Original Research Article

Performance of Turmeric +Pigeon pea intercropping system under North Eastern Ghat Zone of Odisha.

ABSTRACT

Turmeric (*Curcuma longa*L)is an important cash cropgrownbytribal farmersof Odisha fortheir livelihood. Despite thegoodagro-climatic condition, the productivity of turmeric in Odisha is much below(2.4 t/ha)as compared to nation-al average (5.1 t/ha). Therefore, the present study was carried out during 2021-22 and 2022 -23 to evaluate the performance of cropping system to find out suitable planting geometry and row proportions. The different treatments taken were *viz.*T_1 - Sole Turmeric, T_2- Sole Pigeon peaT_3- Turmeric + Pigeon pea (3:1) – one row of pigeon pea after three rows of turmeric (Additive)T_4- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Additive)T_5- Turmeric + Pigeon pea (3:1) -one row of pigeon pea after three rows of turmeric (Replacement)T_6- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Replacement)T_7- Turmeric + Pigeon pea (6:2)- Two rows of pigeon pea after six rows of turmeric (Replacement)T_8- Turmeric + Pigeon pea (10:2)- one row of pigeon pea after ten rows of turmeric (Replacement).- Sole crop of turmeric fresh rhizome (106.04 q/ha)and pigeon pea grain (14.07 q/ha) produced the highest yield when compared with other intercropping systems. Turmeric +Pigeon pea (10:2) geometry gave the highest net return and benefit cost ratio over other intercropping system.

Keywords: Turmeric, pigeon pea, rhizomes, tribal, livelihood..

1.INTRODUCTION

Turmericis an important commercial spice cropgrownin India since ancient times and it is named as "Indian saffron". It is known as the "golden spice" as well as the "spiceof life." It reached China by 700 AD, East Africaby 800 AD and West Africa by 1200. It was introduced to Jamaica in the 18th Centuryand started becoming popular throughout the world. Turmeric was probably cultivated at first as a dye, and then became valued as a condiment as well as for cosmetic purposes. The Arab traders took turmeric to Europe in 13th century.During his travels in China in 1280, Marco Polowassoim-pressed byturmeric that he mentionedit as a vegetable that has properties of saffron, but it is not really saffron. Turmeric is mainly known as a spice all over the world. It isuse as a spice in curry powder,

chickenbouillon, sauces, gravies, dry seasoning, baking mixes, processed cheese pickles, relishes, breading soup, beverages and confections (Sasikumar, 2001). Turmeric is now grown in countries like India, China, Pakistan, Bangladesh, Vietnam, Thailand, Philippines, Japan, Korea, Sri Lanka, Nepal, South Pacific Islands, East and West Africa, Ma-laysia, Caribbean Islands and Central America. The world production of turmeric is 800000 tonnes in which India hold a share of approximately 75- 80% and con-sumesaround 80% of its own production. India is by far the largest producer and exporter of turmeric in the world.Indian turmeric is considered the best in the world market because of its high curcumin content(6.7%). Turmeric occupies about 6% of the total area under spic-es and condiments in country. During 2012-2013, the country produced9,92,900 tonnes of turmeric from an area of 1,95,100 ha (Anonymous, 2013). During the period betweenApril 2011 to January 2012, India ex-ported 67,000 tonnes of turmericvalued at Rs 6,438 mil-lion. From India's total turmeric exports, 65% exported to UAE, USA, Japan, Srilanka, UK, and Malaysia. An-dhra Pradesh, Tamil Nadu, Odisha, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtraand Assam are importantstates cultivating turmeric.Andhra Pradesh alone occupies 35.0% of area and 47.0% of production.

