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Influence of foliar application of nutrients on nutrient content, nutrient uptake and post-harvest soil nutrient status of Horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.] in Chhattisgarh plains

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Abstract

The present investigation was carried out at the Instructional Farm, BTC CARS, Bilaspur (C.G.), during the *kharif* season (2022) to evaluate the Influence of foliar application of nutrients on nutrient content, nutrient uptake and post-harvest soil nutrient status of horse gram [*Macrotyloma uniflorum* (Lam.) Verdc.] in Chhattisgarh plains. The result indicate that significantly higher nutrient uptake by seed, straw and total biomass of horsegram was observed under treatment Recommended dose of nutrients + 2% NPK 19:19:19 spray (T₇), which was statistically at par with treatment Recommended dose of nutrients + 2% DAP spray (T₅). These treatments proved superior to the remaining treatments with respect to nutrient uptake. The lowest nutrient uptake was recorded under the control treatment (T₁). Although the nutrient content of the plant and the post-harvest available soil nutrient status (N, P, and K kg ha⁻¹) were not significantly influenced by the different treatments, numerical variations were observed among them. Treatment Recommended dose of nutrients + 2% NPK 19:19:19 spray (T₇) recorded the highest plant nutrient content, while Recommended dose of nutrients + 2% Urea spray (T₃), Recommended dose of nutrients + 2% DAP spray (T₅) and Recommended dose of nutrients + 2% MOP spray (T₆) registered the highest available soil N, P₂O₅ and K₂O contents, respectively. The lowest values were observed under the control treatment (T₁).

Keywords: Horse gram, NPK (19:19:19) spray, Nutrient content, uptake and available soil nutrient

Introduction

Horsegram is a type of pulse that is also referred to as poor man's pulse crop and kulthi. The crop is a member of the Fabaceae family, a legume crop that is still underutilised. It is also known as Kurti-kalai (Bengali), Gahot (Kumaon and Garhwal), Ullavallu (Telugu), Muthira (Malyalam), Kollu (Tamil) and Kulattha (Sanskrit). As reported by Bravo *et al.* (1999), horsegram possesses high nutritional value, containing approximately 25% protein and 60% carbohydrates, besides being a rich source of essential amino acids, energy, fat, iron and molybdenum. Horsegram, also known as a drought-tolerant crop, is commonly grown in India in conditions with nearly 200-700 mm of rainfall and temperatures between 20 and 35 °C. Horsegram is generally suited to a variety of soil types, including stony and gravelly uplands, cleaned harsh forests, deep red loams, black cotton soils, clayey paddy soils, sandy and shallow soils etc. Horsegram is cultivated across almost all states of India owing to its wide adaptability to diverse soil types and climatic conditions. However, nearly 90-95% of the total cultivated area is concentrated in five major states, namely Karnataka (34.0%), Tamil Nadu (18.0%), Maharashtra (18.0%), Odisha (16.0%) and Andhra Pradesh (16.0%), which together constitute the principal horsegram-growing regions of the country.

Horsegram occupies about 0.458 million ha in India, producing 0.297 million tonnes with a productivity of 6.48 q ha⁻¹ (Anonymous, 2021) ^[2]. In Chhattisgarh, it is cultivated on 0.026 million ha with a production of 0.010 million tonnes and a productivity of 3.90 q ha⁻¹ (Anonymous, 2019) ^[1]. The major horsegram-growing districts are Kondagaon, Jashpur, Kanker and Korba. The crop is predominantly cultivated by tribal farmers in the Northern Hills and Bastar Plateau regions under upland, low-input conditions. Foliar fertilization is an effective nutrient management

practice that facilitates rapid nutrient absorption by plants, reduces nutrient losses due to leaching and soil fixation and improves overall nutrient use efficiency (Manonmani and Srimathi, 2009) ^[10]. In pulse crops, low productivity is frequently attributed to inadequate pod development and poor seed set. The application of nutrients and growth regulators through foliar sprays has been found to enhance reproductive growth, improve pod formation and seed setting, and ultimately increase crop yield (Meena *et al.*, 2017) ^[11]. The application of nitrogen through foliar feeding at critical growth stages plays an important role in overcoming growth limitations, delaying nodule senescence and improving seed yield (Kumar *et al.*, 2019) ^[9]. In addition, foliar nutrient supplementation during the pre-flowering and flowering phases minimizes flower drop and enhances reproductive success, resulting in improved crop performance (Beulah and Ghosh, 2020) ^[3].

