Eco. Env. & Cons. 29 (2) : 2023; pp. (605-609)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i02.011

Performance of summer green gram in response to combined soil and foliar application of major essential nutrients

S. Mohapatra*[1], G.K. Ghosh[2], G.H. Santra[3], A. Snigdha[4], D. Sethi[5], S.P. Das[6] and M.C. Kundu[7]

[1,3,4,6]Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Bhubaneswar 751 029, Odisha, India
[1,2,7]Palli Siksha Bhavana, Visva-Bharati, Sriniketan 731 236, West Bengal, India
[5]Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology, G. Udayagiri, Kandhamal 762 100, India

(Received 10 September, 2022; Accepted 2 December, 2022)

ABSTRACT

Foliar application can be used along with the soil application of fertilizers to enhance the yield and quality of crops for a sustainable approach to nutrient management. In this context, a field experiment was conducted with green gram (cv: NVL-516) in anacidic soil of the Agricultural Research Farm, Siksha 'O' Anusandhan, Bhubaneswar with the objective to study the impact of combined soil and foliar application of nutrients on yield and protein content of summer green gram in Odisha. The experiment was laid out in a Randomized Block Design with three replications and eight treatments consisting of recommended dose of Nitrogen, Phosphorous, Potassium and Sulphur (NPKS) along with foliar application of 2% urea, diammonium phosphate (DAP), KCl, N: P: K (19:19:19) and 1%KNO_3 and control.Foliar application was done two times at 30 and 45 DAS. The highest yield (1582 kg ha-[1]) was recorded in treatment where 1%KNO_3 was applied as foliar spray along with the recommended dose of NPKS and was at par with 2%DAP(1574 kg ha^{-1}). The protein content of seeds was found highest in treatment with foliar application of urea (22.6%) followed by KNO_3(22.4%), N: P: K (19:19:19) (22.4%) and DAP(22.1%). The protein content strongly correlated with the N concentration of seeds.

Key words: *Foliar fertilization, Greengram, Protein, Potassium nitrate, Yield*

Introduction

Green gram occupies a unique position in various farming systems as main, catch, cover, green manure, intercrop and mix crop. It is the third most important pulse crop in India. India contributes more than 70% of the world's green gram production Despite having importance in our daily diet and in agricultural production, productivity of this crop is very low in India. The low productivity of this crop is due to wide gap in adoption of recommended green gram production technology, improper fertilizer management, unavailability of healthy seeds, high cost of seeds, fertilizers and pesticides, high labour wage and non-remunerative price (Das, 2017 and Paradva *et al.,* 2019). Application of native rhizobia strains to pulses also enhances the nutrient availability by influencing microbial properties at root rhizosphere (Sethi *et al.,* 2019a) and also protects from drought stress by pro-

([1]Assistant Prof., [2]Prof., [3]Prof., [4]Scholar, [5]Jr. Scientist, [6]Assistant Prof., [7]Assistant. Prof.)

ducing exopolysaccharides (Sethi *et al*., 2019b)

Nutrients play a pivotal role in overcoming yield stagnation in pulses (Chandrasekhar and Bangarusamy, 2003). Alongwith nitrogen, phosphorous and potassium, sulphur application is very essential to improve the yield of legumes as it influences the BNF (Das, 2017). Hence, balanced fertilization is important to improve the yield of green gram. Apart from balanced soil fertilization, foliar application of fertilizers is also done for quick and efficient utilization of nutrients (Manonmani and Srimathi, 2009). When fertilizer is applied through foliar application, its use efficiency is increased many folds and the ill effects of fertilizers on soil can be reduced to a great extent. Hence, a sustainable approach of nutrient management is essential for the successful cultivation of green gram following the norms of the sustainable developmental goals (SDGs) planned by the UN in 2015. Considering the above facts, the experiment is planned to study the effect of foliar and soil application of fertilizers on yield and quality of green gram (*Vigna radiata* L.) in the east and south eastern coastal plains of Odisha.

