

Original Research Article

Impact of Potassium Fertilization on the Growth and Yield of Small Millets

ABSTRACT

Aims: To evaluate the effects of varying potassium application levels on small millet growth and yield, assess the impact of potassium management on growth parameters and yield attributes, and analyze the economic viability of potassium application in small millet farming.

Study design: Split plot design with three replication.

Place and Duration of Study: Field experiments were conducted during *kharif* 2020 and *kharif* 2021 at the Centre of Excellence in Millets, Athiyandal Thiruvannamalai.

Methodology: In main plot four crops were sown *viz.*, C₁- Proso millet, C₂ - Barnyard millet, C₃ - Kodo millet and C₄-Browntop millet. In sub plot four doses of potassium fertilizer were applied like K₁ - 0, K₂ -10, K₃ - 20 and K₄ - 30 kgs /ha. From each experimental plot, 5 plants were randomly tagged for recording observations on growth *viz.*, plant height (cm), number of tillers/plant; yield attributes *viz.*, number of panicles /plant, 1000 grain weight (g), biomass production/ plant (g) and grain yield (kg/ha). Economics was calculated as per the standard methods formulated by CIMMYT (1988). Growth and yield parameters were observed during different stages of the crops. The statistical analysis of the data was done by the analysis of variance (ANOVA) method.

Results: The results indicated that, Proso millet (C₁) showed a plant height increase from 75.85 to 94.37 cm, number of productive tillers (4.73) with high potassium doses, while Barnyard millet (C₂) reached a maximum height of 119.13 cm, grain yield significantly increased from 1547 kg/ha without potassium to 2055 kg/ha with the highest potassium dose. Barnyard millet (C₂) achieving the highest gross return of Rs 61650/ha and a B: C ratio of 2.20 with the highest potassium dose.

Conclusion: Application of potassium 20 kg/ha, along with the recommended dose of nitrogen and phosphorus, recorded 31.8% higher yield, greater tolerance to lodging, reduced pest and disease incidence and remunerative economics in millet cultivation.

Keywords: *Small millet; Potassium; Economics; Net return; Benefit Cost Ratio*

1. INTRODUCTION

Small millets are vital crops in rainfed semi-arid regions, but their cultivation remains limited compared to other millets, largely due to a shift towards cash crops from traditional varieties [1]. Some small millets, especially wild types, are even considered weeds. Nonetheless, these crops are important locally, flourishing on marginal lands and providing consistent yields, which contributes significantly to food security. Despite their benefits, small millets face several challenges that impede their broader cultivation and adoption [2,3].

A major issue is the inadequate management of nutrients, particularly potassium deficiency in dryland conditions [4]. Potassium is a crucial macronutrient involved in essential physiological processes such as photosynthesis, osmoregulation, and enzyme activation [5,6]. Unfortunately, potassium application is often neglected in rainfed areas, leading to soil depletion and decreased crop yields over time. This nutrient's importance has frequently been underestimated in many regions, including India, resulting in soil potassium depletion and declining crop productivity [7].

Although the role of potassium in crop nutrition is well-recognized, there is limited research on its specific impact on small millet cultivation, especially in rainfed semi-arid

areas. Addressing this research gap is essential for developing sustainable agronomic practices that improve small millet productivity and resilience to environmental stresses. This study aims to evaluate the effects of varying potassium application levels on small millet growth and yield, assess the impact of potassium management on growth parameters and yield attributes, and analyze the economic viability of potassium application in small millet farming.