2. Methods and materials

A field experiment was conducted during the *kharif* season of 2022 at the Instructional Farm, BTC CARS, Bilaspur, Chhattisgarh. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments and three replications. The treatments comprised: Control (T₁); Recommended Dose of Nutrients (RDN: 20 kg N, 40 kg P₂O₅ and 10 kg K₂O ha⁻¹) (T₂); Recommended Dose of Nutrients + 2% urea spray (T₃); Recommended Dose of Nutrients + 2% SSP spray (T₄); Recommended Dose of Nutrients + 2% DAP spray (T₅); Recommended Dose of Nutrients + 2% MOP spray (T₆); Recommended Dose of Nutrients + 2% NPK (19:19:19) spray (T₇); Recommended Dose of Nutrients + 250 ppm cycocel (CCC) spray (T₈); and Recommended Dose of Nutrients + water spray (T₉). These treatments were evaluated to assess their effects on nutrient content, nutrient uptake and post-harvest soil nutrient status of horsegram. Foliar application of nutrient of all treatment was done at 25 Days after sowing. The soil of the experimental plot was sandy clay loam in texture, neutral in reaction, medium in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium content. Weather conditions during the crop season were favorable for the normal growth and development of horsegram. The experimental crop, horsegram variety Alakh Kulthi, was sown on 28 September 2022 and harvested on 22 January 2023 after attaining physiological maturity. The recommended dose of fertilizer (RDF) was 20:40:10 kg ha⁻¹ of N:P₂O₅:K₂O, respectively. All RDF were applied at the time of sowing as per the treatment specifications. The dried straw and grain were grinded and used for following chemical analysis Nitrogen content was determined by KEL plus unit methods as described by Chapman and Pratt, (1961) ^[4]. Phosphorus content in the di-acid digest of plant samples was determined by the vanadomolybdo phosphoric yellow colour method and the absorbance was measured at 420 nm using a spectrophotometer, following the procedure outlined by Jackson (1973) ^[6]. Potassium content in the same digest was estimated using a flame photometer according to the method described by Jackson (1973) ^[6]. Nutrient uptake was computed by multiplying the nutrient concentration (%) in plant samples by the corresponding seed and straw yields.

The soil samples were collected randomly from each experimental plot after the harvest of horsegram. The samples were air-dried, ground and passed through a 2-mm sieve before analysis. The processed soil samples were analyzed to determine the available nitrogen (N), phosphorus (P) and potassium (K) contents. Available nitrogen was determined by the alkaline potassium permanganate method as described by Subbiah and

Asija (1956) ^[13], available phosphorus was estimated by Olsen's method (Olsen *et al.*, 1954) ^[12] and available potassium was determined by extracting the soil with neutral normal ammonium acetate and measuring the potassium concentration using a flame photometer following the procedure described by Toth and Prince (1949) ^[14].

3. Results and Discussion

3.1 Plant analysis

3.1.1 Nitrogen, phosphorus and potassium content in seed and straw (%)

Data regarding nitrogen, phosphorus and potassium content in grain and stover of horsegram as influenced by different treatments. The data in respect nitrogen, phosphorus and potassium content in seed and straw of horsegram were not influenced significantly due to different treatments.

