THE INFLUENCE OF SOWING DATES, SEEDING RATES AND STIMULANTS ON THE DEVELOPMENT OF MUNG BEAN VARIETIES

G.B. Khalimova
Independent Applicant of the Research Institute of Paperwork, Lecturer at the Department of Energy and Environmental Protection of the Yangiyer branch of the Tashkent Institute of Chemical Technology
https://doi.org/10.5281/zenodo.20080592

Abstract. *With an increase in plant density, differences were observed: at the first true leaf stage +7.20%, budding +3.38%, flowering +3.54%, pod formation +2.12%, and maturation +0.71%. At the seeding rate in the 8th variant (400 thousand seeds/ha, Potex 2.5/5.0 L/ha), under the highest density, the indicator at the first true leaf stage did not change, while it increased at budding by +3.15%, flowering by +2.28%, pod formation by +4.63%, and maturation by +1.28%. It was determined that when sowing on July 15, the effect of the biostimulator was most pronounced during the leaf formation and budding stages. An increase in plant density led to a rise in accumulated temperature during the budding and flowering periods.*

Keywords: *population, stress, protein, iron, mung bean, leguminous crops, sowing time, seeding rate, growth dynamics, plant, temperature, yield, photosynthesis, nodules, bacteria.*

Introduction. In the world, the area under mung bean is approximately 7.3 million hectares, and the total production reaches about 5.3 million tons. The main share is accounted for by India and Myanmar - about 30%, China provides 16%, Indonesia - 5%. Mung bean has significant potential for providing nutrition to the population in the future, as it is resistant to heat and dry stress, and its grain is a good source of protein and iron for human nutrition.

According to Kh.N. Ataboeva, mung bean belongs to the genus *Phaseolus* and makes up the bulk of Asian legumes. Some legumes originate from South America - these include common beans, multiflorum, lima and tepari. The other part is typical for Asia, which includes mung beans (*Phaseolus aureus L.*), adzuki (*Phaseolus angularis Wilch*) and rice beans (*Phaseolus calcaratus Piper*). According to historical data, mung bean has been cultivated in agriculture for 5-6 thousand years and is considered a valuable food crop [1; p. 134-137].

According to D. Yormatova, the homeland of mung bean is considered to be Southwest Asia. At present, this crop is widely cultivated in many countries of the world - in India, Afghanistan, Iran, Pakistan, Burma, Japan, China, Vietnam, Uzbekistan, Turkmenistan, Tajikistan, as well as in the CIS countries [3; pp. 100-102].

According to D. Yormatova, there are different views on the origin of mung bean: some researchers believe that it, like other leguminous crops, originated from plants of the mimosa family [2; pp. 138-242].

Mung bean is an annual plant of the legume family, geographically and morphologically divided into three subspecies: s. sp. indicus - thin-handed, bean length 7 cm, weight of 1000 grains 15-30 g; medium- and late-ripening, mainly distributed in India, the stem is erect, suitable for harvesting with a combine, s. sp. chinensis - large-legged, bean length 9-17 cm, seeds are large; early-ripening, mainly distributed in China and the Far East, valuable form, s. sp. Iranicus - length

of beans 7-8 cm, weight of 1000 grains 35-38 g; medium-ripening, widespread in Central Asia, Afghanistan and Iran, the stem is creeping [4; p. 35].

Materials and Methods

The experiment was conducted in 2022–2024 to study the influence of sowing dates, seeding rates, and the Potex biostimulant on the development of mung bean varieties. The research objects were the Mahsuldor and Durdona mung bean varieties. The experiment included two sowing dates: June 30 and July 15. Seeding rates were 230, 300, and 400 thousand seeds per hectare. The Potex biostimulant was applied at the rates of 1.5/3.5, 2.0/4.0, and 2.5/5.0 L/ha. The main phenological phases studied were first true leaf formation, budding, flowering, bean formation, and ripening. The duration of interphase periods and the sum of effective temperatures during the growing season were analyzed.

