

**STUDIES ON INTEGRATED NITROGEN MANAGEMENT AND
SEEDLING AGES IN RICE-GREENGRAM SYSTEM**

BY

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M Sc (Ag.)

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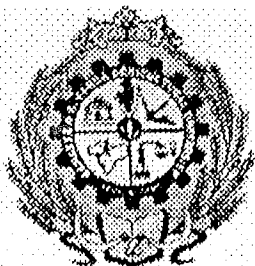
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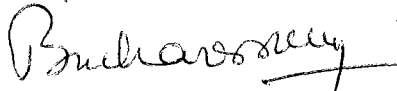
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Mr. A. UPENDRA RAO, has satisfactorily prosecuted the course of research and that the thesis entitled "STUDIES ON INTEGRATED NITROGEN MANAGEMENT AND SEEDLING AGES IN RICE-GREENGRAM SYSTEM" submitted is the result of original research work done and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any university.

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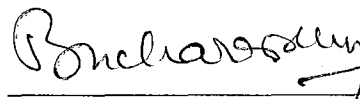
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No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of investigation have been duly acknowledged by the author of the thesis.

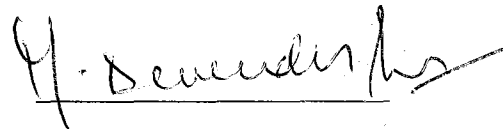

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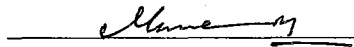
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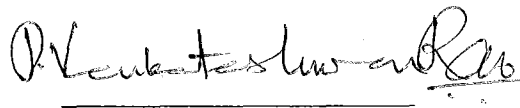
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(A. UPENDRA RAO)

DECLARATION

I, **A. UPENDRA RAO**, hereby declare that the thesis entitled **“STUDIES ON INTEGRATED NITROGEN MANAGEMENT AND SEEDLING AGES IN RICE-GREENGRAM SYSTEM”** submitted to the Acharya N.G. Ranga Agricultural University for the degree of **DOCTOR OF PHILOSOPHY IN AGRICULTURE** is a result of original research work done by me. I also declare that any material contained in the thesis has not been published earlier in any manner.

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ABSTRACT

An experiment on “Studies on integrated nitrogen management and seedling ages in rice-greengram system” was conducted at College Farm, College of Agriculture, Rajendranagar, Hyderabad on sandy clay loam soil during *kharif* and *rabi* 2000-2001 and 2001-2002 to assess the effects of age of seedlings, organic and inorganic sources of nitrogen on rice and its residual effect on succeeding greengram. The *kharif* rice crop was laid out in split-plot design replicated thrice with three age of seedlings (30, 45 and 60 day old) planted on single date in main plots and nine nitrogen management practices (75% RDFN + 25 kg GM-N, 75% RDFN + 25 kg FYM-N, 75% RDFN + 25 kg VC-N, 75% RDFN + 25 kg PM-N, 75% RDFN + 25 kg GM-N + 25 kg FYM-N, 75% RDFN + 25 kg GM-N + 25 kg VC-N, 75% RDFN + 25 kg GM-N + 25 kg PM-N, 100% RDFN and 125% RDFN) in subplots. In *rabi* each of the subplot of *kharif* was subdivided into two plots and were assigned with 50% RDF and 100% RDF to greengram and the results were analysed in a split-split plot design treating 2 levels of RDF to greengram as sub-sub-plot treatments.

In *kharif*, the grain yield, number of filled spikelets per panicle, dry matter production at harvest and NPK uptake of rice were significantly higher in the crop

transplanted with 45 day old seedlings over that of 30 and 60 day old seedlings. Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted significantly higher growth, yield attributes, grain and straw yield, NPK uptake, and available N, P₂O₅ and K₂O in the soil after rice over that of application of 100% RDFN, 75% RDFN + 25 kg GM-N / FYM-N / VC-N. Substitution of 25 kg N ha⁻¹ through poultry manure of 100% RDN resulted comparable grain yield to that of application of 125% RDN through different sources. Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to preceding rice resulted in significantly higher dry matter production at harvest, number of pods per plant and seeds per pod, seed and haulm yield and NPK uptake at harvest in succeeding greengram as compared to that of application of 100 and 125% RDFN and 100% RDN through different sources. Application of 50 and 100% RDF to greengram resulted comparable dry matter production, yield attributes, seed yield and N, K₂O in the soil after greengram. Transplanting of 45 day old seedlings, application of 125% RDFN to rice, application of 50% RDF to greengram and their combinations resulted in higher net returns and BCR.

