Indian Journal of Ecology (2023) 50(3): 676-680
DOI: https://doi.org/10.55362/IJE/2023/3951

Manuscript Number: 3951
NAAS Rating: 5.79

Nutrient Content and Uptake of Soybean (*Glycin max* L Meril) on different Fertility Levels under Guava Based Agri-horticulture System

Ankit Pandey, Avijit Sen and Prabhat Tiwari[1]

Department of Agronomy, Banaras Hindu University, Varanasi-221 005, India
[1]Department of Silviculture and Agroforestry, Rani Lakshmi Bai Central Agriculture University, Jhansi-248 003, India
E-mail: ankitforestry21@gmail.com

Abstract: A field experiment was carried out at Banaras Hindu University, Mirzapur in kharif season 2018 to study about effect of different fertility levels on nutrient content and uptake of soybean under guava based Agri horticulture system. There were five fertility levels in a randomised block design. The sources of fertilizers were urea, DAP, MOP and elemental sulphur for N, P_2O_5, K_2O, and S application, respectively. The variety of soybean was JS-2029, inoculated with rhizobium culture. Among the different fertility levels the application of 50 kg N, 100 kg P_2O_5, 60 kg K_2O, and 40 kg S ha^{-1} with rhizobium inoculation significantly enhances the nitrogen, phosphorus, potassium and sulphur content and uptake in grain and straw of soybean.

Keywords: Agri Horticulture, Fertility, Guava, Nutrient uptake, Soybean

About 42.8 % population of country relies in agricultural sector for their livelihoods, but it is under severe strain condition as an average land holding are steadily declining. In India, each person has access to 0.12 ha of land for cultivation, compared to 0.29 ha worldwide. From recent few decades agriculture become unlikely by farming community because Indian agriculture is so reliant on climate and weather conditions, less remuneration and high-risk involvement, farmers are also dealing with the critical challenges as a result of climate change (Dhyani et al 2016). As a result, a severe risk is anticipated for satisfying the requirement of increasing population for food, fibre, fuel and fodder while also expanding food grain output (Ram et al 2016). However, throughout the previous few decades, there have been a lot of expectations placed on agroforestry's contribution to climate-smart agriculture. Agroforestry is the collective name of land use system where woody perennials are integrated with agriculture crop on same land unit in such a way that is provides sustainable benefits to farmers. Guava, litchi, custard, apple, aonla, mango and bael, are some of the most popular horticulture trees used in agri-horticulture system.

Pulses offered the most affordable source of high-quality protein for human beings. In India, where the bulk of the population consumes a vegetarian diet, protein deficiency is a wide spread concern. Soybean is a prominent oil seed as well as pulse crop, grown in various parts of the world. It is an excellent source of protein, can supplement in diet. Soybean has roughly 40-45 percent protein, 18-20 percent edible oil, 24-26% carbohydrate, and 3.0-3.6% ash and also rich source of vitamins and minerals (Morshed et al. 2008). Guava is one of a various perennial fruit tree intercropped for not only to increase revenue but also to improve the use of the land by obtaining improved output and to enhance soil health by preventing soil erosion (Sharma et al 2006). Guava is one of the most significant fruits farmed in India, ranking fourth in terms of production and fifth in terms of area. Guava is great source of nutrients, dietary fibre, pectin, and ascorbic acid. Water (80-82%), protein (0.71%), fat (0.5%), carbohydrate (11-13%), and acids (2.4%) are all present in guava fruit (Uchôa et al 2014, Gupta et al 2018). Phosphorus encourages nodule formation and rhizobial activity in legumes, which aids in nitrogen fixation. Additionally, it contributes to respiration, cell growth and division, energy storage, and photosynthesis (Akter et al 2013). Sulphur is related to nitrogen metabolism and is necessary for the creation of proteins, vitamins, and important amino acids that include sulphur. Considering the above fact in view the present study was conducted to evaluate the suitable combination of nutrient to enhance the nutrient content (%) and uptake (kg/ha) of soybean under guava based agri-horticulture system.