Materials and Methods

The field experiment was conducted during two successive summer seasons of 2021 and 2022 with greengram variety NVL-516 at the Instructional farm, Institute of Agricultural Sciences, Siksha 'O' Anusandhan, Bhubaneswar, Odisha. The experimental site was situated at 85.7617°E longitude and 20.2809°N latitude and comes under East and South Eastern Coastal Plain Agro-climatic zone of the state of Odisha, India. The climate is hot and humid with a mean annual rainfall of 1467 mm. About 70% of total rainfall is received from July to September. The mean maximum and minimum temperatures were 33.2 ^{0}C and 21.4 ^{0}C, respectively. The experiment was laid out in randomized block design (RBD) with three replications and eight treatments. The treatments were absolute control (no fertilizers), NPK (basal), NPKS (basal), NPKS (basal) with two foliar application of 2 % Urea, MOP (muriate of potash), DAP (diammonium phosphate), KNO_3 and N:P:K (19:19:19) at pre-flowering stage. The recommended dose of 20, 40 and 20 kg ha^{-1} of N, P_2O_5 and K_2O respectively in the form of urea, DAP and MOP along with $ZnSO_4$ (25 kg ha^{-1}) was applied in all the treatments at the time of sowing. The soil of the experimental plot was sandy loam in texture, acidic (pH-6.2) in soil reaction and non-saline (Electrical conductivity-0.12 dSm^{-1}). The soil was low in organic carbon (0.49%), available N (248 kg ha^{-1}) sulphur (8.62 kg ha^{-1}), medium in available phosphorus (14.6 kg ha^{-1}) and potassium (162 kg ha^{-1}). Seeds were treated with*Rhizobium* culture before sowing and sown in rows with 20 cm apart and 10 cm plant to plant spacing. Regularly biometric observations were recorded at specific time intervals by selecting randomly ten plants in each treatment. The initial soil sample at 0-15 cm depth was analysed for different parameters by following standard methods Nutrient availability and nutrient uptake were analysed after harvest. Nitrogen was estimated by Kjeldahl method and the results so obtained were expressed as percent N concentration on dry weight basis. Protein content was found by multiplying the nitrogen concentration with Jones' factors (6.25) to the N concentration. Phosphorus concentration of seedswas determined by "Vanadomolybdophosphate" yellow colour method and expressed as percent phosphorus concentration on dry weight basis (Jackson, 1973). Potassium content of seed samples was estimated by Flame photometric method (Jackson, 1973). Nutrient uptake of individual nutrients (N, P and K) in seeds was estimated as per the following formula (Sahoo *et al.*, 2022).

Nutrient Uptake (kg ha^{-1}) = Dry mass (q ha^{-1}) × Nutrient Concentration (%)

The data collected from field observation and recorded in the laboratory were subjected to statistical analysis by standard analysis of variance techniques.

Results and Discussion

Effect of foliar and soil application of fertilizers

Yield and biomass

The pooled analysis of results showed that the seed yield was highest with foliar application of KNO_3 (1599 kgha^{-1}) which was at par with foliar application of DAP (1590 kgha^{-1}). Their yield was significantly higher than rest of the treatments. The highest stover yield (2169 kg ha^{-1}) as well as biomass yield was also found in the treatment with foliar application of KNO_3 (Table 1 and Fig. 1). The treatment with no fertilizer had significantly the lowest seed (746 kg ha^{-1}), stover (1224 kgha^{-1}) as well as biomass

yield. The increment of yield in green gram by foliar application of KNO_3 was also reported by Vekaria *et al*. (2013), Sridhar *et al.* (2020) and Jagtap *et al.* (2021). Around 30% increase in yield was found with additional foliar application of KNO_3 or DAP as compared to only recommended basal dose of fertilizer application. This might be due to the supply of nutrients through foliage during crop requirement and efficient translocation of photosynthates from source to sink.

N, P and K concentration and uptake of seed

The pooled analysis of results presented in Table 2 showed that the N concentration of seeds was highest (3.62%) in the treatment receiving foliar application of urea, whereas the lowest (2.98) in control. Maitlo *et al.* (2006) reported that foliar application of urea significantly increased the nitrogen content wheat grain as compared to soil application. The P concentration varied significantly between 0.42% (control) to 0.56% (NPKS+DAP). The K concentration varied significantly between 1.34% (control) to 1.61% (NPKS+MOP). As per recent reports, foliar application of nutrients can be highly effective for increasing the concentration and bioavailability of the respective nutrients in the harvested product (Mohapatra *et al*., 2017; Zou *et al*., 2012; Hao *et al.*, 2021).

The N uptake of green gram seeds varied significantly between 22.25 $kgha^{-1}$ (control) and 57.19 kg ha^{-1} (NPKS+ KNO_3). The P uptake was highest (8.86 $kgha^{-1}$) in treatments with foliar application of DAP (Table 2). However, it was at par with the treatments with foliar application of KNO_3 and NPK (19:19:19). The K uptake varied significantly between 9.97 $kgha^{-1}$ (control) to 25.40 $kgha^{-1}$ (NPKS+ KNO_3). Increased NPK uptake by green gram due to the foliar application was observed by Kuttimani and Velayutham (2011).

