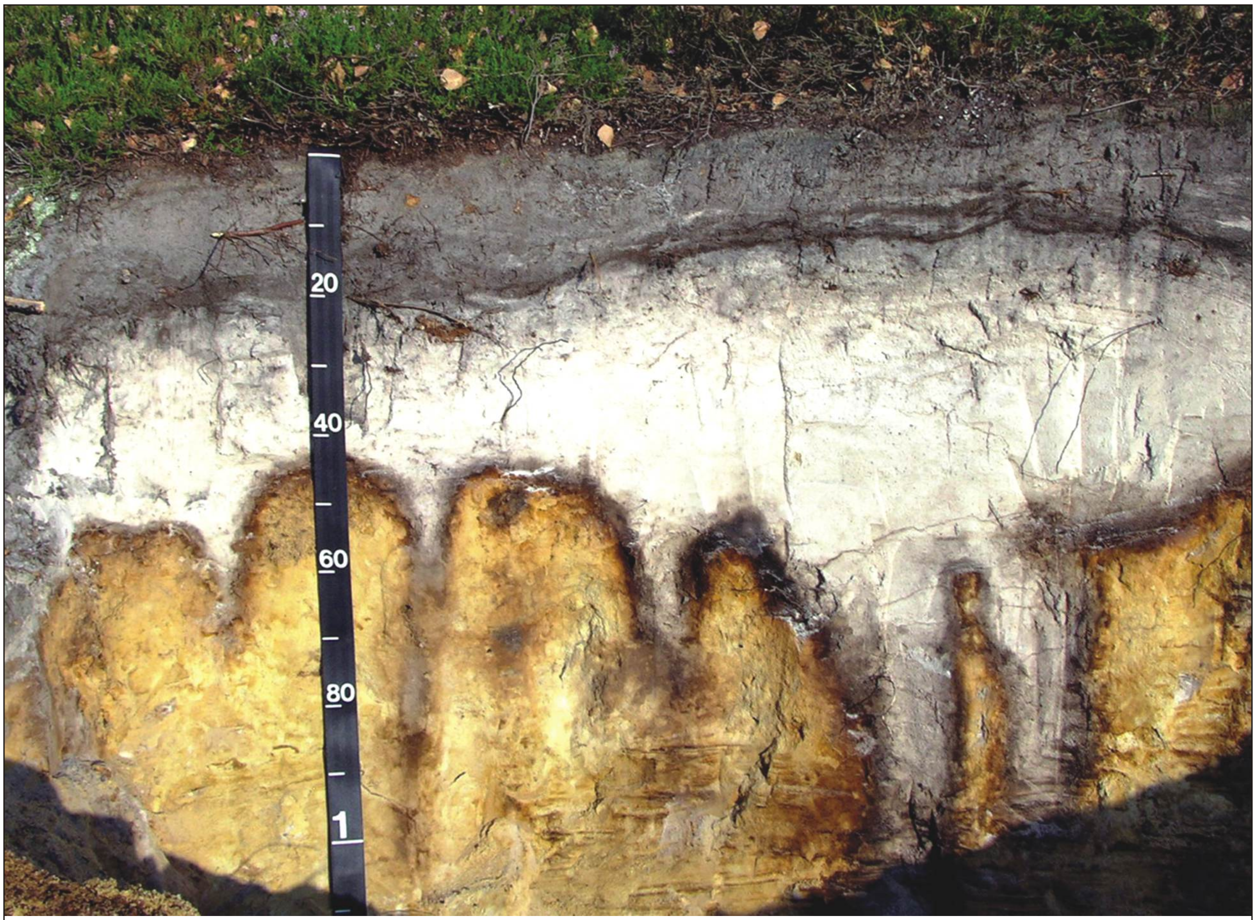

International Journal of Soil Science

ISSN 1816-4978

Academic Journals Inc.

www.academicjournals.com

International Journal of Soil Science 2 (3): 224-229, 2007
ISSN 1816-4978
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Impact of Sesame (*Sesamum indicum* L.) On Succeeding Rice and Optimization of N to Rice (*Oryza sativa* L.)

