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Influence of NPK levels on productivity of finger millet + soybean (4:2) intercropping system under *Alfisol*

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Abstract

A field experiment was conducted during *Kharif* 2024 at College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (KSNUAHS), Navile, Shivamogga, Karnataka to study the effect of different NPK fertilizer levels on crop growth, yield and yield attributes under finger millet + soybean (4:2) intercropping system. The experiment was laid out in a Factorial Randomized Complete Block Design with twelve treatment combinations comprising three cropping systems [Finger millet sole crop (CS₁), Soybean sole crop (CS₂), Finger millet + Soybean (4:2) intercropping (CS₃)] and four nutrient management levels [Control (NM₁), 75% RDF (NM₂), 100% RDF (NM₃), 125% RDF (NM₄)] along with recommended dose of FYM with three replications. Grain and straw yield of finger millet was significantly higher (32.43 and 50.83 q ha⁻¹, respectively) in finger millet sole crop with application of 125 percent RDF along with recommended dose FYM compared to other treatments. Higher plant height (91.61 cm) was also observed in the same treatment. Number of tillers per plant, number of ear heads per plant and number fingers per ear head were found to be higher in the treatment receiving 75% RDF with finger millet + soybean (4:2) intercropping.

Keywords: Cropping system, intercropping, nutrient management, finger millet

Introduction

Intercropping, an age-old agricultural practice, has gained renewed importance due to the declining availability of cultivable land caused by rapid urbanization and industrialization. With only 141 million hectares of India's 329 million hectares under cultivation, expanding cultivated land is no longer a viable option. Therefore, optimizing time and space through intercropping is essential for enhancing agricultural productivity. Cereal-legume intercropping, in particular, offers notable advantages over sole cropping due to complementary root systems, differing nutrient needs, and the nitrogen-fixing ability of legumes, which supports the growth of cereals and improves overall soil fertility.

Finger millet (*Eleusine coracana*), a hardy and nutritious cereal crop predominantly grown in Southern India, is well-suited for intercropping systems due to its adaptability to diverse soil types. Soybean (*Glycine max*), an introduced legume known for its high protein and oil content, is widely cultivated in India and valued for its nutritional and economic benefits. Together, Finger millet and Soybean make a complementary intercropping pair. Soybean's nitrogen-fixing capacity supports the nutrient needs of Finger millet, while the combination helps suppress weeds, reduce pests and diseases, and utilize soil moisture and nutrients more efficiently.

This intercropping system not only enhances land use efficiency and yield but also contributes to sustainable farming by reducing dependency on synthetic fertilizers and promoting ecological balance. However, most fertilizer recommendations are based on sole cropping and may not suit intercropping systems, where nutrient competition can vary throughout growth stages. Therefore, it's crucial to assess nutrient interactions between crops and determine appropriate fertilizer schedules tailored to intercropping. The Finger millet + Soybean system holds promise for improving productivity, farm income, and long-term sustainability in Indian agriculture.

Materials and Methods

The field experiment was conducted at the College of Agriculture, Navale, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, under Alfisol of the Southern Transitional Zone. The texture of soil was sandy loam having acidic pH (5.38) with electrical conductivity of 0.113 dS m^{-1} @ 25°C and low organic carbon content (4.5 g kg^{-1}), available nitrogen ($335.96 \text{ kg ha}^{-1}$) and potassium ($251.19 \text{ kg ha}^{-1}$) were medium in range, whereas available phosphorus (75.76 kg ha^{-1}) was high. The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with twelve treatment combinations comprising three cropping systems [Finger millet sole crop (CS_1), Soybean sole crop (CS_2), Finger millet + Soybean (4:2) intercropping (CS_3)] and four nutrient management levels [Control (NM_1), 75% RDF (NM_2), 100% RDF (NM_3), 125% RDF (NM_4)], replicated thrice. Recommended dose of fertilizer (RDF) was $50:40:25 \text{ N:P}_2\text{O}_5:\text{K}_2\text{O kg ha}^{-1}$ for finger millet and finger millet + soybean intercropping, whereas $25:60:25 \text{ N:P}_2\text{O}_5:\text{K}_2\text{O kg ha}^{-1}$ for soybean, along with FYM. Growth, yield and yield attributes of finger millet viz., plant height, number of tillers per plant, number of ear heads per plant, number of fingers per ear head, grain yield, straw yield, test weight and harvest index were recorded in the study. Finger millet equivalent yield as influenced by soybean intercrop and nutrient management was calculated. The experimental results were and the data interpretation was done by factorial RCBD design of analysis of variance. The data collected from the experiment at different growth stages and at harvest were subjected to statistical analysis as described by Gomez and Gomez (1984) [1].