Results

In 2022, the Mahsuldor and Durdona mung bean varieties were studied in the dynamics of the development phases. According to the data obtained, in the Mahsuldor variety, with a sowing date of June 30 and a seeding rate of 230 thousand / ha (1st version), the first true leaf appeared on July 13, the budding phase began on July 24, flowering - on August 17, bean formation - on August 25, ripening - on September 25. In the 2nd variant (230 thousand hectares), the first true leaf appeared on July 12, budding on July 23, flowering on August 16, bean formation on August 24, ripening on September 22. In the 3rd option, at a rate of 300 thousand per hectare, the first true leaf was observed on July 12, budding - on July 24, flowering - on August 15, bean formation - on August 23, ripening - on September 19. In the 4th variant, at a rate of 400 thousand per hectare, the first true leaf appeared on July 12, budding on July 25, flowering on August 14, bean formation on August 22, ripening on September 18.

Table 1

Timing of the development phases of the Mung Mahsuldor variety in 2022.

T/r	Sowing date	Seeding rate, thousand pieces/ha	Developmental phase				
			1 sheet	Butoni Promotion	Color In this case, the	Bobo Obrazo The First Edition of the	Mature The First Edition of the
1	30 Jun	**230**	13.VII	24.VII	17.VIII	25.VIII	25.IX
2		**230**	12.VII	23.VII	16.VIII	24.VIII	22.IX
3		**300**	12.VII	24.VII	15.VIII	23.VIII	19.IX
4		**400**	12.VII	25.VII	14.VIII	22.VIII	18.IX
5	15 Jul	**230**	24.VII	05.VIII	28.VIII	07.IX	14.X
6		**230**	24.VII	05.VIII	26.VIII	05.IX	11.X
7		**300**	25.VII	06.VIII	25.VIII	04.IX	09.X
8		**400**	26.VII	07.VIII	24.VIII	03.IX	06.X

With a sowing date of July 15, in variant 5 with a seeding rate of 230 thousand/ha, the first true leaf appeared on July 24, the budding phase began on August 5, flowering on August 28, bean formation on September 7, ripening on October 14. In variant 6 (230 thousand/ha), the first true leaf also appeared on July 24, budding on August 5, flowering on August 26, bean formation on

September 5, ripening - October 11. In variant 7, at a rate of 300 thousand per hectare, the first true leaf was observed on July 25, budding on August 6, flowering on August 25, bean formation on September 4, ripening on October 9. In variant 8, at a rate of 400 thousand per hectare, the first true leaf appeared on July 26, budding - on August 7, flowering - on August 24, bean formation - on September 3, ripening - on October 6. At a later sowing date, there was a slowdown in the onset of developmental phases, including leaf formation and other growth stages. For example, when sowing on July 15 in the variant with a norm of 230 thousand / ha, the first true leaf appeared on July 24, while when sowing on June 30 - already on July 12-13. An increase in the seeding rate slightly accelerated the onset of the phases of leaf formation and flowering, but the total difference did not exceed 1-2 days. The ripening period significantly depended on the sowing date: with later sowing, the vegetation period increased by 7-9 days. The results obtained show that the development of the Mahsuldor variety is closely related to local climatic conditions and sowing dates.

Based on the results of the analysis of the timing of the development phases of the Durdona variety in 2022, the following was established. With a sowing date of June 30 and a seeding rate of 230 thousand per hectare (1st version), the first true leaf appeared on July 14, the budding phase began on July 25, flowering on August 21, bean formation on August 30, ripening on September 29. In the 2nd variant (230 thousand hectares), the first true leaf appeared on July 13, budding on July 24, flowering on August 21, bean formation on August 29, ripening on September 27. In the 3rd variant, at a rate of 300 thousand per hectare, the first true leaf was observed on July 13, budding - on July 24, flowering - on August 20, bean formation - on August 28, ripening - on September 24. In the 4th variant, at a rate of 400 thousand per hectare, the first true leaf appeared on July 14, budding - on July 25, flowering - on August 19, bean formation - on August 27, ripening - on September 23.

