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Original Article

Effect of fertilizers and growth stimulants on the yield and feed qualities of the green mass of the yellow melilot in the Akmola region

Efeito de fertilizantes e estimulantes de crescimento na produção e qualidade do alimento da massa verde do meliloto-amarelo na região de Akmola

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Abstract

This study is aimed at evaluating the effect of various types of fertilizers and growth stimulants on the productivity and quality of yellow melilot. Their increase is necessary to ensure a balanced mineral composition of livestock diet. Research methods include the analysis of field germination of seeds, the study of plant growth at various stages, and the analysis of the agrochemical composition of the soil and feed mass. The field experiments were conducted in the steppe zone of the Akmola region, Kazakhstan with fluctuating air temperature and low rainfall. The results show that the use of fertilizers and growth stimulants significantly increased the field germination of seeds, the content of protein, carotene, and feed units, as well as the yield of the green mass of the yellow melilot. Particularly high rates were achieved with the use of the Fulvimax N and Start Up fertilizers and the Gumato Fosfat N and K growth stimulants. The results indicate the potential of fertilizers and growth stimulants to improve agricultural production and emphasize the importance of choosing the optimal fertilizers to achieve maximum results. The study contributes to the expansion of knowledge about methods of increasing the yield and quality of feed crops, which is an important issue in agriculture.

Keywords: melilot, organic, organomineral and mineral fertilizers, growth stimulants, feed qualities, green mass, yield.

Resumo

Este estudo tem como objetivo avaliar o efeito de vários tipos de fertilizante e estimulante de crescimento na produtividade e qualidade do meliloto-amarelo. Seu aumento é necessário para garantir uma composição mineral equilibrada na dieta do gado. Os métodos de pesquisa incluem a análise da germinação de sementes em campo, o estudo do crescimento das plantas em várias etapas e a análise da composição agroquímica do solo e da massa de alimentação. Os experimentos de campo foram conduzidos na zona de estepe da região de Akmola, Cazaquistão, com temperatura do ar oscilante e baixa precipitação. Os resultados mostram que o uso de fertilizantes e estimulantes de crescimento aumentou significativamente a germinação de sementes em campo, o teor de proteína, caroteno e unidades de alimentação, bem como a produção da massa verde do meliloto-amarelo. Taxas especialmente altas foram alcançadas com o uso dos fertilizantes Fulvimax N e Start Up e dos estimulantes de crescimento Gumato-Fosfato N e K. Os resultados indicam o potencial dos fertilizantes e estimulantes de crescimento para melhorar a produção agrícola e enfatizam a importância da escolha dos fertilizantes ideais para alcançar resultados máximos. O estudo contribui para a ampliação do conhecimento sobre métodos de aumento do rendimento e qualidade das culturas alimentares, o que é uma questão importante na agricultura.

Palavras-chave: meliloto, orgânico, organomineral e fertilizantes minerais, estimulantes de crescimento, qualidades de alimentação, massa verde, produção.

1. Introduction

Yellow, or common, melilot (*Melilotus officinalis* Desr.) is a biennial leguminous herbaceous drought-resistant short-day plant (Utelbayev et al., 2021). In the first year of life, it is oppressed by the cover crops and starts the winter with an underdeveloped root system (Ramazanova et al., 2021). It grows better when sown without cover crops.

The rational use of mineral and organic fertilizers is of great importance in increasing the productivity of

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perennial legumes (Popov et al., 2017). The optimization of plant nutrition with macro- and microelements improves the quality of plant products (Atabayeva et al., 2018; Mussynov et al., 2014) and makes it possible to provide animal husbandry with mineral-balanced feed (Voloshin and Avetisyan, 2017; Luo et al., 2018). Thus, the mineral nutrition of plants is one of the most important biological processes that ensure their viability and overall productivity (Farniev et al., 2013; Ansabayeva, 2023).

The study of the dynamics of the formation and activity of the symbiotic apparatus of the yellow melilot, depending on the regime of mineral nutrition and meteorological conditions of the year, and the dynamics of accumulation of dry matter and crop formation are urgent tasks of agricultural research (Farniev et al., 2013; Ansabayeva and Akhmetbekova, 2024).

