The Pharma Innovation Journal 2021; 10(11): 1087-1089

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 1087-1089

www.thepharmajournal.com
Received: 03-09-2021
Accepted: 13-10-2021

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Effect of inorganic fertilizers and neem cake on the growth and yield of green gram (*Vigna radiata* L.)

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Abstract
The present experiment was conducted during the *kharif* season of 2019-20 at Crop Research Centre (CRC), School of Agriculture, ITM University Gwalior, Madhya Pradesh to evaluate the neem cake and inorganic fertilizers on the growth and yield of green gram. The experiment was laid out in Randomized Block Design (RBD) having three replications. The experiment comprises of nine different treatments. Application of NPK @ 20:40:00 kg/ha + Neem cake @ 1 t/ha produced higher growth and yield attributes of green gram. The maximum grain yield (12.55 q ha^{-1}) recorded with treatment $N_{20}P_{40}$ Kg ha^{-1} + Neem cake 1 t ha^{-1}. The maximum net return of Rs.70918 ha^{-1} and benefit cost ratio (3.35:1) were also recorded under this treatment.

Keywords: Inorganic fertilizers, green gram, grain yield, neem cake and net return

Introduction
Green gram (*Vigna radiate* L.) is an important pulse crops in our country after chickpea and pigeon pea. It is important short duration grain legume crop with wide adaptability, low input requirement and has the ability to improve soil fertility by fixing atmospheric nitrogen well suited to small holder production under adverse climatic conditions (Vijayalakshmi and Bhattacharya, 2006) [8]. Green gram is grown on about 3.70 million hectares with annual production of 1.57 million tons. India is the largest producer of green gram and account for 54% of the world production and covers 65% of the world acreage. The nutritive value of green gram lies in its high and easily digestible protein and contains approximately 25-28% protein, 1.0% oil, 3.5-4.5% fiber, 4.5-5.5% ash and 62-65% carbohydrates on dry weight basis. Besides being a rich source of protein, it maintains soil fertility through biological nitrogen fixation and thus plays a vital role in sustainable agriculture. Green gram fixes 63-342 kg N ha^{-1} per season in soil by biological nitrogen fixation. There exists a vast gap between potential productivity and actual productivity of green gram being realized at present. Apart from other agronomical management practices, imbalanced plant nutrition is the major constraint to higher productivity of the crop. Green gram being a leguminous crop requires adequate amount of phosphorus as well as apart from other nutrients these are directly involved in growth and development of plant. Proper fertilization is essential to improve the productivity of green gram.

Nutrient balance is the key component to increase the crop yields. Excess and imbalanced use of nutrients has caused nutrient mining from the soil, deteriorated crop productivity and ultimately soil health environment. Organic manures provide a good substrate for the growth of microorganisms and maintain a favorable nutrient supply environment and improve soil physical- chemical properties (Amruta *et al*., 2015) [1]. Replenishment of these nutrients through organic and combination with neem cake and inorganic fertilizers has a direct impact on soil health environment and crop productivity. Keeping in view all the factors related to soil fertility and productivity, inorganic fertilizers with organic manure like neem cake are applied to soil to maintain soil status and crop productivity.

Method and Materials
The present experiment was conducted during the *kharif* season of 2019-20 at Crop Research Centre (CRC), School of Agriculture, ITM University Gwalior, Madhya Pradesh. The experiment was laid out in Randomized Block Design (RBD) having three replications.