When sowing on July 15, the phases of development of the Durdona variety, depending on the seeding rate, lagged behind somewhat. 230 thousand hectares/ha, 5th option: 1st true leaf - July 26, budding - August 6, flowering - September 1, beaver formation - September 11, ripening - October 20. 230 thousand hectares/ha, 6th option: 1st true leaf - July 27, budding - August 5, flowering - August 31, beaver formation - September 10, ripening - October 18. 300 thousand hectares/ha, 7th option: 1st true leaf - July 27, budding - August 6, flowering - August 30, beaver formation - September 9, ripening - October 16. 400 thousand hectares/ha, 8th option: 1st true leaf - July 27, budding - August 8, flowering - August 28, beaver formation - September 8, ripening - October 14. When sown on June 30, leaf formation and flowering were observed from July 13-14 to August 19-21. When sown on July 15, leaf formation was observed on July 26-27, flowering and bean formation were delayed by 1-2 days, and ripening was completed in mid-October. These data show that at later sowing dates, the growth phases are somewhat delayed, but the sequence of development remains stable.

The duration of the interphase periods of the Durdona variety in 2022 was analyzed depending on the sowing dates, seeding rate and the use of the Potex biostimulant. 1st variant (control, 230 thousand per hectare): 1st true leaf - 13 days, budding - 24 days, flowering - 48 days, bean formation - 56 days, ripening - 87 days. The growing season remained longer. 2nd option (230 thsd/ha + Potex 1.5+3.5 l/ha): ripening - 84 days, 3 days earlier compared to the control. The biostimulant accelerated the passage of the phases. 3rd option (300 thousand/ha + Potex 2.0+4.0 l/ha): ripening - 81 days, 6 days earlier than the control. Increased density and the use of a stimulant accelerated development. 4th option (400 thousand/ha + Potex 2.5+5.0 l/ha): ripening - 80 days, 7

days earlier than the control. The high density accelerated the passage of phases, but the physiological load on the plants increased.

Table 1

Timing of the development phases of the mung bean variety "Durdona", days (2022).

№	Sowing dates	Seeding rate, thousand pieces/ha	Phases of development				
			First page	Butoni Promotion	Flowering	First page	Ripening
1	June 30	**230**	14,VII	25,VII	21,VIII	30,VIII	29,IX
2		**230**	13,VII	24,VII	21,VIII	29,VIII	27,IX
3		**300**	13,VII	24,VII	20,VIII	28,VIII	24,IX
4		**400**	14,VII	25,VII	19,VIII	27,VIII	23,IX
5	July 15	**230**	26,VII	06,VIII	01,IX	11,IX	20,X
6		**230**	27,VII	05,VIII	31,VIII	10,IX	18,X
7		**300**	27,VII	06,VIII	30,VIII	09,IX	16,X
8		**400**	27,VII	08,VIII	28,VIII	08,IX	14,X

According to the experiments (June 30), with an increase in the rate of "Potex" and the sowing density, the development phases decreased, and ripening occurred 3-7 days earlier. At the sowing date of July 15, the 5th option (control, 230 thousand / ha): ripening - 91 days. In conditions of late sowing, due to changes in temperature and day length, the growing season was longer. 6th option (230 thousand/ha + Potex 1.5+3.5 l/ha): ripening - 88 days, 3 days earlier than the control. 7th option (300 thousand/ha + Potex 2.0+4.0 l/ha): ripening - 86 days, 5 days before the control. Option 8 (400 thsd/ha + Potex 2.5+5.0 l/ha): ripening - 83 days, 8 days before the control. Thus, (July 15), with an increase in the rate of biostimulant and sowing density, the phases of development were more intensive, and ripening occurred 3-8 days earlier.

The use of the biostimulant "Potex" activated the metabolism in plants, which led to a faster passage of phenological phases. With the increase in the seeding rate, competition between plants intensified, as a result of which the development processes were reduced. The ripening phase at the sowing date of June 30 varied within 80-87 days, and at sowing on July 15 - 83-91 days. The earliest ripening was observed when sowing on June 30 in the variant with a density of 400 thousand plants/ha and the use of "Potex" at a dose of 2.5 + 5.0 l/ha (80 days), and when sowing on July 15 - in the same variant (83 days).

According to the scientific analysis of the interphase duration of the mung bean variety "Durdona" (2022), with a sowing date of June 30 in the 1st option (control, 230 thousand plants/ha), the following was noted: 1st true leaf - 14 days, budding - 25 days, flowering - 52 days, beaver formation - 61 days, ripening - 91 days. In the control variant, the phenological phases proceeded naturally, and the vegetation period remained relatively longer. 2nd option (230 thousand/ha + Potex 1.5 + 3.5 l/ha): ripening - 89 days, 2 days earlier compared to the control.

