

Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti

A

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By

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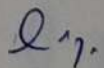
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It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

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ABSTRACT

A field experiment entitled “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” was carried out during 2021-22 at the Research Field of Central Horticultural Experiment Station (Aiginia), ICAR-IIHR, Bhubaneswar with ten numbers of treatments and three replications following Randomized Block Design with varied level of zinc, boron, NAA and GA₃ to study the growth, yield and seed quality of dolichos bean var. Arka Neelachal Pushti. The treatments were T₁ - Boron @ 0.2% as foliar spray, T₂ - Zinc @ 0.5% as foliar spray, T₃ - Boron @ 0.2% + GA₃ @ 50 ppm as foliar spray, T₄ - Boron @ 0.2% + NAA @ 50 ppm as foliar spray, T₅ - Zinc @ 0.5% + GA₃ @ 50 ppm as foliar spray, T₆ - Zinc @ 0.5% + NAA @ 50 ppm as foliar spray, T₇ - Zinc @ 0.5% + Boron @ 0.2% as foliar spray, T₈ - Boron @ 0.2% + Zinc @ 0.5% + GA₃ @ 50 ppm as foliar spray T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm as foliar spray and T₁₀ as Control. From the data obtained during the experiment, it was observed that T₉ with Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm as foliar spray produced maximum plant height (434.14 cm), panicle length (22.62 cm), number of flowers/ panicle (33.38), number of pods/ panicle (10.40), average fresh pod weight (6.14 g), length of fresh pod (9.17 cm), average dried pod weight with seeds (2.19 g), length of dried pod (8.08 cm), girth of dried pod (3.19 cm), average dried seed weight/ pod (2.08 g), average dried shell weight (0.45 g), number of seeds/ pod (5.43), dried pod yield/ plot (5.46 kg), dried pod yield/ plot (0.27 kg), dried pod yield/ ha (3604.04 kg), dried seed yield/ plot (4.33 kg), dried seed yield/ plant (0.22 kg), dried seed yield/ ha (2859.12 kg), germination % (66.41), average seedling length (55.94 cm), seedling dry weight (2.16 mg), seedling vigour index I (3621.91), seedling vigour index II (143604.57), and B:C ratio (3.66). T₄ with Boron @ 0.2% + NAA @ 50 ppm as foliar spray was found to be at par with T₉ for number of flowers/ panicle (31.91), number of pods/ panicle (9.33), length of fresh pod (8.99 cm), average dried pod weight with seeds (2.38 g), girth of dried pod (3.15 cm), average dried seed weight/ pod (1.95 g), average dried shell weight (0.43 g), number of seeds/ pod (5.20), dried pod yield/ plant (0.24 kg). However, the lowest seed yield (1887.60 kg), and lowest B:C ratio (2.22) was obtained in T₁₀. So, from the experiment, it can be concluded that Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm as foliar spray should be applied to get better plant growth and higher marketable seed yield/ha in dolichos bean, var. Arka Neelachal Pushti.

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ABBREVIATIONS USED

Abbreviations	Meaning
/	Per
@	At the rate of
0C	Degree Celcius
CD	Critical Difference
CV	Coefficient of variation
RBD	Randomized Block Design
cv.	Cultivar
var.	Variety
<i>et al.</i>	And others
t/ha	Tonnes/hectare
Ha	Hectare
i.e.	that is
g	gram
Kg	Kilogram
Q/ha	Quintal/hectare
No.	Number
SEm	Standard error of the mean
<i>spp.</i>	Species
viz.	Namely
TSS	Treatment sum of square
RSS	Replication sum of square
ESS	Error sum of square
EMS	Error mean sum of square
RMS	Replication mean sum of square
fig.	Figure
df	Degree of freedom
CHES	Central Horticultural Experiment Station
IIHR	Indian Institute of Horticultural Research
OUAT	Odisha University of Agriculture and Technology

INTRODUCTION

Taxonomically, Dolichos bean belongs to the family Fabaceae and native to India (Nene, 2006). It is a seed-propagated annual herbaceous plant with active trailing and twining growth patterns. The cultivated dolichos bean is classified into two groups namely vegetable and Pulse type. The vegetable type (*Lablab purpureus* L. var. *typicus*) of dolichos bean is predominantly a perennial twining herb, generally trained on a pendal. It produces flat, longer and more tapering pods with less fibre on pod wall. It is usually cultivated for soft and fleshy whole pods for vegetable purpose, and thus popularly known as pole bean. Pulse type Dolichos bean (*Lablab purpureus* L. var. *lignosus*) predominantly a perennial bush, usually cultivated as an annual. It is mainly cultivated for green seeds, and thus, popularly known as field bean (Raghu *et al.* 2019).

Dolichos bean is commonly grown in arid and semi-arid regions of Asia, Africa and America. It is grown all across India, primarily in the states of Karnataka, Andhra Pradesh, Telangana, and the nearby districts of Tamil Nadu and Maharashtra, as well as in the north-eastern hilly terrains. Karnataka alone accounts for nearly 90% of both area and production of Dolichos cultivation in India (Laxmi *et al.*, 2015). It is a popular leguminous vegetable crop spread across the country and is commonly known as sem, hyacinth bean or field bean. It is treated as one of the most nutritious pod vegetable it contains protein, carbohydrates, vitamins, and dietary fibers. The dry seeds are used for a variety of vegetable dishes, while the leaves are utilised to make hay, silage, and green manures (Bose *et al.* 1993). Being indigenous crop, a huge diversity is available in terms of pod colour, pod shape, size and other horticultural traits at biodiversity hotspot regions. It is a climate-resilient crop that provides nutritional and financial security to small and marginal farmers in tropical and sub-tropical regions. Being a legume, it can fix 170 kg/ha of atmospheric nitrogen while also producing enough crop residue to add organic matter to the soil (Ullasa *et al.*, 2018).

Because of the high protein content, it is regarded as poor man's meat (Joshi and Rahevar, 2015). The crop is known for having a high protein (3.6%) and fibre content (1.8 %). Dry seed, on the other hand, has 23.0 to 28.0 per-cent protein and is high in phenol (1.7- 9.67 mg/100 g), antioxidant (Rai *et al.*, 2014). Seeds have been found to have

therapeutic qualities such as diuretic, antispasmodic, anthelmintic, digestive, stomachic, and carminative (Chopra *et al.*, 1986). It has high nutritive value and possess immense health benefits. The flavonoid 'genistein' found in dolichos bean play a role in the prevention of cancer (Kobayashi *et al.*, 2002).

Judicious management of major and minor nutrients plays a pivotal role in increasing seed yield and quality of field bean. In addition to the primary nutrients, field bean also requires optimum amount of micronutrients such as zinc, boron and molybdenum etc., for improving its vegetative and reproductive characteristics leading to higher seed yield and quality (Singh *et al.*, 2008). Foliar application can be considered as one of the best method for micronutrients application (Ali, 2011). Period of seed-filling is considered as one of the most critical stage affecting crop yield in most of the legume plants. Foliar application of micronutrients at this stage increased number of flowers, pods. Robertson and Longman (1974) indicated that boron application improved the uptake of P & N and also stated that balanced application of micronutrients play a critical role in determining the effectiveness of seed development in lab lab bean and thereby, better yield of top quality seeds. Zinc is an essential component of various enzyme activity for energy production, protein synthesis and growth regulation. Besides, it is also helpful in nodulation and nitrogen fixation (Kabi and Poi, 1980).

The plant growth and developmental characters, flowering and quality parameters are generally influenced by several biotic, abiotic, agronomic and management practices besides genetic makeup of a every genotype. The improvement in quantitative characters with respect to different plant growth regulators spray has been recorded in dolichos bean. The plant growth regulators sprays are known to exert stimulatory effect and have significant influence on plant structure, crop growth, flowering, maturity and pod yield in lab lab irrespective of the season (Kumanan *et al.*, 2020).

There are many factors that inhibit germination in dolichos bean viz. some phenolic substances, antinutritional factors such as enzymes (trypsin, chymotrypsin, amylase) inhibitors, phytic acid, flatulence factor, oligosaccharides, namely raffinose, stachyose and verbascose which may inhibit the germination (Ramakrishna *et al.*, 2006). The seed of

dolichos bean showed lower per cent of germination in seed testing laboratory and good germination under field condition.

Recently, a new pole type cultivar “Arka Neelachal Pushti” of dolichos bean has been developed at CHES, ICAR-Indian Institute Horticultural Research, Aiginia, Bhubaneswar, best suited for rabi season. Arka Neelachal Pushti is a high yielding, pole type, round poded dolichos bean variety developed through pure line selection from local collection. The pods are oval, medium in size (7-7.5 cm long), straight, attractive green color, with bold and sweet seeds at edible maturity and good market acceptance. The pods are rich in protein (4.61 g/ 100 g) and micronutrients iron (15 ppm), zinc 37ppm). This is a medium maturity variety and takes approximately 95 days from sowing to green harvest.

In light of above facts, a field experiments was framed to study “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” with the following objectives

- Study on efficacy of micronutrients and plant growth regulators on vegetative growth, pod yield and yield attributes of dolichos bean
- Study on impact of micronutrients and plant growth regulators on seed yield and seed quality of dolichos bean
- Estimation of economics of seed production of dolichos bean as influenced by micronutrients and plant growth regulators

REVIEW OF LITERATURE

This chapter provides a review of relevant works by previous researchers that are either directly or indirectly related to the experiment. From the information that is currently available, the research on study “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” is reviewed in this chapter.

2.1 Effect on vegetative growth and pod yield characters

Study conducted in the Konkan region by Pulekar *et al.* (1993) dolichos bean's reaction to nitrogen application and irrigation scheduling and it was found that 75:50:50 kg N:P:K/ha of fertiliser produced significantly higher pod yields than 0, 25, and 50 kg N/ha, with a yield of 7.93 t/ha.

Patel *et al.* (1994) conducted a field study that demonstrated a significant improvement in the yield metrics of the dolichos bean, including weight of pods/plant, quantity of beans/plant, and grain production/ha, as compared to the control, with the application of fertiliser at a rate of 40:60:40 kg N:P:K/ha.

Singh *et al.* (1998) found that foliar spray of 0.5 percent ZnSO₄ to mungbean seemed to have the highest plant height (28.50 cm), number of branches (5.50), number of leaves (12.80), number of pods per plant (33.10), pod weight per plant (18.40 g), number of seeds per pod (9.20), and seed yield (12.13 q/ha) when compared to control.

Tripathy *et al.* (1999) demonstrated that either individually or in combination, soil applications of Zn (25 kg ha⁻¹), B (10 kg ha⁻¹), and Mo (1.5 kg ha⁻¹) increased nodulation and nitrogenase activity in groundnut. While leaf area and dry matter both increased applying these micronutrients collectively.

Sinha *et al.* (1999) concluded that foliar spraying pea with boron at 0.33 mg per litre considerably increased dry matter production (18.96 g) and pod weight (7.23 g) per plant compared to the control.

Shivakumar (2001) observed enhanced plant height and branch density as a result of soil application of ZnSO₄ @ 12 kg per hectare in chickpea. In comparison to the control (38.52 cm, 4.17 and 985 kg ha⁻¹, respectively), the application of 80 kg sulphur and 40 kg P₂O₅ per ha considerably increased the plant height (40.18 cm), number of branches per plant (5.76) and seed yield (1387 kg ha⁻¹).

Singh *et al.* (2001) recorded that when iron was added to a cluster bean crop @ 10 mg per kg seed as compared to the control, the maximum yield per plot was obtained (5.01 g) (3.55 g).

Dwivedi *et al.* (2002) conducted a field study, which showed that application of fertiliser at a rate of 40:60:40 kg N:P:K/ha significantly increased the yield metrics of dolichos bean, such as weight of pods/plant, quantity of beans/plant, and grain production/ha when compared to the control.

Srimathi *et al.* (2002) conducted a study to examine the impact of the micronutrients ZnSO₄ (250 mg kg⁻¹) and borax (100 mg kg⁻¹). The improvement in field emergence (87, 86, and 85%) and plant height (55, 40, 54, and 53 cm) were recorded respectively, in soybean when ZnSO₄, borax, and DAP were used.

Balachander *et al.* (2003) argued that the number of pods per plant (24.80), number of nodules per plant (65.45), and seed yield (1624 kg ha⁻¹) of black gram were enhanced by rhizobia seed inoculation and foliar application of micronutrients such as molybdenum (50 ppm), cobalt (50 ppm), borax (0.2%), and iron (0.2%).

Findings of Poongothai and Chitdeshwari (2003) showed that applying 5 kg Zn + 1.5 kg B + 0.5 kg Mo + 40 kg S to the soil improved both varieties' yields, however COBG 593's yield gain was higher (34.1%) than TMV.1's (21%). When compared to seed treatment, soil application was the best. Similar outcomes in terms of nutrient availability have been seen in black gram.

Begam and Krishnasamy (2003) reported that when the black gram seeds were hardened with ZnSO₄ at the rate 100 ppm it considerably outperformed control in terms of

germination (93%), root length (15.9 cm), shoot length (25.4 cm), dry matter production (27.8 mg/seedling), vigour index (3834) and field emergence (93%).

Macha (2004) foliar application of boron (0.1%) resulted in greater plant height (88.96 cm) in cluster bean cv. Navabahar compared to MnSO₄ (84.50 cm) and control (73.56 cm).

Application of a micronutrient mixture including 2% iron, 1% manganese, 3% zinc, and 0.5% boron combined with kaolin (17.5%) as compared to 5% micronutrient mixture along with kaolin (15%) resulted in a significantly larger shoot length (32.77 cm) in french bean Babu *et al.*, (2005).

