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Research Paper

Studies on nutrient management in groundnut–field pea-summer groundnut cropping system under SAT of U.P.

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ABSTRACT

A field experiment was carried out on nutrients denuded sandy loam soil during 2000-2001 and 2001-2002 at Regional Research Station, Mainpuri, C.S.Azad University of Agriculture and Technology, Kanpur. The main objective was to enhance the productivity of crops in draught prone area with organic farming under groundnut-field pea-summer groundnut cropping system. Results displayed that the application of 15 kg N+ 30 kg P_2O_5 + 45 kg K_2O ha^{-1} in association of 100 q FYM ha^{-1}, inoculated with vermicompost + vermiculture @ 5 q/100 q FYM gave significantly higher pod yield of rainy season groundnut by 28.14 q ha^{-1} over control and conventional system of RDF. The residual effect of inoculated 100 q FYM ha^{-1} in the integration of 25 kg N+50 kg P_2O_5 ha^{-1} registered significantly higher grain yield of field pea as 35.27 q ha^{-1} over control and conventional system of RDF. Likewise, application of 15 kg N + 30 kg P_2O_5+45 kg K_2O ha^{-1} with remaining residual effect of 100 q FYM ha^{-1} also, significantly increased pod yield of summer groundnut by 22.42 q ha^{-1} over control and conventional system of RDF. The growth and yield contributing characters noted in groundnut and field pea was concordant to the yield of both crops. The uptake of NPK was increased under different crops of cropping system, when fertilized with RDF in association of FYM. Analysis of soil after harvesting of different crops of the sequence showed a significant build up of NPK with the application of FYM. The demography of earthworms was higher in the soil receiving plenty of FYM, inoculated with vermicast and vermicast eggs.

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Key words : Draught prone, Cropping system, Vermicompost, Vermiculture, Vermicast eggs

INTRODUCTION

The indiscriminate use of fertilizers, pesticides, fungicides and plant growth-regulators has resulted into many fold increase in yield potential of almost all the crops on one hand, creating several health hazards and environmental problems to fauna and flora on the other. The quantum of chemicals using has deteriorated our agro-eco-system very badly. Moreover, our soils too have become addicted to be fed with heavy dose of fertilizers to provide maximum returns to the farmers. Thus, residual toxicity is on the increasing trend in our foodstuffs beyond the prescribed limit.

Organic farming provides eco-technological stability, sustainable agriculture and pest management and is an alternative to inorganic fertilizers. Vermiculture is also an effective segment of organic farming especially in denuded and sodic soils. Soil microbes act as bio-indicator of soil health, friend of environment, negative catalyst of nitrogen loss during denitrification, volatilization etc. Bio-fertilizers also increase nitrogen fixation and nutrient availability.

An integrated approach to plant nutrient management gained momentum and importance in recent years. The objectives of this approach are efficient, judicious and economic use of all the major sources of plant nutrients *viz.*, soil, mineral, organic and biological in an integrated so as to get maximum economic yield from a cropping system.

With the view to enhance the productivity of field pea on sandy soils of semi-arid eco-system under groundnut-field pea-summer groundnut cropping system and enrich the soil in microbes, the present experiment was planned and executed under location specific condition.