Table 3

Interphase duration of the productive mung bean variety, 2022, days.

№	Sowing dates	Elevation rate, thousand pieces/ha	Phases of development				
			First page	Budding	Flowering	Bean formation	Ripening

1	June 30	230	13	24	48	56	87
2		230	12	23	47	55	84
3		300	12	24	46	54	81
4		400	12	25	45	53	80
5	July 15	230	9	21	44	54	91
6		230	9	21	42	52	88
7		300	10	22	41	51	86
8		400	11	23	40	50	83

According to the scientific analysis of the interphase duration of the mung bean variety "Durdona" (2022), with a sowing date of June 30 in the 1st option (control, 230 thousand plants/ha), the following was noted: 1st true leaf - 14 days, budding - 25 days, flowering - 52 days, beaver formation - 61 days, ripening - 91 days. In the control variant, the phenological phases proceeded naturally, and the vegetation period remained relatively longer. 2nd option (230 thousand/ha + Potex 1.5 + 3.5 l/ha): ripening - 89 days, 2 days earlier compared to the control. The use of a biostimulant activated physiological processes and led to a reduction in phases. 3rd option (300 thousand/ha + Potex 2.0+4.0 l/ha): ripening - 86 days, 5 days before the control. The combined effect of seeding density and the stimulant contributed to the acceleration of the rate of development. 4th option (400 thousand / ha + Potex 2.5 + 5.0 l / ha): ripening - 85 days, 6 days before the control. In conditions of increased density, plants under the influence of competition completed their development faster. In general, at the sowing date of June 30, with an increase in the Potex rate and sowing density, the development phases were more intensive, and ripening occurred 2-6 days earlier.

With the sowing date of July 15 in the 5th variant (control, 230 thousand plants/ha), the following was noted: 1st true leaf - 11 days, budding - 22 days, flowering - 48 days, beaver formation - 58 days, ripening - 97 days. With late sowing, under the influence of environmental factors (temperature, day length), the growing season was lengthened. 6th option (230 thousand/ha + Potex 1.5+3.5 l/ha): ripening - 95 days, 2 days earlier than the control. 7th option (300 thousand/ha + Potex 2.0+4.0 l/ha): ripening - 93 days, 4 days earlier than the control. 8th option (400 thsd/ha + Potex 2.5+5.0 l/ha): ripening - 91 days, 6 days before the control. In general, at the sowing date of July 15, with an increase in the rate of biostimulant and sowing density, phenological phases accelerated, and mung bean ripening decreased by 2-6 days.

Table 4

Interphase duration of mung bean variety "Durdona", 2022, days

№	**Sowing dates**	**Seeding rate, thousand pieces/ha**	**Phases of development**				
			First page	**Butoni Promotion**	**Flowering**	**Bobo Education**	**Ripening**
1	June 30	**230**	14	25	52	61	91
2		**230**	13	24	52	60	89
3		**300**	13	24	51	59	86
4		**400**	14	25	50	58	85
5	July 15	**230**	11	22	48	58	97

6		**230**	12	21	47	57	95
7		**300**	12	22	46	56	93
8		**400**	12	24	44	55	91

Discussion

The Potex biostimulant activated enzymatic and physiological processes in plants, contributing to the accelerated passage of phenological phases. With an increase in the seeding rate from 230 thousand to 400 thousand plants/ha, competition between plants intensified, which led to an acceleration of the rate of development. The ripening period for sowing on June 30 varied within 85-91 days, and for sowing on July 15 - 91-97 days. The earliest ripening was observed when sowing on June 30 in the variant of 400 thousand plants/ha + Potex 2.5 + 5.0 l/ha (85 days), and when sowing on July 15 - in the same variant (91 days).

According to the results of experiments conducted in 2022 on the Durdona mung bean variety, seeding rates and the use of the Potex biostimulant had a significant impact on the passage of development phases. With an increase in the dose of the biostimulant and the sowing density, the phenological phases were more intensive, and the ripening period at the sowing dates of June 30 and July 15 came 2-6 days earlier. This effect is explained by the activation of physiological processes in plants and the improvement of their adaptation to environmental factors.