MATERIAL AND METHODS

The present investigation was carried out during kharif season, 2018-19 at Banaras Hindu University, situated in

Vindhyan region of Mirzapur, Uttar Pradesh. The experimental site is located in $25^{0}10'$ North latitude $82^{0}37'$ East longitude and at altitude of 427 meter above mean sea level. This region comes under (Semi-arid eastern plain zone) agro-climatic zone III A. The experimental site was fairly uniform in topography and well drained with poor fertility status where varieties of crop like medicinal, agriculture, horticulture, plants were grown. The climate of site is semi-arid with, and characterised extremes of temperature in both summer and winter with moderate humidity and low rainfall. March to May is generally dry, maximum temperature in summer was $46^{0}C$ and minimum temperature in winter fall up to $11^{0}C$. The normal period for onset of monsoon in this region was the third week of June and lasts up to end of September or extended to the first week of October. The annual rainfall of site was 975 mm in 2018, out of which 90 % contributed through south-west monsoon. In order to asses initial fertility status of experimental plots, soil sample from 0-15 cm were randomly collected and analysed for mechanical composition and physio-chemical properties of soil. These samples were air dried and crushed to pass through 2.0 mm sieve. The soil of experimental site was sandy loam in texture with pH 6.1, electrical conductivity 0.18 dS/m (Jackson 1973), organic carbon 0.39 percent (Walkley and Black 1934), available nitrogen 220.89 kg/ha (Subbiah and Asija 1956), available phosphorus 19.50 kg/ha (Olsen et al 1954), available potassium 266.56 kg/ha (Jackson 1973), and available sulphur 1.32 kg/ha (Chesnin and Yein 1950).

Treatment details and input application: The experiment was conducted during the kharif season of 2018-19 in a 12 yar old guava (Allahabad Safeda) based agri horticulture system, which was planted in 2007 with 7×7 meter spacing. Soybean was sown as intercrop at the seed rate 80 kg/ ka, variety JS-2029 was manually sown at 45 cm row to row spacing and planting distance of 5 cm within the row was maintained by thinning at 15 DAS. Before sowing, the seeds were treated with thiram, and rhizobium culture at the rate of 2g/kg and 5g/kg respectively. The experiment was laid out in randomised complete block design with 5 treatments viz., T_1: Control, T2: N (20 kg/ha)+P_2O_5 (40 kg/ha)+K_2O (30 kg/ha)+S (10 kg/ha), T3: N (30 kg/ha)+P_2O_5 (60 kg/ha)+K_2O (40 kg/ha)+S (20 kg/ha),T4: N (40 kg/ha)+P_2O_5 (80 kg/ha)+K_2O (50 kg/ha)+S (30 kg/ha),T5: N (50 kg/ha)+P_2O_5 (100 kg/ha)+K_2O (60 kg/ha)+S (40 kg/ha) with four replications. The data of guava height (m), canopy diameter (m) and stem diameter (cm) were recorded with the help of altimeter and tape at the time of sowing, 40 DAS and at harvesting stage. The data of guava height (m), canopy diameter (m) and stem diameter (cm) were recorded with the help of altimeter and tape at the time of sowing, 40 DAS and at harvesting stage. The different levels of fertilizers as per treatment were applied at the time of sowing. The source of fertilizer Urea, DAP, MOP, Elemental sulphur was calculated per plot and incorporated in the soil at the time of sowing.

$$\text{Fertilizer doses} = \frac{\text{Doses} \times \text{Area}}{100 \times \text{\% of nutrient available in fertilizer}}$$

Analysis of nutrient content in plant sample: The crop was harvested manually when visually observed fully matured. After harvest, the seeds and straw of soybean were dried in hot air oven at $70^{0}C$ for at least 48 hours until a constant weight was reached. After that, samples were grinded to pass through 2 mm sieve. The sieved samples were collected and used for chemical analysis viz., nitrogen was estimated by Kjeldahl method (Jackson 1973), phosphorus by di-acid digestion method by spectrophotometer, potassium by di-acid digestion method by Flame photometer, sulphur by di-acid digestion method by spectrophotometer (Bhargav and Raghupati 1993). The percentage of N, P, K, and S were multiplied with grain and stover yield in kg/ha to obtained respective nutrient uptake (kg/ha). Thereafter, nutrient by plant was calculated through following:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{Dry matter yield (kg)}}{100}$$

RESULTS AND DISCUSSION

The chemical analysis of soybean showed that nutrient content and their removal significantly influenced with different nutrient management. The nitrogen content of soybean significantly increased with increasing doses of fertilizer. The application of 50 kg N, 100 kg P_2O_5, 60 kg K_2O, and 40 kg S ha^{-1} with rhizobium culture recorded highest nitrogen content in grain (6.03 %) and straw (0.92 %), over rest of the treatment. Similarly, highest nitrogen removal in grain, straw and total removal of soybean increased with increasing fertilizer level. The maximum amount of nitrogen removal (120.8 kg/ ha) was in the T_5 which is superior to rest of the treatment, while lowest was in T_1 (38.59 kg/ha). Solanki et al (2018) studied that highest nutrient uptake obtained with the application of 100 % NPK+FYM over rest of the treatment. Guava's growth metrics, such as height (5.10 m), canopy (5.95 m), and stem diameter (25.95 cm), were measured at seeding, however after harvest, the tree height, canopy, and stem diameter were 5.39 m, 6.28 m, and 26.32 cm, respectively. The increase in guava growth parameters may be caused by the advancement of tree age. The data of guava height (m), canopy diameter (m) and stem diameter (cm) were recorded with the help of altimeter and tape at the time of sowing, 40 DAS and at harvesting stage.

