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RESEARCH PAPER

Effect of chemical fertilizers and mulching on growth, yield and residual soil fertility status under yam-maize intercropping system

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Abstract : An experiment on effect of chemical fertilizers and mulching on growth, yield and residual soil fertility status under Yam-Maize intercropping system was carried out during the year 2003-04 under the rainfed conditions, at the Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar, Orissa, to study the impact of graded levels of chemical fertilizers and mulching on the yam-maize intercropping system. Among the graded levels of chemical fertilizers tried in the present experiment, when 150% of the recommended doses of chemical fertilizers for yam were applied to the yam-maize intercropping system, resulted in the higher production of yam tubers (202 q/ha) and maize cobs (2235 kg/ha) and thereby proved its superiority to the rest of the chemical fertilizer treatments. Higher values in relation to the residual fertility status of the experimental plots were recorded when 150% of the recommended doses of chemical fertilizers for yam were applied to the yam-maize intercropping system. Likewise, in case of nitrogen and phosphorus, the residual fertility status also remained at par with the preceding treatment. Mulching the cropping system with the use of farm wastes was found to be of immense use in promoting the growth and development of crops under reference and also resulted in the higher production of yam tubers (160 q/ha) and maize cobs (2067.6 kg/ha), in comparison to those recorded under no mulch treatment.

Key Words : Yam-maize intercropping, Growth, Yield, Residual soil fertility

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INTRODUCTION

Yams are monocotyledonous and belong to the genus *Dioscorea* comprising of about six hundred species which occur mainly in the tropics and subtropics throughout the world. The edible *D. alata* is the most extensively cultivated species in India.

Among the species of yam that are commercially cultivated for edible purpose, *Dioscorea alata* is the most important popular species grown in different parts of India and particularly in the states of Orissa, Andhra Pradesh, Tamil Nadu. Though perennial in habit it is mainly cultivated as an annual. It is a rich source of carbohydrates, certain vitamins and has high calorific value. Failure to stake yams have been reported to cause drastic yield reductions (Okigbo, 1973). This, however, appears to be an expensive input in the commercial cultivation of yam. Maize is thought to be a feasible intercrop which could provide support to the yam vines, apart from giving some additional yield to the grower.

Yams are reported to be highly efficient in utilization of native and applied nutrients in soils. For each metric ton of dry matter produced, yam tubers removed almost the same quantity of nutrient from the soil as that of potato crop, but about four times as much nitrogen and twice as much phosphorus and potassium compared to cassava crop (Obigbesan and Agboola,1979). Maize is also considered to

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a gross feeder of plant nutrients. The present study been carried out to study the impact of chemical fertilizers and mulching on the yam-maize intercropping system.

MATERIAL AND METHODS

An experiment on effect of chemical fertilizers and mulching on growth, yield and residual soil fertility status under yam-maize intercropping system was carried out during the year 2003-04 under the rain fed conditions, at the Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar, Orissa. The soil was well drained, free from gravels and rocks and was of sandy-loam type. The chemical analysis of the soil of the experimental field further revealed that the soil was medium in nitrogen, medium in phosphorus and low in potassium.

The experiment comprised of graded levels of chemical fertilizers comprising of nitrogen, phosphorus and potassium [control (F_0)], seventy five per cent of the recommended doses of chemical fertilizers for yam (F_1) , hundred per cent of the recommended doses of chemical fertilizers for yam(F_2), hundred twenty five per cent of the recommended doses of chemical fertilizers for yam(F_3),hundred fifty per cent of the recommended doses of chemical fertilizers for yam(F_4)]and two treatments related to mulching [mulching with farm wastes (M_1), and no mulching (M_0)].

In the present experiment maize was taken up as an intercrop, yam being the main crop, with a purpose that maize plant would provide support to yam and also give an additional income to the grower The observations on growth and yield of yam and maize as influenced by the treatments were also recorded during course of the study. The experiment consisted of five treatments relating to chemical fertilizers (F_0, F_1, F_2, F_3, F_4) and two relating to mulching (M_0, M_1), thus, there were ten treatment combinations. The experiment was laid out in randomized block design (factorial) with 4 replications. Accordingly, the layout consisted of four blocks each having ten plots arranged in a random order within each block. Yam was planted at a spacing of 90cm x 90 cm with 5 rows having 6 plants / row. Maize was planted at a spacing of 90cm x 30 cm with 5 rows having 18 plants / row. The variety used in the experiment were Orissa Elite for yam and 3816 Mahyco for maize.

