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Integrated nutrient management for groundnut (*Arachis hypogaea*)–horsegram (*Macrotyloma uniflorum*) cropping sequence under rainfed Entisol

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ABSTRACT

A field experiment was conducted during 1999 and 2000 to evaluate the effect of integrated nutrient management with 4 levels of N and 3 integrating factors (bio-fertilizer, enriched farmyard manure and composted coirpith) for groundnut (*Arachis hypogaea* L.)–horsegram [*Macrotyloma uniflorum* (Lam) Verdc.] cropping sequence under rainfed condition in a red loamy sand soil. The use of composted coirpith provided better nutritional environment in the soil for groundnut and also the residual horsegram crop. The 75 and 100% soil test-based levels of N along with composted coirpith rated better, accounting for higher yields in both the crops. The uptake also was more with N level of 75% and beyond, irrespective of the integrating factors.

Key words : Groundnut–horsegram, Integrated nutrient management, Soil-test-based N, Composted coirpith, Biofertilizer, Enriched FYM

Groundnut is an important oilseed crop, grown in an area of about 0.125 million ha. Horsegram is being raised as a follow-up crop in the rainfed red loamy sand soils (Typic Ustorthent) of North–Western zone of Tamil Nadu. The productivity of both the crops is far below the national average due to several inherent soil-related constraints, viz. coarse texture, low organic matter and poor soil fertility. With the economic condition of the farmers being very poor, the increasing cost of fertilizer makes it imperative that the concept of integrated nutrient management (INM) will have to be evolved for achieving better yields at minimum cost. Hence an experiment was conducted to study management for the groundnut–horsegram cropping sequence .

MATERIALS AND METHODS

The field experiment was conducted with groundnut in the rainy season (*kharif*) seasons of 1999 and 2000, followed by horsegram in the winter (*rabi*) season at the Regional Research Station, Paiyur. Tamil Nadu. The soil was loamy sand in texture, having pH 7.6, low organic carbon (0.28%), available N (136 kg/ha), available P (12.0 kg/ha) and medium in available K (252 kg/ha). The treatments consisted of 4 levels levels of soil test-based (0, 50, 75 and 100% STB-N) and 3 integrating factors, viz. seed treatment with bio-fertilizer *Rhizobium* (BF), enriched farmyard manure (FYM) and composted coirpith (CCP), and an absolute control to groundnut ('TMV 7'). Thirteen treatment combinations were tested in randomized block design with 3 replications. Enriched farmyard manure (EFYM) was obtained by incubating soil-test based (STB) level of P_2O_5 as single superphosphate (75 kg/ha) with 750 kg well decomposed and powdered FYM for 30 days. Composted coirpith (CCP) was applied @ 5 tonnes/ha. The biofertilizer (BF) rhizobium was given @ 400 g/ha through seed treatment. The soil test-based NPK worked out to be 24:12:21 kg/ha. The entire doses of P and K were applied as basal, while N dose varied according to the treatments schedule. The horsegram (variety 'Paiyur 1') was raised purely as residual crop after the harvest of the groundnut without imposing any treatment. Data on yield attributes, yield and residual soil fertility after the harvest of groundnut and horsegram were recorded. The mean data for 2 seasons are presented.

RESULTS AND DISCUSSION

Yield attributes of groundnut

Pods/plant ranged from 12.0 to 17.7 (Table 1) and increased with the application of N and effect became more pronounced when integrated with EFYM or CCP. The 100-kernel weight ranged from 26.9 to 28.7 g in the different treatments. Integration of 100% STR-N with CCP and FFYM remained at par and was rated best among the treatments, which recorded 28.7 and 28.6 g respectively. The other treatments also proved superior to the control, though their contribution towards the kernel weight was not as marked as in earlier said cases. This could be evidenced from the mean values of 27.5 to 8.2 g as against

26.9 g in control.