LIST OF ABBREVIATIONS

%	:	Per cent
@	:	at the rate of
a.i.	:	active ingredient
ARI	:	Agricultural Research Institute
AT	:	Active tillering
B:C ratio	:	Benefit : cost ratio
BCR	:	Benefit : cost ratio
CD	:	Critical difference
cm	:	Centimeter
DAS	:	Days after sowing
DAT	:	Days after transplanting
day ⁻¹	:	per day
DMP	:	Dry matter production
DMPH	:	Dry matter production at harvest
dS m ⁻¹	:	deci siemens per metre
EC	:	Electrical conductivity
et al.	:	and others
Fig.	:	Figure
FN	:	Fertilizer nitrogen
FYM	:	Farm yard manure
g	:	gram
G	:	granule
ha	:	hectare
ha ⁻¹	:	per hectare
HI	:	Harvest index
hr ⁻¹	:	per hour
hrs	:	hours
i.e.,	:	that is
K	:	Potassium
K ₂ O	:	Potassium
kg ha ⁻¹	:	kilogram per hectare
kg	:	kilogram
kg ⁻¹	:	per kilogram
L/B ratio	:	Length / breadth ratio
LAI	:	Leaf area index
m	:	metre
m ⁻²	:	per square metre
m ²	:	square metre
max	:	maximum
min	:	minimum
mm day ⁻¹	:	millimeter per day
mm	:	millimeter
MSL	:	mean sea level
N	:	Nitrogen

No.	:	Number
NS	:	non-significant
°C	:	Degree Celsius (centigrade)
P	:	Phosphorus
P ₂ O ₅	:	Phosphorus
panicle ⁻¹	:	per panicle
pH	:	soil reaction
PI	:	panicle initiation
plant ⁻¹	:	per plant
pod ⁻¹	:	per pod
RDF	:	recommended dose of fertilizer
RDFN	:	recommended dose of fertilizer nitrogen
RDN	:	recommended dose of nitrogen through different sources
RH	:	relative humidity
Rs ha ⁻¹	:	Rupees per hectare
Rs.	:	Rupees
SEd±	:	Standard error deviation
t ha ⁻¹	:	tonnes per hectare
t	:	tonne
viz.,	:	namely
WSC	:	water soluble concentration
yr	:	year
yr ⁻¹	:	per year
ZnSO ₄	:	zinc sulphate

Chapter - I

Introduction

CHAPTER – I

INTRODUCTION

Intensive cultivation of land without conservation of soil fertility would lead to the springing of deserts (Swaminathan, 1987). Crop rotations involving leguminous crops and integrated nutrient management are essential to fine tune production practices for sustaining agriculture. Rice-greengram system is one of the predominant cropping systems of Andhra Pradesh. Legumes with their adaptability to different crop-based cropping patterns and their ability to fix nitrogen, may offer opportunities to increase and sustain productivity in rice-based cropping systems.

Integrated plant nutrient supply to lowland rice is successful in varied rice growing agro-ecological situations (Meelu and Morris, 1986). Nutrient management must be sound and effective for achieving the production targets on sustainable basis. Integrated nutrient management being a more knowledge and information intensive and location specific, achieves a better synchronization of nutrients release with the crop needs, which is a key step in newly emerging precision farming.

As nitrogen is the kingpin in the mineral nutrition of rice, increased use of fertilizer N has become universally inevitable to elevate the productivity of modern rice genotypes under lowland conditions. The rice crop consumes about 35 per cent of the total fertilizer N used in Indian agriculture, but the use efficiency of applied fertilizer N by lowland rice is often low, seldom touching 40 per cent.

Nutrient management especially that of nitrogen, in a cropping system is more complex than individual crops. Swaminathan (1981) emphasized the need for systems approach in nutrient management recommendation for increasing fertilizer use efficiency and economizing the use of costly mineral fertilizer. Low cost alternative sources of N with renewable nature are to be identified for sustaining the yield levels and economizing the mineral fertilizers in a systems approach.

In many parts of the country especially tail end areas under canal system and also under irrigation tanks, whose re-charging depends on the receipt of rainfall, often the farmers transplant rice late using over aged seedlings. Under late-planted conditions proper nitrogen management, as well as utilization of seedlings is important to get better crop yield. Application of huge quantities of fertilizer N to the aged seedlings especially at initial stages of crop growth is quite common phenomena to cope up the crop which results in environmental problems. Usefulness of integrated nitrogen management under normal planting is fairly well established fact, but limited information is available on the effect of integrated nutrient management in late planted rice with different seedling ages.

