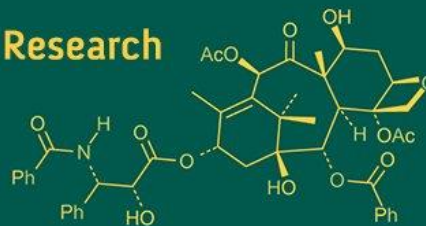
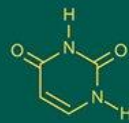


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Effect of fertilizer doses and foliar application of NPK (19:19:19) on growth and yield of little millet (*Panicum sumatrense* L.)

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Abstract

Little millet (*Panicum sumatrense* L.) is an important nutri-cereal cultivated under rainfed conditions because of its adaptability to marginal soils and tolerance to drought. However, its productivity is often constrained by inadequate and imbalanced nutrient management. A field experiment was conducted during the Kharif season of 2025 at the Instructional-cum-Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, to evaluate the effect of fertilizer doses and foliar application of water-soluble NPK (19:19:19) on the growth and yield of little millet. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. Different fertilizer levels were evaluated either alone or in combination with foliar spray of NPK (19:19:19). Growth parameters including plant height, number of tillers, dry matter accumulation, along with yield attributes and yield, were recorded. The results indicated that integrated application of soil fertilizer and foliar nutrition significantly improved crop growth and yield over the control and reduced fertilizer levels. Among all treatments, 100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS recorded the highest plant height, dry matter accumulation, tiller production, panicle length, grains panicle⁻¹, test weight, grain yield and straw yield. The study demonstrated that integrating the recommended fertilizer dose with foliar nutrition enhances nutrient availability during critical growth stages and improves the productivity of little millet under Chhattisgarh condition.

Keywords: Little millet, RDF, NPK (19:19:19), foliar spray, growth, yield

1. Introduction

Little millet (*Panicum sumatrense* L.) is one of the oldest domesticated small millets belonging to the family Poaceae. It is an important nutri-cereal crop cultivated predominantly under rainfed conditions due to its short duration, drought tolerance, and adaptability to marginal and low-fertility soils. The crop plays a significant role in ensuring food and nutritional security, particularly in semi-arid and tribal regions of India (Gavit *et al.*, 2024) [3]. Little millet grains are rich in dietary fibre, protein, essential amino acids, minerals, vitamins, and antioxidants, making them superior to many conventional cereals in terms of nutritional quality (Louhar *et al.*, 2020) [5]. Owing to its low glycaemic index and high micronutrient content, little millet is increasingly recognized as a healthy food suitable for diabetic and health-conscious consumers.

India is the largest producer of millets in the world, and little millet occupies an important place among small millets. However, its productivity remains comparatively low because it is generally cultivated under rainfed conditions with inadequate and imbalanced nutrient management. The continuous depletion of soil fertility, coupled with insufficient fertilizer application, limits crop growth and yield. Therefore, the adoption of efficient nutrient management practices is essential for improving the productivity and profitability of little millet cultivation. Nitrogen (N), phosphorus (P), and potassium (K) are the primary macronutrients required for optimum crop growth and development. Nitrogen promotes chlorophyll formation, vegetative growth, and protein synthesis, phosphorus enhances root development, energy transfer, and early crop establishment, while potassium regulates enzyme activation, photosynthesis, water relations, and translocation of assimilates. Balanced application of these nutrients improves nutrient use efficiency and contributes