Field experiment conducted by Crak *et al.*, (2006), and the results showed that boron treatment at 1.09 kg/ha significantly enhanced soybean output (2298 kg/ha) and the number of pods per plant (29.10) as compared to the control (18.10 and 1540 kg/ha, respectively).

Dixit and Elamathi (2007) demonstrated that foliar application of DAP 2 (%) + NAA 40 ppm + B 0.2 (%) + Mo 0.05 (%) at 30 DAS significantly increased the plant height (32.27 cm), number of pods per plant (25.86) in comparison to the control (31.20 cm, 18 respectively).

When zinc, boron, and molybdenum were applied to chickpea plants in the field, it was observed that the maximum yields were achieved with 2 mg of zinc per plant (6.80 g/plant) and 1 mg of molybdenum per plant (6.73 g/plant) respectively Valenciano *et al.*, (2011).

Awomi *et al.* (2012) reported maximum growth and production of mungbean when 1.5 kg of molybdenum per hectare was applied, this yield was 31.90 and 5.40 percent higher than the control (272 kg per hectare) and 0.75 kg molybdenum treatments (378 kg per hectare, respectively).

Shekhawat and Shivay (2012) concluded that in mung bean, the treatment of boron at 1.50 kg per ha and sulphur at 50 kg per ha significantly increased plant height (46.20

cm) and number of branches per plant (30.89) compared to control (40.70 cm and 23.60 respectively).

There was a significant impact of the various treatments on nutritional concentration and seed protein at the 1% level. Compared to other treatments, iron treatment has a larger influence on the seed's protein content and nutrient uptake. The study's findings indicate that foliar fertilisation with micronutrients may be a potential means of boosting cowpea yield Salih (2013).

In comparison to the uninoculated control, the mungbean treatment of Mo @ 2 kg per hectare increased plant height (59 cm), root length (67 cm), and nodules number per plant (162) While the maximum grain production (1285 kg ha⁻¹) and number of pods per cluster (15.22) were also attained, coupled with Zn at 4 kg per ha (Iftikhar *et al.*, 2013).

Nadia *et al.* (2013) revealed that when molybdenum was applied at a concentration of 16 ppm. cowpea plant produced more nodules per plant (86.80), plant height (47.60 cm), branches per plant (8.80) and pod weight per plant (17.70 g), when compared to the control plant (53.50, 41.60 cm, 6.80 and 11.90 g).

Saileela *et al.* (2014) Regardless of the irrigation method used, either drip irrigation or surface irrigation, the growth parameters, yield contributing characteristics, and green pod yield of bush beans all improved with an increase in fertigation levels when fertigation was provided with 100:100 N and K kg ha⁻¹.

According to Khan and Prakash (2014), applying 2.5 kg of zinc per ha resulted in a significantly greater nodulation (24.74) than the control (22.58). The highest grain and straw production of French bean was dramatically increased by higher doses of nitrogen (150 kg/ha) and phosphorus (75 kg/ha) reported by Lad *et al.*, (2014).

Tahir *et al.* (2014) studied the production potential of soybean in response to boron and found that boron at a rate of 2 kg per ha significantly increased plant height (60.94 cm), the number of pods per plant (43.22), the number of pod-bearing branches (6.55), the biological yield (4122 kg/ha), the harvest index (42.62%), and the protein content (36.48%) compared to other treatments.

Findings of Nasreen *et al.* (2015) showed that the application of B and Mo fertilizer together had a substantial impact on the number of pods/plant, the weight of each pod, and the pod yield ha⁻¹ in both years in dolichos bean. The combination of 2 kg B and 1.5 kg Mo ha⁻¹ resulted in the highest pod yield (9.42 t ha⁻¹ in 2011 and 9.58 t ha⁻¹ in 2010), and it was statistically equivalent to the combination of 2 kg B and 1.0 kg Mo ha⁻¹.

According to the experimental findings of Adil *et al.* (2015), all fertilizer treatments considerably outperformed the control treatment in terms of plant height, branch count, pod length, weight, and yield in French bean. In the treatment receiving 120 kg N, 90 kg P₂O₅, and 90 kg K₂O ha⁻¹, the maximum plant height (39.03 cm), number of branches per plant⁻¹ (18.25), pod length (14.10 cm), pod weight (5.37 gm), and pod yield (8.26 t ha⁻¹) were reported.

Results of a study carried out by Chatterjee and Bandopadhyay (2015) showed that seed treatment with molybdenum (0.5 g/kg seed), biofertilizers, and foliar spray of boron used together at 4 weeks after planting significantly improved the growth and yield attributes of cowpea and registered significant improvement in the number of pods and pod yield per plant of 42 % and 54 % over control, respectively. In contrast, seed treatment with molybdenum (0.5 g/kg seed) and biofertilizers alone recorded improvements of 76 % and foliar application of boron at 4 weeks after planting alone increased pod yield/plant over control by 39%.

According to the findings of Esakkiammal *et al.* (2015) the growth and yield of lab lab beans were most positively influenced by the combination of vermicompost and vermiwash. The outcomes of the experiment revealed notable variations in plant development and yield characteristics. Vermiwash and vermicompost could be used efficiently for sustainable plant production at minimal input-basis green farming.

Chickpea seeds coated with seed polymer (6 ml/kg), ZnSO₄ + boron + ammonium molybdate + FeSO₄ each at 2 g per kg of seed, and received two foliar sprays of ZnSO₄ and FeSO₄ in EDTA at intervals of ten days during flowering stage (50 and 60 DAS) this

led to better growth, improved physiological and yield-attributing characteristics as reported by Shinde *et al.* (2016).

Kharbamon *et al.* (2016) revealed that comparison to lesser dosages, phosphorus doses of 60 kg/ha resulted in the maximum plant growth, number of flowers per panicle (9.41), yield (123.04 g/plant), and maximum crude protein content (25.22%) of the pods in dolichos bean.

Khadgi (2016) revealed that the soil application of boron @ 10 kg ha⁻¹ + zinc sulphate @ 12 kg ha⁻¹ + molybdenum @ 2 kg ha⁻¹ recorded significantly higher plant growth parameters viz., plant height (82.60 cm), number of nodules per plant (37.33), effective nodules per plant (20.67), number of branches per plant (7.80) in dolichos bean.

Findings of Chattha *et al.*, (2017) showed that the application of fertilizer and inoculation together considerably increased mung bean growth and yield the application of 20:50 kg NP kg ha⁻¹ in the case of fertilizer application significantly increased the growth of mung bean.

Pramoda *et al.*, (2018) reported that foliar spray of NAA @ 40 ppm in dolichos bean during rabi season recorded higher crop growth as compared to control.

Jaishankar and Manivannan (2018) studied the growth characteristics like plant height, number of leaves, number of branches, leaf area, leaf area index, chlorophyll in fresh leaf tissue, number of nodes per plant, inter nodal length, number of pods per inflorescence, pod length, pod width, pod weight, Days to first pod harvest, Days to last pod harvest, pod yield per plant, and pod yield per ha and these were all significantly improved by the combined application of nitrogen and phosphorus at 40 and 60 kg/ha doses in dolichos bean.

Debnath *et al.* (2018) reported that with the application of RDF + 1.5 kg B ha⁻¹ + 5 kg Zn ha⁻¹, the highest average plant height (55.8 cm), the number of branches per plant (8.2), and the dry matter yield (51.9 g plant⁻¹) were recorded . Apart from B application, Zn treatment had a significant impact on nodules' dry weight. (RDF + 7.5 kg Zn ha⁻¹) had the highest amount of nodule production (5.2 g plant⁻¹).

Jaishakar and Manivannan (2018) found that treatment (NP 30:50 kg ha⁻¹+ 5 t vermicopmost ha⁻¹ + bio fertilizer 2.5 each kg ha⁻¹) had the largest number of leaves per plant, branches per plant, racemes per plant, pods per plant, pod yield per plant, and pod yield among the treatments (9.88 t ha⁻¹). In terms of growth, yield attributes, and yield of dolichos bean, application of 30 kg N + 60 kg P₂O₅ + 50 kg bio ash + 2.5 kg bio fertilizer ha⁻¹ proved to be the second-best treatment, followed by 30 kg N + 50 kg P₂O₅ + 25t FYM + 2.5 kg bio fertilizer ha⁻¹ treatments.

Islam *et al.* (2018) found that when zinc was applied, the highest pod output (10.85 tonnes per hectare) resulted from 2.0 kg of zinc per hectare, which was statistically similar to 1.0 kg of zinc per hectare of zinc. While Boron application, the highest pod yield (10.31 ton/ha) was obtained from (0.5 kg Zn/ha).

Mahadule *et al.* (2018) concluded that foliar application of boron @ 0.6 per cent through boric acid with general recommended dose of fertilizer at flower initiation and pod development stage was found to be increased in growth and yield, nutrient uptake and quality of french bean.

Bhamare *et al.* (2018) concluded that use of RDF + soil application of FeSO₄ @ 15 kg ha⁻¹ + ZnSO₄ @ 10 kg ha⁻¹ at 25, 40 and 50 days after sowing considerably boosted the yield contributing parameters, including the number of branches per plant, the number of green pods per plant, green pod weight, green pod pod length, and the green pod breadth in French bean.

Singh *et al.* (2018) revealed that higher grain yields per hectare were achieved as a result of nitrogen application at a rate of 120 kg/ha, which outperformed nitrogen applications at 90, 60, and 30 kg/ha in terms of all yield parameters. Application of nitrogen at a rate of 120 kg/ha resulted in considerably higher plant heights of 34.14 cm, 23.01 g of dry weight per plant, 9.75 branches per plant, 11.82 pods per plant, 4.03 grains per pod, 26.62 g of seed index, 13.59 q ha⁻¹ of rajmash seed yield, and 20.16 q ha⁻¹ of straw yield. Maximum seed output and protein content of lablab bean were achieved in both of the research period when 100% N was applied via equal integration of urea and FYM, and this

was combined with 75% P through RDF, PSB, and VAM inoculations as reported by Ahire *et al.* (2020).

Ananth *et al.* (2020) concluded that the best integrated nutrient management method for increasing dolichos bean yield and quality is the usage of 5 t Vermicompost ha⁻¹ + 75% RDF + consortium of biofertilizers.

Desai *et al.* (2020) observed that maximum growth and yield-attributing characteristics and yields of Indian Bean were considerably produced by the application of biocompost @ 2.5 t/ha. In comparison to no seed inoculation, all of the growth, yield, and yield attributes of Indian Bean were significantly higher when the seeds were inoculated with Rhizobium + PSB.

Doddamani *et al.* (2020) Results revealed that foliar application of zinc @ 0.5% and boron @ 0.2%, 45 days after sowing in dolichos bean increases plant height, number of branches and biomass. The number of flowers formed per plant and fruiting efficiency also increases and flower drop decreases significantly.

Padma *et al.* (2020) concluded that Triaccontanol @ 2 ppm foliar spray recorded significantly the highest plant height (68.4 cm), leaf area (1077.0 cm²), number of buds per node (4.87) and took least number of days to 50% flowering (41.64 days) in dolichos bean.

Kumanan *et al.* (2020) revealed that foliar spray of NAA @ 100 ppm had the best performance in almost all of the experiment's characters, including plant height (97.18 cm), number of branches per plant (56.60), days until first flowering (44.88), days until half of the flowers had appeared (57.24), number of nodes on the main stem (62.47), number of spikes/plant (19.47), number of flowers/plant (241.85), individual weight/pod (12.77 g) (0.39 kg).

Uddin *et al.* (2020) concluded that phosphorus and boron applied as a single application had a substantial impact on French bean output. The majority of the time, the treatments had a positive outcome and may therefore be utilised to increase yield and quality. The results above further support the conclusion that the application of 25 kg ha⁻¹

of phosphorus and 1.5 kg ha⁻¹ of boron, coupled with the necessary quantities of N, K, and Zn fertilisers, considerably boosted French bean plant growth and production.

2.2 Effect on seed yield and seed quality parameters

Singh *et al.* (1998) conducted a field experiment on mungbean plants with 0.5 percent ZnSO₄ foliar spray seemed to have the highest seed yield (12.13 q/ha) when compared to control.

Sakal *et al.*, (1998) discovered that zinc application gradually improved chickpea seed yield from 14.5 to 19.0 quintal per hectare. As zinc dose increased from 2.5 to 10 kg per hectare, the response in terms of seed output differed from 150 to 450 kg per hectare. However, it was shown that applying zinc at a rate of 5 kg per hectare was optimum for chickpea.

Hugar and Kurdikeri (2000) found that, as compared to the control, soybean plants with foliar sprays of zinc sulphate @ 0.5% produced the maximum numbers of pods per plant (34.00), seeds per pod (2.60), and seed yield (23.40 q ha⁻¹).

Thalooth *et al.* (2001) found that when Fe, Mo, and Zn were sprayed as foliar fertilizer on broad bean plants to provide different micronutrients, and it was discovered that this caused an increase in the weight of the pods and the seed weight. Furthermore, neither spraying with various micronutrients nor applying P using various techniques had an impact on the proportion of shelling, according to their findings. When P was treated either foliarly or locally, foliar application of Fe or Mo produced the highest seed yield.

Mishra *et al.* (2001) observed that foliar application of boron @ 1 kg per hectare had an edge over control in terms of the number of pods per plant (50.66), seed weight per plant (8.68 g), and seed production (12.39 q ha⁻¹) for chickpea.

Maximum seeds per pod (1.30) and seed yield (17.96 kg ha⁻¹) over control (1.20 and 1180 kg ha⁻¹, respectively) were recorded in chickpea after foliar spraying with 0.2% borax 50 and 60 days after seeding (Masoodali and Mishra, 2001).

Khurana and Chatterjee (2002) revealed that foliar zinc sulphate application @ 0.065 mg per litre increased the number of pods per plant (8.62), the number of seeds per plant (5.68), and the weight of 100 seeds (17.51 g) in pea compared to control.

