Original Research Article

Effect of plant growth regulator and crop geometry on growth and yield of Green gram (*Vigna radiata* L.)

ABSTRACT

A field trial was conducted during the *Zaid*season of2023 at Crop ResearchFarm,Department ofAgronomy,SHUATS,Prayagraj(U.P) on the Green Gram (*Vigna radiata* L.). The experiment was executed in a Randomized Block Design with ten treatments andreplicated three times. Application of brassinolide 0.25%and plant density 35 cm x 10 cm (T2) recorded highest plant height (78.70 cm), dry weight (33.25 g/plant), number of nodules/plant (28.93), numberofpods/plant(42.00), number of seeds/pod (14.00), test weight (31.89 g), seed yield (1273.70 kg/ha), stover yield(3401.50 kg/ha) and harvest index (27.24 %).however, maximum crop growth rate (8.87 $g/m^2/day$) was recorded in GA3 0.50% + 25 cm x 15 cm (T7). Maximum gross returns (INR 89,159.00/ha), net returns (INR 56,539.00/ha), andB:C ratio (1.73)were also obtained highest in the same treatment(T2) in Green Gram crop. Therefore, application of brassinolides 0.25% and plant spacing 35 cm x 10 cm (T2) result in significant improvement in the crop production and also proven economically viable in green gram

Key words: *Brassinolide, Naphthalene acetic acid, Gibberillin, Growth and Yield.*

1. Introduction

Green gram (*Vigna radiata* L.) is also known as ‘Mung bean' or 'Moong' and belongs to the family Leguminoceae. It is a crop with short growing period (0-60 days) and broad adaptability, which is grown in summer as well as in kharif season. According to Parvati*et al.* (2017), it is a significant pulse crop and a great source of premium protein. It is an excellent source of

Riboflavin, Thiamine and Vitamin C (Ascorbic acid). It generates a significant biomass and recovers after grazing to produce plentiful seeds, itserves a dual purpose as both seed and fodder and is also used in broilers diets as a non-traditional feed stuff **(**Pasarla*et al*.,2021).As a leguminous crop, it can fix atmospheric nitrogen and check soil erosion. It is also used as a good silage and green manure crop (Santhosh *et al*., 2021).More than 70% of the world's green gram production was contributed by India. In Uttar Pradesh, it is cultivated in an area of 0.48 million hectares with a production of 0.41 million tonnes and productivity of 854 kg/ha (Fertilizer and Agriculture Statistics, Northern Region 2022-2023). It is grown in about 16 lakh hectares with a total production of 2.05 million tonnes and productivity of about 500 kg/ha. The important growing states include Orissa, Maharashtra, Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan and Bihar (Directorate of Economics and Statistics, 2022-2023).

Crop geometry is important because it influences crop growth and development by reducing plant competition through greater spacing (Ulsi*et al*., 2023). Per unit area, the number of plants affects plant size, yield components, and, in the end, seed production (Ejaz *et al.*, 2010). Highest light interception, efficient photosynthesis, assimilation, and retention of more photosynthates are conditions that are provided by maintaining ideal spacing and population count per unit area. These factors promote luxuriant crop development and more plant canopy area, which in turn produces more seed yield with the highest quality traits Renthunglo*et al.*2018.Since ideal spacing has a direct impact on plant growth and development, it is crucial to achieving potential yields Rabish*et al.* 2017. In order to maintain the necessary plant population and carry out intercultural actions during harvesting for improved yields, line planting spacing is advised. Sulakshana and associates, 2021. The productivity of plants is known to be increased by plant growth regulators because they improve the source-sink connection and encourage the translocation of photoassimilates. Narender and Rajesh (2014). First discovered in rape (Brassica napus L.), brassinolide is a unique plant growth-promoting steroidal lactone. Although they are present in very small amounts, brassinosteroids are widely distributed throughout plants. Shikha and Guggulla (2022).It promotes the production of more proteins, nucleic acids, and photosynthesis in plants, among other metabolic actions. In addition, it aids in the regulation of several processes, including as responses to various abiotic and biotic stimuli, source/sink connections, germination of seeds, photosynthesis, senescence, photomorphogenesis, and blooming. The Pradhan group (2018). Auxin family plant hormone naphthalene the acid acetic (NAA) is synthesized. In turn, it would promote auxiliary bud formation by increasing the cytokinin concentration. In order to boost the synthesis of dry matter, it also moves sugars from the source to the sink (Polepaka*et al*., 2021). naphthalene acetic acid (NAA) treatment can improve flower sex ratio, stop fruit falling, and raise fruit setting ratio. It has also been shown that applying naphthalene acetic acid foliar increases plant height, leaf count per plant, fruit size with an increase in seed output that follows in various plants (Pasarla*et al.*, 2021). By stopping the growth of the layer of abscission in black and green grams, it stops blossom drop. All growth activities, including the germination of seeds and development, rapid stem and root growth, leaf mitosis, increased seed germination rate, regulation of blooming time, and cell elongation, depend heavily on gibberellic acid (GA3). Tensingh*et al.* (2018) found that it regulates the mobilization of dietary reserves and interacts with inhibitors such abscisic acid.

