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Impact of Biofertilizers, Neem coated urea and Foliar NPK (12:32:16) on growth and yield attributes of Mung bean

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Abstract
The goal of the experiment was to determine the performance of Mung bean when it was treated with bio-fertilizers, Neem-coated urea, and foliar NPK (12:32:16) in an integrated manner. The experiment was carried out in the research farm of the Lovely Professional University in Phagwara, Punjab, during the Kharif season of 2022–2023. The experiment was laid out in the Randomized block design with eight treatments, T1- Control (20:40:00 kg/ha); T2- NPK Foliar application (12:32:16); T3- 75% Neem coated urea+ Rhizobium; T4-75% Neem Coated Urea+ VAM; T5- 50% Neem Coated Urea + Rhizobium; T6- 50% Neem coated urea+ VAM; T7- NPK Foliar application+ Rhizobium; T8- NPK application (12:32:16) + VAM. The outcome showed that among all of the therapies, determines that both T7 (NPK Foliar Application 12:32:16 + Rhizobium) and (T8- NPK application 12:32:16 + VAM) showed the best results in all the parameters.

Keywords: Foliar application, green gram, Neem coated urea, Rhizobium, VAM

Introduction
An essential pulse crop in India is green gram (*Vigna radiata* L.). It is a short-lived legume crop mostly produced as a fallow crop in a rice rotation. The nitrogen content of the soil is enriched by the green gram, just like with leguminous pulses. Legumes have the traits to improve the sustainability of dry sub-tropical and tropical agricultural systems since they can be grown in poor ecological settings, are nourishing, and can withstand stress (Khoury, 2015) [10]. Additionally, green gram is grown for green manuring. As a leguminous plant, it has the ability to fix 42 kg of atmospheric nitrogen per hectare. Due to the intensive crop rotation, it also aids in reducing soil erosion. After the pods are harvested, the green plant is pulled out or cut from the ground, and then it is chopped into little pieces and fed to the cattle. The seed husk can be utilized as cattle fodder by being soaked in water. India is the world's greatest producer and consumer of green gram. With an average yield of 500 kg ha-1, it produces 1.5 to 2.0 million tonnes of Moong beans over an area of between 3 and 4 million hectares. About 10–12% of the nation's total production of pulses are produced as green gram (Om Prakash Pandey *et al*., 2019) [15]. The only crop grown on the 38.32 lakh acres of land in our nation is mung bean. And the average productivity is 407 kg/ha, resulting in an output of roughly 17.84 lakh tonnes. (Anon., 2018) [1]. Rajasthan, Maharashtra, Karnataka, Madhya Pradesh, Odisha, and Telangana are the Indian states with the highest per capita production of green gram (Green gram outlook, 2020). With significant quantities of lysine (460 mg g-1 of N) and tryptophan (60 mg g^{-1} of N), green gram is a plentiful quality protein source (24.5%). Additionally, it contains a lot of riboflavin (0.21 mg 100 g^{-1}) and ascorbic acid (Azadi and Chandra, 2013) [2]. It contains 334 calories per 100 grams, 56.7 grams of carbohydrates, 127 mg of magnesium, 124 mg of calcium, 326 mg of phosphorus, and 4.4 mg of iron (Kavya and Lalita, 2014) [9].
The main cause of poor production is a lack of high-quality seeds of improved varieties available to farmers, abiotic and biotic limitations, insufficient crop management practices, and low yield (Pratap *et al*., 2019) [18]. Insects and diseases are the primary biotic pressures on mung beans, while salt, soil moisture stress, and waterlogging are the primary abiotic factors (Ramakrishnan M. Nair *et al*., 2019) [19]. Since it is a leguminous crop, Rhizobium bacteria help in developing nodules, which fix atmospheric nitrogen (Sevilmis & Sevilmis, 2019) [23] and improve crop yield.

