RESEARCH ARTICLE

PERFORMANCE OF INTERCROPS IN HYBRID MAIZE UNDER NORTH CENTRAL PLATEAU ZONE OF ODISHA

T.R. Mohanty[1] , M. Ray[2]*, S.K. Sahoo[3] , K.C. Sahoo[4], N. Mishra[5] and H.K. Patro[6]

[1,2,3,4,5]*Regional Research and Technology Transfer Station [RRTTS] (OUAT), Keonjhar, Odisha - 758002*
[5]*DPME, Orissa University of Agriculture and Technology, Bhubaneswar-751003*
Email: monikarayouat@gmail.com

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Abstract: An experiment was conducted at Field Experimental Block, Regional Research and Technology Transfer Station, Keonjhar, during *Kharif* season for two consecutive years of 2017 and 2018 under RKVY project to study the performance of maize based intercropping system under North Central Plateau Zone of Odisha. . The experiment was laid out in RBD design. The experiment comprised of thirteen treatments viz. T1- Maize + Cowpea (1:1), T2-Maize + Cowpea (2:2), T3-Maize + Radish (1:1), T4-Maize + Radish (2:2), T5-Maize + Cluster bean (1:1), T6-Maize + Cluster bean (2:2), T7-Maize + Arhar (1:1), T8-Maize + Arhar (2:2),T9-Maize (sole), T10-Cowpea (sole) , T11-Radish (sole), T12- Cluster bean (sole), T13-Arhar (sole). The varieties taken were: Maize-Pioneer 3396(Hybrid), Cowpea-Kasi Kanchan, Cluster bean -Pusa Navbahar, Arhar- Corg 9701 and Radish- Pusa Chetki Long. Results revealed that Maize + cowpea (1:1) proved to be the most profitable system being at par with maize + cowpea (2:2) & maize + radish (1:1 & 2:2) systems in both the years. However, maize + arhar (1:1) returned the highest amount per rupee invested (1.78) among all the systems when number of days occupied in the field is not taken into account. Therefore for North Central Plateau Zone of Odisha cowpea and radish are the most suitable intercrops with maize in Kharif season in the above row ratios.

Keywords: Kharif**,** Intercropping, Maize, Cowpea, Profitable

INTRODUCTION

The state of Odisha is located in the eastern part of India. It has 2.62 Mha of maize with a production of 6.08 million tonnes (Mt), resulting in an average productivity of 2,321 kg/ha (Government of Odisha,2012) annually. Nationally, maize is cultivated on 8.78 Mha, with a production of 21.76 Mt and an average annual yield of 2,478 kg/ha (Directorate of Economics and Statistics, 2012). In Odisha maize is cultivated primarily in interior districts such as Keonjhar (27,580 ha). Maize is a staple tribal food crop and amounts to 7.4% of the state's total food consumption .These tribal communities constitute 23% of the total state population (Census-2011, www.censusindia.gov.in). The predominant upland crop in this region is maize, grown during the kharif season. Growing of a heavy feeder maize crop year after year mines the soil and results in decline of fertility of the soil. Farmers mostly use local varieties of maize crops under low management conditions which results in low productivity. So, the production of food grain could be increased by adopting intercropping system. Intercropping increases total productivity through efficient utilization of land, labour and growth resources (Ahmed *et al*., 2006). Greater productivity in intercropping system is commonly achieved by minimizing inter specific competition and maximizing complementary use of growth resources (Islam, 2002). Inter-specific competition may be minimized through judicious choice of crops (Santalla *et al*., 2001). Usually plants differing in growth duration, height, rooting systems and nutrient requirements are considered to grow together in intercropping systems (Reddy and Willey, 1981).

