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Effect of mulching and graded doses of fertilizer on yield and nutrient uptake of greater yam + maize intercropping system

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ABSTRACT

A field experiment was conducted for consecutive three years from 2003-04 to 2005-06 in acid laterite soil under rainfed conditions to find out the effect of mulching and graded doses of fertilizer on yield and nutrient uptake of greater yam + maize intercropping system. Conspicuous increase in yield of greater yam (21.0%) and maize (10.3%) was observed with the application of 2/ha dried farm waste as mulch. Increasing the doses of fertilizer increased the tuber and grain yield of greater yam and maize respectively. Application of 150% recommended dose of fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha) recorded 65.7%, 26.0% and 4.4% higher greater yam tuber yield and 21.5%, 7.6% and 1.8% maize grain yield over 75%, 100% and 125% recommended dose of fertilizer of greater yam respectively. Greater yam tuber yield and maize grain yield with the application of 125% recommended dose of fertilizer of greater yam (N:P:K @ 100:75:100 kg/ha) along with mulching (2 t/ha) was significantly higher than the application of 150% recommended dose of fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha). This indicated that under mulching about 25% recommended dose of fertilizer could be saved. Mulching increased 20.6% N, 25.9% P and 20.3% K higher uptake than no mulching in greater yam + maize intercropping system. Increased availability of mineral nutrition in mulched field due to favourable hydrothermal regimes in rhizosphere along with mineralization of mulched materials was responsible for this higher uptake.

Key words: Greater yam, maize, intercropping, mulching, yield, nutrient uptake.

INTRODUCTION

Greater yam (*Dioscorea alata* L.) is an important vegetable crop grown through out India (Nedunchezhiyan *et al.* 7). It is commercially cultivated in Andhra Pradesh, Kerala, Gujarat, Orissa and Tamil Nadu. In Orissa, it is one of the most priced vegetable. Greater yam being a trailing herb requires staking. Unstaked plants were devasted by anthracnose (*Colletotrichum gloeosporioides* Penz) disease. Maize was found best companion crop in greater yam cultivation under Indian conditions and reduces 60.0% anthracnose incidence and increases yield 26.3% (Nedunchezhiyan *et al.,* 6). Input management for greater yam + maize intercropping is very vital to achieve higher yields. Mulching is considered essential in rainfed conditions due to the many benefits they impact on soil rhizosphere. It reduces the soil temperatures in addition to conserving soil moisture as well as weed control (Mishra *et al.,* 5). Application of mulch in greater yam increased the tuber yield (Budelman, 1). Fertilizer is the other major input, which influence the crop growth and yield tremendously. Nnoke *et al*. (8) reported maize grain yield, cassava root and greater yam tuber yield increased significantly with increasing fertilizer rates in greater yam, maize and cassava intercropping. However, the effect of mulching along with fertilizer doses for yam and maize intercropping is not available. Hence the present investigation was carried out.

MATERIALS AND METHODS

The field experiment was conducted for consecutive three years (2003-04 to 2005-06) in acid laterite soil under rainfed conditions at the Regional Centre of Central Tuber Crops Research Institute, Dumduma, Bhubaneswar. The climate of the region is characterized by hot and humid summer and cold and dry winter. The average annual rainfall is 1400 mm in 55 rainy days. The average maximum temperature ranges between 29.0 and 38.9º C, whereas the average minimum temperature ranges between 14.9 and 26.7ºC. July and August are the highest rains receiving months. The soil was having pH 5.2, available nitrogen 262 kg/ha, available phosphorus 18.2 kg/ha and available potassium 132 kg/ha before start of the experiment. The water holding capacity of the soil was 12.4%.

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The experiment was conducted in split plot with four replications. Main plot treatment consisted of no mulching (M0) and mulching (M1) and sub plot treatment consisted of four levels of fertilizers (F1: 75% recommended dose of fertilizer of greater yam (N:P:K @ 60:45:60 kg/ha), F2: 100% recommended dose of fertilizer of greater yam (N:P:K @ 80:60:80 kg/ha), F3: 125% recommended dose of fertilizer of greater yam (N:P:K @ 100:75:100 kg/ha) and F4: 150% recommended dose of fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha). In mulching treatments, dried farm waste 2 t/ha was applied as mulch. The recommended dose of fertilizer of greater yam was N:P:K @ 80:60:80 kg/ha. A uniform dose of FYM 10 t/ha was applied. Total P was applied during the last ploughing. N and K were applied in two equal splits at 30 and 60 days after planting immediately after weeding. The main crop greater yam variety 'Hinjalicut' tubers of 200 g was planted in 30 x 30 x 30 cm size pits at 90 x 90 cm spacing. One row of maize variety 'Navjot' was sown as intercrop in between two rows of greater yam with intra row spacing of 30 cm (37037 plants/ha) immediately after greater yam planting. Greater yam was trailed on maize one month after planting. Maize cobs were harvested at physiological maturity stage of 90 days after sowing and the haulms were left in the field as such. Greater yam was harvested seven months after planting by careful digging the tubers.

