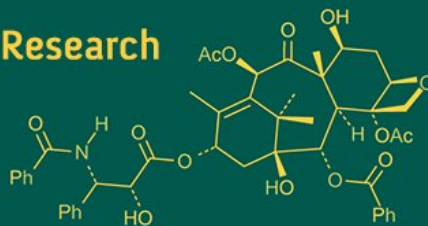
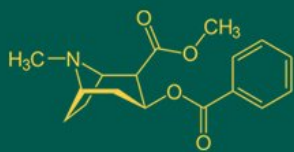


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Foliar spray and growth regulation in Mungbean (*Vigna radiata* L.): Impact of gibberellic acid, salicylic acid, boron and iron on morphological traits

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Abstract

Mungbean is botanically known as *Vigna radiata* (L.) Wilczek and belongs to the family Fabaceae (Leguminaceae). The genus *Vigna* includes about 155 species, of which nearly 22 are native to India. Pulses help maintain soil fertility through biological nitrogen fixation by *Rhizobium* bacteria present in their root nodules. They are also important components of livestock feed in the form of hay, silage, green fodder, concentrates, and other by-products. In 2022, mungbean production in India was expected to cover about 5.5 million hectares, producing 3.74 million tonnes with an average productivity of 570 kg/ha. In Uttar Pradesh, mungbean occupied approximately 88.0 thousand hectares, producing 46.0 thousand tonnes with a productivity of 523.0 kg/ha. This highlights the importance of mungbean cultivation in Uttar Pradesh and its contribution to regional and national agricultural production. The investigation consisted of two experiments, one in the field. The field experiment was conducted first trial during *summer season*, 2023-24 and second trial 2024-25 at Student Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P). Total number of treatments were thirteen viz., T₁ (control), T₂ (GA3 50 ppm), T₃ (GA3 75 ppm), T₄ (GA3 100 ppm), T₅ (Boron 5000 ppm), T₆ (Boron 10000 ppm), T₇ (20000 ppm), T₈ (Iron 5000 ppm), T₉ (10000 ppm), T₁₀ (20000 ppm), T₁₁ (Salicylic acid 50 ppm), T₁₂ (Salicylic acid 75 ppm), T₁₃ (Salicylic acid 100 ppm). Solution of treatments were prepared. Foliar applications done at 41 days after sowing with the help of hand sprayer as per treatment. While in untreated control distilled water was sprayed. The experiment was planned with randomized block design in three replications morpho-physiological parameter. Among the different treatments, T₃-GA3 75 ppm has recorded maximum results viz, plant population per meter sq., plant height, crop growth rate, Number of Primary Branches, Number of Secondary Branches, Days to 50% flowering, Day to maturity. Lowest results recorded in T₁₃-SA 100 ppm over Control.

Keywords: Mungbean, foliar spray, GA3, salicylic acid, boron, iron

Introduction

Mungbean is botanically known as *Vigna radiata* (L.) Wilczek and belongs to the family Fabaceae (Leguminaceae). The genus *Vigna* includes about 155 species, of which nearly 22 are native to India. These species are widely cultivated and are often classified into distinct varieties and subspecies. Among them, *Vigna radiata* is one of the most important, characterized by dark green foliage, spreading pods, and green seeds. Pulses are an inexpensive and rich source of protein, contributing about 27 percent of the total dietary protein in India. They are the third most important group of crops in Indian agriculture after cereals and oilseeds. Pulses help maintain soil fertility through biological nitrogen fixation by *Rhizobium* bacteria present in their root nodules. They are also important components of livestock feed in the form of hay, silage, green fodder, concentrates, and other by-products. In addition, pulses provide fuel, wood, and construction materials. Food legumes have been cultivated for millennia, providing nutritionally balanced food to people in India (Nene, 2006) and many other parts of the world. Major cultivated pulse crops include black gram, chickpea, cowpea, faba bean, grass pea, mungbean, horse gram, lablab bean, lentil, moth bean, pea, and pigeon pea. About a dozen pulse crops are grown on 22-24 million hectares in India, contributing 13-15 million tonnes of grain to the national food basket. However, per capita pulse availability declined from 64 g per capita per day during 1951-1956 to 35 g per

capita per day in 1998, compared with the World Health Organization (WHO) recommendation of 80 g per capita per day. The country's total pulse requirement for 2020 was estimated at around 30 million tonnes. In 2022, mungbean production in India was expected to cover about 5.5 million hectares, producing 3.74 million tonnes with an average productivity of 570 kg/ha. In Uttar Pradesh, mungbean occupied approximately 88.0 thousand hectares, producing 46.0 thousand tonnes with a productivity of 523.0 kg/ha. This highlights the importance of mungbean cultivation in Uttar Pradesh and its contribution to regional and national agricultural production.

