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Effect of groundnut-based millet intercropping systems on growth and productivity of groundnut

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Abstract

A field experiment was conducted during *kharif* 2024 at S.V. Agricultural College, Tirupati, to evaluate the effect of groundnut-based millets intercropping systems on the growth and yield of groundnut. Ten treatments, including sole and intercropping systems with foxtail, finger, and little millets in 5:2 and 5:4 row ratios, were assessed using a randomized block design. Growth parameters such as plant height (52.0 cm), leaf area index (6.5), and dry matter (4638 kg ha^{-1}) were significantly higher in the sole crop of groundnut. Results of the experiment indicated that higher groundnut pod and haulm yields were recorded in the sole crop of groundnut (2295 kg ha^{-1} and 3016 kg ha^{-1}, respectively). Among the intercropping treatments, significantly higher pod and haulm yield (1976 kg ha^{-1} and 2689 kg ha^{-1}, respectively), total number of pods $plant^{-1}$ (22.1), number of filled pods $plant^{-1}$ (16.3), 100-pod weight (110g), kernel weight (69 g) were recorded in groundnut + finger millet in the row proportion of 5:2. Intercropping with millets at a 5:2 ratio showed better compatibility and resource utilization. The study concluded that groundnut + finger millet (5:2) is the most effective system for maximizing yield under sandy loam soils in the Southern Agro-Climatic Zone of Andhra Pradesh.

Keywords: Groundnut, intercropping, millets, row proportion, yield optimisation

Introduction

Groundnut (*Arachis hypogaea* L.) is a major oilseed crop originally native to South America. Commonly referred to as the King of Oilseeds, Poor Man's Almond and Wonder Nut, it holds significant global importance. It ranks 13th among food crops and 6th among oilseed crops worldwide and is widely cultivated across the globe due to its versatility and high demand. India leads the world in groundnut cultivation area, covering approximately 47.07 lakh hectares. It is also the second largest producer globally, with an annual production of 101.8 lakh tonnes and a productivity of 2,163 kg ha^{-1} (*www.indiastat.com*, 2023-24). In Andhra Pradesh, groundnut is cultivated on about 3.11 lakh hectares, yielding around 3.2 lakh tonnes annually, with a productivity of 660 kg ha^{-1} (*www.indiastat.com*, 2023-24). Intercropping is recognized as an effective strategy to adapt to unpredictable climatic variations. The effectiveness of intercropping is influenced by various factors such as seed ratios, planting arrangements,

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choice of crop varieties and the degree of competition between the component crops (Carr *et al*., 2004). It seeks to maximize overall productivity per unit area by ensuring the efficient and balanced utilization of land, labor, and other agricultural inputs. Groundnut, being a low-growing and spreading legume, offers greater scope for intercropping with erect and fast-growing millet crops which differ in canopy structure, rooting pattern and nutrient demand. Such complementary growth habits help in better utilization of available resources such as light, moisture and nutrients under rainfed conditions. Small millets are well known for their drought tolerance and short duration, making them suitable intercrops in groundnut based production systems of semi arid regions. The row proportions of 5:2 and 5:4 were selected to maintain an optimum population of the main crop (groundnut) while accommodating intercrops in an additive series, thereby enabling evaluation of competition and compatibility effects between component crops. The present investigation attempts to identify the most suitable millet intercrop and optimum row proportion for improving the growth and yield of groundnut under rainfed loamy sand conditions.

Materials and Methods

A field experiment was conducted at S. V. Agricultural College Dryland farm, Tirupati campus of Acharya N. G. Ranga Agricultural University, during *kharif*, 2024. It is geographically situated at 13.5°N latitude and 79.5°E longitude, with an altitude of 182.9 m above the mean sea level (MSL) in the Southern Agro-Climatic Zone of Andhra Pradesh. The soil of the experimental site was sandy loam with soil pH (6.72), organic carbon (0.28 %). The Recommended dose of 20 kg N, 40 kg P_2O_5 and 50 kg K_2O ha^{-1} was applied through urea, single super phosphate and muriate of potash respectively for groundnut, 20 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1} for millets. For groundnut 50 per cent of recommended dose of nitrogen, entire dose of phosphorous and potassium was applied as basal at the time of sowing and the remaining half of the nitrogen was top dressed at 30 DAS. The experiment was laid out in randomized block design and each treatment replicated thrice. The crop received rainfall of 590.8 mm in 30 rainy days from sowing to harvest. The mean maximum and minimum temperature were 34.1°C and 22.5°C, respectively during the crop growth period. The treatments included in the experiment were Sole crop of groundnut, Groundnut + littlemillet (5:2), Groundnut + foxtail millet (5:2), Groundnut + finger millet (5:2), Groundnut + little millet (5:4), Groundnut + foxtail millet (5:4), Groundnut + finger millet (5:4). The varieties tested in this experiment were groundnut (Dharani), foxtail millet (SiA-3159), finger millet (Vakula) and little millet (BL-6) in 5:2 and 5:4 row proportion. Groundnut were sown at 30 cm × 10 cm and millets were sown at 22.5 cm × 10 cm. The gross plot size was 5.4 m × 4.0 m, while the net plot size was 4.2 m × 3.6 m. Each crop was provided with its recommended dose of fertilizers according to the area it occupied, and appropriate plant protection measures were implemented as required.