RESULTS AND DISCUSSION

Marked variation in yield attributing characters of greater yam was noticed with mulching (Table 1). Significantly higher tuber girth and tuber yield per plant was obtained with mulching. However, no significant influence on tuber length was noticed with mulching. Similarly mulching has influenced yield attributes of maize (Table 1). Significantly higher grain number/cob was noticed with mulching. Number of cobs/plant and 1000 grain weight were though not significant but higher in mulching than no mulching.

Distinguished variation in yield attributes of greater yam was noticed with the graded doses of fertilizer application (Table 1). Significantly higher greater yam tuber girth and tuber yield per plant was noticed with the application of 150% recommended dose of fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha) compared to other treatments (Table 1). However, it was comparable with 125% recommended dose of fertilizer of greater yam (N:P:K @ 100:75:100 kg/ha). Higher amount of nutrients (N, P and K) available to the crops in these treatments might be responsible for higher yield attributes compared to other treatments. Significantly lower tuber girth and tuber yield per plant was noticed with 75% recommended dose of fertilizer of greater yam (N:P:K @ 60:45:60 kg/ha) (Table 1). Levels of fertilizer were found no effect on tuber length. In maize, graded doses of fertilizer application have significant effect on grains/cob. Levels of fertilizer have no effect on number of cobs/plant and 1000 grain weight.

Significant influence of mulching on greater yam tuber

Table 1. Influence of mulching and graded doses of fertilizer on yield attributes of greater yam and maize (Pooled data of 3 years)

Treatment	Greater yam			Maize		
	Tuber length (cm)	Tuber girth (cm)	Tuber yield (g/plant)	No. of cobs /plant	No. of grains/ cob	1000 grains weight (g)
Mulching						
No mulching	16.2	9.2	1230	1.1	241.5	226
Mulching (2 t/ha dried farm waste)	16.3	9.8	1495	1.2	263.2	230
CD (P=0.05)	NS	0.2	104	NS	11	NS
Graded doses of fertilizers						
75% of rec. fertilizer of greater yam (N:P:K @ 60:45:60 kg/ha)	16.1	8.9	965	1.1	225.8	228
100% of rec. fertilizer of greater yam (N:P:K @ 80:60:80 kg/ha)	16.2	9.4	1290	1.1	251.7	231
125% of rec. fertilizer of greater yam (N:P:K @ 100:75:100 kg/ha)	16.4	9.7	1560	1.2	263.8	233
150% of rec. fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha)	16.5	9.9	1635	1.2	268.2	233
CD (P=0.05)	NS	0.3	152	NS	16	NS

NS= Not significant

yield was noticed (Table 2). Mulching increased 21.0% greater yam tuber yield over no mulching (Table 2). This higher yield was due to higher yield attributes (Table 1). Ikeorgu and Igwilo (2) also reported similar findings.

Appreciable variation in greater yam tuber yield was noticed with the graded doses of fertilizer application (Table 2). Application of 150% recommended dose of fertilizer of greater yam recorded significantly higher yield compared to other treatments (Table 2). However, it was comparable with 125% recommended dose of fertilizer of greater yam. Application of 150% recommended dose of fertilizer of greater yam registered 65.7% higher yield over 75% recommended dose of fertilizer of greater yam, 26.0% higher yield over 100% recommended dose of fertilizer of greater yam (N:P:K @ 80:60:80 kg/ha) and 4.4% higher yield over 125% recommended dose of fertilizer of greater yam (Table 2). Application of 125% recommended dose of fertilizer of greater yam recorded 58.3% higher yield over 75% recommended dose of fertilizer of greater yam and 20.8% higher yield over 100% recommended dose of fertilizer of greater yam. Higher yield attributes (Table 1) and nutrient availability might be responsible for higher yield in higher levels of fertilizer application. However, crop did not significantly respond beyond 125% recommended dose of fertilizer of greater yam. The increase in yield was meager 4.4% by application of 150% recommended dose of fertilizer of greater yam. This indicated crop unable to utilize the applied fertilizer at higher doses under rainfed conditions. The lowest greater yam yield was noticed with 75% recommended dose of fertilizer of greater yam (Table 2). This was due to lesser yield attributes and insufficient nutrients (N, P and K) available to the crop.