The foliar application of nutrients to the crop plants have attracted a considerable attention of farm scientist and farmers. Although spraying of minor nutrients to correct the nutritional disorders or deficiencies of some plant species was in vogue, since early time, foliar application of major nutrients was not tried on large scale. But today with rapid development of efficient spraying equipment's, availability of various forms of highly water-soluble fertilizers, the practise of foliar feeding of nutrients has spread up to economise the quantity of nutrients. Elements used as solid through soil fail to overcome the deficiency of these nutrients caused by unfavourable conditions of the soil.

Gibberellins are gibbane skelt on compounds and biologically active in stimulating cell enlargement, rooting replacement of chilling treatment in short day plant etc. among them gibberellic acid used for seed germination, breaking of dormancy and producing maleness in certain plants. Now, the most important agriculture use of gibberellins is for inducing parthenocarpy and better fruits set. Plant growth regulators can play important role in increasing yield by making the plants photosynthetically more effective.

Salicylic acid (SA) is a phytohormone of phenolic nature. It is ubiquitous in plants generating a considerable impact on plant growth, development, mineral uptake and transport, photosynthesis and transpiration. Salicylic acid and other salicylates are known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity (Nandan *et al.*, 2021) [6]. Salicylic acid is a phenolic phytohormone and is found in plants with roles in plant growth and development, photosynthesis, transpiration, ion uptake and transport. Salicylic acid also induces specific changes in leaf anatomy and chloroplast structure. Foliar application of salicylic acid exerted a significant effect on plant growth metabolism when applied at physiological concentration and thus acted as one of the plant growth regulator substances (Navya *et al.*, 2021) [7].

Iron (Fe) is crucial for plant cell functions, including chlorophyll formation and activation of biochemical processes like respiration, photosynthesis, and nitrogen fixation. Iron deficiency can result from high manganese levels or lime-rich soils. Plants absorb iron in ferrous (Fe²⁺) or ferric (Fe³⁺) forms. Its function relies on easy transitions between these oxidation states. Plants store iron as ferritin, a protein enclosing ferric iron. In aerobic soils, iron is mostly insoluble in oxide and hydroxide forms and is often bound in organic chelates, resulting in low free iron concentration in soil solution. Plants employ mechanisms to mobilize iron, making it accessible to roots. Root activities, such as proton release, lower rhizosphere pH, enhancing iron solubility. Additionally, root-secreted organic acids

lower external pH and can form soluble complexes with iron, aiding its availability. Iron is an important micronutrient because it participates in redox reactions, and functions as a cofactor.

Boron deficiency is a common issue in plants, especially in regions with high rainfall where boron can easily be leached from the soil in the form of B(OH)₃. Additionally, boron availability is reduced in soils with high pH, such as calcareous soils, and those with high clay content. Drought conditions also exacerbate boron deficiency, as both the mobility of boron to the roots and the polymerization of boric acid are hindered. Symptoms of boron deficiency manifest in the shoots, primarily affecting terminal buds and young leaves, which become discolored and may wilt or die. Therefore, the present investigation is planned to "Foliar spary and Growth Regulation in Mungbean (*Vigna radiata* L.): Impact of Gibberellic Acid, Salicylic Acid, Boron and Iron on Morphological Traits" with the following objectives: 1-To assess the effect of treatments on Morphological characteristics of Mungbean. 2-To assess the effect of various treatments applied as foliar spray at different growth stages of Mungbean.