Vairavan *et al.* (2002) concluded that ZnSO₄ @ 25 kg per ha as a soil application together with RDF produced significantly greater yield-attributing characters, such as the number of pods per plant (196), the hundred seed weight (11.50 g), and the seed yield (2119 kg ha⁻¹, as compared to control.

According to Srimathi *et al.* (2002) pelleting soybean seeds with ZnSO₄ at a rate of 250 mg per kg of seed enhanced the seed's initial quality and output potential.

When ZnSO₄ was applied to the soil at a rate of 15 kg per hectare during an experiment on mungbean, it recorded the highest test weight (28.79 g) Vedram *et al.* (2002).

Sundara (2002) noted that with the application of 20 kg ZnSO₄ ha⁻¹ in pea, it was found that higher yield components, such as pods per plant (7.79), dry pod weight (7.09 g), seeds per pod (5.53), 100 seed weight (18.56 g), and seed yield (1777 kg ha⁻¹, were produced.

Salam *et al.* (2004) reported that the maximum pods per plant, seeds per pod, 100 seed weight, seed yield, and harvest index were obtained when 20 kg N+50 kg P+20 kg K + 20 kg S + 10 kg/ha borax was applied in urd bean.

Rao *et al.* (2004) conducted a chickpea pot experiments found that applying molybdenum foliarly (0.5 g/L sodium molybdate solution) for 8 hours increased yield by 27% compared to applying molybdenum to the soil.

Babu *et al.* (2005) found that application of a micronutrient mixture (2% iron + 1% manganese + 3% zinc + 0.5% boron) along with kaolin (17.5%) at 2% as compared to at 5% micronutrient mixture along with kaolin (15%) in green gramme resulted in a significant increase in shoot length (32.77 cm), seedling dry weight (13.90 mg), and vigour index (1390).

Malla *et al.* (2007) revealed that boron seed treatment (4 g/kg seeds) in pigeonpea was productive and cost-effective in enhancing seed production by 10.53% compared with soil application (10 kg/ha), which achieved a 5.26 % increase in seed yield.

Dixit and Elamathi (2007) demonstrated that foliar application of DAP 2 (%) + NAA 40 ppm + B 0.2 (%) + Mo 0.05 (%) at 30 DAS significantly increased the plant height (32.27 cm), number of pods per plant (25.86), test weight (30.33 g), and grain yield per ha (10.16 q) in comparison to the control (31.20 cm, 18, 26.63 g, and 6.26 q, respectively) in mung bean.

Singh *et al.* (2007) reported that cowpea plants produced significantly higher pods per plant and longer pods than controls when 30 kg N and 60 kg P₂O₅/ha were applied.

Pigeon pea crop manured with FYM at 5 t ha⁻¹ significantly improved pods per plant, grains per pod, grain weight per plant and test weight as compared to control over no manuring (Patil and Padmani, 2007).

Chandrashekhar (2008) found that the French bean genotypes DWD-FB-1, DWD-FB-57, and DWD-FB-53 recorded higher seed output (2412, 2247, and 2240 kg/ha), seed recovery (94.70, 92.93, and 91.45%, respectively), seed germination, and seedling vigour index when ZnSO₄ (100 mg) + Borax (250 mg) per kg of seeds was applied.

Monem *et al.* (2009) according to research on the effects of boron and zinc foliar applications on broad bean and lupin, the treated plants significantly increased most of the yield parameters, such as the number of pods and seeds per plant and the weight of 100 seeds.

Valenciano *et al.* (2010) reported that the application of Zinc at 2 mg per plot, Boron at 2 mg per plot and molybdenum at 2 mg per pot gave highest number of pod per plant (27.92) and seed yield (1478 kg ha⁻¹) in chickpea as compared to control (18.57 and 1170 kg ha⁻¹ respectively).

Shubhashree *et al.* (2011) reported that seeds per pod, 100 seed weight and seed yield per plant significantly higher with 80:75:30 N:P₂O₅:K₂O kg ha⁻¹ in common bean.

Pandey and Gupta (2012) found that foliar boron application at 0.1% improved the yield-attributing parameter such as number of pods (24.80), number of seeds per pod (6.20), and yield in blackgram (1.37 kg / plot) as compared to control (21.60, 5.40, and 1.09 kg / plot, respectively).

Nadia *et al.* (2013) revealed that when molybdenum was applied at a concentration of 16 ppm. cowpea plant produced more seed yield (1341 kg ha⁻¹) when compared to the control plant (959 kg ha⁻¹).

Arunakumar *et al.* (2013) reported that when sesame was treated with ZnSO₄ at a concentration of 300 mg/kg, the germination rate increased to 93%, the dry weight of seedlings increased to 63.7 mg, the seedling vigour index increased to 1341, and the electrical conductivity increased to 0.082 dSm⁻¹. These results were significantly higher than those of the control (80%, 52.00 mg, 856, and 0.139 dSm⁻¹, respectively).

Muhammad *et al.* (2014) recorded that when zinc sulphate was applied to the soil at a rate of 20 kg per ha in green gram, the maximum number of pod-bearing branches per plant (9.07), number of nodules per plant (14.00), number of seeds per pod (10.33), 100 seed weight (46.37 g), seed yield (1208.7 kg/ha), biological yield (5738.0 kg/ha), and harvest index (18.20%) were recorded as compared to other treatments.

Gomathi *et al.* (2014) found that when black gram seeds were treated with 100 ppm ZnSO₄ for 3 hours, coated with polymer at 3 ml per kg of seed, carbendazim at 2g per kg of seed, and imidacloprid at 1 ml per kg of seed, recorded significantly higher germination (98%), root length (19.5 cm), shoot length (21.9 cm), dry matter production (262 mg/ 10 seedling), vigour index (3891), and field emergence (89%) than control (92%, 18.10 cm, 19.50 cm, 221 mg/10 seedling, 3459 and 87%, respectively).

Kannan *et al.* (2014) observed a 15–18% improvement in seed yield in black gram, by applying 12.5:25:12.5:10 kg of NPKS per ha to the soil coupled with 5 kg per ha of micronutrient mixture as Enriched FYM.

The soybean seed quality parameters were significantly improved by the application of micronutrients. Seeds from the plots treated with a soil treatment of 30 kg ZnSO₄ per ha and a 0.5 percent foliar spray of ZnSO₄ had the highest seed vigour index (3948) and seed recovery (91%) (Priti *et al.*, 2015).

Shinde *et al.* (2016) Chickpea seeds were coated with seed polymer (6 ml/kg), ZnSO₄ + boron + ammonium molybdate + FeSO₄ each at 2 g per kg of seed, and received

two foliar sprays of ZnSO₄ and FeSO₄ in EDTA at intervals of ten days during flowering stage (50 and 60 DAS). This led to higher seed yield.

Khadgi (2016) the results revealed that the soil application of boron @ 10 kg ha⁻¹ + zinc sulphate @ 12 kg ha⁻¹ + molybdenum @ 2 kg ha⁻¹ in Field bean recorded significantly higher number of pods per spike (11.60), number of pods per plant (24.33), number of seeds per pod (3.70), seed yield (809 kg ha⁻¹) and seed quality parameters like germination (94 %), shoot length (17.07 cm), root length (13.80 cm), mean seedling length (30.57 cm), mean seedling dry weight (18.10 mg), seedling vigour index I (2873) and seedling vigour index II (1701).

Debnath *et al.* (2018) revealed that maximum average seed yield (2.24 t ha⁻¹) was obtained in treatment T9(RDF + 1.5 kg B ha⁻¹ + 5 kg Zn ha⁻¹) and minimum (1.41 t ha⁻¹) in treatment T1 (RDF).

Pramoda *et al.* (2018) reported that foliar spray of NAA @ 40 ppm during rabi season recorded higher seed yield and quality parameters as compared to control in dolichos bean.

Alam and Islam (2018) when zinc was applied, the highest seed yield (1.418 t/ha) obtained from 1.0 kg Zn/ha, which was similar (1.358 t/ha) with dose 1.0 kg Zn/ha and for boron application, the highest seed yield (1.550 t/ha) was found from the treatment 1.50 kg B/ha which was statistically identical with 3.0 kg B/ha.

Marzouk *et al.* (2019) Concluded that foliar application of zinc nano-fertilizer in snap bean significantly improved amount of fresh pods produced, pods of the highest physical quality and nutritional content in comparison to other nano micronutrients.

Doddamani *et al.* (2020) revealed that foliar spray of zinc and boron showed increased test weight and seed yield per plant, fruiting efficiency was also found to be positively correlated with the number of pods and seed yield in dolichos bean. Interestingly individual nutrient spray showed positive response whereas combined spray yield no such responses.

2.3 Estimation of economics of seed production of dolichos bean as influenced by Micro-nutrients and plant growth regulators

Amarnath (2001) obtained from Field bean maximum gross income (Rs.11403 ha⁻¹) and net income (Rs.5597 ha⁻¹) with the treatment combination of 125 kg seeds per ha at 30 cm row spacing supplied with 35:70:35 kg N:P:K /ha followed by gross income of Rs.10,201 and Rs.10,016 and net income of Rs.5362 and Rs.5296 with 25:50:25 and 15:30:15 kg N:P:K /ha fertility levels, respectively at same seed rate and row spacing. Whereas, maximum BC ratio of 1.31 was obtained with 75 kg seeds per ha with 30 cm row spacing supplied with 15:30:15 kg N:P:K /ha.

Salih (2013) The results of the analysis of variance showed that the effect of different treatments of Fe, B, and Zn @ 1% level on nutrient concentration and seed protein were significant. Iron treatment has a greater effect on the nutrient uptake and protein percentage of seed than other treatments. The study results explain that foliar fertilization with micronutrient may have a possibility role for increasing cowpea yield.

Mukund *et al.* (2014) reported that in pigeon pea the soil application of ZnSO₄ @ 25 kg ha⁻¹ along with foliar spray of 19:19:19 @ 0.4 % recorded higher net returns (Rs 36,323 ha⁻¹) followed by soil application of ZnSO₄ @ 25 kg ha⁻¹ along with foliar spray of 0:0:50 @ 0.3% (Rs 32,599 ha⁻¹). Soil application of borax @ 20 kg ha⁻¹ along with no foliar spray recorded lower net returns (Rs 14,468 ha⁻¹).

Lad *et al.* (2014) concluded that highest net returns were obtained with crop receiving 100 kg N/ha, in terms of gross return and net return increased consistently and significantly with varying levels of P up to 75 kg P₂O₅/ha. Whereas net return/rupee invested increased up to 100 kg N/ha and 50 kg P₂O₅/ha.

Adil *et al.* (2015) concluded that all fertiliser levels were found to be beneficial over control, suggesting that the application of fertiliser in appropriate proportions will always be profitable for the growers of French beans. The highest cost-benefit ratio was shown by Treatment-4 (90 kg N+90 kg P₂O₅+60 kg K₂O/ha) (1:6.05).

Khadgi (2016) revealed that foliar application of boron @ 0.2 % + zinc sulphate @ 0.5 % + Molybdenum @ 0.1 % in dolichos bean resulted in highest net returns (Rs. 34066).

Padma *et al.* (2020) concluded that Triacontanol @2 ppm foliar spray recorded significantly the highest plant height (68.4 cm), leaf area (1077.0 cm²), number of buds per node (4.87) and pod yield(190.1q/ha) and took least number of days to 50% flowering (41.64 days) in dolichos bean.

Dalai *et al.* (2020) discovered that higher fertilizer dose of 25:75:50 kg N:P:K /ha recorded highest benefit: cost ratio (5.27) during both the experimental years as well as in pooled data but it was at par with 25:75:25 kg N:P:K /ha. Hence, for profitable cultivation of vegetable type dolichos bean in northern transition zone of Karnataka, NPK fertilizer must be applied at the rate of 25:75:25 kg N:P:K /ha.

MATERIALS AND METHODS

This chapter describes the different materials and methods used during the experiment entitled “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” This field experiment was conducted during 2021-2022 at the Research Field of Central Horticultural Experiment Station (Aiginia), ICAR-IIHR, Bhubaneswar with the goal of investigating the effects of varying zinc, boron, NAA and GA₃ levels on growth, yield and seed quality. The following chapter contains a thorough summary of the materials used and procedures employed throughout the experiment.

3.1 Geographical location of the experimental site

The experimental location is situated in the Central Horticultural Experiment Station (Aiginia), ICAR-IIHR Bhubaneswar, situated in the Khordha district in the eastern part of Odisha. It lies at 85 78 11"E latitude 200 25" 09 N longitudes with an elevation of 25.7 meter above mean sea level and the location is 63 kilometers far from the sea. The experimental field's terrain was flat with adequate irrigation facilities.

3.2 Soil characteristics of the experimental site

The soil texture at the experimental area was medium sandy loam. The soil samples were taken and evaluated for physical and chemical properties prior to the beginning of the experiment. Table-3.1 displays the physical and chemical parameters of the soil.

Table 3.1. Soil physical and chemical characteristics of the experimental site

PHYSICAL PROPERTIES	VALUES
Sand (%)	82.4
Silt (%)	4.2
Clay (%)	13.4
Texture	Sandy loam

CHEMICAL PROPERTIES	VALUES
pH	4.9-5.3
Organic carbon %	0.4 %
NPK CONTENT DURING THE TIME OF CULTIVATION	
N	184.2 Kg/ha
P ₂ O ₅	18.6 kg/ha
K ₂ O	178.4 kg/ha

3.3 Climatic condition

3.3.1 Weather during the experimental period

The observations on climatic parameters during the period of investigation were obtained from the OUAT meteorological observatory and are presented in Table 3.2

Table 3.2 Meteorological data for the period of research from October 2021 to March 2022.

