	9.6	6.7	28.9	8.4	4.5	21.3	8.7	5.5	26.15
5	6.0	3.3	20.7	11.0	7.5	34.3	9.8	6.9	30.1	8.5	4.9	26.3	8.82	5.65	27.85
6	8.8	6.8	28.4	14.4	10.3	36.8	13.8	8.3	36.3	11.9	7.9	32.7	12.22	8.32	33.55
7	8.9	6.7	29.4	14.4	9.9	36.4	13.4	8.5	36.8	12.0	7.7	32.8	12.17	8.2	33.85
8	8.7	6.6	28.3	14.7	9.8	37.3	13.9	8.3	35.9	12.1	7.7	33.4	12.35	8.1	33.72
9	8.8	6.5	28.5	14.6	9.7	37.8	13.8	8.4	36.4	12.1	7.8	33.7	12.32	8.1	34.1

The above table shows that the quantity of mobile nutrient components also decreases in line with the reduction in moisture reserves.

The relationship between the characteristics of the winter wheat leaves' water regime and the rate at which fertilizers and ameliorants are applied is shown in Table 4.

Table 4

Dependence of some features of the water regime of winter wheat leaves on the rate of application of fertilizers and ameliorant

№	Option	The mass of 10 leaves, g		Amount of water, %		Transpiration intensity g/m^2h
		Wet	**Dry**	**By wet mass**	**By dry mass,**	
1	Without fertilization and ameliorant	2,840	1,139	59,87	149,34	2,149
2	P90K60N120	4,770	1,788	62,50	116,77	2,451
3	P90K60N90	4,620	1,784	61,37	158,96	2,320
4	PMM 1500 kg/ha	3,830	1,511	60,54	153,47	2,237
5	PMM 3000 kg/ha	3,920	1,553	60,38	152,41	2,241
6	PMM 1500 kg/ha + P90K60N120	6,630	2,335	64,76	183,94	2,562
7	PMM 1500 kg/ha + P90K60N90	6,590	2,324	64,72	183,56	2,549
8	PMM 3000 kg/ha + P90K60N120	6,890	2,449	64,45	181,33	2,551
9	PMM 3000 kg/ha + P90K60N90	6,720	2,394	64,37	180,70	2,562

These experiments demonstrate that, depending on the specified factors, the total humidity, the amount of water evaporating from the unit surface of the leaf per unit time, and the wet and dry mass of the leaves of the first tier increased to equivalent values.

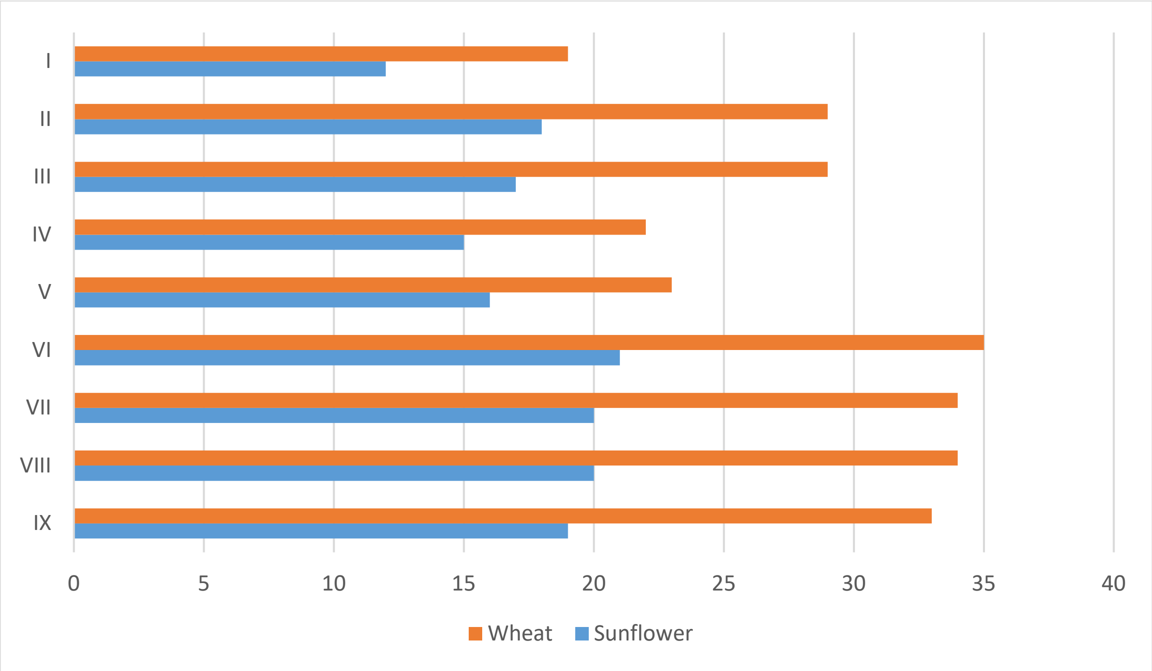

Fig. Yields of wheat (from above) and sunflowers, by option

As a result, fertilizers aid in the efficient use of water by plants and the ameliorant that is applied to the soil controls its filtration capabilities. Because of this, favorable water conditions are created in the 0–15 cm layer of soil, and high atmospheric pressure guarantees agricultural crops a high yield (Fig.).

