



## Effect of integrated nutrient management on the growth and yield of groundnut (*Arachis hypogaea*) in coastal region of Karaikal

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### ABSTRACT

To study the effect of integrated nutrient management on the growth and yield of groundnut (*Arachis hypogaea* L.) field experiments were conducted during summer (March to June) seasons of 2003 and 2004 at Karaikal, Pondicherry. The 13 treatments consisted of combinations of 3 levels of recommended dose of fertilizers [RDF i.e. 17-34-54 kg N-P-K/ha (75, 100 and 125%)], 4 organic manures (no manure, FYM 12.5 tonne/ha, naturally decomposed coirpith 12.5 tonne/ha and enriched compost (EC) 5 tonne/ha) along with a control receiving no organics or fertilizers. The results revealed that application of 125% RDF + 5 t/ha EC increased growth and yield attributes that led to its significantly higher productivity (2.25 and 5.00 tonne/ha of mean pod and haulm yield), and nutrient uptake of groundnut besides enriching soil available nutrients after harvest of groundnut. However, due to high cost of manuring, RDF recorded the highest mean net returns (Rs 16,996/ha) and B:C ratio (2.02). If the 75% subsidized cost of EC as given in Pondicherry is taken into consideration combination of 125% RDF + 5 tonne/ha EC was found promising (Rs. 19,364/ha) to that of RDF.

**Key words:** Economics, Groundnut, Inorganics, Nutrient uptake, Organic manure, Yield

India is one of the largest producers of oilseeds in the world accounting for 8% of the global oilseeds production using 14% of the world land area and notified as the second largest producer of groundnut (*Arachis hypogaea* L.). As per Indian Council of Medical Research (ICMR) recommended consumption of 20 g edible oil /day/person, by 2020 A D, India requires around 20.3 million tonnes of edible oil. To meet this demand, it is essential to enhance the productivity of prominent oilseed crops of the country like groundnut through location specific nutrient management practices. To augment groundnut production, Food and Agricultural Organization (FAO) conceptualized the idea of integrated use of all possible and available resources of plant nutrients in a crop and cropping system for better resource use. It is not only a reliable way of obtaining fairly higher yields with substantial fertilizer economy, but also a concept that is ecologically sound leading to sustainable agriculture. High productivity through crop intensification is the primary goal of agronomic research. But to sustain high productivity over a longer period, soil fertility has to be maintained at fairly high level. Hence, nutrient management strategies should be aimed at achieving these twin goals with minimum cost. The rapid increase in food pro-

duction over the past three decades was at the cost of corresponding increase in the removal of nutrient from the soil. The removal of major nutrients (NPK) at the present level of crop production has been estimated at 125 kg/ha whereas, the annual addition is hardly 75 kg/ha, resulting in depletion of nutrient reserves of soil (Tandon, 1994). The negligence shown to the conservation and use of organic sources of nutrients has not only caused the exhaustion of soil nutrient reserves but also resulted in an imbalance among the available nutrients leading to soil problems. Though many studies have been carried out in groundnut crop, the location specific study on integrated nutrient management for the farmers of Karaikal region in tail end of *Cauvery* delta zone is lacking. Therefore a study was initiated to evaluate the various integrated nutrient management packages on the growth and yield of summer irrigated groundnut.

### MATERIALS AND METHODS

A field experiment on groundnut was conducted at the East farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal (10°55' N, 79°52' E and 4 m above mean sea level) during summer season of 2003 and 2004 under irrigated conditions. Karaikal region coming under Coastal deltaic alluvial plain zone, with tropi-

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cal climate received 103.3 and 228.8 mm, rainfall during 2003 and 2004, respectively. The daily mean maximum and minimum temperatures for the cropping period were 35.7° and 25.8 °C during 2003, and 34.2 and 25.2 °C during 2004, respectively. The experimental soil was neutral in reaction (pH 7.3 and 7.4), EC (0.24 and 0.27 dS/m), medium in organic matter (0.53 and 0.51%), low available N (190 and 182 kg/ha), medium available P (20.5 and 19.2 kg/ha) and available K (180 and 173 kg/ha). The treatments consisted of combination of 3 recommended dose fertilizers (RDF, 17-34-54 kg N-P-K/ha) *i.e.* 75, 100 and 125% RDF and 3 organic manures; FYM @12.5 tonne/ha, Naturally Decomposed Coirpith (NDCP) @ 12.5 t/ha and Enriched compost (EC) @ 5 tonne/ha along with control that received no manures and fertilizers. The RDF and manures as per treatment was applied at sowing. Gypsum was applied uniformly @ 400 kg/ha at 45 days after sowing uniformly. FYM, EC and NDCP contained 0.55, 0.50 and 0.33% N, 0.30, 2.05 and 0.79% P and 0.60, 0.39 and 0.79% K, respectively. The experiment was laid out in a randomized block design with 4 replications. The growth, yield attributing characters and yield as well as nutrient uptake were recorded at harvest. Nutrient (NPK) concentration in plant samples and post-harvest soil were determined as per standard procedures. The economics were worked out using market price of inputs and minimum support prices of output.

