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Influence of Integrated Nutrient Management Practices on Soil Properties under intercropping of Groundnut with Guava based Agri–horti System

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Abstract: *The field experiment entitled was conducted in Alfisols at Students' Farm, College of Agriculture, Rajendranagar, Hyderabad during two kharif seasons. The field experiment was laid out in split plot design with three replications separately in 8 year old guava plantation. The treatments in guava based agrihorticultural system comprised of three cropping situations as main plots viz., intercropping of groundnut in nutritioned guava, intercropping of groundnut in unnutritioned guava and solecropping of groundnut and seven integrated nutrient management practices as sub plots viz., recommended dose of NPK (20:40:40), recommended dose of NPK + FYM (10 t ha^{-1}), recommended dose of NPK + vermicompost (2 t ha^{-1}), enriched FYM (750 kg ha^{-11}) with recommended dose of NPK, 50% recommended dose of NPK + FYM (10 t ha^{-1}), 50% RDF + vermicompost (2 t ha^{-1}), enriched FYM (750 kg ha^{-1}) with 50% RDF. The test variety of groundnut was TMV–2. Physical and chemical properties of soil were found to be improved under intercropping situation in guava tree plantations. Soil moisture status and bulk density improved in soil under tree plantations due to heavy leaf fall from the trees. Available N, P and K contents in soil also considerably increased in soils of both guava plantations when compared to solecropping situation. But uptake of N, P and K by the crop increased to the greater extent and solecropping of groundnut compared to intercropping of groundnut in both guava plantations.*

Keywords: *Agroforestry, guava, nutrition, Groundnut, Intercropping, Solecropping.*

INTRODUCTION

Agroforestry is proposed as a strategy to combat weather aberrations and soil degradation, improve soil fertility and increase crop yields especially in dryland areas. Panjab Singh (1987) reported that the tree based system of cropping proved to be successful in areas receiving < 1000 mm rainfall with nine months of dry season. Among the alternate land use system developed, dryland horticulture and agri–horticulture system (fruit based agroforestry systems) are readily picked up by the farmers due to cash benefits derived from these system. Gupta and Sharma (1987) also emphasized the importance of agroforestry in stabilization of income besides protection of environment. Among various dryland fruit trees, mainly guava is preferred as a perennial tree component for agrihorticultural system because of its wide adaptability to varied soil and climatic conditions. Economics of guava orchards under agrihorticultural system was evaluated with local and improved varieties and reported that the initial time lag between cash inflows and cash outflows to be minimized by growing arable crops like rainfed groundnut in the interspaces of orchards (Reddy and Sudha, 1988).

Curryleaf which is another hardy plant can also be planted as filler plant for efficient utilization of intra row space in most of the fruit trees and to increase returns in drylands. To maintain soil health and to supply nutrients in balanced proportion for higher crop yields, it is imperative to practice

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integrated nutrient supply system through the combined use of organic, biological and chemical sources of nutrients. Escalating cost of inorganic fertilizers, their undesirable impact on the physical condition of soil, erratic rainfall and poverty call for immediate inclusion of organic sources in any rainfed cropping system. Soil fertility buildup through agroforestry and practice of integrated nutrient management were suggested as potential means to increase the soil fertility especially in drylands (Subba Reddy *et al*., 1991).

Keeping in view the importance of agroforestry in soil enrichment, comprehensive studies on production potential of model agroforestry systems under integrated nutrient management practices in drylands were carried out.

MATERIAL AND METHODS

A field experiment was conducted during two *kharif* seasons at Students' Farm, College of Agriculture, Rajendranagar, Hyderabad. The experimental site was under eight years old guava plantation spaced at 8 m × 8 m. The soil in guava plantation was red sandy loam, medium in organic carbon ranges (0.66-0.67%), available N (314.5-319 kg ha^{-1}), available P (37.4-38.2 kg ha^{-1}) and available K (236-237 kg ha^{-1}) during two years of study, whereas the open area was low in organic carbon (0.28-0.30%) and available N (189.8-190.3 kg ha^{-1}), medium in available P (26.4-26.8 kg ha^{-1}) and available K (216.5-217.4 kg ha^{-1}) during two years of study.