Protein content of seed

The pooled data related to the influence of different

Table 1. Effect of foliar and soil application of fertilizers on yield of green gram (pooled)

Treatments	Seed Yield	Stover yield	Harvest Index
		(Kg ha^{-1})	
T_1 Control	746	1224	0.38
T_2 NPK (RD)	1207	1965	0.38
T_3 NPKS (RD)	1240	2006	0.38
T_4 NPKS+ Urea	1355	2092	0.39
T_5 NPKS+ DAP	1590	2134	0.43
T_6 NPKS+ MOP	1440	2198	0.40
T_7 NPKS+ KNO_3	1599	2169	0.42
T_8 NPKS+ NPK (19:19:19)	1475	2085	0.41
SE(m)+	39.44	58.48	0.01
CD(0.05)	118.23	175.30	0.04
CV(%)	5.14	5.11	5.28

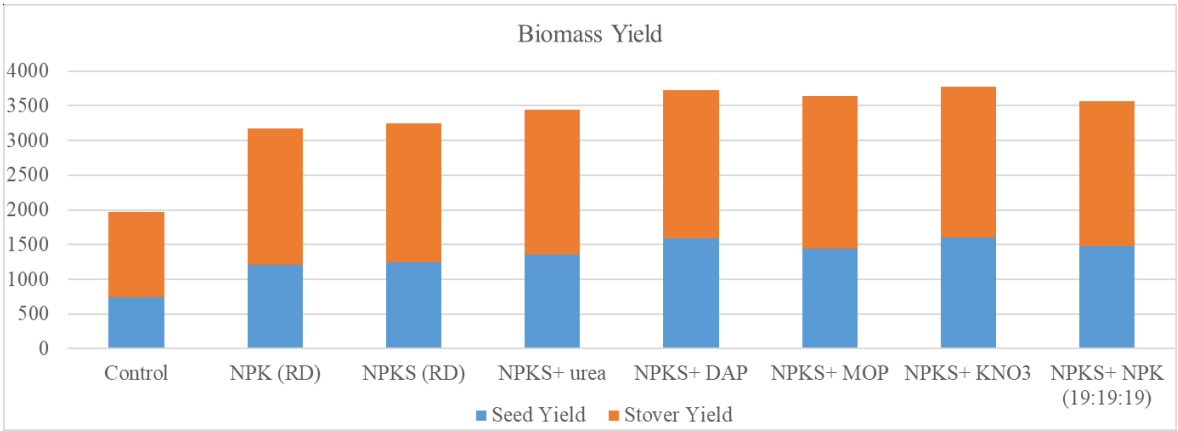


Fig. 1. Effect of foliar and soil application of fertilizers on biomass yield (pooled)

packages in crude protein content of green gram seed has been presented in Fig. 2. The crude protein of green gram seed varied between 18.6 % and 22.6 %. The highest was estimated in NPKS+ Urea (22.6 %) followed by NPKS+KNO_3 and NPKS+NPK (19:19:19) (22.4 %), NPKS+MOP (22.2 %), NPKS+DAP (22.1%), NPKS (22.0 %), NPK (21.2 %) and lowest was in control (18.6 %). There was an enchantment of 14-22 % protein in nutrient management packages over control. The nutrient application to both foliar and soil increased by 0.5-2.7% crude protein over NPKS soil application. The protein content of greengram seeds strongly correlated with the N concentration (Fig. 3**)**. Similar findings were also reported by Maitlo *et al*. (2006).

Conclusion

The results obtained in the study indicated that integrated soil and foliar application of fertilizer is bet-