## RESULTS AND DISCUSSION

### Growth attributes

Each successive increase in RDF from control to 75 % RDF and from 75 to 125% significantly increased plant

height and leaf area index (LAI) during both the years. Integration of organic manures with various levels of RDF markedly enhanced plant height and LAI over fertilizers alone. Use of organic manures produced impacts equal to 25% of additional RDF and for this among organic manures, EC proved superior to FYM and NDCP. EC along with 125% RDF recorded significantly higher plant height and LAI among all the treatments, while unfertilized control has the lowest values of these parameters. The increase in the level of nutrients through fertilizer and organics might have increased the plant height by the promotion of growth characters by rapid meristematic activity in plants. Similar findings were reported by Subrahmaniyan *et al.* (2000). The association of nutrient elements from inorganics and organics produced more number of leaves resulting in higher LAI. Particularly, association of phosphorus nutrient with cell division, cell elongation and photosynthesis might have helped the plants to produce more LAI. Further, application of K in higher dose through 125% RDF in combination with EC might also have increased leaf size. This is in accordance with the findings of Barik *et al.* (1994). The increase in plant height, LAI together resulted in significant increase dry matter production (DMP). 125% RDF + EC treatment recorded significantly higher DMP than all other treatments (6.97 tonne/ha, mean of 2 years).

### Yield attributes

The different combinations of fertilizers and manures had significant influence on the pods/plant only (Table 1). Application of 125% RDF + EC significantly increased the number of pods/plant (27.1, mean) over rest of the treat-

**Table 1.** Influence of nutrient management practices on growth and yield attributes of groundnut

Treatment	Plant height (cm)		LAI (90 DAS)		Dry matter production (t/ha)		Pods/plant		Kernels/pod		Test weight (g)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
75 % RDF	44.2	46.0	4.4	5.0	6.11	6.18	17.5	17.4	1.9	1.8	265	267
RDF	45.2	48.3	5.3	5.9	6.33	6.35	24.3	23.2	1.9	1.9	296	284
125 % RDF	46.9	50.3	6.3	6.2	6.54	6.52	21.2	18.5	1.9	1.8	272	275
75 % RDF + FYM	45.2	48.2	5.0	5.7	6.46	6.44	19.5	19.4	1.8	1.8	253	258
RDF + FYM	47.1	49.9	5.6	6.2	6.63	6.53	22.2	21.4	1.7	1.8	263	276
125 % RDF + FYM	48.6	51.8	6.1	6.5	6.79	6.65	24.7	23.8	1.8	1.8	284	287
75 % RDF + NDCP	45.3	48.5	4.9	5.6	6.31	6.24	19.5	19.3	1.9	1.9	266	271
RDF + NDCP	46.4	49.5	5.3	6.1	6.53	6.46	22.0	22.3	1.9	1.8	273	284
125 % RDF + NDCP	48.0	51.4	5.8	6.4	6.70	6.55	23.7	22.7	1.9	1.8	284	291
75 % RDF + EC	47.7	51.0	5.3	6.1	6.60	6.56	23.5	23.4	1.9	1.8	276	283
RDF + EC	49.4	52.4	5.7	6.6	6.79	6.74	24.7	24.5	1.8	1.8	297	317
125 % RDF + EC	51.7	54.0	6.8	6.8	7.08	6.86	27.8	26.3	1.8	1.8	307	324
Control	37.6	39.8	3.8	4.2	4.62	4.56	15.8	13.1	1.9	1.9	250	245
SEm ±	0.1	0.2	0.1	0.1	0.03	0.03	0.4	0.4	0.03	0.03	15	12
CD (P= 0.05)	0.3	0.9	0.5	0.3	0.12	0.12	1.5	1.7	NS	NS	NS	NS

