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Performance of legumes as intercrop in turmeric (*Curcuma longa* L.)

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Abstract
A field experiment conducted at Horticulture Research and Extension Centre, Hidkal Dam, Tq. Hukkeri, Dist. Belagavi during *kharif* 2023-24 to study the effect of intercrops on growth and yield of turmeric in intercropping system. The experiment consists of 13 treatments, 3 replications laid out in RCBD design. Results revealed that plant height, number of leaves and number of tillers per plant were found maximum in sole turmeric (T_9) which was on par with turmeric + cluster bean at 2:1 ratio (T_3). Higher dried rhizome yield was found in sole turmeric which was on par with turmeric + cluster bean at 3:1 ratio. Finally, it was concluded that intercropping of short duration vegetables at early stage didn't affect growth and yield of turmeric rather than gives extra income through intercrops.

Keywords: Growth, yield, intercropping system

Introduction

Turmeric, scientifically known as *Curcuma longa* L., is a prized spice native to India and often called "Indian saffron." It is a member of the Zingiberaceae family and is commonly referred to as Haldi in Indian culture. Species diversity plays a crucial role in shaping ecosystem productivity, stability, invisibility and nutrient dynamics (Patil *et al*., 2021) [8]. In agroecosystems, crop diversification can be achieved through crop rotations and spatially, through methods such as cover crops, crop mixtures, agroforestry and intercropping. Intercropping is one of these key strategies for enhancing crop diversification in agroecosystems. Turmeric is a long duration crop (9 months). The initial growth phase of turmeric is rather slow and takes about 4-5 months to cover the interspace. Therefore, the available space between the rows of turmeric could be effectively utilized by growing some short duration crops like annual spices, vegetables, cereals *etc*. with an objective to study the growth and yield of turmeric in intercropping system.

Materials and Methods

The investigation was carried out during *kharif* season 2023-24 at Horticulture Research and Extension Centre, Hidkal Dam (University of Horticultural Sciences, Bagalkot), Tq. Hukkeri, Dist. Belagavi, Karnataka. Both turmeric and intercrops grown in the month of July-2023. The experiment consists of 13 treatments with 3 replications laid out in RCBD. The treatment details were T_1: Turmeric + Dolichos bean (long pod type) (2:1), T_2: Turmeric + French bean (2:1), T_3: Turmeric + Cluster bean (2:1), T_4: Turmeric + Dolichos bean (flat pod type) (2:1), T_5: Turmeric + Dolichos bean (long pod type) (3:1), T_6: Turmeric + French bean (3:1), T_7: Turmeric + Cluster bean (3:1),T_8: Turmeric + Dolichos bean (flat pod type) (3:1), T_9: Sole turmeric, T_{10}: Sole dolichos bean (long pod type), T_{11}: Sole french bean, T_{12}: Sole cluster bean and T_{13}: Sole dolichos bean (flat pod type). The observations like plant height, number of leaves per plant, number of tillers per plant recorded at different stages of crop growth (45, 90, 135 and 180 DAP, respectively) recorded. Harvesting of intercrops done three to four times when they came to harvest, turmeric was harvested in the month of April-2024, fresh rhizome yield and dried rhizome yield were recorded.

Results and Discussion

Growth

Vegetables intercropped with turmeric at different row proportions influenced plant height of turmeric at all the stages of crop growth. At 45 DAP, highest plant height of 53.00 cm observed in sole turmeric (T_9) which was on par with turmeric + cluster bean in 2:1 ratio (T_3), turmeric + French bean in 2:1 ratio (T_2) and turmeric + cluster bean in 3:1 ratio (T_7). While, the minimum plant height of 40.57 cm observed in intercropping of turmeric with flat type dolichos bean in the ratio of 3:1 (T_8).

Similarly at 90,135 and 180 DAP, maximum plant height (78.53, 86.87 and 101.33 cm, respectively) was recorded in sole turmeric (T_9) followed by T_3 (turmeric +cluster bean in 2:1 ratio) and T_2 (turmeric +French bean in 2:1 ratio). While minimum plant height (54.40, 64.30 and 79.00 cm at 90, 135 and 180 DAP, respectively) recorded in intercropping of turmeric with flat pod type dolichos bean in the ratio of 3:1 (T_8) as recorded in table 1.

