THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22-Issue-34-December -2019

Influence of paclobutrazol and rhizobium on growth and yield of green gram (*Vigna radiata* L.)

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ABSTRACT

The present investigation was carried out to study the effect of paclobutrazol and rhizobium on the performance of green gram (Vigna radiata L.) at Lovely Professional University, Phagwara, Punjab in 2017-2018. In the present experiment seven treatments were used and all the seven treatments were randomized in three replications. Paclobutrazol was applied at the rate of 10ppm/plots by foliar spray, mycorrhiza 5ml./plot in 5litre of water and rhizobium was inoculated 1.25ml/plot in 12.5ml of water. Growth parameters like plant height, branches number, pods number and yield parameters like pod yield, biological yield of crop residues and harvest index were recorded at 25 DAS and 50 DAS. Results indicates that a recommended dose of rhizobium + mycorrhiza increased plant height, branches number, pod number and total soluble sugar. Paclobutrazol + rhizobium + mycorrhiza treated plants increased the biological yield and total carbohydrates. An application of to paclobutrazol + rhizobium increased protein content, chlorophyll content and harvest index. Whereas rhizobium treated plants increased the pod yield.

Keywords: *Paclobutrazol, Mycorrhiza, Rhizobium, Green gram*

INTRODUCTION

ISSN:0971-1260
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Green gram (*Vigna radiata* L.) is an important high protein short duration pulse crop in India which has a wider adoptability due to high protein and low input. Commonly it is known as 'moongbean' or 'moong'. Crop stands second in line to food grains. The seed contains 24.20% of protein content, 1.30% of fat, and 60.4% carbohydrates, calcium (Ca) is 118 and phosphorus, (P) is 340 mg per 100 g of seed (Imran *et al.,* 2015). It also contains small amount of riboflavin and thiamine. It is generally grown in the season of kharif as well as in summer season where adequate irrigation facilities are available. The optimum temperature for growth is 27-30^{o}C.

Green gram contains nitrogen fixing bacteria which converts the atmospheric nitrogen into the available nitrogen. Green gram is a green manuring crop which increase the concentration of nitrogen within soil. Moreover, green gram fixes about 40-50 kg N ha (Herridge *et al.,* 2005). It is mostly grown in Asian region where India produces more than 70% of green gram.. Traditionally green gram producing states are Rajasthan, Maharashtra, Andhra Pradesh. Tradationally in Tamil Nadu, Uttar Pradesh and Gujarat there is significant rise in production from other states in recent years particularly. With respect to most states the production remained volatile across the years.

The application of biofertilizers would be one of the efficient and cheapest method to maximize the rate of production and yield. The rate of photosynthesis can be reduced by water stress and uptake of nutrient in green gram (Phogat *et al.,* 1984). Paclobutrazol is a growth retardant which comes under triazol fungicides (Wheaton, 1989; Harty and Vanstaden, 1988). Triazoles are the plant multi-protectant characterized which is mainly for biotic and abiotic stresses (Voesenek *et al.,* 2003). It is the antagonist of plant hormones that is gibberellin acid which helps in the root growth. Paclobutrazol which is taken up into the

ISSN:0971-1260
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leaves, stems, or roots, through xylem and trans located to growing sub-apical meristems that enhances flowering and fruiting and produces more compact plants. Paclobutrazol enhance chlorophyll synthesis, causing early fruit set and also helpful in reducing the frost sensitivity within the plants. Earlier, increased in the chlorophyll content was due to paclobutrazol that exhibited a dark green colour (Abolfazl *et al.,* 2013). It reduces the shoot growth, controls tree vigour, increase flowering intensity, increase flowering uniformity, higher yields, improves fruit colour, improves early yield return, increase in sugar content and enhance the morphological characteristics of plants. Hence present investigation was conducted to evaluate the morphological characteristics and increase in yield of green gram.

Mycorrhiza improved drought resistance, increased resistance to soil pathogen (Lingua *et al.,* 2002). The macronutrients like Nitrogen (N), potassium (K), and magnesium (Mg) uptake increase (Hodge *et al.,* 2001) as well as uptake of some micronutrients increased (Azaizeh *et al.,* 1995). Nutrients and water from the soil are allowed by the Mycorrhizal fungi to draw more. Mycorrhiza also enhance the plant tolerance to deal with the different environmental stresses, which increase the water holding capacity and water infiltration also better the root development and higher nutrient cycling and microbial activity, for a better resistance to erosion.

Rhizobium is a gram negative soil bacteria that fixes the nitrogen present in the atmosphere. The metabolized nitrogen must be in the form of nitrates or ammonia compounds. Rhizobium bacteria helps the plants to uptake nitrogen unavailable into available form. Inoculation of rhizobium can save up to 25% N fertilizer application to crops. Two major biofertilizers are used in this experiment which are Rhizobium and Mycorrhiza. An application of Biofertilizer follows an objective of increasing

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the number of biological activity of essential microorganisms in soil by foliar or soil drench method. It enhance the plants to uptake essential nutrients and also in various other factors like water uptake, increasing soil fertility. Apart from biofertilizer a chemical is used named as paclobutrazol as per dozes which is growth retardant and helps in drought resistant and increase in chlorophyll content in plants.