Materials and Methods

The investigation consisted of two experiments in the field. The field experiment was conducted first trial during *summer season*, 2023-24 and second trial 2024-25 at Student Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P). Total number of treatments were thirteen viz., T₁ (control), T₂ (GA3 50 ppm), T₃ (GA3 75 ppm), T₄ (GA3 100 ppm), T₅ (Boron 5000 ppm), T₆ (Boron 10000 ppm), T₇ (20000 ppm), T₈ (Iron 5000 ppm), T₉ (10000 ppm), T₁₀ (20000 ppm), T₁₁ (Salicylic acid 50 ppm), T₁₂ (Salicylic acid 75 ppm), T₁₃ (Salicylic acid 100 ppm). Solution of treatments were prepared. Foliar applications done at 41 days after sowing with the help of hand sprayer as per treatment. While in untreated control distilled water was sprayed. The experiment was planned with randomized block design in three replications morphological parameter were taken, Plant height at harvest, 50% of flowering, days to maturity.

Results and Discussion

Plant population per meter square

Plant population per meter square of mungbean was not showed significantly effect of different treatments. However, the highest Plant population per meter square was observed with the treatment T₃-GA3 75 ppm (34.00) and the lowest Plant population per meter square which was salicylic acid 100 ppm (30.24). Hydrolysis of starch into sugars lowers the cell water potential, encouraging water entry into cells and promoting elongation. Under GA₃ application, these osmotic responses may have increased photosynthetic efficiency, assimilate movement, and utilization of photosynthetic products, resulting in rapid cell division and elongation. Consequently, GA₃ increased plant height significantly over the control. Similar increases in plant height were reported by Mekki (2016) [4] in green gram, and Rathore *et al.* (2022) [10] in broad bean.

Plant height and Crop Growth Rate

Plant height at harvest and Crop Growth Rate of mungbean significantly increased by application of GA3 75 ppm and the significantly lowest plant height at harvest and Crop

Growth Rate was showed in T₁₃ SA 100 ppm. Plant growth regulator particularly GA3 played important role in enhancement of stem elongation, it stimulates cell proliferation and elongation at intercalary meristem stem level, thus leading to internodal growth. A similar result was reported by Mishra *et al.* (2021) [5] found more plant height at all stages by the foliar application of GA3 @ 75 PPM.

Number of primary branches per plant

The pooled data also showed similar trends, as there was significant effect of different treatments with Number of Primary Branches per Plant of Mungbean, variety VIRAT. However, However, the significantly higher Number of Primary Branches per Plant found in T₃-GA3 @ 75ppm (3.57), which was significantly at par with T₁₂-SA @ 75 ppm (3.47), T₅-B @ 5000 ppm (3.40) and T₂-GA3 @ 50 ppm (3.37) than the other treatments. The significantly

lower Number of Primary Branches per Plant was found in T₁₃-SA @ 100 ppm (2.40). This response may be due to the inhibitory effect of GA3 on auxin activity, which reduces apical dominance and diverts polar auxin transport toward the basal nodes. This process may break lateral bud dormancy and promote branching. Branching is directly associated with leaf area index, total dry matter production, and ultimately yield (Singh and Singh, 1982) [17]. Similar effects of GA3 were reported by Parmar *et al.* (2012) [8] and Pasarla *et al.* (2021) [9] in green gram. The increase in number of primary branches due to foliar application of salicylic acid, boron and iron might be attributed to enhanced metabolic activity, improved photosynthetic efficiency, better nutrient translocation and stimulation of meristematic growth, which collectively promoted lateral shoot development in mungbean