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Abstract: A field experiment was conducted in loamy sand soils of Tamil Nadu, India to optimize the nitrogen requirement to rice after sesame during the year 2004-2005 in two consecutive seasons in a Factorial Randomized Block Design (FRBD). The field was divided into 60 plots and in the summer season sesame was raised in 30 plots and the other 30 plots were kept fallow. In the next season (Kharif), the rice was raised in all the 60 plots of two different situations viz., with sesame as previous crop (Situation I) and without sesame as pervious crop (Situation II) with two rice cultivars viz., ADT 38 and KR 99001 and five levels of nitrogen viz., 0, 50, 100, 150 and 200 kg N ha^{-1}. In rice, the plant height was significantly influenced by the situations in earlier stages and but not in the later stages. The number of tillers was found to be higher in situation II than in situation I in all the three stages studied viz., active tillering, panicle initiation and harvest stage. The same trend was noticed in number of productive tillers also. The variation in the situations did not bring any significant variation in grain yield, but slightly higher yield was noticed in situation II over situation I. Both ADT 38 and KR 99001 manifested higher yields at 150 kg N ha^{-1} in both the situations reveals the fact that this level of N, which is a recommended dose of N for medium and long duration rice, is sufficient for better growth and development of rice. The straw yield was comparable in both the situations.

Key words: Nitrogen, rice, sesame, impact, optimization

INTRODUCTION

Nitrogen is the most important nutrient for rice and its deficiency occurs almost everywhere, unless nitrogen (N) is applied through fertilizer. Rice is the maximum consumer of N fertilizer constituting one third of the total N consumption of the world (Saravana Pandian and Perumal, 2002). Thus, N is the most critical input that limits rice productivity and increasing rice productivity would mean more supply of N to the crop. Lowland rice depends more on soil fertility than on fertilizers. The dependence of lowland rice on soil fertility is best illustrated by a Japanese saying Grow paddy with soil fertility, Grow barley with fertilizers (Yoshida, 1981). This shows that it is necessary to have a specific recommendation of fertilizers for rice under specific growing environments than blanket recommendation. So, the optimization of N to rice with situation specific is necessary for higher yield and to sustain its demand.

A specific situation in the Cauvery delta region of Tamil Nadu and Pondicherry is the crop rotation of rice-rice-sesame, where sesame is grown as rice-fallow crop during summer season in with the use of residual moisture and nutrients of pervious season (Rabi) rice. Hence, no fertilizers are applied to the sesame, which is also an N responsive. The response of sesame to N fertilizer varies

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from 20-150 kg ha^{-1} (Hemalatha *et al*., 1999). This sesame may utilize the native soil N also for its growth and development. This may leads to deficiency of N in the soil for the next season rice, which is grown in the next season. This situation necessitates finding out the impact of sesame grown in previous season on rice grown after that and optimizing the N requirement to the rice.

MATERIALS AND METHODS

Experimental Design and Treatment Details

The experiment was conducted in a loamy sand soil of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Union Territory of Pondicherry, India during the year 2004-05. The experimental site, which is situated 12 km from Bay of Bengal lies between latitude 10°49' and 11°01' North and longitude 78°43' and 79°52' East with an altitude of 4 m above Mean Sea Level (MSL). The initial soil analyses show that the soil was loamy sand in texture falls in *Fluventic Haplustept* taxonomic class. The soil was optimum in bulk density (1.33 Mg m^{-3}) and particle density (2.66 Mg m^{-3}) with the porosity of 50%. The soil reaction was neutral (pH: 7.61) and the electrical conductivity is low (EC: 0.21 dS m^{-1}). The soil was low in organic carbon content (0.32%) and available nitrogen ($KMnO_4$-N: 213 kg ha^{-1}), medium in available potassium (NH_4OAc-K: 262 kg ha^{-1}) and high in available phosphorous (Olsen-P: 31.4 kg ha^{-1}). The experiment was conducted in FRBD design with three replications.