Month (2021-22)	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Mean bright sunshine hours/day	Wind velocity(Km/h r)
	Max	Min	Max	Min			
Oct	32.9	24.6	94	67.2	19.3	4.8	0.4
Nov	30.4	22.5	86.7	65.7	20.65	3.7	1.0
Dec	27.1	15.8	90.2	73.6	14.52	4.9	1.9
Jan	26.5	15	94.2	45.7	7.27	5.5	3.4
Feb	29.2	16.3	95	69.5	0	6.0	5.0
Mar	33.1	20.1	94	69	0	5.9	5.3

3.4 Previous cropping history

During the previous kharif season, the experimental plot was used for undertaking research trials on Dolichos bean, before sowing, the field was properly cultivated followed by harrowing until a fine tilth was achieved.

3.5 Experimental details

- i. Crop taken : Pole type dolichos bean
- ii. Variety taken for study : Arka Neelachal Pushti
- iii. Year of planting : 2021
- iv. Experimental Design : RBD
- v. Number of treatments : 10
- vi. Number of replications : 03
- vii. Row to row spacing : 2 m
- viii. Plant to plant spacing : 75 cm
- ix. Number of plants/Treatment/Replication : 20

3.5.1 Treatment details

- i. T₁ : Boron @ 0.2% as foliar spray
- ii. T₂ : Zinc @ 0.5% as foliar spray
- iii. T₃ : Boron @ 0.2% + GA3 @ 50 ppm as foliar spray
- iv. T₄ : Boron @ 0.2% + NAA @ 50 ppm as foliar spray
- v. T₅ : Zinc @ 0.5% + GA3 @ 50 ppm as foliar spray
- vi. T₆ : Zinc @ 0.5% + NAA @ 50 ppm as foliar spray
- vii. T₇ : Zinc @ 0.5% + Boron @ 0.2% as foliar spray
- viii. T₈ : Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm as foliar spray
- ix. T₉ : Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm as foliar spray
- x. T₁₀ : Control

3.5.2 Plan and Layout

The experiment was laid out in the randomized block design, with three replications.

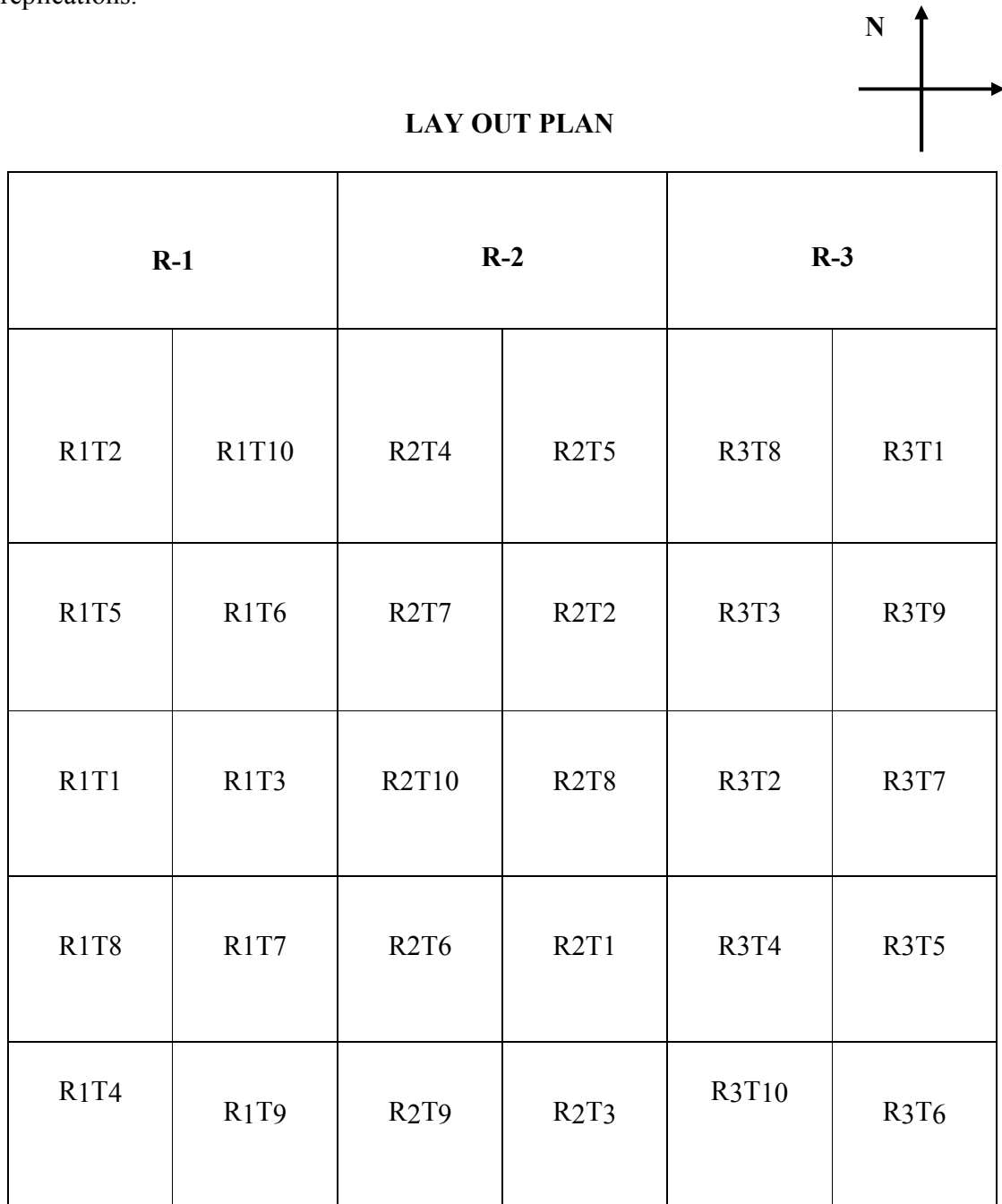


Fig. 1 Plan and layout of experimental plot

3.5.3 Varietal characteristics of Arka Neelachal Pushti

Arka Neelachal Pushti: It is a high yielding, pole type, round poded dolichos bean variety developed through pure line selection from local collection. The pods are oval, medium in size (7-7.5 cm long), straight, attractive green color, with bold and sweet seeds at edible maturity and good market acceptance. The pods are rich in protein (4.61 g/ 100 g) and micronutrients iron (15 ppm), zinc 37ppm). This is a medium maturity variety and takes approximately 95 days from sowing to green harvest.

3.6 Details of field operations

3.6.1 Field preparation

The experimental field was ploughed to a fine tilth. Recommended dose of fertilizer along with one ton of farm yard manure (FYM) were incorporated into the field. Then weeds, stones and other debris were removed from the field two weeks before seed sowing and the land was properly levelled. Plots were laid out using the Randomized Block Design (RBD) for ten treatments and three replications. The irrigation channels were laid out by following the gradient of the field on which experiment was done.

3.6.2 Manures and fertilizers

The recommended dose of Nitrogen, Phosphorus and Potassium (20:60:50 kg per ha) were incorporated to the experimental soil. The main sources of these soils were urea, single super phosphate (SSP) and muriate of potash (MOP) respectively. Nitrogen was provided in 2 splits i.e. 10 kg was applied as basal dose and 10 kg was applied as split dose at 30 days after sowing. The full dose of phosphorus and potash were applied at the time of sowing as basal dose.

3.6.3 Seed sowing

After planning the layout and making the sub-plots accordingly, the seeds were sown by dibbling at 3-4 cm deep in each replication randomly following the principle of RBD and two to three seeds were sown per hill. After sowing, the seeds were covered with soil and adequately irrigated.

3.6.4 Thinning of excess seedlings

After a span of 25 days weak and non-vigorous seedlings were thinned out and one good seedlings was left per hill. All the recommended practices were used for getting a good dolichos bean crop and all the treatments were given equal treatment while raising the crops.

3.6.5 Intercultural operations

Weeding: Weeding is the major problem in dolichos bean crop during early growth. Hand weeding was carried out by the help of sickle.

Staking: The genotype used for the experiment were pole type dolichos bean so they were raised on the trellis system using iron poles and wires. The pole type dolichos bean should be trained on some support always for better growth and fruit set.

3.6.6 Irrigation

Irrigation was done immediately after sowing further irrigations were given on regular basis depending on the soil moisture status of the field. During the experimental trial, irrigation was provided at 7-10 days interval basing upon the moisture regime of field soil. The flowering stage and pod development stage are critical stages for irrigation in dolichos bean.

3.6.7 Plant protection measures

During the raising of crop, it was observed that aphids and pod borers are the major pest in dolichos bean. Granular insecticides were sprayed to control these pest i.e. Aldicarb 10G @ 10-15 kg per hectare at the time of sowing was effective for aphids. Chlorpyrifos 25 EC @ 1.5 per cent spray was applied to control the pod borer incidence. The anthracnose and rust disease was found in the crop. Wettable sulphur @ 3g per litre was sprayed to control rust disease.

3.6.8 Harvesting

After reaching physiological maturity, the pods were collected when the pod colour changed to brown. Multiple harvesting of pods was done and sun dried separately as per the treatments. Then the seeds were extracted after proper sun drying.

3.7 Collection of Experimental data

3.7.1 Sampling technique

Ten plants were chosen randomly from each treatment and tagged to get different desirable observations. For each character under consideration, the mean values were taken for further analysis.

3.8 Observations recorded

3.8.1 Growth parameters

3.8.1.1 Plant height

Plant height was measured from soil surface to the tip of the main stem up to a fully opened top leaf on five randomly selected tagged plants. The average height was calculated and expressed in cm.

3.8.1.2 Average fresh leaf weight

Fresh leaf weight of ten randomly selected leaves from each treatment were measured separately and their average value was calculated and expressed in gram.

3.8.2 Flowering parameters

3.8.2.1 Number of days to 1st flowering

Each plot was monitored on a daily basis from the day of seeding. The number of days taken from the day of sowing to the commencement of the very 1st flower of the 1st plant out of the total number of plants in a treatment plot was observed and considered as days to flower initiation and presented in number of days.

3.8.2.2 Days to 50 percent flowering

The number of days from the date of seed sowing to 50 % flowering of the plant population within a treatment plot was calculated as days to 50 % flowering and expressed in days.

3.8.2.3 Panicle length

The average length of the panicle was measured from the point of its initiation till its apex and was expressed in centimeters.

3.8.3 Yield attributing parameters

3.8.3.1 Number of pods/plant

The pods from the ten matured tagged plants were counted and the average was calculated.

3.8.3.2 Average fresh pod weight

Ten randomly selected fresh pods were taken from the tagged plants and average pod weight was calculated and expressed in gram.

3.8.3.3 Length of fresh pod

Length of ten randomly selected fresh pods of each treatment was measured by using a thread and scale and the average value was calculated and expressed in centimeter.

3.8.3.4 Girth of fresh pod

Girth of ten randomly selected dried pods of each treatment was measured by using a thread and scale and the average value was calculated and expressed in centimeter.

3.8.3.5 Length of dried pods

Length of ten randomly selected dried pods of each treatment was measured by using a thread and scale and the average value was calculated and expressed in centimeter.

3.8.3.6 Girth of dried pod

Girth of ten randomly selected dried pods of each treatment was measured by using a thread and scale and the average value was calculated and expressed in centimeter.

3.8.3.7 Average weight of dried pod with seed

Ten fully matured pods were taken and sun dried for 4-5 days until a constant weight was reached, after which average pod weight was calculated and expressed in gram.

3.8.3.8 Average number of seeds/pod

The seeds from the ten randomly selected pods were extracted and counted. The average was calculated by dividing the total number of seeds by number of pods taken.

3.8.3.9 100 seed weight

The weight of 100 seeds was taken from dried pods randomly from each replication of every treatment separately and the average 100 seed weight was expressed in gram.

3.8.3.10 Average dried seed weight/pod

The total dried seed weight of ten randomly selected pods of each treatment was taken and the average value was calculated and expressed in gram.

3.8.3.11 Average dried shell weight

After seed extraction, the shell weight of ten pods was measured and average value was expressed in gram.

3.8.3.12 Total dried pod yield/plot

Total dried pod yield/plot was measured in kg in all the three replications and the average was calculated and expressed in kg/plot for all the treatments.

3.8.3.13 Total dried pod yield/ plant

Total dried pod yield/plant was measured by dividing pod yield/ plot with the number of plants in the plot for each treatment. The total pod yield was expressed in gram/plant.

3.8.3.14 Total dried pod yield/ ha

Total pod yield/ha was calculated by multiplying the total average pod yield/plot with the number of plots/ha. The seed yield was expressed in kg/hectare.

3.8.3.15 Total dried seed yield/plot

Total dried seed yield/plot was measured in kg in all the three replications and the average was calculated and expressed in kg/plot for all the treatments.

3.8.3.16 Total dried seed yield/ plant

Total dried seed yield/plant was measured by dividing the seed yield/ plot with the number of plants in the plot for each treatment. The total seed yield was expressed in gram/plant.

3.8.3.17 Total dried seed yield/ha

Total seed yield/ha was calculated by multiplying the total average seed yield/plot with the number of plots/ha. The seed yield was expressed in kg/hectare.

3.8.4 Seed quality parameters

3.8.4.1 Germination percentage

The germination test was carried out according to the ISTA rules (Anon-1999 b) with between paper method. On the tenth day, the number of normal seedlings were counted and expressed as germination percentage.

3.8.4.2 Average seedling length

On the tenth day, ten normal seedlings were chosen at random from each germination test and the seedling length was measured in centimeters.

3.8.4.3 Average seedling root length

On the tenth day, ten normal seedlings were chosen at random from each germination test and the seedling root length was measured in centimeters.

