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THE EFFECT OF PLANTING DENSITY AND NORMS OF MINERAL FERTILIZERS ON THE NUMBER OF LEAVES AND LEAF PRODUCTIVITY OF FODDER BEET

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Annotation: The article discusses the number of leaves in the plant, their surface area and mass, which affect the future yield weight and quality. The development and activity of leaves in the plant depend on plant care, namely planting density, norms of mineral fertilizers, water requirements, and the quality and timing of additional agrotechnical measures. For fodder beet, the most optimal planting density is 110-120 thousand/ha, and with this planting density, applying mineral fertilizers at the rate of NPK 200:140:100 kg/ha resulted in an average leaf yield of 256.1-261.7 c/ha per hectare.

Keywords: fodder beet, soil, mineral fertilizer, planting density, number and mass of leaves, leaf productivity.

Introduction. Fodder beet is grown only in irrigated lands in Uzbekistan. In Uzbekistan, the fodder beet varieties “Uzbekiston – yarimkand” and “Uzbekiston -83” are included in the State Register. It is a easily digestible forage crop that increases milk production in cattle. In farms, fodder beet makes up 40-50% of the ration for dairy cattle. The beet root is composed of useful minerals and vitamins, and is rich in carotene. In terms of digestibility, the roots are not inferior to pasture grasses, facilitate the digestion of coarse feeds, allow saving on concentrate feeds, and improve reproduction.

The application of growth-regulating preparations during the vegetation period of fodder beet has a positive effect on its leaf development, with leaf productivity being 27.8-31.2 c/ha higher compared to the control variant [6], [7], [8].

In the conditions of Samarkand region, when fodder beet is sown on April 10, germination occurs on April 21, 2-3 true leaves appear on April 25, 4-5 true leaves on April 30, 6-7 true leaves on May 4, 8-10 true leaves on May 10, leaf rosette formation on May 26, and maturation on October 8 [4].

According to data, the process of leaf formation in fodder beet in terms of days is as follows: from the 10th to the 20th leaf, leaves develop every 1.5 days; from the 21st to the 30th leaf, every 2 days; subsequent ones every 2.5-3 days, with one leaf developing [5].

Research objective: To determine the optimal planting density and norms of mineral fertilizers for obtaining abundant and high-quality yields from the roots and leaves of fodder beet in the conditions of typical gray soils in Samarkand region, and to provide recommendations for production.

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Materials and methods: This research was conducted in 2023-2025 at the Samarkand scientific experimental station of the cotton breeding, seed production and cultivation agrotechnologies scientific research institute in Samarkand region, under typical gray soil conditions (Table 1). The experiment consisted of 12 variants, with each variant's area being 240 m², and the accounting area 120 m². The experiment was carried out in one tier, with three replications. The area of one replication was 2880 m², with a total area of 0.85 hectares.

Table 1

Experiment scheme

№	Plant density, thousand/ha	Mineral fertilizer rate, kg/ha
1	70-80	Without fertilizer (control)
2		NPK 120:90:60
3		NPK 160:120:90
4		NPK 200:140:100
5	90-100	Without fertilizer (control)
6		NPK 120:90:60
7		NPK 160:120:90
8		NPK 200:140:100
9	110-120	Without fertilizer (control)
10		NPK 120:90:60
11		NPK 160:120:90
12		NPK 200:140:100

Mathematical analysis of the field experiment results was conducted according to B.A. Dospekhov [2], while phenological observations in plants were carried out based on “Methodology of state variety testing of agricultural crops” [3] and “Methods of conducting field experiments” [1].

Results and discussion: It is known that leaves perform basic functions in plant life and play a very significant role in its growth and development. The number of leaves in a plant, their surface area, and mass determine the future yield weight and quality. The development and activity of leaves in a plant depend on plant care, namely seedling density, mineral fertilizer rates, water requirements, and the quality and timing of additional agrotechnical measures.

In fodder beet, after the initial cotyledons emerge, as the root crop develops, an increase in the growth and development of leaves is also observed. From the beginning to the middle of the vegetation period, mainly leaf development is observed in the plant, while from the second half of the vegetation period, root crop development accelerates. At this time, leaf development in the plant slows down, and the lower leaves begin to complete their activity. By the end of the vegetation period, the initial leaves in the plant will have dried and fallen off. Therefore, in fodder beet sown at the main time, the highest period of leaf development is considered July.

Observations on studying the number and mass of leaves were started from June, based on the goals and objectives of the experiment. Based on these, in this experiment, the effects of different levels of seedling density and mineral fertilizer rates on the number and mass of leaves in fodder beet were studied, and the obtained results were analyzed (Table 2).

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According to the data obtained in the initial stage of the research, in June 2023, the number of leaves per plant in the experiment variants ranged on average from 8.6 to 18.7 pieces, and the mass from 42.1 grams to 74.1 g.