The highest value of P content in grain and straw were with application of (50 kg N, 100 kg P_2O_5, 60 kg K_2O, and 40 kg S ha^{-1}) with rhizobium culture which prove significantly better that rest of the treatment (Table 2). The minimum P content in grain and straw obtained under control. The total phosphorus removal in seed and straw was enhanced with treatment and highest P removal (23.81 kg/ha) in T_5 with rhizobium inoculation and minimum was in control (6.28 kg/ha). The combined application of fertilizer with rhizobium inoculation might enhanced the activity of enzymes in soil which increased availability of P to the plant uptake. Jahangir et al (2009) found that maximum P uptake was (0.72 %) in higher level of fertility management. Dhage et al (2014) also observed that uptake of phosphorus and sulphur in plants increased with increase in rate of combined application of P and S. Similar trend was also reported by Tiwari et al (2019).

The uptake of potassium by seed and straw was significantly enhanced by different fertilizer level with rhizobium inoculation. The highest potassium content in grain (2.55 %) and straw (2.83 %) were found in T_5 where lowest was in T_1. The maximum removal of potassium in grain and straw was found in 50 kg N, 100 kg P_2O_5, 60 kg K_2O, and 40 kg S ha^{-1} with rhizobium culture while minimum was in control (Table 3). Morya et al (2018) has close proximity of nutrient content uptake with the treatment 50 % RDF and 50 % vermicompost which was at par with 100 % RDF in soybean. The application of 75% RDF + Rhi + PSB+ VAM (T_{16}) provides highest K uptake in grain and straw than control (Kumar and Sharma 2018).

Table 1. Effect of NPKS and *rhizobium* on nitrogen content (%) and removal (kg/ha) of soybean under guava based agri-horticulture system

Treatment (N, P_2O_5, K_2O, S)	Nitrogen content (%)		Nitrogen removal (kg/ha)		Total (seed+straw) removal of nitrogen (kg/ ha)
	Seed	Straw	Seed	Straw	
T_1 (Control)	4.23	0.59	33.71	4.88	38.59
T_2 (20,40,30,10)	4.55	0.66	45.38	8.16	53.54
T_3 (30,60,40,20)	5.03	0.73	60.26	10.08	70.34
T_4 (40,80,50,30)	5.55	0.80	72.74	14.92	87.66
T_5 (50,100,60,40)	6.03	0.92	98.68	22.12	120.8
CD (P=0.05)	0.42	0.05	10.19	1.49	

Table 2. Effect of NPKS and *rhizobium* on phosphorus content (%) and removal (kg/ha) of soybean under guava based agri-horticulture system

Treatment (N, P_2O_5, K_2O, S)	Phosphorus content (%)		Phosphorus removal (kg/ha)		Total (seed+straw) removal of Phosphorus (kg/ ha)
	Seed	Straw	Seed	Straw	
T_1 (Control)	0.52	0.24	4.09	2.19	6.28
T_2 (20,40,30,10)	0.63	0.28	6.28	3.70	9.98
T_3 (30,60,40,20)	0.72	0.36	7.88	4.93	12.81
T_4 (40,80,50,30)	0.78	0.44	9.80	8.12	17.92
T_5 (50,100,60,40)	0.86	0.47	14.12	9.69	23.81
CD (p=0.05)	0.03	0.03	1.28	1.05	

Table 3. Effect of NPKS and *rhizobium* on potassium content (%) and removal (kg/ha) of soybean under guava based agri-horticulture system

Treatment (N, P_2O_5, K_2O, S)	Potassium content (%)		Potassium removal (kg/ha)		Total (seed+straw) removal of Potassium (kg/ ha)
	Seed	Straw	Seed	Straw	
T_1 (Control)	1.03	1.90	9.44	15.67	25.11
T_2 (20,40,30,10)	1.82	2.04	15.91	24.85	40.76
T_3 (30,60,40,20)	2.16	2.22	22.54	31.20	53.74
T_4 (40,80,50,30)	2.33	2.76	28.14	45.75	73.89
T_5 (50,100,60,40)	2.55	2.83	37.76	59.32	97.08
CD(p=0.05)	0.16	0.18	1.91	5.63	