The number of leaves per plant varied among different intercropping systems. The highest number of leaves per plant (6.97) observed in sole turmeric (T_9) at 45 DAP which was on par with T_3 (turmeric +cluster bean in 2:1 ratio), T_2 (turmeric +French bean in 2:1 ratio) and T_7 (turmeric +cluster bean in 3:1 ratio). The lowest number of leaves (3.83) recorded in turmeric intercropped with flat pod type dolichos bean in a 3:1 ratio (T_8).

At 90, 135 and 180 DAP, maximum number of leaves per plant (9.62, 15.82 and 16.57, respectively) recorded under sole turmeric (T_9) followed by T_3 (turmeric +cluster bean in 2:1 ratio) and T_2 (turmeric +french bean in 2:1 ratio). While the minimum number of leaves per plant (6.25, 10.22 and 11.14, respectively) recorded when turmeric was intercropped with flat type dolichos bean in a 3:1 ratio (T_8) as showed in table 2.

The number of tillers per plant recorded during different growth stages (45, 90, 135 and 180 DAP) of turmeric, varied among companion planting. At 45 DAP, maximum number of tillers per plant (2.19) was noted in sole turmeric (T_9) which was on with T_3 (turmeric + cluster bean in 2:1 ratio), T_2 (turmeric + french bean in 2:1 ratio), T_7 (turmeric + cluster bean in 3:1 ratio) and T_6 (turmeric + french bean in 3:1 ratio). Conversely, the fewest tillers (0.90) observed in the intercropping of turmeric with flat type dolichos bean at a 3:1 ratio (T_8).

At 90, 135 and 180 DAP, the maximum number of tillers (3.88, 4.56 and 4.97) documented in sole turmeric (T_9) followed by T_3 (turmeric +cluster bean in 2:1 ratio) and T_2 (turmeric +french bean in 2:1 ratio). At 180 DAP, T_3 (turmeric +cluster bean in 2:1 ratio) and T_2 (turmeric +french bean in 2:1 ratio) were on par with sole turmeric (T_9). In contrast, the fewest tillers (1.67, 2.47 and 2.93, respectively at 90, 135 and 180 DAP) recorded in the intercropping of turmeric with flat pod type dolichos bean at a 3:1 ratio (T_8) as observed in table 3.

Vegetables likely caused turmeric plants to grow taller in search of adequate sunlight, with variations in height resulting from differing shade conditions. The lowest plant height is likely due to competition for growth resources. Different intercropping systems resulted in less number of leaves per plant compared to sole turmeric, indicating a reduction in the crop's photosynthetic area. Variations in tiller numbers may be influenced by the nutrient concentrations of different vegetables and the microclimatic conditions created by the intercrops.

Yield

Intercropping of turmeric with vegetables influenced fresh rhizome yield (per plant, per plot and per hectare) in turmeric. The sole cropping of turmeric(T_9) had higher fresh rhizome yield of 510.34 g/plant which was on par with T_7 (turmeric + cluster bean at 3:1 ratio) of 452.84 g/plant, 142.23 kg/plot and 25.42 t/ha which was on par with intercropping of turmeric with cluster bean in ratio of 3:1 (T_7) of 24.81 t/ha and T_6 (turmeric + French bean at 3:1 ratio). The lowest fresh rhizome yield of turmeric (189.27 g/plant, 53.76 kg/plot and 19.11 t/ha) recorded under intercropping of turmeric with flat type dolichos bean in the ratio of 2:1 (T_4) as observed in table 4.

Intercropping of turmeric with cluster bean at 3:1 ratio recorded higher dried rhizome yield (per plant, per plot and per hectare) in turmeric. The sole cropping of turmeric(T_9) had higher dried rhizome yield of 127.59 g/plant which was on par with T_7(turmeric + cluster bean at 3:1 ratio), 35.56 kg/plot and 5.49 t/ha which was on par with intercropping of turmeric with cluster bean in ratio of 3:1 (T_7) of 5.34 t/ha, T_6(turmeric+ french bean at 3:1 ratio) and T_5 (turmeric+ long type dolichos bean at 3:1 ratio). The lowest fresh rhizome yield of turmeric recorded under intercropping of turmeric with flat type dolichos bean in the ratio of 2:1 (T_4) by 47.32 g/plant, 13.44 kg/plot and 3.51 t/ha. The dry recovery percentage didn't show significant variation.