3.8.4.4 Average seedling shoot length

On the tenth day, ten normal seedlings were chosen at random from each germination test and the seedling shoot length was measured in centimeters.

3.8.4.5 Seedling dry weight

After measuring the average seedling length, ten seedlings of each treatment were dried in a hot air oven at $75 \pm 1^\circ\text{C}$ for 24 hours and seedling dry weight was measured. Then the average value was calculated and expressed in milligram.

3.8.4.6 Seedling vigour index

Seed vigour is defined by ISTA as “the sum total of those properties of the seed which determine the level of activity and performance of the seed of seed lot during germination and seedling emergence.” The vigour index was calculated using the formula proposed by Abdul-Baki and Anderson (1973), which is shown below

$$\text{Vigour index-I} = \text{Average germination (\%)} \times \text{Average seedling length (cm)}$$

$$\text{Vigour Index II} = \text{Average seedling dry weight (mg)} \times \text{Germination (\%)}$$

3.8.5 Economics

3.8.5.1 Total cost of cultivation (Rupees/ha)

Cost of cultivation during seed production was calculated by adding cost of all the inputs and labour cost during the trial.

3.8.5.2 Total income (Rupees/ha)

The value from the produce obtained was calculated as the total revenue in Rupees/ha based on the current market price of the seeds. This was computed by multiplying the total quantity of marketable seeds (kg) by the selling price of seeds/kg.

3.8.5.3 Benefit-cost ratio

The benefit cost ratio is an index that indicates total monetary income over each rupee invested under various treatments. The following formula was used to calculate it.

$$B : C = [\text{Total income (Rs. /ha)} / \text{Total cost of cultivation (Rs. /ha)}]$$

3.8.6 Statistical analysis

The experimental data were statistically analyzed using the analysis of variance technique proposed by Panse and Sukhatme (1985). The critical differences for the treatment comparison were determined, wherever the 'F' test was found to be significant at the 5% level of significance. To elucidate effects, summary tables with SEM± and critical difference as described in the chapter "Results," as well as their analysis of variance are provided in the appendices at the end.

Table 3.3 Analysis of variance (ANOVA)

Source	Degree of freedom (df)	Sum of square	Mean sum of square	F test
Replication	r-1	RSS	RSS/r-1 = RMS	RMS/EMS
Treatment	t-1	TSS	TSS/t-1 = TMS	TMS/EMS
Error	(r-1)(t-1)	ESS	ESS/(r-1)(t-1) = EMS	

$$SE(m) \pm : \sqrt{\frac{2 \text{ EMS}}{r}}$$

$$CD : SE(m) \times t \text{ value at error degree of freedom}$$

$$CV\% : (\sqrt{\text{EMS}} / \text{overall mean}) \times 100$$



Fig. 2 General view of the Experimental Plot



Fig. 3 Spraying of Micronutrients and Growth Regulators



Fig. 4 Taking Observations



Fig. 5 Flowering & Fruiting Stage

RESULTS

The field experiment entitled “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” This field experiment was conducted during 2021-2022 at the Research Field of Central Horticultural Experiment Station (Aiginia), ICAR-IIHR, Bhubaneswar. Data on growth, seed yield, seed quality and other parameters recorded throughout the course of investigation were statistically analyzed and presented in this chapter.

4.1 Growth parameters

4.2 Flowering behavior

4.3 Yield attributing characters

4.4 Seed quality parameters

4.5 Economics

4.1 Growth parameters

4.1.1 Plant height

The data presented on plant height at harvest presented in Table 4.1. During the experiment, it was observed that maximum plant height was recorded in treatment T₉ (434.14 cm) followed by T₈ (422.94 cm) and T₆ (421.67 cm) and lowest in T₁₀ (393.93 cm). It was observed that there was no significant variation in plant height among the treatments.

4.1.2 Panicle length (cm)

It was found that panicle length varied from 22.62 cm to 21.38 cm. The minimum panicle length was recorded in T₁₀ (21.38 cm) followed by T₅ (21.63 cm) and T₆ (21.72 cm) while, the maximum panicle length was obtained in T₉ (22.62 cm) followed by T₈ (22.39 cm) and T₁ (22.26 cm). From the result shown in table 4.1 it was observed that there was no significant difference among the treatments.

4.1 Mean performance of different treatments on Arka Neelachal Pushti for plant height, panicle length and average fresh leaf weight

Treatments		Plant Height at Harvest (cm)	Panicle Length (cm)	Average Fresh Leaf Weight (g)
T ₁	Boron @ 0.2%	400.27	22.26	3.60
T ₂	Zinc @ 0.5%	398.73	21.81	3.31
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	408.76	21.92	3.65
T ₄	Boron @ 0.2% + NAA @ 50 ppm	415.17	22.06	3.84
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	401.43	21.63	3.32
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	421.67	21.72	3.39
T ₇	Zinc @ 0.5% + Boron @ 0.2%	411.27	22.04	3.88
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	422.94	22.39	4.06
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	434.14	22.62	3.91
T ₁₀	Control	393.93	21.38	3.28
S.E (m)±		24.37	0.98	0.09
C.D.at 5%		NS	NS	0.28
CV%		10.28	7.529	4.58

4.1.3 Average fresh leaf weight (g)

The data on average fresh leaf weight varied significantly by influence of different micro-nutrients and growth regulators treatments and presented in Table 4.1. The range of average fresh leaf weight varied from 4.06 g to 3.28 g. The maximum fresh leaf weight was recorded in T₈ (4.06 g) which was found to be at par with treatment T₉ (3.91 g), T₇ (3.88g) and T₅ (3.84 g). All the above treatments were found to be significantly superior to the rest of the treatments.

4.1.4 Number of flowers/ panicle

An appraisal of data pertaining to number of flowers/ panicle, which was influenced by application of different levels of treatments are presented in Table 4.2. The results revealed that maximum flowers/ panicle was recorded in T₉ (33.38) which was found to be at par with treatment T₁ (33.16), T₈ (31.94), T₄ (31.91), T₇ (31.34) and T₃ (31.17). All the above treatments were found to be significantly superior to the rest of the treatments.

4.1.5 Number of pods/ panicle

The data on number of pods/panicle as influenced by application of different treatments are presented in Table 4.2. The results revealed that maximum pods/ panicle was recorded in T₉ (10.40) followed by treatment T₁ (9.73), T₃ (9.60), T₇ (9.46), T₄ (9.33) and T₈ (9.03). However it was observed that there was no significant variation in number of pods/panicle.

4.2 Flowering behavior

4.2.1 Days to 1st flowering

The number of days required for 1st flowering is presented in Table 4.3. The least number of days was observed in treatment T₄ (49.34 days) whereas most number of days was recorded in treatment T₁₀ (51.67 days). However it was observed that there was no significant variation in days to 1st flowering among the treatments.

4.2.2 Days to 50% flowering

The number of days required for 50% flowering is presented in Table 4.3. The least number of days was observed in treatment T₄ (54.66 days) whereas maximum number of

4.2 Mean performance of different treatments on Arka Neelachal Pushti for days to 1st flowering, days to 50% flowering and Number of flowers/ panicle

Treatments		Days to 1st flowering	Days to 50% flowering	Number of flowers/ panicle
T ₁	Boron @ 0.2%	50.67	58.33	33.16
T ₂	Zinc @ 0.5%	51.33	58.66	30.38
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	50.67	57.66	31.17
T ₄	Boron @ 0.2% + NAA @ 50 ppm	49.34	54.66	31.91
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	50.67	58.33	30.78
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	49.66	56.66	30.68
T ₇	Zinc @ 0.5% + Boron @ 0.2%	50.67	57.33	31.34
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	50.33	57.33	31.94
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	49.67	56.33	33.38
T ₁₀	Control	51.67	59.33	28.90
S.E (m)±		1.27	0.78	1.04
C.D.at 5%		NS	2.326	NS
CV%		4.36	4.32	3.13

4.3 Mean performance of different treatments on Arka Neelachal Pushti for average fresh pod weight, average fresh pod length and average fresh pod girth

Treatments		Number of pods/panicle	Average fresh pod weight (gm)	Length of fresh pod (cm)	Girth of fresh pod (cm)
T ₁	Boron @ 0.2%	9.73	4.15	7.98	3.47
T ₂	Zinc @ 0.5%	8.20	3.61	7.87	3.36
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	9.60	4.15	8.03	3.76
T ₄	Boron @ 0.2% + NAA @ 50 ppm	9.33	4.98	8.99	4.33
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	8.36	4.04	8.23	3.57
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	8.00	4.44	8.37	3.82
T ₇	Zinc @ 0.5% + Boron @ 0.2%	9.46	4.55	8.27	3.84
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	9.03	4.15	8.05	3.41
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	10.40	6.14	9.17	3.90
T ₁₀	Control	7.06	3.59	7.74	3.34
S.E (m)±		0.62	0.14	0.10	0.07
C.D.at 5%		NS	0.42	0.32	0.22
CV%		12.19	5.65	2.28	3.48

days was recorded in treatment T₁₀ (59.33 days). It was observed that there was no significant variation in days to 1st flowering among the treatments.

4.3 Yield attributing characters

4.3.1 Average fresh pod weight

The data on average fresh pod weight varied significantly by different micro-nutrients and growth regulators treatments are presented in Table 4.4. The results revealed that maximum fresh pod weight was recorded in treatment T₉ (6.14 g) and was significantly higher than rest of the treatments. The lowest fresh pod weight was observed in T₁₀ (3.59 g).

4.3.2 Length fresh pod

The data on average fresh pod length varied significantly by different micro-nutrients and growth regulators treatments are presented in Table 4.4. The range of pod length varied from 9.17 cm to 7.74 cm. The results revealed that maximum pod length was observed in treatment T₉ (9.17 cm) which was found to be at par with treatment T₄ (8.99 cm). Both the above treatments were found to be significantly higher than rest of other treatments.

4.3.3 Girth fresh pod

The data on average fresh pod girth varied significantly by different micro-nutrients and growth regulators treatments are presented in Table 4.4. The results revealed that maximum pod girth was observed in treatment T₄ (4.33 cm). The above treatment was found to be significantly higher than rest of other treatments.

4.3.4 Average dried pod weight with seeds

The data on average dried pod weight with seed as influenced by application of different treatments are presented in Table 4.5. The results revealed that the highest dried pod weight was recorded in treatment T₉ (2.38 g) which was found to be at par with treatment T₄ (2.19 g) followed by treatment T₇ (2.10 g). All the above treatments were found to be significantly higher than treatments T₁, T₂, T₃, T₅, T₆, T₈ and T₁₀.

4.4 Mean performance of different treatments on Arka Neelachal Pushti for average dried pod weight with seeds, average dried pod girth and average dried pod length

Treatments		Average dried pod weight with seeds (g)	Length of dried pod (cm)	Girth of dried pod (cm)
T ₁	Boron @ 0.2%	1.92	3.01	7.23
T ₂	Zinc @ 0.5%	1.78	2.81	7.15
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	1.85	3.08	7.24
T ₄	Boron @ 0.2% + NAA @ 50 ppm	2.19	3.15	7.75
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	1.81	2.85	7.28
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	1.96	3.02	7.47
T ₇	Zinc @ 0.5% + Boron @ 0.2%	2.10	3.08	7.32
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	1.83	2.92	7.27
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	2.38	3.19	8.08
T ₁₀	Control	1.70	2.79	7.11
S.E (m)±		0.10	0.10	0.05
C.D.at 5%		0.29	0.31	0.17
CV%		8.88	2.50	3.37

4.3.5 Girth of dried pod

The data on girth of dried pod (cm) varied significantly by different micro-nutrients and growth regulators treatments are presented in table 4.6. The girth of dried pod varied from 3.19 cm to 2.79 cm. Maximum girth of dried pod was observed in T₉ (3.19 cm) which was found to be at par with treatments T₄ (3.15 cm), T₃ (3.08 cm), T₇ (3.08 cm) and T₆ (3.02 cm). All the above treatments were found to be significantly superior to the rest of the treatments.

4.3.6 Length of dried pod

The data on length of dried pod varied significantly as influenced by application of different treatments are presented in Table 4.6. The results revealed that maximum dried pod length was recorded in treatment T₉ (8.08 cm). And was found to be significantly higher than rest of other treatments. The lowest dried pod length was recorded in treatment T₁₀.

4.3.7 Average dried seed weight/ pod

The witnessed data documented in the table 4.6 was analyzed statistically and found that significant differences was observed between treatments. The highest dried seed weight/ pod was found in treatment T₉ (2.08 g) which was found to be statistically at par with treatment T₄ (1.95 g). Both the above treatments were found to be significantly higher than rest of other treatments.

4.3.8 Average dried shell weight

The witnessed data demonstrated in the table 4.6 was analyzed statistically and found that significant differences are observed for the treatments with respect to dried shell weight. The highest dried shell weight was observed in treatment T₉ (0.45 g) which was significantly superior over other treatments and statistically at par with treatment T₄ (0.43 g).

4.3.9 Number of seeds/ pod

The data on days to first flowering are presented in Table 4.6. The perusal of data for number of seeds/ pod ranged from 5.43 to 4.93 and Significant differences were

4.5 Mean performance of different treatments on Arka Neelachal Pushti for average dried seed weight/ pod, average no. of seeds/ pod and 100 seed weight

Treatments		Average dried seed weight/ pod (g)	Average dried shell weight	Number . of seeds/ pod	100 seed weight (g)
T ₁	Boron @ 0.2%	1.56	0.40	5.03	35.10
T ₂	Zinc @ 0.5%	1.45	0.31	5.01	33.47
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	1.56	0.38	5.03	33.90
T ₄	Boron @ 0.2% + NAA @ 50 ppm	1.95	0.43	5.20	39.36
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	1.43	0.35	5.06	33.89
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	1.63	0.38	5.16	36.31
T ₇	Zinc @ 0.5% + Boron @ 0.2%	1.72	0.40	5.10	38.65
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	1.51	0.36	5.03	34.99
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	2.08	0.45	5.43	37.28
T ₁₀	Control	1.43	0.35	4.93	30.39
S.E (m)±		0.05	0.01	0.08	0.90
C.D.at 5%		0.16	0.04	0.24	2.72
CV%		5.88	6.05	2.79	4.46

observed between the treatments. The maximum number of seeds were recorded in the treatment T₉ (5.43) which was found to be statistically at par with treatment T₄ (5.20) and the above treatments were found to be significantly higher than rest of other treatments.