MATERIALS AND METHODS

The experiment was laid out for two consecutive years during 2000-2001 and 2001-2002 at Regional Research Station, Mainpuri, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental site was sandy loam in texture having pH 8.5, organic carbon 0.45%, total nitrogen 0.04%, available phosphorus 10 kg ha^{-1} and available potash 278 kg ha^{-1}, therefore, the fertility status of experimental soil was low. The treatments comprised of control, conventional system of RDF, RDF + FYM @ 20 q ha^{-1}, RDF + FYM @ 40 q ha^{-1}, RDF + FYM @ 60 q ha^{-1}, RDF + FYM @ 80 q ha^{-1}, RDF + FYM @ 100 q ha^{-1} and RDF + FYM @ 120 q ha^{-1} for rainy season groundnut. FYM was not applied to the succeeding crop of field pea and summer groundnut, which were raised on residue of different levels of FYM and RDF. A recommended dose of 15 kg N + 30 kg P_2O_5 + 45 kg K_2O ha^{-1} was applied to rainy and summer season groundnut while 25 kg N + 50 kg P_2O_5 ha^{-1} given to field pea. The different doses of FYM applied to first year rainy season groundnut were inoculated with vermicompost + vermiculture @ 5 q /100 q FYM just to prepare the vermiculture *in situ* and increase the demography of earthworms in the experimental field. FYM applied in the experimental field contained 0.30% N, 0.15% P_2O_5 and 0.30% K_2O. Similarly, vermicast and vermicast eggs used as a inoculants was comprised of organic matter 16.98%, total nitrogen 1.50%, phosphorus 0.30%, potassium 0.46%, sodium 0.15%, calcium 0.10%, copper 8.5 ppm, iron 7.3 ppm, zinc 10.5 ppm and sulphur 448 ppm. FYM was applied before the field preparation as per treatment. Recommended doses of NPK to rainy and summer season groundnut and field pea were applied at sowing. The groundnut cv. DH 86 planted in rows 30 cm apart using 100 kg kernel ha^{-1} in the second fortnight of July harvested after 85 days in the first week of October during both experimental years.

The succeeding crop of field pea cv. SAPANA was planted in rows at 30 cm apart using 100 kg seed ha^{-1} on 5 November and harvested after 125 days on 10 March during two experimental seasons. After harvesting of field pea , the field was prepared for summer groundnut and it was seeded on 20 March and harvested after 85 days on 15 June during both experimental years. No irrigation was given to rainy season groundnut while three irrigations to field pea and four irrigations to summer groundnut were given. The experiment was conducted in Randomized Block Design with three replications.

RESULTS AND DISCUSSION

The results obtained from the present investigation have been discussed in the following sub heads :

Effect on growth, yield traits and pod yield of rainy season groundnut:

The main shoot height and branches $plant^{-1}$ did not show significant response due to combination of different doses of FYM. Functioning leaves $plant^{-1}$ significantly

Table 1: Growth, yield traits and yield of *Kharif* groundnut as affected by different treatments (pooled data of 2000 and 2001)

Treatments	Pooled growth, yield traits and pod yield								
	Main shoot height (cm)	Branches $plant^{-1}$	Functioning leaves $plant^{-1}$	Pods $plant^{-1}$	Pods weight $plant^{-1}$ (g)	Kernel weight $plant^{-1}$ (g)	Kernel pod^{-1}	100-kernel weight (g)	Pod yield (q ha^{-1})
Control	17.44	10.22	107.55	19.55	16.44	10.66	1.11	25.66	14.05
Conventional system of RDF	17.66	11.00	109.77	24.66	20.66	13.33	1.44	31.33	17.89
RDF + FYM @ 20 q ha^{-1}	17.77	12.22	111.55	32.00	26.77	17.21	1.77	40.00	23.71
RDF + FYM @ 40 q ha^{-1}	17.88	13.00	114.33	33.77	28.33	18.22	1.88	41.00	24.41
RDF + FYM @ 60 q ha^{-1}	17.99	13.44	115.55	34.88	29.22	18.77	1.88	42.00	24.99
RDF + FYM @ 80 q ha^{-1}	18.11	13.55	116.77	36.11	30.33	19.44	2.00	43.33	26.04
RDF + FYM @ 100 q ha^{-1}	18.22	14.00	118.77	37.00	31.11	19.88	2.00	47.00	28.14
RDF + FYM @ 120 q ha^{-1}	18.22	14.00	119.00	37.33	31.33	20.00	2.00	47.33	28.22
S.E. $\pm$	0.53	1.15	1.21	0.34	0.87	0.58	0.15	0.90	0.88
C.D. (P=0.05)	N.S.	N.S.	3.67	1.03	2.63	1.75	0.45	2.73	2.66