In the recent past, bio-inoculants have become widely utilized to increase soil fertility, lessen environmental contamination, or use chemical fertilizers less frequently (Roy Chowdhary *et al*. 2017) [21]. A well-known plant microbes connection called the legume-rhizobium symbiosis is utilized to boost crop output by biologically fixing nitrogen. Leguminous plants' root nodules can be colonized by Rhizobium spp., which are frequently used as biofertilizers. These plants' roots are home to two different types of microorganisms: bacteria (Rhizobium) and fungi (mycorrhiza). Leguminous plants' growth and productivity are known to be positively impacted by these root symbionts. The main advantages of using mycorrhiza include improved soil structure, decreased pathogenic root infections, and improved moisture and nutrient absorption from the soil. (Kavita Singh Chaudhary., 2019) [8]. Urea is typically the main source of nitrogen, but when urea is applied, leaching losses are significant and nitrogen utilization efficiency is low. As a result, urea is coated with neem to prevent the repercussions since it prevents leaching losses and increases nitrogen use efficiency (Ramappa. K.B. *et al*., 2020) [20]. Foliar administration of nutrients is regarded as the greatest technique for applying fertilizers to plants, and it aids in the plants' ability to produce quickly and with less losses. This method of providing nutrients aids in getting the ingredients to the food site immediately. (S. K. Das and K. Jana., 2015) [22]. Therefore the present study was conducted to determine the effect of Biofertilizers, Neem coated urea, and Foliar NPK(12:32:16) on the growth and yield parameters of a Green gram.

Materials and Methods

The experiment was carried out in the Agricultural Research Farm at Lovely Professional University in Phagwara during the Kharif season of 2022. The effects of bio fertilizers, urea coated with neem, and foliar spray (12:32:16) on Kharif mung bean have been studied in Chaheru village, Kapurthala district. Eight treatments were used in three replications of the RBD (Randomized Block Design) experiment. The varied Neem coated urea (75% and 50%) concentrations, NPK Foliar-12:36:16, and seed treatment with biofertilizers such as Rhizobium and VAM were all used in the treatments. The 8 treatments are T1- Control (20:40:00 kg/ha); T2- NPK Foliar application (12:32:16); T3- 75% Neem coated urea+ Rhizobium; T4-75% Neem Coated Urea+ VAM; T5- 50% Neem Coated Urea + Rhizobium; T6- 50% Neem coated urea+ VAM; T7- NPK Foliar application 12:32:16 + Rhizobium; T8- NPK Foliar application 12:32:16 + VAM. Seeds were inoculated with VAM and Rhizobium. Before being sown in plots according to the treatment, the treated seeds were placed in the shade to get properly dried. Nitrogen and phosphorous were taken as recommended and entire dose of both nitrogen and phosphorus was given at the time of sowing as basal application but nitrogen was given according to the doses and in a split manner. Foliar spray (12:32:16) was given in split doses 1st on 15 DAS and 2nd dose of 45DAS i.e., Flowering stage.

Result and Discussion

Fresh weight

The fresh weight parameters are recorded @ 30,45 and 60 DAS by taking a sample of 4 plants per plot from each treatment. The visual presentation was shown in the Fig: 1 and the statistically data was represented in the Table: 1. The highest recorded treatment for the fresh weight is T8 (NPK Foliar 12:32:16 + VAM) which is Statistically par with the T7 (NPK Foliar 12:32:16 + Rhizobium), T2 (NPK Foliar application 12:32:16), T3 (75% Neem coated urea+ Rhizobium) and T4 (75% Neem coated urea + VAM). Foliar application of the major nutrients like NPK nutrients which is supplied directly to the leaves and promotes the photosynthesis and makes the plant to increase the fresh weight of the plant. Similar results were found in the following papers K.K. Yadav *et al*., (2022) [7], Maya Yadav *et al*., (2017) [7].

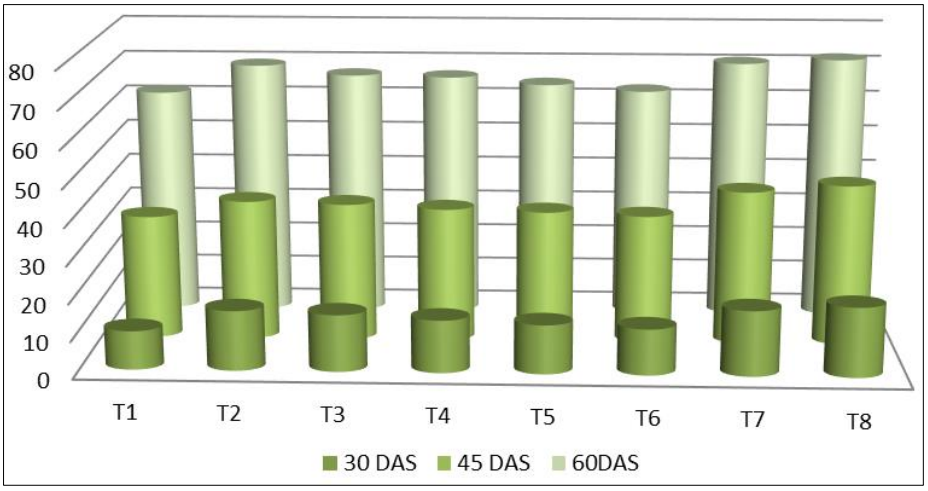

Fig 1: Effect of biofertilizer, Neem coated and foliar NPK on number of branches in green gram

