Response of spacing and row proportions of Turmeric + Okra intercropping system of Odisha in India

ABSTRACT

Farmers of Kandhamal district of Odisha are cultivating turmeric as sole crop where interspace are not properly utilised. Therefore**,** One experiment was conducted at RRTTS, G.Udayagiri, Kandhamal, Odisha to study the response of spacing and row proportions on growth and yield attributes of okra in turmeric + okra intercropping System during 2022-23 *kharif*. T_{1} - Sole turmeric at 30x 20 cm (Recommended), T_{2}- Sole Oka 45x20 cm (Recommended**),**T_{3}- Okra + Turmeric (1:1), T_{4}- Okra + turmeric (1:2), T_{5}- Okra + turmeric (1:3),T_{6}- Okra + turmeric (1:4),T_{7}- Okra + turmeric (2:1),T_{8}- Okra + turmeric (2:2), T_{9}- Okra + turmeric (2:3), T_{10}- Okra + turmeric (2:4). Sole crop of turmeric fresh rhizome (119.2 q ha^{-1})and okra fresh fruit (72.8 q ha^{-1}) produced the highest yield when compared with other intercropping systems. Turmeric + Okra Intercropping system(1:4) spacing and row proportion in T6 registered highest turmeric rhizome equivalent yield 149.9q ha^{-1}over other intercropping system and B: C ration of 2.17 where as in sole crop of B: C ratio -1.43.

Key Words: Intercropping, Turmeric, Equivalent yield**.**

Introduction

"Turmeric is an important cash crop for thousands of tribal farmers in the Kandhamal district of Odisha. The southern districtis generally clogged with hills and forests and is blessed with appropriate agro-climatic conditions for turmeric cultivation. People familiar with the crop and its economic importance report that around 50,000 farmers were growing turmeric without applying chemical fertilizers or pesticides on approximately 25,000 hectares, and give a yield of more than 26,000 metric tonnes of dry turmeric per year" (Mohanty, 2021). "Turmeric of Kandhamal contains 2-3per cent curcumin, 12.15 per cent oleoresin, and 5.3 per cent volatile oil (Project report KASAM), the highest among other varieties. It has a powerful aroma and higher medicinal value ,making it popular in domestic and international markets. As per the report of the Trade Promotion Council of India (TPCI) 2019, India is the largest producer and exporter of turmeric" (Pushp,2019). "Odisha accounts for about 21 per cent of India's turmeric area, and more than half of this is in Kandhamal. The 'KandhamalHaldi' got Geographical Indication" (GI)tag (Behera, 2019). "The primary source of income for tribal farmers in Kandhamal is the turmeric crop. Tribal farmers are socio-economically and educationally backward compared to non-tribal farmers" (Chetri*et al*., 2020). "Turmeric is typically grown in uplands, hill slopes, and even hilltops where shifting cultivation (PODU) is practiced; however, some farmers continue to rely on traditional methods" (Sharma, 2013). "But

farmers need to test and improve their Indigenous technical knowledge with modern technologies to increase the yield". (Babu et al., 2013) "Farmers have always been forced to sell the harvest at a minimum price. As a result, most districtfarmers sell turmeric at Rs. 30-35 per kg. This price is half of the market rate. The state government-run cooperative agency , Kandhamal Apex Spices Association for Marketing (KASAM), promotes turmeric cultivation in the district, which offers Rs. 60per kg. This price is the least assured price fixed by the district administration. However, KASAM is buying little, so all the farmers are not benefited". [20]Global food demand is rising rapidly and so more in developing countries specially in South Asia where arable lands and resources barely produce adequate crops needed to meet demand for food (McLaughlin and Kinzelbach 2015). Sustainable crop intensification is crucial to feed the entire population through efficient mitigation of possible adverse impacts on soil and environment. In this context several innovative and efficient technologies need to be adopted for increasing food production by alleviating land use efficiency (Timmusk*et al*. 2017) . "It is a long duration crop and the initial growth 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 short duration crops like, vegetables, cereals etc. Hence, it is worthwhile to explore the possibilities of growing compatible crops with turmeric. With this background, this research project was formulated to find out the best compatible intercrop with turmeric, to study the effect of intercrops on growth and yield of turmeric and to determine the economic feasibility of turmeric based intercropping. Intercropping could increase 25% yield as compared to monoculture, and ensure several additional services, such as enhance nutrient use efficiency and grain quality in food systems" (Jensen *et al.* 2015; Bedoussac*et al*. 2015). "Intercropping also ensures efficient utilization of their resources to maximize crop production and family income" (Islam *et al*. 2012). "Turmeric is a very popular tropical and subtropical rhizomatous species widely cultivated in Asia including Bangladesh" (Islam *et al*. 2018). "It is a long duration wide-spaced crop that remains under the field for about 270-300 days. However, the adoption of long-duration turmeric crop challenged farmers with short duration vegetable crop like okra in the region. Turmeric is a shade tolerant crop and grows well under partial shade" (Haque and Hossain 1985; Joyachandran*et al*. 1991). "It takes 60 to 70 days to 100% emergence after planting of rhizome" (Islam *et al.* 2018). The relevant literature on turmeric + okra intercropping practice for crop intensification still scarce thus, this experiment has been undertaken to evaluate the turmeric + okra intercropping system for optimum crop density, yield advantage, and profitability using intercropping indices. So, farmers can easily grow another crop like okra as an intercrop with turmeric at the early growth stage (130 days).