The residual effect of integrated nutrient management practices to rice on succeeding crops particularly greengram cropping system with reference to productivity and dynamics of soil fertility has not been adequately investigated especially under late planted situation.

Keeping the above aspects in view, the present study was conducted with conjunctive use of different sources of organic and inorganic N and three ages of rice seedlings under late planted conditions during two successive *kharif* and *rabi* seasons of 2000 and 2001, with the following objectives.

- 1) To study the conjunctive use of organic and inorganic sources of nitrogen on growth and yield of late planted rice
- 2) To find out the influence of different ages of seedlings on performance of late planted crop
- 3) To workout an appropriate nitrogen management practice based on productive, economic and soil health criteria
- 4) To study the growth and yield of rice as influenced by ages of seedlings under different sources of N
- 5) To find out the residual effect of N management practices of rice on succeeding crop.

Chapter - II

Review of Literature

CHAPTER – II

REVIEW OF LITERATURE

The information on effect of seedling ages, nitrogen management practices on lowland rice and residual effect of organic and inorganic sources on the succeeding greengram is briefly reviewed in this chapter under the following sub-heads.

- 2.1 Rice
 - 2.1.1 Age of seedlings in rice
 - 2.1.1.1 Growth
 - 2.1.1.2 Yield attributes
 - 2.1.1.3 Yield
 - 2.1.1.4 Nutrient uptake
 - 2.1.2 Inorganic nitrogen on rice
 - 2.1.2.1 Growth
 - 2.1.2.2 Yield attributes
 - 2.1.2.3 Yield
 - 2.1.2.4 Nutrient uptake
 - 2.1.3 Conjunctive use of organic and inorganic sources of N in rice
 - 2.1.3.1 Conjunctive use of green manure and fertilizer N to rice
 - 2.1.3.2 Conjunctive use of farm yard manure (FYM) and fertilizer N to rice
 - 2.1.3.3 Conjunctive use of vermicompost and fertilizer N to rice
 - 2.1.3.4 Conjunctive use of poultry manure and fertilizer N to rice
 - 2.1.4 Residual effect of nitrogen sources applied to rice

- 2.1.5 Interaction between ages and nitrogen management practices
- 2.1.6 Economics of the rice based cropping systems
- 2.2 Effect of fertilization on greengram

- 2.1 **RICE**
- 2.1.1 **Age of seedlings**
- 2.1.1.1 **Growth**

Reduced plant growth with aged seedlings was well documented (AICRIP, 1972; Murthy and Sahu, 1979; Ghosh, 1982; Mandal *et al.*, 1984 and Raju and Rao, 1984). There was no significant difference in tillering between 20 and 40 days old seedlings on the other hand, the 60 days old seedlings resulted in poor tillering (AICRIP, 1978; Mannan and Siddiqui, 1990). The crop raised from younger seedlings produced more number of tillers per unit area than those raised from aged seedlings (AICRIP, 1972; Ghosh, 1982; Mandal *et al.*, 1984; Raju and Rao, 1984).

The LAI at flowering was unaffected by age of the seedlings in mid-late varieties and dry matter production (DMP) at harvest was maximum with 40 days old seedlings as compared to 20 and 60 days old (Murthy and Sahu, 1979). On the other hand Reddy and Narayana (1984) reported that planting 20 and 30 days old seedlings recorded significantly higher DMP at all stages of crop growth than that of 40 days old seedlings.

Further the crop planted with 55 days old seedlings took about two weeks lesser to flower and mature (from planting to harvest) as compared to 25 days old seedlings (Shahi *et al.*, 1976). The young seedlings planted late in the season resulted in prolonged growth, duration and delayed flowering (Gill and Shahi, 1987).

and Reddy *et al.*, 1987). With the increase in age of seedlings at transplanting, there was an increase in the total duration of the crop but decrease in main field duration (Murthy and Sahu, 1979; Kurmi *et al.*, 1993).

2.1.1.2 Yield components

Younger seedlings produced significantly more number of effective tillers compared to aged seedlings (Mandal and Mahapatra, 1968; Kumar, 1969; Jagadeswar, 1969; Barthakur and Gogoi, 1974; Ghosh, 1982; Rao and Raju, 1987; Kurmi *et al.*, 1993; Patel, 1999 and Singh *et al.*, 1999). Contrary there are reports that panicle number was unaffected by planting 50 days aged seedlings (Balasubramaniyan, 1987, Singh *et al.*, 1996), or 60 days old seedlings (Murthy *et al.*, 1983).