The duration of the reduction phases in the varieties "Mahsuldor" and "Durdona" depends on factors such as temperature, sowing density, application of a biostimulant, humidity and plant nutrition conditions. For the "Mahsuldor" variety at the sowing date of June 30 (2022-2024 data), the total temperatures by phases were as follows:1st variant (230 thousand/ha, without stimulant): first true leaf - 255°C, budding - 430°C, flowering - 1115°C, beaver formation - 1185°C, ripening - 1350°C. 2nd variant (230 thousand/ha + Potex 1.5/3.5 l/ha): compared to the control, there was an increase of +0.42-2.33% in all phases, which indicates the effect of the biostimulant. 3rd option (300 thsd/ha + Potex 2.0/4.0 l/ha): the increase was +3.11% in the first leaf phase, +4.55% in budding, +1.34% in flowering, +1.68% in beaver formation and +1.84% in ripening; The greatest effect is noted in the phases of budding and ripening. 4th variant (400 thsd/ha + Potex 2.5/5.0 l/ha): at the maximum density and dose of the stimulant, the total temperatures increased in all phases: +5.28% (first leaf), +4.35% (budding), +3.54% (flowering), +2.07% (beaver formation), +5.42% (ripening); The maximum effect is also noted in budding and ripening. Thus, when sowing on June 30, the biostimulant and high seeding density increased the total temperatures in all phases, especially during the budding and ripening stages. At the sowing date of July 15 for the "Mahsuldor" variety, the temperature sums and the influence of the biostimulant and sowing density were distributed as follows. 5th variant (230 ths./ha, without stimulant): first true leaf - 260°C, budding - 495°C, flowering - 1105°C, beaver formation - 1155°C, ripening - 1310°C; This option is the base for the July sowing period.

Option 6 (230 thsd/ha + Potex 1.5/3.5 l/ha): increased by +0.43-3.46% by phase; The effect was weaker than in June sowing due to less favorable climatic conditions. 7th option (300 thsd/ha + Potex 2.0/4.0 l/ha): the increase was +7.43% (first leaf), +3.0% (budding), +2.23% (flowering), +2.16% (beaver formation), +0.76% (ripening); The sowing density had a noticeable effect on the temperature amounts. 8th variant (400 thsd/ha + Potex 2.5/5.0 l/ha): no changes were observed at the stage of the first leaf, then +2.91% (budding), +2.18% (flowering), +2.11% (beaver formation), +0.75% (ripening); High density in combination with a biostimulant provided a moderate increase in temperature amounts.

5-Grim

Sum of effective temperatures (average for 2022-2024) during the growing season of mung bean variety "Mahsuldor", °C.

№	Sowing dates	Seeding rate, thousand pieces/ha	Phases of development				
			First page	Butoni Promotion	Flowering	First page	Ripening
1	June 30	230	255,0	430,0	1115,0	1185,0	1350,0
2		230	257,0	440,0	1120,0	1190,0	1360,0
3		300	265,0	460,0	1135,0	1210,0	1385,0
4		400	279,0	480,0	1175,0	1235,0	1460,0
5	July 15	230	260,0	495,0	1105,0	1155,0	1310,0
6		230	269,0	500,0	1120,0	1160,0	1320,0
7		300	289,0	515,0	1145,0	1185,0	1330,0
8		400	289,0	530,0	1170,0	1210,0	1340,0

Since the sowing date was in July, even with a high sowing density, the total temperature did not increase significantly. When sowing on July 15, the effect of the biostimulant manifested itself mainly in the ripening phase, where the effect was minimal (+0.7%). An increase in sowing density increased the total temperature at the stages of budding and flowering, but due to the climatic conditions of July, the maximum values were lower compared to the June sowing date.

When studying the sum of effective temperatures in the growing season of the mung bean variety "Durdona" (in the context of 2022-2024), it was found that at the sowing date of June 30 in variant 1 (230 thousand seeds/ha, without the use of a stimulant), the total temperatures were: at the phase of the first true leaf - 255.7°C, budding - 433.2°C, flowering - 1148.1°C, beaver formation - 1238.6°C, ripening - 1421.3°C.

