



Synergistic Effect of Potassium and Bio Stimulants on Growth and Yield of Dolichos bean [*Lablab purpureus* (L.) Sweet]

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ABSTRACT

Background: Field experiments were conducted at Annamalai University Farm during *kharif* seasons of three consecutive years from 2020-2022 to find out the effect of potassium and bio stimulants on growth and yield of dolichos bean.

Methods: The experiments were conducted in RBD and replicated thrice. The treatments viz., T₁- Control (without foliar nutrition), T₂- Foliar application of KNO₃ @ 1%+panchagavya @ 3%, T₃- Foliar application of KNO₃ @ 1% + panchagavya @ 6%, T₄- Foliar application of KNO₃ @ 1% + seaweed extract @ 2%, T₅- Foliar application of KNO₃ @ 1% + seaweed extract @ 4%, T₆- Foliar application of potassium humate @ 1% + panchagavya @ 3%, T₇- Foliar application of potassium humate @ 1% + panchagavya @ 6%, T₈- Foliar application of potassium humate @ 1% + seaweed extract @ 2% and T₉- Foliar application of potassium humate @ 1% + seaweed extract @ 4%. The dolichos bean variety Arka Jay was used for this study.

Result: The result of present investigation indicated that the growth and yield parameters viz., plant height, branches plant⁻¹, pods plant⁻¹, pod length and single pod weight were found to be superior in treatment T₅ as compared to control. The higher yield (15.16 t ha⁻¹) of dolichos bean was significantly improved due to application 1% KNO₃ + seaweed extract @ 4% (T₅) followed by T₄ and T₁ over the control. The same treatment fetched the highest net return of Rs. 81626 ha⁻¹ with a benefit cost ratio of Rs.1.79.

Key words: Bio-stimulants, Dolichos bean, Foliar nutrient, KNO₃, Potassium humate.

INTRODUCTION

The dolichos bean, also known as the garden bean [*Lablab purpureus* L. (sweet) or *Dolichos lablab* (Roxb.) L. var. *typicus*], is an essential leguminous vegetable in India. Per 100 grams of its edible green pods, the nutritional composition includes 86.1 g of moisture, 3.8 g of protein, 0.7 g of fat, 6.7 g of carbohydrates, 68 mg of phosphorus, 1.7 mg of iron and 210 mg of calcium. Additionally, it contains trace amounts of thiamine (0.1 mg), niacin (0.7 mg) and riboflavin (0.06 mg). It is a rich source of vitamin A (617 IU) (Thorat *et al.*, 2020). In India, beans are cultivated over 2.28 lakh hectares, yielding an annual production of 25.1 lakh tonnes. Specifically, lablab beans in Tamil Nadu was 7,871.02 hectares, producing 107,397.34 metric tonnes with a productivity rate of 13.64 t ha⁻¹ (National Horticulture Board, 2021-22; TN Horticulture, 2021-2022). However, on farmers' fields, the productivity of dolichos beans typically ranges between 7 to 13 tonnes per hectare. Despite strong market demand, cultivation remains limited due to its relatively low productivity. This issue is primarily linked to inadequate nutrient management practices. Integrating chemical fertilizers with organic manures and biofertilizers can improve dolichos bean productivity, enhance soil fertility and reduce production costs (Gandhi and Sivakumar, 2010; Tomar and Saika, 2022).

Soil application of essential plant nutrients alone is often insufficient to achieve maximum economic yields, as plants may experience hidden hunger. Foliar fertilization can effectively complement soil fertilization in addressing

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this issue. While soil application is the most common method for delivering essential nutrients to plants, crops can also absorb minerals through foliar sprays when applied at appropriate concentrations. Foliar fertilization allows for faster nutrient absorption and utilization, correcting deficiencies more quickly than traditional soil applications (Fageria *et al.*, 2009; Patil and Chetan, 2018). Therefore, KNO₃ and potassium humate have been identified as promising foliar nutrient sources for dolichos beans. These can be combined with biostimulants like panchagavya and seaweed extract to evaluate their efficacy. The flowering and pod development phases are critical stages for dolichos beans, with flowering beginning around 40 days after sowing (DAS) and continuing alongside pod development at approximately 60 DAS. Foliar applications

at 30 and 60 DAS ensure that the plants receive essential nutrients before these critical growth stages. To maximize dolichos bean productivity, it is necessary to test the effectiveness of foliar biostimulants and various potassium sources in combination with integrated nutrient management (INM) practices.