Five plants were selected at randomly from each net plot area and labeled with tags for recording growth and yield parameters at 25, 50, 75, 90 DAS and at harvest. As intercrop took 90 days to harvest all the observations were recorded at 25, 50, 75 DAS and at harvest. For recording leaf area index and dry matter production, destructive sampling was done by taking five successive plants each time in the second row from the borders thus avoiding the border effect. The data was statistically analysed by following the method of analysis of variance suggested by Panse and Sukhatme (1985). Critical difference (CD) values were worked out at 5% level of significance, wherever the treatment differences were significant. Treatment differences that are nonsignificant were denoted as NS.

Results and Discussion

Effect of different intercropping systems on growth attributes of groundnut

Several growth parameters of groundnut such as plant height, leaf area index and dry matter production varied significantly in different sole and intercropping systems. Data presented in Table 1 revealed that, significantly higher plant height (52.0 cm), leaf area index (6.50) and dry matter production (4638 kg ha^{-1}) were recorded in sole crop of groundnut at different growth stages. This might be due to better availability and efficient utilization of growth resources such as light, moisture and nutrients in the absence of interspecific competition. Under sole cropping, groundnut plants experienced intraspecific competition which was comparatively less severe than competition from intercrops. Improved radiation interception and moisture availability might have further favoured vegetative growth and biomass accumulation. Consequently, favourable growth conditions under sole cropping resulted in enhanced plant growth and dry matter production which was followed by groundnut + finger millet (5:2) which was on par with groundnut + foxtail millet 5:2 ratio and groundnut + little millet 5:2 ratio while the lowest values were noticed in groundnut + little millet (5:4). This could be due to the smothering effect and strong competitive ability of little millet for essential resources such as light, moisture and nutrients. Intense interspecific competition under this intercropping system resulted in restricted vegetative growth and poor biomass accumulation of groundnut. Consequently, the growth performance of groundnut was adversely affected in this treatment. These results were in conformity with findings of Maitra *et al.* (2000); Nigade *et al.* (2012); Manjunath and Salakinkop (2017); Shwethanjali *et al*. (2018); Lenka *et al*. (2023) and Praharsha *et al*. (2020).

Effect of different intercropping systems on intercropping indices

The Land Equivalent Ratio (LER), Area Time Equivalent Ratio (ATER), Relative Crowding Coefficient (RCC) and Groundnut Pod Equivalent Yield (GPEY) were highest in the intercropping system of groundnut + finger millet (5:2) because the yield advantages observed under intercropping systems may be attributed to differential utilization of growth resources by the component crops, resulting in improved efficiency and higher productivity per unit area compared to sole cropping. Mutualistic and complementary interactions between the intercrops further enhanced equivalent ratio values and yields, leading to higher area time equivalent ratio (ATER), which indicates efficient use of both land and time. Moreover, the relative crowding coefficient (RCC) values greater than unity across all intercropping treatments clearly signify the yield benefits of integrating intercrops with groundnut which was closely followed by groundnut + finger millet (5:4). The lowest values were observed in the intercropping system of groundnut + little millet (5:2). Variations in groundnut pod equivalent yield was due to differences in crop yields and market prices (Table 2). The present findings align with those reported by Lenka *et al*. (2023); Sukanya *et al*. (2024) and Triveni (2016).

Effect of different intercropping systems on yield attributes and yield of groundnut

Among the various treatments evaluated, yield attributing characters including total number of pods per plant, number of filled pods per plant, 100-pod weight, kernel weight and shelling percentage were assessed. The sole crop of groundnut recorded the highest total number of pods plant^{-1} (24.1) and number of filled pods plant^{-1} (18.0), followed by groundnut + finger millet (5:2), while the lowest values were observed in groundnut + little millet (5:4). Similarly, the sole crop of groundnut exhibited the highest 100-pod

Table 1. Growth parameters of groundnut as influenced by groundnut based millets intercropping system

Treatment	Plant height (cm)	Leaf area index	Dry matter production (kg ha^{-1})
Sole crop of groundnut	52.0	6.50	4638
Groundnut + little millet (5:2)	45.2	5.71	3870
Groundnut + foxtail millet (5:2)	46.0	5.83	4003
Groundnut + finger millet (5:2)	46.5	5.92	4149
Groundnut + little millet (5:4)	33.0	4.53	2710
Groundnut + foxtail millet (5:4)	39.5	5.11	3278
Groundnut + finger millet (5:4)	40.0	5.17	3412
SEm ±	1.49	0.16	140.7
CD (P=0.05)	4.6	0.5	433