Results

Growth parameters of finger millet

Plant height (cm): Significant variations in finger millet plant height was observed across cropping systems and nutrient management treatments at 60 days after sowing (DAS) and at harvest, while no notable differences were recorded at 30 DAS, with heights ranging from 25.85 to 25.87 cm. At 60 DAS, the intercropping system CS_3 (Finger millet + Soybean intercropping) recorded the higher plant height (64.67 cm), closely followed by finger millet sole crop (CS_1) (63.43 cm). A similar trend continued at harvest, where CS_3 recorded 80.59 cm and CS_1 recorded 79.09 cm. Under nutrient management, plants in control plots (NM_1) had the lower plant height (51.23 cm at 60 DAS and 55.74 cm at harvest), whereas those receiving 125% RDF (NM_4) had higher plant height (69.10 cm at 60 DAS and 89.48 cm at harvest). A significant interaction was observed between cropping systems and nutrient levels. The higher plant height at harvest (91.61 cm) was recorded in CS_3NM_4 , followed closely by CS_3NM_2 (90.55 cm), while the lowest was observed in the control treatment CS_1NM_1 (54.89 cm).

Number of tillers plant⁻¹

Significant differences in the number of tillers per plant of finger millet were observed at 60 DAS and at harvest across cropping systems and nutrient management treatments, but not at 30 DAS. At 60 DAS, CS_3 (Finger millet + Soybean intercropping) recorded the maximum number of tillers (3.33), significantly more than CS_1 (sole crop, 3.05). A similar trend continued at harvest, with CS_3 (3.52) outperforming CS_1 (3.15). Under nutrient management, NM_4 (125% RDF) showed the maximum number of tillers at both 60 DAS (3.63) and harvest (3.80), while NM_1 (control) had the lower number of tillers (2.47 and 2.57, respectively). Interaction effects were significant at 60 DAS and harvest. CS_3NM_2 (75% RDF with intercropping) had the highest tillers at both stages (3.73 and 3.93), on par with CS_1NM_4 , CS_3NM_3 and CS_3NM_4 . The lower number of tillers (2.47) were recorded in CS_3NM_1 (control with intercropping). At 30 DAS, tiller numbers showed no significant variation.

Yield and yield parameters of finger millet

Number of ear heads plant⁻¹

The number of ear heads per plant was significantly influenced by cropping system, nutrient management and their interaction. CS_3 (Finger millet + soybean 4:2) recorded the higher number of ear heads (3.37), significantly higher than CS_1 (sole crop, 3.22). Among nutrient treatments, NM_4 (125% RDF) showed the higher number of ear heads (3.93), followed by NM_3 (3.43) and NM_2 (3.30), while the lower number of ear heads (2.50) was in control (NM_1). Interaction effects revealed the maximum ear heads (4.27) in CS_1NM_4 , statistically on par with CS_3NM_2 (3.73). The minimum (2.47) was observed in CS_3NM_1 (control with intercropping).

Number of fingers ear head⁻¹

The number of fingers per ear head in finger millet was significantly influenced by cropping systems, nutrient management and their interaction. The intercropping system CS_3 (Finger millet + Soybean) recorded a higher number of fingers per ear head (4.78) compared to the sole cropping system, CS_1 (4.61). Among nutrient management treatments, 125% RDF (NM_4) recorded the highest number of fingers (4.98), followed by 75% RDF (NM_2) with 4.80 and 100% RDF (NM_3) with 4.77, all significantly superior to the control (NM_1), which recorded the lowest (4.22). The interaction effect was also significant, with CS_1NM_4 (125% RDF with sole crop) showing the highest number of fingers (5.07), statistically on par with CS_3NM_2 (75% RDF with intercropping) with 5.03 fingers per ear head, followed by CS_3NM_3 (4.93) and CS_3NM_4 (4.90). The lower number of fingers per ear head (4.20) was recorded in CS_1NM_1 , the control treatment under sole cropping.