**Table 2.** Influence of nutrient management practices on haulm, pod yield and economics (Rs/ha) of groundnut

Treatment	Haulm yield		Pod yield		Economics					
	(t/ha)		(t/ha)		2003			2004		
	2003	2004	2003	2004	Cost of cultivation	Net returns	B:C ratio	Cost of cultivation	Net returns	B:C ratio
75 % RDF	4.66	4.30	1.80	1.69	16,179	12,537	0.77	16,449	12,410	0.75
RDF	4.84	4.38	2.02	2.04	16,479	15,929	0.97	16,756	18,062	1.08
125 % RDF	4.93	4.56	1.91	1.89	16,779	13,839	0.82	17,063	15,251	0.89
75 % RDF + FYM	4.96	4.44	1.86	1.84	19,034	10,792	0.57	19,454	11,987	0.62
RDF + FYM	5.00	4.58	1.96	1.92	19,334	12,207	0.63	19,761	13,254	0.67
125 % RDF + FYM	5.13	4.70	2.06	2.08	19,634	13,793	0.70	20,068	15,704	0.78
75 % RDF + NDCP	4.83	4.42	1.83	1.85	19,434	9,797	0.50	19,879	10,947	0.55
RDF + NDCP	4.92	4.52	1.76	1.90	19,734	8,710	0.44	20,186	11,755	0.58
125 % RDF+NDCP	5.07	4.63	1.90	2.00	20,034	10,776	0.54	20,493	13,367	0.65
75 % RDF + EC	4.97	4.48	1.92	1.96	23,949	6,914	0.29	24,219	9,112	0.38
RDF + EC	5.07	4.68	2.06	2.01	24,249	9,369	0.39	24,526	10,373	0.42
125 % RDF + EC	5.22	4.81	2.26	2.25	24,549	12,714	0.52	24,833	14,613	0.59
Control	4.05	3.89	0.95	0.96	15,195	-167	-0.01	15,444	681	0.04
SEm±	0.04	0.04	0.06	0.05						
CD (P= 0.05)	0.12	0.16	0.16	0.15						

ments in both the years while absolute control resulted in the lowest number of pods/plant (14.0). Application of 25% extra level of fertilizers over RDF + EC might have promoted higher growth rate from the early stage onwards in terms of plant height, LAI as well as DMP. Thus, the optimum growth of the plant due to a favourable nutritional environment and higher uptake of nutrients might have favoured significant increase in number of pegs/plant and thus more number of pods/plant. This is in agreement with the findings of Gogoi *et al.* (2000). RDF in combination with FYM/NDCP, 75% RDF + EC and RDF + EC are at par with each other during both the years of study. Though the differences in test weight among treatments were not significant, 125% RDF + EC recorded the highest values (315.5 g).

#### Yield

The nutrient management practices had significant influence on pod and haulm yield of groundnut during both the years (Table 2). The pod and haulm yield were significantly higher at 125% RDF + EC. This was followed by 125% RDF + FYM, RDF + EC and RDF alone and they were on par with each other. The absolute control recorded the lowest pod and haulm yields. Application of 125 % RDF + EC increased the pod and haulm yields significantly over all other treatments during both the years. However, the haulm yield of 125% RDF + EC and 125% RDF + FYM in both the years and RDF + EC in 2004 were at par. The increase in pod yield was significant up to RDF only. Increase in RDF to 125% decreased pod yields; while the haulm yields continued to increase signifi-

cantly (2004) and non significantly (2003) over RDF. Higher pod yield could be attributed to favourable changes in physical and chemical characteristics of the soil which might have enabled better pod formation. Moreover, the positive influence of these treatments through immediate supply of nutrients from inorganic sources especially at the early stage of the crop and slow and steady supply of nutrients from EC as well as FYM throughout the crop growth period might have improved adequate biomass production and improvement in yield parameters resulting in higher pod and haulm yield. Earlier reports also confirmed the significant increase in pod yield of groundnut due to organic manure application (Rao and Shaktawat, 2001).

#### Nutrient uptake and soil nutrient status

Application of inorganic fertilizers in combination with organic manures had significantly influenced the N, P and K uptake by groundnut crop during both the years of study (Table 3). Among the treatments, application of 125% RDF + EC recorded significantly higher N, P and K uptake than rest of the treatments. This was followed by 125% RDF + FYM and RDF + EC and they are at par. The uptake of major nutrients increased with higher levels of fertilizer and organic amendments application. Similar results were reported by Sharma and Sharma (2006). Among the different organic manure combination with fertilizers, FYM and NDCP registered comparatively lower P uptake owing to wider C: N ratio as compared to EC. The application of higher doses of mineral K with organics favoured higher root and shoot development

which might have also increased the uptake of K. The EC, besides supplying major and minor plant nutrients, might have influenced the soil physical properties favourably resulting in better soil structure, greater water retention, more favourable environment for root and pod development ultimately registering increased nutrient uptake. This is evidenced from the reports of Hegde (1998).