Significant interaction was noticed between mulch and fertilizer application (Table 2). Significantly higher greater yam tuber yield was obtained with the highest level of fertilizer application of 150% recommended dose of fertilizer of greater yam along with mulching compared other treatments. However, it was comparable with 125% recommended dose of fertilizer of greater yam along with mulching. Greater yam tuber yield with the application of 125% recommended dose of fertilizer of greater yam along with mulching was significantly higher than 150% recommended dose of fertilizer of greater yam. Similarly tuber yield with 125% recommended dose of fertilizer of greater yam without mulching was comparable with application of 100% recommended dose of fertilizer of greater yam along with mulching. Greater yam tuber yield with 100% recommended dose of fertilizer of greater yam without mulching was on par with 75% recommended dose of fertilizer of greater yam with mulching. This indicated that mulches contributes considerable amount of nutrients for crop growth and development apart from conserving soil moisture and reducing soil temperature (Kundu *et al.* 4). Thus under mulching about 25% recommended dose of fertilizer could be saved.

Marked variation in maize yield was observed with mulching (Table 3). An increase of 10.3% maize yield was noticed with mulching than no mulching (Table 3). The increase in yield under mulching was due to increase in yield attributes like number of grains/cob (Table 1). Kathmale *et al*. (3) also reported similar findings in groundnut. Responses of maize to fertilizer application was found with the increasing level of fertilizer increased the yield (Table 3). However at higher level of fertilizer application the yield increase was very less. The maize yield with 150% recommended dose of fertilizer of greater yam and with 125% recommended dose of fertilizer of greater yam were on par. Significantly lower yield was noticed with 75% recommended dose of fertilizer of greater yam.

The interaction effect between mulch and fertilizer application on maize yield was distinguishable (Table 3). Maize grain yield with the application of 150% recommended dose of fertilizer of greater yam along with mulching was on par with 125% recommended dose of fertilizer of greater yam along with mulching. However,

Table 2. Effect of mulching and graded doses of fertilizer on greater yam yield (pooled data of 3 years).

Treatment	Greater yam tuber yield (kg/ha)		
	No mulching	Mulching	Mean
75% of rec. fertilizer of greater yam(N:P:K @ 60:45:60 kg/ha)	10109	13451	11780
100% of rec. fertilizer of greater yam(N:P:K @ 80:60:80 kg/ha)	13689	17294	15492
125% of rec. fertilizer of greater yam(N:P:K @ 100:75:100 kg/ha)	17027	20386	18707
150% of rec. fertilizer of greater yam(N:P:K @ 120:90:120 kg/ha)	18460	20587	19523
Mean	14821	17930	
CD (P=0.05): Mulching:		822	
Doses of fertilizer		1202	
Interaction:		1694	

Table 3. Effect of mulching and graded doses of fertilizer on maize yield (pooled data of 3 years)

Treatment	Maize grain yield (kg/ha)		
	No mulching	Mulching	Mean
75% of rec. fertilizer of greater yam(N:P:K @ 60:45:60 kg/ha)	1786	2024	1905
100% of rec. fertilizer of greater yam(N:P:K @ 80:60:80 kg/ha)	2036	2267	2151
125% of rec. fertilizer of greater yam(N:P:K @ 100:75:100 kg/ha)	2177	2366	2272
150% of rec. fertilizer of greater yam(N:P:K @ 120:90:120 kg/ha)	2221	2405	2314
Mean	2055	2266	
CD (P=0.05): Mulching:		63	
Doses of fertilizer:		92	
Interaction		130	

maize grain yield with the application of 125% recommended dose of fertilizer of greater yam along with mulching was significantly higher than 150% recommended dose of fertilizer of greater yam. Similarly maize grain yield with 125% recommended dose of fertilizer of greater yam without mulching and 100% recommended dose of fertilizer of greater yam along with mulching as well as 100% recommended dose of fertilizer of greater yam without mulching and 75% recommended dose of fertilizer of greater yam with mulching were comparable. The yield responses due to interaction effect of mulching and graded doses of fertilizer application in maize followed similar trends of greater yam. Kundu *et al*. (2006) also reported higher yield in sweet potato under mulching.