4.3.10 100 seed weight

It was found that 100 dried seed weight varied from 39.36 g to 30.39 g and Significant differences were observed between the treatments which was presented in table 4.6. The highest 100 seed weight was obtained in treatment T₄ (39.36 g) which was found to be statistically at par with treatments T₇ (38.65 g) and treatment T₉ (37.28 g). All the above treatments were found to be significantly superior to the rest of the treatments.

4.3.11 Dried pod yield/ plot

The witnessed data demonstrated in the table 4.7 was analyzed statistically and found that significant differences are observed for the treatments with respect to dried pod yield/ plot. The maximum pod yield/ plot was recorded in treatment T₉ (5.46 kg) and was found to be statistically at par with the treatment T₇ (5.09 kg). And was found to be significantly higher than rest of other treatments.

4.3.12 Dried pod yield/ plant

It was found that dried pod yield/plant varied from 0.27 g to 0.18 g and significant differences were observed between the treatments which was presented in table 4.7. The maximum pod yield/ plant was recorded in treatment T₉ (0.24 g) which was found to be statistically at par with treatments T₈ (0.24 g), T₄ (0.24 g) and T₁ (0.23 g). All the above treatments were found to be significantly superior to the rest of the treatments.

4.3.13 Dried pod yield/ ha

Total dried pod yield/ ha varied from 3604.04 kg to 2378.20 kg and significant differences were observed between the treatments which was presented in table 4.7. The maximum pod yield/ plant was recorded in treatment T₉ (3604.04 kg) which was found to be statistically at par with treatment T₈ (3358.52 g). Both the above treatments were found to be significantly superior to the rest of the treatments.



Fig. 6. Harvesting dried pods



Fig. 7. Sun drying of harvested pods



Fig. 8. Selecting 100 no. of seeds randomly from each treatment

4.6 Mean performance of different treatments on Arka Neelachal Pushti for dried pod yield/ plot, dried pod yield/ plant and total pod yield/ ha

Treatments		Dried pod yield/ plot (kg)	Dried pod yield/ plant (kg)	Total pod yield/ ha (kg)
T ₁	Boron @ 0.2%	4.62	0.23	2654.52
T ₂	Zinc @ 0.5%	3.85	0.19	2381.28
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	3.61	0.18	3102.44
T ₄	Boron @ 0.2% + NAA @ 50 ppm	4.73	0.24	2944.92
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	4.46	0.22	3049.01
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	4.02	0.20	2541.44
T ₇	Zinc @ 0.5% + Boron @ 0.2%	5.09	0.25	3120.48
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	4.70	0.24	3358.52
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	5.46	0.27	3604.04
T ₁₀	Control	3.60	0.18	2378.20
S.E (m)±		0.22	0.01	147.56
C.D.at 5%		0.66	0.03	438.37
CV%		8.77	8.77	8.77

4.7 Mean performance of different treatments on Arka Neelachal Pushti for dried seed yield/ plot, dried seed yield/ plant and total seed yield/ ha

Treatments		Dried seed yield/ plot (kg)	Dried seed yield/ plant (Kg)	Total seed yield/ ha (kg)
T ₁	Boron @ 0.2%	3.51	0.18	2188.56
T ₂	Zinc @ 0.5%	2.97	0.15	1933.80
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	2.93	0.15	2401.52
T ₄	Boron @ 0.2% + NAA @ 50 ppm	3.66	0.18	2270.84
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	3.44	0.17	2316.16
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	3.32	0.17	1960.64
T ₇	Zinc @ 0.5% + Boron @ 0.2%	3.93	0.20	2415.60
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	3.64	0.18	2596.44
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	4.33	0.22	2859.12
T ₁₀	Control	2.86	0.14	1887.60
S.E (m)±		0.18	0.09	121.52
C.D.at 5%		0.54	0.02	361.01
CV%		9.22	9.21	9.22

4.3.14 Dried seed yield/ plot

The witnessed data demonstrated in the table 4.8 was analyzed statistically and found that significant differences are observed for the treatments with respect to dried seed yield/ plot. The maximum seed yield/ plot was recorded in treatment T₉ (4.33 kg) and was found to be statistically at par with the treatment T₇ (3.93 kg). And was found to be significantly higher than rest of other treatments.

4.3.15 Dried seed yield/ plant

It was found that dried seed yield/plant varied from 0.22 g to 0.14 g and significant differences were observed between the treatments which was presented in table 4.8. The maximum seed yield/ plant was recorded in treatment T₉ (0.22 g) which was found to be statistically at par with treatment T₇ (0.20 g). Both the treatments were found to be significantly superior to the rest of the treatments.

4.3.16 Dried seed yield/ ha

Total dried seed yield/ ha varied from 2859.12 kg to 1887.60 kg and significant differences were observed between the treatments which was presented in table 4.7. The maximum seed yield/ ha was recorded in treatment T₉ (2859.12 kg) which was found to be statistically at par with treatment T₈ (2596.12 kg). Both the above treatments were found to be significantly superior to the rest of the treatments.

4.4 Seed quality parameters

4.4.1 Germination %

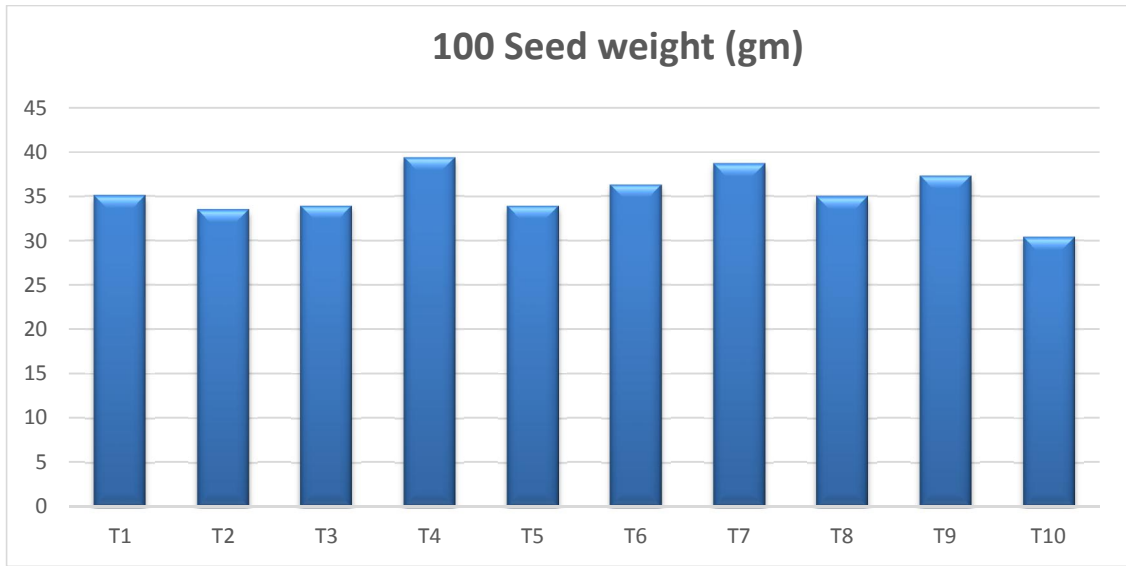
The data presented on germination percentage as influenced by different treatments are presented in Table 4.9. The findings indicated that germination percentage showed significant differences among the treatments. The maximum germination percentage was recorded in treatment T₉ (66.41 %) which was found to be significantly superior over other treatments and statistically at par with treatments T₈ (63.12 %), T₇ (63.07 %), T₃ (62.23 %) and T₅ (60.99 %).

4.4.2 Average seedling length (cm)

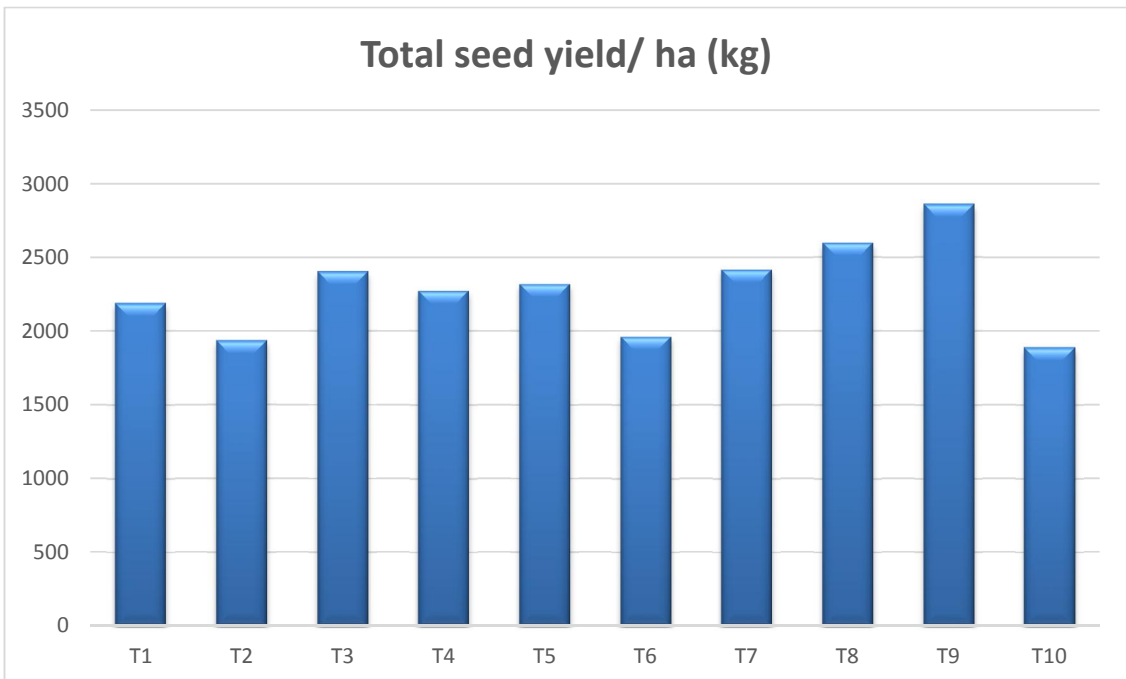
The witnessed data demonstrated in the table 4.9 was analyzed statistically and found that significant differences are observed for the treatments with respect to average seedling length. The maximum seedling length was found in the treatment T₉ (55.94 cm)

4.8 Mean performance of different treatments on Arka Neelachal Pushti for germination %, average seedling length and average seedling dry weight

Treatments		Germination %	Average seedling length (cm)	Seedling dry weight (mg)
T ₁	Boron @ 0.2%	51.62	47.23	1750
T ₂	Zinc @ 0.5%	49.98	41.44	1660
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	62.23	49.87	1800
T ₄	Boron @ 0.2% + NAA @ 50 ppm	52.34	47.69	1770
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	60.99	49.64	1790
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	50.41	42.81	1660
T ₇	Zinc @ 0.5% + Boron @ 0.2%	63.07	52.83	1860
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	63.12	54.49	1890
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	66.41	55.94	2160
T ₁₀	Control	47.25	36.49	1610
S.E (m)±		4.47	1.75	44.62
C.D.at 5%		13.29	5.20	132.56
CV%		13.66	6.33	4.30



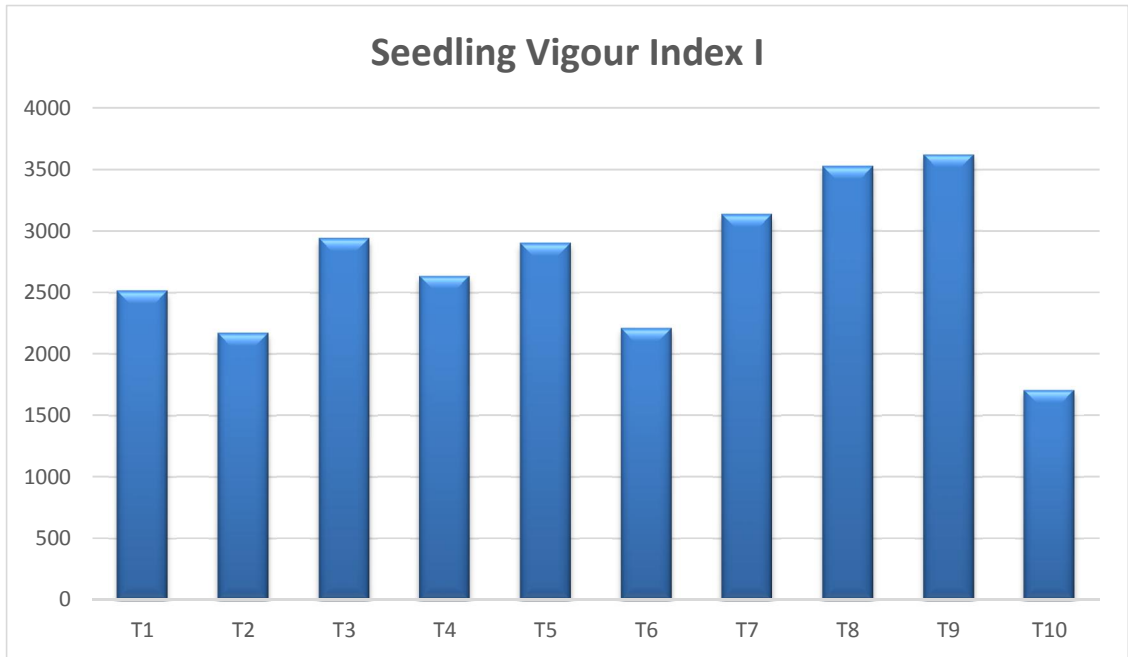
Graph 4.1. Effect of different micronutrients and growth regulators on 100 Seed weight