In Odisha, turmeric is an important cash crop grownbytribal families for their livelihoodand more than 50% of this crop grower is tribals. Odisha contributes about 21 % of India's turmeric cultivation in terms of area and Kandhamal makes up for over 50 % of the state' s share. Odisha produced turmeric 59361 t from 24733 ha.Kandhamal district stands first in turmeric area as well as production (28,828 t from 11,088 ha). Koraput is the second largest producing district (7,761 t from 3,168 ha) followed by Nayagarh (5343 t from 2473 ha) and Keonjhar (2937 t from 1224 ha).Turmeric is a cash crop grown by Kondhatribes of Kandhamal district and LangiKondhaof Gajapati district. The crop is grown in back-yard by the tribals with their indigenous methods of crop production. The crop is mostly produced organically and the farmers get a good return. In view of the po-tential of turmeric, the stateproposed for the Agri Export Zone (AEZ). The zone covers the district of Kandhamal(Ray, 2007). Turmeric is also credited with religious and magical rites in India and certain South- East Asian countries. Traditionally turmeric has been used in India for treatment of a variety of human and veterinary ailments, as a natural dye, as well as preparation of delicious dishes. Though traditional Indian Ayurvedic and Siddha systems of med-icine have recognized the medicinal value of turmeric in its crude from since very ancient times, the few decades have witnessed extensive research interests worldwide in the biomedical activity of turmeric and its compounds. Thus

Curcumais now gaining importance all overtheworld as a mighty cure to combat a variety of ailments, as the genus carries molecules credited with anti-inflammatory, hypocholestremic, choleratic, antimicro-bial, antirheumatic, antifibrotic, antivenomous, antiviral antidiabetic, antihepatoxic and anticancerous properties as well as insect repellent activity(Chattopadhya*et al,*2004) .Turmeric can be grown in Odishaas an intercrop in coconut and areca nutplantations.Turmeric is the third-largest spice exported from India. In terms of quan-tity and value, it accounts about 12% and 5% respective-ly.

Due to the rapidly increasing population of the country, the pressure on agricultural land to get maximum yield per unit is increasing continuously. On the other hand, due to climate change, there is also a significant change in the uncertainty of rainfall. Intercropping farming is considered very useful in dealing with such challenges. In tur growing areas of the country, farmers often plant tur on the bunds of paddy fields. This gives less yield. But if turmeric farming is done with tur, then farmers can earn double.

Intercropping Farming is such a scientific technique, which has been found to be very effective in increasing income of the farmers. In this regard, it is recommended by agricultural experts to do turmeric with tur or ginger with tur or turmeric with drumstick or inter-cultivation of ginger and turmeric with papaya. With this modern technology, farmers can increase their income apart from reducing the risk of farming.

Actually, turmeric can be cultivated easily even in shady environment. Turmeric is a popular medicinal and spice crop. That's why it gets good price in the market. Cultivation of turmeric with tur as an intercropping crop yields income from both the costly crops. The inclusion of tur cultivation in the crop rotation maintains the fertility of the soil, because the roots of pulse crops provide natural fertility to the soil by absorbing nitrogen directly from the atmosphere.

2.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 arhar with additive and replacement series.

Experimental Design: RBD Replication : three Treatments: 8. 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, and available K_2O is 160kg ha^{-1}.Observations on growth and yield parameters wererecorded in each replication and the meanobtained were used for statistical analysis (Panse andSukhatme, 1985).

Treatments :

T_1 - Sole Turmeric,

T_2- Sole Pigeon pea

T_3- Turmeric + Pigeon pea (3:1) – one row of pigeon pea after three rows of turmeric (Additive)

T_4- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Additive)

T_5- Turmeric + Pigeon pea (3:1) -one row of pigeon pea after three rows of turmeric (Replacement)

T_6- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Replacement)

T_7- Turmeric + Pigeon pea (6:2)- Two rows of pigeon pea after six rows of turmeric (Replacement)

T_8- Turmeric + Pigeon pea (10:2)- one row of pigeon pea after ten rows of turmeric (Replacement)

Recommended Ecosystem – Rain fed Upland

3.EXPERIMENTAL FINDINGS

The morphologicalcharacters of turmeric were found significantlyinfluenced by various intercrops. The pigeon-pea as purecrop recorded significantly higher values for plant height(174.9 cm), no of branches/plantat harvest-15.3,no of pods /plant-132.3, no of seeds /pod-4.7, 1000seed weight-82.11g,weight of secondary rhizome /plant-405.1, yield of 14.07q$ha^{-1}$and B:C ratio-1.40 . The turmeric as pure crop recorded plant height-78.30cm, Rooting depth-13.11cm, length of leaves—36.31cm, weight ofmother rhizome-34.40g, weight of primary rhizome-132.30g, and weight of secondary and tertiary rhizome-75.20g ,total weight clump-241.80g , fresh turmeric rhizome-106,04qha-