MATERIALS AND METHODS

Location: The present investigation was undertaken during *Kharif* season of year 2017-18 on experimental field of Lovely Professional University, Phagwara, Punjab. The Experimental site geographically situated at 31°14'48.0"N 75°41'45.0"E and 252 m above sea level. It falls under central plain zone of agro climatic zones of Punjab. The soil of the experimental site was alkaline soil, having the pH of 7.5.

Treatment Details: For the present investigation green gram variety SML 832 was used with seven different treatments. The combination of seven different treatments were tried in Randomized Block Design (RBD) using three replications. The treatments were Paclobutrazol (10ppm), Mycorrhiza (5ml), rhizobium (5gm) where [T_0: control, T_1: paclobutrazol, T_2: mycorrhiza, T_3: rhizobium, T_4: paclobutrazol + mycorrhiza, T_5: paclobutrazol + rhizobium, T_6: mycorrhiza + rhizobium, T_7: paclobutrazol + mycorrhiza + rhizobium]. Growth parameters like plant height, branches number, pods number and yield parameters like pod yield, biological yield of crop residues and harvest index were recorded at 25 DAS and 50 DAS. Harvest Index was calculated as per as formula suggested by Donald (1962).

$$\text{Harvest Index (HI)} = \frac{\textbf{Grain yield}}{\textbf{Biological yield}} \times 100$$

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RESULTS AND DISCUSSION

A. Morphological Parameters:

Plant height ranged from 13.46 to 14.53 cm at 25 DAS. The maximum height was recorded in T_6 (14.53 cm) followed by T_5 (14.20 cm) while the least plant height was recorded in T_2 (13.46 cm). As compare to T6 and T2 showed 92.65% increase in the plant height at 25 DAS. Plant height ranged from 23.80 to 36.00 cm at 50 DAS. The maximum height was recorded in T_6 (36.00 cm) followed by T_3 (32.26 cm) while the least plant height was recorded in T_1 (23.80 cm). As compare to T6 and T2 showed 66.11% increase in the plant height at 50 DAS. The results (Table 1 and Fig 1) indicated that all the treatments were significant in height over the treatment of paclobutrazol. Paclobutrazol is a growth retardant which suppress the plant growth. Plant height was maximum due to an application of mycorrhiza and rhizobium. An application of paclobutrazol has been reported to decrease the plant height in the case of pigeon pea (Sontakey *et al.,* 1999). The inoculation of mycorrhizae had been found to increase the plant height of soybean (Singh *et al.,* 1987) and cowpea (Yaseen *et al.,* 2011).

The results in respect of branches number per plant at 25 DAS and 50 DAS maturity as shown in (Table 1) where all the treatments recorded significantly superior than control. It was observed that branches number ranged from 3.86 to 4.93 at 25 DAS. Maximum branches

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were recorded in T_3 (4.93) followed by T_6 (4.73). While the minimum branches were recorded in T_0 (3.86). As compare to T_0 with T_1 showed 78.39 % increase in the number of branches at 25 DAS. It was observed that branches number ranged from 7.77 to 11.13 at 50 DAS. Maximum branches were recorded in T_6 (11.13) followed by T_6 (11.06). While the minimum branches were recorded in T_0 (7.77). As compare to T_0 with T_6 showed 69.79 % increase in the number of branches at 50 DAS. At DAS 25 the maximum branches was recorded in T_3 and at 50 DAS recorded in T_6 due to the combine treatment of rhizobium and mycorrhiza applied in a different interval of time.

It was observed that pods number ranged from 11.06 to 17.13 at maturity. Maximum pods were recorded in T_6 (17.13) followed by T_1 (16.46). While the minimum pods were recorded in T_0 (11.06). As compare to T_0 with T_6 showed 64.59 % increase in the pods number at maturity. Maximum pods number were recorded in T_6 which was due to Mycorrhiza and rhizobium. The uptake of macronutrients Increased due to mycorrhiza, including nitrogen, potassium, and magnesium (Hodge *et al.*, 2001) along with micronutrients (Azaizeh *et al.*, 1995) which helps in increasing pods number and rhizobium also enhance the macronutrients which helps in increasing in the pods number. The same result was reported by (Adholeya *et al.*, 1988). The results (Table 3 and Fig 3) indicated that all the treatments were significant in pods number over the treatment of control. Among them the maximum pods number were recorded due to the combine treatment of rhizobium and mycorrhiza applied in a different interval of time.