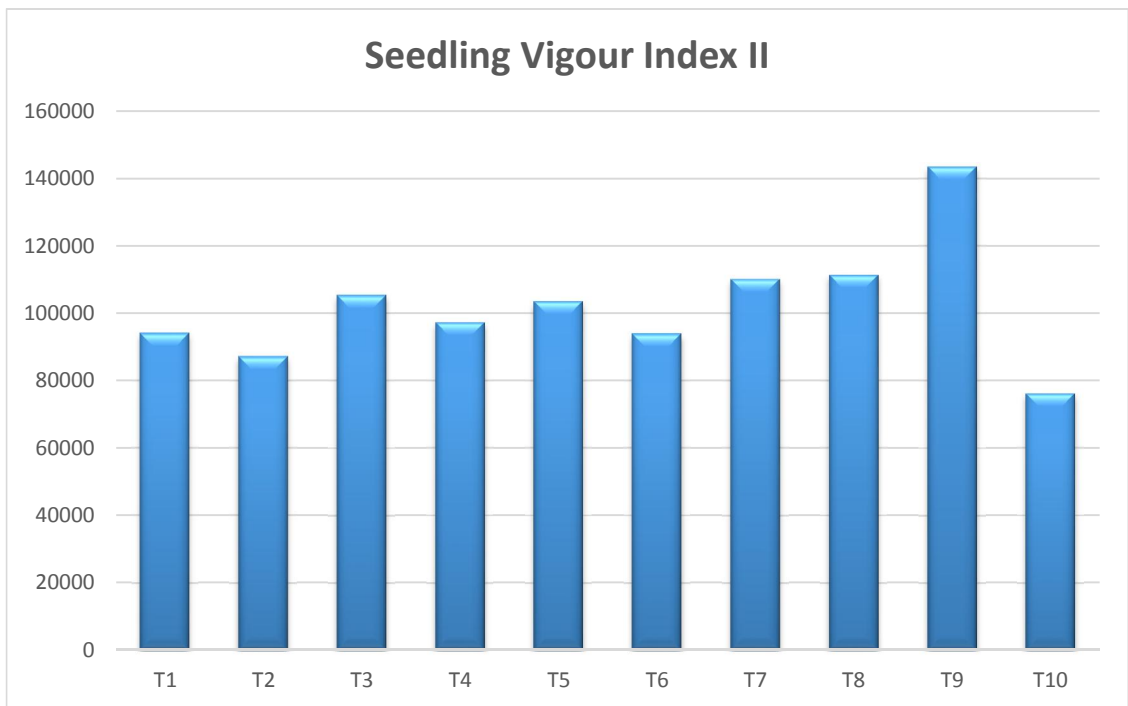
Graph 4.2. Effect of different micronutrients and growth regulators on Total seed yield/ ha

4.9 Mean performance of different treatments on Arka Neelachal Pushti for seedling vigour index I and seedling vigour index II

Treatments		Vigour index I	Vigour index II
T ₁	Boron @ 0.2%	2515.94	94138.96
T ₂	Zinc @ 0.5%	2171.97	87214.15
T ₃	Boron @ 0.2% + GA3 @ 50 ppm	2941.35	105452.55
T ₄	Boron @ 0.2% + NAA @ 50 ppm	2634.67	97275.14
T ₅	Zinc @ 0.5% + GA3 @ 50 ppm	2903.94	103556.05
T ₆	Zinc @ 0.5% + NAA @ 50 ppm	2209.70	93942.63
T ₇	Zinc @ 0.5% + Boron @ 0.2%	3138.14	110183.45
T ₈	Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm	3529.08	111372.21
T ₉	Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm	3621.91	143604.57
T ₁₀	Control	1705.99	76197.52
S.E (m)±		228.99	8626.40
C.D.at 5%		680.29	25627.45
CV%		14.94	14.61



Graph 4.1. Effect of different micronutrients and growth regulators on Seedling vigour index I



Graph 4.1. Effect of different micronutrients and growth regulators on Seedling vigour index II

which was found to be statistically at par with treatments T₈ (54.49 cm) and T₇ (52.83cm). And was found to be significantly higher than rest of other treatments.

4.4.3 Seedling dry weight (mg)

The data on seedling dry weight (mg) varied significantly by different micro-nutrients and growth regulators treatments are presented in Table 4.9. The results revealed that maximum seedling dry weight was recorded in treatment T₉ (2.16 mg) and was significantly higher than rest of the treatments. The lowest seedling dry weight was observed in T₁₀ (1.61 mg).

4.4.4 Seedling vigour index I

Vigour index-I among different treatments was calculated and presented in Table 4.9. The highest vigour index-I was obtained in T₉ (3621.91) which was found to be statistically at par with treatments T₈ (3529.08) and T₇ (3138.14). And was found to be significantly higher than rest of other treatments.

4.4.5 Seedling vigour index II

Vigour index-II among different treatments was calculated and presented in Table 4.9. The highest vigour index-II was obtained in T₉ (143604.57). And was found to be significantly higher than rest of other treatments. The lowest vigour index II was recorded in treatment T₁₀ (76197.52).

4.5 Economics

The data on economics of seed production in dolichos bean, var. Arka Neelachal Pushti is presented in Table 4.10. The total cost of cultivation was lowest in T₁₀ (Rs. 1,75,594) and highest in T₉ (Rs. 1,83,794).

4.10 Economics of seed production in dolichos bean, var. Arka Neelachal Pushti

Treatments	Cost of cultivation (Rs)	Yield/ ha (kg)	Rate of seeds/ kg	Gross return (Rs)	B:C ratio
T ₁	181194	2188.56	300	656568	2.62
T ₂	177094	1933.80	300	580140	2.27
T ₃	181794	2401.52	300	720456	2.96
T ₄	181694	2270.84	300	681252	2.74
T ₅	177694	2316.16	300	694848	2.91
T ₆	177594	1960.64	300	588192	2.31
T ₇	182694	2415.60	300	724680	2.96
T ₈	183294	2596.44	300	778932	3.24
T ₉	183794	2859.12	300	857700	3.66
T ₁₀	175594	1887.60	300	566280	2.22

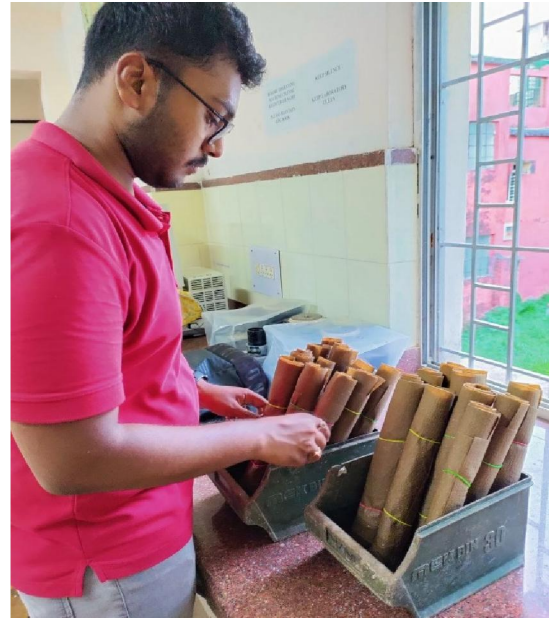


Fig. 6. Seed germination test by between paper method (Roll Towel Method)



Fig. 7. Measuring the length of seedlings of different treatments



Fig.8. Drying seedlings in hot air oven

DISCUSSION

The field experiment entitled “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” was conducted during 2021-2022 at the Research Field of Central Horticultural Experiment Station , ICAR-Indian Institute of Horticultural Research, Bhubaneswar. The key findings obtained throughout the experiment are described in this chapter in the following broad groupings, with appropriate references in order to establish a cause and effect link in light of available data and literature.

1. **Growth parameters**
2. **Flowering behaviour**
3. **Yield attributing characters**
4. **Seed quality parameters**
5. **Economics**

5.1 Vegetative growth parameters

5.1.1 Plant height, panicle length and fresh leaf weight

Maximum plant height (434.14 cm) and panicle length (22.62 cm) was observed in T₈ (Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm) There was no significant difference for plant height and panicle length found among the treatments. However, there was slight increase in plant height T₈ (434.14 cm) followed by T₉ (422.94 cm) and T₆ (421.67 cm) and lowest in T₁₀ (393.93 cm) as well as in panicle length where the maximum length was obtained in T₈ (22.62 cm) and minimum in T₁₀ (21.38 cm). The slight increase in plant height and panicle length might be attributed to the combined effect of micronutrients and growth regulators in tissue development, cell division, the development of vigorous and stronger root system there by enabling the plant to derive available soil moisture and nutrients and hence resulted in increased plant height and also which might be due to apical dominance effect of auxins resulted in rapid cell division and cell elongation in the growing portions of the plant or stimulation of growth besides increasing uptake of nutrients (Pandita *et al.*, 1980) and Ravichandran (1989). Similar results were reported by Chaudhary *et al.*, (2006) in chilli and Singh (2010) in fenugreek. Bhattacharya *et al.* (1997) in groundnut, Ponnuswamy and Vijaya (1997) in cowpea, Vijaya and Ponnuswamy (1998) in black gram.

Application of micronutrients and growth regulators through foliar spray has shown significant difference with respect to fresh leaf weight The maximum fresh leaf weight was

recorded in T₈ Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm (4.06 g) which was found to be at par with treatment T₉ (3.91 g), T₇ (3.88g) and T₅ (3.84 g)

5.1.2 Number of flowers/ panicle and number of pods/ panicle

The data on number of flowers/ panicle varied significantly among the treatments was recorded in T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm (33.38) which was found to be at par with treatment T₁ (33.16), T₈ (31.94), T₄ (31.91), T₇ (31.34) and T₃ (31.17). Whereas the data on number of pods/panicle did not show significant differences. The results revealed that maximum pods/ panicle was recorded in T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm (10.40) followed by treatment T₁ (9.73), T₃ (9.60), T₇ (9.46), T₄ (9.33) and T₈ (9.03). This might be due to combined application of boron and zinc which reduces flower drop increases the number of flowers per plant and fruiting efficiency in field bean. Further, it was reported that Planofix (NAA) has showed beneficial effect on preventing flower drop in legume crops which may be perhaps due to maintenance of favorable balance of endogenous hormones related to flowering and phenological traits which in turn resulted in decrease in flower drop but increase of pod yield per hectare. Similar reports were also reported by Pramoda and Sajjan, (2018) Jaisankar and Manivannan, (2018), Dahmardeh *et al.*, (2010) and Upadhayay, (2010) in lablab and chick pea and Doddamani *et al.*, (2020) in dolichos bean.

5.2 Flowering behavior

5.2.1 Days to 1st flowering and Days to 50% flowering

Foliar application of plant growth regulators and micro-nutrients did have a significant effect on days to 1st and 50% flowering. The least number of days require for 1st flowering (49.34) and 50% flowering (54.66) was observed in treatment T₄ - Boron @ 0.2% + NAA @ 50 ppm. The early flowering in treated plants could be attributed to increased photosynthesis and respiration with enhanced CO₂ concentration in early stage of growth. This finding is in conformity with the reports of Kalyani (1993) that number of pods per plant and reduced number of days to flowering with application of Boron (300 ppm) in Pigeon pea and Kumanan *et al.*, (2020) in dolichos bean.

5.3 Yield attributing characters

5.3.1 Average fresh pod weight, length and girth

The yield attributing parameters like fresh pod weight, length and girth of pod are directly related to seed yield of dolichos bean. Maximum fresh pod weight (6.48 g) and fresh pod length (9.17 cm) was recorded in T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm and lowest in T₁₀ (fresh pod weight-3.59 g and length- 7.74 cm) while maximum fresh pod

weight was found to be significantly superior to rest of other treatments, fresh pod length was found to be statistically at par with treatment T₄ - Boron @ 0.2% + NAA @ 50 ppm (length- 8.99 cm). The data on girth of fresh pod have also shown significant differences the maximum girth (4.33 cm) was observed in treatment T₄ - Boron @ 0.2% + NAA @ 50 ppm which was found to be significantly superior to rest of the treatments. This result might be due to the interaction effect of micronutrients and NAA which increased rate of cell elongation process. These results were supported by Gowda (1977), Kandagal (1990) in green gram and Medhi (2000) in French bean and Kumanan *et al.*, (2020) in dolichos bean.

5.3.2 Average dried pod weight with seeds, length and girth of dried pod

The data on average dried pod weight, length and girth of dried pod varied significantly by the application on micronutrients and growth regulators. The maximum dried pod weight with seeds, length and girth were found to be maximum (2.38 cm, 8.08cm, 3.19 cm) in the treatment T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm. While maximum dried pod girth was found to be significantly superior to all other treatments, weight of dried pod found to be statistically at par with treatments T₄ (2.19 g) and T₇ (2.10 g) and data on girth of dried pod found to be at par with treatments T₄ (3.15 cm), T₃ (3.08 cm), T₇ (3.08 cm) and T₆ (3.02 cm). This might be due to Auxins which promote growth along longitudinal axis, when applied in low concentration to shoot of the plant. The increased yield may be attributed to higher dry matter production and chlorophyll content and all these parameters are having a significant and positive correlation with seed yield as reported by Ramesh and Ramprasad (2013) in soybean. These results were in line with the reports of Upadhyay (2002), who reported that foliar application of NAA improved the yield in chickpea which was due to their stimulative action to improve vegetative growth and biochemical constituents like chlorophyll.

