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Effect of plant growth regulators on yield of Wal (*Lablab purpureus* (L.) Sweet)

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Abstract
A field trial was carried out during the Rabi season of 2024-25 at the Education and Research Farm, Department of Agricultural Botany, College of Agriculture, Dapoli, Tal-Dapoli, Dist. Ratnagiri, to study the influence of plant growth regulators on the yield and yield attributes of lablab bean. The experiment included 14 treatments: T_1-GA_3 20 ppm, T_2-GA_3 30 ppm, T_3-GA_3 40 ppm, T_4-GA_3 50 ppm, T_5-NAA 20 ppm, T_6-NAA 30 ppm, T_7-NAA 40 ppm, T_8-NAA 50 ppm, T_9-Cycocel 50 ppm, T_{10}-Cycocel 100 ppm, T_{11}-Cycocel 200 ppm, T_{12}-Cycocel 300 ppm, T_{13}-Control (water spray), and T_{14}-Absolute control. Treatments were arranged in a Randomized Block Design with two replications. Among all treatments, GA_3 at 40 ppm (T_3) produced the maximum grain yield per plant (11.14 g) and per hectare (1237.63 kg), along with the greatest pod length, number of pods per plant, and number of seeds per pod. This treatment also recorded higher protein content. On the other hand, the absolute control (T_{14}) showed the lowest performance across all traits. The findings indicate that GA_3 at 40 ppm is the most effective treatment for enhancing growth, yield, and quality of lablab bean.

Keywords: Lablab bean, PGR, GA_3, NAA, Cycocel

Introduction

Lablab bean (*Lablab purpureus* (L.) Sweet), also known as Dolichos bean, Hyacinth bean, Bonavist (sem), Chicharas, Chink, Pavta, Kadva, Auri, Field bean, Sem, Indian bean, and Country bean, is an important pulse crop cultivated across India. In Maharashtra, it is commonly referred to as *Wal*. The crop is highly versatile—its tender pods and immature seeds are consumed as vegetables, while the dry seeds are used in various food preparations. Additionally, it serves as a source of fodder, hay, silage, green manure, and a cover crop. Lablab bean is believed to have dual centers of origin in Asia and Africa. Cytologically, it has 2n = 2x = 22 chromosomes and belongs to the family *Leguminosae*. Verdcourt (1981) [18] reclassified the species into the genus *Lablab*, designating it as *Lablab purpureus* (L.), with synonyms including *Dolichos lablab*, *Dolichos purpureus*, *Lablab niger*, and *Lablab vulgaris*, a classification now widely accepted.

The crop is adaptable to diverse agro-climatic conditions, including arid, semi-arid, humid, and subtropical regions, with an optimal temperature range of 22 °C-35 °C and soil pH between 4.4-7.8 (Kimani *et al*., 2012) [9]. Being a legume, it has the ability to fix atmospheric nitrogen, thereby enriching soil fertility. Lablab bean grows well in soils ranging from sandy to clayey textures, tolerates acidity better than most legumes, but performs poorly in saline or waterlogged soils. It can thrive in areas receiving annual rainfall between 25-120 mm and tolerates both drought and shade (Cook *et al*., 2005) [2].

Nutritionally, *Wal* is highly valuable. Its pods and seeds are rich in protein (20-28%) (Khan *et al*., 2005) [8]. Green pods contain about 3.8% protein, 86.1% moisture, 6.7% carbohydrates, 0.7% fat, 1.8% fiber, and 0.9% ash. In contrast, the dry seeds have approximately 24.9% protein, 9.6% moisture, 60.1% carbohydrates, 0.8% fat, 1.4% fiber, and 3.2% ash (Kay, 1975) [5].

Plant growth regulators (PGRs) are among the most effective tools for improving horticultural crop production. They enhance physiological processes such as photosynthesis, strengthen the source-sink relationship, and facilitate the translocation of photo-assimilates, ultimately boosting crop productivity (Khan and Mazed, 2018) [7].

PGRs are organic compounds, distinct from nutrients, that influence plant physiological functions. Acting as biostimulants or bioinhibitors, they regulate enzyme systems at very low concentrations within plants, thereby modifying growth and metabolism. Since their importance was first recognized in the 1930s, both natural and synthetic compounds have been developed to alter plant growth, morphology, and productivity, with applications ranging from germination to post-harvest management.