2. MATERIAL AND METHODS

Field experiments were conducted during *kharif* 2020 and *kharif* 2021 at the Centre of Excellence in Millets, Athiyandal Thiruvannamalai. During the cropping period monthly mean maximum and minimum temperature ranged between 34.4 and 24.9°C. The treatments were laid out in split plot design with three replication. In main plot four crops were sown viz., C₁- Proso millet, C₂ - Barnyard millet, C₃ - Kodo millet and C₄ -Browntop millet. In sub plot four doses of potassium fertilizer were applied like K₁ - 0, K₂ -10, K₃ - 20 and K₄ - 30 kgs /ha. After sowing where seeds failed to germinate, gap filling was done 10 days after sowing. When more than one seedling was present in a hill, which were thinned out to maintain one seedling for proper spacing at 20 days after sowing. From each experimental plot, 5 plants were randomly tagged for recording observations on growth viz., plant height (cm), number of tillers/plant; yield attributes viz., number of panicles /plant, 1000 grain weight (g), biomass production/ plant (g) and grain yield (kg/ha) Economics was calculated as per the standard methods formulated by [8]. For each treatment budget was calculated to determine the expenses incurred and net returns based on the present prices of inputs prevailing in the market during 2020 and 2021 of cropping season to calculate the benefit-cost ratio (BCR). Growth and yield parameters were observed during different stages of the crops. The statistical analysis of the data was done by the analysis of variance (ANOVA) method for split plot design.

3. RESULTS AND DISCUSSION

From the pooled data, various potassium management practices had significant effect on the growth and yield parameters (Table 1 & 2).

Effect of potassium on growth of small millets

The impact of different potassium doses on small millets was assessed across various growth and yield parameters. For growth parameters, plant height and the number of productive tillers were measured. The results indicated that increasing potassium doses generally enhanced plant height and tiller numbers across different millet types. Specifically, Proso millet (C₁) showed a plant height increase from 75.85 cm to 94.37 cm with potassium doses, while Barnyard millet (C₂) reached a maximum height of 119.13 cm. The number of productive tillers also improved with potassium application, with the highest count of 4.73 tillers observed in Proso millet with the highest potassium dose.

Table 1. Role of potassium in growth of various small millets

Treatments	Plant height (cm)					No. of productive tillers				
	C ₁	C ₂	C ₃	C ₄	Mean	C ₁	C ₂	C ₃	C ₄	Mean
K ₀	73.0	109.7	66.6	58.9	77.1	3.2	4.2	6.1	9.4	5.7
K ₁	81.9	113.4	67.3	64.4	81.8	3.6	4.9	6.1	13.8	7.1
K ₂	96.6	125.7	68.9	71.5	90.7	4.7	4.4	6.3	15.6	7.7
K ₃	88.0	118.3	67.2	69.1	85.6	4.0	4.0	6.5	14.1	7.2

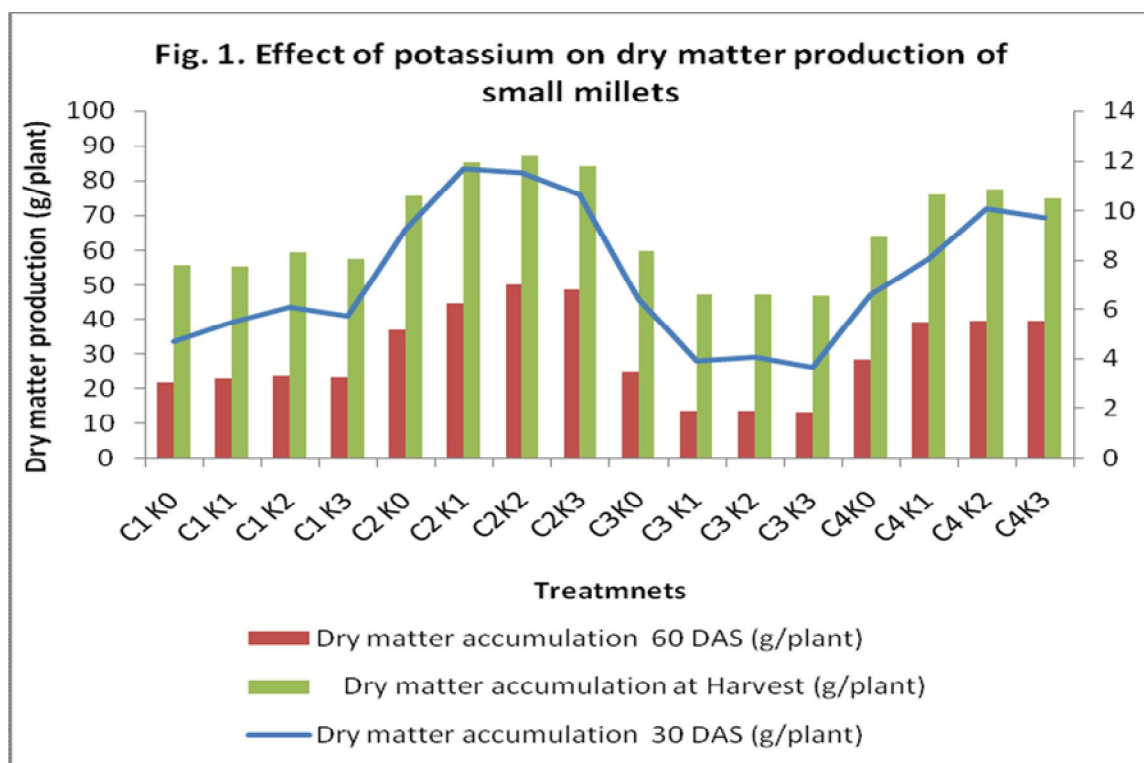
Mean	84.9	116.8	67.5	66.0		3.9	4.4	6.3	13.3	
		C	K	C x K	K x C		C	K	C x K	K x C
S.E.d.		1.58	1.52	3.07	3.04		0.28	0.35	0.66	0.69
CD (p=0.05)		3.86	3.14	6.65	6.28		0.67	0.71	1.41	1.43