Yield attributes of horsegram

The pods/plant (24.1) in control significantly enhanced from 30.2 to 33.3 in the other treatments (Table 1). However, neither the N levels nor the integrating factors brought any appreciable. Seeds/pod increased (3.9–4.2) in the treatments. The 75 and 100% STB-N with FYM and CCP recorded significantly higher number of seeds/pod. This is in accordance with the findings of Subramaniam and Palaniappan (1981) and Jain *et al.* (1987) in blackgram and greengram respectively. The 100-seed weight, which was 4.6 g in control, was enhanced to 4.7 in other treatments.

Groundnut pod yield

The pod yield of groundnut increased significantly from 1,198 kg/ha in the control to 1,742 kg/ha in 100% STB-N + composted coirpith. The impact of CCP could be observed (Table 1) and integration of CCP with 75% STB-N and 100% STB-N resulted in significantly higher yields of 40 and 45%, respectively, over the control. This particular benefit may be attributable to the effect on physical properties, moisture conservation and augmenting the soil availability of K. Similar benefits were also observed by Nagarajan *et al.* (1986). Integrating EFYM also proved beneficial over the control, though not to the same tune as that of CCP. Thus, 75 and 100% STB-N in combination with FYM registered yield improvement (33 to 38%) over the control. The above beneficial effects were also found to be extended to haulms yield as well. The CCP involving treatments were better in improving haulms yield by 19 to 27% over the control. The favourable effect on moisture retention and enhanced availability of K perhaps played a vital role with the use of CCP (Durai and Rajagopal, 1983).

Horsegram seed yield

The seed yield of residual horsegram also differed with application of either biofertilizer or composted coirpith (CCP) at 50% STB-N, 75% STB-N and 100% STB-N, accounting for relatively higher yields than the control. While beneficial effects of CCP became obvious, the use of rhizobium perhaps helped the horsegram crop as well in the N nutrition. Moreover, the influence of the groundnut roots on the residual values of the soil may also have contributed for such effect. The haulms yield was however not appreciably influenced by the treatments. But by virtue of being a legume, perhaps the N nutrition was not a limiting factor and the haulms yield only varied marginally among the treatments. The N- haulms yield relation was also earlier indicated by Yellappa (1983).

Nutrient uptake by groundnut

The uptake of N by pod varied phenomenally within the treatments and indicated statistical significance (Table 2). The poor uptake of N (40.6 kg/ha) was associated with the control. The incorporation of BF and CCP but not the EFYM accounted for significantly higher N uptake. The highest N uptake was associated with the 100% STB-N+ CCP treatment with mean of 252 kg/ha, this however was on a par with the other treatments involving 75% STB-N

Table 1. Effect of integrated nutrient management on yield attributes and yield in groundnut – horsegram sequence (mean data of 1999 and 2000)

Treatment	Groundnut				Horsegram				
	Yield attribute		Yield (kg/ha)		Yield attribute			Yield (kg/ha)	
	Pods/plant	100-kernel weight (g)	Pod	Haulms	Pods/plant	Seeds/ pod	100-seed weight(g)	Seed	Haulms
N_0 + BF	14.0	27.5	1,453	2,630	31.4	4.00	4.69	590	1,100
N_0 + EFYM	13.7	27.2	1,332	2,537	31.0	3.87	4.66	578	1,085
N_0 +CCP	14.7	28.0	1,450	2,677	32.3	3.97	4.68	586	1,100
50% + CCP	15.3	27.7	1,402	2,540	30.6	3.93	4.66	512	1,093
50% STB-N+EFYM	16.3	28.0	1,443	2,667	31.3	40.3	4.70	610	1,067
50% STB-N+CCP	16.0	27.8	1,542	2,687	30.2	3.97	4.70	626	1,140
75% STB-N+BF	17.0	28.0	1,595	2,640	33.0	4.03	4.69	630	1,117
75% STB-N+EFYM	16.3	28.2	1,677	2,663	31.2	4.23	4.70	638	1,175
75% STB-N+CCP	16.3	28.0	1,685	2,677	31.7	4.03	4.70	628	1,129
100% STB-N+BF	17.0	28.6	1,650	2,880	32.4	4.20	4.69	639	1,155
100% STB-N+EFYM	17.0	28.6	1,742	2,847	33.3	4.20	4.70	636	1,148
Control	12.0	6.9	1,198	2,247	24.1	3.83	4.63	567	993
CD (P=0.05)	3.3	0.4	227	249	4.2	0.21	0.04	38	91

