



THE INFLUENCE OF SOWING SCHEMES AND NUTRITIONAL NORMS ON SOIL WATER PERMEABILITY IN AMARANTH FIELD SOWN FOR GRAIN YIELD

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Abstract. This article studies the effect of different planting schemes and mineral and foliar feeding rates on soil water permeability in amaranth crops grown for grain crops. The studies were conducted in 2023 at the end of the growing season in 0–30 and 30–50 cm soil layers. In the experiment, the planting schemes 70×15–1, 70×20–1, 70×25–1 and 70×30–1 were compared with the fertilizer rates N₂₅₀P₁₇₅K₁₂₅, N₂₀₀P₁₄₀K₁₀₀ and N₁₅₀P₁₀₅K₇₅ and foliar feeding methods with the water-soluble complex fertilizer Akvarin-14 during different growing seasons. According to the results obtained, the soil permeability was high in wide planting schemes, and the total amount of water absorbed in the 0–30 cm layer over 6 hours was 843–892 mm. The results of the study serve as a scientific basis for improving the water-air regime of the soil and selecting optimal agrotechnologies in the cultivation of amaranth for grain crops.

Kalit so‘zlar: Amaranth, grain yield, planting scheme, mineral fertilizers, foliar feeding, soil water permeability.

INTRODUCTION

Amaranthus cruentus is grown for its leaves and is a highly valued leafy vegetable in Nigeria due to its high nutritional and commercial value. *Amaranthus cruentus* contains vitamins such as β-carotene (a precursor of vitamin A), vitamin B6, vitamin C, riboflavin and folate, as well as nutritional minerals such as calcium, iron, magnesium, phosphorus, potassium, zinc, copper and manganese [1;147-154-p]. *Amaranthus cruentus* species are widely cultivated. Due to their early maturity and ability to survive in mixed cropping, they remain the most preferred crop for early income and survival by many farmers, while farmers wait for other crops to mature in traditional natural mixed cropping systems. *Amaranthus cruentus* is grown in various cropping systems in home gardens, farms, inland valleys (fadams) and in peri-urban gardens [2; 289-293-p], [3; 29-35-p].

Amaranth is also known as amaranth, African spinach, bush greens, spinach greens, etc. Amaranths belong to the Amaranth family. There are many species and varieties of amaranths. Many hybrids are found among amaranths and are recognized



as separate species. There are two types of amaranths, namely vegetable and grain amaranths [4; pp. 85–96].

Good growth and development of the amaranth plant directly depends on the properties of the soil and environmental conditions. At the same time, although the amaranth plant is not demanding on nutrients, it requires the presence of these substances in the minimum amount necessary for its development; if they are not enough, the plant growth process slows down or stops. Researchers note that the optimal ratio of nutrients in the soil should be 1:0.5:1.2 against nitrogen [5; pp. 10–12].

It has been noted that agrotechnical measures applied to amaranth plants have a significant impact on soil properties. In particular, the amount of mineral fertilizers and irrigation used for amaranth significantly increases the volume and mass of the soil. [6; pp. 341–351, 7; pp. 18–12].

MATERIALS AND METHODS

Field experiments were conducted in 2023-2025 in the field of the TDAU experimental farm in the Kibray district of the Tashkent region under typical sierozem soil conditions. The experiment was conducted using the “Methodology of Field Experiments” by B.A. Dospekhov, the “Methods of Accounting and Mapping of Weed Vegetation” by A.M. Tulikov, and the “Methodology of Field Experiments” developed at the UZPITI. Field experiments were conducted in the Kibray district of the Tashkent region under sierozem soil conditions in 24 variants, 4 repetitions, and 4 tiers.

RESULTS AND DISCUSSION

Soil permeability is the ability of the soil to conduct water quickly and efficiently. The purpose of determining soil permeability is to understand the movement of water in the soil and its ability to store it, as well as to effectively irrigate plants and properly organize irrigation systems. By studying the water permeability of the soil, it is possible to determine the irrigation regime, ensure plant development, manage and increase soil fertility, and design irrigation systems, and properly construct drainage and irrigation systems. When planting amaranth for grain crops, the soil water permeability in each variant in the 0-30 and 30-50 cm layers at the 1st hour of determination in 2023 was determined as follows: in the 70x15-1 planting scheme, the $N_{250}P_{175}K_{125}$ fertilization rate was 313 in the 0-30 cm layer and 207 in the 30-50 cm layer; in the 70x20-1 planting scheme, the 0-30 cm layer was 312 and 212 in the 30-50 cm layer; in the 70x25-1 planting scheme, the 0-30 cm layer was 323 and 214 in the 30-50 cm layer; and in the 70x30-1 planting scheme, the 0-30 cm layer was 318 and 235 in the 30-50 cm layer. It was determined that the $N_{200}P_{140}K_{100}$ fertilization rate was 311 in the 0-30 cm layer and 206 in the 30-50 cm layer in the 70x15-1 planting scheme; 310 in the 0-30 cm layer and 211 in the 30-50 cm layer in the 70x20-1 planting scheme; 321 in the 0-30 cm layer and



