Responseofspacingandrowproportionstogrowth,yieldandeconomicsofturmericandokraintercropping systemunderNorthEastern Ghat ZoneofOdisha

Comment [1]: Its too long

ABSTRACT

Farmers of Kandhamal district of Odisha are cultivatingturmeric as sole crop where interspaceare not properly utilised. Therefore,One experiment was conducted at RRTTS, G.Udayagiri,Kandhamal, Odisha to studythe response of spacing and row proportions on growth and yieldattributes of okra inturmeric + okra Intercropping System during 2022-23 *kharif*. T_1 - Soleturmeric 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 turmericfresh rhizome(119.2 q ha^{-1})and okra fresh fruit(72.8 qha^{-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 turmericrhizomeequivalent yield149.9q ha^{-1}over other intercropping system and B: C ration of 2.17whereas in sole crop ofB: C ratio-1.43.

Comment [2]: Small letter

KeyWords: Intercropping,Turmeric,Equivalentyield**.**

Introduction

Turmeric is an important cash crop for thousands of tribal farmers in the Kandhamaldistrict of Odisha. The southern districtis generally clogged with hills and forests and isblessed with appropriate agro-climatic conditions for turmeric cultivation. People familiarwiththecrop andits economicimportancereportthat around50,000 farmers were

growing turmeric without applying chemical fertilizers or pesticides on approximately 25,000hectares, 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 5.3percentvolatileoil(ProjectreportKASAM),thehighestamongothervarieties.Ithasapowerful aroma and higher medicinal value ,making it popular in domestic and internationalmarkets. As per the report of the Trade Promotion Council of India (TPCI) 2019, India is thelargest producer and exporter of turmeric (Pushp,2019). Odisha accounts for about 21 per cent ofIndia's turmeric area, and more than half of this is in Kandhamal.The 'KandhamalHaldi' gotGeographical Indication (GI)tag (Behera, 2019). The primary source of income for tribal farmersin Kandhamal is the turmeric crop. Tribal farmers are socio-economically and educationallybackward compared to non-tribal farmers (Chetri*et al*., 2020). Turmeric is typically grown inuplands, 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 testand improve their Indigenous technical knowledge with modern technologies (Babu*et al*., 2013)to increase the yield. Farmers have always been forced to sell the harvest at a minimum price. Asa result, most districtfarmers sell turmeric at Rs. 30-35 per kg. This price is half of the marketrate. The state government-run cooperative agency, Kandhamal Apex Spices Association forMarketing (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 isbuying little, so all the farmers are not benefited. Global fooddemandisrisingrapidlyandsomorein developing countries specially in South Asia where arable landsandresourcesbarelyproduceadequatecrops neededtomeetdemandforfood(McLaughlinandKinzelbach2015).Sustainablecropintensificationis crucial tofeedtheentirepopulationthroughefficient mitigationofpossibleadverseimpactsonsoiland environment.Inthiscontextseveralinnovativeand efficienttechnologiesneedtobe adoptedfor increasing foodproductionbyalleviatinglanduseefficiency (Timmusk*et al*. 2017). It is a long duration cropandthe initialgrowthof turmeric israther slow andtakesabout4-5monthstocover theinterspace. Therefore, the available space between the rows of turmeric could be effectivelyutilized by growing short duration crops like, vegetables, cereals etc. Hence, it is worthwhile toexplore the possibilities of growing compatible crops with turmeric. With this background, thisresearch project was formulated to find out the best compatible intercrop with turmeric, to studythe effect of intercrops on growth and yield of turmeric and to determine the economic feasibilityof turmeric based intercropping. Intercroppingcould increase25%yieldascomparedtomonoculture, and ensure several additional services, such asenhancenutrientuseefficiencyandgrain quality in food systems (Jensen *et al.* 2015; Bedoussac*et al*. 2015). Intercroppingalsoensures efficientutilizationoftheir resourcestomaximizecrop productionandfamilyincome(Islam*etal*.2012).Turmericisaverypopulartropicalandsubtropicalrhizo matousspecieswidelycultivatedinAsiaincludingBangladesh(Islam*etal*.2018).Itisa longduration wide-spacedcropthatremainsunderthe fieldfor about270-300days.However,theadoptionof long-durationturmericcropchallengedfarmerswith shortdurationvegetablecroplikeokraintheregion. Turmeric is a shadetolerant cropandgrowswell under partial shade (Haque andHossain 1985; Joyachandran*et al*. 1991).It takes60 to70 days to 100% emergenceafter plantingof rhizome(Islam*et al*.2018). Therelevantliteratureonturmeric+okra intercropping practicefor cropintensification still scarce thus,this experiment has been undertaken to evaluate the turmeric+ okra intercroppingsystemforoptimumcropdensity,yieldadvantage,andprofitabilityusingintercroppingin dices.So,

Comment [3]: Spacing should me maintained and look other parts too

Comment [4]: Check spacing

Comment [5]: Same problem

Comment [6]: Same problem

farmerscaneasily growanothercroplikeokraasanintercropwithturmeric attheearlygrowthstage(130days).

MaterialsandMethods

Oneexperiment wasconducted atRRTTS, G.Udayagiri,Kandhamal, Odishato studytheperformance of cropping system to find out suitablerow proportions of turmeric and okraduring2022-23*kharif*.

