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Effects of fertilizer levels, foliar nutrient sprays and seed treatment with biofertilizers on nutrient uptake, available nutrients and microbial status at harvest of *kharif* soybean (*Glycine max* L. Merrill)

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Abstract

The field experiment was conducted during *kharif* 2022 at Agronomy Farm, College of Agriculture, Pune. The experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications. After the analysis, the total nutrient uptake in soybean was highest (180.75, 23.38, 84.23 NPK kg ha⁻¹ respectively) in treatment (T₁₀) - 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form and it was followed by T₉ and T₆. Similar trend was followed in nutrient availability after the harvest of soybean. The highest soil microbial population at harvest of soybean which includes bacteria (85.50 x 10⁻⁷ CFU g⁻¹ soil), fungi (46.17 x 10⁻³ CFU g⁻¹ soil), actinomycetes (42.67 x 10⁻³ CFU g⁻¹ soil), *Rhizobium* (43.83 x 10⁻⁷ CFU g⁻¹ soil), *PSB* (42.67 x 10⁻⁷ CFU g⁻¹ soil) and *KSB* (40.83 x 10⁻⁷ CFU g⁻¹ soil) were found highest with application of 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form (T₁₀).

Keywords: Soybean, FYM, foliar sprays, 19:19:19, DAP, microbial status

Introduction

Soybean (*Glycine max* L.) is known as Chinese pea and Manchurian bean which belongs to the family *leguminaceae*, subfamily *papilionaceae*. Soybean is major oilseed crop in world, accounting for nearly 50 per cent of total oilseeds acreage as well as production. It ranks third in vegetable oil economy in India, following groundnut and rapeseed. Soybean has not only gained vital importance in Indian agriculture, but also plays decisive role in oil economy of India. It is one of the most popular pulse and oilseed crop grown in Maharashtra and often called as 'Gold bean' and designated as 'Miracle crop' of 20th century. Generally, essential plant nutrients are applied as a basal dose during land preparation to attain maximum yield of a crop. Although soil application is the most effective method but under some circumstances foliar fertilization is more effective and economic. Foliar spraying is helpful when crop roots are unable to provide enough nutrients and much more economic since foliar application rate is less compared to soil application. Many researchers reported that supplemental nutrients applied at different reproductive stages of crop through foliar application increases the yield of soybean. Specially, at early flowering or pod initiation stage, soybean requires more nutrients for the development of pod and seed along with optimum soil moisture (Dandge *et al.*, 2018) [5]. Applying of fertilizers as a foliar spray produced effective absorption and usage under rainfed conditions, when the availability of moisture becomes limited. This method is cost-effective compared to other forms of fertilization. The primary problems with soybean are flower senescence and improper pod filling, which can be corrected by foliar application of growth regulators and nutrients (Kumar *et al.*, 2013) [9]. Nutrients contained in compost and biofertilizers can aid in the availability of plant nutrients so that soybean plants show a better number of yield. In addition to this, the microorganisms in biofertilizers also increase the efficiency of nutrient absorption and help to provide nutrients in the soil in the available form to the plants (Garuda *et al.*, 2022) [6]. Liquid biofertilizers have more shelf life which facilitates the long survival of microbes sufficient for the entire crop cycle (Krishnaprabu S., 2020) [8].

Keeping these points in view the experiment was carried out to study the nutrient uptake, nutrient and microbial status of soil.

Materials and Methods

The present investigation was conducted at plot no.10 C of B Division; Agronomy Farm, College of Agriculture, Pune, during *khariif* 2021-22. The experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications. The gross and net plot size was 4.00 m × 3.60 m and 3.60 m × 2.70 m, respectively. There were ten treatments *viz.*, (T₁) 100% GRDF, (T₂) 75% GRDF, (T₃) 75% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form, (T₄) 75% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form, (T₅) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form, (T₆) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form, (T₇) 75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB solid form, (T₈) 75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB liquid form, (T₉) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form and (T₁₀) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form. The experimental field topography was uniform and levelled. The experimental sites soil was medium black in colour and well drained, with a uniform depth of up to 90 cm. The soil of the experimental field was clay loam in texture with moderately alkaline in reaction (pH 7.73). The soil was low in available nitrogen (168.88 kg ha⁻¹), medium in available phosphorous (18.22 kg ha⁻¹) (Olsen and Sommers, 1982) ^[11] and high in available potassium (260.50 kg ha⁻¹) (Page *et al.*, 1982) as well as low in organic carbon content (0.35%). Initial population of bacteria (64×10⁻⁷ CFU g⁻¹ soil), fungi (32×10⁻³ CFU g⁻¹ soil), actinomycetes (31.33×10³ CFU g⁻¹ soil) (Cappuccino and Sherman, 1987), *Rhizobium* (24×10⁻⁷ CFU g⁻¹ soil), *PSB* (22×10⁻⁷ CFU g⁻¹ soil) and *KSB* (21.66×10⁻⁷ CFU g⁻¹ soil) (Colwell and Zambruski, 1972). Soybean variety KDS-726 (*Phule Sangam*) was sown at spacing 45 cm X 5 cm. Before sowing seed treatment with solid and liquid biofertilizers according to the treatments were carried out. Basal dose of chemical fertilizers, FYM and foliar sprays of fertilizers were also applied according to the treatments.

