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Effect of nutrients on performance of turmeric [*Curcuma longa* (L.)] under Karanj (*Pongamia pinnata*) based agroforestry system

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Abstract

A field experiment was conducted at Herbal garden of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during 2019-20 to assess the most efficient nutrients for cultivation of turmeric under Karanj based agroforestry system. It was laid out in a randomized block design with eight treatments and three replications were carried out on the field, the treatments were divided into T1 (100 % inorganic), T2 (75 % inorganic), T3 (50 % inorganic), T4 (75% inorganic + 25 % FYM), T5 (50 % inorganic + 50 % FYM), T6 (25 % inorganic + 75 % FYM), T7 (100 % FYM) and T8 (control zero fertilizer). The analyzed results showed that the 100% Farm Yard Manure (FYM) (T7) gave higher growth parameter viz. plant height, number of tillers and number of leave plant $^{-1}$ fallowed by T6 (25 % inorganic + 75 % FYM), T5 (50 % inorganic + 50 % FYM), T4 (75% inorganic + 25 % FYM), T1 (100 % inorganic), T2 (75 % inorganic), T3 (50 % inorganic), T8 (control zero fertilizer) respectively. Simultaneously the tree growth (Tree height and Diameter at breast height) showed non-significant result.

Keywords: Growth attributes turmeric, karanj and agro forestry system

Introduction

Agroforestry is a collective name for land- use system and technologies where woody perennials (tree, shrubs, bamboos etc.) are deliberately used on the same land management units as agricultural crops and/ or animals, in some form of spatial arrangement or temporal sequence. Agroforestry system is cultivation of tree species and agricultural crops, is an ancient and still widespread practice throughout the world. It encompasses a variety of land use practices and system. In agro forestry systems, woody and herbaceous perennials are deliberately grown on land that also supports agricultural crops or animals. The mixture of these components, in the form of spatial arrangement or temporal sequence, enhances ecological stability and production sustainability. This integration allows the components to complement one another in their use of resources and in the timing of that use. Perennials have deeper roots and higher canopies than those of annuals, allowing better management of above and below ground resources. Agroforestry systems have the potential to improve production and to enhance the agronomic and ecological sustainability of resource-poor farmers in the humid tropics. Thus, a wide range of agro forestry systems has been designed to alleviate agronomic, ecological, or managerial constraints. Turmeric (*Curcuma longa* (L.)) is a herbaceous flowering and shade loving plant of Zingeraceae family, the tubers of turmeric is used in cooking. The plant is rhizomatous, herbaceous, and perennial, and is native to the Indian subcontinent and Southeast Asia, and requires temperatures between 20 and 30 °C (68 and 86 °F) and a considerable amount of annual rainfall to thrive. Plants are gathered each year for their rhizomes, some for propagation in the following season and some for consumption. Turmeric is rich in arsenic, calcium, magnesium and vitamin A nutrients. Turmeric is a horticultural root crop that is not only important as a spice and cosmetic, but also as a medicinal plant worldwide (Ishimine *et al.,* 2003). Turmeric, a big, long-lasting crop (8-9 months), reacts well to nutrition. Karanj (*Pongamia pinnata)* is a fast growing deciduous tree up to 20 meters tall that is believed, originated in India and is found in Asia. It is a deciduous tree that grows over in India height of about 15-20 meters with a large canopy that spreads equally wide. The leaves are a soft, shiny burgundy in early summer and mature to a glossy, deep green as the season progresses. Small clusters of white, purple, and pink flowers blossom on their branches through the year, maturing into brown seed pots. The tree is well suited to intense heat and

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sunlight and dense network of lateral roots and its thick, long taproot make it drought tolerant.

