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Effect of nano DAP on nutrient uptake and available nutrients status of soil after harvest of soybean (*Glycine max* L.)

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Abstract
A field experiment on effect of nano DAP on nutrient uptake and available nutrients status after harvest of soybean (*Glycine max* L.) was conducted during *Kharif* 2022 at ICAR-KVK, Kalaburagi. The soil of the experimental site was black, shallow to medium in depth with moderately alkaline pH, low in EC, SOC and nitrogen, medium in phosphorus, high in potassium and medium in sulphur. The experiment was laid out in RCBD with eight treatments replicated thrice. The results revealed that, soil pH, electrical conductivity, SOC and $CaCO_3$ were not significantly influenced by foliar application of nano DAP. Application of 100% RDF + foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS recorded significantly higher available nutrients in soil (215, 33.77, 351 and 17.28 kg ha^{-1} N, P_2O_5, K_2O and SO_4^{-2}, respectively) and uptake of nitrogen (180 kg ha^{-1}), phosphorus (44.21 kg ha^{-1}), potassium (75.38 kg ha^{-1}), Sulphur (24.91 kg ha^{-1}) and micronutrients. However it was on par with 100% RDF + foliar spray of 2 ml L^{-1} nano DAP at 30 and 45 DAS. Hence, for effective management of crop nutrition, the application of 100% RDF and foliar spray of 2 ml L^{-1} nano DAP at 30 and 45 DAS was recommended.

Keywords: Nano DAP, Foliar spray, Soybean, RDF

1. Introduction
Soybean seed contains approximately 38 to 43 percent protein, 18 to 20 percent oil, 26 percent carbohydrate, 4 percent minerals and 2 percent phospholipids. The protein is rich in lysine and the oil extracted is edible with fairly high unsaturated fatty acids (Endres, 2001) [1]. It is also known as “wonder crop”. It thrive in well-drained soils with good fertility and known for their unique ability to fix atmospheric nitrogen with the help of symbiotic bacteria, which can enhance soil fertility over time. This nitrogen-fixing capability makes soybean an essential component of crop rotation systems, as it contribute to soil enrichment by increasing nitrogen levels.

The application of fertilizers in the right quantity and balanced manner at the right time is an important factor in enhancing the productivity of crops. Among different major nutrients, nitrogen and phosphorus are applied in high dose and the nutrient use efficiency of nitrogen is only 30 to 50 percent. The remaining 50 to 70 percent is lost due to volatilization, deep percolation and weed clearance. Further the phosphorus usage efficiency is just 15 to 20 percent and remaining is lost due to soil fixation. Hence, nanotechnology assumes a greater role in reaching this task. Nano DAP (liquid) is the source of nitrogen and phosphorus. Nitrogen is the first and foremost nutrient required for crops as it is the constituent of chlorophyll, proteins and enzymes, thus playing a significant role during the vegetative growth of crops. Along with nitrogen, phosphorus is also an important plant nutrient having a vital role in plant growth and is found in every living plant cell. It is involved in several key plant functions, including energy transfer, photosynthesis and transformation of sugars, starches and nutrient movement within the plant. This nano DAP contains about 8 percent (80,000 ppm) of nitrogen and 16 percent (1,60,000 ppm) of phosphorus. IFFCO nano DAP is prepared by nanotechnology and effectively fulfills the crop nitrogen and phosphorus requirement when used as a foliar spray. In view of the above facts, the current study was to carried out determine the Effect of nano DAP on nutrient uptake and available nutrients status of soil after harvest of soybean (*Glycine max* L,).

2. Materials and Methods

A field experiment was conducted during *kharif* 2022 at ICAR-Krishi Vigyan Kendra, Kalaburagi. It is situated in the North Eastern Dry Zone of Karnataka (Zone-2) between 17º 34' N latitude and 76º 79' E longitude with an altitude of 478 meters above the mean sea level. The experiment was laid out in randomized complete block design (RCBD) with three replications. There were nine treatments *viz.*, RDF (40:80:25 N: P_2O_5: K_2O kg ha^{-1}), 50% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS, 50% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS, 75% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS, 75% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS, 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS, 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS, Absolute control and were replicated thrice in the experiment. Whereas, recommended dose of fertilizers in the form of urea, DAP, MoP, bentonite sulphur, zinc sulphate and borax were applied as per treatments with recommended dose of fertilizer. FYM @ 10 tonnes ha^{-1} was applied to all the treatments except absolute control. The soybean variety, KDS-726 was used for the study with a spacing of 30 cm × 10 cm.