In July, these indicators ranged from 16.7 to 32.0 pieces, and the mass from 142.1 grams to 183.4 grams. If we compare these indicators with those from June, it was determined that there were noticeable changes in the number and mass of leaves, namely, within one month, the average number of leaves per plant increased by 8.0-12.0 pieces, and the mass by 90-100 grams.

Now, when comparing the indicators from July with those obtained in August, we can see that even higher results were achieved. According to the data, the leaves increased by 12.0-16.0 pieces within one month, and their mass by 100-110 grams. In the subsequent months, as mentioned above, a decrease in the number and mass of leaves was observed. Therefore, the highest level of leaf development in fodder beet was observed in July.

According to the obtained data, in the experiment, the lowest number of leaves was observed in the control variants without fertilizer, and these indicators were 27.5; 29.4; 30.1 pieces in variants 1, 5, and 9, respectively. This is the lowest indicator among the variants.

Table 2

Effect of seedling density and mineral fertilizer rates on the number and mass of leaves in fodder beet, 2023

Var №	Seedling density, thousand/ha	Mineral fertilizer rates, kg/ha	1.06		1.07		1.08		1.09		Before harvest	
			Number of leaves, pieces	Leaf mass, g	Number of leaves, pieces	Leaf mass, g	Number of leaves, pieces	Leaf mass, g	Number of leaves, pieces	Leaf mass, g	Number of leaves, pieces	Leaf mass, g
1	70-80	Without fertilizer (control)	8,6	42,1	16,7	142,1	27,5	237,3	21,4	211,2	17,6	167,6
2		NPK 120:90:60	11,3	54,3	21,4	156,4	34,1	264,1	28,3	238,7	24,7	201,4
3		NPK 160:120:80	14,2	59,7	25,2	168,9	38,6	275,2	32,1	249,7	28,9	214,7
4		NPK 200:140:100	15,6	63,4	27,6	174,1	43,1	289,7	35,5	257,8	31,4	223,7
5	90-100	Without fertilizer (control)	9,1	45,7	17,7	145,7	29,4	247,9	23,7	225,4	19,7	172,4
6		NPK 120:90:60	13,4	58,6	23,6	160,2	38,7	274,6	32,4	244,3	28,4	216,7
7		NPK 160:120:80	16,8	69,7	28,7	175,4	41,2	280,1	34,5	253,4	30,5	218,7
8		NPK 200:140:10	18,6	73,4	31,2	182,1	45,3	291,2	36,4	261,2	32,4	225,6

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9	110-120	Without fertilizer (control)	9,8	49,7	17,9	148,1	30,1	249,3	24,1	228,7	20,9	173,4
10		NPK 120:90:60	14,1	61,0	24,1	162,1	40,3	278,1	33,1	237,8	29,7	219,7
11		NPK 160:120:80	17,1	71,2	29,1	178,2	42,8	282,3	34,8	257,4	30,8	221,6
12		NPK 200:140:100	18,7	74,1	32,0	183,4	45,9	292,2	36,5	262,6	32,6	226,6

It can be concluded from the obtained data that, in the cultivation of fodder beet, when the mineral fertilizer rates are increased from NPK 120:90:60 kg/ha to NPK 160:120:80 kg/ha, the number of leaves per plant becomes 2.5 to 4.5 pieces more, and when increased to NPK 200:140:100 kg/ha, it becomes 5.6 to 9.0 pieces more.

In fodder beet, besides the number of leaves, the mass was also analyzed, and data were obtained in accordance with the above.

In fodder beet, increasing the number of seedlings also caused the leaf mass to be higher. In the experiment's variants 2, 3, and 4 where the seedling density was 70-80 thousand per ha, the leaf mass was respectively 264.1; 275.2; 289.7 g. In variants 6, 7, and 8 with seedling density of 90-100 thousand/ha, it was 274.6; 280.1; 291.2 g, and in variants 10, 11, and 12 with seedling density of 110-120 thousand/ha, it was 278.1; 282.3; 292.2 g.

According to the data obtained on the effect of seedling density on the leaf productivity of fodder beet, in the study, the highest indicator was determined in the variants where the seedling density was the highest amount, namely 110-120 thousand pieces per hectare. In the experiment's variant 10, where the seedling density was 110-120 thousand per hectare and the mineral fertilizer rate was NPK 120:90:60 kg/ha, the leaf productivity averaged 250.5 c/ha over three years, whereas in variant 2 with seedling density of 70-80 thousand per hectare and the same mineral fertilizer rate applied, it was 154.4 c/ha, and in variant 6 with seedling density of 90-100 thousand per hectare, this indicator was 205.0 c/ha. Here, in variant 10 with seedling density of 110-120 thousand/ha, the additional leaf yield compared to variant 2 (with 70-80 thousand seedlings per hectare) was 96.1 c/ha, and compared to variant 6 (with 90-100 thousand seedlings per hectare), it was 45.5 c/ha (Figure 1).