With a seeding rate of 230 thousand seeds/ha in the 2nd variant (Potex 1.5/3.5 l/ha), the use of a biostimulant led to an increase in the sum of effective temperatures compared to the control: at the phase of the first true leaf by +0.66%, budding by +2.68%, flowering by +0.15%, beaver formation by +0.44%, ripening by +0.88%. This impact contributed to the acceleration of growth and development processes in all phases. With an increase in the seeding rate to 300 thousand plants/ha in the 3rd option (Potex 2.0/4.0 l/ha), a further increase in the sum of temperatures was observed due to the thickening of crops: at the phase of the first true leaf +3.20%, budding +4.18%, flowering +1.24%, beaver formation +2.13%, ripening +1.88%. The greatest increase was noted at the stages of budding and ripening. In the 4th variant (400 thousand plants/ha + Potex 2.5/5.0 l/ha), at the maximum density and the use of a biostimulant, the largest increase in the sum of effective temperatures was observed: at the phase of the first true leaf +5.17%, budding +4.11%, flowering +3.50%, beaver formation +4.53%, ripening +4.83%. Thus, the combined effect of seed thickening and the biostimulant "Potex" provided the most pronounced increase in total temperatures and contributed to more intensive growth and development of plants.

At the sowing date of July 15, the accumulation of effective temperatures for the control variant (5th option, 230 thousand seeds/ha, without the use of a stimulant) was: the first true leaf - 260.1°C, budding - 500.8°C, flowering - 1132.4°C, beaver formation - 1194.0°C, ripening - 1367.7°C. In the 6th variant (230 thousand/ha + Potex 1.5/3.5 l/ha), the use of a biostimulant

provided an increase in total temperatures compared to the control: at the phase of the first true leaf by +3.55%, budding +0.78%, flowering +1.40%, bean formation +0.42%, ripening +0.76%. The most pronounced effect was observed in the early phases (leaf formation and budding), while at the ripening stage the effect was less significant. In the 7th variant (300 thousand/ha + Potex 2.0/4.0 l/ha), the increase in sowing density had a noticeable effect on the sum of temperatures: the first true leaf +7.20%, budding +3.38%, flowering +3.54%, beaver formation +2.12%, ripening +0.71%. In the 8th variant (400 thousand/ha + Potex 2.5/5.0 l/ha) at the maximum density and dose of the biostimulant, the following increase was observed: at the stage of the first true leaf, no changes were noted, budding +3.15%, flowering +2.28%, beaver formation +4.63%, ripening +1.28%.

Table 6

Sum of effective temperatures during the growing season of mung bean variety "Durdona" (average for 2022-2024), °C.

№	Sowing dates	Seeding rate, thousand pieces/ha	Phases of development				
			First page	Budding	Flowering	First page	Ripening
1	June 30	**230**	255,7	433,2	1148,1	1238,6	1421,3
2		**230**	257,4	445,0	1149,8	1244,1	1433,7
3		**300**	265,3	463,9	1163,8	1270,8	1460,7
4		**400**	278,8	483,1	1204,0	1295,2	1531,8
5	July 15	**230**	260,1	500,8	1132,4	1194,0	1367,7
6		**230**	269,4	504,7	1148,1	1199,1	1378,2
7		**300**	289,0	521,7	1173,1	1224,8	1387,4
8		**400**	289,0	538,4	1199,1	1251,0	1393,4

Conclusion

Thus, when sowing on July 15, it was found that the effect of the biostimulant is most pronounced in the early phases of development (leaf formation and budding), and an increase in sowing density enhances heat accumulation mainly in the phases of budding and flowering.

REFERENCES.

1. Bakhromov S., Bakhromov Sh. Influence of repeated (intermediate) crops on cotton yield. In: Proceedings of the Scientific and Practical Conference "Sources and Water-Saving Technologies for Obtaining High Yields in the Farming System". Tashkent, 2010. Pp. 125-127.
2. Yormatova D. Plant Production. Textbook. - Tashkent. East. 2002. Pp. 138-242.
3. Yormatova D. Technology of Plant Products Production. Textbook. - Tashkent: Ilm-Ziyo, 2010. Pp. 100-102.
4. Bitocchi E., Nani L., Bellucci E., Rossi M., Giardini A., Spagnoletti Zeuli P., Logozzo G., Stougaard J., McClean P., Attene G., and Papa R. 2012. Mesoamerican pp-35.