Experimental Design: RBD Replication : ThreeTreatments:10.Theexperimentwasconducted in medium land site. The soil is sandy loam in texture, pH 5.39, low available P_2O_5 ,organic carbon-5.4g/kg, and available K_2O is 160kg ha^{-1}. Observations on growth and yieldparameters were recorded ineach replication and the mean obtained were used for statisticalanalysis(Panseand Sukhatme, 1985).

Comment [7]: Use SI units

Treatments:

T_1 -Soleturmericat30x20cm(Recommended)T_2-

SoleOkra45x20cm(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)

RecommendedEcosystem–RainfedUpland

ResultsandDiscussion

Growth and yield parameters and the pooled data arepresented inTables 1 , 2 and 3. Themorphologicalcharacters of turmeric were found significantly influenced by various intercrops.The turmeric as purecrop recorded significantly higher values for plant height(63.5 cm), numberof , dry matter 30.5q ha^{-1},number of rhizome /plant-28.2, weight of mother rhizome(g/plant)-93.1, weight of primary rhizome/plant-72.3, weight of secondary rhizome /plant-405.1, and freshrhizome yield of 119.2q ha^{-1} . The okra as pure croprecorded plant height-41.12cm,dry matter-27.0qha^{-1},no.ofbranches/plant-1.4, no . offruits/plant-11.16,sizeof

Comment [8]: Use SI unit

okra fruit/plant-12.34cm, and weight of okra fruit/plant were 73.12g . The okra:turmeric(1:4) inT6 crop recordedsignificantlyvalues forturmeric plant height(58.8 cm),, dry matter 26.6q ha^{-1},number of rhizome /plant-26.4, weight of mother rhizome(g/plant)-92.6, weight of primaryrhizome/plant-65.2, weight of secondary rhizome /plant-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,drymatter-16.8q ha^{-1}, number of branches/plant-2.1, no. of fruit /plant-8.58, size of okra fruit/plant-7.71cm, weight of okra fruit/plant-48.34g and B: ratio of 2.17. . Islam *et al*. (2016) indicated thathigher biomass production and consequently more efficient useof land and available resourcesunder intercropping than under sole cropping contributed to the higher turmericyield.

Similarresultswereobtainedby Balashanmugam*etal*.(1988)andNarayanpurandSulikeri(1996)intur meric and Kumar *et al.* (2018) in ginger. Paraye*etal.* (2014) reported that ginger equivalentyield and netreturn was higher in ginger (Raigarh local) + turmeric(Sudershana) in 1:1 row ratiointercroppingsystem.

Comment [9]: Very old references

In this experiment, the treatments containing both turmeric and intercrop were found to beeconomicallyfeasiblethanthetreatmentwithturmericaspurecrop.Amongthedifferentintercropping 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 andReddy (2000); Narayanpur and Sulikeri(1996); Singh and Randhawa (1988) , and Sivaraman andPalaniappan(1994), Biswajit*et al*.(2023)in turmeric.

Comment [10]: Very old references

Table1.Responseofspacingandrowproportionsongrowthandyieldattributesofokrai n turmeric+okra IntercroppingSystem ((Pooledover2021-22&2022-23).

Treatments	Plant height (cm)	Dry matter (q/ha)	Number ofBranches/Plant	Number ofFruits/Plant	Sizeof OkraFruits/ Plant	Weightof okrafruits/plant(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)

Comment [11]: SI units

Comment [12]: ??

Table2.Response of spacingandrow proportionsongrowthandyieldattributesofturmericin Turmeric + Okra Intercropping system

Treatments	Plant height (cm)	Drymatter(q/ha)	NumberofRhizome/Plant	WeightofMotherRhizome (g/plant)	WeightofPrimaryRhizome (g/plant)	WeightofSecondaryRhizome (g/plant)
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

Comment [13]: Use SI units

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)

Table3.ResponseofspacingandrowproportionsoneconomicsinTurmeric+OkraInterc roppingsystemunderNorthEastern Ghat ZoneofOdisha

Treatments	TurmericFreshRhizome (q/ha)	Fresh Fruit Okra yield (q/ha)	Turmeric(FreshRhizome)EquivalentYield (q/ha)	Gross Return (Rs/ha)	Net return(Rs/ha)	B:CRatio
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

Comment [14]: Use SI unit

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

Responseofspacingandrowproportionstogrowth,yieldandeconomicsofturmeric+okraintercropping systemhasbeenstudied underNorth EasternGhat Zoneof Odisha.

Adoptionofokraandturmeric(1:4)spacingandrowproportiontookraandturmericintercropping system was found to be the most stable, productive and remunerative plantinggeometry forthe okraand turmericintercroppingsystem.

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

Profitability– Turmeric+OkraIntercroppingsystem(1:4)spacingandrowproportionregisteredhighestnetreturnand benefitcostratiooverotherintercroppingsystemwhichindicatedthat this proportion performedbetter interms of investment.

Sustainability–Sustainabletechnologyasbeneficialovermonocroppingsystem

Future research-MLTscan be taken andpopularisation of the technology by conducting OFTandFLDs throughKVKand Govt. Line Department.

Comment [15]: Not require

Comment [16]: Should be revised

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Comment [17]: Should be as per guideline