The effectiveness of PGRs depends greatly on the type of regulator, dosage, crop, growth stage, and season (Khan and Chaudhary, 2006) [6]. Importantly, the same regulator can produce variable effects at different concentrations. Hence, identifying the optimal application levels is crucial for maximizing their benefits. With this in view, the present study was designed to evaluate the most suitable concentrations of GA_3, NAA, and Cycocel for enhancing the morpho-physiological, biochemical, and yield-related traits of *Wal*.

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Materials and Methods

A field experiment was carried out during the Rabi season of 2024-25 at the Education and Research Farm, Department of Agricultural Botany, College of Agriculture, Dapoli, Dist. Ratnagiri, Maharashtra. The site is located in the sub-tropical region at 17°45′ N latitude and 73°12′ E longitude, with an altitude of 250 m above mean sea level. The area receives an average annual rainfall of 3500-4000 mm, predominantly from June to October.

The experiment was laid out in a Randomized Block Design (RBD) with two replications, comprising 14 treatments. Each experimental plot measured 4.2 m × 3.6 m, with a spacing of 30 cm × 30 cm between plants. Foliar application of plant growth regulators was carried out at 30, 45, and 60 days after sowing (DAS). The treatment details were as follows:

- T_1: 20 ppm Gibberellic Acid (GA_3)
- T_2: 30 ppm Gibberellic Acid (GA_3)
- T_3: 40 ppm Gibberellic Acid (GA_3)
- T_4: 50 ppm Gibberellic Acid (GA_3)
- T_5: 20 ppm Naphthalene Acetic Acid (NAA)
- T_6: 30 ppm Naphthalene Acetic Acid (NAA)
- T_7: 40 ppm Naphthalene Acetic Acid (NAA)
- T_8: 50 ppm Naphthalene Acetic Acid (NAA)
- T_9: 50 ppm Cycocel
- T_{10}: 100 ppm Cycocel
- T_{11}: 200 ppm Cycocel
- T_{12}: 300 ppm Cycocel
- T_{13}: Control (Water spray)
- T_{14}: Absolute Control

Preparation and application of growth regulators

Gibberellic Acid (GA_3)

The required solutions of gibberellic acid (GA_3) were prepared by dissolving 20 mg, 30 mg, 40 mg, and 50 mg of GA_3 separately in a small quantity of ethyl alcohol to ensure complete dissolution of the granules. Once the GA_3 particles were fully dissolved, the final volume was made up to one litre with distilled water, resulting in concentrations of 20, 30, 40, and 50 ppm, respectively.

Naphthalene Acetic Acid

Solutions of Naphthalene Acetic Acid (NAA) at concentrations of 20, 30, 40, and 50 ppm were prepared by dissolving 20 mg, 30 mg, 40 mg, and 50 mg of NAA, respectively, in 1000 ml of water, and applied as foliar spray.

Cycocel

Solutions of Cycocel at concentrations of 50, 100, 200, and 300 ppm were prepared by dissolving 50 mg, 100 mg, 200 mg, and 300 mg of Cycocel, respectively, in 1000 ml of water, and applied as foliar spray.

Results and Discussion

1. Pod length (cm)

Treatment T_3, comprising 40 ppm gibberellic acid (GA_3), recorded the maximum pod length of 4.45 cm. This was significantly higher than the absolute control (T_{14}), which registered the lowest pod length of 3.88 cm. The pod length under T_3 was also statistically at par with T_8 (4.44 cm), T_{12} (4.29 cm), T_4 (4.28 cm), T_7 (4.27 cm), and T_{11} (4.26 cm), confirming its superior performance. The enhancement in pod length due to GA_3 application may be attributed to its role in stimulating rapid cell division and promoting elongation of individual cells. Similar findings have been reported by Rajani *et al*. (2016) [14] in French bean, Rathore *et al*. (2022) [15] in broad bean, Roy *et al*. (2023) [16] in field pea, and Mavdiya *et al*. (2023) [10] in cowpea.