Dry Weight

The dry weight was recorded at 30, 45, 60 DAS and at harvest and the statistical data was represented in the Table: 1. The dry weight get increased from 30, 45, 60 DAS and decreased from 60 DAS to harvest. At harvest, the highest dry weight was recorded in the T8 (NPK Foliar 12:32:16 + VAM) with (14.36 g). At 60 DAS the highest dry weight was observed in the treatment T8 (NPK Foliar 12:32:16 + VAM) with (18.90 g) which is statistically par with the T7 (NPK Foliar 12:32:16 + Rhizobium) with dry weight (17.33 g). As we can observe the treatments which showed higher results in the fresh weight gave the highest values in the dry weight also. Similar findings were given by the V Tejaswini *et al*., (2022) [25], P.K. Tyagi *et al*. (2020) [17], N Khumdemo Ezung *et al*. (2020) [13].

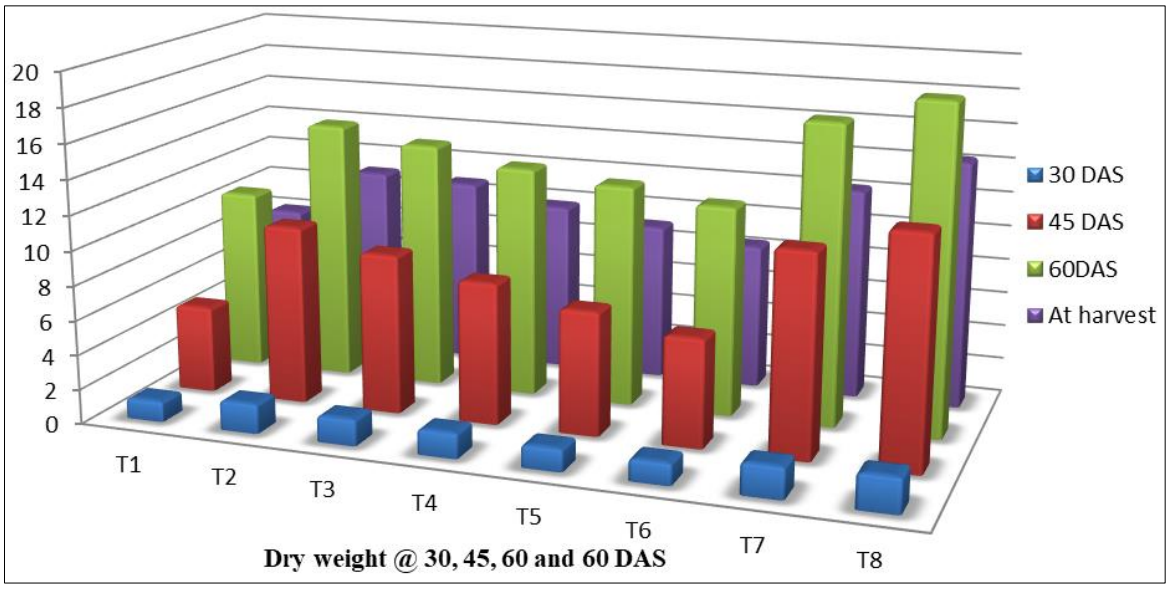

Fig 2: Effect of biofertilizer, Neem coated and foliar NPK on dry weight of green gram

Table 1: Effect of Bio fertilizer, Neem coated urea and Foliar NPK (12:32:16) on Fresh weight and Dry weight