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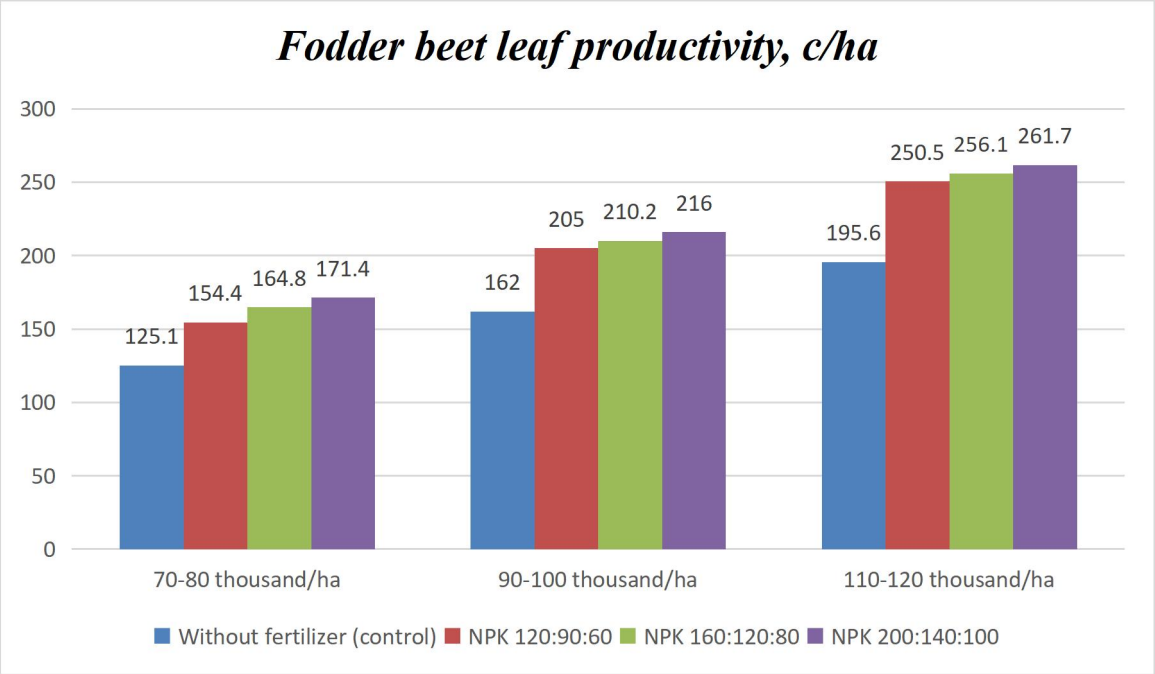

Figure 1. Effect of seedling density and mineral fertilizer rates on fodder beet leaf productivity, average over three years (2023-2025)

When comparing the mineral fertilizers used in the research with the control variants of the experiment, i.e., variants without fertilizer application, it was determined that in fodder beet, in variants where the lowest amount of mineral fertilizers NPK 120:90:60 kg/ha was applied, the additional yield compared to the control was respectively 29.3; 43.0; 54.9 c/ha according to seedling densities, when the fertilizer rate was NPK 160:120:80 kg/ha, it was 39.7; 48.2; 60.5 c/ha, and when NPK 200:140:100 kg/ha, it was 46.3; 54.0; 66.1 c/ha.

Regarding obtaining additional yield due to mineral fertilizers, if from the root crop of fodder beet it was obtained from variants where mineral fertilizers were applied at NPK 160:120:80 kg per hectare, then in leaf yield, the additional yield obtained from leaves was higher in variants where mineral fertilizers were applied at rates of NPK 200:140:100 kg/ha.

Conclusion: It can be concluded from the data obtained on the effect of seedling density and mineral fertilizer rates on the number and mass of leaves in fodder beet that increasing the seedling density in fodder beet from 70-80 thousand pieces per hectare to 90-100 thousand pieces increases the number of leaves from 2.2 pieces to 4.6 pieces, the leaf mass from 4.5 g to 9.9 g, increasing to 110-120 thousand pieces increases from 2.8 pieces to 6.2 pieces, the mass from 7.1 g to 14.0 g more, increasing the mineral fertilizer rates from NPK 120:90:60 kg/ha to NPK 160:120:80 kg/ha increases the number of leaves from 2.5 pieces to 4.5 pieces, the leaf mass from 4.2 g to 11.1 g, increasing to NPK 200:140:100 kg/ha increases the number of leaves from 5.6 pieces to 9.0 pieces, the mass from 14.1 g to 25.6 g higher. The most optimal seedling density for fodder beet is 110-120 thousand/ha, and cultivating with mineral fertilizers at rates of NPK 200:140:100 kg/ha at this seedling density ensures obtaining an average leaf yield of 256.1-261.7 c/ha per hectare.

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