Treatment combinations:

M_0F_0	M_1F_0
M_0F_1	M_1F_1
M_0F_2	M_1F_2
M_0F_3	M_1F_3
M_0F_4	M_1F_4

Nitrogen, phosphorus and potassium fertilizers were supplied in the form of urea, single super phosphate and muriate of potash, respectively.

Fertilizer required in each plot (g)				
	F_1	F_2	F_3	F_4
	75% of recommended 80:60:80	100% of recommended 80:60:80	125% of recommended 80:60:80	150% of recommended 80:60:80
Urea	318	423	530	636
SSP	683	911	1140	1366
MOP	243	323	403	486

Seed tubers of yam either whole or cut ones of 150-200g were planted in each of the pit at a depth of 5 cm. Mulching was provided to the plots by using farm wastes as per the plan of layout. Maize plants were planted as intercrops inside two rows of yams with a purpose of providing support to the yam plants in due course of time. Altogether 3 weeding were done to keep the plots free of weeds and earthing up was done to prepare a mound around each yam plant. The crop (Yam) came to maturity after 7month of planting. At maturity the vines and leaves turned yellow and dried gradually. On being completely dried up, the tubers were harvested with spade. The harvesting was carried out during second week of February 2004.

Characters studied:

The observations on different growth, yield of yam and maize were recorded on 3 randomly selected plants of the aforesaid crops from each net plot. The residual soil fertility status under yam - maize intercropping was recorded following standard procedure.

Statistical analysis:

In order to test the significance of results, standard statistical methods based on analysis of variance technique as suggested by Panse and Sukhatme (1967) was employed. The treatment differences were compared with critical differences (C.D.) at 5% level of probability to ascertain their significance.

RESULTS AND DISCUSSION

In the present investigation graded levels of chemical fertilizers comprising of nitrogen, phosphorus and potassium were tried with yam-maize intercropping system with and without mulching. The impact of treatments resulted in the considerable variation in the growth and yield of both the crops. The residual fertility status of the soils of the experimental plots was also significantly influenced by the treatments (Table 1-7).

Effect of graded levels of chemical fertilizers:

Application of 150% of the recommended doses of chemical fertilizers comprising of nitrogen, phosphorus and potassium for yam to the yam-maize intercropping system, resulted in the production of highest yield of tubers (202.0q/

h) which was 6.3% higher in comparison to that recorded under the preceding dose of chemical fertilizers. However, incase of maize, cob yield went on increasing with each incremental increase in the level of chemical fertilizers upto F_4 treatment wherein 150% of the recommended doses of chemical fertilizers for yam were applied to the aforesaid intercropping system, which was found to be statistically at par with preceding doses of chemical fertilizers.

Growing of maize as an intercrop in the yam field not only provided support to the yam vines, but also the land and chemical fertilizers, which are considered to be the most valuable resources in the production system, were effectively utilized. Staking plays a crucial role in realizing higher tuber yields. As soon as the yam vine emerges, it tends to climb on any available support. In the absence of available support, the yam vines would simply lie on the ground. Failure to stake yams has been reported to cause drastic yield reductions (Okigbo, 1973) and taller the stake the greater is the yield, upto a stake height of about 3 m. The higher yield associated with staking is probably due to greater display of leaves whereby mutual shading and overlapping of leaves is minimized. A greater amount of light is available to the leaves of staked plants because of the vertical orientation of the leaves (Mohan Kumar *et al.*, 2000). In the present experiment support provided by maize to the yam vine must have helped in better display to leaves which ultimately must have increased the photosynthetic efficiency of the plant resulting in the better growth of yam vines and also higher production of tubers. This kind of cropping system also does not need any additional expenditure for providing staking to the yam vines.

Application of graded levels of chemical fertilizers

Table 1 : Length of vine (cm) at 150 days after planting as influenced by the graded levels of chemical fertilizers and mulching in yam

Mulching / Chemical fertilizers	M_0 (No mulch)	M_1 (Mulched)	Mean
F_0	417.0	505.0	461.0
F_1	468.0	544.0	506.0
F_2	528.0	624.0	585.0
F_3	543.5	686.0	614.7
F_4	594.0	695.0	644.5
Mean	510.1	614.4	
Treatments	M	F	M x F
S.E.M (±)	12.80	20.24	28.62
C.D. (P=0.05)	37.1	58.7	Non significant

Table 2 : Number of leaves per vine at 150 days after planting as influenced by the graded levels of chemical fertilizers and mulching in yam