The experiment comprises of nine different treatments *viz*. T_0: $N_0P_0K_0$ + Neem cake 0 t ha^{-1}, T_1: $N_0P_0K_0$ + Neem cake 0.5 t ha^{-1}, T_2: $N_0P_0K_0$ + Neem cake 1 t ha^{-1}, T_3: $N_{10}P_{20}K_0$ + Neem cake 0 t ha^{-1}, T_4: $N_{10}P_{20}K_0$ + Neem cake 0.5 t ha^{-1}, T_5: $N_{10}P_{20}K_0$ + Neem cake 1 t ha^{-1}, T_6: $N_{20}P_{40}K_0$ + Neem cake 0 t ha^{-1}, T_7: $N_{20}P_{40}K_0$ + Neem cake 0.5 t ha^{-1} and T_8: $N_{20}P_{40}K_0$ + Neem cake 1 t ha^{-1}. The seed of green gram variety "Maya" were sown in the furrows on July, 20th 2019 with constant spacing of 30 x 10 and 20 kg ha^{-1} seed rate. All other agronomical practices were done as per package of practices of greengram.

Results and Discussion

It is clear from results (Table-1) that Application of NPK @ 20:40:00 kg ha^{-1} combined with neem cake @ 1 t ha^{-1} recorded maximum plant height and number of branches. The combined application of inorganic fertilizers to the green gram increased the availability of major nutrients to plant as it might has enhanced early root growth and cell multiplication leading to more absorption of other nutrients from soil deeper layers ultimately resulting in increased plant growth. Research results and on farm trail reports have also revealed that application of 15- 20 kg N, 30-40 kg P_2O_5 and 20-40 kg K_2O ha^{-1} proved beneficial for most of the pulses in India (Vipul and Ajay, 2019) [9].

The growth attributes of plants also significantly increased with the increasing levels of fertilizers during the year of experiment. The increase in growth attributes might be due to increase in availability of major nutrients of nitrogen and phosphorus due to direct addition in the form of fertilizer. Nitrogen is one of the major essential plant nutrients required for growth and also accelerates photosynthetic rate and thereby increases the supply of carbohydrates to plant, which might have in turn increased dry matter production in plant of green gram. Similarly, increased supply of available phosphorus in soil has long been considered as an essential constituent of all living organisms and plays an important role in the conservation and transfer of energy in the metabolic reactions of living cells including biological energy transformations. Phosphorus also plays a vital role in proliferation of root. Increased availability of phosphorus owing to its application in low phosphorus soils might have improved the availability of phosphate and resulted in more uptake and in turn increased growth attributes of the plants. Thus, application of recommended dose of fertilizers at optimum level increased the plant growth of green gram. The observed improvement in overall vegetative growth of the green gram crop with the application of fertilizer, nitrogen and phosphorus are in conformity with the findings of Singh *et al.* (2018) [6] and Sai *et al.* (2020) [4].

Yield attributing characters of green gram were significantly improved due to application of higher level of nutrients. Application of NPK @ 20:40:00 kg ha^{-1} with combined application of neem cake @ 1 t ha^{-1} recorded maximum number of pods per plant, number of grains per pod, and test weight. It may be attributed to the beneficial effects of higher growth parameters in this treatment. Large available of stored photosynthetic and translocated in to various yield attributes. Continuous mineralization and availability of nutrients as per the requirements during later stage of the plant growth might be the reason for higher values of yield attributes. The results are in close agreement with the findings of Sharma and Abraham (2010) [5], Yadav *et al.* (2019) [11], Reddy *et al.* (2020) [3] and Subrata *et al.* (2020) [7].

In the present investigation, the application of NPK @ 20:40:00 kg/ha^{-1} with combined application of neem cake @ 1 t/ha^{-1} registered significantly higher grain and straw yield over most of the treatments (Table-2). This was largely attributed to better growth of plant which resulted in adequate supply of photosynthates for development of sink under higher level of inorganic fertilizer. Increase in the yield under these treatments could be owing to enhancement of yield components and growth parameters. Apart from this, with the higher concentration of NPK might have helped in enhancing the availability of more plant nutrients which enhanced the yield attributes ultimately resulted in higher yield. These results are in collaboration with the finding of Reddy *et al.* (2020) [3] and Subrata *et al.* (2020) [7]. The application of NPK (@ 20: 40: 20 kg ha^{-1}) with higher level of neem cake fetched maximum gross returns and net returns. The significantly maximum return per rupee invested during the experimental year, was obtained under the same treatment. The cost involved under these treatments was comparatively lower than additional income, which led to more returns under these treatments as compared to others. It also indicated that additional dose of manures would yield no profit (Bhattacharyya *et al.*, 2008 and Yadav *et al.* 2017) [2, 10].