Results and Discussion

Nutrient uptake in seed

The data regarding N, P and K uptake by seed and stover of soybean at harvest as a result of different fertilizer levels and foliar nutrient sprays are provided in table 1. The data shows that uptake of N, P, K was significantly varied due to

effect of different fertilizer levels and foliar nutrient sprays. The mean uptake of N, P, K by seeds of soybean was 139.05, 14.55 and 27.61 kg ha⁻¹, respectively. Among the different treatments the application of 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form (T₁₀) noted significantly highest N, P and K uptake in seed (158.94, 17.55 and 33.37 NPK kg ha⁻¹, respectively) as compared to other treatments but it was found at par with (T₉) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form and (T₆) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form. Lowest uptake of N, P and K in seed of soybean nutrients was recorded in (T₂) that is 75% GRDF. The maximum uptake of N, P and K in seed in treatment (T₁₀) might be due addition of FYM which improved the soil physical properties. Also single or double seed inoculation with biofertilizers enhances the microbial population and organic acids which resulted quick release of nutrients. Foliar sprays of 19:19:19 possibly resulted in effective absorption of nutrients. Due to this yield contributing characters like number of pods⁻¹, number of seeds pod⁻¹, test weight etc. were increased which ultimately increased seed yield. Also the uptake of nutrients depends on yield. Hence as yield increased, uptake also increased. Similar results were noted by Bansode and Math (2018) ^[11] and Raja and Takankhar (2018) ^[13].

Nutrient uptake by stover

The significant variation in N P K uptake of soybean stover was noted due to various fertilizers levels and foliar nutrient sprays. The mean N, P, K uptake in stover was 18.36, 4.922 and 44.77 NPK kg ha⁻¹, respectively. In various treatments (T₁₀) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form noted significantly higher uptake of NPK in straw (21.81, 5.83 and 50.86 NPK kg ha⁻¹ respectively) but, it was followed by (T₉) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form and (T₆) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form. Lowest uptake of N, P and K in stover of soybean nutrients was recorded in (T₂) that is 75% GRDF. The maximum uptake of nutrients in stover in treatment (T₁₀) might be due appropriate basal dose along with FYM which developed soil physical properties and seed treatment with liquid biofertilizer influenced the microbial activities in the rhizosphere. Also foliar application of 19:19:19 stimulated the vegetative growth which ultimately resulted in more stover yield and increased the uptake. Similar results were recorded by Mudalagiriappa *et al.* (2016) ^[10], Bansode and Math (2018) ^[11] and Raja and Takankhar (2018) ^[13].

Table 1: Effect of fertilizer levels and foliar nutrient sprays on nutrient uptake (kg ha⁻¹) in seed and stover of soybean

Tr. No.	Treatment	Nutrient uptake					
		Seed			Stover		
		N	P	K	N	P	K
T ₁	100% GRDF	129.24	12.98	24.27	16.61	3.41	42.44
T ₂	75% GRDF	110.04	10.70	19.97	13.37	2.67	35.40
T ₃	75% + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	130.05	13.30	25.56	16.99	3.40	43.34
T ₄	75% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	136.44	14.00	26.81	17.51	3.64	44.02
T ₅	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	143.04	15.21	28.30	19.57	4.74	46.16
T ₆	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	149.72	16.11	30.43	20.08	5.07	47.37
T ₇	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB solid form	136.96	14.21	26.93	17.87	3.84	43.99
T ₈	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB liquid form	141.53	14.84	27.98	18.61	3.97	44.87
T ₉	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form	154.50	16.61	32.46	21.16	5.58	49.27
T ₁₀	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form	158.94	17.55	33.37	21.81	5.83	50.86
S.E.m. ±		4.83	0.70	1.15	0.73	0.28	1.56
C.D. @ 5%		14.34	2.07	3.43	2.17	0.84	4.63
General Mean		139.05	14.55	27.61	18.36	4.22	44.77

*GRDF: General Recommended Dose of Fertilizer

Available nutrient content in soil after harvest (kg ha⁻¹)

Availability of nutrients after harvest The highest available values of nitrogen, phosphate and potassium (196.54, 21.11 and 281.69 kg ha⁻¹) was obtained with the application of (T₁₀) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form but it was found at par with (T₉) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form and (T₆) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form and also with (T₅) 100% GRDF + 2 foliar spray

of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form in case of N and P. Whereas, it was found at par with (T₉) and (T₆) in case of K. The lowest available nutrient was found in treatment in (T₂) 75% GRDF. The highest availability of nutrient in soil might be due to the more incorporation of dry matter and FYM. Also, the liquid biofertilizer significantly enhanced the soil nutrient status due to more microbial activities and mineralization of the organic matter in the soil retained the maximum nutrient status.