R.V. Veldin (Veldin, 2021) establishes a reliable influence of the background of mineral nutrition, seed treatment, and foliar fertilization with bio-fertilizers and complex fertilizers.

According to R.D. Nurymova et al. (2018), the yield and quality of feed for various technological methods of growing melilot on saline soils largely depend on the methods of sowing (without and with cover crops). In the case of sowing without cover crops, the highest yield and feed quality are ensured with boardless tillage by applying optimal fertilizer doses (Kashina et al., 2022), observing a rational irrigation regime, and harvesting in the budding phase (Dosmanbetov et al., 2020).

The purpose of the work is to study the effect of various types of fertilizers and growth stimulants on the yield and feed qualities of the green mass of the yellow melilot.

2. Materials and Methods

Field experiments were conducted in 2022-2023 in the Kokshetau Experimental Production Farm within the framework of the project "Improving the technology of cultivating melilot for seeds following the green technology with elements of organic farming in the Akmola region" for grant financing of young scientists under the Zhas Galim project for 2022-2024 in the Republic of Kazakhstan, Akmola region, Zerendinsky district.

The object of the study was the Altynbas yellow melilot variety. It was bred by breeders of A.I. Baraev Research and Production Center for Grain Farming, Republic of Kazakhstan, Akmola region, Shortandy district. The authors of the variety: E.I. Parsaev, T.M. Kobernitskaya, N.I. Filippova, G.V. Devyatkina, and G.N. Churkina.

The variety is midseason-ripening, the interphase period from the beginning of spring regrowth to cutting ripeness (the beginning of blossoming) equals 46-52 days, and the period to the full seed ripeness is 90-101 days. It is characterized by cold resistance from the period of regrowth to the beginning of blossoming and resistance to early spring and summer drought. It is characterized by a short period of seed maturation.

The variety is high-yielding. On average, over four years of study in competitive variety testing, the yield of the green mass of Altynbas was 154.6 c/ha, the yield of dry matter 53.4 c/ha, and the yield of seeds 2.6 c/ha.

The crude protein content in dry matter was 15.5-20.0%, crude fiber 13.6-16.6%, and feed units 0.95-1.02 feed units/kg.

The nitragine inoculation of Altynbas melilot seeds contributed to an increase in atmospheric nitrogen fixation and amounted to 190.0 mg/100 g of soil, or 82% of total nitrogen.

The samples were collected at the end of the growing season. The weather conditions of this period in 2023 differed significantly from the average annual data. The agro-climatic indicators during the year of the study indicate significant fluctuations in the temperature regime and humidification conditions, characterized by a small amount and uneven distribution of precipitation (Table 1). Thus, the average daily temperature during the growing season ranged from 4.1 to 22.8°C. The amount of precipitation during the years of the study was significantly lower than the average annual amount by 8.6...22.5 mm.

The field experiments were established in 4-fold repetition. Agricultural technology in the experiments was zonal (Asadulagi et al., 2024). The area of the experimental

Table 1. Meteorological data for the growing season, 2023.

Indicator	Period (decade)	Month						Average vegetation
		April	May	June	July	August	September	
Temperature, °C	1st decade	+2.0	+10.7	+24.6	+23.2	+21.9	+12.1	+15.8
	2nd decade	-0.2	+10.3	+17.7	+23.6	+16.8	+12.5	+13.5
	3rd decade	+10.5	+17.2	+14.0	+21.7	+15.6	+12.3	+15.2
	Average monthly	+4.1	+12.7	+18.7	+22.8	+18.1	+12.3	+14.8
	Average multi-year	+4.9	+12.4	+17.1	+17.1	+16.8	+11.3	+13.3
Atmospheric precipitation, mm	1st decade	-	10.0	-	-	4.5	43.7	9.7
	2nd decade	-	5.5	13.5	20.5	3.5	18.3	10.2
	3rd decade	1.2	0.3	17.3	-	27.5	4.2	8.2
	total	1.2	15.8	30.8	20.5	35.5	66.2	28.1
	Average multi-year	18.7	34.1	46.0	46.0	44.1	25.6	32.6

plot was 15 m2, and the placement of plots was randomized. The preceding crop was black fallow.