Table 1: Influence of NPK levels on plant height and number of tillers per plant of finger millet under Finger millet + Soybean (4:2) intercropping system

Treatments	Plant height (cm)			No. of tillers plant ⁻¹		
	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At Harvest
Factor A: Cropping System (CS)						
CS_1	25.85	63.43	79.09	2.20	3.05	3.15
CS_3	25.87	64.67	80.59	2.33	3.33	3.52
SEm±	0.393	0.691	0.479	0.066	0.040	0.084
CD @5%	NS	2.10	1.45	NS	0.12	0.25
Factor B: Nutrient management (NM)						
NM_1	25.20	51.23	55.74	2.03	2.47	2.57
NM_2	26.06	67.75	86.60	2.33	3.27	3.40
NM_3	26.08	68.12	87.53	2.33	3.40	3.57

NM ₄	26.10	69.10	89.48	2.37	3.63	3.80
SEm±	0.554	0.977	0.678	0.093	0.057	0.119
CD @5%	NS	2.96	2.06	NS	0.17	0.36
Interaction (CS×NM)						
CS ₁ NM ₁	25.16	50.23	54.89	2.00	2.60	2.67
CS ₁ NM ₂	25.60	64.63	82.65	2.20	2.80	2.87
CS ₁ NM ₃	26.05	67.27	87.22	2.27	3.13	3.27
CS ₁ NM ₄	26.59	71.59	91.61	2.33	3.67	3.80
CS ₃ NM ₁	25.23	52.23	56.59	2.07	2.33	2.47
CS ₃ NM ₂	26.52	70.86	90.55	2.47	3.73	3.93
CS ₃ NM ₃	26.11	68.97	87.83	2.40	3.67	3.87
CS ₃ NM ₄	25.62	66.62	87.36	2.40	3.60	3.80
SEm±	0.786	1.382	0.959	0.131	0.080	0.168
CD @5%	NS	4.19	2.91	NS	0.24	0.51

Factor A: Cropping System (CS)			Factor B: Nutrient Management (NM)		
CS ₁	:	Finger millet Sole crop	NM ₁	:	Control
CS ₂	:	Soybean Sole crop	NM ₂	:	75% RDF
CS ₃	:	Finger millet + Soybean (4:2) intercropping	NM ₃	:	100% RDF
			NM ₄	:	125% RDF

Test weight (g)

Test weight of finger millet was not significantly affected by cropping systems, nutrient management, or their interaction. Values ranged from 2.72-2.73 g across cropping systems and

2.68-2.75 g across nutrient levels. The interaction effect also showed no significant variation, with test weights ranging from 2.68 to 2.76 g.

Table 2: Influence of NPK levels on number of ear heads per plant, number of fingers per ear head and test weight of finger millet under Finger millet + Soybean (4:2) intercropping system

Treatments	No. of ear heads plant⁻¹	No. of fingers ear head⁻¹	Test weight (g)
Factor A: Cropping System (CS)			
CS ₁	3.22	4.61	2.72
CS ₃	3.37	4.78	2.73
SEm±	0.042	0.046	0.041
CD @5%	0.13	0.14	NS
Factor B: Nutrient management (NM)			
NM ₁	2.50	4.22	2.68
NM ₂	3.30	4.80	2.73
NM ₃	3.43	4.77	2.73
NM ₄	3.93	4.98	2.75
SEm±	0.059	0.066	0.057
CD @5%	0.18	0.20	NS
Interaction (CS×NM)			
CS ₁ NM ₁	2.53	4.20	2.68
CS ₁ NM ₂	2.87	4.57	2.70
CS ₁ NM ₃	3.20	4.60	2.73
CS ₁ NM ₄	4.27	5.07	2.76
CS ₃ NM ₁	2.47	4.23	2.69
CS ₃ NM ₂	3.73	5.03	2.75
CS ₃ NM ₃	3.67	4.93	2.74
CS ₃ NM ₄	3.60	4.90	2.73
SEm±	0.084	0.093	0.081
CD @5%	0.25	0.28	NS

Factor A: Cropping System (CS)			Factor B: Nutrient Management (NM)		
CS ₁	:	Finger millet Sole crop	NM ₁	:	Control
CS ₂	:	Soybean Sole crop	NM ₂	:	75% RDF
CS ₃	:	Finger millet + Soybean (4:2) intercropping	NM ₃	:	100% RDF
			NM ₄	:	125% RDF

Grain yield (q ha⁻¹): Grain yield of finger millet was significantly influenced by cropping systems and nutrient management. The highest yield was in sole cropping (CS₁) with 24.89 q ha⁻¹, followed by intercropping (CS₃) at 22.92 q ha⁻¹. Nutrient-wise, 125% RDF (NM₄) produced the highest yield

(29.30 q ha⁻¹), followed by 100% RDF (NM₃) at 27.99 q ha⁻¹, while the control (NM₁) had the lowest (13.11 q ha⁻¹). Interaction effects showed the maximum yield (32.43 q ha⁻¹) in CS₁NM₄ and the lowest (12.03 q ha⁻¹) in CS₃NM₁, with higher nutrient levels in sole cropping generally yielding better results.