FYM = Farm yard manure NS=Non-significant

RDF = Recommended dose of fertilizer

Nutrients status of applied FYM – 0.30% N, 0.15% P_2O_5 and 0.30% K_2O

Nutrients status of vermicast and vermicast eggs used as a inoculants – 16.98% organic matter, 1.50% total nitrogen, 0.30% phosphorus, 0.40% potassium, 0.15% sodium, 0.10% calcium, 8.5 ppm copper, 7.3 ppm iron, 10.5 ppm zinc and 448 ppm sulphur.

increased with the integration of FYM over control and conventional system of RDF (Table 1). The integration of FYM @ 100 q ha^{-1} significantly increased the pods $plant^{-1}$, pods weight $plant^{-1}$, kernel weight $plant^{-1}$, kernel pod^{-1} and 100-kernel weight as compared to control and conventional system of RDF. The highest integrated dose of FYM *i.e.* 120 q ha^{-1} confined the development in yield traits in comparison to integration of FYM @ 100 q ha^{-1}.

Application of 15 kg N + 30 kg P_2O_5 + 45 kg K_2O in association of 100 q FYM ha^{-1} gave significantly higher pod yield of rainy season groundnut by 28.14 q ha^{-1} over control, conventional system of RDF and FYM (20 to 80 q ha^{-1}). The further installment of FYM stagnated the pod yield of groundnut. The yield of groundnut pushed up due to better availability of trace nutrients and good moisture retaining capacity of soil under combined application of chemical fertilizers and FYM. The results are in line with those of Chawale *et al*. (1995), Mehta *et al.* (1995), Singh (2004a) and Singh (2004b).

Effect on growth, yield traits and grain yield of field pea:

Crop growth in term of main shoot height, branches $plant^{-1}$ and pods $plant^{-1}$ improved by application of 25 kg N + 50 kg P_2O_5 and residue of 100 q FYM ha^{-1}. Integration of 25 kg N + 50 kg P_2O_5 with residue of 100 q FYM ha^{-1} significantly increased the pods weight $plant^{-1}$, grains pod^{-1}, grain weight $plant^{-1}$ and 100-grain weight, which culminated into significant increase in grain yield (Table 2). The grain yield markedly increased with increasing residue levels of FYM up to 100 q ha^{-1} in association of recommended dose of chemical fertilizer. The residue of FYM beyond 100 q ha^{-1} did not effect significantly.

The relationship of grain yield and applied nutrients through agro-chemicals and residue of FYM was linear in nature. The better yield of field pea was harvested due to integrated nutrients management with vermicast and vermicast eggs inoculated organic amendment in the preceding crop of rainy season groundnut.

Effect on growth, yield traits and pod yield of summer season groundnut:

The main shoot height and branches $plant^{-1}$ numerically increased due to residue of different doses of FYM with RDF over the control and conventional system of RDF while functioning leaves $plant^{-1}$ significantly pushed up by the residue of FYM. The residue of 120 q FYM ha^{-1} confined the development of these growth parameters as compared to residue of FYM @ 100 q ha^{-1} (Table 3). Pod $plant^{-1}$, pods weight $plant^{-1}$, kernel weight $plant^{-1}$, kernel pod^{-1} and 100-kernel weight significantly increased due to residue of FYM up to 100 q ha^{-1} with recommended dose of chemical fertilizer over the control and conventional system of RDF. The residue of higher dose of FYM @ 120 q ha^{-1} with RDF stagnated improvement of these yield traits over residue of FYM @ 100 q ha^{-1}. The increase in growth and yield traits was attributed to the continuous release of nutrients from organic matter.

The residue of FYM @ 100 q ha^{-1} in conjunction with 15 kg N + 30 kg P_2O_5 + 45 kg K_2O ha^{-1} gave significantly higher pod yield of summer groundnut by 22.42 q ha^{-1} over control and conventional system of RDF. The yield of summer groundnut pushed up due to better availability of trace plant nutrients and good moisture retaining capacity of soil under moisture stress condition in association of residue of FYM with agro-chemicals.