The sowing method was wide-row, with a row spacing of 60-70 cm. The seeding rate of melilot seeds with the wide-row method was 3-5 kg/ha. 19 preparations were used in the treatment of plants: Control, Aminostim, Sancrop, BIO Energy, BIO Kraft, Bor premium, Isabion, Gumat 7B, Liquid effluent NPK (nitrogen, phosphorus, and potassium), Gumi NPK, BIO selitra, Krasny Yar organic fertilizer, Biohumus (Ildar), Fulvimax N, Start Up, Aiginamin (N), Humika, Enray vel, Gumato-Fosfat NK, and Boro+. The experimental plots underwent treatment twice during the growing season.

2.1. Regulations for the use of the preparations

BioEnergy is a complex liquid fertilizer that is quickly absorbed by the root hairs of plants, providing optimal digestibility, which guarantees balanced vegetative and generative development, increasing the overall metabolism in plants (Harnez.kz, 2021a).

Isabion is an organomineral fertilizer designed to increase yields due to better fruit setting rates and an increase in their size, improve the quality of marketable products and plant survival, the plant's ability to overcome various stresses, and better overwintering of perennial plants. Agrochemical group by chemical nature: a liquid organomineral fertilizer consisting of a mixture of amino acids and peptides (hydrolyzed protein) produced from leather production waste by alkaline hydrolysis followed by filtration and removal of insoluble calcium from the final product (Syngenta, 2023).

Gumat 7B is a liquid concentrated organomineral fertilizer with a set of macro- and microelements (a mixture of K and sodium salts of humic acids, Cu, Zn, Mn, Co Fe, B) (Rosselhozcentr, 2017).

Gumi NPK is a mineral fertilizer that is used to stimulate the growth of garden and vegetable crops. This complex belongs to humic preparations since up to 60% of its mass consists of sodium salts. The remaining 40% are traditional mineral fertilizers: N, P, and K with microelement additives. When developing this top dressing, the standard NPK complex was used as a basis, as it has been used in agriculture for decades (Udobreniya.info, 2023).

Bioselitra is a growth stimulant that eliminates N deficiency, with a set of microelements in chelated form with properties of increasing fruit formation and fungicidal action (Biomeliorant, 2023).

KazBioHumus is a vermicompost (biohumus) produced at the Sh. Ualikhanov Kokshetau University and adapted to local raw materials. Vermicomposting is performed using modular box technology using a population of Dendrobene Veneta worms. The finished fertilizers have been certified for compliance with State Standard (GOST) 56004-2014 (Protocol No. 270/1 dated 11.07.2021). Laboratory indicators of the total nitrogen content exceed the standard by 2 times and amount to 2.03%, 0.7% of total phosphorus P2O5, and 1.3% of total potassium K2O.

Fulvimax N is an organomineral fertilizer, with 40.8% organic substances and 3.4% N. It is an organic soil improver in liquid suspension, with 20% humic acid and 80% fulvic acids. It has an acidic character and a high ability to form and transfer other nutrients. The preparation can be applied separately or in a mixture with basic fertilizers or microelements, through leaf dressing, or by fertigation (Harnez.kz, 2021b).

Start Up is an organomineral fertilizer, which contains: 45% organic substances, 6% \N, and 24% C (Agro-Kazakhstan, 2023).

2.2. Experiment design

1. Control (without fertilizers)
2. Control (mineral fertilizer): ammonium phosphate
3. Organic fertilizer Aminostim (N+C)
4. Organic fertilizer Sancrop (NPK+microelements)
5. Organic fertilizer Bio Energy (N)
6. Organic fertilizer Bio Kraft (N)
7. Organic fertilizer Bor premium
8. Organic fertilizer Isabion
9. Organic fertilizer Gumat 7B
10. Organic fertilizer Liquid effluent (NPK)
11. Organic fertilizer Gumi (NPK)
12. BIO selitra
13. Organic fertilizer (Krasny Yar) in granules
14. Organic fertilizer KazBioHumus
15. Organic and mineral Fulvimax (N)
16. Organic and mineral Start Up (N)
17. Organic and mineral Aiginamin (N)
18. Biostimulant Humika (leaf dressing)
19. Biostimulant Enray vel (N+microelements)
20. Stimulant Gumato-Fosfat N and K (Gufos)
21. Boro + (top dressing before blossoming)