Table 1: Influence of foliar application of nutrients on nitrogen, phosphorus and potassium content on seed and straw of Horsegram

Treatment	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Seed	Straw	Seed	Straw	Seed	Straw
T ₁	3.38	0.33	0.44	0.24	0.72	0.83
T ₂	3.41	0.35	0.46	0.25	0.75	0.86
T ₃	3.52	0.38	0.47	0.26	0.76	0.87
T ₄	3.42	0.36	0.49	0.27	0.79	0.9
T ₅	3.49	0.37	0.5	0.29	0.79	0.91
T ₆	3.41	0.36	0.48	0.26	0.83	0.95
T ₇	3.59	0.4	0.52	0.3	0.85	0.97
T ₈	3.42	0.36	0.47	0.26	0.76	0.87
T ₉	3.43	0.36	0.46	0.25	0.76	0.87
SEM ±	0.11	0.03	0.03	0.02	0.05	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS

3.1.2 Protein content in seed and protein yield

The results revealed that protein content in horsegram grain was not significantly influenced by the different treatments. However, treatment Recommended dose of nutrients + 2% NPK 19:19:19 foliar spray (T₇) numerically recorded the highest protein content, while the lowest protein content was observed under the control treatment (T₁).

Protein yield of horsegram was significantly affected by the treatments. The highest protein yield was recorded under treatment Recommended dose of nutrients + 2% NPK 19:19:19 foliar spray (T₇), which was statistically at par with treatment Recommended dose of nutrients + 2% DAP foliar spray (T₅). Both treatments proved significantly superior to the remaining treatments with respect to protein yield. The lowest protein yield was recorded under the control treatment (T₁).

Table 2: Influence of foliar application of nutrients on protein content on seed and protein yield of Horsegram

Treatment	Protein content in seed (%)	Protein yield (kg ha ⁻¹)
T ₁	21.13	108.61
T ₂	21.31	148.42
T ₃	22.00	215.60
T ₄	21.38	197.98
T ₅	21.81	251.04
T ₆	21.31	189.94
T ₇	22.44	267.63
T ₈	21.38	185.93
T ₉	21.44	151.15
SEM ±	0.67	12.17
CD (P=0.05)	NS	36.50

3.1.3 Nitrogen uptake in seed and straw (kg ha⁻¹)

Treatment Recommended dose of nutrients + 2% NPK 19:19:19 foliar spray (T₇) recorded the maximum nitrogen uptake in seed, straw and total biomass of horsegram. However, it was statistically at par with treatment Recommended dose of nutrients + 2% DAP spray (T₅). Both treatments showed significantly higher nitrogen uptake compared to all other treatments. The lowest nitrogen uptake in seed, straw and total biomass of horsegram was recorded under the control treatment (T₁). The results are in conformity with those earlier reported by Kolekar *et al.* (2018) [8] concluded that total uptake of macro and micronutrients was higher in soybean by foliar sprays of 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS. Comparable results were obtained by Jaybhaye *et al.* (2022) [7] and Deore, (2021) [5].

3.1.4 Phosphorus uptake in seed and straw (kg ha⁻¹)

Treatment Recommended dose of nutrients + 2% NPK 19:19:19 foliar spray (T₇) registered the maximum phosphorus uptake in seed, straw and total biomass of horsegram and was statistically

at par with treatment Recommended dose of nutrients + 2% DAP spray (T₅). Both treatments showed significantly higher phosphorus uptake compared to all other treatments. The lowest phosphorus uptake in seed, straw and total biomass of horsegram was recorded under the control treatment (T₁). Comparable results were obtained by Kolekar *et al.* (2018) [8], Jaybhaye *et al.* (2022) [7] and Deore, (2021) [5].

3.1.5 Potassium uptake in seed and straw (kg ha⁻¹)

Treatment Recommended dose of nutrients + 2% NPK 19:19:19 foliar spray (T₇) recorded the maximum potassium uptake in seed, straw and total biomass of horsegram and was found to be statistically at par with treatment Recommended dose of nutrients + 2% DAP spray (T₅). Both treatments significantly outperformed the remaining treatments with respect to potassium uptake. In contrast, the control treatment (T₁) registered the lowest potassium uptake in seed, straw and total biomass of horsegram. Comparable results were obtained by Jaybhaye *et al.* (2022) [7] and Deore, (2021) [5].

