as basal, uniformly @ 50 kg ha^{-1} for all the treatments.

The experimental results showed that plant height, productive tillers and grain yield were the highest with the crop transplanted by May 15, followed by June 1 and lowest in July 1 planting (Table 1). Crop transplanted by May 15 recorded maximum plant height (52.96 cm) on 30 DAT, followed by the crop transplanted on June 1st and 15th and both were also comparable. However, the same trend was not observed in plant height on 60 DAT. The significant decline in productive tillers per hill was observed with delayed transplanting resulting in reduced grain yield. Similar findings were also reported by Thakur *et al.* (1996) and Muthukrishnan *et al.* (2000). There was 43 per cent grain yield increase in the crop transplanted by May 15th (5.66 t ha^{-1}) compared to July 1st planting (3.96 t ha^{-1}). The yield increase in earlier planting might be due to the availability of more sunshine hours, which may exert effect on high conversion of light energy into chemical energy and subsequent translocation to assimilatory organs (Hari Om *et al.* 1997).

Graded levels of N also showed significant influence on plant height, productive tillers and grain yield (Table 1). Results showed that highest plant height, productive tillers hill^{-1} and grain yield were recorded at 200 kg N ha^{-1}, but it was comparable with 150 kg N ha^{-1}. However grain yield was significantly high with increase of N from 0 to 150 kg ha These findings were in agreement with t findings of Muthukrishnan *et al.* (1999).

From the study, it is concluded that highe yield in rice hybrid (ADTRH-1) could be exploite by planting during May 15th with an applicatio of 150 kg N ha^{-1} in three splits (50,25 an 25% at basal, maximum tillering and panicl initiation respectively) during *Kuruvai* (June September) season under Coimbatore condition

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Research Notes

Integrated nutrient management for rice and mustard croppin system

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Indiscriminate use of chemical fertilizer causes environmental pollution. Considering this, integrated approach of plant nutrient management (conjunctive use of organic, bio and inorganic fertilizers) is gaining importance. Integrated nutrient management (INM) concept if properly designed not only meets the nutrient requirement of component crops of a system but keeps th system intact. The imporance of bio and organi sources such as blue-green algae (Singh an Singh, 1987) and organic manures (Chakrabort *et al.* 1988) to rice cultivation has been accepte globally. Green manuring with *Sesbania* is mor promising technique in increasing the yield o able 1. Effect of combined use of organic manures, bio-and inorganic fertilizers on yield and yield component of rice.

reatments	Panicles m^{-2}		Grain yield ($t\ ha^{-1}$)	
	1999	2000	1999	2000
ontrol	177	198	1.84	1.93
YM F_0	2.12	2.37	2.08	2.34
LM F_0	220	245	2.12	2.38
GA F_0	215	248	2.11	2.27
YM F_1	238	270	2.18	2.43
LM F_1	240	272	2.23	2.40
GA F_1	232	261	2.20	2.45
YM F_2	331	360	2.91	3.15
LM F_2	325	347	2.89	3.18
GA F_2	335	351	2.94	3.12
YM F_3	343	372	2.99	3.24
LM F_3	348	378	3.04	3.21
GA F_3	340	369	2.98	3.19
) (P=0.05)	33	38	0.19	0.21

ntrol = Unfertilized control; FYM = Farmyard manure 5 t ha^{-1}; GLM = Green leaf manure 5 t ha^{-1}; GA = Blue green algae 10 kg ha^{-1}; $F_0 = N_0P_0K_0$ Kg ha^{-1}; $F_1 = N_{25}P_{12.5}K_{12.5}$ kg ha^{-1}; $F_2 = N_{50}P_{25}K_{25}$ kg ha^{-1}; $= N_{75}P_{37.5}K_{37.5}$ kg ha^{-1}.

by augmenting the organic matter status the soil as well as enhancing nitrogen and sphorus availability (Mohapatra and Pradhan, 0). Keeping this in view, the present investigation conducted to find out the optimum combination n inorganic fertilizers with bio-fertilizer (blue-reen algae) and organic manures (farmyard nanure and green leaf manure) to wet (rainy) eason rice (*Oryza sativa* L.) and their residual ffect on succeeding mustard (*Brassica jüncea* L.) Czernj.& Cosson) crop.