Intercropping also increases land equivalent ratio (LER) to varying degrees (Mehta and De, 1980; Hashem *et al.,* 1990). Islam *et al.* (2004) reported that maize and bush been exhibited similar competitiveness in simultaneous sowing and resulted in the highest intercrop productivity in maize-bush bean intercropping system. They suggested that two rows of bush bean in between maize rows can be grown by experiment was conducted in different locations during *rabi* season 2005-06. Findings from different locations showed that the highest maize equivalent yield was obtained from Maize + Bush bean intercropping systems at Jamalpur, Maize + Spinach at Jessore, Mymensigh, and Rangpur, Maize + coriander (as vegetable) at Pabna. Maize + Red amaranth at Kushtia and Manikganj (OFRD, 2006). The association of bush bean with maize provides some N economy (Singh *et al.,* 2000). Generally legumes in association with non-legumes not only helps in utilization of the nitrogen being fixed in the current growing season, but also helps in residual nutrients build up of the soil (Sharma *et al.,* 1991). However, the benefit accrued from intercropping may vary according to the nature and type of intercrops and their population densities. Therefore, it is necessary to identify maize-based productive systems for higher monetary returns in North Central Plateau Zone of Odisha as here there is ample scope for intercropping with short duration vegetables with maize in the inter row space without hampering the

*Corresponding Author

main yield of maize. In view of this a study was conducted to evaluate the performance of maize under intercropping with different crops viz. Cowpea, Cluster bean, radish and Arhar for selection of suitable inter crop with maize and to increase the cropping intensity, as well as increase the farmers' income.

MATERIALS AND METHODS

The experiment was conducted at Field Experimental Block, Regional Research and Technology Transfer Station, Keonjhar, during *Kharif* season of two consecutive years of 2017 and 2018 under RKVY project. The soil of the experimental field was loamy sand having pH 8 and N (107 kg/ha) and K (78 kg/ ha) status was low whereas P (21 kg/ha) status was medium. The experiment was laid out in a Randomized Complete Block Design with thirteen treatments combinations and three replications. The thirteen treatment combinations studied were as follows: T1- Maize + Cowpea (1:1), T2-Maize + Cowpea (2:2), T3-Maize + Radish (1:1), T4-Maize + Radish (2:2), T5-Maize + Cluster bean (1:1), T6-Maize + Cluster bean (2:2), T7-Maize + Arhar (1:1), T8-Maize + Arhar (2:2),T9-Maize (sole), T10-Cowpea (sole) , T11-Radish (sole), T12- Cluster bean (sole), T13-Arhar (sole). The varieties taken were: Maize-Pioneer 3396, Cowpea-Kasi Kanchan, Cluster bean -Pusa Navbahar, Arhar- Corg 9701 and Radish-Pusa Chetki Long. Sowing was done on 24 June and 27 June in 2017 and 2018 respectively. Maize and all intercrop vegetable seeds were sown at the same time. All intercrops were sown in lines in between the maize rows maintaining the standard spacing of the respective crops. Maize seeds were sown in a planting configuration of 60 cm x 30 cm spacing in 1:1 planting pattern and vegetable seeds were sown in between them. A spacing 30 cm x 30 cm was maintained in 2:2 planting pattern of maize and vegetable intercropping, The crop was fertilized at the rate of 120-60-60 kg ha-^{1} of NPK and FYM at the rate of 5 t ha-^{1}. Full amount of P and K and 1/3rd of N along with full amount of cow dung were applied at the time of final and preparation. The rest N was applied into two equal splits at knee height stage and at tasselling stage. Intercultural operation was done as and when necessary. Data on plant height, cobs per plant, grains/cob , 100 seeds weight and grain yield per hectare were recorded for data analysis. Grain yield of maize was determined at 14% moisture content. Ten cobs were randomly harvested from each plot, which was later converted into ton per hectare. Maize equivalent yield (MEY) and BCR were calculated to ascertain the efficiency of intercropping. Maize equivalent yield was calculated by converting the yield of intercrops to the yield of Maize on the basis of prevailing market prices of individual crops. Economic analysis on the basis of net monetary return was performed to evaluate the intercropping system.

Maize Equivalent Yield was calculated after Bandyopadhyay (1984):

$$\text{Maize Equivalent Yield (MEY)} = \frac{\text{Yield of Intercrop (Kg ha-1) x Price of Intercrop (Rs Kg-1)}}{\text{Price of Maize (Rs Kg-1)}}$$

RESULTS AND DISCUSSION

Yield and yield contributing characters of Maize

Plant characters and yield attributes of Pioneer 3396 Hybrid Maize in maize- vegetable intercropping system are presented in Table 1. The highest plant height (185.3cm) and Cobs/ plant (1.51), was recorded from sole maize followed by Maize + cowpea (1:1) (185.3cm and 1.45 respectively). The lowest plant height (176.4cm) and Cobs/ plant (1.09), was recorded from Maize + Arhar (2:2) intercropping. The highest grains/cob (455.0) and 100 grain weight (33.9g) was achieved from sole maize and it was almost similar to treatments T1 and T2 i.e. Maize + cowpea in the ratio 1:1(32.5g) and 2:2 (31.2g). Treatments T7 and T8 i.e. Maize + Arhar in the ratio 1:1(420.6) and 2:2 (419.5) produced the lowest grains/cob .