Treatments	Fresh weight (g)			Dry weight(g)			
	30DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	At harvest
RDF (100% NPK)	10.40	33.56	61.83	1.20	5.06	10.56	8.16
NPK foliar application(12:32:16)	16.13	38.00	69.56	1.73	10.36	15.13	11.06
75% Neem coated urea + Rhizobium	15.30	37.40	67.00	1.53	9.26	14.36	10.83
75% Neem Coated Urea + VAM	14.16	36.30	66.63	1.46	8.20	13.43	9.86
50% Neem coated urea + Rhizobium	13.20	35.76	64.70	1.30	7.16	12.86	9.13
50% Neem coated urea + VAM	12.40	34.86	63.03	1.26	6.26	12.16	8.46
NPK foliar12:32:16 + Rhizobium	17.60	41.73	70.96	1.81	11.63	17.33	12.26
NPK foliar12:32:16 + VAM	18.80	43.66	72.13	2.00	13.13	18.90	14.36
S.Em (±)	0.43	1.15	2.22	0.05	0.33	0.61	0.31
C. D. @ 5%	1.34	3.54	6.82	0.15	1.02	1.89	0.95

Yield parameters

Pods/plant, Seeds/ pod and Pod length

According to the recorded data in Table: 2 and the graphical representation can be seen in Fig: 3, Significantly, it is seen that the higher number of pods/plant (19.33), Seeds/pod (9.56) and Pod length(8.80 cm) can be seen in the treatment T7 (NPK Foliar 12:32:16+ Rhizobium) but the maximum pods/plant were observed in T8 (NPK Foliar 12:32:16) statistically par with the highest treatment T7 (NPK Foliar 12:32:16+ Rhizobium) and the remaining parameters like seeds/pod which is non-significant and does not show any effect of treatments. The presence of the rhizobium makes the soil fix the atmospheric nitrogen for the availability of nitrogen to the plant which helps in plant growth in a healthier way and increases the yield parameters like Pods/plant, seeds/pod and pod length. Similar, observations were reported by Priyanka Sharma and Prakash Borah, (2020) [24], Nusakho Nyekha *et al.*, (2015) [14], P Vinodhini *et al.*, (2022) [16], F. K. Mbaka *et al.*, (2022) [5], Yubaraj Dhakal *et al.*, (2016) [26], B Bhabai *et al.*, (2019) [6].

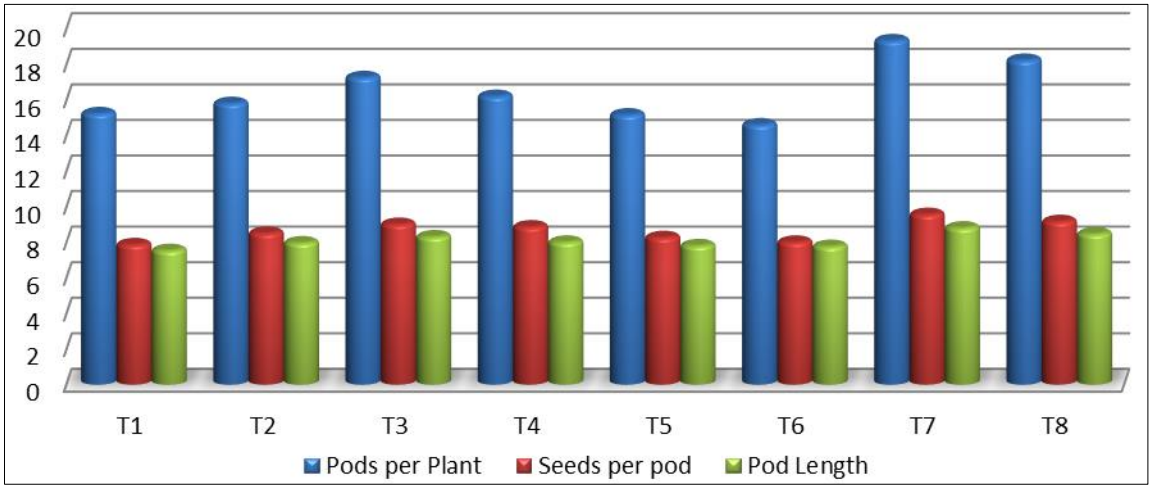

Fig 3: Effect of biofertilizer, Neem coated and foliar NPK on pods/plant, seeds/pod and pod length of green gram

Grain yield: The treatment T7 (NPK Foliar 12:32:16 + Rhizobium) produced the maximum grain yield among all the other treatments and statistically at par with T8 (NPK Foliar 12:32:16 + VAM). Fig. 4 shows the information in graphical form. The other factors, including plant and pod counts, the number of seeds per pod, test weight, etc., have a significant impact on grain yield. Additionally, nutrients are easily transferred into the leaves when applied using the foliar method, which boosts photosynthesis and decreases nutrient loss. Similar findings were obtained by Manapuram Vaishnavi and Dr. Biswarup Mehera., (2022) [11], Dakhane Vimal P and Tiple Neha, (2021) [4].