BF, Rhizobium; EFYM, enriched farmyard manure; STBN, soil-test based nitrogen; CCP, composted coirpith

and above. The haulms N uptake varied between 47.0 and 62.2 kg/ha due to the inherent capability of groundnut in fulfilling its N requirement. The more beneficial nature of CCP was obvious and it ensured a better nutritional environment and its effect got further augmented with supplementation of more and more of inorganic N. Increased uptake of N in groundnut with N application was also reported by Chavan and Kalra (1983).

Nagarajan *et al.* (1986) also reported favourable influence of CCP on N nutrition of groundnut. The uptake of N by the haulms was not appreciably influenced by the treatments. It ranged within a narrow limit of 16.0–18.4 kg/ha. However, CCP in combination with higher levels on N tended to favour higher N uptake by the haulms.

The uptake of P by groundnut pod was 6.9 - (10.3 kg/ha), and relatively higher uptake by pods could be well visualized with integrating CCP with STB-N. These observations are in accordance with findings of Durai and Rajagopal (1983) and Nagarajan *et al.* (1991). The haulms P uptake values however, varied within a narrow range of 6.6 to 8.5 kg/ha. The uptake of K by groundnut pod was influenced significantly (Table 2). With increasing N levels, uptake of K increased and this effect was more pronounced with CCP. The cause for such a phenomenon may be attributed to the enhanced root growth, increasing N and also the high K control of CCP. Similar results with the use of EFYM were also reported by Yadav *et al.* (1991). The uptake of K by haulms was 30.1 to 45.0 kg/ha. Lower level of N+BF and higher N+ CCP/EFYM treatments enhanced the uptake of K over the control.

Nutrient uptake by horsegram

The grain N uptake differed significantly in 75% STB-N and 100% STB-N with CCP or BF or FYM compared to other treatments (Table 2), as evident from the mean range of 25.5–26.3 kg/ha for the former and 25.7 – 26.5 kg/ha for the latter. However, the use of CCP with 50% STB-N remained at par with higher levels of N. The uptake of N by the haulms was not appreciably influenced by the treatments. Integration of biofertilizer at all levels of N was found to be associated with significantly greater P uptake over the control. However, with increased N levels, the uptake increased under all cases of integrated factors. The highest uptake of 1.49 kg/ha was associated with 100% STB-N+EFYM. The grain K uptake value of 161 kg/ha in control increased 1.81 – 2.10 kg/ha. in the treatments, indicating significantly higher K uptake. However in haulms, the K uptake varied within narrow range (9.54 -11.82 kg/ha).

Post-harvest soil fertility after groundnut

Available N in the soil after the harvest of the groundnut was 178- 213 kg/ha with BF and CCP involving treatments favouring greater accumulation (Table 3). The cause for such a phenomenon may be due to N fixation by the former and higher N content in the latter. Such effects were also observed earlier by Devarajan and Kothandaraman (1982). The P was 15.6-18.4 kg/ha and the treatment differences were not significant. The soil is prone for high P fixation and the various treatments including EFYM did not result in differential accumulation

Table 2. Effect on integrated nutrient management on the uptake of nutrients (kg/ha) in groundnut–horesegram sequence (mean data of 1999 and 2000)