With the aforementioned considerations in mind, the current study was conducted to determine **"Effect of plant growth regulator and crop geometry on growth and yield of Green gram (*Vigna radiata* L.)"**

Justification

In India, Green gram is grown widely throughout the year. Plant population and nutrient use efficiency are the most limiting factors affecting crop production and productivity. Spacing plays an important role for higher yield because thick plant population will not get proper light for photosynthesis and infestation of diseases whereas very low plant population will also reduce the output. Plant growth regulators are well known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops. Due to this optimum plant population and growth regulators are the effective components for fetching higher returns.

2. Materials and Methods

A Field experiment was conducted during *Zaid* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on green gram (*Vigna radiata* L.). The soil of experimental plot was sandy loam in texture, low in organic carbon (0.72%), nearly neutral in soil pH (7.2), Nitrogen (178.48 kg/ha), Phosphorous (27.80 kg/ha), Potassium (233.24 kg/ha)were determined by Jackson's method, Subbaiah and Asija's method, Olsen's method, Flame photometer method, respectively.The experiment was laid out in randomized block design (RBD) consists of three plant growth hormones; three different crop geometry and were replicated thricewhen applied in combinations as follows,T_1: Brassinolide 0.25% + 25 cm x 15 cm, T_2: Brassinolide 0.25% + 35 cm x 10 cm, T_3: Brassinolide 0.25% + 45 cm x 10 cm, T_4: NAA 0.40 % + 25 cm x 15 cm, T_5: NAA 0.40 % + 25 cm x 15 cm, T_6: NAA 0.40 % + 25 cm x 15 cm, T_7: GA3 0.50 % + 25 cm x 15 cm, T_8: GA3 0.50 % + 25 cm x 15 cm, T_9: GA3 0.50 % + 25 cm x 15 cm and T_{10} : Control (RDF) 25:50:25 NPK kg/ha + Spacing 30cm x 10cm.The pure, healthy, disease, insect free vigorous and good quality green gramseeds were used for sowing. Seeds were sown at a depth of 3-4 cm in lines at a spacing of 30 cm × 10 cm. Weeding was done manually at 25 and 45days after sowing with the help of khurpi. First light irrigation was done just after sowing then subsequent irrigations were applied as per the requirement of the crop.The observations on various growth and yield parameters were recorded from the selected plants. The data collected was computed and statistical analysis by analysis of variance method (Gomez and Gomez, 1984).The results are presented at 5% level of significance (p=0.05) for making comparison between treatments.