213 in the 30-50 cm layer in the 70x25-1 planting scheme, and 316 in the 0-30 cm layer and 234 in the 30-50 cm layer in the 70x30-1 planting scheme. It was found that the fertilization rate of N₁₅₀P₁₀₅K₇₅ was 307 in the 0-30 cm layer and 203 in the 30-50 cm layer in the 70x15-1 planting scheme; 306 in the 0-30 cm layer and 208 in the 30-50 cm layer in the 70x20-1 planting scheme; 317 in the 0-30 cm layer and 210 in the 30-50 cm layer in the 70x25-1 planting scheme, and 312 in the 0-30 cm layer and 231 in the 30-50 cm layer in the 70x30-1 planting scheme.

At the 2nd hour of soil permeability determination, it was determined that the N₂₅₀P₁₇₅K₁₂₅ fertilization rate was 202 in the 0-30 cm layer and 177 in the 30-50 cm layer in the 70x15-1 planting scheme; 202 in the 0-30 cm layer and 182 in the 30-50 cm layer in the 70x20-1 planting scheme; 182 in the 0-30 cm layer and 176 in the 30-50 cm layer in the 70x25-1 planting scheme, and 177 in the 0-30 cm layer and 173 in the 30-50 cm layer in the 70x30-1 planting scheme. It was determined that the N₂₀₀P₁₄₀K₁₀₀ fertilization rate was 201 in the 0-30 cm layer and 175 in the 30-50 cm layer in the 70x15-1 planting scheme; 201 in the 0-30 cm layer and 181 in the 30-50 cm layer in the 70x20-1 planting scheme; 181 in the 0-30 cm layer and 174 in the 30-50 cm layer in the 70x25-1 planting scheme, and 175 in the 0-30 cm layer and 171 in the 30-50 cm layer in the 70x30-1 planting scheme. It was determined that the fertilization rate of N₁₅₀P₁₀₅K₇₅ was 198 in the 0-30 cm layer and 174 in the 30-50 cm layer in the 70x15-1 planting scheme; 198 in the 0-30 cm layer and 178 in the 30-50 cm layer in the 70x20-1 planting scheme; 178 in the 0-30 cm layer and 177 in the 30-50 cm layer in the 70x25-1 planting scheme, and 174 in the 0-30 cm layer and 170 in the 30-50 cm layer in the 70x30-1 planting scheme. At the 3rd hour of soil permeability determination, it was determined that the N₂₅₀P₁₇₅K₁₂₅ fertilization rate was 148 in the 0-30 cm layer and 119 in the 30-50 cm layer in the 70x15-1 planting scheme; 192 in the 0-30 cm layer and 121 in the 30-50 cm layer in the 70x20-1 planting scheme; 157 in the 0-30 cm layer and 123 in the 30-50 cm layer in the 70x25-1 planting scheme, and 162 in the 0-30 cm layer and 120 in the 30-50 cm layer in the 70x30-1 planting scheme. It was found that the N₂₀₀P₁₄₀K₁₀₀ fertilization rate was 147 in the 0-30 cm layer and 118 in the 30-50 cm layer in the 70x15-1 planting scheme; 191 in the 0-30 cm layer and 120 in the 30-50 cm layer in the 70x20-1 planting scheme; 155 in the 0-30 cm layer and 122 in the 30-50 cm layer in the 70x25-1 planting scheme, and 160 in the 0-30 cm layer and 119 in the 30-50 cm layer in the 70x30-1 planting scheme. It was found that the fertilization rate of N₁₅₀P₁₀₅K₇₅ was 146 in the 0-30 cm layer and 117 in the 30-50 cm layer in the 70x15-1 planting scheme; 188 in the 0-30 cm layer and 119 in the 30-50 cm layer in the 70x20-1 planting scheme; 154 in the 0-30 cm layer and 121 in the 30-50 cm layer in the 70x25-1 planting scheme, and 159 in the 0-30 cm layer and 118 in the 30-50 cm layer in the 70x30-1 planting scheme.