The best options for planting both spring and autumn crops are identified by the data as options 6, 7, 8, and 9, where the appropriate amounts of fertilizer and ameliorant were applied to the soil.

Conclusions

To ensure a harvest of field crops under natural circumstances in the post-forest medium-brown soils of the foothill zone, where the average annual atmospheric precipitation is 497–520 mm and the average annual temperature is 11.8^{0}C, it is required:

1. To replace deep conventional tillage with minimal tillage.
2. To introduce a crop rotation that is based on science and takes into account the market, soil, climate, and other factors.
3. To determine the effective rates of the ameliorant PMM polymer mineral additive and fertilizer combination.

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ԲՆԱԿԱՆ ՊԱՅՄԱՆՆԵՐՈՒՄ ՄԵԼԻՈՐԱՆՏԻ ԵՎ ՊԱՐԱՐՏԱՆՅՈՒԹԵՐԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ՀՈՂԻ ՖԻԼՏՐԱՑԻՈՆ ՀԱՏԿՈՒԹՅՈՒՆՆԵՐԻ, ԲՈՒՅՍԵՐԻ ՋՐԱՅԻՆ ՌԵԺԻՄԻ ԵՎ ԲԵՐՔԱՏՎՈՒԹՅԱՆ ՎՐԱ

Գալստյան Ս.Բ., Թոքմաջյան Հ.Վ., Միքայելյան Ն.Ա., Օհանյան Հ.Ա.
Շուշիի տեխնոլոգիական համալսարան

Նախալեռնային գոտու հետանտառային դարչնագույն, գլաքարային, կարբոնատացված, միջին հզորության հողերում, նվազագույն մշակման և կարճ ռոտացիայով ցանքաշրջանառության պայմաններում, հետազոտվել է «ПММ» պոլիմերահանքային հավելանյութի ազդեցությունը հողի ֆիլտրացիոն հատկությունների բարելավման, բույսերի չորադիմացկունության ավելացման և մշակաբույսերի բերքատվության բարձրացման վրա: Բացահայտվել է «ПММ» հավելանյութի, ինչպես առանձին, այնպես էլ՝ պարարտանյութերի հետ համատեղ կիրառման ազդեցությունը վարելաշերտում խոնավության և լուծված սննդատարրերի փոփոխման դինամիկայի, տերևային միավոր մակերեսից միավոր ժամանակահատվածում գոլորշացած ջրի քանակության նվազեցման վրա: Փորձերի արդյունքում պարզվել է, որ նշված ագրոտեխնիկական միջոցառումները նպաստում են վարելաշերտի վերին (0-15սմ) հորիզոններում խոնավությամբ և սննդատարրերով ապահովված բարենպաստ միջավայրի ստեղծմանը, ինչը մշակաբույսերի բերքատվության բարձրացման երաշխիք է:

Բանալի բառեր. հող, ֆիլտրացիա, պարարտանյութ, բերքատվություն, խոնավություն, տրանսպիրացիա, սննդատարրեր, վարելաշերտի տարբերակում:

ВЛИЯНИЕ МЕЛИОРАНТОВ И УДОБРЕНИЙ НА ФИЛЬТРАЦИОННЫЕ СВОЙСТВА ПОЧВЫ, ВОДНЫЙ РЕЖИМ И УРОЖАЙНОСТЬ РАСТЕНИЙ В ЕСТЕСТВЕННЫХ УСЛОВИЯХ

Галстян С.Б., Токмаджян О.В., Микаелян Н.А., Оганян О.А.
Шушинский технологический университет

В залесных коричневых, глинистых, карбонатных среднемощных почвах предгорной зоны в условиях минимальной обработки и короткоротационного севооборота было исследовано влияние полимерно-минеральной добавки «ПММ» на улучшение фильтрационных свойств почвы, повышение засухоустойчивости и урожайности сельскохозяйственных культур. Выявлено влияние внесения добавки «ПММ», как по отдельности, так и в сочетании с удобрениями, на динамику изменения влажности и растворенных питательных веществ в пахотном слое, на количество воды, испаренной с единицы листовой поверхности за единицу времени. В результате опытов было установлено, что указанные агротехнические мероприятия способствуют созданию в верхних горизонтах пахотного слоя (0-15 см) благоприятной среды, обеспеченной влагой и питательными веществами, что является залогом повышения урожайности сельскохозяйственных культур.

Ключевые слова: почва, фильтрация, удобрение, урожайность, влажность, транспирация, питательные вещества, дифференциация пахотного слоя.

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