Materials and Methods

The present investigation on"Effect of nutrients on performance of turmeric [*Curcuma longa* (L.)] under Karanj (*Pongamia pinnata*) based Agroforestry System" was carried out during session of 2019-20 at the Herbal Garden of Indira Gandhi Krishi Vishwavidyalaya, Raipur(C.G.) to assess the most efficient nutrients for cultivation of turmeric under Karanj based agroforestry system. The experiment was conducted during the month of Jun 2019 to march 2020. For this, the suitable experimental design was laid out on Randomize Block Design (RBD), wherein 8 Treatments and 3 Replications were carried out on the field, the treatments were divided into T1 (100 % inorganic), T2 (75 % inorganic), T3 (50 % inorganic), T4 (75% inorganic + 25 % FYM), T5 (50 % inorganic + 50 % FYM), T6 **(**25 % inorganic + 75 % FYM), T7 (100 % FYM) and T8 (control zero fertilizer). The turmeric crop was harvested manually in 24th of March 2020 when crop attained maturity stage *i.e.* the stem and leaves of crop get turn yellowing, withering and drying of standing crop. The light irrigation was given 4-5 days before the harvesting of turmeric crop. Harvesting was done by using a pick-axe, so that the plant could be removed with full root system. After removing the whole plant the rhizome were cleaned by removing stem residues and roots and they were washed thoroughly in water to remove the soil partials each plots. The observations were made in turmeric crop and Karanj plantation along with microclimatic featured. Data was collected from ten randomly selected plants per plots to represent the crop of each plot.

Results and Discussion

Plant height

The plant height were observed maximum in T_7 (100% FYM) at 30, 60, 90, 120 and 150 days after planting and found significant variation among the treatments of integrated nutrient management (Table 1). The plant height for various level of nutrient at 30, 60, 90, 120 and 150 days after planting was reported in the range of 23.00-31.00, 34.33-44.00, 64.67-74.67, 67.67-85.33, 61.00-76.67 respectively. Height of turmeric plants highest in 100% FYM as compare to control zero fertilizer. This may be due to turmeric was shade loving plant then the height was increased in shade and in AFS higher nutrient available in soil due to Karanj crop. Plant height was found to be positively correlated to soil moisture content in a significant manner. Similar results, Singh *et al.* (2004) studied the maximum height of plants (102.40 cm) of ginger crop was under dense shade more than 90 percent of *Cajanus cajan*, Tabin *et al.* (2015) studied that the height of plants was maximum in 40.71cm under 70 per cent crown cutting of orange tree.

Table 1: Effect of integrated nutrient management on plant height (cm) of turmeric under Karanj based agro forestry system

Treatments	Plant height (cm)				
	30 Days	60 Days	90 Days	120 Days	150 Days
T_1	25.33	37.00	67.33	71.00	66.33
T_2	25.00	35.00	65.00	69.67	64.67
T_3	23.33	35.00	65.00	68.33	63.00
T_4	25.67	37.00	67.67	72.00	67.00
T_5	27.00	37.33	69.67	77.00	69.67
T_6	27.33	38.67	69.67	77.33	70.00
T_7	31.00	44.00	74.67	85.33	76.67
T_8	23.00	34.33	64.67	67.67	61.00
SEm±	0.70	0.92	0.78	0.83	0.87
CD(P=0.05)	2.12	2.80	2.38	2.53	2.65

Number of tillers per plant

The tillers per plant were counted at 30, 60, 90, 120 and 150 DAP got analyzed. The statistical data was given in the table 2. At 30 DAP maximum number of tillers per plant observed in T_7 100 % FYM (3.33) and it was followed by T_6 25 % Inorganic + 75 % FYM (2.67), T_5 50 % Inorganic + 50 % FYM (2.67) whereas, minimum number of tillers per plant was recorded in T_8 (1.00). At 60 DAP maximum number of tillers per plant observed in T_7 100 % FYM (3.67) and it was followed by T_6 25 % Inorganic + 75 % FYM (2.67), T_5 50 % Inorganic + 50 % FYM (2.33), whereas, minimum number of tillers per plant was recorded in T_8 (1.67). Number of tillers per plant at 90 DAP was significantly maximum recorded in T_7 100 % FYM (3.67) followed by T_6 25 % Inorganic + 75 % FYM (2.67), T_5 50 % Inorganic + 50 % FYM (2.33), while the minimum number of tillers per plant was registered in T_8 (1.67). At 120 DAP, maximum number of tillers per plant recorded in T_7 100 % FYM (3.67) and it was followed by T_6 25 % Inorganic + 75 % FYM (2.67), T_5 50 % Inorganic + 50 % FYM (2.33) whereas, the minimum number of tillers per plant was recorded in T_8 (1.67). The maximum number of tillers per plant at 150 DAP was observed in T_7 100 % FYM (2.67) which was followed by T_6 25 % Inorganic + 75 % FYM (1.67), T_5 50 % Inorganic + 50 % FYM (1.67), simultaneously minimum number of tillers per plant was recorded in T_8 (1.00). Amin *et al.* (2010) studied the positive impact of shade on numbers of tillers per plant, Kandiannan *et al.* (1999) who recorded insignificant variation in No. of tiller bed^{-1} when ginger crop are grown pure and with maize (Table 2).