significantly to higher biomass production and grain yield (Louhar *et al.*, 2020) [5]. Foliar application of water-soluble fertilizers has emerged as an effective complementary nutrient management strategy for supplying nutrients during critical crop growth stages. Foliar feeding ensures rapid nutrient absorption, minimizes nutrient losses, and enhances physiological processes such as photosynthesis, dry matter accumulation, and grain filling. When integrated with soil-applied fertilizers, foliar nutrition improves fertilizer use efficiency and sustains crop productivity under rainfed conditions (Veer *et al.*, 2025; Sase *et al.*, 2025) [10, 8]. Although several studies have demonstrated the beneficial effects of balanced fertilization and foliar nutrition in cereal crops, limited information is available regarding the combined effect of different fertilizer doses and foliar application of NPK (19:19:19) on the growth and yield of little millet under the agro-climatic conditions of Chhattisgarh. Therefore, the present investigation was undertaken to evaluate the effect of fertilizer doses and foliar application of NPK (19:19:19) on the growth and yield of little millet (*Panicum sumatrense*) under Chhattisgarh condition.

2. Materials and Methods

2.1 Experimental site and location

A field experiment was conducted during the Kharif season of 2025 at the Instructional-cum-Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India. The experimental farm is situated at 22.09° N latitude and 82.15° E longitude in the Chhattisgarh Plains Agro-climatic Zone. The region experiences a sub-tropical climate characterized by hot summers and monsoon rainfall.

2.2 Soil characteristics

Before sowing, composite soil samples were collected from a depth of 0–15 cm and analysed using standard laboratory procedures. The experimental soil was neutral in reaction, low in available nitrogen, medium in available phosphorus, and high in available potassium, making it suitable for evaluating the response of little millet to different fertilizer doses and foliar nutrition.

2.3 Experimental design and treatments

The experiment was laid out in a Randomized Block Design (RBD) with Seven treatments and three replications. The treatments comprised different fertilizer doses with and without foliar application of water-soluble NPK (19:19:19). Treatments are: T₁ - Control, T₂ - 100% RDF (40:30:20 kg NPK ha⁻¹), T₃ -100% RDF +NPK Foliar spray (19:19:19) once (30 DAS), T₄ -75% RDF + NPK Foliar spray (19:19:19) once at (30 DAS), T₅ -75% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS), T₆ -50% RDF + NPK Foliar spray (19:19:19) once at (30 DAS), T₇ - 50% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS).

Table 1: Details of treatment combinations

S. No.	Treatments
T ₁	Control
T ₂	100% RDF (40:30:20 kg NPK ha ⁻¹)
T ₃	100% RDF + NPK Foliar spray (19:19:19) once (30 DAS)
T ₄	75% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)
T ₅	75% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)
T ₆	50% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)
T ₇	50% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)

2.4 Statistical analysis

The experimental data were subjected to Analysis of Variance (ANOVA) appropriate for the Randomized Block Design as described by Gomez and Gomez (1984) [11]. The significance of treatment effects was tested using the F-test, and treatment means were compared using the Critical Difference (CD) test at the 5% probability level.

3. Results and Discussion

3.1 Growth parameters

3.1.1 Plant population (m⁻²)

Plant population at 30 DAS was not significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). The non-significant variation indicated that plant establishment was primarily governed by seed quality, germination and crop geometry rather than nutrient management practices. These findings are in close agreement with those reported by Patel *et al.* (2020) [7].

3.1.2 Plant height (cm)

Plant height of little millet was significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19) at all growth stages (30 DAS, 60 DAS and harvest). At 30 DAS, the highest plant height (38.27 cm) was recorded with T₃ (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), significantly superior to all other treatments but was statistically at par with T₂ (100% RDF). Since the foliar spray was applied at 30 DAS, the variation observed at this stage was mainly due to the effect of basal fertilizer application.

At 60 DAS and at harvest, T₃ maintained significantly higher plant height (106.87 and 112.40 cm, respectively) compared with most of the other treatments. However, it remained statistically at par with T₂ (100% RDF) and T₅ (75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS). The lowest plant height at all growth stages was recorded under the control treatment (T₁). Similar result findings were reported by Behera *et al.* (2025) [1].

The increase in plant height under integrated nutrient management may be attributed to improved nutrient availability, enhanced chlorophyll synthesis, greater photosynthetic activity, and increased cell division and elongation, which collectively promoted vigorous vegetative growth.