The different levels of fertilizers and manures significantly influenced the soil available nutrients (NPK) after harvest of groundnut crop during both the years of study (Table 3). The soil available N and K was maximum in 125% RDF + EC and it was significantly superior to rest of the treatments. This was followed by RDF + EC and evenly comparable with 125% RDF + NDCP in 2003. During 2004, 125% RDF + EC has at par soil N with RDF + EC. The N availability in the soil was found to be increased by 16% over initial values with 125% RDF + EC. Whereas, in control N availability was found to be decreased by 14% over its initial values. The rate of release of nutrients from organic manure may depend on initial chemical composition together with the stage of composting. The highest enrichment of N availability in soil due to addition of EC may be attributed to its narrow C:N ratio. Application of EC with fairly high amounts of N than FYM and NDCP, increased the post harvest soil available N due to the mineralization of organically bound N.

The K availability in the soil was also found to decrease irrespective of the treatments over the initial values. The reduction of available K in soil is due to the addition of large amounts of fertilizer K generally results in increased K fixation because solution K concentration is greatly in-

creased, pushing the equilibrium between soluble and fixed K toward the fixed K pool (Prasad and Power, 1997).

The soil available P was highest in 125% RDF + FYM and it was comparable with 125% RDF + EC in 2003. During 2004, application of 125% RDF + EC maintained higher soil available P and this was followed by 125% RDF + NDCP, RDF + FYM, 75% RDF + EC and 125% RDF + FYM in order and they are all on par with each other. The P availability in the soil was also found high (34%) with the 125% RDF + FYM and was comparable with 125% RDF + EC (33%) in first year whereas, in second year 125% RDF + EC registered higher (44%) soil available P over control. The P availability in the soil was found to be increased by 22% over initial values with 125% RDF + FYM. Whereas, in control the P availability was found to be decreased by 19% over its initial values. The added organic manures *viz.*, FYM and EC might have promoted the release of native soil P (Mohanty *et al.*, 2006) due to the fact that the organic anions compete with phosphate ions for the binding sites on the soil particles and the complex organic anions chelate  $Al^{3+}$ ,  $Fe^{3+}$  and  $Ca^{2+}$  and thus decrease the phosphate precipitating power of these cations, increasing the solubility and desorption of P.

### Economics

The economics (Table 2) data reveal that the net return and B: C ratios were highest with the application of RDF during both the years. The highest cost of cultivation with organic manures {(Rs 3,000 (12.5 t FYM/NDCP) to Rs. 8,000 (5 tonne EC)} their combination with various RDF levels proved less profitable. However, if the 75% subsidy of Pondicherry Government on EC is taken into consider-

**Table 3.** Influence of nutrient management practices on nutrient uptake of groundnut and nutrient status (kg/ha) of soil after harvest

Treatment	Plant uptake						Soil available status					
	N		P		K		N		P		K	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
75 % RDF	142	146	16.6	16.3	66	64	188	182	19.1	18.4	170	162
RDF	150	152	17.5	17.7	70	66	194	188	20.3	19.7	172	164
125 % RDF	156	154	18.1	18.4	72	69	196	194	21.0	20.4	172	166
75 % RDF + FYM	153	150	17.9	17.4	70	67	189	185	20.6	19.9	170	163
RDF + FYM	159	151	18.1	17.8	71	69	193	192	22.0	21.3	171	164
125 % RDF + FYM	165	159	19.3	18.2	73	71	201	197	22.7	21.2	174	169
75 % RDF + NDCP	150	143	17.6	16.9	69	64	192	187	20.7	20.2	172	164
RDF + NDCP	150	147	17.9	17.1	70	65	199	196	21.2	20.9	172	168
125 % RDF+NDCP	158	149	19.2	18.3	73	68	209	202	22.4	21.5	172	170
75 % RDF + EC	156	152	18.9	17.2	72	65	197	193	21.7	21.3	173	171
RDF + EC	164	158	19.8	18.5	75	68	209	208	21.9	20.8	174	173
125 % RDF + EC	175	167	21.0	20.4	78	72	220	210	22.6	22.4	175	175
Control	119	116	13.2	12.6	54	51	160	159	16.9	15.5	149	142
SEm ±	1	1	0.1	0.2	0.4	1	1	1	2.0	0.3	0.3	2
CD (P= 0.05)	4	5	0.4	0.9	2	4	3	4	7.0	1.3	1.3	7

Initial soil status: Available N (190 and 182 kg/ha), available P (20.5 and 19.2 kg/ha) and available K (180 and 173 kg/ha)

ation, the manuring share in cost of cultivation (*i.e.* Rs 6,000), will make 125% RDF + EC, the most profitable treatment.

It was concluded that in areas where organics are available at cheaper prices, 125% RDF along with 5 tonne/ha of enriched compost and in places, where organics could not be recycled within the farm, RDF *i.e.* 17-34-54 kg N-P-K/ha could be recommended for higher yield and profit in groundnut crop in Karaikal region of Union Territory of Pondicherry.

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