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THE EFFECT OF APPLICATION TIMING AND RATES OF BIOSTIMULANTS ON THE GROWTH AND DEVELOPMENT OF CROTALARIA

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Abstract
This article examines the impact of different application times and rates of biostimulants on the growth and development of Crotalaria juncea. The study was conducted in field conditions in Jizzakh region, assessing the plant height, number of leaves, branches, flowers, and pods throughout various phenological stages. The biostimulants “UzGumi” and “Geogumat” were applied at sowing and during specific vegetative phases, resulting in significantly improved growth parameters. “Geogumat” showed the most notable effects. The findings suggest that proper and timely use of biostimulants plays a crucial role in optimizing Crotalaria growth and yield potential.

Keywords: Crotalaria, biostimulant, growth, development, UzGumi, Geogumat, phenology, yield.

Introduction

Various factors such as soil, climate, fertilizers, and water influence plant growth and development. In addition, the timing and rates of biostimulant application were also studied in the experiments. On the experimental field, phenological observations were conducted on the first day of each month, and parameters such as plant height, lateral branches, productive branches, panicles, flowers, and pods were recorded.

According to the literature, Crotalaria is an upright-growing plant, with a height ranging from 1.5 to 3.0 meters, and in some regions, it has been reported to grow up to 4.0 meters. Under the soil and climatic conditions of the Khorezm region, when seeds were sown at a rate of 18 kg per hectare on May 1, the average height of a single plant reached up to 290.0 cm, which was 12–30 cm taller than in treatments with lower seeding rates. This provides a foundation for obtaining high yields when Crotalaria is cultivated for fodder or fiber purposes [1].

According to information obtained from the experiments of foreign scientists such as Maldonado-Peralta María et al. [2], it was found that the denser the planting, the taller the stem and the greater the number of leaves. When the density of Crotalaria reached 400,000 plants per hectare, the plant height on the 45th day of development was observed to be 186 cm.

Crotalaria is a fast-growing plant, and according to observational data, at the beginning of June (01.06), the plant height across different treatments ranged from 51.4 to 70.8

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cm. Among the variants treated with biostimulants, no significant differences were observed [3]. However, compared to the control, the variants treated with biostimulants showed an increase in plant height of 8.6 to 18.4 cm.

The effect of the timing and rates of biostimulant application on the dynamics of plant height growth is shown in Table 3.6.

One of the main characteristics of Crotalaria is that it continues to flower and form yield until the onset of cold weather. Since the grain harvest occurs at the end of October and the beginning of November, phenological observations were also carried out in October [4]. In October, the plant stem height ranged from 235.0 to 298.0 cm, with some plants exceeding 3.0 meters.

The highest results were observed in Variant 5, where UzGumi biostimulant was applied at a rate of 0.4 L/t at sowing, 0.7 L/ha during the 3–4 true leaf stage, and 0.8 L/ha during the panicle formation stage, reaching a height of 288 cm. In Variant 9, where Geohumat biostimulant was applied at 1.0 L/t at sowing and 1.8 L/ha during the 3–4 true leaf and panicle formation stages, plant height reached 298.0 cm.

Compared to UzGumi, the variants treated with Geohumat showed better results, with the highest value observed in Variant 9, where Geohumat was applied at 1.0 L/t at sowing and 1.8 L/ha during later growth stages. In this variant, the plant height exceeded the control by 63.0 cm; was 30 cm taller than Variant 6, where only Geohumat was applied at sowing; 15.0–7.0 cm taller than Variants 7–8, where Geohumat was used at rates of 1.4 and 1.6 L/ha; and 40 cm taller than Variant 2, where UzGumi was used only at sowing [5].

In the growth and development of the Crotalaria plant, productive branches also play a significant role. The increase in Crotalaria's productive branches was observed during the phenological observations in July. Crotalaria exhibits branching of four orders. If we take a single plant with a total height of 150 cm, the length of the first-order branch ranges from 60 to 120 cm, the second-order from 60 to 110 cm, the third-order from 35 to 40 cm, and the fourth-order from 15 to 20 cm [6].

Special attention was also given to determining the effect of the timing and rates of biostimulant application on the formation of productive branches. According to data obtained in early July, the number of productive branches per plant ranged from 4.0 to 8.0 depending on the treatment. Compared to the control, the variants treated with biostimulants showed an increase of 2 to 4 additional productive branches per plant.

According to the data obtained in September, each plant had between 9 to 16 productive branches. In the variants treated with UzGumi biostimulant, the number of branches ranged from 11 to 14. In Variant 4—where UzGumi was applied at a rate of 0.4 L/t during sowing, 0.5 L/ha during the 3-4 leaf stage, and 0.6 L/ha during the budding stage—up to 14 branches were recorded, which is 5 more than in the control. In Variant 8, where GeoGumat biostimulant was applied at 1.0 L/t during sowing and 1.6 L/ha during the 3-4 leaf and budding stages, the number of branches reached 16. [7]

In this variant, the number of productive branches was 7 more than in the control; 5 more than in Variant 2 (UzGumi applied only during sowing); 4 more than in Variant 6

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(GeoGumat applied only during sowing); and 3 more than in Variant 5 (GeoGumat applied at 0.4 L/t during sowing, 0.5 L/ha during 3-4 leaf stage, and 0.6 L/ha during budding).