Table 4. Effect of NPKS and *rhizobium* on Sulphur content (%) and removal (kg/ha) of soybean under guava based agri-horticulture system

Treatment (N, P_2O_5, K_2O, S)	Sulphur content (%)		Sulphur removal (kg/ha)		Total (seed+straw) removal of Sulphur (kg/ ha)
	Seed	Straw	Seed	Straw	
T_1 (Control)	0.48	0.29	3.89	2.43	6.32
T_2 (20,40,30,10)	0.52	0.32	5.17	3.97	9.14
T_3 (30,60,40,20)	0.55	0.34	6.10	4.61	10.71
T_4 (40,80,50,30)	0.61	0.35	7.71	6.51	14.22
T_5 (50,100,60,40)	0.67	0.37	11.04	8.95	19.99
CD(p=0.05)	0.04	0.03	1.07	0.74	

Sulphur content in grain and straw increased progressively with increasing fertilizer level up to (50 kg N, 100 kg P_2O_5, 60 kg K_2O, and 40 kg S ha^{-1}) with rhizobium inoculation. The highest sulphur content in grain was (0.67) and in straw was (0.37 %) in (T_5) and lowest value in grain and straw were (0.48) and (0.29) respectively in (T_1). The data presented in table (4) shows that sulphur removal was highest in (T_5) with rhizobium culture over rest of the fertility level. Whereas, lowest was recorded in (T_1). The inoculation of seed by rhizobium culture increased the nitrogen content inn seed and straw. This might be due to more nitrogen fixed by bacteria which in turn helped in better absorption and utilization of all the plant nutrients. This beneficial influence might be due to the better root establishments, nodulation and fixing atmospheric nitrogen by nitrogen fixing bacteria. Patel et al (2018) found that application of 40 sulphur kg/ ha significantly enhanced the nutrient uptake in grain and straw over rest of the treatments. The higher nutrient content and uptake was recorded under T_5 in pearl millet cultivation (Kumar et al 2022).

Increased nutrient uptake is associated with higher biomass production and nutrient assimilation in plant tissue. When inorganic fertilizer and biofertilizers are applied combined, root growth and cell division are encouraged. This enhances nutrient uptake from deeper soil layers and, as a result, increases N, P, K, and S concentrations (Bhabai et al 2019). The application of NPK and S with rhizobium culture significantly enhanced bacterial population in rhizosphere of soybean which, play crucial role in decomposition of organic matter and release nutrient for plant growth and development. Thakur et al (2022) reported that the application of 100 % dose of NPK + FYM significantly increases the nutrient content and uptake in maize grain and stover.

CONCLUSION

The combined application of 50 kg N, 100 kg P_2O_5, 60 kg K_2O, and 40 kg S ha^{-1} with rhizobium culture significantly enhanced the N, P, K and S content (%) as well as removal (kg/ha) in seed and straw of soybean under guava based agri-horticulture system. The lowest nutrient content and uptake of nutrient was in the control.

REFERENCES

Akter F, Islam N, Shamsuddoha ATM, Bhuiyan MSI, and Shilpi S 2013. Effect of phosphorus and sulphur on growth and yield of soybean (*Glycine max* L.). *International Journal of Bio-resource and Stress Management* **4**(4): 555-560.

Bhabai B, Mukhopadhyay D and Mitra B 2019. Effect of biofertilizer and phosphorus on green gram (*Vigna radiata*). *Journal of Pharmacognosy and Phytochemistry* **8**(4): 505-509.

Bhargava BS and Raghupathi HB 1993. *Analysis of plant materials for macro and micronutrients.* Methods of analysis of soils, plants, water and fertilizers pp. 49-82.

Black CA 1965. *Methods of soil analysis,* part 1. Agronomy, 9: 383-390.

Chesnin L and Yien CH 1951. Turbidimetric determination of available sulphates. *Soil Science Society of America Journal* **15**(C): 149-151.

Dhage, SJ, Patil VD and Patange MJ 2014. Effect of various levels of phosphorus and sulphur on yield, plant nutrient content, uptake and availability of nutrients at harvest stages of soybean [*Glycine max* (L.)]. *International Journal of Current Microbiology and Applied Sciences* **3**(12): 833-844.

Dhyani SK, Ram A and Dev I 2016. Potential of agroforestry systems in carbon sequestration in India. *Indian Journal of Agricultural Sciences* **86**(9): 1103-1112.