3.1.3 Number of tillers (per meter row length)

The number of tillers at harvest was significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). The maximum number of tillers (66.67 m⁻¹ row length) was recorded under T₃ (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), which was statistically at par with T₂ (100% RDF) and T₅ (75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS). The lowest number of tillers (26.00 m⁻¹ row length) was recorded under the control treatment (T₁). The increase in tiller production under integrated nutrient management may be attributed to the adequate and balanced supply of essential nutrients, which enhanced photosynthetic activity, nutrient uptake, and vegetative growth, thereby promoting the development of productive tillers. Similar result findings were reported by Gavit *et al.* (2024) [3].

3.1.4 Dry matter accumulation

Dry matter accumulation of little millet was significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19) at all growth stages (30 DAS, 60 DAS

and harvest). At 30 DAS, the maximum dry matter accumulation ($5.20 \text{ g plant}^{-1}$) was recorded under T_3 (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), which was significantly superior to all other treatments but was statistically at par with T_2 (100% RDF) ($4.86 \text{ g plant}^{-1}$), whereas the minimum value ($3.46 \text{ g plant}^{-1}$) was observed under the control (T_1). A similar trend was observed at 60 DAS, where T_3 recorded the highest dry matter accumulation ($37.24 \text{ g plant}^{-1}$) which was significantly superior to all other treatments but was statistically at par with T_2 ($35.03 \text{ g plant}^{-1}$) and T_5 ($33.33 \text{ g plant}^{-1}$), while the lowest value ($17.04 \text{ g plant}^{-1}$) was recorded in the control. At harvest, T_3 again produced the maximum dry matter accumulation ($50.67 \text{ g plant}^{-1}$), which was significantly superior to all over the treatment and remained statistically at par with T_2 ($46.85 \text{ g plant}^{-1}$) and T_5 ($45.45 \text{ g plant}^{-1}$), whereas the minimum dry matter accumulation ($19.70 \text{ g plant}^{-1}$) was recorded under the control treatment. The increased dry matter accumulation under integrated nutrient management may be attributed to improved nutrient availability, enhanced photosynthetic efficiency, and greater production and translocation of assimilates, resulting in increased biomass accumulation throughout the crop growth period. Similar result findings were reported by Parjane *et al.* (2025) [6].

3.2 Yield parameters

3.2.1 Panicle length (cm)

The highest panicle length (cm) at harvest was recorded under T_3 (100% RDF + NPK foliar spray (19:19:19) once at 30 DAS) (35.05 cm), which was significantly superior to all other treatments but was at par with treatment T_2 (100% RDF) (31.70 cm) and T_5 (75% RDF + NPK foliar spray twice at 30 and 50 DAS) (30.82 cm).

3.2.2 Number of grains per panicle

The number of grains per panicle was significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). The highest number of grains per panicle (556.67) was recorded under T_3 (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), which was significantly superior to all other treatments but was statistically at par with T_2 (100% RDF) (516.67 grains panicle $^{-1}$) and T_5 (75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS) (506.67 grains panicle $^{-1}$), but was significantly superior to the remaining treatments. The lowest number of grains per panicle (305.00) was observed under the control (T_1).

3.2.3 Test weight

Test weight was not significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). Although numerical differences were observed among the treatments, the variations were statistically non-significant,

indicating that nutrient management practices had no marked effect on the individual grain weight of little millet.

3.2.4 Grain yield

Grain yield was significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). The highest grain yield ($1303.33 \text{ kg ha}^{-1}$) was recorded under T_3 (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), which was significantly superior to all other treatments but was statistically at par with T_2 (100% RDF) ($1200.00 \text{ kg ha}^{-1}$) and T_5 (75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS) ($1176.67 \text{ kg ha}^{-1}$). The lowest grain yield ($670.00 \text{ kg ha}^{-1}$) was recorded under the control (T_1). The higher grain yield under T_3 may be attributed to the combined effect of adequate basal fertilization and foliar nutrient application, which ensured continuous nutrient availability during critical growth stages, resulting in improved growth, enhanced yield attributes, and efficient translocation of photosynthates towards grain development. The present findings are in agreement with those of Veer *et al.* (2025) [10], Behera *et al.* (2025) [1], and Dewangan *et al.* (2025) [2], who also reported higher grain yield with integrated soil and foliar nutrient management.