The incidence of termite under moisture stress period

Table 2 : Growth, yield attributes and yield of field pea as influenced by different treatments (pooled data of 2000 and 2001)

Treatments	Pooled growth, yield attributes and grain yield							
	Main shoot height (cm)	Branches $plant^{-1}$	Pods $plant^{-1}$	Pods weight $plant^{-1}$ (g)	Grains pod^{-1}	Grain weight $plant^{-1}$ (g)	100-grain weight (g)	Grain yield (q ha^{-1})
Control	33.92	3.33	13.77	12.55	3.55	10.81	16.77	20.95
Conventional system of RDF	49.77	4.22	21.55	18.77	5.55	16.18	18.33	31.82
RDF + FYM @ 20 q ha^{-1}	51.22	4.33	22.22	19.44	5.66	16.76	18.88	32.70
RDF + FYM @ 40 q ha^{-1}	52.55	4.55	22.78	19.99	5.77	17.22	19.44	33.49
RDF + FYM @ 60 q ha^{-1}	53.66	4.66	23.22	20.33	5.99	17.51	19.77	34.16
RDF + FYM @ 80 q ha^{-1}	54.88	4.66	23.88	20.77	6.11	17.90	20.22	34.63
RDF + FYM @ 100 q ha^{-1}	55.99	4.77	24.33	21.33	6.22	18.37	20.66	35.27
RDF + FYM @ 120 q ha^{-1}	55.99	4.88	24.22	21.22	6.11	18.29	20.55	35.23
S.E. $\pm$	1.00	0.42	0.65	0.63	0.45	0.54	0.56	1.01
C.D. (P=0.05)	3.03	NS	1.97	1.91	1.36	1.63	1.69	3.07

FYM = Farm yard manure NS=Non-significant
RDF = Recommended dose of fertilizer

Table 3: Growth, yield traits and yield of summer groundnut under residual effect of FYM (pooled data of 2001 and2002)

Treatments	Pooled growth, yield traits and pod yield								
	Main shoot height (cm)	Branches plant^{-1}	Functioning leaves plant^{-1}	Pods plant^{-1}	Pods weight plant^{-1} (g)	Kernel weight plant^{-1} (g)	Kernel pod^{-1}	100-kernel weight (g)	Pod yield (q ha^{-1})
Control	17.33	10.00	104.11	19.11	16.11	10.66	1.22	26.66	14.82
Conventional system of RDF	17.55	10.33	106.66	24.33	20.33	13.66	1.55	30.66	17.13
RDF + FYM @ 20 q ha^{-1}	17.66	11.88	108.55	31.66	26.33	18.00	1.77	39.33	19.06
RDF + FYM @ 40 q ha^{-1}	17.77	12.66	111.44	33.33	27.66	18.33	1.88	40.33	20.24
RDF + FYM @ 60 q ha^{-1}	17.88	13.11	113.11	34.44	28.66	18.66	2.00	41.00	20.90
RDF + FYM @ 80 q ha^{-1}	18.00	13.22	115.00	35.66	29.66	19.55	2.00	43.33	21.57
RDF + FYM @ 100 q ha^{-1}	18.00	14.00	117.11	36.88	30.88	21.33	2.00	46.66	22.42
RDF + FYM @ 120 q ha^{-1}	18.11	13.66	117.33	37.00	30.77	21.44	2.00	46.66	23.19
S.E. (m±)	0.34	1.40	0.62	0.58	0.48	0.51	0.16	0.70	1.40
C.D. 5%	NS	NS	1.88	1.75	1.45	1.54	0.48	2.12	4.24

FYM = Farm yard manure NS=Non-significant
RDF = Recommended dose of fertilizer

of summer season damage the plants of summer groundnut resulted in, the reduction in plant stand during summer season declined the pod yield of summer groundnut as compared to rainy season groundnut.