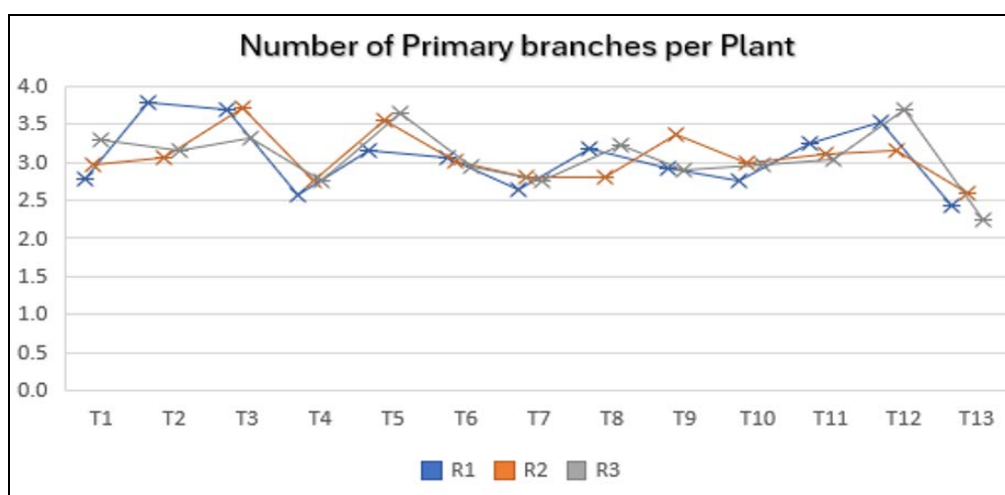


Fig a: Effect of foliar application of GA3, B, Fe and SA on number of primary branches per plant in mungbean

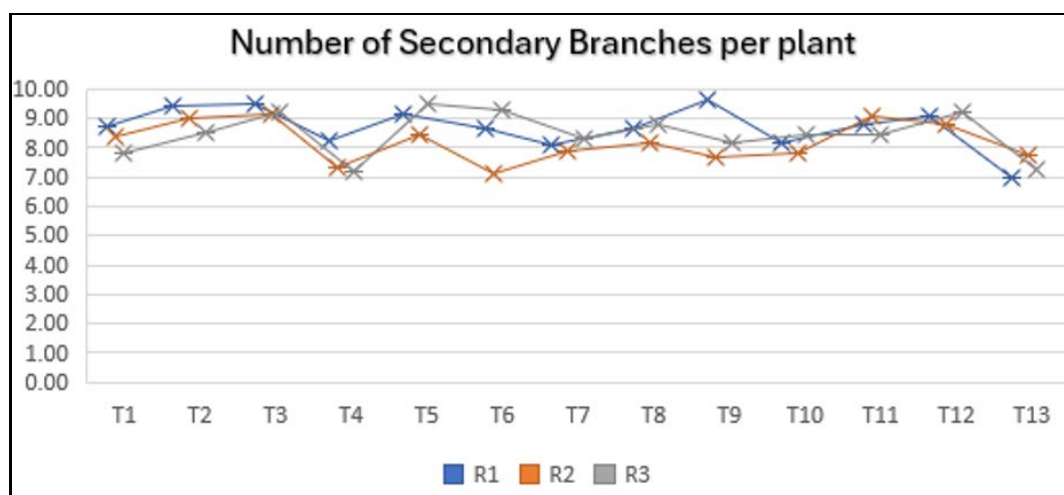


Fig b: Effect of foliar application of GA3, B, Fe and SA on number of secondary branches per plant in munbean

Number of secondary branches per plant

The pooled data also showed similar trends, as there was significant effect of different treatments with Number of secondary Branches per Plant of Mungbean, variety VIRAT. However, However, the significantly higher Number of secondary Branches per Plant found in T₃-GA3 @ 75ppm (9.29), which was significantly at par with T₁₂-SA @ 75 ppm (9.05), T₅-B @ 5000 ppm (9.04), T₂-GA3 @ 50 ppm (8.99), T₁₁-SA 75 ppm (8.76), T₈-Fe 5000 ppm (8.56) and T₉-Fe 10000 ppm (8.49) than the other treatments. The

significantly lower Number of secondary Branches per Plant was found in T₁₃-SA @ 100 ppm (7.31).

