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Effect of Phosphorus and Naphthalene Acetic Acid on Growth and Yield of Green Gram

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ABSTRACT

The field experiment entitled "Effect of Phosphorus and Naphthalene acetic acid (NAA) on growth and yield of Green gram" was conducted during *Zaid*, 2022 at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. 'The experiment was conducted in Randomized Block Design with ten treatments which are replicated thrice with three levels of application of Phosphorus 20, 40, 60 kg/ha and three levels of application of Naphthalene acetic acid 20, 40, 60 ppm and control. The different treatments combinations are T_1: Phosphorus 20 kg/ha + Naphthalene acetic acid 20 ppm, T_2: Phosphorus 20 kg/ha + Naphthalene acetic acid 40 ppm, T_3: Phosphorus 20 kg/ha + Naphthalene acetic acid 60 ppm, T_4: Phosphorus 40 kg/ha + Naphthalene acetic acid 20 ppm, T_5: Phosphorus 40 kg/ha + Naphthalene acetic acid 40 ppm, T_6: Phosphorus 40 kg/ha + Naphthalene acetic acid 60 ppm, T_7: Phosphorus 60 kg/ha + Naphthalene acetic acid 20 ppm, T_8: Phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm, T_9: Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm, T_{10}: RDF:20-40-20 NPK kg/ha (Control) is used'. Results revealed that higher plant height (53.30), plant dry weight (12.52 g/plant), number of branches per plant (7.60), number of nodules per plant (21.60), number of pods per plant (22.93), number of seeds per pod (6.67), seed yield (1.36 t/ha), stover yield (2.46 t/ha), gross return (₹ 97,920.00/ha), net returns (₹ 65,689.00/ha) and B: C ratio was (2.04) were obtained by the application of Phosphorus at the rate 60 kg/ha along with Naphthalene acetic acid 60 ppm in Treatment-9.

Keywords Green gram, Naphthalene acetic acid, Phosphorus, Yield attributes, Yield.

INTRODUCTION

Pulse crops, also called grain legumes are economic, easy to obtain, easily digestible, have high biological values, and are relatively cheaper than animal protein. Green gram is considered to be the hardest of all pulse crops. It belongs to the family Leguminosae. Greengram is grown on 1.04 lakh hectares with a production of 0.84 lakh tons and productivity was 808 kg/ha.

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In the marketing year 2021-22, the consumption of Green gram was 24 lakh tons against the production of 23.25 lakh tons (Anonymous 2021). Green gram has many local names "mung, mash, or golden gram". It is a short-duration pulse crop that contains 25% protein of high digestibility and has an appreciable amount of riboflavin and thiamine (Lokhande *et al.* 2018). It contains 20.97-31.32% protein content, 1-3% fat, 3.5-4.5% fiber, 50.4% carbohydrates and 4.5-5.5% ash (Masih *et al.* 2020) adequate amounts of calcium, phosphorus and key vitamins in grain.

Phosphorus is an integral component of virtually all the biochemical compounds that make plant life possible and its application to Green gram increases plant growth, yield attributes and grain yield. Phosphorus also promotes early, lateral, fibrous, and healthy root formation which is very important for nodule formation and to fix atmospheric nitrogen (Singh *et al.* 2017). Phosphorus play a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops (Kumar *et al.* 2020). Specific growth parameters that have been associated with phosphorus are stimulated the development of root, increased stalk, and strength of stem, improved flower formation and production of seed, more uniform crop maturity, increased N-fixing capacity of legumes, improvements in crop quality, and increased resistance to plant diseases (Prajapati *et al.* 2013). Naphthalene acetic acid (NAA) is a synthetic plant hormone in the Auxin family. It would enhance the cytokinin content and in turn, auxiliary bud growth and more branches (LAI, LAD) were influenced positively by Naphthalene acetic acid. The primary job of Naphthalene acetic acid rests with the efficient transport of sugars from photosynthesizing parts of the plant (source) to the creating grain (sinks) and further working with nitrogen accumulation that mostly brought about higher complete dry matter production and also foliar application of Naphthalene acetic acid has also found to increase plant height, leaves per plant with consequent enhancement in seed yield in different crops (Navya *et al.* 2021).