The collected soil samples were dried under shade and were analyzed for pH, EC, SOC and $CacO_3$ and available NPK and micronutrients. Standard procedures were adopted for analysis of the nutrients in the laboratory. The pH of the soil was determined by using digital pH meter (Jackson, 1973) [2], the electrical conductivity (dS m^{-1}) by conductivity bridge (Jackson, 1973) [2], the soil organic carbon (g kg^{-1}) by wet oxidation method (Walkley & Black, 1934) [3], the free $CaCO_3$ (%) by rapid titration method (Piper, 1966) [4], the available nitrogen (kg ha^{-1}) content in soil was determined by adopting alkaline potassium permanganate method (Subbiah and Asija, 1956) [5], the available phosphorus (kg ha^{-1}) by Olsen's method (Jackson, 1973) [2], the available potassium (kg ha^{-1}) by flame photometer (Jackson, 1973) [2], the available sulphur (kg ha^{-1}) by turbidometric method (Piper, 1966) [4] and the available micronutrients (Fe, Cu, Zn, Mn) (mg kg^{-1}) by DTPA method (Lindsay & Norvell, 1978) [6], the available boron (mg kg^{-1}) by colorimetric method (Berger and Troug, 1939) [7]. Nutrient uptake was calculated by multiplying the nutrient (%) concentration with biomass (kg ha^{-1}) and whole divided by hundred. Data analysis and interpretation was done using Gomez and Gomez (1984) [8] technique.

3. Results and discussion

3.1 Effect of nano DAP on nutrient uptake

3.1.1 Macronutrients uptake

The data on nutrient uptake of N, P_2O_5, K_2O and SO_4^{-2} by soybean crop was analyzed and represented in Table 1. Significantly higher uptake of nitrogen, phosphorus, potassium and sulphur (180.39, 44.21, 75.38 and 24.91 kg ha^{-1}, respectively) was recorded with the application of 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS. It was on par with the application of 100% RDF and two foliar sprays of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS (165.37, 38.91, 70.28 and 22.56 kg ha^{-1}, N, P_2O_5, K_2O and SO_4^{-2}, respectively). This might be due to foliar application of nano DAP covers larger surface area and particles that are smaller than the pores in the plant leaves can penetrate into the plant from the applied surface more deeply and improve nutrient uptake. Similar results were noticed by Shankaralingappa *et al*. (2000) [9], Burhan and Hassan (2019) [10] and Rashmi *et al*. (2022) [11].

3.1.2 Micronutrients uptake

The results related to micronutrients (Fe, Cu, Zn, Mn and B) uptake at harvest by soybean crop as influenced by nano DAP application is furnished in Table 2. Higher micronutrients uptake (668.08, 59.76, 63.39, 175.28 and 111.89 g ha^{-1}, Fe, Cu, Zn, Mn and B, respectively) was recorded in 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS. It was on par with 100% RDF and 2 ml L^{-1} nano DAP at 30 and 45 DAS (636.23, 54.77, 61.85, 162.12 and 104.07 g ha^{-1}, Fe, Cu, Zn, Mn and B, respectively). An application of nano DAP directly on the leaves, where nutrients can be absorbed more quickly and efficiently, adequate nutrients can lead to increased nutrient uptake in plants. Uptake of nutrients in plant mainly depends upon yield of crop. In general higher the yield of the treatment higher the uptake of nutrient. Similar results were opined by Dash *et al.* (2015) [12] and Apoorva *et al.* (2017) [13].

3.2 Effect of nano DAP on soil chemical properties

The data related to soil chemical properties such as pH, EC, SOC and free $CaCO_3$ as influenced by nano DAP foliar application in soybean are furnished in Table 3. The soil chemical properties are not significantly influenced by nano DAP foliar spray. Because inorganic fertilizer application like urea, DAP and nano DAP for only one season of experimentation has not much influenced pH, EC, OC and $CaCO_3$ of soil.