The analysis of the feed qualities of yellow melilot was carried out in the Akmola region, Zhaksyn district, by the accredited agrochemical laboratory AgroComplexExpert, accreditation number No. KZ.T.03.E1096: humidity, %: GOST 27548-97, ash, %: GOST 26226-95, protein, %: GOST 13496.4-2019, nitrates, mg/kg: GOST 13496.19-2015, nitrites, %: GOST 13496.19-2015, phosphorus, %: GOST 26657-97, calcium, %: GOST 26570-95, sugar, %: Standard of Kazakhstan (ST RK) 1564-2006, starch, %: ST RK 1564-2006, carotene, mg/kg: ST RK 1564-2006, feed units: ST RK 1564-2006.

Soil and agrochemical studies were conducted in the Akmola region, Shortandy district, by A.I. Baraev Research and Production Center for Grain Farming. Accreditation number No. KZ.T.03.1538: N-NO3, mg/kg: GOST 26205-91; P2O5, mg/kg: GOST 26205-91; K2O, mg/kg: GOST 26205-91; humus, %: GOST 26213-91; pHGOST 26423-85.

3. Results

According to the results of the study, it was determined that the sowing qualities of the Altynbas seeds were high, and the field germination of the bulk of the samples was in the range of 32.9 to 74.3% (Table 2).

In the control variant, field germination was 44.3%. The highest field germination, equal to 74.3%, was observed in the variant using the Krasny Yar organic fertilizer. The lowest field germination was noted in the variant with the use of KazBioHumus organic fertilizer (32.3%).

Table 2. The effect of various types of fertilizers and growth stimulants on the field germination of yellow melilot.

Item No.	Variant	Indicator	
		Number of plants, plants/sq.m.	Field germination, %
1	Control	62±4.43	44.3
2	Aminostim	92±3.13	65.7
3	Sancrop	64±4.62	45.7
4	BIO Energy	60±2.72	42.9
5	BIO Kraft	76±2.45	54.3
6	Bor Premium	67±1.53	47.9
7	Isabion	98±2.89	70.0
8	Gumat 7B	101±2.86	72.1
9	NPK effluent	74±4.44	52.9
10	Gumi NPK	74±2.66	52.9
11	BIO selitra	88±2.77	62.9
12	Organic fertilizer (Krasny Yar)	104±2.25	74.3
13	KazBioHumus	46±3.3	32.9
14	Fulvimax N	70±2.86	50.0
15	Start Up	80±3.33	57.1
16	Aiginamin (N)	102±2.69	72.9
17	Humika	101±1.84	72.1
18	Enray vel	86±2.16	61.4
19	Gumato-Fosfat N and K	82±1.67	58.6
20	Boro+	82±3.74	58.6
v, %			

According to the results presented in Figure 1, there was a positive correlation between the number of plants per linear meter and field germination; in those two indicators, the average r equaled 0.99. This means that the relationship is strong, that is, the greater the number of plants per linear meter, the higher the field germination in the studied variants.

The use of various types of fertilizers and growth stimulants for the growth and development of melilot plants affected the height of plants in the experimental variants. According to the results presented in Table 3, the height of the plants in the control variant during the budding phase was 11.7 cm. The maximum height of plants in the budding phase (26.3 cm) was observed when using the Fulvimax (N) organic and mineral fertilizer.

During the blossoming period, the height of the plants in the control variant was 30.7 cm. The maximum height of 40.0 cm was observed in the variant using the Fulvimax (N) organic and mineral fertilizer. The minimum height of the melilot plants in the blossoming phase (18.2 cm) was noted in the variant with the use of the organic fertilizer Gumi (NPK).