Nutrients uptake of greater yam tubers and maize grains were computed from the greater yam + maize intercropping system. The vegetative parts of greater yam and maize were not included in the uptake calculation because they were retained/applied back on the field. Notable variation in NPK uptake was noticed with mulching (Table 4). Mulching increased 20.6% N, 25.9% P and 20.3% K higher uptake than no mulching in greater yam + maize intercropping system. Maize uptake was 2.0% N, 3.8% P and 2.6% K and greater yam uptake was 18.6% N, 22.1% P and 17.7% K of the total uptake. Increased availability of mineral nutrition in mulched field due to favourable hydrothermal regimes in rhizosphere along with mineralization of mulched materials was responsible for this higher uptake. Higher nutrients uptake of greater yam was due to higher yield and nutrients contribution from mulches as well as maize haulms. Roy Chowdhury *et al*. (9) also reported similar findings in sweet potato.

Marked variation in NPK uptake by greater yam + maize intercropping system was recorded for the graded levels of fertilizer application (Table 4). Uptake of NPK by crops increased with the increase of the levels of NPK. The higher NPK uptake of greater yam + maize intercropping system was noticed with the application of 150% recommended dose of fertilizer of greater yam. Application of 150% recommended dose of fertilizer of greater yam recorded 61.7% N, 67.1% P and 57.9% K higher uptake over 75% recommended dose of fertilizer of greater yam, 23.1% N, 22.8% P and 21.7% K higher over 100% recommended dose of fertilizer of greater yam and 3.8% N, 3.2% P and 3.6% K higher uptake over 125% recommended dose of fertilizer of greater yam (Table 4). Application of 125% recommended dose of fertilizer of greater yam recorded 55.7% N, 61.8% P and 52.4% K higher uptake over 75% recommended dose of fertilizer of greater yam and 18.5% N, 18.9% P and 17.5% K higher uptake over 100% recommended dose of fertilizer of greater yam. Higher uptake of nutrition in higher levels of fertilizer application was due to higher nutrients availability to the crop and higher yield (Table 4). Lower uptake of NPK in 75% recommended dose of fertilizer of greater yam was due to lower yield.

Thus, greater yam tuber yield and maize grain yield with the application of 125% recommended dose of fertilizer of greater yam (N:P:K @ 100:75:100 kg/ha) along with mulching (dried farm waste 2 t/ha) was found significantly higher than the application of 150% recommended dose of fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha) with out mulching. Thus under mulching about 25% recommended dose of fertilizer could be saved. The yield and nutrient uptake between 125% recommended dose of fertilizer of greater yam and 150% recommended dose of fertilizer of greater yam under mulching was 4.4% and below 4.0% (3.8% N, 3.2% P and 3.6% K) respectively. Hence, greater yam + maize intercropping system a fertilizer dose of N:P:K @ 100:75:100 kg/ha (125% recommended dose of fertilizer of greater yam) along with mulching (2 t/ha dried farm waste) can be recommended.

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Table 4. Influence of mulching and graded doses of fertilizer on nitrogen, phosphorus and potassium uptake in greater yam + maize intercropping system (Pooled data of 3 years).

Treatment	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)		
	Greater yam	Maize	Total	Greater yam	Maize	Total	Greater yam	Maize	Total
Mulching									
No mulching	70.69	16.74	87.43	8.96	3.38	12.34	84.30	26.46	110.76
Mulching (2 t/ha dried farm waste)	86.97	18.48	105.45	11.69	3.85	15.54	103.90	29.35	133.25
CD (P=0.05)	4.22	1.30	7.24	0.72	0.08	0.82	4.56	0.86	7.21
Graded doses of fertilizers									
75% of rec. fertilizer of greater yam (N:P:K @ 60:45:60 kg/ha)	55.22	15.08	70.30	7.02	2.85	9.87	65.99	24.39	90.38
100% of rec. fertilizer of greater yam (N:P:K @ 80:60:80 kg/ha)	74.57	17.78	92.35	9.66	3.77	13.43	89.07	28.15	117.22
125% of rec. fertilizer of greater yam (N:P:K @ 100:75:100 kg/ha)	90.82	18.65	109.47	12.07	3.90	15.97	108.35	29.37	137.72
150% of rec. fertilizer of greater yam (N:P:K @ 120:90:120 kg/ha)	94.73	18.93	113.66	12.55	3.94	16.49	112.98	29.72	142.70
CD (P=0.05)	6.24	1.98	10.68	1.06	1.12	1.21	6.73	1.32	10.63

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