The field was divided in 60 equal plots of 20 m^2. The experiment was carried out in two consecutive seasons. In the summer season (*Chithirai pattam*), the 30 plots of the field was raised with sesame and the other plots were kept fallow without any vegetation. The sesame was cultivated with residual nutrients of previous season (Rabi) rice without fertilizer application. The regular agronomic practice for dry land sesame was followed and crop was harvested after 97 days after sowing. In the *Kharif* season, the left out sesame stubbles of about 15-20 cm height were incorporated 15 days before transplanting. Rice was raised in all the 60 plots of two different situations viz., with sesame as previous crop (situation I) and without sesame as pervious crop (situation II) with two cultivars viz., a medium duration variety of ADT 38 and a long duration pre-release culture of KR 99001 with five levels of N viz., 0, 50, 100, 150 and 200 kg N ha^{-1}. The treatment details are given in Table 1. The N was supplied through urea in four equal splits as basal, at Active Tillering (AT), Panicle Initiation (PI) and grain filling stage as per the treatment levels. Phosphorous (P) at the rate of 50 kg ha^{-1}) was supplied through single super phosphate in two equal splits as basal and at AT; potassium (K) at the rate of 50 kg ha^{-1}) through muriate of potash in four equal splits as that of N and zinc through zinc sulphate at the rate of 12.5 kg ha^{-1}) as basal. A hand weeding was done at 25 days after transplanting and a pesticide spray of monocrotophos at the rate of 250 mL ha^{-1} was given at 30 days after transplanting to control leaf folders. Plant height and number of tillers were recorded at AT, PI and Harvest Stage (HS) and number of productive tillers was recorded at HS. The crop was harvested separately from the plots, harvested and winnowed and grain and straw yields were recorded. The observations collected from the field experiment and the data on the results of analysis of soil and plant samples were subjected to statistical scrutiny as per the procedure of Gomez and Gomez (1984).

Optimization of N Requirement

The data on the grain yields of rice under the various treatments were fitted into the appropriate response function following statistical procedures. In cases where the response function was quadratic type, the physical optimum dose of N was calculated by equating the first order derivative of the response function to zero.

Table 1: Treatment details rice varieties (V) under varying field conditions (S) with Nitrogen levels (N)

	Treatment details		
Notation	Previous season crop	Variety	N dose (kg ha^{-1})
$S_1V_1N_0$	Sesame	ADT 38	0
$S_1V_1N_{50}$	Sesame	ADT 38	50
$S_1V_1N_{100}$	Sesame	ADT 38	100
$S_1V_1N_{150}$	Sesame	ADT 38	150
$S_1V_1N_{200}$	Sesame	ADT 38	200
$S_1V_2N_0$	Sesame	KR99001	0
$S_1V_2N_{50}$	Sesame	KR99001	50
$S_1V_2N_{100}$	Sesame	KR99001	100
$S_1V_2N_{150}$	Sesame	KR99001	150
$S_1V_2N_{200}$	Sesame	KR99001	200
$S_2V_1N_0$	Fallow	ADT 38	0
$S_2V_1N_{50}$	Fallow	ADT 38	50
$S_2V_1N_{100}$	Fallow	ADT 38	100
$S_2V_1N_{150}$	Fallow	ADT 38	150
$S_2V_1N_{200}$	Fallow	ADT 38	200
$S_2V_2N_0$	Fallow	KR99001	0
$S_2V_2N_{50}$	Fallow	KR99001	50
$S_2V_2N_{100}$	Fallow	KR99001	100
$S_2V_2N_{150}$	Fallow	KR99001	150
$S_2V_2N_{200}$	Fallow	KR99001	200

$$\left[\frac{dy}{dx} = 0\right]$$

The economic optimum dose was calculated by equating the first order derivative of the response function to the rice ratio (px/py) i.e.,

$$\left[\frac{dy}{dx} = \frac{px}{py}\right]$$

taking into account the unit cost of N kg^{-1} as 10.4 and price of rice grain as Rs. 5 kg^{-1}.