Table 1 The Effect of Timing and Dosage of Biostimulant Application on the Growth and Development of Crotalaria, 2023

№	Name of biostimulants	Duration and norms of biostimulants			Plant height, cm					Number of leaves, pcs.				
		With sowing, l/t	During the period of 3-4 chinbarg, l/ha	During plowing, l/ha	1.06	1.07	1.08	1.09	1.10	1.06	1.07	1.08	1.09	1.10
1	Control	-	-	-	51,4	84,4	147,0	220,0	235,0	73,5	138,5	242,0	296,0	284,0
2	UzGumi	0,4	-	-	60,0	90,5	178,6	242,0	258,0	78,2	155,0	255,9	310,0	297,0
3	UzGumi	0,4	0,3	0,4	63,3	95,0	184,0	260,0	277,0	80,0	168,8	258,5	323,0	302,0
4	UzGumi	0,4	0,5	0,6	64,5	98,0	186,7	273,0	288,0	84,4	172,0	273,0	328,0	315,0
5	UzGumi	0,4	0,7	0,8	66,8	103,4	195,0	278,0	292,0	82,0	170,0	260,0	325,0	309,0
6	Geohumat	1,0	-	-	64,0	92,5	180,6	255,0	268,0	80,0	168,4	260,0	320,0	300,0
7	Geohumat	1,0	1,4	1,4	67,3	100,0	189,0	272,0	283,0	85,5	175,0	264,6	325,0	313,0
8	Geohumat	1,0	1,6	1,6	66,5	108,0	195,7	280,0	291,0	92,0	186,5	285,0	336,0	322,0
9	Geohumat	1,0	1,8	1,8	70,8	110,4	202,0	286,0	298,0	80,0	178,0	270,0	331,0	317,0

Table 1 The Effect of Timing and Dosage of Biostimulant Application on the Growth and Development of Crotalaria, 2023

№	Name of biostimulants	Duration and norms of biostimulants			Number of branches, pcs.			Number of combs, pcs.			Number of flowers, pcs.		
		With sowing, l/t	During the period of 3-4 chinbarg, l/ha	During plowing, l/ha	1.07	1.08	1.09	1.06	1.07	1.08	1.06	1.07	1.08
1	Control	-	-	-	4	6	9	11,0	26,0	23,0	7,0	26,7	28,0
2	UzGumi	0,4	-	-	6	8	11	14,0	31,0	28,0	10,0	33,0	35,0
3	UzGumi	0,4	0,3	0,4	7	10	13	15,0	33,0	30,0	13,0	36,0	38,0
4	UzGumi	0,4	0,5	0,6	7	11	14	19,0	35,0	32,0	17,0	38,0	41,0
5	UzGumi	0,4	0,7	0,8	7	10	13	17,0	32,0	30,0	15,0	35,0	40,0
6	Geohumat	1,0	-	-	6	9	12	15,0	27,7	25,0	12,0	28,7	35,0
7	Geohumat	1,0	1,4	1,4	7	11	14	18,0	32,5	30,0	16,0	35,5	39,0
8	Geohumat	1,0	1,6	1,6	8	12	16	21,0	37,0	34,0	19,0	40,0	44,0
9	Geohumat	1,0	1,8	1,8	7	11	15	19,0	34,0	32,0	17,0	36,0	42,0

In early June, panicles (flowering structures) started to appear in 13–15% of plants. Some plants developed up to 11–21 panicles, and by early July, the number of panicles ranged from 26 to 37 depending on the variant. It was observed that the variants treated

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with biostimulants produced 10–15 more panicles than the control. [8] Across all phenological observations, the best results were found in the variants where biostimulants were applied both during sowing and at the 3-4 leaf and budding stages.

It is known that the flowering stage is the most biologically mature phase of a plant. If there are sufficient nutrients and moisture in the soil, this process proceeds steadily, and the number of reproductive organs increases. However, not all flowers on a plant are pollinated evenly. Some of the pollinated reproductive organs may be shed due to a lack of nutrients and moisture. [9] It is important to note that the plant's ability to retain and accumulate yield directly depends on sowing time and rate, the amount of fertilizer applied, and other factors.

In Crotalaria species, the simultaneous appearance of inflorescences, flowers, and pods, as well as the shedding of seed husks, has been observed. The flowers of this plant are very attractive and continue blooming until the end of the vegetation period. Additionally, the flowers serve as a source of nectar for bees.

The number of flowers produced by Crotalaria is influenced by various factors, including the timing and dosage of biostimulant applications. According to phenological observations conducted in August, the phases of inflorescence formation, flowering, and pod development occurred concurrently. Depending on the treatment, each plant produced between 28.0 and 44.0 flowers, with 7 to 16 more flowers observed in biostimulant-treated variants compared to the control. The highest number of flowers, corresponding to the number of inflorescences, was recorded in variants where biostimulants were applied not only at sowing but also during the 3–4 leaf stage and the inflorescence phase.

Therefore, under the conditions of meadow gray soils of the Jizzakh region, optimal growth, development, and enhanced formation of yield components in Crotalaria can be achieved by sowing at a rate of 14 kg/ha in the last ten days of April, and applying GeoHumate biostimulant at 1.0 L/t during sowing and at 1.6 L/ha during the 3–4 leaf and inflorescence stages. This approach provides favorable conditions for obtaining a high grain yield.

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