In terms of yield, the variants using Boro+ preparation and Gumi organic fertilizer (NPK) showed significantly bad results compared to the control variant. The highest yield of 451 c/ha was noted in the variant using the Fulvimax (N) organic and mineral fertilizer. In the variants using the Start Up organic and mineral fertilizer (N) and the Gumato-Fosfat N and K growth stimulant (Gufos), the yield was 335 and 330 c/ha, respectively (Figure 2).

According to the results of the study of the chemical composition of the feed mass of the melilot, it was determined that the humidity equaled the following: in the variant with the use of Aminostim preparations it was 6.9%, with Start Up 6.9%, with the use of organic fertilizer Krasny Yar 7.2%, and with Bor Premium 7.5% (Table 4).

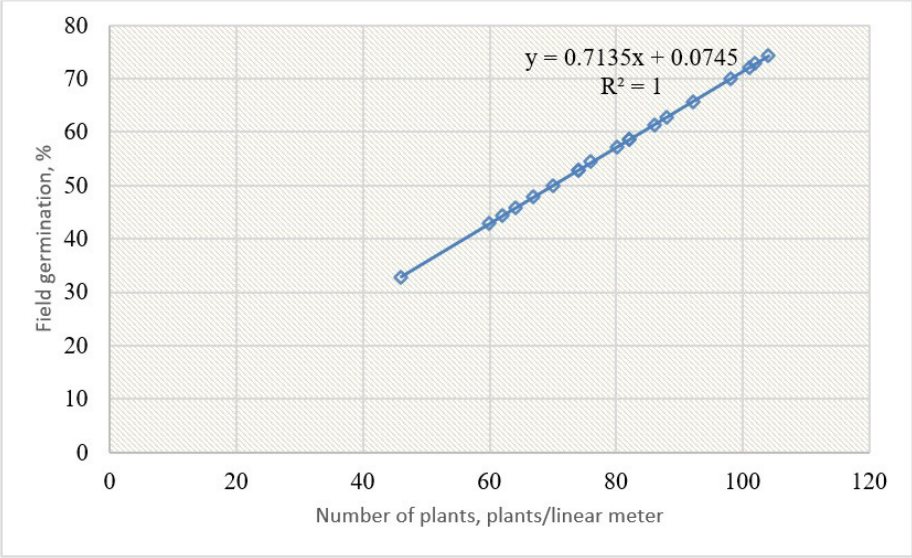

Figure 1. Correlation between the number of plants per linear meter and field germination. Note. LSD_{05} = 8.5; mean error m=2.8; experimental accuracy Sm%=1.59; difference error md=3.95.

Table 3. The effect of various types of fertilizers and growth stimulants on the yield and height of the yellow melilot.

Item No.	Variant	Height, cm		Yield, c/ha
		budding	blossoming	
		20.07.2023	13.08.2023	
1	Control	11.7	30.7	246
2	Aminostim	19.7	34.0	258
3	Sancrop	14.0	32.7	296
4	BIO Energy	15.7	24.3	290
5	BIO Kraft	21.0	27.7	258
6	Bor Premium	20.7	30.7	288
7	Isabion	18.3	30.0	294
8	Gumat 7B	22.3	31.7	328
9	NPK effluent	17.0	24.7	199
10	Gumi NPK	16.7	18.0	153
11	BIO selitra	19.7	34.7	305
12	Organic fertilizer (Krasny Yar)	18.3	31.7	199
13	KazBioHumus	12.7	32.7	242
14	Fulvimax N	26.3	40.0	451
15	Start Up	18.0	30.0	335
16	Aiginamin (N)	10.7	32.0	202
17	Humika	12.0	34.7	316
18	Enray vel	21.0	33.3	301
19	Gumato-Fosfat N and K	22.3	32.0	330
20	Boro+	16.3	27.0	167
Least Significant Difference, LSD_{05}, c/ha				8.5

Table 4. The effect of various types of fertilizers and growth stimulants on the feed qualities of yellow melilot.