Gupta M, Wali A, Gupta S and Annepu SK 2018. Nutraceutical potential of Guava. *Bioactive Molecules in Food*: 1-27.

Jackson ML 1973. Soil Chemical Analysis. Prentice Hall of India, New Delhi, India, pp 134-182.

Jahangir A A, Mondal RK, Nada K, Sarker MAM, Moniruzzaman M and Hossain MK 2009. Response of different level of nitrogen and phosphorus on grain yield, oil quality and nutrient uptake of soybean. *Bangladesh Journal of Scientific and Industrial Research* **44**(2): 187-192.

Kumar P and Sharma H 2018. Effect of integrated nutrient management on yield, quality and nutrient uptake of soybean (*Glycine max*). *Annals of Plant and Soil Research* **20**: S57-S60.

Kumar A 2017. Effect of boron and zinc application on nutrient uptake in guava (*Psidium guajava* L.) cv. Pant Prabhat leaves. *International Journal of Current Microbiology and Applied Sciences* **6**(6): 1991-2002.

Kumar R, Ram H, Meena RK, Kumar S, Kumar B, Praveen BR and Hindoriya PS 2022. Nutrients content, uptake and soil biological properties as influenced by various nutrient management practices under fodder pearl millet cultivation. *Indian Journal of Ecology* **49**(6): 2119-2124.

Morshed RM, Rahman MM and Rahman MA 2008. Effect of nitrogen on seed yield, protein content and nutrient uptake of soybean

(*Glycine max* L.). *Journal of Agriculture & Rural Development* **6**(1): 13-17.

Morya J, Tripathi RK, Kumawat N, Singh M, Yadav RK, Tomar IS and Sahu YK 2018. Influence of organic and inorganic fertilizers on growth, yields and nutrient uptake of soybean (*Glyscine max* Merril L.) under Jhabua Hills. *International Journal of Current Microbiology and Applied Sciences* **7**(2): 725-730.

Olsen SR, Cole CV, Watanable FS, and Dean LA 1954. *Estimation of NaHCO 3 extractable phosphorus from soil.* Cire, US Department of Agriculture pp. 939.

Patel HF, Maheriya VD, Attar SK and Patel HR 2018. Nutrient uptake and yield of Kharif green gram as influenced by levels of sulphur, phosphorus and PSB inoculation. *Legume Research-An International Journal* **41**(3): 405-409.

Sharma AS, Sehrawat SK, Singhrot RS and Boora KS 2006. Assessment of genetic diversity and relationship among Psidium spp. through RAPD analysis. *International Guava Symposium* **735**: 71-78.

Ram A, Dev I, Kumar D, Uthappa AR, Tewari RK, Singh R, Sridhar KB, Singh M, Shrivastav M, Kumar V and Chaturvedi OP 2016. Effect of tillage and residue management practices on blackgram and greengram under bael (*Aegle marmelos* L.) based agroforestry system. *Indian Journal of Agroforestry* **18**(1): 90-95.

Solanki AC, Solanki MK, Nagwanshi A, Dwivedi AK and Dwivedi BS 2018. Nutrient uptake and grain yield enhancement of soybean by integrated application of farmyard manure and NPK. *International Journal of Current Microbiology and Applied Sciences* **7**: 1093-102.

Subbiah BV and Asija GL 1956. A rapid procedure for the determination of available nitrogen in soils. *Current Science* **25:** 259-260.

Tiwari R, Sharma YM, Dwivedi BS, Mitra NG and Kewat ML 2019. Nutrient content and uptake by soybean as influenced by continuous application of fertilizer and manure in black soil. *Journal of Pharmacognosy and Phytochemistry* **8**(4): 140-144.

Thakur A, Sharma RP and Sankhyan NK 2022. Long Term effect of fertilizers and amendments on macronutrients uptake by maize and relationship with soil organic carbon in maize-wheat system in acid Alfisol of North-Western Himalayas. *Indian Journal of Ecology* **49**(2): 388-393.

Uchôa-thomaz AMA, Sousa EC, Carioca JOB, Morais SMD, Lima AD, Martins C G, and Rodrigues LL 2014. Chemical composition, fatty acid profile and bioactive compounds of guava seeds (*Psidium guajava* L.). *Food Science and Technology* **34**: 485-492.

Walkley CA 1934. An estimation of soil organic matter and proposed modification on the chromic acid titration method. *Soil Science* **37:** 29-38.

Received 03 February, 2023; Accepted 15 May, 2023