The treatments comprised of 3 cropping situations *viz.,* intercropping of groundnut in nutritioned guava, intercropping of groundnut in unnutritioned guava and solecropping of groundnut as main plots and seven integrated nutrient management practices as sub plots *viz.,* recommended dose of NPK (20:40:40), recommended dose of NPK + FYM (10 t ha^{-1}), recommended dose of NPK + vermicompost (2 t ha^{-1}), enriched FYM (750 kg ha^{-1}) with recommended dose of NPK, 50% recommended dose of NPK + FYM (10 t ha^{-1}), 50% RDF + vermicompost (2 t ha^{-1}) and enriched FYM (750 kg ha^{-1}) with 50% RDF. The experiment was laid out in split plot design with three replications. The plot sizes were 8m × 4m in intercropping and solecropping as well. Groundnut (TMV-2) was grown as rainfed crop in the system. The total rainfall was received in the cropping season was 800 mm rainfall distributed in 41 rainy days during first year and 498 mm rainfall distributed in 35 rainy days during second year.

RESULTS AND DISCUSSION

Pod Yield

Pod yield of groundnut was significantly influenced by cropping situations and integrated nutrient management practices in both the years of study (table 1). Among the cropping situations studied, solecropping of groundnut recorded the maximum pod yield (948.2 in first year and 875.1 kg ha^{-1} in

Table 1
Pod yields (kg ha^{-1}) of groundnut as influenced by cropping situations and integrated nutrient management practices in agrihorticultural system

	I year	*II year*
Treatments	*Pod yield*	*Pod yield*
Cropping situations (CS)		
Intercropping in nutritioned guava	656.9	521.2
Intercropping in unnutritioned guava	629.4	509.5
Solecropping	948.2	875.1
SEm±	26.76	15.62
CD (P = 0.05)	74.29	43.36
Integrated nutrient management practices (INM)		
RDF (20: 40: 40 kg ha^{-1})	750.9	639.5
RDF + FYM (10 t ha^{-1})	870.9	730.5
RDF + Vermicompost (2 t ha^{-1})	955.7	847.1
Enriched FYM (750 kg ha^{-1}) with RDF	943.1	854.0
50% RDF + FYM (10 t ha^{-1})	519.3	415.9
50% RDF + Vermicompost (2 t ha^{-1})	587.5	477.9
Enriched FYM (750 kg ha^{-1}) with 50% RDF	586.6	482.1
SEm±	23.36	22.67
CD (P = 0.05)	45.37	45.99
CS × INM at main		
SEm±	38.73	39.26
CD (P = 0.05)	NS	NS
CS × INM at sub		
SEm±	67.17	41.03
CD (P = 0.05)	NS	NS

RDF (Recommended dose of NPK)

second year), which was found to be significantly higher than that of intercropping situations in both the years. Whereas, the pod yield of groundnut was not influenced significantly when grown either in nutritioned or unnutritioned guava plantations in both the years of study. Pod yield of groundnut was significantly influenced to the maximum extent under recommended dose of NPK + vermicompost as well as enriched FYM with recommended dose of NPK when compared to other integrated nutrient management practices. This was followed by recommended dose of NPK + FYM and recommended dose of NPK alone which were significantly superior to 50% recommended dose of NPK with combination of FYM or vermicompost or enriched FYM in increasing the pod yield in both the years.