Item No.	Variant	Name of quality indicators										
		Humidity, %	Ash, %	Protein, %	Nitrates, mg/kg	Nitrites, %	Phosphorus, %	Calcium, %	Sugar, %	Starch, %	Carotene, mg/kg	Feed unit
1	Control	5.2	12	25.6	2,188	14.2	1.5	2.8	2.08	2.15	18	0.49
2	Aminostim	6.9	11.6	26.9	2,314	43.3	1.5	5.9	1.44	1.48	20.4	0.49
3	Sancrop	6.6	12.7	29.4	2,455	14.5	1.3	1.3	2.68	2.3	18.9	0.53
4	BIO Energy	6.8	12.2	25.6	2,455	31.1	1.3	3.8	0.6	6.75	14.3	0.65
5	BIO Kraft	6.6	13.1	28.7	2,570	17.3	1.3	2.6	1.96	3.9	20.6	0.57
6	Bor Premium	7.5	12.4	26.2	1,698	17.2	1.3	5.7	1.58	2.01	19.4	0.64
7	Isabion	5.1	12.1	25.6	1,549	18.3	1.3	3.6	0.89	2.05	17.6	0.43
8	Gumat 7B	5.6	12.7	28.1	1,230	15.4	1.2	3.3	1.93	2.07	19.2	0.49
9	NPK effluent	5.7	10.1	25.6	2,314	49.4	1.3	3.2	1.08	3.65	18.9	0.57
10	Gumi NPK	5.8	12.3	28.1	1,122	17.8	1.3	7	1.95	2.47	19.6	0.51
11	BIO selitra	4.7	12.4	28.7	1,095	12.6	1.2	4.6	1.68	2.04	18.2	0.47
12	Organic fertilizer (Krasny Yar)	7.2	13.1	27.5	2,399	35.1	1	7.4	0.98	5.09	14.9	0.7
13	KazBioHumus	5.3	12.6	26.2	977	15.8	1.3	4.6	2.08	2	18.6	0.54
14	Fulvimax N	6.6	12	26.2	977	7.6	1.2	4.9	1.52	3.04	20.5	0.58
15	Start Up	6.9	12.5	25	2,087	18.4	1.2	1.5	1.8	3.2	20.4	0.53
16	Aiginamin (N)	6.7	12.6	28.1	2,089	18.1	1.4	1.5	2.06	4.1	20.6	0.52
17	Humika	5.4	12.8	25	1,230	13.1	1.3	4.6	0.73	3.2	19.7	0.46
18	Enray vel	5.0	13.5	25	1,288	32.4	1.4	5.4	0.83	2.9	18.6	0.52
19	Gumato-Fosfat N and K	6.6	10.8	31.8	2,754	12.2	1.2	5.3	1.45	1.7	20.3	0.5
20	Boro+	5.6	13.5	25	2,818	16.1	1.5	6.4	2.68	2.1	17.4	0.64

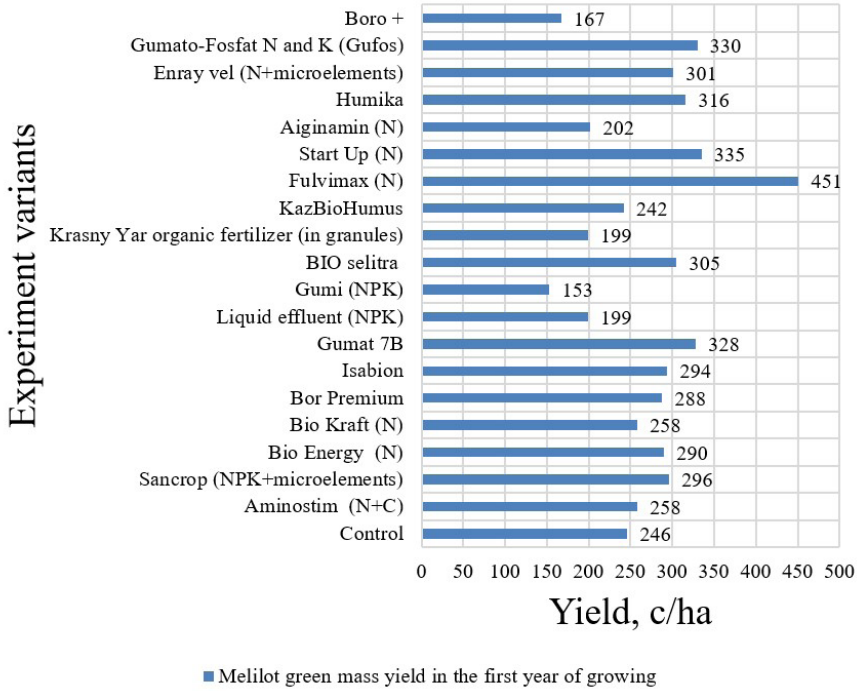

Figure 2. Yield of the green mass of the melilot of the first year of growing, 2023.