3.3 Effect of nano DAP on available nutrients status of soil

3.3.1 Available macronutrients status

Application of 100% RDF and two foliar sprays of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS was recorded significantly higher soil available nitrogen, phosphorus, potassium and sulphur (Table 4 and Fig 1) and it was statistically on par with 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS. It might be due to a higher rate of nutrients were applied through two sources, *viz.*, soil application of 10 tonnes FYM, conventional fertilizers @ 100% RDF and foliar application of nano DAP @ 4 ml L^{-1} which might have resulted in higher levels of available nutrients after meeting the crop nutrient requirement at different crop growth stages. The results are in agreement with the findings of Mala *et al.* (2017) [14], Singh and Kumar (2017) [15] and Dhansil *et al.* (2018) [16].

3.3.2 Available micronutrients status

No significant differences were observed among the various treatments for iron, copper and manganese uptake (Table 5). The application of 100% RDF and 4 ml L^{-1} nano DAP foliar spray at 30 and 45 DAS was recorded higher soil available zinc and boron (2.77 and 1.91 mg kg^{-1}, respectively). It followed by 100% RDF and two foliar sprays of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS (2.61, 1.87 mg kg^{-1}, Zn, B, respectively). The increment in the availability of zinc and boron may be attributed to the RDF, nano DAP and FYM, which might have provided better mobilization and mineralization of added zinc and boron in soil. The results are in accordance with findings of Devi *et al.* (2012) [17] and Poudel *et al*. (2023) [18].

Table 1: Macronutrients uptake by soybean as influenced by foliar spray of nano DAP

Treatments	Macronutrients uptake (kg ha^{-1})			
	N	P_2O_5	K_2O	SO_4^{-2}
T_1 – RDF (40:80:25 N:P_2O_5:K_2O kg ha^{-1})	134.06	28.23	55.02	16.56
T_2 – 50% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	106.35	18.72	40.72	11.68
T_3 – 50% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	118.01	21.79	45.25	13.26
T_4 – 75% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	137.18	29.66	56.33	17.31
T_5 – 75% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	148.38	33.17	60.75	19.57
T_6 – 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	165.37	38.91	70.28	22.56
T_7 – 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	180.39	44.21	75.38	24.91
T_8 – Absolute control	69.02	7.26	22.63	7.91
S.Em. ±	5.22	1.96	2.41	0.95
C.D. @ 5%	15.83	5.94	7.32	2.89

Table 2: Micronutrients uptake of soybean as influenced by foliar spray of nano DAP

Treatments	Micronutrients uptake (g ha^{-1})				
	Fe	Cu	Zn	Mn	B
T_1 – RDF (40:80:25 N:P_2O_5:K_2O kg ha^{-1})	555.23	44.74	59.49	135.63	85.80
T_2 – 50% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	446.68	34.40	51.13	105.52	63.41
T_3 – 50% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	498.78	39.45	55.00	120.89	72.03
T_4 – 75% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	566.46	45.82	58.99	139.46	88.27
T_5 – 75% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	599.87	50.30	60.84	150.83	95.67
T_6 – 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	636.87	54.77	61.85	162.12	104.07
T_7 – 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	668.08	59.76	63.39	175.28	111.89
T_8 – Absolute control	358.42	20.59	43.15	80.92	43.13
S.Em. ±	15.33	0.14	0.60	5.11	2.99
C.D. @ 5%	46.50	0.43	1.80	15.33	9.08

Table 3: Chemical properties of soil after harvest of crop as influenced by foliar spray of nano DAP

Treatments	pH	EC (dS m^{-1})	SoC (g kg^{-1})	$CaCO_3$ (%)
T_1 – RDF (40:80:25 N:P_2O_5:K_2O kg ha^{-1})	8.20	0.22	4.30	5.31
T_2 – 50% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	8.10	0.19	4.15	4.21
T_3 – 50% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	8.10	0.20	4.17	4.57
T_4 – 75% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	8.12	0.20	4.20	5.23
T_5 – 75% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	8.17	0.21	4.22	5.29
T_6 – 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	8.20	0.22	4.31	5.32
T_7 – 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	8.23	0.25	4.33	5.45
T_8 – Absolute control	8.09	0.19	3.94	4.70
S.Em. ±	0.07	0.01	0.13	0.33
CD @ 5%	NS	NS	NS	NS

Table 4: Influence of foliar application of nano DAP on available macronutrients status in soil after harvest of soybean crop