Exogenous GA3 application at flowering and pod-development stages also significantly increased seed yield, likely by improving plant height, branch number, pods per plant, and yield per plant in soybean. Foliar GA3 application promotes growth by enhancing cell division, cell expansion, food accumulation, and cell-wall plasticity (Giri *et al.*, 2018) [2]. Comparable findings were reported by Reddy (2021) [12] in lentil; Dawar *et al.* (2020) [1] in black gram;

and Pasarla *et al.* (2021)^[9] and Yeswanth and Singh (2022)^[18] in mungbean. Yeswanth and Singh (2022)^[18] further reported that foliar GA₃ application significantly increased grain yield over the control. In their study, a 1000 ppm stock solution was prepared using 1.1 g GA₃, and spraying was done at 30 and 45 DAS. GA₃ application also significantly improved leaf area index and harvest index in green gram (*Vigna radiata* L.). Foliar application of salicylic acid, boron, and iron significantly influenced the number of secondary branches in mungbean. The increased branching may be attributed to improved photosynthetic activity, enhanced nutrient availability, stimulation of lateral bud growth, and better translocation of assimilates towards vegetative organs. Salicylic acid improved physiological efficiency, while boron and iron supported cell development and chlorophyll synthesis, collectively promoting higher secondary branch production.

Days to 50% flowering

The pooled data of days to 50% flower was recorded earlier in treatments showed that there was no significant effect of different treatments with Day to 50% flowering of Mungbean, variety VIRAT. However, the earliest flowering appearance in T₃-GA₃ @ 75ppm (39.59 days) than the other treatments. The maximum days taken to appear Days to 50% flowering was T₁₃-SA @ 100 ppm (44.79 days). GA₃ have important role in increase in number of flowers, induction of flower, induce early flowering, controlling flowering time. Shimano and Matsumoto (1991)^[16] reported that GA₃ was most effective in promoting internodal elongation when applied at the flower-initiation stage in soybean, and GA₃ concentrations of 10-100 ppm increased internodal length compared with the control.

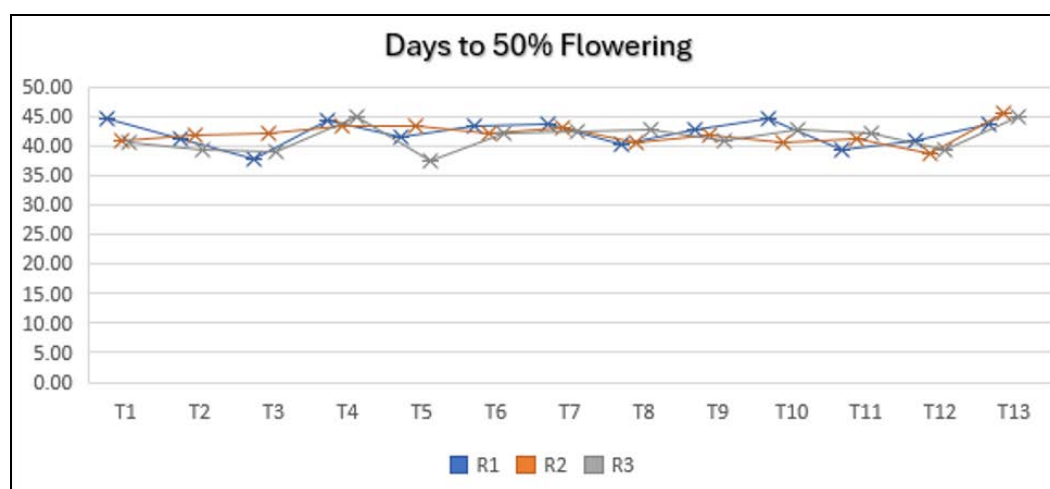


Fig c: Effect of foliar application of GA₃, B, Fe and SA on days to 50% Flowering in Mungbean

Days to maturity

The pooled data of days to Maturity was recorded earlier in treatments showed that there was no significant effect of different treatments with Day to Maturity flowering of Mungbean, variety VIRAT. However, the earliest flowering appearance in T₃-GA₃ @ 75ppm (39.59 days) than the other treatments. The maximum days taken to appear Days to Maturity was T₁₃-SA @ 100 ppm (44.79 days). GA₃ have important role in increase in number of flowers, induction of flower, induce early flowering, controlling flowering time. Sharma *et al.* (2020)^[14] conducted an experiment on

mungbean with growth regulators and observed that days to maturity were early in treatment T₂ (GA₃ @ 100) compared to other treatments of GA₃, Boron, Iron and Salicylic Acid. Sandhya *et al.* (2012)^[13] conducted an experiment on mungbean with growth regulators and observed that flower initiation was early in case of PGR applied plant as compared to stressed plant. Sharma *et al.*, (2020)^[14] conducted an experiment on mungbean with growth regulators and observed that days to maturity were early in treatment T₂ (GA₃ @ 100) compared to other treatments.