In terms of ash content, the highest indicator was observed in variants using BioKraft preparations (13.1%), Krasny Yar organic fertilizer (13.1%), Enray vel (13.5%), and Boro+ (13.5%).

The protein content in the variant using Gumato-Fosfat exceeded the control variant by 6.2%, in the variant with Sancrop by 3.8%, and with BIOselitra by 2.1%. The lowest protein index (25.0%) was observed in variants using the Start Up, Humika, Enray vel, and Boro+ preparations.

A high nitrate content was noted in variants using BIO Kraft (2,570 mg/kg), Gumato-Fosfat N and K (2,754 mg/kg), and Boro+ (2,818 mg/kg). A low nitrate index of 977 mg/kg was observed in variants using the preparations KazBioHumus and Fulvimax N.

The P content was at the level of the control variant and ranged from 1 to 1.5%.

In the variants using the organic fertilizer Krasny Yar, the calcium content exceeded the control variant by 2.6 times, which amounted to 7.4%. With the Effluent fertilizer, the liquid NPK calcium content was 7%. Variants using Boro+, Aminostim, BorPremium, Enray vel, and Gumato-Fosfat N and K also exceeded the control variant by 1.9-2.3 times. The lowest calcium content was shown by the variant with the use of Sancrop fertilizer (1.3%), the variants with the use of Start Up fertilizers (1.5%), and Aiginamin (N) (1.5%).

Sugar content indicators were higher in variants using Sancrop and Boro+ fertilizers. These variants exceeded the control variant and had a 2.68% sugar content. The sugar content in the variant using BIO Energy fertilizer was 3.5 times lower than in the control variant.

In terms of starch content, the studied variants of the experiment were at the same level as the control variant (2.15%). The variants with the use of BIO Kraft (6.75%) and organic fertilizer Krasny Yar (5.09%) had a higher starch content. The lowest starch content was shown by the variants with Aminostim and Gumato-Fosfat N and K.

In the control variant, the carotene content was 18.0 mg/kg. In variants using fertilizers Aminostim, Sancrop, BIO Kraft, Bor Premium, Gumat 7B, Liquid effluent NPK, Gumi NPK, BIO Selitra, KazBioHumus, Fulvimax N, Start Up, Aiginamin (N), Humika, Enray vel, Gumato-Fosfat N and K, this indicator was in the range of 18.2-20.6 mg/kg, and the other variants were below the control level.

The feed unit content in the control variant was 0.49. In the variant with the use of organic fertilizer Krasny Yar, the feed unit index was 0.7, which exceeded the control variant by 0.21 mg/kg.

According to the study results, the use of Bor Premium, Krasny Yar organic fertilizer, KazBioHumus, and Boro+ increased the content of N-NO3 by 2-3 times in comparison with the control variant. The content of P2O 5 and K2O in the variants with the use of fertilizers was lower than in the control variant. Humus in all variants was at the control level (Table 5).

The maximum concentration of mobile P was noted in the control variant. As a result of the application of fertilizers, a decrease in P content was observed. The minimum content of mobile P, equal to 1.4 mg/kg, which is 4.3 times lower than the control variant, was noted in variants using Boro+ and Krasny Yar organic fertilizer.

The maximum content of K2O was observed in the control variant. The variants with the use of fertilizers had a lower content compared to the control by 40-280 mg/kg. The minimum content of K2O (603 mg/kg) was noted in the variant using Boro+.

Table 5. The effect of various types of fertilizers and growth stimulants on soil composition, 2023.