At the 4th hour of soil permeability determination, it was determined that the N₂₅₀P₁₇₅K₁₂₅ fertilization rate was 96 in the 0-30 cm layer and 84 in the 30-50 cm layer



in the 70x15-1 planting scheme; 106 in the 0-30 cm layer and 91 in the 30-50 cm layer in the 70x20-1 planting scheme; 108 in the 0-30 cm layer and 96 in the 30-50 cm layer in the 70x25-1 planting scheme; and 111 in the 0-30 cm layer and 82 in the 30-50 cm layer in the 70x30-1 planting scheme. It was found that the fertilization rate of $N_{200}P_{140}K_{100}$ was 95 in the 0-30 cm layer and 83 in the 30-50 cm layer in the 70x15-1 planting scheme; 105 in the 0-30 cm layer and 90 in the 30-50 cm layer in the 70x20-1 planting scheme; 107 in the 0-30 cm layer and 95 in the 30-50 cm layer in the 70x25-1 planting scheme, and 110 in the 0-30 cm layer and 81 in the 30-50 cm layer in the 70x30-1 planting scheme. The fertilization rate of $N_{150}P_{105}K_{75}$ was 94 in the 0-30 cm layer and 82 in the 30-50 cm layer in the 70x15-1 planting scheme; It was found that in the 70x20-1 planting scheme, the number of seedlings in the 0-30 cm layer was 104 and in the 30-50 cm layer was 89; in the 70x25-1 planting scheme, the number of seedlings in the 0-30 cm layer was 106 and in the 30-50 cm layer was 94; and in the 70x30-1 planting scheme, the number of seedlings in the 0-30 cm layer was 109 and in the 30-50 cm layer was 80.

At the 5th hour of soil permeability determination, it was determined that the $N_{250}P_{175}K_{125}$ fertilization rate was 39 in the 0-30 cm layer and 33 in the 30-50 cm layer in the 70x15-1 planting scheme; 45 in the 0-30 cm layer and 35 in the 30-50 cm layer in the 70x20-1 planting scheme; 48 in the 0-30 cm layer and 37 in the 30-50 cm layer in the 70x25-1 planting scheme, and 35 in the 0-30 cm layer and 35 in the 30-50 cm layer in the 70x30-1 planting scheme. It was found that the fertilization rate of $N_{200}P_{140}K_{100}$ was 39 in the 0-30 cm layer and 33 in the 30-50 cm layer in the 70x15-1 planting scheme; 44 in the 0-30 cm layer and 35 in the 30-50 cm layer in the 70x20-1 planting scheme; 47 in the 0-30 cm layer and 37 in the 30-50 cm layer in the 70x25-1 planting scheme, and 35 in the 0-30 cm layer and 35 in the 30-50 cm layer in the 70x30-1 planting scheme. The fertilization rate of $N_{150}P_{105}K_{75}$ was 38 in the 0-30 cm layer and 32 in the 30-50 cm layer in the 70x15-1 planting scheme; It was found that in the 70x20-1 planting scheme, there were 44 in the 0-30 cm layer and 34 in the 30-50 cm layer; in the 70x25-1 planting scheme, there were 47 in the 0-30 cm layer and 36 in the 30-50 cm layer; and in the 70x30-1 planting scheme, there were 34 in the 0-30 cm layer and 34 in the 30-50 cm layer.

At the 6th hour of soil permeability determination, it was determined that the $N_{250}P_{175}K_{125}$ fertilization rate was 25 in the 0-30 cm layer and 22 in the 30-50 cm layer in the 70x15-1 planting scheme; 35 in the 0-30 cm layer and 25 in the 30-50 cm layer in the 70x20-1 planting scheme; 37 in the 0-30 cm layer and 27 in the 30-50 cm layer in the 70x25-1 planting scheme, and 40 in the 0-30 cm layer and 33 in the 30-50 cm layer in the 70x30-1 planting scheme. It was found that the fertilization rate of $N_{200}P_{140}K_{100}$ was 25 in the 0-30 cm layer and 22 in the 30-50 cm layer in the 70x15-1 planting scheme; 35 in the 0-30 cm layer and 25 in the 30-50 cm layer in the 70x20-1 planting scheme; 37 in the 0-30 cm layer and 27 in the 30-50 cm layer in the 70x25-1

planting scheme, and 40 in the 0-30 cm layer and 33 in the 30-50 cm layer in the 70x30-1 planting scheme. The fertilization rate of $N_{150}P_{105}K_{75}$ was 24 in the 0-30 cm layer and 21 in the 30-50 cm layer in the 70x15-1 planting scheme; In the 70x20-1 planting scheme, it was found that there were 34 in the 0-30 cm layer and 24 in the 30-50 cm layer; in the 70x25-1 planting scheme, there were 36 in the 0-30 cm layer and 26 in the 30-50 cm layer; and in the 70x30-1 planting scheme, there were 39 in the 0-30 cm layer and 32 in the 30-50 cm layer.