The interaction effects between cropping situations and integrated nutrient management practices were found to be non–significant in influencing the pod yield of groundnut in both the years. Increase in pod yield under solecropping of groundnut was clearly due to the resultant effects of favourable plant growth and better yield attributes because of no competition from the trees in solecropping situation. Whereas under intercropping situation, tree component had affected the growth of groundnut because of its competition on light, moisture and nutrients. These results are in conformity with those of Bheemaiah and Subrahmanyam (2001). Higher pod yields obtained with recommended dose of NPK could be due to adequate supply of essential nutrients and also application of vermicompost and enrichment of FYM might have helped steady supply of nutrients because of favourable soil properties maintained throughout the crop growth period. Singh *et al*. (2001) and Das (2002) stated that an increase in pod yield of groundnut due to recommended dose of fertilizer application with combination of organic manures which might be attributed to enhanced synthesis of carbohydrates and proteins.

Effect of Cropping Systems on Physical and Chemical Properties of Soil

It was clearly evident from the data (table 2) on physical properties of soil that the physical condition of the soil improved under intercropping situation with the presence of trees with respect It was clearly evident from the data on physical properties of soil that the physical condition of soil moisture status and bulk density. Higher soil moisture status was maintained throughout the crop growth period coupled with lower bulk density under intercropping situation when compared to the soil under solecropping situation. It could be clearly attributed to the advantage of growing trees which contributed the improvement of physical condition of soil through addition of organic matter over the years and more light interception by the trees. These results are in agreement with Young (1989) that the agroforestry systems maintain more favourable soil physical properties than agricultural systems including soil structure, porosity and water holding capacity through maintenance of organic matter and the effects of roots.

From the data (table 3) recorded on chemical properties of soil, it was clearly noticed that there was an improvement in soil fertility status under intercropping situation with trees where available N, P and K in soil increased when compared to solecropping situation. Jha *et al*. (2000) also stated

Table 2
Physical and chemical properties of soil before and after cropping

	Guava plantations				*Open area (Sole)*			
Physical and chemical properties of soil	*I year*		*II year*		*I year*		*II year*	
	Before cropping	*After cropping*	*Before cropping*	*After cropping*	*Before cropping*	*After cropping*	*Before cropping*	*After cropping*
Bulk density (g cm^{-3})	1.56	1.37	1.52	1.39	1.58	1.41	1.55	1.43
P^H (1:1.25 soil:water)	6.8	6.8	6.8	6.8	7.0	7.0	7.0	7.0
Electrical conductivity (dSm^{-1} at 25^oC)	0.13	0.12	0.12	0.12	0.17	0.16	0.16	0.16
Organic carbon (%)	0.50	0.52	0.51	0.52	0.28	0.28	0.30	0.31

Table 3
Available N, P and K contents (kg ha^{-1}) in soil after harvest of groundnut as influenced by cropping situations and integrated nutrient management practices in agrihorticultural system

Treatments	*I year*			*II year*		
	N	*P*	*K*	*N*	*P*	*K*
Cropping situations (CS)						
ING	257.9	34.9	287.6	242.3	33.5	269.2
IUNG	247.4	34.5	281.5	241.8	32.8	269.0
SC	243.8	31.5	267.1	229.9	30.8	261.3
SEm±	6.62	0.15	6.73	4.15	0.38	2.29
CD (P = 0.05)	NS	0.59	NS	NS	1.49	6.35
Integrated nutrient management practices (INM)						
Recommended dose of NPK (20:40:40 kg ha^{-1})	249.3	34.0	280.1	241.4	32.8	264.9
Recommended dose of NPK + FYM (10 t ha^{-1})	260.9	35.9	292.4	251.2	34.7	284.3
Recommended dose of NPK + Vermicompost (2 t ha^{-1})	286.5	37.7	313.3	272.2	36.5	304.8
Enriched FYM (750 kg ha^{-1}) with Recommended dose of NPK	286.3	37.6	301.1	258.4	36.5	295.2
50% Recommended dose of NPK + FYM (10 t ha^{-1})	212.7	28.8	243.4	203.8	28.0	228.6
50% Recommended dose of NPK + Vermicompost (2 t ha^{-1})	231.1	31.4	264.2	222.0	29.3	246.5
Enriched FYM (750 kg ha^{-1}) with 50% Recommended dose of NPK	221.2	30.3	256.6	216.7	29.1	241.1
SEm±	7.50	0.52	6.14	6.02	0.43	6.01
CD (P = 0.05)	15.22	1.50	12.45	12.22	1.24	12.20
CS × INM at main						
SEm±	12.99	0.90	10.63	10.43	0.75	10.41
CD (P = 0.05)	NS	NS	NS	NS	NS	NS
CS × INM at sub						
SEm±	16.94	0.85	16.97	10.91	0.79	6.85
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