A field experiment was conducted during 999 and 2000 at the Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, Majhian, Dakshin Dinajpur, West Bengal on a sandy oam alluvial soil with 0.38% organic carbon 221 kg available N ha^{-1}, 7.2 kg available P ha^{-1} and 250 kg available K ha^{-1}. The soil H was 5.6. Farmyard manure (FYM), green eaf manure (GLM) and blue-green algae (BGA) with and without inorganic fertilizers consisted of 13 treatments (Table 1). The experiment was laid out in a randomized complete block design with three replications. Well decomposed FYM (containing 0.4% N) was applied @ 5 t ha^{-1} through mixing with the soil 15 days before transplanting of rice. Green leaves and twigs from 50 days old *dhaincha* plant (*Sesbania aculeata*) was applied as green leaf manure @ 5 tonnes ha^{-1} and incorporated to the soil during puddling for rice field. BGA culture @ 10 kg ha^{-1} was applied to rice plots 7 days after transplanting. Inorganic fertilizer were applied as per treatments *viz.* $F_0 = N_0\ P_0\ K_0$ kg ha^{-1}, $F_1=N_{25}\ P_{12.5}\ K_{12.5}$ kg ha^{-1}, $F_2=N_{50}\ P_{25}\ K_{25}$ kg ha^{-1}, $F_3=N_{75}\ P_{37.5}\ K_{37.5}$ kg ha^{-1}, where N in the form urea was broadcasted in three splits, P as single superphosphate and K as muriate of potash were applied basally at the time of planting. Twenty one day old seedlings of rice (cv.Parijat) were transplanted in the last week of July with a spacing of 20 x 10 cm. After harvest of rice, individual plots without changing the layout were prepared for mustard (cv.R.W-351) and sown at the third week of November with a spacing of 30 x 10 cm. Rice was gown under rainfed condition which received rainfall 1480 mm in 1999 and 1560 mm in 2000 during cropping period, whereas mustard received irrigation at branching, flowering and siliqua development stage. Plant protection measures were taken for both the crops on need base. Grain and straw samples of rice were analysed for total N,P and K (Jackson, 1973). Soil samples were collected after harvest of rice (from 0-15 cm depth) and analysed for organic C through Walkley-Black method (Piper, 1950) and available N,P and K (Jackson, 1973).

Yield and yield component of rice were significantly higher in FYM, GLM and BGA-treated plots as compared to the unfertilized control (Table 1). The effect may be attributed to steady supply of nutrients, particularly N through FYM, GLM and BGA, which could be explained by increase in plant uptake of nutrients in FYM, GLM and BGA-treated plots as compared with the control (Table 2). Higher P availability to rice may be ascribed to the solubilizing effect of carbonic acids formed during the decomposition of organic matter, which promoted the release of organic P for crop uptake (Berasteskii *et al.* 1986). Besides fixing nitrogen, BGA excreted vitamin B_{12}, ascorbic acid and auxins, which might also improve the growth of rice plants (Singh *et al.* 1995). The effect of FYM, GLM and BGA alone and in combination with given level (F_2&F_3) of inorganic fertilizers was statistically at par on grain yield, yield component and uptake of nutrients by rice. Application of inorganic

Table 2. Effect of combined use of organic manuers, bio-and inorganic fertilizers on nutrient uptake by rice and their residual effect on soil fertility (mean of two years)

Treatments	Uptake of nutrients (kg ha^{-1})						Organic C(%)	Soil available nutrients (kg ha^{-1})		
	N		P		K			N	P	K
	1999	2000	1999	2000	1999	2000				
Control	29.57	29.68	4.91	5.17	48.43	48.52	0.40	228	7.9	241
FYM F_0	34.19	37.94	6.41	7.43	53.58	63.30	0.49	240	8.1	265
GLM F_0	34.15	38.17	6.34	7.41	57.37	63.74	0.48	241	8.1	262
BGA F_0	33.87	37.57	6.29	7.22	56.11	62.11	0.49	242	8.2	267
FYM F_1	36.15	41.31	7.37	8.02	59.04	64.61	0.50	246	8.0	280
GLM F_1	36.11	40.98	7.33	81.1	59.16	63.83	0.49	243	8.3	270
BGA F_1	35.80	41.23	7.28	8.13	59.48	64.92	0.49	244	8.3	273
FYM F_2	49.54	57.29	10.34	12.31	87.32	88.44	0.54	253	8.2	290
GLM F_2	51.14	57.38	10.76	12.65	86.23	90.29	0.52	250	8.4	274
BGA F_2	50.36	58.64	11.11	12.01	86.61	88.20	0.51	250	8.4	292
FYM F_3	52.25	60.58	11.41	13.42	87.27	94.65	0.54	254	8.2	295
GLM F_3	52.21	61.33	11.71	13.49	90.31	93.17	0.55	253	8.3	287
BGA F_3	51.45	60.10	11.28	13.13	88.87	93.01	0.59	252	8.3	298
CD(P=0.05)	3.87	4.11	1.48	1.83	5.67	6.18				

Treatment details are given in Table 1.