Yield of Maize

The maximum grain yield (5.35 t ha-1) was recorded from sole maize and it was statistically identical to all other treatments (Fig. 1). OFRD (2006) and Bhuiyan *et al*., 1999 also reported that sole maize gave the highest yield among the treatments

Yield of Intercrops

The highest average yield of intercrops (3.59 t ha-1) was found from the Maize + Radish(2:2) intercropping system whereas the lowest average yield (0.48 t ha-1) was found in Maize + Arhar (2:2) intercropping system.

Maize Equivalent Yield (MEY)

Maize equivalent yields in the intercrops were significantly higher than the sole crops. The pooled data showed that the highest average Maize equivalent yield of 7.10 t ha-1 was obtained from Maize + Arhar (1:1) intercropping systems followed by maize + cowpea(1:1) and maize + radish(1:1) , which was 25.2% higher than the sole crop of Maize(Fig. 1). The results indicated that cereal (Maize) – vegetable intercropping could bring more benefit to farmers over sole maize. The increment of total production by intercropping than sole cropping was also reported by Rao and Willey (1980); Umrani *et al*. (1984); Bandhyopadhyay (1984); Basak *et al.* (2006) and Bhowal *et al*. (2014).

Cost and benefit analysis

Productivity, net return , profitability and BCR of maize-vegetable intercropping systems were shown in Table 2. The productivity was highest Maize + cowpea (1:1) intercropping (68.75 Kg/ha/day)

followed by Maize+Radish(1: 1) intercropping (67.55 Kg/ha/day). Though the intercropping system Maize + Arhar (2:2) gave the highest MEY but the productivity was the less (41.5 Kg/ha/day). The least productivity was obtained from sole Cluster bean crop(24.5 Kg/ha/day).

Maize + Arhar (1:1) gave the highest net return(Rs 42,580ha^{-1}) and BCR(1.73) among all the systems when no. of days occupied in the field was not taken into account which was statistically at par with h Maize + Cowpea(1:1) intercropping (Rs40,100 ha^{-1}) and BCR(1.69). The lowest net return(Rs 4,290.5 ha^{-1}) and BCR(1.08) was obtained from sole radish crop. (Razzaque *et al.,* 2007; Alam *et al.,* 2008; Bhuiyan *et al*., 2013; and Farhad *et al.,* 2014. Uddin *et al.* (2009) also documented that all the Maize-vegetables intercropping system in the hilly areas of Bangladesh showed higher BCR than sole maize, which also strongly supports the above findings.

Table 1. Plant and yield contributing characters of Maize (Pioneer 3396) during the *Kharif* season of 2017 and 2018 (Pooled).

Treatment	Plant height (cm)	Cobs/ plant(no)	Grains/cob(no)	100 grain weight(g)
T1 (M+C-1:1)	185.3	1.45	451.6	32.5
T2 (M+C-2:2)	181.4	1.16	436.7	31.2
T3 (M+R-1:1)	168.4	1.11	435.2	30.9
T4 (M+R-2:2)	169.7	1.05	426.9	30.6
T5 (M+CB-1:1)	173.5	1.01	427.4	31.2
T6 (M+CB-2:2)	180.0	1.03	423.1	30.8
T7 (M+A-1:1)	178.3	1.10	420.6	31.4
T8 (M+A-2:2)	176.4	1.09	419.5	30.8
T9 (Sole M)	186.4	1.51	455.0	33.9
T10 (Sole C)	---	---	---	---
T11 (Sole R)	---	---	---	---
T12 (Sole CB)	---	---	---	---
T13 (Sole A)	---	---	---	---
Mean	177.7	1.2	432.9	31.5

Table 2. Cost and Return analysis of maize based intercropping systems at North Central Plateau Zone of Odisha.