MATERIALS AND METHODS

A field experiment was conducted during the summer season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, and Uttar Pradesh which is located at 25˚ 39" 42" N latitude, 81˚ 67" 56" E longitude and 98 m altitude above the mean sea level (MSL). The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice with three levels of application of Phosphorus 20, 40, 60 kg/ha and three levels of application of Naphthalene acetic acid 20, 40, 60 ppm and control. The treatments combinations are T_1: Phosphorus 20 kg/ha + Naphthalene acetic acid 20 ppm, T_2: Phosphorus 20 kg/ha + Naphthalene acetic acid 40 ppm, T_3: Phosphorus 20 kg/ha + NAA 60 ppm, T_4: Phosphorus 40 kg/ha + Naphthalene acetic acid 20 ppm, T_5: Phosphorus 40 kg/ha + Naphthalene acetic acid 40 ppm, T_6: Phosphorus 40 kg/ha + Naphthalene acetic acid 60 ppm, T_7: Phosphorus 60 kg/ha + Naphthalene acetic acid 20 ppm, T_8: Phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm, T_9: Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm, T_{10}: RDF:20-40-20 NPK (Control) kg/ha are used. The soil in the experimental area was sandy loam with pH (7.2), organic carbon (0.694%), available N (260.2 kg/ha), available P (41.6 kg/ha) and available K (227.3 kg/ha) were determined by Jackson's method, Subbaiah, and Asija's method, Olsen's method, Flame photometer method, respectively. The variety of Green gram is "PDM 139 (Samrat)". The crop was sown with pre-sowing irrigation. The line-to-line spacing was kept at 30 cm using a seed rate of 20 kg/ha. A distance of 10 cm was maintained between plant to plant in rows. First irrigation was applied at 25 days after sowing followed by second irrigation at 45 days after sowing to attain uniform maturity of the crop in all treatments. Hand weeding was done twice at 20 and 40 days after sowing. The observations on five randomly selected plants from each treatment were recorded at maturity. The crop was harvested 68 days after sowing. The recommended dose of nitrogen (20 kg/ha) and potassium (20 kg/ha) was applied as basal dose just before sowing and phosphorus and Naphthalene acetic acid (Foliar spray at 20 and 35 DAS) were applied as per the treatments. Urea, SSP, and MoP were taken as fertilizer sources of N, P and K respectively. The collected data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez 1984).

Table 1. Response of Green gram to Phosphorus and naphthalene acetic acid on growth attributes at 60 DAS.

Sl. No.	Treatments	Plant height (cm)	Branches/ plant	Nodules/ plant	Dry weight (g/plant)
1	Phosphorus 20 kg/ha + NAA 20 ppm	49.97	6.07	13.93	9.45
2	Phosphorus 20 kg/ha + NAA 40 ppm	50.16	6.20	15.73	9.56
3	Phosphorus 20 kg/ha + NAA 60 ppm	50.87	6.40	16.13	9.70
4	Phosphorus 40 kg/ha + NAA 20 ppm	51.42	6.67	16.73	10.38
5	Phosphorus 40 kg/ha + NAA 40 ppm	51.72	6.87	17.27	10.27
6	Phosphorus 40 kg/ha + NAA 60 ppm	51.84	6.93	18.27	10.47
7	Phosphorus 60 kg/ha + NAA 20 ppm	52.34	6.93	20.13	10.62
8	Phosphorus 60 kg/ha + NAA 40 ppm	52.67	7.40	21.40	12.29
9	Phosphorus 60 kg/ha + NAA 60 ppm	53.30	7.60	21.60	12.52
10	Control (20-40-20 NPK kg/ha)	51.40	6.53	14.20	10.12
	F test	S	S	S	S
	SEm (±)	0.25	0.20	0.30	0.66
	CD (5%)	0.75	0.60	0.90	1.95