Treatments	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	SO_4^{-2} (kg ha^{-1})
T_1 – RDF (40:80:25 N:P_2O_5:K_2O kg ha^{-1})	211.61	31.26	345.51	16.63
T_2 – 50% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	198.72	25.87	322.65	15.27
T_3 – 50% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	200.52	26.98	325.34	15.64
T_4 – 75% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	206.49	28.37	338.79	16.02
T_5 – 75% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	208.62	30.17	340.47	16.45
T_6 – 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	213.15	32.62	348.33	17.03
T_7 – 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	215.48	33.77	351.13	17.28
T_8 – Absolute control	164.90	19.65	316.18	12.30
S.Em. ±	1.22	0.76	1.77	0.28
CD @ 5%	3.69	2.30	5.36	0.86

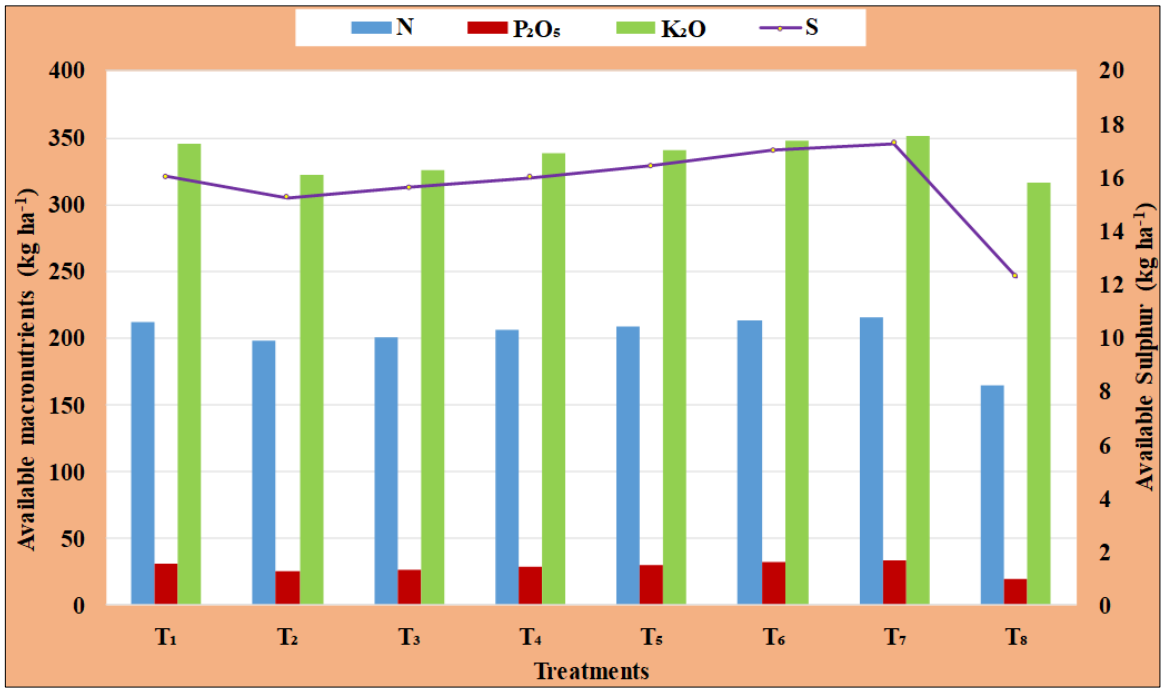

Fig 1: Influence of foliar application of nano DAP on available macronutrients (kg ha^{-1}) status in soil after harvest of soybean crop

Table 5: Influence of foliar application of nano DAP on available micronutrients status in soil after harvest of soybean crop

Treatments	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})	B (mg kg^{-1})
T_1 – RDF (40:80:25 N:P_2O_5:K_2O kg ha^{-1})	3.07	1.39	2.35	4.44	1.80
T_2 – 50% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	2.43	1.29	1.95	3.66	1.61
T_3 – 50% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	2.58	1.31	2.13	3.72	1.68
T_4 – 75% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	2.98	1.35	2.19	4.18	1.76
T_5 – 75% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	3.10	1.38	2.38	4.39	1.78
T_6 – 100% RDF and foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS	3.47	1.39	2.61	04.51	1.87
T_7 – 100% RDF and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS	3.53	1.42	2.77	4.69	1.91
T_8 – Absolute control	1.92	1.15	0.37	3.34	0.23
S.Em. ±	0.33	0.05	0.09	0.30	0.03
CD @ 5%	NS	NS	0.26	NS	0.08

4. Conclusion

Application of 100% RDF (40:80:25 N: P_2O_5: K_2O) and foliar spray of nano DAP @ 4 ml L^{-1} at 30 and 45 DAS in soybean was found to be on par with 100% RDF along with foliar spray of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS in terms of nutrients uptake and nutrients available status in soil after harvest of crop. Hence, for effective management of nutrients in soybean, application of 100% RDF and two foliar sprays of nano DAP @ 2 ml L^{-1} at 30 and 45 DAS was recommended.