The combined application of chemical fertilizers along with enough bulk of FYM in groundnut-field pea-summer groundnut cropping system has stimulated the uptake of plant nutrients and partly because of stimulated microbes flush and improved root growth due to congenial soil physical condition created by addition of FYM. Increase in total productivity of sequence might be the outcome of increased availability of nutrients to the plants of different crops by decomposition of applied FYM throughout the year.

Effect on nutrient uptake:

The integration of different doses of FYM with RDF significantly improved the N uptake of rainy season groundnut with control and conventional system of RDF and it was maximum with highest tested dose of FYM. The combination of FYM also significantly enhanced the P uptake of groundnut over the control and conventional system of RDF. Similarly, the uptake of K was significantly influenced due to conjunction of different doses of FYM over control and conventional system of RDF. The increase in NPK content in rainy season groundnut by FYM application due to greater availability of these nutrients with extended root system. Similar results on nutrients uptake were also reported by Parasuraman and Mani (2003).

The uptake of NPK by the field pea was considerably higher when RDF integrated with residue of different doses of FYM. In such case of higher uptake of NPK nutrients could be due to proper and timely release of nutrients for uptake. The higher NPK content coupled with higher yields of field pea resulted in, substantial increase in NPK uptake.

The uptake of N by summer groundnut varied phenomenally with in the treatments and indicated statistical significance. The poor uptake of N (105.2 kg ha^{-1}) was associated with control. The residue of FYM accounted for significantly higher N uptake. The highest N uptake was associated with the 120 q FYM ha-^{1}, this, however, was at par with residue of 100 q FYM ha^{-1}. The more beneficial nature of residue of FYM was obvious and it ensured a better nutritional environment. The uptake of P by summer groundnut pod was 16.4 to 23.9 kg ha^{-1} and relatively higher uptake could be well visualized with integration of residue of FYM. The uptake of K by summer groundnut was influenced significantly. With the increasing residue of FYM levels, uptake of K increased and this effect was more pronounced at higher levels of FYM residue. The cause for such a phenomenon may be attributed to enhanced root growth and N and K content of FYM residue (Table 4). These observations are in accordance with findings of Parasuraman and Mani (2003).

Effect of organic and inorganic management on the soil fertility status:

In general, improvement in available soil NPK was observed over their initial levels in continuous groundnut-field pea-summer groundnut cropping system followed for two years and fertilized with inorganic fertilizers in conjunction with different levels of FYM and its residue. The effect of amended FYM was slightly more pronounced

Table 4: Effect of organic and inorganic sources of nutrients on the uptake of nutrients and earthworm demography in groundnut-field pea-summer groundnut sequence

Treatments	Pooled data of nutrients uptake (kg ha^{-1})									Earthworms demography Sqm^{-1}	
	Groundnut			Field pea			Summer groundnut			2000	2001
	N	P	K	N	P	K	N	P	K		
Control	99.7	15.5	45.0	100.2	12.0	43.5	105.2	16.4	47.9	12.0	23.0
Conventional system of RDF	128.8	18.1	52.1	153.0	18.1	66.1	123.3	17.5	50.3	18.0	28.0
RDF + FYM @ 20 q ha^{-1}	166.5	24.1	69.9	156.8	18.6	68.0	133.8	19.3	56.2	62.0	79.0
RDF + FYM @ 40 q ha^{-1}	175.9	24.7	71.7	161.2	19.1	69.6	145.8	20.5	59.6	71.0	93.0
RDF + FYM @ 60 q ha^{-1}	180.0	25.4	73.5	163.8	19.5	71.0	150.6	21.3	61.7	78.0	99.0
RDF + FYM @ 80 q ha^{-1}	184.7	26.4	76.6	165.9	19.7	72.0	151.9	22.1	63.9	98.0	115.0
RDF + FYM @ 100 q ha^{-1}	189.0	28.7	81.9	169.1	20.1	73.3	153.6	23.0	66.4	106.0	118.0
RDF + FYM @ 120 q ha^{-1}	190.1	29.1	82.1	169.0	20.0	73.1	155.4	23.9	67.2	108.0	121.0
S.E. $\pm$	0.9	0.5	0.6	0.7	0.5	0.6	0.7	0.7	1.6	2.2	1.4
C.D. (P=0.05)	2.8	1.5	2.0	2.2	1.5	2.0	2.3	2.1	5.0	6.8	4.3

Earthworms demography at initial stage was 2 Sqm^{-1} counted after on set of rain.