3. Results and Discussion

3.1 Growth attributes

At 60 DAS,significantlyhighest plant height (78.70 cm), Number of nodules per plant (28.93), dry weight (33.25 g/plant) was recorded in treatment-2with (Brassinolide 0.25% + 35 cm x 10 cm).Brassinolide, a plant growth promoting hormone induce the plant height by increasing the metabolic processes such as photosynthesis, nucleic acid and protein synthesis. It stimulate cell elongation, elongation of shoot, cell division, membrane permeability to water uptake and RNA synthesis. Similar results were found by Islam *et al.* (2005) and Hari *et al.* (2020).Increase of vegetative growth in wider spacing might be due to in wider spacing less competition for space, mutual shading effect, nutrients and moisture due to reduced plant density per unit area Amruta *et al*., (2015). Application of brassinolide resulted in efficient nutrient better root development and nodulation Pradeep and Elaimathi (2007). The widest row spacing of 45 x 15 cm produced higher number of branches per plant, functional leaves, greater spread and more aerial dry matter production per plant Kadam *et al*., (2015).

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3.2 Yield attributes and Yield

According to yield attributes data that was collected and analyzed at harvest, significantly higher numberofpods/plant(42.00), number of seeds/pod (14.00), test weight (31.89 g), seed yield (1273.70 kg/ha) and stover yield(3401.50 kg/ha)were recorded in treatment-2 with (Brassinolide 0.25% + 35 cm x 10 cm). The decreased plant height by the application ofplant growth regulator is effective for 25 to 30 days which coincides with the pod formation and pod development stages. During this time, maximum photosynthates are utilized by the reproductive parts rather than the vegetative parts. The reduction of vegetative growth at critical stage like flowering and pod development stages are important for the enhancement of yield and harvest index of the crop Sivakuma*et al*., (2020).Brassinolidesapplication as foliar spray enhances the growth parameter which ultimately results in higher yield attributes like number of pods per plants, number of seeds per plants, test weight, seed and stover yield Guggulla and Shikha (2022). Application of hormones at the flowering and pod formation stages influenced the growth parameters and resulted in higher seed yield Karuppusamy*et al*., (2022).The increase in yield attributes might be due to supplementation of nutrients at the critical stage without physiological stress Sruthi *et al.* (2020).Individual crops are able to absorb moistures and nutrients due to wider spacing which results in higher yield Kabir and Sarkar (2018). The translocation and accumulation of photosynthates in the economic sinks thus increased yield attributes, chlorophyll content and nitrate reductase activity resulted in increased grain yield Santosh *et al*., (2021).Optimum to low plant population had produced significantly highest harvest index while high population stand had produced minimum harvest index. This might be due to the fact that in case of low seed rate, seed yield to biological yield ratio was higher as compared to higher seed rate where seed yield to biological yield ratio was low. As harvest index value is positively correlated with seed yield and had negative correlation with biological yield therefore the harvest index value was higher in low seed rate and minimum in higher seed rate Ejaz *et al*., (2010).Optimum row spacing plays an important role in contributing to the high yield because thick plant population won't get sufficient light for photosynthesis and can be easily attacked by diseases. The more biomass produced at narrow plant spacing was due to more plant population contributing to the final biomass production Suraj *et al*., (2020).

3.3Economics (INR/ha)

Maximum gross return (INR 89,159.00/ha), net return (INR 56,539.00/ha) andbenefit cost ratio (1.73)were obtained highest in treatment-2 with (Brassinolide 0.25% + 35 cm x 10 cm). Foliar spray of brassinolides significantly improved seed yield and highest benefit cost ratio in green gram crop Sripal*et al.*, (2022).Spacing of 30 cm × 10 cm recorded economically feasible Suraj *et al*., (2020).

4. CONCLUSION

It can be concluded that plant density of 35 cm x 10 cm along with application of brassinolide 0.25% brought about significant improvement in the production and also proven economically viable in Green gram crop.

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Table1.Effect of plant growth regulator and crop geometry on Growth attributesofGreengram.