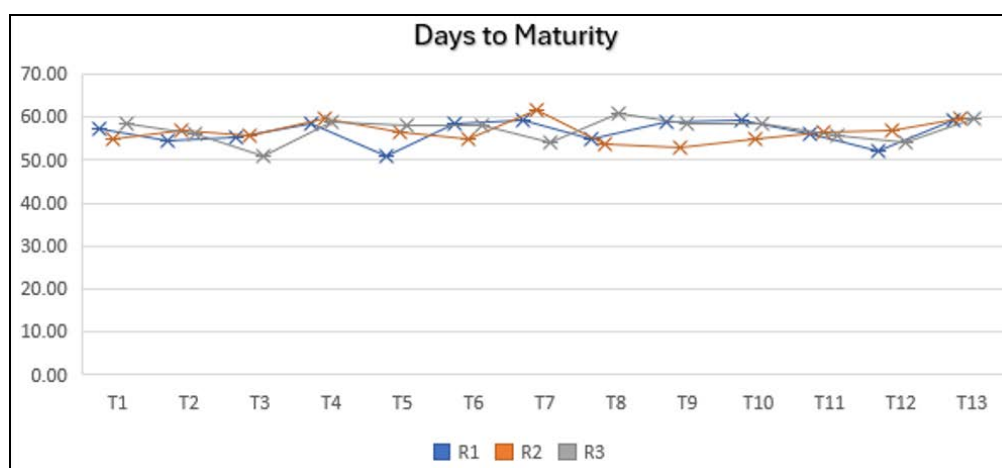


Fig d. Effect of foliar application of GA₃, B, Fe and SA on days to Maturity in Mungbean

Table 1: Influence of foliar application of GA₃, B, Fe and SA on Morphological parameters in mungbean

Mean Pooled data of 2023-2024 and 2024-2025							
Treatments		plant population/m ²	Plant height at harvest	Days to 50% flowering	Day to maturity	Number of primary branches per plant	Number of Secondary branches per plant
T ₁	Control	31.83	39.80	42.08	56.67	3.03	8.32
T ₂	GA ₃ 50 ppm	32.31	43.30	40.83	56.00	3.37	8.99
T ₃	GA ₃ 75 ppm	34.00	49.00	39.59	54.00	3.57	9.29
T ₄	GA ₃ 100 ppm	31.09	35.40	44.29	59.00	2.73	7.58
T ₅	Boron 5000 ppm	32.66	43.73	40.75	55.33	3.40	9.04
T ₆	Boron 10000 ppm	31.60	38.87	42.57	57.00	3.00	8.34
T ₇	Boron 20000 ppm	31.33	38.47	43.05	58.33	2.77	8.10
T ₈	Iron 5000 ppm	32.11	42.23	41.27	56.67	3.07	8.56
T ₉	Iron 10000 ppm	31.85	41.53	42.92	56.67	3.07	8.49
T ₁₀	Iron 20000 ppm	31.35	38.57	42.65	57.67	2.93	8.15
T ₁₁	Salicylic acid 50 ppm	32.21	42.77	41.02	56.33	3.13	8.76
T ₁₂	Salicylic acid 75 ppm	33.37	45.03	39.74	54.33	3.47	9.05
T ₁₃	Salicylic acid 100 ppm	30.24	34.53	44.79	59.33	2.40	7.31
Mean		32.00	41.02	41.96	56.72	3.07	8.46
C.D.		NS	3.66	NS	NS	0.39	0.86
SE(d)		1.66	1.76	1.75	2.12	0.19	0.41
C.V.		6.37	5.26	5.11	4.57	7.48	5.99

Conclusion

Among all the treatments, foliar application of T₃-GA₃ @ 75 ppm exhibited superior performance in enhancing growth, physiological attributes, and yield-related parameters of mungbean. The treatment significantly improved overall crop productivity compared to other treatments. Therefore, GA₃ @ 75 ppm can be recommended as an effective growth regulator treatment for improving mungbean performance.

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