This outcome is attributed to the higher plant population per unit area, more number of tillers, primary and secondary rhizomes, efficient use of sunlight, water and nutrients. In contrast, the lowest yields were recorded with the flat-type dolichos bean at 2:1 ratio, due to lower plant population and increased competition between crops. These results are consistent with findings by Sidhu *et al*. (2016) [9] for turmeric interplanted with green gram, Chitra and Hemalatha (2017) [2] for turmeric combined with cowpea, as well as Singh (2010), Devkota (2022) [3] in ginger and maize, Mehta *et al*. (2015) [5] in garlic + onion or carrot, Asangi *et al*. (2023) [1] in ajwain with coriander, Shuqin *et al*., 2023 [10] in ginger with maize.

Table 1: Influence of intercrops on plant height of turmeric at various stages of crop growth

Treatments	Plant height (cm)			
	45 DAP	90 DAP	135 DAP	180 DAP
T_1: Turmeric + Dolichos bean (long pod type) (2:1)	44.50	66.67	76.47	85.67
T_2: Turmeric + French bean (2:1)	48.37	70.00	81.67	95.10
T_3: Turmeric + Cluster bean (2:1)	51.40	73.97	83.50	98.33
T_4: Turmeric + Dolichos bean (flat pod type) (2:1)	43.33	63.40	72.33	82.67
T_5: Turmeric + Dolichos bean (long pod type) (3:1)	42.67	56.00	70.37	80.97
T_6: Turmeric + French bean (3:1)	45.53	65.67	78.33	89.67
T_7: Turmeric + Cluster bean (3:1)	47.67	69.67	80.27	91.33
T_8: Turmeric + Dolichos bean (flat pod type) (3:1)	40.57	54.40	64.30	79.00
T_9: Sole turmeric	53.00	78.53	86.87	101.33
Mean	46.34	66.48	77.12	89.34
S.Em±	2.16	4.65	4.27	4.84
C.D. @ 5%	6.47	13.95	12.79	14.51
CV (%)	8.06	12.12	9.59	9.38

Table 2: Influence of intercrops on the number of leaves per plant of turmeric at various stages of crop growth

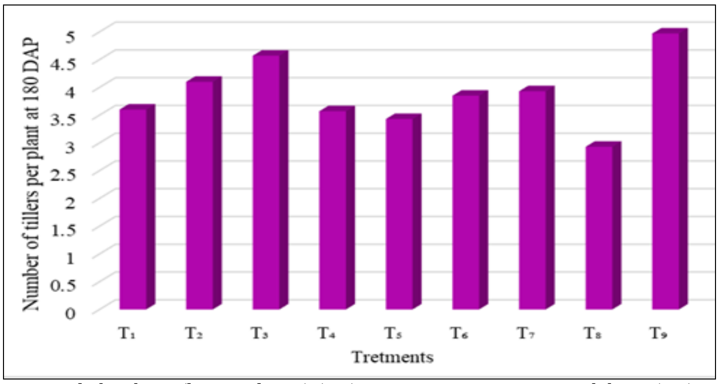
Treatments	Number of leaves/plant			
	45 DAP	90 DAP	135 DAP	180 DAP
T_1: Turmeric + Dolichos bean (long pod type) (2:1)	5.27	7.80	11.27	12.74
T_2: Turmeric + French bean (2:1)	6.30	8.79	13.88	14.39
T_3: Turmeric + Cluster bean (2:1)	6.87	9.23	14.55	15.38
T_4: Turmeric + Dolichos bean (flat pod type) (2:1)	4.77	7.30	10.58	11.21
T_5: Turmeric + Dolichos bean (long pod type) (3:1)	4.43	6.38	10.41	11.19
T_6: Turmeric + French bean (3:1)	5.77	8.12	12.06	13.82
T_7: Turmeric + Cluster bean (3:1)	6.17	8.57	13.51	14.09
T_8: Turmeric + Dolichos bean (flat pod type) (3:1)	3.83	6.25	10.22	11.14
T_9: Sole turmeric	6.97	9.62	15.82	16.57
Mean	5.59	8.01	12.48	13.39
S.Em±	0.39	0.52	1.18	0.78
C.D. @ 5%	1.18	1.56	3.55	2.34
CV (%)	12.14	11.28	16.42	10.08