[1]and B:C ratio -1.37. . The turmeric:Pigeonpea(10:2) in T8havingone row of pigeon pea after ten rows of turmeric (Replacement) recorded significantly values for plant height-74.59cm, Rooting depth-12.46cm, length of leaves—35.46cm, weight of mother rhizome-30.60g, weight of primary rhizome-127.40g, and weight of secondary and tertiary rhizome-64.20g ,total weight clump-221.20g , fresh turmeric rhizome-84.02q

ha^{-1},Grain yield of Pigeon pea ($qha^{-1)}$ -4.54 and B:C ratio -2.11. ha^{-1}, dry turmeric rhizome yield-16.81qha^{-1}, dry turmeric rhizome equivalent yield is 19.91$qha^{-1,}$,Islam *et al.* (2016) indicated that higherbiomass production and consequently more efficient useof land and available resources under intercropping thanunder sole cropping contributed to the higher turmericyield. Similar results were obtained by Balashanmugam*et al*. (1988) and Narayanpur and Sulikeri (1996) inturmeric and 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.

when the base crop and intercrops were adequately fertilised then there is no yield reduction in the main crop (Nayar and Suja, 2004). Similar results were observed by Kannan *et al*., (2001), Chattopadhyay *et a*l., (2008) in elephant foot yam intercropped with vegetables. It was interpreted by Singh *et al.*, (2013) that less competition for resources and better scope of intercultural operations at early growth stages were the favourable points, which might have triggered the process of partitioning photosynthates from source to sink resulting in higher yield of main crop. Further, Das and Maharana (1995) explained that elephant foot yam does not compete for light because it is able to tolerant shade. Yield of inter crops .Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 1247-1253 1250 yam sole crop. The higher productivity of the intercrop system compared to the sole crop might have resulted from complementary and efficient use of growth resources by the component crops as explained by Li *et al.,* (2006). Willey (1979) also elucidated that mixed cropping was more efficient and productive than sole cropping because of higher combined yield and better energy use efficiency. Ravindran *et al*., (2006) also advocated intercropping of tuber crops for better remuneration.

Table1.

Effect of planting geometry on growth and yield attributes of Pigeon pea in turmeric + pigeon pea intercropping system(Pooled over 2021-22 &2022-23)

Treatments	Plant height (cm) at harvest	No of branches $plant^{-1}$ at harvest	No of field pods/plant	No of seeds/for pods	1000- Seed weight (g)

T1	-	-	-	-	-
T_2	174.9	15.3	132.3	4.7	82.11
T_3	169.4	14.6	130.3	4.6	82.10
T_4	161.2	14.0	125.7	4.4	81.78
T_5	166.4	14.5	130.3	4.5	81.98
T_6	156.1	13.5	122.2	4.3	81.55
T_7	165.2	14.1	127.8	4.5	81.78
T_8	151.5	13.1	120.4	4.1	81.34
SEm (±)	5.29	0.46	2.78	0.22	1.65
CD(0.05)	10.78	0.95	5.77	0.46	NS

T_1 - Sole Turmeric,

T_2- Sole Pigeon pea

T_3- Turmeric + Pigeon pea (3:1) – one row of pigeon pea after three rows of turmeric (Additive)

T_4- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Additive)

T_5- Turmeric + Pigeon pea (3:1) -one row of pigeon pea after three rows of turmeric (Replacement)

T_6- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Replacement)

T_7- Turmeric + Pigeon pea (6:2)- Two rows of pigeon pea after six rows of turmeric (Replacement)

T_8- Turmeric + Pigeon pea (10:2)- one row of pigeon pea after ten rows of turmeric (Replacement)

Table2.