5.3.3 Average dried seed weight/ pod, average dried shell weight, number of seeds/ pod and 100 seed weight

In the present study, it was revealed that the application of micronutrients and plant growth regulators significantly increased the dried seed weight/ pod, shell weight, number of seeds per pod and 100 seed weight which are the most important yield determining components in dolichos bean. The results of this study indicated that maximum dried seed weight/ pod, dried shell weight and number of seeds/ pod (2.08 g, 0.45 g, 5.43) in treatment T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm which were found to be statistically at par with treatment T₄ - Boron @ 0.2% + NAA @ 50 ppm This may be due to interaction effect

of boron and NAA, which helps in better vegetative growth and assimilation of nutrients which might have translocated to reproductive parts and ultimately resulted in improving the number of seeds/ pods, dried seed weight and shell weight . Similar findings were reported by Shirpurkar *et al.*, (2006) in soybean. These results were in line with the reports of Upadhyay (2002). Likewise, developing seeds are the major sources of auxin and gibberellin like substances responsible for higher pod set with more seeds. In the present study, the exogenous applications of chemicals have boosted the above processes resulting into higher number of seeds per pod. These results are in accordance with those reported by Swamy *et al.*, (1983) in pea and Hoque and Hoque (2002) in mung bean, Jadhav *et al.*, (1987) in Indian bean and Sharma *et al.*, (1989) in Soybean.

Significant differences were also observed in case of 100 seed weight, where the highest 100 seed weight was obtained in treatment T₄ - Boron @ 0.2% + NAA @ 50 ppm (39.36 g) which was found to be statistically at par with treatments T₇ (38.65 g) and treatment T₉ (37.28 g) The increased 100 seed weight might be due to combined effect of micronutrients on pollen germination, seed development, cell division, translocation of sugar and starch from source to sink (Dileep kumar *et al.*, 2009). The results are in comfirmity with findings of Dixit and Elamathi (2007) in green gram and Umarani *et al.*, 2003 in black gram.

5.3.4 Dried seed yield and pod yield

The data on dried pod yield/ ha and dried seed yield/ ha varied significantly by the application on micronutrients and growth regulators. The maximum dried pod yield/ ha and dried seed yield/ ha were found to be maximum (3604.04 kg, 2859.12 kg) in the treatment T₉ - Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm. And both were found to be statistically at par with treatment T₈ (3358.52 kg, 2596.44 kg). This might be due to increased growth and yield attributing parameters. Which might have ultimately resulted in more number of flowers and pod set per plant and these ultimately gave rise to increased seeds per pod, seed yield per plant and seed yield per hectare as evident from the results of the study. Further, the significant increase in seed yield was also attributed to the higher chlorophyll content, photosynthetic activity, increased assimilation and accumulation of photosynthates from source to sink (seeds) due to application of growth regulators unlike (control) seeds. The similar promotary and significant effects of growth regulators in enhancing seed yield was reported by Ramesh and Ramprasad (2013) in soybean, Pandey and Gupta (2012) in black gram, Dixit and Elamathi (2007) in mung bean and Pramoda *et al.* (2018) in dolichos bean.

5.4 Seed quality parameters

5.4.1 Germination %, Average seedling length and seedling dry weight

Good seed is the basis for successful seed production programme. The quality seed are ensured with uniform germination, rapid root and shoot development and results in increased yield per unit area. In fact, there has been interdependence in use of quality seed and higher seed yield. However, realization of seed yield always depends on production of superior quality seeds as further dividends in cultivation of the crop depend on utility of quality seed without which targeted profits cannot be obtained.

After proper sun drying of pods the seeds are extracted and germination test was carried out in seed testing laboratory by using between paper method. Significant difference was observed among the treatments highest germination percentage was observed in treatment T₉ (66.41 %) with Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm which was found to be statistically at par with treatments T₈ (63.12 %), T₇ (63.07 %), T₃ (62.23 %) and T₅ (60.99 %). This might be due to combined application of micronutrients and growth regulators which resulted in greater accumulation and assimilation of food reserves in the seeds due to adequate availability of growth regulators and micronutrients especially at flower bud stage. These findings are in confirmation with the findings of Ramesh and Ramprasad (2013) in soybean. Similar findings were reported by Vijaya and Ponnuswamy (1998) in black gram, Shirpurkar *et al.*, (2006) in soybean and Khadgi *et al.*, (2016) in field bean. There are many factors that inhibit germination in dolichos bean viz. some phenolic substances, antinutritional factors such as enzymes (trypsin, chymotrypsin, amylase) inhibitors, phytic acid, flatulence factor, oligosaccharides, namely raffinose, stachyose and verbascose which may inhibit the germination (Ramakrishna *et al.*, 2006). The seed of dolichos bean showed lower per cent of germination in seed testing laboratory and good germination under field condition.

The maximum average seedling length (55.94 cm) and seedling dry weight (2.16 g) was observed in treatment T₉ - @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm which showed significant results. This might be due to seeds with higher weight shall have higher germination potential and seedling growth, this in turn might have increased the metabolic activity of indole acetic acid and auxin (Krishnasamy, 2003) through micronutrients and its translocation leading to early germination, cell division and elongation of cells leading increase in root and shoot length and higher seedling dry weight. These results confirmed with

the findings of Srimathi *et al.*, 2007, Khadgi *et al.*, (2016) in field bean and Harish Babu *et al.*, 2005 in green gram.

5.4.2 Seedling vigour index I and II

The seedling vigor index I and seedling vigor index II were differed significantly between the treatments, maximum seedling vigor index I (3621.91) and seedling vigor index II (143604.57) were recorded in treatment T₉. The maximum seedling vigor index might be due to higher root and shoot length (cm) and higher germination (%). These results also confirmed the findings of Harish Babu *et al.* (2005) in green gram and Khadgi *et al.*, (2016) in field bean.

5.5 Economics

The B:C ratio was found to be highest in T₉ (3.66) followed by T₈ (3.22) and lowest in T₁₀ (2.22). This is due to high quantity of marketable seed yield in T₉ which resulted in higher total income/ha and ultimately increased the B:C ratio.

SUMMARY AND CONCLUSION

An experiment entitled “**Influence of micro-nutrients and growth regulators on growth, yield and seed quality of Dolichos bean (*Lablab purpureus* var. *typicus* L.) cv. Arka Neelachal Pushti**” was conducted in 2021-22 at the Research Field of Central Horticultural Experiment Station (Aginia), ICAR-IIHR, Bhubaneswar. The experiment was laid out in randomized block design with ten treatments and replicated thrice. The results have been discussed in the preceding chapter. The silent findings of the experiment are summarized as follows.

1. The highest plant height was recorded in treatment T₉ (434.14 cm) followed by T₈ (422.94 cm) and T₆ (421.67 cm) and lowest in T₁₀ (393.93 cm). There was no significant variation in plant height among the treatments.
2. The maximum panicle length was obtained in T₉ (22.62 cm) followed by T₈ (22.39 cm). While lowest was recorded in T₁₀ (21.38 cm). There was no significant variation in panicle length.
3. The average fresh leaf weight varied significantly. The maximum fresh leaf weight was recorded in T₈ (4.06 g) while lowest was recorded in T₁₀ (3.28 g).
4. The maximum flowers/ panicle was recorded in T₉ (33.38) followed by T₁ (33.16), T₈ (31.94), T₄ (31.91), T₇ (31.34) and T₃ (31.17). Treatments T₂, T₅ and T₆ found to be significantly lower than T₉.
5. The maximum pods/ panicle was recorded in T₉ (10.40) followed by treatment T₁ (9.73). There was no significant variation in number of pods/panicle.
6. There was no significant variation in days to 1st flowering among the treatments. Least number of days was observed in treatment T₄ (49.34 days) whereas most number of days was recorded in treatment T₁₀ (51.67 days).
7. The least number of days was observed in treatment T₄ (54.66 days) whereas maximum number of days was recorded in treatment T₁₀ (59.33 days). There was no significant variation in days to 50 % flowering among the treatments.

8. The average fresh pod weight varied significantly. The maximum fresh pod weight was recorded in treatment T₉ (6.14 g) and was significantly higher than rest of the treatments. The lowest fresh pod weight was observed in T₁₀ (3.59 g).
9. The maximum pod length was observed in treatment T₉ (9.17 cm) which was found to be at par with treatment T₄ (8.99 cm). Both the treatments were found to be significantly higher than rest of other treatments.
10. The average fresh pod girth varied significantly by different micro-nutrients and growth regulators treatments. The maximum pod girth was observed in treatment T₄ (4.33 cm) and minimum pod girth was recorded in T₁₀ (3.34 cm).
11. The average dried pod weight with seed as influenced by application of different treatments varied significantly. The highest dried pod weight was recorded in treatment T₉ (2.38 g) followed by treatment T₄ (2.19 g) and T₇ (2.10 g).
12. The girth of dried pod varied significantly from 3.19 cm to 2.79 cm. Maximum girth of dried pod was observed in T₉ (3.19 cm) which was at par with treatments T₄ (3.15 cm), T₃ (3.08 cm), T₇ (3.08 cm) and T₆ (3.02 cm).
13. The length of dried pod varied significantly as influenced by application of different treatments. The maximum dried pod length was recorded in treatment T₉ (8.08 cm) and lowest dried pod length was recorded in treatment T₁₀ (7.11 cm).
14. Significant differences was observed between treatments. The highest dried seed weight/ pod was found in treatment T₉ (2.08 g) which was statistically at par with treatment T₄ (1.95 g).
15. The highest dried shell weight was observed in treatment T₉ (0.45 g) which was significantly superior over other treatments and statistically at par with treatment T₄ (0.43 g).
16. The number of seeds/ pod ranged from 5.43 to 4.93 and Significant differences were observed between the treatments. The maximum number of seeds were recorded in the treatment T₉ (5.43) while minimum number of seeds were recorded in the treatment T₁₀ (4.93).
17. 100 dried seed weight varied from 39.36 g to 30.39 g and Significant differences were observed between the treatments. The highest 100 seed weight was obtained

- in treatment T₄ (39.36 g) which was statistically at par with treatments T₇ (38.65 g) and treatment T₉ (37.28 g).
18. Pod yield/ plot varied significantly as influenced by application of different treatments. The maximum pod yield/ plot was recorded in treatment T₉ (5.46 kg) followed by T₇ (5.09 kg) and lowest pod yield/ plot was recorded in T₁₀ (3.60 kg).
 19. It was found that dried pod yield/plant varied from 0.27 g to 0.18 g and significant differences were observed between the treatments. The maximum pod yield/ plant was recorded in treatment T₉ (0.24 g) which was found to be statistically at par with treatments T₈ (0.24 g), T₄ (0.24 g) and T₁ (0.23 g).
 20. The maximum pod yield/ plant was recorded in treatment T₉ (3604.04 kg) which was statistically at par with treatment T₈ (3358.52 g). Both the treatments were found to be significantly superior to the rest of the treatments.
 21. The maximum seed yield/ plot was recorded in treatment T₉ (4.33 kg) and was found to be statistically at par with the treatment T₇ (3.93 kg). Significant differences are observed for the treatments with respect to dried seed yield/ plot.
 22. The dried seed yield/plant varied from 0.22 g to 0.14 g and significant differences were observed between the treatments. The maximum seed yield/ plant was recorded in treatment T₉ (0.22 g) which was statistically at par with treatment T₇ (0.20 g).
 23. The maximum seed yield/ ha was recorded in treatment T₉ (2859.12 kg) which was statistically at par with treatment T₈ (2596.12 kg). Both the treatments were found to be significantly superior to the rest of the treatments.
 24. The germination percentage varied significantly as influenced by different treatments. The maximum germination percentage was recorded in treatment T₉ (66.41 %) which was significantly superior over other treatments and statistically at par with treatments T₈ (63.12 %), T₇ (63.07 %), T₃ (62.23 %) and T₅ (60.99 %).
 25. Significant differences are observed for the treatments with respect to average seedling length. The maximum seedling length was found in the treatment T₉ (55.94 cm) while lowest seedling length was found in T₁₀ (36.49 cm).

26. The seedling dry weight (mg) varied significantly by different treatments. The maximum seedling dry weight was recorded in treatment T₉ (2.16 mg) and lowest seedling dry weight was observed in T₁₀ (1.61 mg).
27. The highest vigour index-I was obtained in T₉ (3621.91) which was at par with treatments T₈ (3529.08) and T₇ (3138.14). And was found to be significantly higher than rest of other treatments.
28. Significant differences are observed for the treatments with respect to Vigour index-II. The highest vigour index-II was obtained in T₉ (143604.57) and the lowest vigour index II was recorded in treatment T₁₀ (76197.52).
29. The B:C ratio was found to be highest in T₉ (3.66) followed by T₈ (3.24) and lowest in T₁₀ (2.22). This is due to more quantity of marketable seed yield in T₁₀, which resulted in higher total income/ha and ultimately increased the B:C.

CONCLUSION

From the perusal of data obtained from the experiment it is observed that in treatment T₉ Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm as foliar spray produced significantly higher vegetative growth and resulted in more seed yield/ha (2859.12) Whereas, in treatment T₈ Boron @ 0.2% + Zinc @ 0.5% + GA3 @ 50 ppm produced 2595.44 kg seed yield. Both were found to be statistically at par. But, taking in to consideration the B:C ratio of 3.66 in T₉ and 3.24 in T₈, it is recommended to use combination of micronutrients along with growth regulator (Boron @ 0.2% + Zinc @ 0.5% + NAA @ 50 ppm as foliar spray) in dolichos bean var. Arka Neeachal Pushti to get more marketable seed yield/ ha.

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