Table 1: Effect of inorganic fertilizers and neem cake on growth and yield attributing parameters of greengram

Tr. No.	Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of pods /plant	Number of grains per pod	Test weight (g)
T_0	$N_0P_0K_0$ + Neem cake 0 t ha^{-1}	49.33	6.75	23.89	5.62	40.57
T_1	$N_0P_0K_0$ + Neem cake 0.5 t ha^{-1}	52.51	7.84	27.67	8.38	43.70
T_2	$N_0P_0K_0$ + Neem cake 1.0 t ha^{-1}	52.65	8.04	28.33	9.16	44.85
T_3	$N_{10}P_{20}K_0$ + Neem cake 0 t ha^{-1}	52.78	8.24	28.67	9.46	45.05
T_4	$N_{10}P_{20}K_0$ + Neem cake 0.5 t ha^{-1}	52.98	8.13	28.78	10.21	45.29
T_5	$N_{10}P_{20}K_0$ + Neem cake 1.0 t ha^{-1}	53.00	8.33	29.45	11.05	46.19
T_6	$N_{20}P_{40}K_0$ + Neem cake 0 t ha^{-1}	53.08	8.65	30.00	11.21	47.15
T_7	$N_{20}P_{40}K_0$ + Neem cake 0.5 t ha^{-1}	53.41	8.96	30.44	11.58	48.13
T_8	$N_{20}P_{40}K_0$ + Neem cake 1.0 t ha^{-1}	53.75	9.38	30.78	13.00	49.19
S. E m±		0.75	0.21	1.26	0.63	0.87
CD(p=0.05)		2.17	0.60	3.66	1.83	2.52

Table 2: Effect of inorganic fertilizers and neem cake on yield and economical parameters of greengram

Tr. No.	Treatments	Yield parameters			Economics	
		Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)	Net monetary return (Rs ha^{-1})	Return per rupee invested
T_0	$N_0P_0K_0$ + Neem cake 0 t ha^{-1}	4.09	9.94	28.35	12289	0.68
T_1	$N_0P_0K_0$ + Neem cake 0.5 t ha^{-1}	5.76	10.74	34.97	23886	1.28
T_2	$N_0P_0K_0$ + Neem cake 1.0 t ha^{-1}	6.76	11.09	37.86	30617	1.60
T_3	$N_{10}P_{20}K_0$ + Neem cake 0 t ha^{-1}	6.91	11.22	38.12	31683	1.65
T_4	$N_{10}P_{20}K_0$ +Neem cake 0.5 t ha^{-1}	7.04	11.24	38.53	32121	1.63
T_5	$N_{10}P_{20}K_0$ +Neem cake 1.0 t ha^{-1}	7.99	13.83	36.63	38716	1.92
T_6	$N_{20}P_{40}K_0$ + Neem cake 0 t ha^{-1}	9.60	14.55	39.75	50348	2.49
T_7	$N_{20}P_{40}K_0$ + Neem cake 0.5 t ha^{-1}	11.24	16.92	39.93	61886	2.99
T_8	$N_{20}P_{40}K_0$ + Neem cake 1.0 t ha^{-1}	12.55	17.97	41.08	70918	3.35
S. E m±		0.38	0.34	1.70	-	-
CD(p=0.05)		1.09	0.98	4.95	-	-

Conclusion

Based upon this experiment it is concluded that application of NPK @ 20:40:00 kgha^{-1} combined with neem cake @ 1 tha^{-1} recorded the maximum and significantly higher grain yield (12.55 q/ha), net returns (Rs. 70918/ ha) and highest Net Return per Rupee Invested of 3.35:1. Hence, application of this combination nutrient may be adopted in semi-arid eastern plain zone of Madhya Pradesh.

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