Table 5: Effect of organic and inorganic management on the soil fertility status after two years groundnut-field pea-summer groundnut cropping system (pooled data of 2001 and 2002)

Treatments	Post harvest status				Net change (net gain/loss)			
	O.C.(%)	Available soil N (kg ha^{-1})	Available soil P (kg ha^{-1})	Available soil K (kg ha^{-1})	O.C.(%)	Available soil N (kg ha^{-1})	Available soil P (kg ha^{-1})	Available soil K (kg ha^{-1})
Control	0.45	223.3	10.3	281.3	0.00	+5.1	+0.3	+3.3
Conventional system of RDF	0.46	228.1	10.8	287.2	+0.01	+9.9	+0.8	+9.2
RDF + FYM @ 20 q ha^{-1}	0.46	233.2	11.0	290.3	+0.01	+15.0	+1.0	+12.3
RDF + FYM @ 40 q ha^{-1}	0.48	238.1	11.7	292.7	+0.03	+19.9	+1.7	+14.7
RDF + FYM @ 60 q ha^{-1}	0.50	243.5	12.2	295.3	+0.05	+25.3	+2.2	+17.3
RDF + FYM @ 80 q ha^{-1}	0.51	248.6	12.5	295.8	+0.06	+30.4	+2.5	+17.8
RDF + FYM @ 100 q ha^{-1}	0.51	251.0	12.6	296.7	+0.06	+32.8	+2.6	+18.7
RDF + FYM @ 120 q ha^{-1}	0.52	252.4	12.8	296.9	+0.07	+34.2	+2.8	+18.7
S.E. $\pm$	0.008	1.1	0.4	0.9	-	-	-	-
C.D. (P=0.05)	0.024	3.4	1.2	2.8	-	-	-	-

Initial fertility status: O.C. 0.45%, Total N. 0.04%, Available soil N 218.2 kg ha^{-1}, Available soil P 10 kg ha^{-1} and Available soil K 278.0 kg ha^{-1}

than that of conventional system of RDF on the build up of NPK. With regard to NPK balance in the soil, it is evident from data that increase in FYM levels has resulted in, substantial increase in soil NPK status (Table 5). Available soil N increased due to integrated nutrient supply with FYM and N_2 fixation by rainy season groundnut, field pea and summer groundnut. A considerable build up of available soil P was noticed. This increased availability of nutrient may be assigned usual residual effect of applied P fertilizer. Beside, legume crops *i.e.* groundnut, field pea and summer groundnut roots secret certain acidic substances which dissolve insoluble P converting into easily assimilable form. Available soil K was found to increase over its initial level. This may be due to release of non-exchangeable K on account of addition of organic manure for utilization of groundnut-field pea-summer groundnut.

Effect on earthworms demography in soil:

The population of earthworm was higher in the soil receiving plenty of FYM, inoculated with vermicast and vermicast eggs compared with control and conventional system of RDF. With the increasing levels of FYM, population of earthworms increased, it was maximum at RDF + FYM @ 120 q ha-^{1} closely followed by RDF + FYM @ 100 q ha^{-1}, while minimum counted at RDF + FYM @ 20 q ha^{-1}. The earthworms counted in control and conventional system of RDF plots was less even than to the population counted at lower level of FYM (RDF+FYM @ 20 q ha^{-1}). The demography of earthworms was more pronounced to the second year

(Table 4). The difference in the earthworms population was due to the variation in the levels of FYM. These results are in line with those of Agasimani *et al.* (1994).

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