RESULTS AND DISCUSSION

Growth attributes

Plant height - At 60 DAS, a significantly higher plant height (53.30 cm) was observed in treatment with the application of Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm. However, the application of Phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm (52.67 cm) is statistically at par with Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm (Table 1). This might be due to the known role of phosphorus in the stimulation of cell division, photosynthetic process as well as formation of chlorophyll. It also promotes the root nodules in legumes, which cause more phosphorus available during the vegetative growth period and the development of plant occurs. These results are by following per under with those of Gajera *et al.* (2014) and Patel *et al.* (2019) concerning for the height in Green gram.

Number of branches per plant- At 60 DAS, a significantly higher number of branches per plant (7.60) was observed in Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm. However, the application of Phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm (7.40) is statistically at par with Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm (Table 1). The application of phosphorus with the recommended dose of fertilizers recorded the maximum number of branches per plant. These results are in accordance with those of Prajapathi *et al.* (2013) and Singh *et al.* (2017) and the application of NAA resulted in a higher branches as active role in cell division and cell elongation. As a result, significant increases in the number of branches of plants was reported by Mithare *et al.* (2018).

Number of Nodules per plant - At 60 DAS, the significantly higher number of nodules per plant (21.60) was observed in treatment receiving Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm. However, application of Phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm (21.40), Phosphorus 60 kg/ha + Naphthalene acetic acid 20 ppm (20.13) is statistically at par with Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm (Table 1). This might be due to the known role of phosphorus in root proliferation and thereby atmospheric nitrogen fixation or phosphorus plays a vital role in the crop production of pulses by the rapid bacterial growth and resulting the improved nodulation by production of more infected sites. These were in accordance with those of Gajera *et al.* (2014). Application of NAA was resulting efficient nutrient application also profuse better root development and nodulation Navya *et al*. (2021).

Plant dry weight (g/plant)- At 60 DAS, a significantly higher dry weight (12.52 g/plant) was observed in treatment receiving Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm. However, application of Phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm (12.29 g/plant), Phosphorus 60 kg/ha + Naphthalene acetic acid 20 ppm (10.62 g/plant) is statistically

Table 2. Response of Green gram to phosphorus and Naphthalene acetic acid on yield attributes and yield.

Sl. No.	Treatments	Pods/plant	Seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1	Phosphorus 20 kg/ha + NAA 20 ppm	19.93	5.27	29.63	0.95	1.88	33.46
2	Phosphorus 20 kg/ha + NAA 40 ppm	19.87	5.33	29.97	1.01	1.95	34.25
3	Phosphorus 20 kg/ha + NAA 60 ppm	19.93	5.80	30.00	1.04	1.99	34.39
4	Phosphorus 40 kg/ha + NAA 20 ppm	20.07	6.07	31.10	1.07	2.03	34.62
5	Phosphorus 40 kg/ha + NAA 40 ppm	20.13	6.13	31.37	1.11	2.04	35.21
6	Phosphorus 40 kg/ha + NAA 60 ppm	20.47	6.20	31.60	1.20	2.19	35.29
7	Phosphorus 60 kg/ha + NAA 20 ppm	20.80	6.27	32.33	1.26	2.29	35.55
8	Phosphorus 60 kg/ha + NAA 40 ppm	21.60	6.40	33.10	1.28	2.31	35.62
9	Phosphorus 60 kg/ha + NAA 60 ppm	22.93	6.80	35.23	1.36	2.46	35.63
10	Control (20-40-20 NPK kg/ha)	20.00	5.87	31.63	1.06	2.01	34.56
	F test	S	S	NS	S	S	NS
	SEm (±)	0.52	0.15	1.20	0.03	0.06	0.82
	CD (5%)	1.55	0.47	-	0.10	0.17	-

at par with Phosphorus 60 kg/ha + Naphthalene acetic acid 60 ppm (Table 1). The significant increase in dry weight with the application of Phosphorus might be due to the cumulative effect of increase in plant height and the number of branches which resulted in increasing the dry matter production of the plant. This finding was found similar to the results of Masih *et al.* (2020) and Gajera *et al*. (2014). This might be due to the quick availability of NAA to crop during the entire growing season.