Table 1

The effect of sowing schemes and feeding rates on soil permeability in an amaranth field planted for grain production (end of the implementation period), 2023

№	Sowing schemes	Fertilizers rates, kg/ha	dates and rates of foliar application	Soil layers	Detection hours						Total in 6 hours	
					1	2	3	4	5	6		
1	70x15-1	$N_{250}P_{175}K_{125}$	Control (treated with water)	0-30	313	202	148	96	39	25	823	
				30-50	207	177	119	84	33	22	642	
2	70x20-1			0-30	312	202	192	106	45	35	892	
				30-50	212	182	121	91	35	25	666	
3	70x25-1			0-30	323	182	157	108	48	37	855	
				30-50	214	176	123	96	37	27	673	
4	70x30-1		0-30	318	177	162	111	35	40	843		
			30-50	235	173	120	82	35	33	678		
5	70x15-1		$N_{200}P_{140}K_{100}$	Aquarin-14 (NPK 20-20-20) water-soluble complex fertilizer at a rate of 1.4 kg/ha during the 5-6 leaf stage and 1.8 kg/ha during the panicle formation stage	0-30	311	201	147	95	39	25	818
					30-50	206	175	118	83	33	22	637
6	70x20-1				0-30	310	201	191	105	45	35	887
					30-50	211	181	120	90	35	25	662
7	70x25-1	0-30			321	181	155	107	48	37	849	
		30-50			213	174	122	95	37	27	668	
8	70x30-1	0-30		316	175	160	110	35	40	836		
		30-50		234	171	119	81	35	33	673		
9	70x15-1	$N_{150}P_{105}K_{75}$		Aquarin-14 (NPK 20-20-20) water-soluble complex fertilizer at 1.4 kg/ha during the 5-6 leaf stage, 1.8 kg/ha during the panicle formation stage, and 1.8 kg/ha during grain formation	0-30	307	198	146	94	39	25	809
					30-50	203	174	117	82	33	22	631
10	70x20-1				0-30	306	198	188	104	45	35	876
					30-50	208	178	119	89	35	25	654
11	70x25-1		0-30		317	178	154	106	48	37	840	
			30-50		210	177	121	94	37	27	666	
12	70x30-1		0-30	312	174	159	109	35	40	829		
			30-50	231	170	118	80	35	33	667		

When the soil water permeability index was determined and studied for 6 hours when amaranth was planted for grain crops, it was determined that the total $N_{250}P_{175}K_{125}$ fertilization rate was 823 in the 0-30 cm layer and 642 in the 30-50 cm layer in the 70x15-1 planting scheme; 892 in the 0-30 cm layer and 666 in the 30-50 cm layer in the 70x20-1 planting scheme; 855 in the 0-30 cm layer and 673 in the 30-50 cm layer in the 70x25-1 planting scheme, and 843 in the 0-30 cm layer and 678 in the 30-50 cm layer in the 70x30-1 planting scheme. It was determined that the $N_{200}P_{140}K_{100}$ fertilization rate was 818 in the 0-30 cm layer and 637 in the 30-50 cm layer in the 70x15-1 planting scheme; 887 in the 0-30 cm layer and 662 in the 30-50 cm layer in the 70x20-1 planting scheme; 849 in the 0-30 cm layer and 668 in the 30-50 cm layer in the 70x25-1 planting scheme, and 836 in the 0-30 cm layer and 673 in the 30-50 cm



layer in the 70x30-1 planting scheme. It was found that the $N_{150}P_{105}K_{75}$ fertilization rate was 809 in the 0-30 cm layer and 631 in the 30-50 cm layer in the 70x15-1 planting scheme; 876 in the 0-30 cm layer and 654 in the 30-50 cm layer in the 70x20-1 planting scheme; 840 in the 0-30 cm layer and 666 in the 30-50 cm layer in the 70x25-1 planting scheme, and 829 in the 0-30 cm layer and 667 in the 30-50 cm layer in the 70x30-1 planting scheme.

CONCLUSION

The results of the study showed that planting patterns and feeding rates significantly affect the water permeability of the soil in the amaranth field grown for grain crops. Water absorption was high in wide planting patterns and when using average mineral fertilizer rates and foliar feeding with Aquarin-14. The results obtained serve as a scientific basis for choosing optimal agrotechnologies for growing amaranth for grain crops.

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