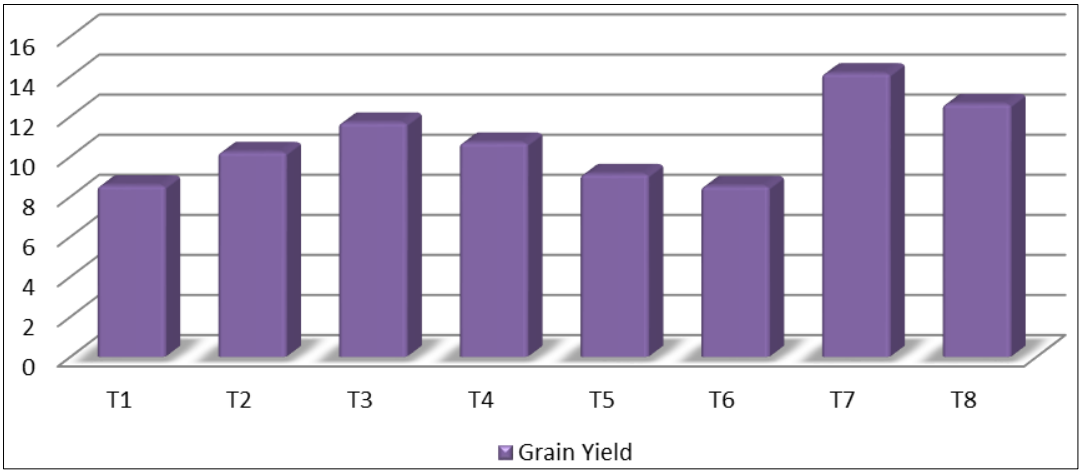

Fig 4: Effect of biofertilizer, Neem coated and foliar NPK on grain yield of green gram

Table 2: Effect of Bio fertilizer, Neem coated urea and Foliar NPK (12:32:16) on No. of pods/plant, seeds/pod, pod length, and Grain yield

Treatments	No. of Pods/plant	No. of seeds/plant	Pod length	Grain yield
RDF (100% NPK)	15.23	7.86	7.53	8.56
NPK foliar application(12:32:16)	15.80	8.50	7.96	10.23
75% Neem coated urea + Rhizobium	17.26	9.00	8.30	11.70
75% Neem Coated Urea + VAM	16.20	8.86	8.00	10.70
50% Neem coated urea + Rhizobium	15.16	8.26	7.80	9.13
50% Neem coated urea + VAM	14.60	8.00	7.76	8.53
NPK foliar12:32:16 + Rhizobium	19.33	9.56	8.80	14.16
NPK foliar12:32:16 + VAM	18.23	9.16	8.46	12.63
S.Em (±)	0.54	0.37	0.09	0.41
C. D. @ 5%	1.68	NS	0.27	1.27

Conclusion

Based on the results of the current study, it can be concluded that applying nutrients in an integrated manner-for example, using a mix of inorganic and living microorganisms as fertilizers-has a significant impact on growth traits and yields like Fresh weight, Dry weight and yield parameters such as number of pods/plant, no. of seeds/pod, Pod length and seed yield of mung bean. When compared to other treatments that are statistically comparable to NPK Foliar (12:32:16) with VAM seed treatment, NPK Foliar (12:32:16) application with Rhizobium seed treatment in the yield parameters and NPK Foliar (12:32:16) + VAM which is statistically parred with NPK Foliar (12:32:16) + Rhizobium in the growth parameters like Fresh and Dry weight determined to be superior, it can be said that the greatest strategy to improve green gram growth features and production is to use biofertilizer in conjunction with NPK foliar. The farmer might be encouraged to minimize the use of inorganic fertilizer by reducing nutrient losses and take advantage of the use of biofertilizer in combination with NPK Foliar (12:32:16). Additionally, it preserves sustainability while enhancing the health of the soil.

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