Table 3: Influence of foliar application of nutrients on nitrogen, phosphorus and potassium uptake in seed, straw and total biomass of Horsegram

Treatments	Nitrogen uptake (kg ha ⁻¹)			Phosphorus uptake (kg ha ⁻¹)			Potassium uptake (kg ha ⁻¹)		
	Seed	Straw	Total	Seed	Straw	Total	Seed	Straw	Total
T ₁	17.37	1.69	19.06	2.26	1.23	3.49	3.70	4.26	7.96
T ₂	23.66	2.42	26.09	3.19	1.73	4.92	5.20	5.96	11.17
T ₃	34.49	3.72	38.31	4.60	2.54	7.15	7.44	8.52	15.97
T ₄	31.66	3.33	34.99	4.53	2.50	7.03	7.31	8.33	15.64
T ₅	40.10	4.25	44.35	5.74	3.33	9.07	9.07	10.45	19.53
T ₆	30.38	3.2	33.59	4.27	2.31	6.59	7.39	8.46	15.85
T ₇	42.79	4.76	47.79	6.19	3.57	9.77	10.13	11.56	21.69
T ₈	29.95	3.15	33.02	4.11	2.27	6.39	6.65	7.62	14.27
T ₉	24.18	2.53	26.71	3.24	1.76	5.00	5.35	6.13	11.49
SEm ±	1.60	0.19	1.80	0.24	0.15	0.38	0.39	0.42	0.90
CD (P=0.05)	4.80	0.58	5.39	0.73	0.45	1.15	1.18	1.27	2.71

3.2 Soil analysis

3.2.1 Soil pH, EC and organic carbon content and Available N, P, and K content of soil following horsegram harvest

The post-harvest soil analysis revealed that soil pH, electrical conductivity (EC), organic carbon content, and available

nitrogen, phosphorus and potassium contents (kg ha⁻¹) did not vary significantly among the different foliar nutrient application treatments. Thus, the foliar nutrient treatments had no significant effect on the soil physico-chemical properties and available nutrient status following the harvest of horsegram.

Table 4: Influence of foliar application of nutrients on soil pH, EC, organic carbon, Available N, P and K content in soil after harvest

Treatments	Soil pH	EC (dSm ⁻¹)	Organic carbon content	Available nitrogen (kg ha ⁻¹)	Available phosphorus (kg ha ⁻¹)	Available potassium (kg ha ⁻¹)
T ₁	7.2	0.40	0.45	208.84	9.95	319.65
T ₂	7.1	0.39	0.46	211.71	10.98	324.86
T ₃	6.9	0.36	0.48	218.78	11.11	327.78
T ₄	7.1	0.39	0.47	213.18	11.26	326.64
T ₅	7.0	0.37	0.53	215.62	11.34	327.26
T ₆	7.1	0.39	0.5	213.24	11.1	331.27
T ₇	7.0	0.37	0.52	216.45	11.3	329.11
T ₈	7.1	0.39	0.47	213.02	11.02	325.36
T ₉	7.1	0.39	0.46	212.48	11.05	325.54
SEm ±	0.12	0.02	0.03	4.73	0.50	5.85
CD (P=0.05)	NS	NS	NS	NS	NS	NS

4. Conclusion

Foliar application of nutrients improved nutrient uptake in horsegram. The treatment Recommended dose of nutrients + 2% NPK (19:19:19) spray at 25 DAS (T₇) recorded the highest nitrogen, phosphorus, and potassium uptake and was statistically at par with Recommended dose of nutrients + 2% DAP spray (T₅). However, nutrient content in seed and straw, post-harvest soil available N, P, and K, as well as soil pH, EC, and organic carbon,

were not significantly affected by the treatments. Therefore, foliar application of 2% NPK (19:19:19) along with the recommended dose of fertilizers is good for enhancing nutrient uptake in horsegram without adversely affecting soil fertility

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