MATERIALS AND METHODS

The experiments were conducted at Annamalai University Farm during *kharif* seasons of 2020 to 2022 to study the foliar application of potassium sources and bio stimulants on growth and yield of dolichos bean. This area is located at 11°24' North latitude, 79°41' East longitude and at an altitude of ±5.79 meters above mean sea level in the Cuddalore district of Tamil Nadu. The soil type of the experimental field at Annamalai University was clay loam with pH of 8.01 and EC value of 2.87 m mhos cm⁻¹. The available nitrogen was estimated by alkaline permanganate method of Subbiah and Asija (1956) and expressed in kg ha⁻¹. The available phosphorus was estimated by the method of Olsen *et al.* (1954) and expressed in kg ha⁻¹. Available potassium was estimated by neutral normal ammonium acetate extraction and flame photometry developed by Stanford and English (1949) and expressed in kg ha⁻¹. The soil pH and EC was estimated as per the method suggested by Jackson (1973). The soil was low in available nitrogen (235 kg ha⁻¹), low in available phosphorus (9.52 kg ha⁻¹) and high in available potassium (295 kg ha⁻¹) respectively.

The experimental field was thoroughly ploughed to achieve a fine tilth and then levelled. Twenty-seven plots, each measuring 4 m², were established with 0.5 meter spacing between them and bunds of 45 cm width. The treatments were randomly assigned within each replication. The recommended quantities of organic manure (25 tonnes of FYM per hectare) and inorganic fertilizers (25 kg N+50 kg P₂O₅ per hectare) were applied. FYM was incorporated as a basal dose, along with half of the nitrogen and the full phosphorus dose (P₂O₅). The remaining nitrogen was applied 30 days after sowing. Inorganic fertilizers were applied according to standard recommendations for lablab cultivation in Tamil Nadu. Urea served as the nitrogen source, while single super phosphate was used for phosphorus. A field experiment was conducted on dolichos beans to evaluate potassium sources, including KNO₃ and potassium humate, along with bio stimulants such as panchagavya and seaweed extract at different concentrations. The experiment followed a randomized block design (RBD) with nine foliar treatments, each replicated three times.

Treatment details

- T₁- Control (without foliar nutrition).
- T₂- Foliar application of KNO₃ @ 1% + Panchagavya @ 3%.
- T₃- Foliar application of KNO₃ @ 1% + Panchagavya @ 6%.
- T₄- Foliar application of KNO₃ @ 1% + Seaweed extract @ 2%.

T₅- Foliar application of KNO₃ @ 1% + Seaweed extract @ 4%.

T₆- Foliar application of potassium humate @ 1% + Panchagavya @ 3%.

T₇- Foliar application of potassium humate @ 1% + Panchagavya @ 6%.

T₈- Foliar application of potassium humate @ 1% + Seaweed extract @ 2%.

T₉- Foliar application of potassium humate @ 1% + Seaweed extract @ 4%.

Dolichos bean seeds of the cultivar 'Arka Jay' were sown at a spacing of 60 cm × 30 cm. Before sowing, the seeds were treated with 2 kg of Rhizobium using the seed inoculation method. Planting was done on both sides of the ridges, maintaining the specified spacing. The field was irrigated immediately after sowing, with a follow-up irrigation on the third day. Subsequent irrigations were scheduled every 10 to 15 days, depending on soil moisture levels and continued until the harvest stage. Hand weeding was performed at 15 and 30 days after sowing and one inter-cultivation was conducted at 20 days after sowing to ensure the plots remained weed-free. The potassium nutrients and bio stimulants were sprayed at two critical stages of crop growth on 30th and 60th days after sowing as per the treatment schedule. In each replication, five plants were selected randomly for recording observations.