Yield attributes and yield

The recorded and analysis of data on yield attributes indicate that a significantly higher number of pods per plant (22.93), seeds per pod (6.80), seed yield (1.36 t/ha) and stover yield (2.46 t/ha) of Green gram were recorded with the application of Phosphorus 60 kg/ha along with Naphthalene acetic acid 60 ppm. However, the application of phosphorus 60 kg/ha + Naphthalene acetic acid 40 ppm having pods per plant (21.60), seeds per pod (6.40), seed yield (1.28 t/ha) and stover yield (2.31 t/ha) was statistically at par with phosphorus 60 kg/ha + naphthalene acetic acid 60 ppm (Table 2). This might be due to its role in yield attributing character because phosphorus increased the photosynthesis activity of plants and helps to develop a more extensive root system and thus enables the plant to extract more water and nutrients from soil depth, resulting in better yield attributes. Phosphorus is an important element in all biological systems, participating in most metabolic pathways and as a structural component of nucleic acids, coenzymes, phosphoproteins and phospholipids. These results in spectacular improvement in grain and stover yields

Table 3. Response of Green gram to phosphorus and Naphthalene acetic acid on economics.

Sl. No.	Treatments	Gross returns (INR/ha)	Net returns (INR/ha)	B: C ratio
1	Phosphorus 20 kg/ha + NAA 20 ppm	68,160.00	39,709.00	1.40
2	Phosphorus 20 kg/ha + NAA 40 ppm	72,960.00	44,494.00	1.56
3	Phosphorus 20 kg/ha + NAA 60 ppm	75,120.00	46,63900	1.64
4	Phosphorus 40 kg/ha + NAA 20 ppm	77,280.00	46,95400	1.55
5	Phosphorus 40 kg/ha + NAA 40 ppm	79,920.00	49,579.00	1.63
6	Phosphorus 40 kg/ha + NAA 60 ppm	86,160.00	55,80400	1.84
7	Phosphorus 60 kg/ha + NAA 20 ppm	90,960.00	58,759.00	1.82
8	Phosphorus 60 kg/ha + NAA 40 ppm	92,160.00	59,944.00	1.86
9	Phosphorus 60 kg/ha + NAA 60 ppm	97,920.00	65,689.00	2.04
10	Control (20-40-20 NPK kg/ha)	76,560.00	46,249.00	1.53

of Green gram. Biological yield is a function of seed and stover yields. This might be due to the role of phosphorus in promoting root growth and there by enhancement in renewable of nitrogen by the crop Kumawat *et al.* (2022) and auxin like Naphthalene acetic acid stimulates cell elongation, elongation the shoot, cell division, membrane permeability to water uptake, and RNA synthesis. So an attempt has been made to reduce the number of flower drops and increase seed yield with foliar spray of Naphthalene acetic acid of various concentrations. The combined application of different levels of phosphorus and Naphthalene acetic acid has increased the yield attributes and yield of Green gram. Similar findings were recorded by Patel *et al.* (2019), Singh *et al.* (2017), Mahesh *et al.* (2021).

Economics

Maximum Gross returns (97,920.00 INR/ha), Net returns (65,689.00 INR/ha) and B: C ratio (2.04) was observed with the application of Phosphorus 60 kg/ha + Naphthalene acetic acid 60ppm (Table 3).

CONCLUSION

Based on the findings of this field experiment it is concluded that the treatment combination of Phosphorus 60 kg/ha along with Naphthalene acetic acid 60 ppm (Treatment-9) has performed better in growth and yield parameters and also proven economically viable when compared to others under agroclimatic conditions of Prayagraj, UP.

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