Number of grains panicle⁻¹ increased with the increase in age of seedlings (AICRIP, 1968). There are reports that grain number panicle⁻¹ decreased with increase in the age of seedlings (Ghosh, 1982; Raju and Rao, 1984; Rao and Raju, 1987 and Patel, 1999).

Planting of aged seedlings resulted more number of filled spikelets panicle⁻¹ due to decrease in spikelet sterility (Murthy and Sahu, 1979; Gill and Shahi, 1987 and Pattar *et al.*, 2001). Contrarily Ghosh (1982) reported reduced filled spikelet number per panicle with increase in age of the seedlings.

Higher thousand grain weight was observed with younger seedlings (Rao and Raju, 1987; Singh and Singh, 1998 and Patel, 1999). Balasubramaniyan (1987) reported that 1000 grain weight was unaffected by planting upto 50 days old seedlings. Whereas Murthy *et al.* (1983) observed no significant difference in 1000 grain weight due to planting of 30, 45 and 60 days aged seedlings.

The spikelet sterility decreased with increase in age of seedlings (Murthy *et al.*, 1983). Contrary to this, Kumar (1969), Jagadeswar (1969) reported more spikelet sterility with aged seedlings.

2.1.1.3 Yield

Planting younger seedlings (30 days) resulted in maximum grain yield (Raju and Rao, 1984; Reddy and Narayana, 1984; Chandrasekaran *et al.*, 1984; Rao and Raju, 1987; Wagh *et al.*, 1988; Singh and Singh, 1998 and Patel, 1999). Planting of 45 days old seedlings resulted in significantly higher yield under late planted conditions (Gill and Shahi, 1987; Channabasappa *et al.*, 1998 and Pattar *et al.*, 2001).

During *kharif*, there was no reduction in yield when seedlings aged upto 50 days were planted as they started with high dry matter production and greater assimilating system (Setty *et al.*, 1987; Balasubramaniyan, 1987; Kurmi *et al.*, 1993).

The maximum grain yield as well as gross returns obtained with 45 days old seedlings and closely followed by 30 days and 60 days old seedlings (Singh *et al.*, 1996 and Singh *et al.*, 1999). On the other hand, late transplanted 60 days old seedlings gave highest grain yield and N recovery than 30 and 45 days old seedlings (Gill and Shahi, 1987). The grain yield was not impaired by planting 40 days old seedlings in early varieties and 60 days old seedlings in mid-late varieties (Murty and Sahu, 1979). Reddy *et al.* (1987) reported the higher grain yield (3.9 t ha^{-1}) was obtained when 60 days old seedlings were used for late transplanting.

On the other hand, no difference in the grain yield was observed due to planting of aged seedlings upto 60 days old (Mukherjee and Debnath, 1982; Shahani, 1984 and Mannan and Siddiqui, 1990). There was more than 10 per cent reduction in grain yield when the age of the seedlings exceeded 45 days (Balasubramanian *et al.*, 1977; Pillai and Katyal, 1977). The reduction in grain yield due to transplanting of 60 days old seedlings over 20 and 40 days old seedlings was because of lower number of effective tillers per unit area (AICRIP, 1978 and 1979).

2.1.1.4 Nutrient uptake

N uptake by grain was higher in younger seedlings than aged ones. On the other hand, the N uptake by straw at harvest was not significantly differed with age of seedlings (Reddy and Narayana, 1984). The harvest index increased with decrease in the age of rice seedlings (Mandal *et al.*, 1984).

2.1.2 Inorganic Nitrogen

2.1.2.1 Growth

Several investigators revealed that increased nitrogen application enhanced tiller number and dry matter production (Dubey *et al.*, 1983; Ramaiah *et al.*, 1986; Reddy *et al.*, 1987; Raju and Reddy, 1997), LAI (Prasad *et al.*, 1994 and Raju and Reddy, 1997) and tiller number, LAI (Balasubramanian and Palaniappan, 1991), dry matter production (Raju *et al.*, 1989; Balasubramanian and Palaniappan, 1991 and Hari *et al.*, 1997).

2.1.2.2 Yield attributes

Increased nitrogen application enhanced panicle number (Chander and Pandey, 1996; Gopal, 1994), total spikelets/panicle (Hariprasad, 1993; Chander

and Pandey, 1996), filled spikelets/panicle, 1000 grain weight (Singh and Verma, 1989), all yield components (Raju and Reddy, 1997) and panicle number (Pandian and Perumal, 1994; Hari *et al.*, 1997).