S.No	Treatments	Plant height (cm)	Dry weight (g/Plant)	CGR ($g/m^2/day$)	Nodules/plant (No.)
1	Brassinolide 0.25% + 25 cm x 15 cm	76.20	30.45	8.15	24.73
2	Brassinolide 0.25% + 35 cm x 10 cm	78.70	33.25	6.18	28.93
3	Brassinolide 0.25% + 45 cm x 10 cm	72.50	29.59	4.86	21.33
4	NAA 0.40 % + 25 cm x 15 cm	75.60	30.32	8.39	24.27
5	NAA 0.40 % + 35 cm x 10 cm	78.20	32.48	6.31	27.60
6	NAA 0.40 % + 45 cm x 10 cm	72.20	28.14	3.91	20.87
7	GA3 0.50 % + 25 cm x 15 cm	74.60	30.28	8.87	23.07
8	GA3 0.50 % + 35 cm x 10 cm	76.30	32.22	6.83	25.00
9	GA3 0.50 % + 45 cm x 10 cm	72.20	29.61	6.03	20.87
10	Control(RDF)25:50:25 NPK kg/ha + 30 cm x 10 cm	71.20	25.25	8.07	20.00
	SEm (±)	0.86	0.41	1.03	0.39
	CD (p=0.05)	2.56	1.23	3.05	1.16

Table 2. Effect of plant growth regulator and crop geometry on yield attributes and yield of Greengram.

S. No.	Treatment combinations	Pods/plant (no.)	Seeds/pod (no.)	Test weight (g)	Seed yield(Kg/ha)	Stover yield (Kg/ha)	HarvestIndex (%)
1.	Brassinolide 0.25% + 25 cm x 15 cm	38.00	11.00	30.19	1174.90	3302.70	26.24
2.	Brassinolide 0.25% + 35 cm x 10 cm	42.00	14.00	31.89	1273.70	3401.50	27.24
3.	Brassinolide 0.25% + 45 cm x 10 cm	33.00	10.00	29.00	1110.40	3238.20	25.54
4.	NAA 0.40 % + 25 cm x 15 cm	37.00	10.00	29.76	1170.00	3297.80	26.20
5.	NAA 0.40 % + 35 cm x 10 cm	41.00	12.00	31.01	1251.20	3379.00	27.02
6.	NAA 0.40 % + 45 cm x 10 cm	32.00	10.00	28.56	1080.10	3207.90	25.20
7.	GA3 0.50 % + 25 cm x 15 cm	35.00	10.00	29.41	1141.20	3269.00	25.88
8.	GA3 0.50 % + 35 cm x 10 cm	40.00	12.00	30.34	1210.90	3338.70	26.62
9.	GA3 0.50 % + 45 cm x 10 cm	31.00	9.00	27.00	1064.50	3192.30	25.01
10.	Control(RDF) 25:50:25 NPK kg/ha + 30 cm x 10 cm	31.00	8.00	28.26	1001.00	3140.20	24.17
	SEm (±)	0.48	0.16	0.43	17.62	47.52	0.39
	CD (p=0.05)	1.44	0.49	1.29	52.37	141.2	1.16

Table 3. Effect of plant growth regulator and crop geometry on economics of Greengram.

S. No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net returns (INR/ha)	B C ratio (B: C)
1.	Brassinolide 0.25% + 25 cm x 15 cm	32620.00	82243.00	49623.00	1.52
2.	Brassinolide 0.25% + 35 cm x 10 cm	32620.00	89159.00	56539.00	1.73
3.	Brassinolide 0.25% + 45 cm x 10 cm	32620.00	77728.00	45108.00	1.38
4.	NAA 0.40 % + 25 cm x 15 cm	32194.00	81900.00	49706.00	1.54
5.	NAA 0.40 % + 35 cm x 10 cm	32194.00	87584.00	55390.00	1.72
6.	NAA 0.40 % + 45 cm x 10 cm	32194.00	75607.00	43413.00	1.35
7.	GA3 0.50 % + 25 cm x 15 cm	32864.00	79884.00	47020.00	1.43
8.	GA3 0.50 % + 35 cm x 10 cm	32864.00	84763.00	51899.00	1.58
9.	GA3 0.50 % + 45 cm x 10 cm	32864.00	74515.00	41651.00	1.27
10.	Control(RDF) 25:50:25NPK kg/ha + 30 cm x 10 cm	31950.00	70070.00	38120.00	1.19