ING – Intercropping in nutritioned guava
NS– Non Significant
IUNG – Intercropping in unnutritioned guava
SC – Solecropping

that soil under agroforestry land use was enriched by organic carbon, nitrogen and calcium.

Maximum total N, P and K uptake by the crop was noticed under solecropping of groundnut among the cropping situations studied (table 4 and 5). The mean reduction of N and P uptake in intercropping of groundnut with nutritioned guava and unnutritioned guava was by 16.1% and 7.5% in first year and 16.7% and 8.3% in second year, respectively over solecropping of groundnut. This considerable decline in total N, P and K uptake by crop under intercropping nitrogen might be due to competition for nutrient absorption by the trees. Overall, it was observed that there was no considerable variation in improvement of soil physical and chemical properties between inter-cropping situations either with nutritioned guava or unnutritioned guava.

Effect of Integrated Nutrient Management Practices on Physical and Chemical Properties of Soil in Guava Based Agrihorticultural System

The physical properties like soil moisture status and bulk density showed favourable improvement by

Table 4
Total N uptake (kg ha^{-1}) of groundnut at harvest as influenced by cropping situations and integrated nutrient management practices in agrihorticultural system

	I year				*II year*			
Treatments	*Cropping Situations (CS)*				*Cropping Situations (CS)*			
Integrated Nutrient Management (INM)	*IPH*	*IUPH*	*SC*	*Mean*	*IPH*	*IUPH*	*SC*	*Mean*
Recommended dose of NPK (20: 40: 40 kg ha^{-1})	167.2	166.5	183.4	172.4	154.3	164.3	183.0	167.2
Recommended dose of NPK + FYM (10 t ha^{-1})	167.6	167.1	186.6	173.8	162.4	165.3	185.6	171.3
Recommended dose of NPK + Vermicompost (2 t ha^{-1})	171.3	170.6	196.2	179.4	171.2	170.3	195.4	178.9
Enriched FYM (750 kg ha^{-1}) with Recommended dose of NPK	172.2	171.6	196.6	180.1	171.0	169.2	195.0	178.4
50% Recommended dose of NPK + FYM (10 t ha^{-1})	132.1	131.4	173.9	145.8	129.9	130.5	172.9	144.4
50% Recommended dose of NPK + Vermicompost (2 t ha^{-1})	138.2	136.8	177.4	150.8	137.4	135.9	174.4	149.3
Enriched FYM (750 kg ha^{-1}) with 50% Recommended dose of NPK	137.4	136.3	176.0	149.9	137.2	135.5	175.3	149.3
Mean	155.1	154.3	184.3		151.9	153.1	183.1	

	SEm±	*CD (P = 0.05)*	*SEm±*	*CD (P = 0.05)*
CS	0.36	1.00	0.70	1.94
INM	1.12	2.27	1.26	2.55
CS × INM at main	1.94	3.93	2.17	4.41
CS × INM at sub	1.15	2.37	1.90	4.01

the way of increasing soil moisture content and decreasing bulk density due to application of organic manures like vermicompost, enrichment of FYM and FYM with combination of NPK either at 100% or 50% recommended dose of NPK when compared to recommended dose of NPK alone. These might be due to conjunctive use of organic and inorganic fertilizers which have improved the soil physical conditions and subsequently increased in nutrient status of soil. Similar results were obtained by Ilaiah (2003).