Materials and Methods

One experiment was conducted at RRTTS, G.Udayagiri, Kandhamal, Odisha to study the performance of cropping system to find out suitable row proportions of turmeric and okra during 2022-23*kharif*.

Experimental Design: RBD Replication : Three Treatments: 10. The experiment was conducted in medium land site. The soil is sandy loam in texture, pH 5.39, low available P_2O_5 , organic carbon-5.4g kg^{-1}, and available K_2O is 160kg ha^{-1}. Observations on growth and yield parameters were recorded in each replication and the mean obtained were used for statistical analysis (Panse and Sukhatme, 1985).

Treatments :

T_1 - Sole turmeric at 30x 20 cm (Recommended)

T_2- Sole Okra 45x20 cm (Recommended)

T_3- Okra + turmeric (1:1), T_4- Okra + turmeric (1:2)

T_5- Okra + turmeric (1:3), T_6- Okra + turmeric (1:4)

T_7- Okra + turmeric (2:1), T_8- Okra + turmeric (2:2)

T_9- Okra + turmeric (2:3),
T_{10}- Okra + turmeric (2:4)

Recommended Ecosystem – Rain fed Upland

Results and Discussion

Growth and yield parameters and the pooled data arepresented in Tables 1 , 2 and 3. The morphologicalcharacters of turmeric were found significantly influenced by various intercrops. The turmeric as purecrop recorded significantly higher values for plant height(63.5 cm), number of , dry matter 30.5q ha^{-1},number of rhizome $Plant^{-1}$-28.2, weight of mother rhizome(g $plant^{-1}$)-93.1, weight of primary rhizome/plant-72.3, weight of secondary rhizome $plant^{-1}$-405.1, and fresh rhizome yield of 119.2q ha^{-1} . The okra as pure crop recorded plant height-41.12cm,dry matter-27.0q ha^{-1},no.of branches $plant^{-1}$-1.4, no . of fruits $plant^{-1}$-11.16,size of

okra fruit plant^{-1}-12.34cm, and weight of okra fruit plant^{-1} were 73.12g . The okra:turmeric(1:4) in T6 crop recordedsignificantly values for turmeric plant height(58.8 cm), , dry matter 26.6q ha^{-1},number of rhizome plant^{-1}-26.4, weight of mother rhizome(g plant^{-1})-92.6, weight of primary rhizome plant^{-1}-65.2, weight of secondary rhizome plant^{-1}-318.8, fresh rhizome yield of 114.2q ha^{-1} and fresh rhizome equivalent yield is 149q ha$^{-1,}$, whereas for okra plant height of-38.23cm,dry matter-16.8q ha^{-1}, number of branchesplant^{-1}-2.1, no. of fruit plant^{-1}-8.58, size of okra fruit plant^{-1}-7.71cm, weight of okra fruit plant^{-1}48.34g and B: ratio of 2.17. . Islam *et al*. (2016) indicated that higher biomass production and consequently more efficient useof land and available resources under intercropping than under sole cropping contributed to the higher turmericyield. Similar results were obtained by Kumar *et al.* (2018) in ginger. Paraye*etal.* (2014) reported that ginger equivalent yield and netreturn was higher in ginger (Raigarh local) + turmeric(Sudershana) in 1:1 row ratio intercropping system.

In this experiment, the treatments containing both turmeric and intercrop were found to be economicallyfeasible than the treatment with turmeric as pure crop.Among the different intercropping systems, T6 (turmeric+ okra) recorded maximum gross returns (Rs. 480050ha^{-1}), net returns (Rs. 233050 ha-1) and B:C ratio (2.17). Similar results were obtained by Kumar and Reddy (2000), Biswajit*et al*.(2023) in turmeric.

Table1.Response of spacing and row proportions on growth and yield attributes of okra in turmeric + okra Intercropping System ((Pooled over 2021-22 &2022-23).