Growth parameters and yield attributes were recorded, including plant height (cm), number of branches per plant, leaf area index, chlorophyll content (mg g⁻¹), dry matter production (kg ha⁻¹), days to 50% flowering, number of pods per plant, pod length (cm), single pod weight (g) and pod yield (t ha⁻¹). Protein content in pods was determined using the method described by Lowry *et al.* (1951). Plant height was measured from the ground level to the topmost growing point for five plants at the maturity stage and the average height was calculated and expressed in centimeters. The total number of branches per plant was counted for each treatment and the mean number of branches was recorded. The leaf area index (LAI) was calculated using the formula provided by Watson (1952), dividing the leaf area per plant by the land area covered by the plant.

$$LAI = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Land area covered by the plant (cm}^2\text{)}}$$

Total chlorophyll content was measured using the method described by Cock *et al.* (1976) and expressed in mg g⁻¹ of fresh weight. The number of days to 50% flowering was recorded as the time taken from the sowing date until half of the plants in each treatment showed visible flowering (anthesis). Statistical analysis of the data was conducted following the procedures outlined by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

Growth characters

The results show that foliar application of potassium and bio stimulants significantly enhanced the growth attributes

of dolichos bean when compared to control (Table 1). The highest values of growth parameters viz., plant height (109.53 cm), branches plant⁻¹ (9.28), leaf area index (9.21), total chlorophyll content (3.07 mg g⁻¹), days to 50% flowering (39.33) and dry matter production (774.44 kg ha⁻¹) were recorded with 1% KNO₃ foliar application + seaweed extract @ 4% (T₅), followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% (T₄). The least values of growth parameters viz., plant height (90.05 cm), branches plant⁻¹ (7.63), chlorophyll content (2.53 mg g⁻¹) and dry matter production (636.67 kg ha⁻¹) were recorded in control (T₁). Next least values in growth attributes were recorded with foliar application of potassium humate @ 1% + panchagavya @ 3% (T₆) which was on par with potassium humate @ 1% + panchagavya @ 6% (T₇) (Table 1). This trend in data on growth attributes revealed KNO₃ as the better foliar nutrient source when compared with potassium humate and among the bio stimulants seaweed extract as the better source when compared with panchagavya. Enhanced growth due to the application of KNO₃ might be attributed by the presence of 44 per cent potassium and 13 per cent nitrogen in the source. The role of potassium in ionic balance might be reflected in nitrate metabolism. Enhanced chlorophyll contents observed in the current experiment due to KNO₃ confirms the fact that nitrogen being an active participant of chlorophyll and protein hold its importance as an essential element for plant growth. The present results pertaining to influence of KNO₃ on growth attributes are in conformity with the reports of Elhindi *et al.* (2016) in lentil and Naz *et al.* (2021) in spinach. Further, enhanced growth in dolichos bean observed due to the seaweed extract application might be attributed to the beneficial effects of seaweed extract as it is rich with the presence of natural plant growth substances, cytokinin and substance mimicking cytokinin activity betaines, amino acids and higher composition of minerals (Shevchenko *et al.*, 2007 and Ji *et al.*, 2009). Several studies have shown the stimulating effects of seaweed on growth attributes of varied crop plants (Alam

et al., 2014; Shahbazi *et al.*, 2015 and Mirparsa *et al.*, 2016). Similar result was also reported by Venkatesan *et al.* (2024).