Treatment	Groundnut						Horsegram					
	N		P		K		N		P		K	
	P	H	P	H	P	H	G	H	G	H	G	H
N_0+ BF	56.0	55.9	8.3	7.6	9.9	44.7	24.1	17.7	1.42	2.16	1.81	11.02
N_0 + EFYM	46.4	51.2	7.8	7.8	9.6	39.3	23.5	16.5	1.27	1.99	1.85	10.62
N_0 + CCP	52.9	58.0	8.3	7.8	9.8	40.2	24.6	17.7	1.29	2.01	1.84	10.59
50% STB-N+BF	48.1	52.2	7.9	7.4	10.0	45.0	24.8	17.9	1.48	1.97	2.00	10.88
50% STB-N+EFYM	54.5	53.0	8.4	7.7	10.3	39.9	23.8	17.5	1.35	1.96	1.89	11.07
50% STB-N+CCP	53.3	57.6	8.3	7.8	9.8	45.1	24.9	17.8	1.32	1.95	1.91	10.60
75% STB-N+BF	59.7	60.2	9.0	8.0	10.8	37.5	25.5	17.8	1.38	1.98	2.03	11.22
75% STB-N+EFYM	62.9	56.1	9.6	8.2	11.5	38.1	25.5	17.6	1.33	2.23	2.02	11.07
75% STB-N+CCP	63.6	54.6	10.0	7.8	12.4	43.9	26.3	18.4	1.34	2.03	2.10	11.71
100% STB-N+BF	65.7	54.7	9.8	7.8	11.6	39.9	25.7	17.4	1.26	2.14	2.05	11.57
100% STB-N+EFYM	64.6	61.7	9.8	8.6	11.7	41.8	26.1	17.5	1.49	2.01	1.98	11.82
100% STB-N+CCP	72.1	62.2	10.2	8.5	13.1	43.3	26.5	18.2	1.31	2.07	1.91	11.26
Control	40.6	47.0	6.9	6.6	8.8	30.1	21.5	16.0	1.12	1.79	1.61	9.54
CD (P=0.05)	12.6	7.0	2.0	NS	2.6	NS	1.8	NS	0.17	NS	0.30	NS

P, Pod; H, haulms; G, grain

BF, Rhizobium; EFYM, enriched farmyard manure; STBN, soil-test based nitrogen; CCP, composted coirpith

Table 3. Effect of intergrated nutrient management on the residual soil-fertility (kg/ha) groundnut – horsegram sequence (mean data of 1999 and 2000)

Treatment	Groundnut			Horsegram		
	N	P	K	N	P	K
N_0+ BF	205	16.5	284	202	16.3	279
N_0+ EFYM	196	16.9	293	172	16.3	277
N_0+ CCP	198	17.2	293	194	16.7	282
50% STB-N+BF	213	15.6	282	213	15.4	277
50% STB-N+EFYM	209	18.0	293	211	18.3	284
50% STB-N+CCP	191	16.9	295	213	16.5	279
75% STB-N+BF	202	15.8	286	211	15.2	279
75% STB-N+EFYM	189	16.7	290	207	16.5	284
75% STB-N+CCP	196	16.1	290	200	15.8	27.9
100% STB-N+BF	200	16.7	284	218	16.1	279
100% STB-N+EFYM	205	17.4	290	198	16.5	279
100% STB-N+CCP	209	15.8	293	222	15.6	286
Control	178	15.6	275	172	15.4	271
CD (P=0.05)	13	NS	8.8	37	NS	NS

BF, Rhizobium; EFYM, enriched farmyard manure; STBN, soil-test based nitrogen; CCP, composted coirpith

of available P. The stage indicating the beneficial effect of integrating nitrogen with composted coirpith, enriched farmyard manure and biofertilizers.

Post-harvest soil fertility after horsegram

The post-harvest soil samples of horsegram recorded mean available N 172-222 kg/ha. The continuation of the benefit of integrating BF and CCP in groundnut was found extended to this crop as well. Horsegram being a legume, enriched the soil with greater available N. Gohokar (1983) reported similar effect. The status of available P again a factor not appreciably influenced by the treatment effects. Though the EFYM was expected to keep greater available P values, the high P-fixing nature and the non-return of crop residues to soil have nullified the marginal benefits acquiring out of EFYM. The available K values continued to remain at par. The high available K and unified K supplementation have accounted for such phenomenon.

It could be concluded that, the use of composted coirpith provided better nutritional environment in the soil for groundnut and also the residual horsegram crop. The 75 and 100% soil test-based level of N along with composted coirpith rated better accounting for higher yields in both the crops. The uptake also was more with N levels of 75% and beyond, irrespective of the integrating factors.

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