Table 3. Residual effect of combined use of organic manures, bio-and inorganic

Treatments	Branches plant^{-1}		Siliqua plant^{-1}		Seeds siliqua^{-1}		Yield (q ha^{-1})	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001
Control	2.5	2.9	79	80	6.4	7.0	4.2	4.[illegible]
FYM F_0	2.7	2.5	77	80	7.2	7.5	4.4	4.[illegible]
GLM F_0	2.7	2.8	82	83	7.3	7.2	4.4	4.[illegible]
BGA F_0	2.9	2.7	80	84	8.1	7.9	4.9	5.[illegible]
FYM F_1	3.2	3.0	81	83	7.5	7.1	4.3	4.[illegible]
GLM F_1	3.1	3.2	84	82	7.9	8.3	4.6	4.[illegible]
BGA F_1	3.1	3.2	84	82	8.4	8.8	4.8	5.1
FYM F_2	3.0	2.9	83	86	8.7	9.0	4.8	5.[illegible]
GLM F_2	2.9	3.3	83	80	7.9	80	4.3	4.[illegible]
BGA F_2	2.6	2.8	78	81	8.1	7.6	4.7	4.5
FYM F_3	2.8	2.6	81	86	8.5	8.3	4.9	5.2
GLM F_3	3.0	2.8	85	87	8.6	8.4	5.0	5.2
BGA F_3	3.2	3.1	83	85	8.3	8.0	4.6	5.0
SEd	0.48	0.54	5.32	4.91	1.82	1.76	0.53	0.71
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS = Not significant; Treatment details are given in Table 1.

fertilizers to organic manures and bio-fertilizer treated plots proved beneficial and resulted in higher yield of rice, but the effect of F_0 (no fertilizer) and F_1 (25:12.5:12.5 kg NPK ha^{-1}) level was statistically at par (Table 1). The increase in the levels of inorganic fertilizers improved the grain yield significantly upto F_2 level and beyond this level, the response was not significant. This might be due to lower use efficiency of inorganic fertilizers during wet season. Similar trend was also observed by Rathore *et al.* (1995). The positive correlation between grain yield and uptake of N,P and K (r=0.998, 0.995 and 0.998 during 1999 and 0.996, 0.996 and 0.997 during 2000 respectively) substantiated the fact that crop N,P and K uptake increased with increased grain yield of rice (Tables 1 & 2).

FYM, GLM and BGA alone and in combination with inorganic fertilizers considerably improved organic C and available nutrients (N,P and K) after harvest of rice (Table 2). The increase in fertility status was due to more mineralization of organic matter and release of soil nutrients in time (Kanwar, 1981).

FYM, GLM and BGA with and without inorganic fertilizers applied to rice did not exhibit any residual effect to the succeeding crop mustard in both the years (Table 3). Similar observation was also made by Sharma and Mittra (1990) incase of wheat and chickpea grown on residual soil fertility after harvest of rice.

It is concluded from the study that a judicious combination of 50:25:25 kg of N,P and K ha^{-1} as inorganic fertilizers along with 5 t ha^{-1} organic manures (FYM or GLM)/ 10 kg ha^{-1} bio-fertilizer (BGA) proved superior to other treatments for wet season rice. On the residual soil fertility to mustard crop, the result was not encouraging and this indicated that for higher mustard yield in this system, additional nutrients have to be applied to the succeding crop mustard.

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Research Notes

Effect of foliar nutrition of major and chelated micronutrients an rhizobium seed treatment on rice-fallow blackgram

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Blackgram is the predominant pulse crop of Tamil Nadu and it is the main source of food protein to the vegetarians. The crop is mainly raised in rice-fallow after harvest of samba rice crop. Foliar application of macro and micronutrients and seed treatment with *Rhizobium* biofertilizer were reported to be efficient in increasing the grain yield, haulm yield, NPK uptake and protein content of pulse grains (Gopal Singh and Sudhakar, 1991). In order to find out the effect of *Rhizobium* seed treatment and foliar application of macro and chelated micronutrients on grain yield, haulm yield, nutrient uptake and protein content rice-fallow blackgram, the present investigatio was undertaken.

Field experiments were conducted duri the year 1999-2000 (Rice-fallow condition) Vertisols of Annamalai University Experiment Farm, Annamalai University, Tamil Nadu. T blackgram cv.ADT 3 was grown as test cro The experimental soil was found to be neutr in reaction (pH 7.2) with EC of 0. dSm^{-1}. The available N,P and K were 23 21.8 and 285 kg ha^{-1}, respectively.