Total available N, P and K contents in soil were considerably increased with application of organic manures like vermicompost, enrichment of FYM and FYM with combination of recommended dose of NPK when compared to recommended dose of NPK alone as well as 50% recommended dose of NPK with the combination of organic manures (table 3). This could be attributed to the added advantages of application of organic manures along with recommended dose of NPK which might have contributed in more availability of nutrients coupled with favourable status of soil physically and chemically. Goswami (1996) also stated that the available nutrient content by application of vermicompost as well as their rate of release was much higher and faster than the normal compost. Similarly Palaniappan and Annadurai (1992) reported that enriched FYM is recommended to rainfed crops, which require available P for their root proliferation to withstand the initial stages under dryland conditions.

Total uptake of N, P and K by groundnut was found to be maximum with the application recommended dose of NPK along with vermicompost as well as enrichment of FYM among all the integrated nutrient management practices studied (table 4 and 5). Application of FYM along with recommended dose of NPK was also found better in increasing total N, P and K uptake when compared to recommended dose of NPK alone. Application of 50% recommended dose of NPK with different organic manures combination showed reduction in total N, P and K uptake when compared

Table 5
Total P and K uptake (kg ha^{-1}) of groundnut at harvest as influenced by cropping situations and integrated nutrient management practices in agrihorticultural system

	I year		*II year*	
Treatments	*P*	*K*	*P*	*K*
Cropping situations (CS)				
ING	17.0	146.1	16.2	140.8
IUNG	16.4	137.4	15.3	134.8
SC	18.0	137.6	17.2	132.8
SEm±	0.14	3.87	0.21	4.82
CD (P = 0.05)	0.54	NS	0.82	NS
Integrated nutrient management practices (INM)				
Recommended dose of NPK (20: 40: 40 kg ha^{-1})	17.4	140.6	17.0	136.3
Recommended dose of NPK + FYM (10 t ha^{-1})	19.3	145.6	18.8	140.8
Recommended dose of NPK + Vermicompost (2 t ha^{-1})	21.3	171.3	19.9	163.2
Enriched FYM (750 kg ha^{-1}) with Recommended dose of NPK	20.3	162.4	19.1	157.0
50% Recommended dose of NPK + FYM (10 t ha^{-1})	13.4	115.2	12.7	114.4
50% Recommended dose of NPK + Vermicompost (2 t ha^{-1})	14.4	126.6	13.3	121.3
Enriched FYM (750 kg ha^{-1}) with 50% Recommended dose of NPK	13.9	120.9	13.0	120.0
SEm±	0.55	5.45	0.35	3.75
CD (P = 0.05)	1.56	11.06	1.02	7.61
CS × INM at main				
SEm±	0.94	9.44	0.61	6.50
CD (P = 0.05)	NS	NS	NS	NS
CS × INM at sub				
SEm±	0.88	10.14	0.61	12.05
CD (P = 0.05)	NS	NS	NS	NS

to recommended dose of NPK alone or with the combination of organic manures. The higher nutrient uptake by the crop with proper dose of N, P and K was mainly due to improvement in vegetative and reproductive structures of the plant. Further, application of organic manures namely vermicompost and enrichment of FYM might have contributed in improving the availability of nutrients because of aggregation of soil particles with more pore space and better aeration resulting in higher uptake of nutrients by the crop. Similar results were reported by Tolessa *et al.* (2001) and Madhukar Rao (2005).

CONCLUSION

The combined use of organic and inorganic fertilizers in groundnut crop showed better response when grown in rainfed areas, because of adequate supply of nutrients coupled with improvement of soil physical and chemical properties. Application of 100% recommended dose of NPK with organic manures like FYM, vermicompost and enriched FYM along showed favourable results on performance of groundnut grown either as solecrop or intercrop of groundnut in tree plantation when compared to those with application 50% recommended dose of NPK along with organics.

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