Treatments	Plant height (cm)	Dry matter (q ha^{-1})	Number of Branches $Plant^{-1}$	Number of Fruits $Plant^{-1}$	Size of Okra Fruits $Plant^{-1}$	Weight of okra fruits $plant^{-1}$(g)
T_1	-	-	-	-	-	
T_2	41.12	27.0	1.4	11.16	12.34	73.12
T_3	48.12	32.4	2.1	12.13	13.23	75.64
T_4	44.10	22.4	1.8	10.45	11.98	69.19
T_5	39.34	18.2	2.3	8.82	8.01	52.22
T_6	38.23	16.8	2.1	8.58	7.71	48.34
T_7	49.23	34.0	2.3	14.21	14.67	79.12
T_8	46.45	30.4	1.9	11.34	12.87	72.54
T_9	42.17	20.4.	1.6	9.78	9.67	59.23
T_{10}	40.16	19.1	1.5	9.21	8.52	56.65
SEm (±)	NS	2.12	.0.14	1.0	0.62	4.02
CD(0.05)	NS	4.42	0.30	2.08	1.3	8.4

T_{1} - Sole turmeric at 30x 20 cm (Recommended), T_2- Sole Oka 45x20 cm (Recommended),

T_{3}- Okra + Turmeric (1:1), T_4- Okra + turmeric (1:2), T_5- Okra + turmeric (1:3),

T_6- Okra + turmeric (1:4),T_7- Okra + turmeric (2:1),T_8- Okra + turmeric (2:2), T_9- Okra + turmeric (2:3),

T_{10}- Okra + turmeric (2:4)

Table 2. Response of spacing and row proportions on growth and yield attributes of turmeric in Turmeric + Okra Intercropping system

Treatments	Plant height (cm)	Dry matter (q ha^{-1})	Number of Rhizome $Plant^{-1}$	Weight of Mother Rhizome (g $plant^{-1}$)	Weight of Primary Rhizome (g $plant^{-1}$)	Weight of Secondary Rhizome (g $plant^{-1}$)
T_1	**63.5**	**30.5**	**28.2**	**93.1**	**72.3**	**405.1**
T_2	-	-	-	-	-	-
T_3	50.5	12.4	21.3	63.5	38.8	209.2
T_4	53.4	22.2	22.6	82,6	40.8	245.7
T_5	56.2	24.3	24.5	89.4	51.6	322.7
T_6	58.8	26.6	26.4	92.6	65.2	381.8
T_7	49.5	10.9	20.4	43.3	35.2	191.6
T_8	41.3	17.8	21.8	73.1	38.8	216.4
T_9	44.6	23.7	23.7	87.4	44.3	272.7
T_{10}	42.1	20.6	22.1	77.6	39.5	225.7
SEm (±)	1.2	1.3	1.05	9.5	26.1	23.1
CD(0.05)	2.6	2.8	2.2	19.81	54.1	48.2

T_1 - Sole turmeric at 30x 20 cm (Recommended), T_2- Sole Okra 45x20 cm (Recommended),T_3- Okra + Turmeric (1:1),

T_4- Okra + turmeric (1:2), T_5- Okra + turmeric (1:3),T_6- Okra + turmeric (1:4),T_7- Okra + turmeric (2:1),

T_8- Okra + turmeric (2:2), T_9- Okra + turmeric (2:3), T_{10}- Okra + turmeric (2:4)

Table3. Response of spacing and row proportions on economics in Turmeric + Okra Intercropping system under North Eastern Ghat Zone of Odisha

Treatments	Turmeric Fresh Rhizome (qha^{-1})	Fresh Fruit Okra yield (qha^{-1})	Turmeric (Fresh Rhizome) Equivalent Yield ($q\ ha^{-1}$)	Gross Return ($Rs\ ha^{-1}$)	Net return ($Rs\ ha^{-1}$)	B:C Ratio
T_1	119.2			401200	126200	1.43
T_2		72.8		145600	83600	1.36
T_3	84.8	60.0	135.7	416800	172050	1.87
T_4	94.5	52.4	138.0	435550	188550	1.91
T_5	102.8	42.7	142.2	445200	198200	1.97
T_6	114.3	40.0	149.9	480050	233050	2.17
T_7	81.6	63..6	144.6	412800	165800	1.68
T_8	87.5	56.4	139.1	419050	169340	1.78
T_9	96.3	49.2	140.9	435450	188450	1.97
T_{10}	91.6	44.7	130.8	410000	163000	1.51
SEm (±)	1.04	2.54	2.46	7345	3549	0.04
CD(0.05)	2.16	5.29	5.13	15321	7403	0.08

Conclusion

Response of spacing and row proportions to growth, yield and economics of turmeric + okra intercropping system has been studied under North Eastern Ghat Zone of Odisha.

Adoption of okra and turmeric (1:4) spacing and row proportion to okra and turmeric intercropping system was found to be the most stable, productive and remunerative planting geometry for the okra and turmeric intercropping system.

Sole crop of turmeric fresh rhizome (114.3 q/ha)and okra fresh fruit (40.0 q/ha) produced the highest yield when compared with other intercropping systems. Turmeric + Okra Intercropping system(1:4) spacing and row proportion inT6 registered highest turmeric rhizome equivalent yield over other intercropping system.

Profitability– Turmeric + Okra Intercropping system(1:4) spacing and row proportion registered highest net return and benefit cost ratio over other intercropping system which indicated that this proportion performed better in terms of investment.

Sustainability – Sustainable technology as beneficial over monocropping system

Future research-MLTs can be taken andpopularisation of the technology by conducting OFT and FLDs through KVK and Govt. Line Department.

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