3.2.5 Straw yield

Straw yield was significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). The maximum straw yield ($2632.00 \text{ kg ha}^{-1}$) was recorded under T_3 (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), which was significantly superior to all other treatments but was statistically at par with T_2 (100% RDF) ($2550.00 \text{ kg ha}^{-1}$) and T_5 (75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS) ($2496.67 \text{ kg ha}^{-1}$), while the minimum straw yield ($1606.67 \text{ kg ha}^{-1}$) was observed under the control (T_1). The increased straw yield under integrated nutrient management may be attributed to improved vegetative growth, higher dry matter accumulation, and enhanced nutrient uptake throughout the crop growth period. Similar result findings were reported by Veer *et al.* (2025) [10].

3.2.6 Harvest index

Harvest index was not significantly influenced by different fertilizer doses and foliar application of NPK (19:19:19). Although numerical differences were observed among the treatments, the highest harvest index (33.09%) was recorded under T_3 (100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS), followed by T_2 (100% RDF) (32.12%) and T_5 (75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS) (32.07%). The lowest harvest index (29.39%) was recorded under the control (T_1), indicating that nutrient management practices had no significant effect on the partitioning of total biomass into economic yield. Similar result findings were reported by Patel *et al.* (2020) [7].

Table 2: Effect of fertilizer doses and foliar application of NPK on Little millet (*Panicum sumatrense* L.) on plant population at 30 DAS and number of tillers (per meter row length) at harvest

Treatments	Plant population (m^{-2})	Number of tillers
	30 DAS	At harvest
T1 - Control	29.00	26.00
T2 - 100% RDF (40:30:20 kg NPK ha^{-1})	29.67	60.00
T3 - 100% RDF + NPK Foliar spray (19:19:19) once (30 DAS)	30.00	66.67

T4 - 75% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)	29.33	51.00
T5 - 75% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)	29.67	59.00
T6 -50% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)	29.00	41.33
T7 - 50% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)	29.00	50.00
SEm ($\pm$)	1.20	2.57
CD (5%)	NS	7.92

Table 3: Effect of fertilizer doses and foliar application of NPK on Little millet (*Panicum sumatrense* L.) on Plant height (cm)

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At harvest
T1 - Control	25.20	54.63	61.30
T2 - 100% RDF (40:30:20 kg NPK ha ⁻¹)	38.07	99.60	105.87
T3 - 100% RDF + NPK Foliar spray (19:19:19) once (30 DAS)	38.27	106.87	112.40
T4 - 75% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)	31.40	83.93	90.47
T5-75% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)	31.73	97.10	103.90
T6 -50% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)	29.60	69.73	77.97
T7-50% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)	29.80	82.30	91.27
SEm ($\pm$)	2.14	4.00	4.29
CD (5%)	6.59	12.32	13.22

Table 4: Effect of fertilizer doses and foliar application of NPK of Little millet (*Panicum sumatrense* L.) on dry matter accumulation (g plant⁻¹) at 30, 60 DAS and at harvest