Table 3: Influence of intercrops on fresh rhizome yield of turmeric

Treatments	Fresh rhizome yield		
	g/plant	kg/plot	t/ha
T_1: Turmeric + Dolichos bean (long pod type) (2:1)	199.40	53.95	19.17
T_2: Turmeric + French bean (2:1)	243.20	85.70	21.11
T_3: Turmeric + Cluster bean (2:1)	295.50	90.91	21.23
T_4: Turmeric + Dolichos bean (flat pod type) (2:1)	189.27	53.76	19.11
T_5: Turmeric + Dolichos bean (long pod type) (3:1)	227.96	64.69	20.58
T_6: Turmeric + French bean (3:1)	312.58	98.56	23.17
T_7: Turmeric + Cluster bean (3:1)	452.84	105.63	24.81
T_8: Turmeric + Dolichos bean (flat pod type) (3:1)	226.66	62.64	20.21
T_9: Sole turmeric	510.34	142.23	25.42
Mean	295.31	84.23	21.65
S.Em±	20.31	6.42	1.38
C.D. @ 5%	60.91	19.25	4.15
CV (%)	11.92	13.20	11.08

Table 4: Influence of intercrops on dried rhizome yield of turmeric

Treatments	Dried rhizome yield			
	g/plant	kg/plot	t/ha	Dry recovery (%)
T_1: Turmeric + Dolichos bean (long pod type) (2:1)	49.85	13.49	3.88	20.24
T_2: Turmeric + French bean (2:1)	60.80	21.43	4.13	19.56
T_3: Turmeric + Cluster bean (2:1)	73.88	22.73	4.41	20.77
T_4: Turmeric + Dolichos bean (flat pod type) (2:1)	47.32	13.44	3.51	18.37
T_5: Turmeric + Dolichos bean (long pod type) (3:1)	56.99	16.17	4.98	24.19
T_6: Turmeric + French bean (3:1)	78.15	24.64	5.32	22.96
T_7: Turmeric + Cluster bean (3:1)	113.21	26.41	5.34	21.52
T_8: Turmeric + Dolichos bean (flat pod type) (3:1)	56.67	15.66	4.41	21.82
T_9: Sole turmeric	127.59	35.56	5.49	21.59
Mean	73.83	21.06	4.61	21.23
S.Em±	5.08	1.61	0.34	2.36
C. D. @ 5%	15.28	4.81	0.92	NS
CV (%)	11.92	13.20	11.50	7.08



T_1: Turmeric+ Dolichos bean (long pod type) (2:1)
T_2: Turmeric + French bean (2:1)
T_3: Turmeric + Cluster bean (2:1)
T_4: Turmeric + Dolichos bean (flat pod type) (2:1)
T_5: Turmeric + Dolichos bean (long pod type) (3:1)
T_6: Turmeric + French bean (3:1)
T_7: Turmeric + Cluster bean (3:1)
T_8: Turmeric + Dolichos bean (flat pod type) (3:1)
T_9: Sole turmeric

Fig 1: Effect of intercropping system on number of tillers per plant at 180 DAP

Conclusion

From this study, we concluded that intercropping cluster bean or French bean with turmeric at a 3+1 planting ratio results in higher overall yields compared to sole cropping of turmeric. This combination not only enhances the productivity of the land but also contributes to better resource utilization, as the legumes fix nitrogen in the soil, improving soil fertility for turmeric. Additionally, the intercropping system helps in efficient use of space, as the legumes provide a complementary growth pattern, reducing competition for sunlight. Overall, this intercropping system proves to be a more sustainable and profitable approach than growing turmeric alone.

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