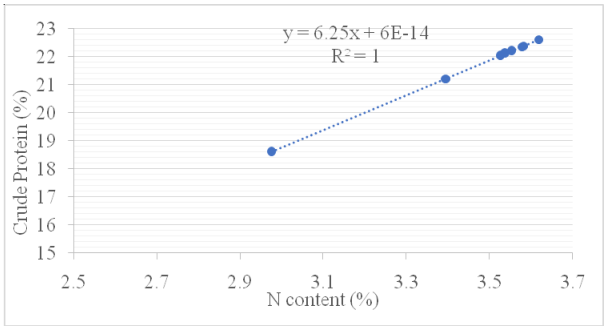
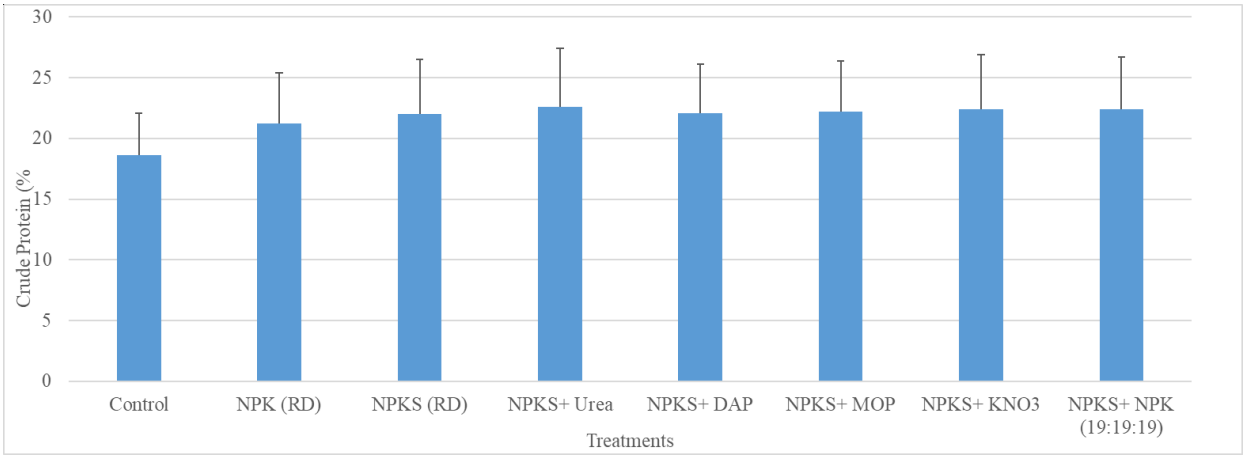


Fig. 3. Correlation of protein content(%) of seeds with N concentration (%) of seeds

Table 2. Effect of foliar and soil application of fertilizers on N, P and K concentration and uptake of green gram seeds (pooled)

Treatments	N	P	K	N	P	K
	Concentration (%)			Uptake (kg ha^{-1})		
T_1 Control	2.98	0.42	1.34	22.25	3.16	9.97
T_2 NPK (RD)	3.40	0.51	1.48	40.93	6.30	17.98
T_3 NPKS (RD)	3.53	0.52	1.49	43.60	6.43	18.53
T_4 NPKS+ Urea	3.62	0.51	1.55	49.00	6.88	21.02
T_5 NPKS+ DAP	3.54	0.56	1.51	56.16	8.86	24.10
T_6 NPKS+ MOP	3.55	0.50	1.61	51.02	7.26	23.32
T_7 NPKS+ KNO_3	3.58	0.52	1.59	57.19	8.32	25.40
T_8 NPKS+ NPK (19:19:19)	3.58	0.55	1.59	52.70	8.08	23.44
SE(m)+	0.09	0.03	0.09	1.59	0.47	1.35
CD(0.05)	0.28	0.1	0.26	4.77	1.42	4.05
CV(%)	4.55	11.73	9.85	5.92	11.84	12.16



*Cap over each bar indicates standard error

Fig. 2. Effect of foliar and soil application of fertilizers on seed crude protein (%)

ter than soil application alone. Potassic fertilizers especially KNO_3 is highly beneficial for increasing yield and quality of crop. Foliar application of 1% KNO_3at pre flowering along with soil application of recommended basal dose of N, P, K and S can be a better nutrient mangement option to enhance the yield and protein content of green gram in summer season.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Bhavya, M., Sridhara, C.J., Nandish, M.S., Mavarkar, N.S., Suchitha, Y. and Sumithra, B.S. 2020. Influence of Foliar Application of water-soluble fertilizers on Nodule Count and Rhizosphere Microbial Population in Green gram (*Vigna radiata* L.). *Int. J. Curr. Microbiol. App. Sci*. 9(2) : 2383-2392. DOI: 10.20546/ijcmas.2020.902.271

Chandrasekhar, C.N. and Bangarusamy, U. 2003. Maximizing the yield of mung bean by foliar application of growth regulating chemicals and nutrients. *Madras Agric. J.* 90(1-3) : 142-145.

Das, S.K. 2017. Effect of phosphorus and sulphur on yield attributes, yield, nodulation and nutrient uptake of green gram (*Vigna radiate* (L.) wilczek). *Legume Research-An International Journal*. (40): 138-143.