Spikelet sterility increased with increase in level of nitrogen and the reason for higher chaffyness was due to accumulation of more soluble and non-productive nitrogen at higher N levels (Reddy *et al.*, 1987; Peeran and Sreeramulu, 1995).

2.1.2.3 Yield

Nitrogen application has a significant and positive influence on grain yield of rice. Increase in grain yield with increased N application was reported by several research workers (Pyarelal *et al.*, 1988; Duraisamy and Palaniappan, 1989; Budhar *et al.*, 1991; Prasad *et al.*, 1992; Thakur, 1993; Pandey and Thripathi, 1994; Chander and Pandey, 1996). There are reports that grain yield improved with application of nitrogen upto 100 kg ha⁻¹ (Dahatonde, 1992; Chavan *et al.*, 1996), 113 kg ha⁻¹ (Krishnappa *et al.*, 1986; Raju *et al.*, 1989), 120 kg ha⁻¹ (Agarwal *et al.*, 1990; Marazi *et al.*, 1993 and Shanmugasundaram and Selva Kumar, 1993) and 150 kg ha⁻¹ (Balasubramanian and Palaniappan, 1991; Hari *et al.*, 1997).

Increase in N application significantly influenced the straw yields (Reddy *et al.*, 1987; Sukumar *et al.*, 1988; Mirza and Reddy, 1989; Sharma *et al.*, 1990 and Upadhyay and Patel, 1992 and Suresh *et al.*, 1995) and the response was observed upto 113 kg ha⁻¹ (Raju *et al.*, 1989), 120 kg ha⁻¹ (Agarwal and Sharma, 1992; Marazi *et al.*, 1993) and even 200 kg ha⁻¹ (Balasubramanian and Palaniappan, 1991 and Hari *et al.*, 1997).

Harvest index of rice significantly increased with nitrogen nutrition (Purohit *et al.*, 1988; De *et al.*, 1992). Dalal and Dixit (1987) did not find any significant difference in harvest index with increased level of N from 0 to 120 kg ha⁻¹. Satyanarayana (1986) and Karunasagar (1989) observed a decrease in harvest index with increased level of nitrogen application.

2.1.2.4 Nutrient uptake

A gradual increase in uptake of NPK with increased level of N application has been reported by several workers (Antil *et al.*, 1989; Tyagi and Agarwal, 1989; Rayar, 1990; Agarwal and Sharma, 1992; Thakur, 1993; Shukla and Sharma, 1994). The increase in N application was significant upto 120 kg N ha⁻¹ (Sreedevi and Thangamuthu, 1991; Mahajan and Tripathy, 1992; Hariprasad, 1993; Blaise and Rajendra Prasad, 1996), similar increase in P uptake was observed upto 120 kg N ha⁻¹, K uptake (Mehta *et al.*, 1983).

2.1.3 Conjunctive Use of Organic and Inorganic Sources of Nitrogen

2.1.3.1 Green manure and fertilizer N

Constant N supply due to slow release from the incorporated green manure could match with the absorption pattern of rice resulting in improved crop performance (Westcott and Mikkelsen, 1987).

Efficiency of sunhemp as green manure crop especially to rice was well documented by many researchers (Vacchani and Murty, 1964; Maskina *et al.*, 1989; Hundal *et al.*, 1992).

Incorporation of green manure resulted in increased tiller production (Ramasamy, 1990, Kolambe and Patel, 1994), LAI and dry matter production

(Halepyati and Sheelavantar, 1992; Balasubramaniyan *et al.*, 1993; Matiwade and Sheelavantar, 1994; Vaiyapuri *et al.*, 1995 and Prasad, 2000). The growth characters and yield attributes were positively influenced by green manuring along with chemical fertilizers (Singh *et al.*, 1990). Siddeswaran (1992) noticed that mineralization of green manures ensured a continuous supply of NH_4^+ -N, which was preferred and readily absorbed by the low land rice crop, resulting in better growth.