No. of the item	Variant	$N\text{-}NO_3$ mg/kg	P_2O_5 mg/kg	K_2O mg/kg	Humus %	pH
		GOST	GOST	GOST	GOST	GOST
		26205-91	26205-91	26205-91	26213-91	26423-85
1	Control	6.9	6.0	883	4.75	7.90
2	Bor Premium	20.4	4.4	843	4.68	8.24
3	Organic fertilizer Krasny Yar	12.6	1.4	670	4.67	8.10
4	KazBioHumus	15.5	3.2	645	4.85	8.10
5	Boro+	15.6	1.4	603	4.28	7.66

In the variant with the use of KazBioHumus, the maximum humus content was noted (4.85%). The lowest humus content, amounting to 4.28%, was noted in the variant using Boro+ fertilizer, which is 0.47% lower than the control variant.

Organic fertilizers together can reduce the acidity of the soil. When applying organic and organic plus mineral fertilizers Bor Premium, organic fertilizer Krasny Yar, and KazBioHumus, the pH value increased from 7.9 to 8.24.

The use of Boro+ fertilizer reduced the pH value in comparison with the control variant by 0.24.

4. Discussion

In comparison with many crops, perennial legumes are characterized by a particularly low field seed germination, which, even with the most careful tillage, amounts to 30-50% (Chukhlebova, 1991; Tuturzhans, 2009; Chukhlebova et al., 2014; Bao et al., 2024).

In our studies, the use of fertilizers Bor Premium, Fulvimax N, Effluent NPK, Gumi NPK, BioKraft, Start Up, Gumato-Fosfat N and K, Boro+, Enray Vel, Bioselitra, Aminostim, Isobion, Humika, Gumat 7B, Aiginamin (N) and organic fertilizer Krasny Yar had a positive effect on productivity and the development of melilot.

Field germination in the control variant was 44.3%. The use of various fertilizers helped to increase the field germination of melilot plants. The difference with the control in the variants using Boron premium, Fulvimax N, Effluent NPK, Gumi NPK, BIOKraft, Start Up, Gumato-Fosfat N and K, Boro+, Enray Vel, BIOselitra, Aminostim, Isobion, Humika, Gumat 7B, Aiginamin (N) and organic fertilizer Krasny Yar was significant because it exceeds the value of LSD05 (2.18) (field germination in the range of 45.7-74.3%). Sancrop organic fertilizer did not provide a significant increase in field germination, and the difference compared to the control was 0.78, which is lower than the LSD. In the variants with the use of fertilizers KazBioHumus and BioEnergy, field germination was significantly lower than the control variant (32.9% and 42.9%, respectively).

The protein content in the variant treated with the growth stimulant Gumato-Fosfat showed the highest result and amounted to 31.8 g/1 kg of feed at natural humidity, exceeding the control sample by 6.3 g.

The samples treated with Aminostim, BIO Kraft, Bor Premium, Gumat 7B, Gumi NPK, Fulvimax N, Start Up, Aiginamin (N), Humika, and Gumato-Fosfat N and K exceeded the control sample by 1.2-2.6 mg/kg in carotene content.

The study of the nutritional composition of the control sample of melilot amounted to 0.49 feed units. In the variants with the use of Bor Premium, Boro+, and Bio Energy fertilizers, high nutrient content of the dry matter of the green mass of melilot was observed, amounting to 0.64-0.65 feed units.

The best yield of melilot (451.0 c of green mass/ha) was observed in the variant treated with organomineral fertilizer Fulvimax (N).

5. Conclusions

The samples of yellow melilot obtained with the use of various types of fertilizers and growth stimulants exceeded the control values in several indicators. In addition, the study showed that the use of fertilizers affected changes in the biochemical composition of the soil and, subsequently, the characteristics of growing species.

The results allow us to determine the positive effect of fertilizers and growth stimulants on feed qualities and productivity of the green mass of yellow melilot in the Akmola region. The fertilizers Fulvimax (N) and Start Up (N) and growth stimulants Gumato-Fosfat N and K (Gufos) contributed to an increase in the yield of the green mass of melilot from 330 to 451 c/ha. The difference in indicators when using the preparations indicates the importance of choosing the optimal fertilizers to improve agricultural results.

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