Hao, B., Ma, J. and Jiang, L. 2021. Effects of foliar application of micronutrients on concentration and bioavailability of zinc and iron in wheat landraces and cultivars. *Sci Rep*. 11: 22782. DOI:10.1038/s41598-021-02088-3

Jadhav, R.L. and Kulkarni, S. 2016. Effects of foliar spray of nutrients on productivity of green gram (*Vigna radiata*) in North Eastern transitional zone of Karnataka, India. *Legume Research*. 39(5) : 817-819.

Jagtap, P. Ilhe, S.S. , Ilhe, S. and Basawrajx, B. 2021. Effect of foliar application of potassium on growth and yield of summer greengram (*Vigna radiata* L. Wilczek). *Current Advances in Agricultural Sciences.* 13: 128-130. DOI: 10.5958/2394-4471.2021.00027.7

Kuttimani, R. and Velayutham, A. 2011. Foliar Application of Nutrients and Growth Regulators on Yield and Economics of Greengram. *Madras Agricultural Journal.* 98 (4-6): 141-143.

Lyu, X., Liu, Y., Li, N., Ku, L., Hou, Y. and Wen, X. 2021. Foliar applications of various nitrogen (N) forms to winter wheat affect grain protein accumulation and quality via N metabolism and remobilization. *Crop J.* DOI: 10.1016/j.cj.2021.10.009 [Epub ahead of print].

Mailto, A., Zai-ul-Hassan, Shah, A. N. and Khan, H. 2006. Growth, Yield and Nutrient Uptake of Wheat (*Triticum aestivum* L.) in relation to Foliarand Soil Application of Urea. *International Journal of Agriculture and Biology*. 8(4): 477-481.

Manonmani, V. and Srimathi, P. 2009. Influence of Mother Crop Nutrition on Seed and Quality of black gram. *Madras Agric. J.* 96 (16) : 125-128.

Mohapatra, S., Rout, K.K., Khanda, C.M., Mukherjee, S.K., Mishra, A., Mahapatra, S.S. and Mishra, M. 2017. Role of potassium on insect pests and diseases of puddled transplanted rice cv. Lalat in Odisha. *ORYZA-An International Journal on Rice.* 54: 314. DOI: 10.5958/2249-5266.2017.00043.1

Naidu, T.C.M., Rao, N., Siva, D., Rani, and Ashoka, Y. 2015. Effect of foliar nutrition on antioxidant enzymes, photosynthetic rate, dry matter production and yield of mung bean under receding soil moisture condition. *International Journal of Pure and Applied Bioscience.* 3(1): 115-23.

Paradva V.B. 2019. Constraints Faced by The Green Gram Growers in Adoption of Recommended Green Gram Production Technology. *International Journal of Agriculture Sciences*. 11(6): 8148-8149.

Sahoo, S.K., Mishra, K.N., Panda, N., Panda, R.K., Padhan, K., Mohanty, S., Kumar, K. and Sethi, D. 2022. System Productivity and Nutrient Recoveries as Influenced by Nine Years of Long-term INM Practices under Acidic *Inceptisols* of India. *Biological Forum.* 14(3): 1036-1040.

Sengupta, K. and Tamang, D. 2015. Response of green gram to foliar application of nutrients and brassinolide. *J. Crop Weed*. 11(1): 43- 45.

Sethi, D., Mohanty, S. and Pattanayak, S.K. 2019b. Effect of different carbon, nitrogen and vitamine sources on exopolysaccharide production of *Rhizobium* species isolated from root nodule of redgram. *Indian Journal of Biochemistry & Biophysics.* 56: 86-93.

Sethi, D., Mohanty, S. and Pattanayak, S.K. 2019a. Acid and salt tolerance behavior of Rhizobium isolates and their effect on microbial diversity in the rhizosphere of redgram (*Cajanus cajan* L.). *Indian Journal of Biochemistry and Biophysics.* 56: 245-252.

Sridhar, S. M., C. Supriya, Anandha Krishnaveni, S. 2020. Productivity Enhancement through Foliar Nutrition in Green Gram (*Vigna radiata*). *Int. J. Curr. Microbiol. App. Sci*. 9(4): 807-811. DOI: 10.20546/ijcmas.2020.904.096.

Vekaria, G.B., Talpada, M.M., Sutaria, G.S. and Akbari, K.N. 2013. Effect of foliar nutrition of potassium nitrate on the growth and yield of green gram (*Vigna radiata* L.). *Legume Research*. 36: 162-164

Zou, C. Q. 2012. Biofortification of wheat with zinc through zinc fertilization in seven countries. *Plant Soil.* 361 : 119–130. DOI: 10.1007/s11104-012-1369- 2.