Number of leaves plant^{-1}

Data on number of leaves per plant were given in (Table 3), which was taken at 30, 60, 90, 120 and

Table 2: Effect of integrated nutrient management on number of tillers of turmeric under Karanj based agroforestry system.

Treatments	Number of tillers/plant				
	30 Days	60Days	90 Days	120 Days	150 Days
T_1	1.67	2.33	2.33	2.33	1.67
T_2	1.33	2.33	2.33	2.33	1.67
T_3	1.33	2.00	2.00	2.00	1.67
T_4	2.33	2.33	2.33	2.33	1.67
T_5	2.67	2.33	2.33	2.33	1.67
T_6	2.67	2.67	2.67	2.67	1.67
T_7	3.33	3.67	3.67	3.67	2.67
T_8	1.00	1.67	1.67	1.67	1.00
SEm±	0.32	0.33	0.33	0.33	0.31
CD(P=0.05)	0.97	1.00	1.00	1.00	NS

150 DAP. At 30 DAP maximum number of leaves per plant observed in T_7 100 % FYM (10.67) and it was followed by T_6 25 % Inorganic + 75 % FYM (10.00), T_5 50 % Inorganic + 50 % FYM (8.00), whereas, minimum number of leaves per plant was recorded in T_8 (4.67). At 60 DAP maximum number of leaves per plant observed in T_7 100 % FYM (18.00) and it was followed by T_6 25 % Inorganic + 75 % FYM (17.67), T_5 50 % Inorganic + 50 % FYM (15.67), whereas, minimum number of leaves per plant was recorded in T_8 (11.00). Number of leaves per plant at 90 DAP was significantly maximum recorded in T_7 100 % FYM (26.67), followed by T_6 25 % Inorganic + 75 % FYM (24.67), T_5 50 % Inorganic + 50 % FYM (23.00), while the minimum number of leaves per plant was registered in T_8 (17.33). At 120 DAP, maximum number of leaves per plant recorded in T_7 100 % FYM (26.67) and it was followed by T_6 25 % Inorganic + 75 % FYM (22.67), whereas, the minimum number of leaves per plant was recorded in T_8 (15.67). The maximum number of leaves per plant at 150 DAP was observed in T_7 100 % FYM (19.00) which was followed by T_6 25 % Inorganic + 75 % FYM (17.33), T_5 50 % Inorganic + 50 % FYM (17.33), simultaneously minimum number of leaves per plant was recorded in T_8 (9.00). Similar result also reported in Sanwal *et al.* (2006) studied that the ginger with cowpea produced more leaves number plant^{-1} (97.17) which was at par with ginger pure crop (96.73) and ginger with french bean (96.10) and Choudhary *et al.* (2015) studied that the alder tree had statistically significant beneficial impact on leaves number tiller^{-1} (15.10) as compared to pure crop of ginger (12.60).

Table 3: Effect of integrated nutrient management on number of leaves plant^{-1} of turmeric under Karanj based agroforestry system

Treatments	Number of leaves/plant				
	30 Days	60Days	90 Days	120 Days	150 Days
T_1	6.33	13.67	22.00	20.67	15.33
T_2	5.33	12.33	20.00	18.00	12.67
T_3	5.33	12.00	19.67	17.67	12.00
T_4	7.67	15.00	22.67	22.00	16.00
T_5	8.00	15.67	23.00	22.67	17.33
T_6	10.00	17.67	24.67	24.00	17.33
T_7	10.67	18.00	26.67	26.67	19.00
T_8	4.67	11.00	17.33	15.67	9.00
SEm±	0.46	0.50	0.68	0.61	0.76
CD(P=0.05)	1.38	1.52	2.07	1.86	2.31

Mother rhizome length

The effect of nutrients on mother rhizome length of turmeric was recorded after harvesting which sown in (Table 4). The effect of integrated nutrient management systems was found significant statistically. The mother length was recorded maximum 6.17 cm in T_7 100 % FYM followed by T_6 25 % Inorganic + 75 % FYM (5.83cm), T_5 50 % Inorganic + 50 % FYM (5.17cm) and minimum 4.00 cm in T_8 i.e. control zero fertilizer. Mother rhizome length was higher in 100% FYM as compare to control zero fertilizer. Mother rhizome width was higher in Karanj based agroforestry system it might be due to turmeric crop was shade loving crop and presence of tree canopy in agroforestry than increase mother rhizome width.