Table 2: Effect of fertilizer levels and foliar nutrient sprays on available nutrient content (kg ha⁻¹) in soil at harvest

Tr. No.	Treatment	Available nutrient content (kg ha ⁻¹)		
		N	P	K
T ₁	100% GRDF	191.59	19.92	276.74
T ₂	75% GRDF	181.48	18.78	269.67
T ₃	75% + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	183.12	19.37	272.58
T ₄	75% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	183.56	19.54	273.49
T ₅	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	192.78	20.19	275.17
T ₆	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	193.12	20.68	276.67
T ₇	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB solid form	186.69	19.69	273.85
T ₈	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB liquid form	188.47	19.86	274.23
T ₉	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form	195.16	20.75	280.54
T ₁₀	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form	196.54	21.11	281.69
S.E.m. ±		2.78	0.36	2.16
C.D. @ 5%		8.27	1.08	6.43
General Mean		189.25	19.99	275.46
Initial values		168.88	18.22	260.5

Microbial studies**Microbial count of Bacteria, fungi and Actinomycetes**

The soil microbial count was significantly influenced due to different fertilizer levels and foliar nutrient sprays with inoculation of solid and liquid biofertilizers. The significantly higher count of bacteria, fungi and

actinomycetes as (85.50 x 10⁻⁷ CFU, 46.17 x 10⁻³ CFU, 42.67 x 10⁻³ CFU), respectively were observed with treatment (T₁₀) of 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form. Whereas, it was at par with (T₉) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of

Rhizobium, PSB and KSB solid form, (T₆) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form and (T₅) 100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form, in case of bacteria and also it was found at par with (T₉), (T₈), (T₇), (T₆) and (T₅) in case of fungi and actinomycetes. Less microbial count was observed

in the treatments of uninoculated seed. More microbial count was observed in treatment (T₁₀). It might be due to inoculation of liquid biofertilizer to seed at the time of sowing at proper moisture condition of soil increased the activities and multiplication of beneficial microorganisms. Similar results were also obtained by Bhavya *et al.* (2020) [2], Shete *et al.* (2021) [14].

Table 3: Effect of fertilizer levels and foliar nutrient spray on soil microbial count at harvest of soybean

Tr. No.	Treatment	Bacteria X 10 ⁻⁷ CFU g ⁻¹ of soil	Fungi X 10 ⁻³ CFU g ⁻¹ of soil	Actinomycetes X 10 ⁻³ CFU g ⁻¹ of soil
T ₁	100% GRDF	78.17	39.83	34.33
T ₂	75% GRDF	75.67	34.17	33.50
T ₃	75% + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	79.33	40.00	38.17
T ₄	75% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	80.17	41.17	38.83
T ₅	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	83.17	44.33	41.17
T ₆	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	84.33	45.50	42.33
T ₇	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB solid form	80.83	42.83	39.50
T ₈	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB liquid form	81.50	43.17	40.17
T ₉	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form	84.67	45.00	42.33
T ₁₀	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form	85.50	46.17	42.17
S. Em. ±		1.31	1.20	1.11
C.D. at 5%		3.88	3.56	3.29
General Mean		81.38	42.22	39.28
Initial Count		64	32	31.33

*CFU: Colony Forming Units

Microbial count of Rhizobium, PSB and KSB

The soil microbial count of Rhizobium, PSB and KSB was significantly affected due to different fertilizer levels and foliar nutrient sprays. Higher count of Rhizobium, PSB and KSB was observed as (43.83 x 10⁻⁷ CFU, 42.67 x 10⁻³ CFU, 40.83 x 10⁻³ CFU), respectively in the treatment (T₁₀) of 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form but, it was found at par with (T₉) 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form and (T₆) 100% GRDF + 2 foliar spray of

2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form in PSB and KSB and also found at par with (T₅) in case of *Rhizobium*. The less microbial counts was observed in treatments involving uninoculated seeds. The higher microbial count obtained in (T₁₀) might be attributed due to improved soil physical properties resulting from the application of farmyard manure as well as increased microbial viability in the liquid consortium. Similar results were also obtained by Bhavya *et al.* (2020) [2] and Shete *et al.* (2021) [14].