Effect of planting geometry on growth and yield attributes of Turmeric in turmeric + pigeon pea intercropping system(Pooled over 2021-22 &2022-23)

Treatments	Plant height (cm)	Rooting depth (cm)	Length of leaves (cm)	Weight of mother rhizome (g)	Weight of primary rhizome (g)	Weight of secondary and tertiary rhizome (g)	Total weight clump (g)
T_1	78.30	13.11	36.31	34.40	132.30	75.20	241.80
T_2	-		-	-	-	-	-
T_3	63.75	8.70	28.45	23.98	107.56	46.76	178.24
T_4	67.68	11.53	34.56	26.21	126.34	60.67	216.22
T_5	66.21	9.89	30.18	25.21	119.23	54.45	201.22

T_6	67.37	10.57	32.10	28.34	121.01	56.28	205.63
T_7	65.34	9.23	27.42	24.11	117.34	52.75	194.23
T_8	74.59	12.46	35.46	30.60	127.40	64.20	221.20
SEm (+)	2.15	0.54	1.17	1.24	3.68	2.46	4.55
CD (0.05)	6.30	1.59	3.44	3.64	10.78	7.20	13.34

T_1- Sole Turmeric, T_2- Sole Pigeon peaT_3- Turmeric + Pigeon pea (3:1) – one row of pigeon pea after three rows of turmeric (Additive)

T_4- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Additive)

T_5- Turmeric + Pigeon pea (3:1) -one row of pigeon pea after three rows of turmeric (Replacement)

T_6- Turmeric + Pigeon pea (5:1)- one row of pigeon pea after five rows of turmeric (Replacement)

T_7- Turmeric + Pigeon pea (6:2)- Two rows of pigeon pea after six rows of turmeric (Replacement)

T_8- Turmeric + Pigeon pea (10:2)- one row of pigeon pea after ten rows of turmeric (Replacemen

Table3.

Yield and economics of Turmeric +Pigeon pea intercropping system (Pooled over 2021-22 &2022-23)

Treatment	Fresh Turmeric Rhizome (q/ha)	Grain yield of Pigeon pea (q/ha)	Dry Turmeric Rhizome (q/ha)	Turmeric (dry rhizome) equivalent yield (q/ha)	Gross Return (Turmeric) (Rs/ha)	Gross Return (Pigeon pea) (Rs/ha)	Gross Return (Turmeric &Pigeon pea) (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
T1-Sole turmeric	106.04		22.21		371140	-	371140	40140	1.37
T2- Sole Pigeon pea	-	14.07	-	9.62	-	92862	92862	41863	1.40
T3- T+P(3:1) Additive	42.99	11.13	8.60	16.26	150465	73458	223923	51563	1.51
T4- T+P(5:1)Additive	59.90	7.30	11.83	16.88	209650	48180	257830	57590	1.54
T5T+P(3:1)Replacement	53.22	8.81	10.65	16.66	186270	58146	244416	69736	1.67
T6T+P(5:1)Replacement	61.59	5.97	12.32	16.40	215565	39402	254967	75927	1.87
T7- T+P(6:1Replacement	52.60	8.28	10.52	16.21	184100	54648	238748	66068	1.71
T8-T+P(10:2) Replacement	84.02	4.54	16.81	19.91	294070	29964	324034	98994	2.11
SEm (+)	6.74	1.08	0.55	0.71	3396	2983	2359	2431	0.04
CD(0.05)	18.04	3.16	1.16	1.50	7199	6323	5001	5154	0.08

4.CONCLUSION

Details of the Technology- Adoption of turmeric and pigeon pea (10:2) planting pattern to turmeric and pigeon pea intercropping system was found to be the most stable, productive and remunerative planting geometry for the turmeric and pigeon pea intercropping system

Recommended Ecosystem – Rainfed Upland

Superiority Over Existing Technology

Productivity - Sole crop of turmeric fresh rhizome (106.04 q/ha)and pigeon pea grain (14.07 q/ha) produced the highest yield when compared with other intercropping systems.

Profitability – Turmeric +Pigeon pea (10:2) geometry gave the highest net return and benefit cost ratio over other intercropping system

Message to Farmers – Turmeric and pigeon pea (10:2) planting pattern to turmeric and pigeon pea intercropping system recommended for higher productivity and net return

FUTURE RESEARCH- Popularization of the technology by conducting OFT and FLDs through KVK and Govt. Line Department.

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