RESULTS AND DISCUSSION

Plant Height

Plant height of rice was not affected by varying field conditions created with sesame and without sesame as previous crop i.e., situation I and II respectively at all the three stages viz., AT, PI and HS (Table 2). This might be due to the probable reason that the minimum requirement of nutrients at the early stages of crop growth (Angayarkanni and Ravichandran, 2001) might be met out from the applied N in both the situations and the deficit of nutrients in situation I and at later stages the nutrient deficit might be compensated by the release of N through mineralization of incorporated stubbles of sesame along with applied N. The mineralization of crop residues, which could be benefited for the crop growth, was reported by many authors (Omar Hattab *et al*., 1998; Saravana Pandian and Perumal, 2000; Deka Medhi and Medhi, 2000; Sharma and Verma, 2000). In general, increasing N levels increased the plant height. It is quite expected and was in line with the research findings of Shivay *et al*. (2001) and Somasundaram *et al*. (2002).

Number of Tillers and Productive per m^{-2}

The tillering ability at AT, PI and HS of rice was significantly higher in situation II (365, 385 and 385 tillers m^{-2}) over situation I (342, 352 and 352 tillers m^{-2}) with the percentage increase of 6.73,

Table 2: Influence of previous season sesame on growth and yield of succeeding rice

Treatments	Active tillering			Panicle initiation			Harvest stage		
Height	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
S_1N_0	78.6	88.1	83.4	84.9	105.4	95.1	98.1	132.1	115.1
S_1N_{50}	75.5	92.2	83.8	99.4	109.5	104.4	114.3	141.3	127.8
S_1N_{100}	81.1	86.1	83.6	100.4	102.4	101.4	120.0	142.9	131.5
S_1N_{150}	89.3	92.0	90.6	103.2	115.2	109.2	118.6	140.2	129.4
S_1N_{200}	94.8	99.0	96.9	113.0	126.7	119.9	126.9	142.2	134.6
Mean	83.8	91.5	87.7	100.2	111.8	106.0	115.6	139.7	127.7
S_2N_0	81.3	75.2	78.2	89.0	86.9	87.9	98.6	119.8	109.2
S_2N_{50}	87.4	85.6	86.4	96.0	103.3	99.7	110.8	126.7	118.7
S_2N_{100}	87.2	95.9	91.5	98.6	104.1	101.3	115.3	138.8	127.0
S_2N_{150}	92.6	103.2	97.9	106.8	112.7	109.8	129.0	143.0	136.0
S_2N_{200}	93.6	101.4	97.5	119.6	117.0	118.3	129.7	143.8	136.7
Mean	88.4	92.2	90.3	102.0	104.8	103.4	116.7	134.4	125.5
	S	S×N	S×V×N	S	S×N	S×V×N	S	S×N	S×V×N
SED	2.40	3.3	4.6	2.4	5.4	7.7	2.0	4.9	6.9
CD	NS	6.6	9.3	NS	10.9	15.5	NS	8.9	12.5
Tillers	Active tillering			Panicle initiation			Harvest stage		
S_1N_0	274	281	277	279	281	280	279	281	280
S_1N_{50}	278	342	310	289	353	321	289	353	321
S_1N_{100}	394	333	364	397	347	372	403	347	375
S_1N_{150}	414	364	389	414	381	397	414	369	392
S_1N_{200}	394	347	371	414	369	392	414	369	392
Mean	351	333	342	359	346	352	360	344	352
S_2N_0	331	256	293	331	272	301	331	272	301
S_2N_{50}	353	331	342	361	342	351	361	342	351
S_2N_{100}	425	319	372	442	342	392	442	342	392
S_2N_{150}	464	378	421	514	417	465	514	417	465
S_2N_{200}	422	375	399	444	386	415	444	386	415
Mean	399	332	365	418	352	385	418	352	385
SED	11	25	36	12	28	39	12	27	39
CD	23	51	72	25	56	79	25	56	79
Yield	No. of productive tillers			Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		
S_1N_0	272	275	274	2.63	3.48	3.05	5.17	5.95	5.56
S_1N_{50}	280	331	305	2.82	3.95	3.39	5.23	7.12	6.17
S_1N_{100}	397	342	369	3.24	4.31	3.78	6.51	8.75	7.63
S_1N_{150}	408	361	385	3.93	4.70	4.32	7.73	9.86	8.79
S_1N_{200}	408	367	387	3.22	4.06	3.64	7.17	8.87	8.02
Mean	353	335	344	3.17	4.10	3.64	6.36	8.11	7.24
S_2N_0	325	267	296	2.84	3.68	3.26	5.03	6.97	6.00
S_2N_{50}	353	331	342	3.15	4.02	3.58	6.18	8.63	7.41
S_2N_{100}	436	339	387	3.83	4.68	4.25	6.28	9.68	7.98
S_2N_{150}	514	417	465	3.91	4.74	4.32	6.95	9.45	8.20
S_2N_{200}	444	381	412	3.48	4.1	3.79	7.21	9.20	8.21
Mean	414	347	381	3.44	4.24	3.84	6.33	8.79	7.56
SED	10	23	33	0.12	0.28	0.39	0.33	0.74	1.04
CD	21	47	66	NS	NS	0.79	NS	1.49	2.11