Table 3: Influence of NPK levels on grain yield, straw yield and harvest index of finger millet under Finger millet + Soybean (4:2) intercropping system

Treatments	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest index (%)	FEY (kg ha ⁻¹)
Factor A: Cropping System (CS)				
CS ₁	24.89	40.96	37.28	-
CS ₃	22.92	35.42	39.40	-
SEm±	0.233	0.689	0.725	-
CD @5%	0.71	2.09	NS	-
Factor B: Nutrient management (NM)				
NM ₁	13.11	23.65	36.28	-
NM ₂	25.20	38.93	39.29	-
NM ₃	27.99	43.94	38.96	-
NM ₄	29.30	46.25	38.83	-
SEm±	0.330	0.974	1.044	-
CD @5%	1.00	2.95	NS	-
Interaction (CS×NM)				
CS ₁ NM ₁	14.20	29.02	32.85	-
CS ₁ NM ₂	23.37	37.25	38.57	-
CS ₁ NM ₃	29.54	46.74	38.74	-
CS ₁ NM ₄	32.43	50.83	38.95	-
CS ₃ NM ₁	12.03	18.28	39.70	17.27
CS ₃ NM ₂	27.03	40.60	40.00	38.24
CS ₃ NM ₃	26.44	41.13	39.18	37.71
CS ₃ NM ₄	26.18	41.67	38.71	37.63
SEm±	0.466	1.378	1.450	-
CD @5%	1.41	4.18	NS	-

Factor A: Cropping System (CS)			Factor B: Nutrient Management (NM)		
CS ₁	:	Finger millet Sole crop	NM ₁	:	Control
CS ₂	:	Soybean Sole crop	NM ₂	:	75% RDF
CS ₃	:	Finger millet + Soybean (4:2) intercropping	NM ₃	:	100% RDF
			NM ₄	:	125% RDF

Straw yield (q ha⁻¹)

Straw yield varied notably across cropping systems and nutrient treatments. Finger millet grown as a sole crop (CS₁) produced the highest straw yield of 40.96 q ha⁻¹, outperforming the finger millet + soybean intercropping system (CS₃), which yielded 35.42 q ha⁻¹. Nutrient management significantly influenced these results, with the highest yields recorded under 125% RDF (NM₄) at 46.25 q ha⁻¹, closely followed by 100% RDF (NM₃) at 43.94 q ha⁻¹, while control plots (NM₁) yielded considerably less (23.65 q ha⁻¹). The interaction of cropping system and nutrient level was also significant: the combination of sole cropping with 125% RDF (CS₁NM₄) delivered the greatest straw yield at 50.83 q ha⁻¹, whereas the control intercropping treatment (CS₃NM₁) resulted in the lowest yield of 18.28 q ha⁻¹. This highlights how nutrient application and cropping choice together drive biomass production.

Harvest index (%)

Harvest index was not significantly affected by cropping systems or nutrient management. The highest harvest index (39.40%) was observed in finger millet + soybean intercropping (CS₃), followed by finger millet sole crop (CS₁) at 37.28%. Nutrient-wise, 75% RDF (NM₂) recorded the highest value (39.29%), while the control (NM₁) had the lowest (36.28%). The interaction effect was also non-significant, with the highest harvest index (40.00%) in CS₃NM₂ and the lowest (32.85%) in CS₁NM₁.

Finger millet equivalent yield

Among intercropping systems, higher amount of finger millet equivalent yield (38.24 q ha⁻¹) was observed in CS₃NM₂ (Finger millet + soybean intercropping + 75% RDF) followed by

CS₃NM₃ (Finger millet + soybean intercropping + 100% RDF) (37.71 q ha⁻¹), CS₃NM₄ (Finger millet + soybean intercropping + 125% RDF) (37.63 q ha⁻¹) and the least (17.27 q ha⁻¹) was observed in CS₃NM₁ (Finger millet + soybean intercropping + control) (Table 3).

Discussion**Growth parameters of finger millet**

Plant height of finger millet increased significantly with higher NPK application, especially under 125% RDF (NM₄) at 60 DAS and harvest (Table 1). This growth response is linked to adequate nutrient absorption, particularly nitrogen, phosphorus, and potassium, which enhance vegetative development (Krishna *et al.*, 2020) [3]. The intercropping system (CS₃) produced slightly taller plants than sole cropping at later stages, likely due to improved microclimate and nutrient mobilization by soybean roots (More, 1990) [4]. Similarly, the number of tillers per plant increased with nutrient levels, with NM₄ showing the highest values at 60 DAS and harvest. Nitrogen's role in tiller initiation and survival through enhanced leaf area and photosynthate supply is crucial (Siddeshwaran *et al.*, 1987) [8]. CS₃ intercropping recorded more tillers, likely from better root activity and nitrogen fixation by soybean (Shankaralingappa and Rajashekhara, 1992) [6]. Interaction effects suggest moderate to high nutrient levels under proper cropping improve tillering.