Mulching / Chemical fertilizers	M_0 (No Mulch)	M_1 (Mulched)	Mean
F_0	156.48	254.28	205.38
F_1	190.71	317.85	254.28
F_2	195.6	326.4	264.0
F_3	220.05	352.0	286.06
F_4	205.38	371.0	288.51
Mean	193.64	325.67	
Treatments	M	F	M x F
S.E.M (±)	4.678	7.38	10.46
C.D. (P=0.05)	13.57	21.45	30.34

Table 3 : Yield of tubers (q/ha) as influenced by the graded levels of chemical fertilizers and mulching in yam

Mulching / Chemical fertilizers	M_0 (No mulch)	M_1 (Mulched)	Mean
F_0	73.0	91.0	82.0
F_1	102.0	128.0	115.0
F_2	136.0	170.0	153.0
F_3	176.0	204.0	190.0
F_4	197.0	207.0	202.0
Mean	136.8	160.0	
Treatments	M	F	M x F
S.E.M (±)	0.30	0.47	0.67
C.D. (P=0.05)	0.8	1.3	Non significant

Table 4 : Plant height (cm) at harvest as influenced by the graded levels of chemical fertilizers and mulching in maize

Mulching / Chemical fertilizers	M_0 (No mulch)	M_1 (Mulched)	Mean
F_0	128.1	210.0	169.05
F_1	199.5	232.05	215.77
F_2	233.1	237.30	235.20
F_3	237.82	239.40	238.61
F_4	239.40	245.70	242.55
Mean	208.8	231.63	
Treatments	M	F	M x F
S.E.M (±)	4.700	7.434	10.512
C.D. (P=0.05)	13.64	21.56	30.45

Table 5 : Number of leaves per plant at harvest as influenced by the graded levels of chemical fertilizers and mulching in maize

Mulching / Chemical fertilizers	M_0 (No Mulch)	M_1 (Mulched)	Mean
F_0	8.0	11.0	9.5
F_1	11.0	12.0	11.5
F_2	11.0	12.0	11.5
F_3	11.0	12.0	11.5
F_4	12.0	12.0	12.0
Mean	10.6	11.8	
Treatments	M	F	M x F
S.E.M (±)	.38	.59	0.83
C.D. (P=0.05)	1.0	1.7	Non significant

significantly influenced the residual soil fertility status of the experimental plots. Higher levels of chemical fertilizers not only resulted in the higher production in both the crops but also maintained a higher soil fertility status even after the harvest of the crops. As compared to the initial status, the residual soil exhibited a decline in available nitrogen and phosphorus upto the level wherein 100% of the recommended doses of chemical fertilizers for the yam crop were applied to the yam-maize intercropping system. However, the decrease in available potassium in the residual soil was recorded upto the level wherein 75% of the recommended doses of chemical fertilizers for the yam were applied to the yam-maize intercropping system.

Effect of mulching:

Mulching in the yam-maize intercropping system with the use of farm wastes was found to be quite effective for improving the growth, yield and yield- attributing characters of both the crops. Mulching treatment had a significant impact on the uptake of nitrogen, phosphorus and potassium by the yam crop. Mulching resulted in an increased number of branches and leaves and increased leaf length and width. Total top dry weight, leaf area, tuber weight and number of tubers at harvest were generally larger under mulched condition (Toyohara *et al.*, 1997).Mulching treatment increased the yield of yam tubers to the tune of 43.5-45 t/ha against 38 t/ha recorded under non-mulched condition (Manu, 1997).

Effect of interaction:

As regards the effect of interaction, between the factors under reference, most of the characters studied for both the crops did not respond.

The yield of maize cobs per hectare were higher under mulching treatment, than those recorded under the control (no mulch). Likewise with each incremental increase in the dose of chemical fertilizers from control upto the treatment $F_{3,}$ a corresponding increase in yield under reference exhibited an increasing trend.The effect of interaction between mulching and fertilizer treatments was however,

Table 6 : Yield attributes and yield of maize cobs as influenced by the graded levels of chemical fertilizers and mulching