Yield and quality parameters

The results revealed that foliar application of potassium and bio stimulants significantly enhanced the yield attributes of dolichos bean when compared to control. Significantly days to 50 per cent flowering (37.33 days) was observed with 1% KNO₃ foliar application + seaweed extract @ 4% (T₅) followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% (T₄) in which days to 50 per cent flowering was observed on 39.33 days. Flowering was significantly late when compared to all other treatments in control (T₁), which, took 39.66 days to flowering and 42.33 days to 50 per cent flowering. Improved growth and early dry matter accumulation augmented by the physiological role of KNO₃ @ 1% and seaweed extract @ 4% might have advanced the plant growth and flowering. In terms of pods plant⁻¹, foliar application of KNO₃ was found better when compared with potassium humate. The maximum of 73.42 pods plant⁻¹ recorded with 1% KNO₃ foliar application + seaweed extract @ 4% (T₅), followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% (T₄) which recorded 72.11 panchagavya @ 3% (T₆). The least number of pods plant⁻¹ (60.36) was recorded in control (T₁). It was followed by foliar application potassium humate @ 1% + panchagavya @ 3% (T₆) with 64.93 pods plant⁻¹. The maximum pod length of 11.85 cm recorded with 1% KNO₃ foliar application + seaweed extract @ 4% (T₅) was followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% (T₄), which recorded 11.64 cm of pod length. The maximum single pod weight of 5.37 g recorded with recorded with 1% KNO₃ foliar application + seaweed extract @ 4% (T₅) followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% (T₄). The observed improvements in pod characteristics with seaweed extract application can be attributed to its cytokinin content. This extract may enhance pod weight by increasing the source capacity of leaves,

Table 1: Growth characters of dolichos bean crop in relation to different treatment application (mean of three years).

Treatments	Plant height (cm)	Branches plant ⁻¹	Leaf area index	Chlorophyll content (mg g ⁻¹)	Dry matter production (kg ha ⁻¹)
T ₁	90.05	7.63	7.57	2.53	636.67
T ₂	103.86	8.80	8.73	2.92	734.35
T ₃	105.71	8.96	8.89	2.97	747.44
T ₄	107.58	9.12	9.05	3.02	760.66
T ₅	109.53	9.28	9.21	3.07	774.44
T ₆	96.88	8.21	8.15	2.72	684.97
T ₇	97.95	8.30	8.24	2.75	692.55
T ₈	100.58	8.50	8.46	2.82	711.15
T ₉	101.67	8.63	8.55	2.85	718.86
S.Em ±	0.75	0.06	0.06	0.02	5.33
CD (p=0.05)	1.60	0.14	0.13	0.04	11.30

thereby boosting the supply of assimilates needed for pod filling. This enhancement could result from expanded leaf area or improved photosynthetic efficiency. Additionally, seaweed extract may increase pod weight by enhancing the beans' sink potential for assimilates, possibly through promoting cotyledon cell multiplication, leading to a higher final pod mass. These findings are consistent with those of Paramanick *et al.* (2013) and Youssef *et al.* (2019). Similar result was also reported by Dalai *et al.* (2022). Similarly, applying panchagavya at a rate of 3% concentration has shown significant improvements in pod traits. This effect may be due to its higher carbohydrate content, which promotes growth and increases the number of pods, single pod weight and other related characteristics. The increase in pod weight could result from better mineral utilization, enhanced photosynthesis and overall metabolic activity, leading to more efficient nutrient allocation to the pods. The least values of yield attributes like pods plant⁻¹ (60.36), pod length (9.74 cm), single pod weight (4.41 g) and pod yield (15.16 t ha⁻¹) were recorded in control (T₁). Next least values in yield attributes were recorded with foliar application of potassium humate @ 1% + panchagavya @ 3% (T₆) which was on par with potassium humate @ 1% + panchagavya @ 6% (T₇) (Table 2).

The yield enhancement in treatment with 1% foliar application of KNO₃ + seaweed extract @ 4% over control treatment was observed to be 21.64 per cent followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% with 19.48 per cent. This trend in data on yield attributes also revealed KNO₃ and seaweed extract as the better foliar nutrient source and bio stimulants respectively for flowering and yield of dolichos bean. Consistency in availability of nutrients through foliar means might have supplemented the additional nutrient requirement caused due to early flowering coupled with concomitant increase in flower number and consecutive

pod development. Enhanced yield observed in dolichos bean due to foliar application of 1% KNO₃ is in line with earlier reports on the influence of KNO₃ reported by Priyadarshini and Madhanakumari (2021) in bush bean, Kocira *et al.* (2019) in soybean and Elhindi *et al.* (2016) in lentil. Effects of seaweed extract observed on yield parameters and yield of dolichos bean is in conformity with the reports of Blunden *et al.* (1996) in French bean, Paramanick *et al.* (2013) in green gram and Latique *et al.* (2013) in bean crops. Similar result was also reported by Sitienei *et al.* (2017) and Sajjan *et al.* (2022).