Treatment	Productivity (Kg/ha/day)		Net Return (Rs./ha)		Profitability (Rs./ha/day)		B:C	
	2017	2018	2017	2018	2017	2018	2017	2018
T1 (M+C-1:1)	67.6	69.9	38469	41731	384.7	417.3	1.66	1.72
T2 (M+C-2:2)	64.4	67.6	33826	38445	338.3	384.5	1.58	1.66
T3 (M+R-1:1)	66.4	68.7	35001	38255	350.0	382.6	1.59	1.64
T4 (M+R-2:2)	62.6	66.6	29660	35366	296.6	353.7	1.50	1.59
T5 (M+CB-1:1)	60.3	63.8	28981	34052	289.8	340.5	1.51	1.60
T6 (M+CB-2:2)	56.0	57.4	22822	24814	228.2	248.1	1.40	1.44
T7 (M+A-1:1)	43.1	45.6	39719	45441	248.2	284.0	1.68	1.78
T8 (M+A-2:2)	39.3	43.5	30910	40624	193.2	253.9	1.53	1.69

T9 (Sole M)	52.4	54.6	26867	30033	268.7	300.3	1.56	1.63
T10 (Sole C)	37.1	37.4	21185	21661	211.9	216.6	1.67	1.68
T11 (Sole R)	40.6	40.6	3402	5179	34.0	34.0	1.06	1.10
T12 (Sole CB)	26.3	22.7	13268	5189	132.7	81.9	1.55	1.34
T13 (Sole A)	25.8	24.3	23349	19889	145.9	124.3	1.66	1.56
Sem (±)	2	2.1	3560	3202	28.1	29.8	-	-
CD (0.05)	5.8	6.1	10390	9343	82.1	87.1	-	-

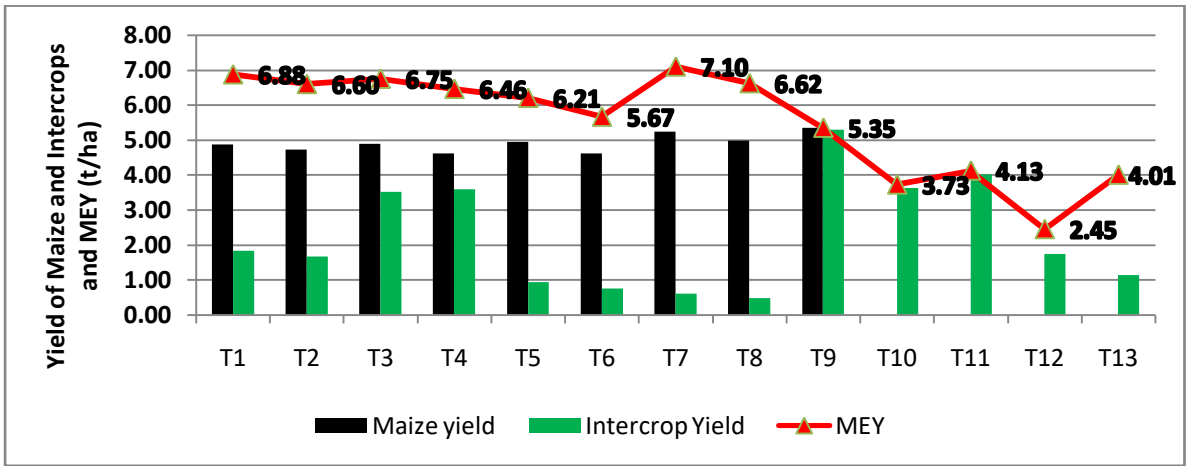

Fig. 1: Comparison of Maize and Intercrop (vegetables) Yield with Maize Equivalent Yield (MEY) in Maize vegetable intercropping system.

CONCLUSION

Maize + cowpea (1:1) proved to be the most profitable system being at par with maize + cowpea (2:2) & maize + radish (1:1 & 2:2) systems in both the years. However, maize + arhar (1:1) returned the highest amount per rupee invested (1.78) among all the systems when no. of days occupied in the field is not taken into account. Therefore the farmers of North Central Plateau Zone are advised to take cowpea and radish as intercrops with maize in Kharif season in the above row ratios.

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