Number of fingers rhizomes^{-1} per plant^{-1}

The effect of integrated nutrient management systems was found significant statistically for the number of fingers / rhizome per plant and it was recorded maximum 4.67 in T_7 100 % FYM followed

Table 4: Effect of integrated nutrient management on length of rhizome (cm), Number of fingers plant^{-1}, Mother Rhizome length plant^{-1} (cm) and Width of Rhizome (cm) of turmeric under Karanj based agroforestry system

Treatments	Length of Rhizome(cm)	No. of fingers plant^{-1}	Mother Rhizome length plant^{-1}	Width of Rhizome
T_1	4.67	3.67	4.67	6.00
T_2	4.00	2.67	4.33	5.33
T_3	3.67	2.33	4.17	5.17
T_4	5.50	4.00	5.00	6.83
T_5	6.33	4.33	5.17	7.17
T_6	7.20	4.33	5.83	7.83
T_7	8.50	4.67	6.17	8.67
T_8	3.50	2.33	4.00	4.67
SEm±	0.49	0.39	0.41	0.49
CD(P=0.05)	1.49	1.20	1.25	1.50

by T_6 25 % Inorganic + 75 % FYM (4.33), T_5 50 % Inorganic + 50 % FYM (4.33) and minimum 2.33 in T_8 i.e. Control zero fertilizer. (Table 4).

Length of rhizome

The effect of integrated nutrient management systems growth of Rhizome was found statistically significant. The length of rhizome was recorded maximum 8.50 cm in T_7 100 % FYM followed by T_6 25 % Inorganic + 75 % FYM (7.20cm), T_5 50 % Inorganic + 50 % FYM (6.33cm) and minimum in T_8 i.e. 3.50 cm (Table 4).

Width of rhizome

The effect of integrated nutrient management systems was found to statistically significant for the growth in width of rhizome and it was found maximum 8.67 cm in T_7 100% FYM followed by T_6 25 % Inorganic + 75 % FYM (7.83cm), T_5 50 % Inorganic + 50 % FYM (7.17cm) and minimum 4.67 cm in T_8 i.e. control zero fertilizer (Table 4).

Tree growth parameters

Tree growth characteristics *viz.* tree height (m), and diameter at breast height (cm) were recorded before sowing of turmeric crop *i.e.* 2019 June and after the harvest of turmeric crop *i.e.* March 2020 and data are presented in table 4.

Height (m)

The effect of integrated nutrient management on growth of tree height (*Pongamia pinnata*) during intercropping, data with respect to tree height is presented in (Table 5). The results revealed that there is no significant growth on tree height during intercropping period. The results showed that there was a minor difference in height in the tree after the harvest of intercrops because 09 month period did not showed much in height of the tree.

DBH (cm)

Table 5: Effect of integrated nutrient management on tree height (m) and tree DBH (cm) of Karanj in agroforestry system

Treatments	Tree height (m)		Tree DBH (cm)	
	Before sowing turmeric crop	After harvesting turmeric crop	Before sowing turmeric crop	After harvesting turmeric crop
T_1	6.4	6.6	14.1	15.3
T_2	7.4	7.5	15.0	16.1
T_3	5.8	6.0	13.0	13.9
T_4	7.1	7.3	14.3	15.5
T_5	6.7	7.0	13.7	15.1
T_6	7.4	7.7	15.2	16.9
T_7	7.0	7.3	13.3	15.1
T_8	6.9	6.9	12.4	13.2
SEm±	0.76	0.77	1.36	1.34
CD(P=0.05)	NS	NS	NS	NS

The effect of nutrient management on growth of tree DBH (*Pongamia pinnata*) during intercropping, data with respect to tree height is presented in (Table 5). The results revealed that there is no significant growth on tree DBH during intercropping period. The results showed that there was a minor difference in DBH in the tree after the harvest of intercrops because 09 month period did not showed much in DBH of the tree. Results on character morphology of C. Pentandra, before ginger crop sowing and after crop harvesting showed a non signification influence. Slight increase was therefore observed in DBH (15.32 cm) before sowing and 15.33 cm after crop harvesting. Whereas, there was no recorded difference in tree height (7.95m) before and after seedling. Therefore, the result of the present study was in confirmatory with Prajapati *et al.*, (2007).

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