9.38 and 9.38, respectively (Table 2). This might be due to the higher requirement of nutrient for tillering in the earlier stage was not met in situation I where nutrient loss caused by previous season sesame. The low production in tillers at AT was maintained in the PI and HS also. This is because the tillering of rice is mainly during AT and deficit of nutrient at this stage can not be over come by the supply of nutrients in the later stages. Increasing N levels enhanced the number of tillers in both the situations in all the three stages. This result is in consonance to the findings of Somasundaram *et al.* (2002) and Pariyani and Naik (2004).

Grain Yield

The variation in the field conditions due to the situations did not bring significant variation in grain yield, but slightly higher yield was noticed in situation II over situation I (Table 2). This might be due to the reason that the incorporated stubbles of sesame in field might have released the immobilized N in the later stages and supported the crop growth and yield. The slight variation might be due to the differential supply of nutrients in the initial stages of growth, wherein the nutrient supply was low in situation I, caused by depletion of nutrients by sesame.

Optimization of Nitrogen Requirement

In the case of medium duration variety ADT 38 the physical optimum was 157 kg N ha^{-1} and the economic optimum with 133 kg N ha^{-1}. The pre-release culture KR 99001 showed its physical optimum with 131 kg N ha^{-1} and economic optimum with 114 kg N ha^{-1}. Both medium duration variety ADT 38 and long duration pre-release culture KR 99001 manifested higher yields at 150 kg N ha^{-1} in both the situations. This reveals the fact that this level of N, which is a recommended dose of N for medium and long duration rice crop, is capable of supplying nutrients to the demand of the crop at appropriate stages both by direct supply of nutrients and by indirect supply through mineralization of sesame stubbles. This kind of result that is the combination of organic and inorganic sources of N in enhancing the yield finds support from Wopereis *et al.* (1994) Saravana Pandian and Perumal (1994) and Omar Hattab *et al.* (2000).

Straw Yield

The straw yield was not significantly influenced by the situations studied (Table 2). This might be due to late recovery of rice from the impact of nutrient loss caused by the sesame in the previous season in situation I. The immobilized N by the sesame stubbles would have been released in the later stages. The beneficial effect of mineralization of nutrients from the crop residues was well established by Omar Hattab *et al.* (1998), Singh *et al.* (1997), Grace *et al.* (1999), Deka Medhi and Medhi (2000) and Rani and Srivastava (2001).

CONCLUSION

The sesame grown in previous season with residual moisture of Rabi rice has no profound effect on next season rice. The rice in both field conditions (with and without sesame in previous season) produced comparable yields. The variation was noticed in plant height, number of tillers and number of seeds per panicle but the variation was not much higher which resulted in comparable grain and straw yield. The optimization procedure reveals that 133 kg N ha^{-1} will sufficient for ADT 38 and 114 133 kg N ha^{-1} will sufficient for KR 99001 and hence, the recommended dose of N for these varieties i.e., 150 kg N ha^{-1} will be sufficient for better growth and development.

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