Treatments	No. of cobs/plant	No. of grain rows/cob	No. of grains/row	No. of grains/cob	1000 grain weight.	Yield of cobs (kg/ha)
Mulching						
M_0	1.04	14.18	33.48	476.00	108.80	1798.4
M_1	1.12	14.32	34.32	492.75	115.20	2067.6
S.E.M(±)	.017	.272	.462	8.80	2.034	29.64
C.D. (P=0.05)	.05	.80	1.34	25.54	5.90	85.1
Fertilizer						
F_0	1.00	13.90	31.20	435.0	102.5	1435.0
F_1	1.05	14.20	33.75	480.0	107.0	1840.0
F_2	1.05	14.25	34.50	492.0	115.0	2065.0
F_3	1.15	14.40	34.85	502.5	117.5	2180.0
F_4	1.14	14.50	35.20	511.87	118.0	2235.0
SEM(±)	.027	.430	.730	13.918	3.216	46.87
C.D. (P=0.05)	.08	1.25	2.12	40.38	9.33	135.1
Interaction						
M_0F_0	1.0	13.80	30.70	425.0	100.0	215.0
M_0F_1	1.0	14.20	33.00	470.0	104.0	1702.0
M_0F_2	1.0	14.20	34.10	485.0	112.0	1920.0
M_0F_3	1.1	14.30	34.60	495.0	114.0	2050.0
M_0F_4	1.08	14.40	35.00	505.0	114.0	2105.0
M_1F_0	1.01	14.00	31.70	445.0	105.0	1475.0
M_1F_1	1.1	14.20	34.50	490.0	110.0	1978.0
M_1F_2	1.1	14.30	34.90	500.0	118.0	2210.0
M_1F_3	1.2	14.50	35.10	510.0	121.0	2310.0
M_1F_4	1.2	14.60	35.40	518.7	122.0	2365.0
SEM(±)	.038	.609	1.103	19.683	4.548	66.282
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 7 : Residual fertility status as influenced by the graded levels of chemical fertilizers and mulching

Treatments	'N' status			'P' status			'K' status		
	M_0	M_1	Mean	M_0	M_1	Mean	M_0	M_1	Mean
F_0	248.900	256.200	252.550	11.500	12.300	11.900	110.200	116.200	113.200
F_1	257.600	268.800	263.200	11.800	12.800	12.300	117.600	128.800	123.200
F_2	262.800	291.200	277.000	12.400	13.100	12.750	119.800	141.200	130.500
F_3	280.000	302.400	291.200	12.600	13.800	13.200	130.000	151.900	140.950
F_4	296.400	317.200	306.800	12.800	15.600	14.200	146.400	157.200	151.800
Mean	269.140	287.160		12.220	13.520		124.800	139.060	
SE(±)M	3.850			0.2547			1.8005		
F	6.087			0.4027			2.8469		
MxF	8.609			.5695			4.0261		
CD M	11.169			0.738			5.223		
F	17.660			1.168			8.258		
MxF	N.S.			N.S.			N.S.		

	'N' status	'P' status	'K' status
Initial	290	13	125

NS=Non-signficant

found to be statistically non significant for the characters under reference.

Residual fertility status:

After the harvest of both the crops from the field a representative soil sample was collected from each of the plots to assess the post harvest fertility status of soil of each plot as being influenced by the fertilizer and mulching treatments.

A careful analysis of the Table-7, clearly indicated the significant influence of both mulching and fertilizer treatments on the available nitrogen, phosphorus and potassium status of the soil after the harvest of both the crops. But the effect of interaction between mulching and chemical fertilizer treatments on the available nitrogen, phosphorus, potassium status of the soil, after the harvest of the crops was found to be statistically non significant. The highest values in respect of available nitrogen, phosphorus and potassium were recorded under the treatment wherein 150% of the recommended doses of chemical fertilizers for yam were applied to the yam-maize intercropping system.

Conclusion:

With each incremental increase in the dose of chemical fertilizers, the highest length of vine (644.5cm) and the maximum number of leaves per vine at 150 days after planting (288.51 were observed under the treatment wherein 150% of the recommended doses of chemical fertilizers for yam were applied to the yam-maize intercropping system. Application of 150% of the recommended doses of chemical fertilizers for yam to the yam-maize intercropping system resulted in the production of highest yield of yam tubers (202.0q/ha).

All the growth and yield of maize cobs (2235kg/ha) relating to the maize crop exhibited the best performance under the treatment recorded wherein 150% of the recommended doses of chemical fertilizers for yam were applied to the yam-maize intercropping system. This treatment was found to be statistically at par in respect all the aforesaid characters with the preceding treatment.

The highest values in respect of available nitrogen, phosphorus and potassium after harvest of both the crops were recorded under the treatment wherein 150% of the recommended doses of chemical fertilizers of yam were applied to the yam-maize intercropping system. All these values were found to be statistically superior to those recorded under the preceding doses of chemical fertilizers. However incase of nitrogen and phosphorus the fertility status recorded under the treatment F_4 was found to be statistically at par with that recorded under the preceding fertilizer treatment (F_3). Mulching the crop with the use of farm wastes (dried leaves and stems of the tuber crops) proved beneficial to both the crops, which ultimately resulted in the higher production of yam tubers (160q/ha), cob yield (2067.6kg/ha).

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