Table 2. Land equivalent ratio, Area time equivalent ratio, Groundnut pod equivalent yield and Relative crowding coefficient as influenced by different groundnut based intercropping systems

Treatment	LER	ATER	GPEY	RCC
Sole crop of groundnut	1.00	1.00	2295	-
Groundnut + little millet (5:2)	1.12	1.07	2154	2.10
Groundnut + foxtail millet (5:2)	1.24	1.18	2293	2.57
Groundnut + finger millet (5:2)	1.54	1.47	2906	3.10
Groundnut + little millet (5:4)	1.27	1.20	1739	2.61
Groundnut + foxtail millet (5:4)	1.45	1.36	2132	2.81
Groundnut + finger millet (5:4)	1.52	1.38	2747	2.95
SEm ±	0.03	0.04	69.21	0.10
CD (P=0.05)	0.1	0.1	213.2	0.3

weight (115g) and kernel weight (70.7g) (Fig. 1), with the lowest values recorded in groundnut + little millet (5:2). Higher values recorded under sole crop of groundnut may be attributed to the competition-free environment, which facilitated efficient utilization of growth resources such as light and nutrients. Improved radiation interception and balanced nutrient uptake might have enhanced enzymatic and stomatal activities, thereby promoting effective synthesis and translocation of photosynthates from source to sink. Greater availability and efficient use of resources under sole cropping could have resulted in better sugar transport, protein and starch synthesis, ultimately leading to improved pod filling and kernel development. Consequently, enhanced production and translocation of assimilates contributed to superior yield attributes of groundnut in the sole cropping system. No significant differences were observed in shelling percentage across the treatments (Table 3).

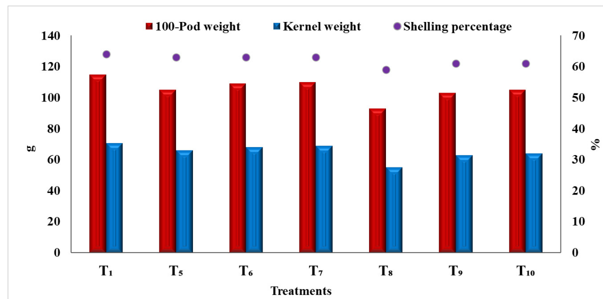

Fig. 1. 100-pod weight (g), kernel weight (g) and shelling percentage of groundnut at harvest as influenced by different groundnut based intercropping systems.

Significantly higher groundnut pod yield (2295 kg ha^{-1}) and haulm yield (3016 kg ha^{-1}) were recorded in sole crop of groundnut may be attributed to optimum plant population and reduced competition for growth resources compared to intercropping systems. Better availability and efficient utilization of light, moisture and nutrients might have improved growth parameters such as plant height, leaf area index and dry matter production, which in turn enhanced yield attributes including number of pods, filled pods, pod weight and kernel weight. Enhanced vegetative growth under favourable conditions could

Table 3. Yield and yield attributes of groundnut as influenced by groundnut based millets intercropping system

Treatment	Total no of pods $plant^{-1}$	No of filled pods $plant^{-1}$	100-Pod weight (g)	Kernel weight (g)	Shelling percentage	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
Sole crop of groundnut	24.1	18.0	115	70.7	64	2295	3016
Groundnut + little millet (5:2)	19.7	14.2	105	66.0	63	1819	2376
Groundnut + foxtail millet (5:2)	20.8	15.4	109	68.0	63	1927	2510
Groundnut + finger millet (5:2)	22.1	16.3	110	69.0	63	1976	2689
Groundnut + little millet (5:4)	13.0	10.4	93	55.0	59	1061	1405
Groundnut + foxtail millet (5:4)	16.4	12.1	103	63.0	61	1370	1879
Groundnut + finger millet (5:4)	17.7	12.6	105	64.0	61	1480	2018
SEm ±	0.60	0.43	2.9	2.03	2.0	97.4	102.4
CD (P=0.05)	1.9	1.3	9.0	6.2	NS	300	316

have further contributed to increased biomass accumulation and haulm yield. Consequently, superior growth and yield performance under sole cropping resulted in higher overall productivity of groundnut which was followed by groundnut + finger millet (5:2) which was on par with groundnut + foxtail millet 5:2 ratio and groundnut + little millet 5:2 ratio while the lowest values were noticed in groundnut + little millet (5:4). Similar results were found by Ramamoorthy *et al*. (2002), Dutta *et al*. (2006), Berhanu *et al.* (2016) and Lenka *et al*. (2023).

Conclusion

The present study revealed that intercropping of groundnut + finger millet at 5:2 row ratio is the best combination for getting higher yield followed by groundnut + foxtail millet under same row ratio during *kharif* season on loamy sand soils of the Southern Agro-Climatic Zone of Andhra Pradesh.

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