Table 2. Role of potassium in yield parameters and yield of various small millets

Treatments	1000 seed weight (g)					Grain yield (t/ha)					Straw yield (kg/ha)				
	C ₁	C ₂	C ₃	C ₄	Mean	C ₁	C ₂	C ₃	C ₄	Mean	C ₁	C ₂	C ₃	C ₄	Mean
K ₀	4.42	5.36	3.21	2.98	3.99	0.99	1.63	1.83	2.27	1.68	1.39	2.50	2.74	3.42	2.51
K ₁	4.64	5.38	4.09	3.57	4.42	1.06	1.80	2.06	2.54	1.87	1.54	2.74	3.07	3.76	2.78
K ₂	4.72	7.27	4.56	3.67	5.05	1.41	2.11	2.26	2.81	2.15	2.09	3.18	3.44	4.21	3.23
K ₃	4.80	6.47	4.33	3.51	4.78	1.19	1.92	2.16	2.65	1.98	1.81	2.95	3.31	4.03	3.03
Mean	4.64	6.12	4.05	3.43		1.16	1.86	2.08	2.57		1.71	2.85	3.13	3.86	
		C	K	C x K	K x C		C	K	C x K	K x C		C	K	C x K	K x C
S.E.d.		0.06	0.06	0.13	0.13		0.04	0.04	0.07	0.07		0.05	0.05	0.09	0.09
CD (p=0.05)		0.15	0.13	0.28	0.27		0.09	0.08	0.16	0.15		0.11	0.09	0.19	0.19

Role of potassium on dry matter production of small millets

Regarding dry matter production (Fig.1), potassium application significantly boosted dry matter accumulation at 30 days after sowing (DAS), 60 DAS, and harvest. For instance, Barnyard millet (C₂) achieved the highest dry matter accumulation at harvest, increasing from 75.43 g/plant without potassium to 86.87 g/plant with 20 kg/ha of potassium. Similarly, Browntop millet (C₄) also showed considerable increases in dry matter across the growth stages with potassium application.



Effect of potassium on yield parameters and yield of small millets

In terms of yield parameters, potassium application had a notable effect on seed weight, grain yield, straw yield, and harvest index (Table 3). For example, the grain yield of Barnyard millet (C_2) increased significantly from 1547 kg/ha without potassium to 2055 kg/ha with the highest potassium dose. The harvest index also improved with potassium application, reaching a maximum of 43.43% for Proso millet (C_1) with 30 kg/ha of potassium. The economic analysis showed a positive impact on gross returns and the benefit-cost ratio, with Barnyard millet (C_2) achieving the highest gross return of Rs 61650/ha and a B: C ratio of 2.20 with the highest potassium dose.