2. Number of pods per plant

The effect of foliar application of growth regulators such as NAA, GA_3, and Cycocel on the total number of pods per plant in *wal* revealed significant differences among treatments. The highest number of pods per plant (23.10) was recorded in treatment T_3 (GA_3 at 40 ppm). This was followed by T_8 (22.80), T_{12} (22.10), T_4 (21.90), T_7 (21.40), T_6 (21.10), T_{11} (20.70), and T_2 (20.50), which were statistically at par with each other. In contrast, the lowest number of pods per plant (14.70) was observed in T_{14} (absolute control). The superior performance of GA_3 treatments may be attributed to the promotion of branching and increased fruiting points, which enhanced light interception and photosynthetic activity, ultimately resulting in a higher pod set. These results are in agreement with the findings of Rajani *et al*. (2016) [14] in French bean, Roy *et al*. (2023) [16] in field pea, and Mavdiya *et al*. (2023) [10] in cowpea.

3. Number of seeds per pod

Treatment T_3, with a foliar spray of 40 ppm gibberellic acid (GA_3), recorded the highest number of seeds per pod (3.98). This was significantly higher than the absolute control (T_{14}), which had the minimum value of 3.38 seeds per pod. The number of seeds per pod under T_3 was statistically at par with T_8 (3.80), T_{12} (3.79), T_7 (3.77), and T_4 (3.76), reaffirming the effectiveness of GA_3 in enhancing this yield attribute. The improvement in seed number may be attributed to enhanced cell division and greater accumulation of dry matter within pods, leading to a higher seed set. Similar results were reported by Tasnim *et al*. (2019) [17] in mungbean, Rathore *et al*. (2022) [15] in broad bean, and Roy *et al*. (2023) [16] in field pea.

Table 1: Influence of foliar spraying of Gibberellic Acid (GA_3), Naphthalene Acetic Acid (NAA) and Cycocel on pod length, number of pods per plant, number of seeds per pod, grain yield per plant, grain yield per plot, grain yield per ha, 100 seed weight and harvest index of Wal.

Treatments	Pod length (cm)	Number of pods per plant	Number of seeds per pod	Grain yield per plant (g)	Grain yield per plot (kg)	Grain yield per ha (kg)	100 seed weight (g)	Harvest Index (%)
T_1	4.01	19.30	3.44	8.84	360.25	982.34	13.74	46.35
T_2	4.17	20.50	3.62	9.28	384.25	1031.32	14.06	47.60
T_3	4.45	23.10	3.98	11.14	559.25	1237.63	14.70	50.73
T_4	4.28	21.90	3.76	10.40	513.50	1155.15	14.47	48.61
T_5	3.95	19.40	3.58	8.87	430.25	985.59	14.02	45.87
T_6	4.17	21.10	3.64	8.99	435.00	998.37	14.37	47.13
T_7	4.27	21.40	3.77	10.77	466.75	1196.87	14.41	48.92
T_8	4.44	22.80	3.80	10.96	529.00	1217.93	14.54	49.69
T_9	4.06	18.10	3.54	8.14	364.00	904.26	13.77	45.17
T_{10}	4.13	19.30	3.60	8.85	430.50	983.32	13.92	47.57
T_{11}	4.26	20.70	3.62	10.32	448.25	1146.76	13.94	47.77
T_{12}	4.29	22.10	3.79	10.79	525.50	1199.19	14.52	49.07
T_{13}	3.90	16.70	3.48	7.70	345.00	855.34	13.58	43.78
T_{14}	3.88	14.70	3.38	6.04	326.25	670.98	13.36	43.41
S.E±	0.09	1.12	0.07	0.67	36.68	74.28	0.51	1.22
CD at 5%	0.27	3.42	0.22	2.04	112.08	226.94	NS	3.73

4. Grain yield per plant (g)

The effect of foliar application of growth regulators such as GA_3, NAA, and Cycocel on grain yield per plant in *wal* revealed significant treatment differences. The highest yield per plant (11.14 g) was obtained under T_3 (40 ppm GA_3), which was superior to all other treatments. This was followed by T_8 (10.96 g), T_{12} (10.79 g), T_7 (10.77 g), T_4 (10.40 g), T_{11} (10.32 g), and T_2 (9.28 g), which were statistically comparable with one another. The lowest yield per plant (6.04 g) was recorded in the absolute control (T_{14}), confirming the effectiveness of GA_3 at 40 ppm in enhancing productivity.