B. Yield Parameters:

It was observed that the grain yield ranged from 2951.40 to 3882.43 after harvesting. Maximum grain yield was recorded in T_3 (3882.43) followed by T_6 (3690.26). While the

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minimum grain yield was recorded in T_0 (2951.40). As compare to T_3 with T_0 showed 76.01% increase in the total protein content. As maximum grain yield was recorded in T_3 which was due to rhizobium followed by T_6 which was mycorrhiza + rhizobium and minimum protein content was recorded in T_0 which was a control treatment. The same result was reported by (Setia RC and Sangeeta 2009). Similarly an inoculation of rhizobium reported to increase yield in pigeonpea (Singh and Yadav, 2008, Shivprasad and Rai , 1991), in chickpea (Emran *et al.*, 2011), in green gram (Bhat *et al.*, 2011), in pea (Rahman *et al.*, 2010).

It was observed that biological yield of crop residues ranged from 7.66 to 12.21 after harvesting. Maximum biological yield was recorded in T_7 (12.21) followed by T_6 (11.05). While the minimum biological yield were recorded in T_5 (7.66). As compare to T_7 with T_5 showed 62.80 % increase in the biological yield of crop residues. As maximum biological yield was recorded in T_7 which was due to rhizobium. Rhizobium and paclobutrazol which by combining shows a significant increase in biological yield. The results (Table 4.3.2 and Fig.4.3.2) indicated that an application of paclobutrazol combining mycorrhiza and rhizobium significantly increased the biological yield of crop residues. Where as a combine application of rhizobium and paclobutrazol in a different interval reported as minimum biological yield. Similar result was reported by (Osman *et al*., 2011).

It was observed that the harvest index ranged from 27.58 to 33.30 after harvesting. Maximum harvest index was recorded in T_5 (33.30) followed by T_3 (31.10). While the minimum harvest index was recorded in T_0 (27.58). As compare to T_3 with T_0 showed 82.83% increase in harvest index. As maximum grain yield was recorded in T_5 which was due to Paclobutrazol + Rhizobium followed by T_3 which was rhizobium and minimum

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protein content was recorded in T_0 which is control. The results (Table 4.3.3 and Fig 4.3.3) indicated that all the treatments were significant in protein content over the treatment of control. Maximum harvest index was reported in an application of paclobutrazol along with an inoculation of rhizobium in a different interval of time.

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Table 1: Effect of paclobutrazol, mycorrhiza and rhizobium on growth and yield parameters of green gram

Treatments	Plant Height		Branch No.		Pod No.	Grain yield	Biological yield	Harvest Index (%)
	25 DAS	50 DAS	25 DAS	50 DAS				
T_0	13.53^{a}±0.28	26.26^{cd}±1.20	3.86^{ab}±0.14	7.77^{bc}±0.76	11.06^{b}±0.66	1180.40^{a}±0.26	9.78ab±0.41	27.58^{a}±1.74
T_1	13.46^{a}±0.38	23.80^{d}±0.86	4.06^{b}±0.21	11.06^{a}±0.61	16.46^{a}±0.65	1131.60^{a}±0.37	10.20ab±0.77	29.61^{a}±1.50
T_2	13.80^{a}±0.57	29.06^{bc}±1.99	4.13^{b}±0.19	10.06^{ab}±0.23	13.20^{ab}±2.06	1292.40^{a}±0.33	10.43ab±0.59	28.98^{a}±1.37
T_3	13.60^{a}±0.15	32.26^{ab}±0.23	4.93^{a}±0.19	10.46^{a}±0.35	13.53^{ab}±1.49	1552.80^{a}±0.21	10.70ab±0.43	31.10^{a}±0.20
T_4	13.93^{a}±0.58	27.26^{bcd}±1.26	4.60^{ab}±0.16	8.00^{c}±0.24	11.66^{b}±0.47	1171.20^{a}±0.12	8.60ab±2.11	30.31^{a}±0.51
T_5	14.20^{a}±0.59	25.86^{cd}±1.29	4.66^{ab}±0.02	9.80^{ab}±0.48	11.65^{b}±0.68	1457.20^{a}±0.20	7.66b±0.43	33.30^{a}±1.31
T_6	14.53^{a}±0.19	36.00^{a}±0.31	4.73^{ab}±0.19	11.13^{a}±0.30	17.13^{a}±1.15	1476.00^{a}±0.27	11.05ab±0.59	30.09^{a}±1.30
T_7	13.53^{a}±0.05	29.40^{bc}±0.18	4.53^{ab}±0.05	10.26^{ab}±0.10	12.40^{b}±0.60	1489.20^{a}±0.57	12.21a±0.61	28.54^{a}±1.48

Where the mean followed by different letters are significantly different at p<0.05, according to DMRT (Dum can's Multiple Range Test) for separation of means T0-Control, T1-Paclobutrazol, T2-Mycorrhiza, T3-Rhizobium, T4-Paclobutrazol+mycorrhiza, T5-Paclobutrazol+rhizobium, T6-Mycorrhiza+rhizobium, T7-Mycorrhiza+rhizobium+paclobutrazol

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