5. References

1. Endres JG. Soybean protein products: characteristics, nutritional aspects, and utilization. The American Oil Chemists Society. 2001, p. 1-13.
2. Jackson ML. Soil Chemical Analysis. Prentice Hall India Pvt. Ltd., New Delhi. 1973, p. 498.
3. Walkley AJ, Black CA. Estimation of soil organic carbon by the chromic acid and titration method. Journal of Agricultural Science. 1934;25:598-609.
4. Piper CS. Soil and Plant Analysis. Academic Press, New York. 1966, p. 367.
5. Subbiah, Asija. A rapid procedure for estimation of available nitrogen in soils. Current Science. 1956;25:259-260.
6. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of American Journal. 1978;42:421-428.
7. Berger KC, Troug E. Boron determination in soils and plants. Industrial and Engineering Chemistry Analytical Edition. 1939;11(10):540-545.
8. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 *ed.*). John wiley and sons, NewYork. 1984, p. 680.
9. Shankaralingappa BC, Shivaraj B, Sudhir K, Viswanatha KP. Interaction effect of phosphorus and sulphur on uptake of nitrogen, phosphorus, potassium and sulphur by pigeonpea (*Cajanus cajan*). Indian Journal of Agronomy. 2000;45(2):348-352.
10. Burhan MG, Hassan SA. Impact of nano NPK fertilizers to correlation between productivity, quality and flag leaf of some bread wheat varieties. Iraqi Journal of Agricultural Sciences. 2019;50(4):1-7.
11. Rashmi CM, Prakash SS, Basavaraj PK, Krishnamurthy R, Yogananda SB, Bhavani P, *et al*. Effect of nano phosphorus fertilizers on uptake of nitrogen, phosphorus and potassium by maize. The Pharma Innovation Journal. 2022;11(11):2172-2175.
12. Dash AK, Singh HK, Mahakud T, Pradhan KC, Jena D. Interaction effect of nitrogen, phosphorus, potassium with sulphur, boron and zinc on yield and nutrient uptake

by rice under rice-rice cropping system in inceptisol of coastal Odisha. International Research Journal of Agricultural Science and Soil Science. 2015;5(1):14-21.
13. Apoorva MR, Rao PC, Padmaja G. Effect of zinc with special reference to nano zinc carrier on yield, nutrient content and uptake by rice (*Oryza sativa* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(8):1057-1063.
14. Mala R, Celsia Arul Selvaraj R, Barathi Sundaram V, Blessina Siva Shanmuga Rajan R, Maheshwari Gurusammy U. Evaluation of nano structured slow-release fertilizer on the soil fertility, yield and nutritional profile of *Vigna radiata*. Recent Patents on Nanotechnology. 2017;11(1):50-62.
15. Singh MD, Kumar BA. Bio efficacy of nano zinc sulphide (ZnS) on growth and yield of sunflower (*Helianthus annuus* L.) and nutrient status in the soil. International Journal of Agricultural Sciences. 2017;9(8):0975-3710.
16. Dhansil A, Zalawadia NM, Prajapati BS, Yadav K. Effect of nano phosphatic fertilizer on nutrient content and uptake by Pearl millet (*Pennisetum glaucum* L.) crop. The International Journal of Current Microbiology and Applied Sciences. 2018;7(12):2327-2337.
17. Devi KN, Singh LNK, Singh MS, Singh SB, Singh KK. Influence of sulphur and boron fertilization on yield, quality, nutrient uptake and economics of soybean (*Glycine max* L.) under upland conditions. Journal of Agricultural Science. 2012;4(4):1-18.
18. Poudel A, Singh SK, Jimenez-Ballesta R, Jatav SS, Patra A, Pandey A. Effect of Nano-Phosphorus Formulation on Growth, Yield and Nutritional Quality of Wheat under Semi-Arid Climate. Agronomy. 2023;13(3):768.