Yield parameters of finger millet

Number of ear heads per plant significantly increased with higher nutrient levels, with 125% RDF (NM₄) showing the highest values, followed by 100% RDF (NM₃) (Table 2). Intercropping finger millet with soybean (CS₃) also improved ear head numbers compared to sole cropping, likely due to

enhanced phosphorus availability from legumes (More, 1990) ^[4]. The combination of sole finger millet with 125% RDF (CS₁NM₄) produced the maximum ear heads, indicating that sole cropping can fully utilize nutrient inputs. Similarly, the number of fingers per ear head increased significantly with nutrient supply, peaking at NM₄ (125% RDF). Intercropping recorded more fingers per ear head than sole cropping, possibly due to nitrogen fixation and phosphorus mobilization by soybean roots (Singh and Arya, 1999) ^[9]. The highest values were seen in CS₁NM₄ and CS₃NM₂, showing both sole and intercropped finger millet respond well to improved nutrition.

Test weight remained stable across cropping and nutrient treatments, ranging from 2.68 to 2.75 g, indicating genetic control over grain size (More, 1990) ^[4]. Grain and straw yields were highest in sole finger millet with 125% RDF (CS₁NM₄), highlighting the importance of adequate nutrient supply for maximizing yield (Singh and Arya, 1999; Thorat *et al.*, 1990) ^[9]. Intercropping yielded slightly less grain but contributed to overall system productivity due to soybean. Harvest index was unaffected by treatments, while finger millet equivalent yield favoured intercropping with moderate nutrient levels due to better resource use and soybean market value (Jena *et al.*, 2002; Ramamoorthy *et al.*, 2003) ^[2, 5].

Conclusion

Intercropping of finger millet + soybean (4:2 row proportion) proved highly compatible under *Alfisols* and recorded significantly higher growth parameters, yield attributes and system productivity compared to sole cropping. Finger millet sole crop with 125% RDF recorded significantly higher grain and straw yield. However, the highest finger millet equivalent yield was obtained in CS₃NM₂ (Finger millet + Soybean (4:2) + 75% RDF), closely followed by CS₃NM₃ (Finger millet + Soybean (4:2) + 100% RDF). The increase in system productivity under intercropping was mainly due to the complementary effects of soybean in enhancing soil nitrogen and phosphorus availability, resulting in improved finger millet performance.

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References

1. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2nd ed. New York: John Wiley; 1984. p. 693.
2. Jena BK, Patro H, Panda SC. Intercropping in finger millet. *Environ Ecol*. 2002;18(2):463-464.
3. Krishna KV, Deepthi CH, Reddy MD, Raju PS, Pal A. Effect of nitrogen and phosphorus levels on growth and yield of finger millet [*Eleusine coracana* (L.)] during summer. *Indian J Agric Res*. 2020;54(2):227-231.
4. More VG. Study of intercropping of some oilseed and pulse crop in Kharif finger millet under high rainfall condition of Konkan [MSc thesis]. Dapoli (MH): B.S.K.K.V.; 1990.
5. Ramamoorthy K, Christopher LA, Radhamani S, Sankaran N, Thiyagarajan TM. Effect of strip cropping and intercropping of legumes on productivity and economics of rainfed finger millet. *Crop Res*. 2003;26(3):519-521.
6. Shankaralingappa BC, Hegde BR. Intercropping studies in finger millet with pigeon pea and field bean. *Mysore J Agric Sci*. 1992;26:248-253.
7. Shankaralingappa BG, Rajashekara BG. Intercropping of legume in finger millet [*Eleusine coracana*] genotype. *Farming Syst*. 1992;8(1-2):24-29.
8. Siddeshwaran KC, Ramasamy, Morachan YB. Light interception and dry matter production under finger millet-based cropping system. *Madras Agric J*. 1987;74(8-9):413-417.
9. Singh RV, Arya MPS. Nitrogen requirement of finger millet + pulse intercropping system. *Indian J Agron*. 1999;44(1-3):47-50.
10. Thorat ST, Sonune SP, Chavan SA. Intercropping of some pulse and oil crop in finger millet. *J Mah Agric Univ*. 1990;11(2):268-271.