Potassium application improved both growth and yield parameters of small millets, enhancing their productivity and economic viability [9].

Table 3. Role of potassium in harvest index and B:C ratio of various small millets

Treatments	Harvest index					B: C ratio				
	C ₁	C ₂	C ₃	C ₄	Mean	C ₁	C ₂	C ₃	C ₄	Mean
K ₀	41.37	39.40	40.00	39.87	40.16	1.08	1.79	2.01	2.49	1.84
K ₁	40.83	39.63	40.07	40.37	40.23	1.16	1.96	2.24	2.77	2.03
K ₂	40.30	39.83	39.63	40.00	39.94	1.52	2.27	2.44	3.03	2.32
K ₃	39.70	39.37	39.43	39.63	39.53	1.27	2.05	2.31	2.83	2.12
Mean	40.55	39.56	39.78	39.97		1.26	2.02	2.25	2.78	
		C	K	C x K	K x C					
S.E.d.		0.22	0.25	0.49	0.50					
CD (p=0.05)		0.53	0.52	1.04	1.04					

4. CONCLUSION

From the above results, it could be concluded that the application of 20 kgs of potassium per hectare, along with the recommended dose of nitrogen and phosphorus, recorded higher yield and remunerative economics in millets. Yield increased by up to 31.8%, showing significant improvement and greater tolerance to lodging. Additionally, this treatment reduced pest and disease incidence compared to the control. The data indicates that higher potassium levels not only enhance potassium uptake but also contribute to overall plant health and productivity, leading to better economic outcomes for millet cultivation.

REFERENCES

1. Malathi, B, Appaji Chari, Rajender, G, Dattatri, K, and Sudhakar, N. Growth pattern of millets in India. *Indian Journal of Agricultural Research*. 2016; 50(4):382-386. doi: 10.18805/ijare.v50i4.11257.
2. Malleshi, N, and Dayakarrao, B. Creating demand of millets through value addition. In Tonapi VA, Patil JV (eds) *Millets ensuring climate resilience and nutritional security*. Daya Publishing House, New Delhi. 2015; 551-574.
3. Kumar, A, Tomer, V, Kaur, A, Kumar, V, and Gupta, K. Millets: A solution to agrarian and nutritional challenges. *Agriculture and Food Security*. 2018;7(31):13989547. <https://doi.org/10.1186/s40066-018-0183-3>
4. Jyoti Rawat, Pankaj Sanwal, and Jyoti Saxena. Potassium and Its Role in Sustainable Agriculture. In V.S. Meena et al. (eds.). *Potassium Solubilizing Microorganisms for Sustainable Agriculture*. Springer, India 2016;231-253. doi:10.1007/978-81-322-2776-2_17.
5. Hawkesford, M, Horst, W, Kichey, T, Lambers, H, Schjoerring, J, Møller, IS and White, P. Functions of Macronutrients. In P. Marschner (Ed.), *Marschner's Mineral Nutrition of Higher Plants* (3rd ed., pp. 135-189). Pergamon. 2012. <https://doi.org/10.1016/B978-0-12-384905-2.00006-6>
6. Rawat, J, Pandey, N, Saxena, J. Role of Potassium in Plant Photosynthesis, Transport, Growth and Yield. In: Iqbal, N., Umar, S. (eds) *Role of Potassium in Abiotic Stress*. Springer, Singapore. 2022; https://doi.org/10.1007/978-981-16-4461-0_1.
7. Brar, MS, Bijay-Singh, SK. Bansal and Ch. Srinivasarao. Role of Potassium Nutrition in Nitrogen Use Efficiency in Cereals. 2022; e-ifc No. 29 - Research Findings
8. CIMMYT. *An Economic Training Handbook*. Economic Programme, CIMMYT, Mexico. 1988
9. Reddy, ES and Shikha Singh. Effect of spacing and potassium levels on growth and yield of finger millet (*Eleusine coracana* L.), *Asian Journal of Microbiology, Biotechnology and Environmental Sciences*. 2021;23(2):158-162