Treatments	Dry matter accumulation (g plant ⁻¹)		
	30 DAS	60 DAS	At harvest
T ₁ - Control	3.46	17.04	19.70
T ₂ - 100% RDF (40:30:20 kg NPK ha ⁻¹)	4.86	35.03	47.09
T ₃ - 100% RDF + NPK Foliar spray (19:19:19) once (30 DAS)	5.16	37.24	50.67
T ₄ - 75% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)	4.16	28.56	36.27
T ₅ - 75% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)	4.53	33.33	45.57
T ₆ -50% RDF + NPK Foliar spray (19:19:19) once at (30 DAS)	3.69	21.89	26.27
T ₇ - 50% RDF + NPK Foliar spray (19:19:19) twice at (30 and 50 DAS)	4.10	26.98	33.16
Sem ($\pm$)	0.20	1.30	1.78
CD (5%)	0.61	3.99	5.50

Table 5: Panicle length (cm), no of grains panicle⁻¹ and test weight of little millet (*Panicum sumatrense* L.) as influenced by fertilizer doses and foliar application of NPK

Treatments	Panicle length (cm)	No. of grains panicle ⁻¹	Test weight (g)
T ₁ - Control	18.18	305.00	2.42
T ₂ - 100% RDF (40:30:20 kg NPK ha ⁻¹)	31.70	516.67	2.65
T ₃ - 100% RDF + NPK Foliar spray (19: 19: 19) once (30 DAS)	35.03	556.67	2.73
T ₄ - 75% RDF + NPK Foliar spray (19: 19: 19) once (30 DAS)	25.75	443.33	2.55
T ₅ - 75% RDF + NPK Foliar spray (19: 19: 19) twice (30 and 50 DAS)	30.82	506.67	2.69
T ₆ - 50% RDF + NPK Foliar spray (19: 19: 19) once (30 DAS)	20.60	360.00	2.46
T ₇ - 50% RDF + NPK Foliar spray (19: 19: 19) twice (30 and 50 DAS)	24.97	425.00	2.51
SEm ($\pm$)	1.40	19.44	0.10
CD	4.32	59.91	NS

Table 6: Grain yield (Kg ha⁻¹), straw yield (Kg ha⁻¹) and harvest index (%) of little millet (*Panicum sumatrense* L.) as influenced by fertilizer doses and foliar application of NPK

Treatments	Grain yield (Kg ha ⁻¹)	Straw yield (Kg ha ⁻¹)	Harvest index (%)
T ₁ - Control	670.00	1606.67	29.39
T ₂ - 100% RDF (40:30:20 kg NPK ha ⁻¹)	1200.00	2550.00	32.12
T ₃ - 100% RDF + NPK Foliar spray (19: 19: 19) once (30 DAS)	1303.33	2632.00	33.09
T ₄ - 75% RDF + NPK Foliar spray (19: 19: 19) once (30 DAS)	1003.33	2176.67	31.55
T ₅ -75% RDF + NPK Foliar spray (19: 19: 19) twice (30 and 50 DAS)	1176.67	2496.67	32.07
T ₆ -50% RDF + NPK Foliar spray (19: 19: 19) once (30 DAS)	805.00	1833.33	30.46
T ₇ -50% RDF + NPK Foliar spray (19: 19: 19) twice (30 and 50 DAS)	976.67	2133.33	31.37
SEm ($\pm$)	54.76	95.73	-----
CD	168.73	294.97	-----

4. Conclusion

The present study demonstrated that different fertilizer doses and foliar application of NPK (19:19:19) significantly influenced the growth and yield of little millet. Among the nutrient management treatments, 100% RDF + one foliar spray of NPK (19:19:19) at 30 DAS (T_3) consistently recorded superior performance with respect to plant height, number of tillers, dry matter accumulation, panicle length, number of grains per panicle, grain yield, and straw yield. The treatment was statistically at par with 100% RDF (T_2) and 75% RDF + two foliar sprays of NPK (19:19:19) at 30 and 50 DAS (T_5) for most of the parameters. Plant population, test weight, and harvest index were not significantly affected by the nutrient management treatments. Overall, the application of 100% RDF supplemented with one foliar spray of NPK (19:19:19) at 30 DAS proved to be the most effective nutrient management practice for improving the growth and productivity of little millet under the agro-climatic conditions of Chhattisgarh.

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