The increase in grain yield under GA_3 application may be attributed to improved net photosynthetic activity, coupled with an increase in the number of branches, leaves, and leaf area index. These factors likely contributed to a greater number of pods, enhanced pod length and diameter, and ultimately higher yield per plant. Similar findings have been reported by Mavdiya *et al*. (2023) [10] in cowpea, Rajani *et al*. (2016) [4] in French bean, and Giri *et al*. (2018) [4] in pigeonpea.

5. Grain yield per plot (kg)

Treatment T_3, with 40 ppm gibberellic acid (GA_3), recorded the maximum grain yield per plot (559.25 kg), making it the most effective treatment. This was significantly higher than the yields obtained from T_8 (529.00 kg), T_{12} (525.50 kg), T_4 (513.50 kg), T_7 (466.75 kg), and T_{11} (448.25 kg), which were statistically at par with each other. The lowest yield per plot (326.25 kg) was observed in the absolute control (T_{14}), further highlighting the superiority of T_3 in enhancing productivity.

The improvement in yield with GA_3 application may be attributed to its role in promoting cell division and elongation, leading to an increase in the number of branches, leaves, and leaf area index. These factors enhance photosynthetic efficiency and assimilate production, ultimately resulting in higher yields per plant and per plot. Similar results were reported by Baraskar *et al*. (2018) [1] in okra.

6. Grain yield per hectare (kg)

Treatment T_3, with a foliar application of 40 ppm gibberellic acid (GA_3), recorded the maximum grain yield per hectare (1237.63 kg), showing a significant improvement over the absolute control (T_{14}), which produced the lowest yield (670.98 kg). This superior performance was closely followed by T_8 (1217.93 kg), T_{12} (1199.19 kg), T_7 (1196.87 kg), T_4 (1155.15 kg), and T_{11} (1146.76 kg), all of which were statistically at par with one another.

The substantial increase in yield under T_3 can be attributed to the enhanced yield per plant and per plot brought about by GA_3 application. This growth regulator likely stimulated physiological processes such as cell division and elongation, leading to greater vegetative growth, improved photosynthesis, and higher assimilate accumulation, which ultimately translated into increased grain yield per hectare. Similar findings have been reported by Rajani *et al*. (2013) [13] in French bean, Nabi *et al*. (2014) [11] in cowpea, Dholariya *et al*. (2018) [3] in cluster bean, Patil *et al*. (2019) [12] in groundnut, and Giri *et al*. (2018) [4] in pigeonpea.

7. 100 seed weight (g)

The effect of foliar application of growth regulators on the test weight of *wal* was found to be non-significant. No statistically significant differences were observed in 100-seed weight among the treatments. However, the highest test weight (14.70 g) was recorded in T_3 (40 ppm GA_3), while the lowest (13.36 g) was noted in T_{14} (absolute control). These observations are in line with the findings of Dholariya *et al*. (2018) [3] in cluster bean.

8. Harvest Index (%)

Treatment T_3 (40 ppm GA_3) recorded the maximum harvest index of 50.73%, which was significantly higher than the absolute control (T_{14}), registering the lowest value of 43.41%. Treatments T_8 (49.69%), T_{12} (49.07%), T_7 (48.92%), and T_4 (48.61%) also exhibited relatively high harvest indices and were statistically comparable to one another. The higher harvest index under GA_3 application may be attributed to accelerated assimilate translocation to the sink and more efficient utilization of assimilates by the reproductive organs. These findings are consistent with those reported by Giri *et al*. (2018) [4] in pigeonpea and Tasnim *et al*. (2019) [17] in mungbean.

Conclusion

The results indicate that treatment T_3, comprising foliar application of gibberellic acid (GA_3) at 40 ppm, recorded the highest grain yield per plant (11.14 g) and per hectare (1237.63 kg), significantly outperforming the control and other treatments. It also produced the maximum pod length, number of pods per plant, and number of seeds per pod. These findings clearly demonstrate the effectiveness of GA_3 at 40 ppm in enhancing growth, yield attributes, and overall productivity of *wal*. The substantial improvement in yield highlights the role of GA_3 in optimizing both vegetative and reproductive processes, thereby contributing to higher productivity and better quality produce.

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