The quality parameters viz., number of seeds pod⁻¹ (5.89) and pod protein content (8.28%) were recorded the highest with 1% KNO₃ foliar application + seaweed extract @ 4%, followed by the treatment with 1% KNO₃ foliar application + seaweed extract @ 2% (5.81 seeds pod⁻¹ and 8.18 % of pod protein). Whereas, the control treatment recorded significantly less number of seeds pod⁻¹ (5.10) and pod protein content (6.34%) when compared with all treatments. Assimilation of NO₃⁻ is most important for protein synthesis in plants. Change in balance between soluble amino acids and proteins may also cause decrease in NO₃⁻ assimilation. Increased pod protein content in KNO₃ and seaweed extract treatments may be due to increased NO₃ absorption, nitrate reductase activity and assimilation (Ruiz and Romero, 1999) and also due to the presence of more amino acids in seaweed extract (Shevchenko *et al.*, 2007).

Economics analysis

The profitability of treatments in terms of benefit cost ratio suggests that the treatment 1% KNO₃ foliar application + seaweed extract @ 4% (T₅) has showed the highest value of Rs. 81626 ha⁻¹ net return with a benefit cost ratio of Rs.1.79. The next best treatments in terms of benefit cost ratio was 1% KNO₃ foliar application + seaweed extract @

Table 2: Yield and yield attributing characters of dolichos bean crop in relation to different treatments application (mean of three years).

Treatments	Days to 50% flowering	Pods plant ⁻¹	Pod length (cm)	Single Pod weight (g)	Seeds pod ⁻¹	Pod protein content %	Pod yield (t ha ⁻¹)
T ₁	42.33	60.36	9.74	4.41	5.10	6.34	15.16
T ₂	39.66	69.62	11.23	5.09	5.66	7.98	17.48
T ₃	39.66	70.86	11.44	5.18	5.74	8.08	17.79
T ₄	39.33	72.11	11.64	5.27	5.81	8.18	18.11
T ₅	37.33	73.42	11.85	5.37	5.89	8.28	18.44
T ₆	41.33	64.93	10.48	4.75	4.38	6.98	16.31
T ₇	40.66	65.65	10.60	4.80	5.42	7.20	16.49
T ₈	40.66	67.42	10.88	4.93	5.53	7.24	16.93
T ₉	40.33	68.15	11.00	4.98	5.57	7.51	17.11
S.Em ±	0.12	0.51	0.08	0.04	0.03	0.04	0.13
CD (p=0.05)	0.26	1.07	0.17	0.08	0.06	0.09	0.27

Table 3: Economic impact of dolichos bean crop in relation to different treatment application (mean of three years).

Treatments	Total cost of cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B:C ratio
T ₁	97469	151559	54090	1.55
T ₂	101354	174811	73458	1.72
T ₃	102479	177927	75448	1.74
T ₄	101479	181075	79597	1.78
T ₅	102729	184355	81626	1.79
T ₆	103219	163057	59839	1.58
T ₇	104344	164861	60517	1.58
T ₈	103344	169288	65945	1.64
T ₉	104594	171125	66531	1.64

2% (T₄) with a benefit cost ratio of 1.78. In control treatment the benefit cost ratio was recorded as 1.55 (Table 3).

CONCLUSION

Hence, the current investigation concluded that the cultivation of dolichos bean with 1% KNO₃ + seaweed extract @ 4% as foliar spraying at 30th and 60th days after sowing (T₅) fetched the highest net return of Rs. 81626 ha⁻¹ with a benefit cost ratio of 1.79.

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Conflict of interest

All authors declared that there is no conflict of interest.

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