Table 4: Effect of fertilizer levels and foliar nutrient sprays on soil microbial count of Rhizobium, PSB and KSB after harvest of soybean

Tr. No.	Treatment	Rhizobium X 10 ⁻⁷ CFU g ⁻¹ of soil	PSB X 10 ⁻⁷ CFU g ⁻¹ of soil	KSB X 10 ⁻⁷ CFU g ⁻¹ of soil
T ₁	100% GRDF	34.17	26.00	27.00
T ₂	75% GRDF	32.17	23.55	24.40
T ₃	75% + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	37.67	35.80	35.17
T ₄	75% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	38.83	36.50	36.50
T ₅	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB solid form	41.33	40.67	38.83
T ₆	100% GRDF + 2 foliar spray of 2% DAP and seed treatment of Rhizobium, PSB and KSB liquid form	43.17	42.17	40.33
T ₇	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB solid form	39.50	36.43	37.33
T ₈	75% GRDF + 2 foliar spray of 1% 19:19:19 and Rhizobium, PSB and KSB liquid form	40.00	38.00	38.00
T ₉	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB solid form	42.17	41.33	39.50
T ₁₀	100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form	43.83	42.67	40.83
S. Em. ±		0.84	0.64	0.62
C.D. at 5%		2.51	1.91	1.83
General Mean		41.32	40.76	39.00
Initial Count		24	22	21.66

Conclusion

Results of the experiment revealed that higher quantities of nutrient uptake, available nutrient content and microbial populations was obtained in treatment with application of 100% GRDF + 2 foliar spray of 1% 19:19:19 and seed treatment of Rhizobium, PSB and KSB liquid form. However, it was found at par with treatments (T₉) and (T₆). Hence, to ensure higher yield by increasing nutrient uptake, to restore the fertility (available nutrient content) and microbial activities (population) it is recommended that farmers should apply 100% GRDF + 2 foliar spray of 19:19:19 + seed treatment with Rhizobium, PSB and KSB in liquid form. Further work is advised before making a farming suggestion, though, given conclusions are based on a single season of research work.

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References

1. Bansode C, Math KK. Effect of foliar feeding of 19:19:19 and potassium nitrate water soluble fertilizers on major nutrient status of soybean in a vertisol. *Int J Chem Stud*. 2018;6(3):2251-2523.
2. Bhavya M, Sridhara CJ, Nandish MS, Mavarkar NS, Suchitha Y, Sumithra BS. 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*. 2020;9(2):2383-92.
3. Cappuccino JG, Sherman N. Microbiology: A laboratory manual. 1st ed. U.S.A.: The Benjamin Cummins Publishing Co.; c1987. p. 451-458.
4. Colwell RR, Zambruski MS, editors. Methods in aquatic microbiology. London: Univ Park Press; c1972.
5. Dandge MS, Ingle YV, Peshattiwar PD, Dikey HH. Effect of foliar nutrition on soybean productivity. *Int J Chem Stud*. 2018;6(1):1290-1292.
6. Garuda SR, Syaiful SA, Syam'un DE. Growth and production response of soybeans applying compost and biofertilizers. *Chem Biomol Eng*. 2022;7(3):38-45.
7. Gord NB, Zade SP, Bodke VS, Nakhate PS. Effect of organic farming on enzymatic activity and microbial populations of soybean. *The Pharma Innovation J*. 2022;11(22):2182-2186.
8. Krishnaprabu S. Liquid microbial consortium: a potential tool for sustainable soil health. *J Pharmacogn Phytochem*. 2020;9(2):2191-2199.
9. Kumar CV, Vaiyapuri K, Amanullah MM, Gopaldaswamy G. Influence of foliar spray of nutrients on yield and economics of soybean (*Glycine max* L. Merrill). *J Biol Sci*. 2013;13(6):263-265.
10. Mudalagiriappa, Ali MS, Ramchandrapa BK, Basavaraja PK, Kiran. Effect of foliar application of water soluble fertilizers on nutrient uptake and reproductive efficiency of chickpea (*Cicer arietinum* L.). *The Bioscan*. 2016;11(3):1601-1604.
11. Olsen SR, Sommers LE. Phosphorus. In: Page AL, et al., editors. Methods of soil analysis. Part 2. 2nd ed. Agron Monogr 9. Madison, WI: ASA and ASSA; c1982. p. 403-430.
12. Page AL, Miller RH, Keeney DR. Methods of soil analysis. Part 2. Chemical and microbiological properties. 2nd ed. Madison, WI: ASA, SSSA Publishing; c1982. p. 1159.
13. Raja D, Takankhar VJ. Response of liquid biofertilizers (Bradyrhizobium and PSB) on nutrient content in soybean. *IJCMAS*. 2018;7(5):3701-3706.
14. Shete MH, Murumkar DR, Landge KB. Effect of consortium of Rhizobium, PSB and KMB on growth and yield of mungbean (*Vigna radiata* L.). *Int J Curr Microbiol App Sci*. 2021;10(01):1697-705.
15. Subbaih BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. *Curr Sci*. 1956;25:259-260.