Panicle number m^{-2} , filled grains panicle⁻¹ and 1000 grain weight were significantly higher with green manuring coupled with mineral nitrogen over that of FYM with mineral nitrogen (Pandian and Perumal, 1994). Application of 75 per cent N through fertilizer and 25 per cent N through organic manure resulted in higher number of grains panicle⁻¹ and 1000 grain weight as compared to that of 100 per cent N applied through inorganic fertilizer (Setty and Channabasavanna, 1990). There was a marked improvement in 1000-grain weight with application of sunhemp green manuring in combination with inorganic fertiliser (Ramana, 1994). On the other hand, Budhar *et al.* (1991) found no significant effect on 1000 grain weight of rice by application of green manures.

Mehta *et al.* (1996), Beena and Balachandran (2002) reported that 100 per cent nitrogen through fertilizer coupled with sunhemp green manuring resulted more number of panicles m^{-2} over 100 per cent N through fertilizer alone. Application of 25 or 50 per cent N through sunhemp + remaining N through urea significantly increased panicles m^{-2} , grains per panicle, 1000 grain weight over 100 per cent N through fertiliser (Prasad, 2000). But, Reddy *et al.* (2003) reported decreased number of panicles, total number of grains, filled grains and 1000 grain

weight with 75 per cent N through urea + 25 per cent N through sunhemp over 100 per cent N through urea.

Sunhemp green manuring resulted higher grain yield of rice (Hundal *et al.*, 1992). Pandey *et al.* (2001) reported that sunhemp green manuring combined with prilled urea proved better than prilled urea alone increasing grain and straw yields. However, the yield was comparable with that of received FYM.

Combined application of sunhemp as green manure with 150 kg N ha⁻¹ recorded significantly higher grain yield as compared to the same level of N through green manure or inorganic N alone (Balasubramanian and Palaniappan, 1991; Purushothaman *et al.*, 1990 and Mehta *et al.*, 1996). Half of the recommended fertilizer dose along with sunhemp green manuring or 25% N through GM + 75% NPK through fertiliser recorded comparable yield of rice with that of recommended NPK (Pradhan and Mandal, 1997 and Subashchandra *et al.*, 2001). Contrary to this significantly decrease in grain and straw yields was observed with 75 per cent N urea + 25 per cent N sunhemp compared to 100 per cent N through urea (Reddy *et al.*, 2003).

Green manuring enhanced the uptake of N (Hundal and Thind, 1993), P (Siddeswaran, 1992) and K (Sreedevi and Thangamuthu, 1991). Green manuring with sunhemp significantly increased the uptake of N, P and K (Balasubramanian *et al.*, 1991 and Prasad, 2000). Combined application of green manure coupled with 100 kg N ha⁻¹ through urea significantly increased the N uptake compared to urea alone (Rabindra *et al.*, 1989, Halepyati and Sheelavantar, 1990). Reddy (2001) recorded significantly lower NPK uptake with 75 per cent N urea + 25 per cent N sunhemp compared to 100 per cent N through urea.

The proportion of nitrogen retained in the soil was higher with green manuring than that of inorganic nitrogen. Nitrogen supplying pattern became steady and long lasting when green manure and fertilizer nitrogen were combined (Wen, 1991). Because of relatively slower N release pattern from plant materials the magnitude of leaching, denitrification and NH_3 volatilization losses may be lower for green manure-N than for fertilizer-N in rice crop (Mu and Quian, 1983; Nagarajah, 1988; Becker *et al.*, 1994). In a laboratory study, it was observed that soil amended with green manure was not having any NH_3 volatilization (Khind *et al.*, 1989; Rekhi and Bajwa, 1994). Application of green manure along with urea reduce NH_3 losses from urea (De Datta, 1995) due to volatilization and leaching (Das *et al.*, 1995).

Application of green manure influenced the availability of P and other elements through better mobilization (Muneendranaidu, 1981). Organic acids produced during decomposition of green manure besides solubilizing the insoluble P (Ventura *et al.*, 1987) adds substantial quantities of Ca, Mg, S, Cu, Fe and Mn in soil after incorporation of green manure (Ponnamperuma, 1984). In waterlogged soils, green manures increased the availability of P through the mechanism of reduction, chelation and favourable changes in soil pH (Hundal *et al.*, 1987).

The available N increased under green manuring, whereas urea N alone made no impact on fertility buildup (Rathore *et al.*, 1995). Green manure enhanced the sustainability of soil due to higher residual recoveries of nutrients besides increased grain yield (Deka Medhi and De Datta, 1996).

Inorganic fertilization not capable of maintaining soil fertility (Subhashchandra *et al.*, 2001). Higher NPK availability was observed in the soil

with application of 25 to 50 per cent N through sunnhemp + remaining N through urea compared to 100 per cent N through inorganic fertiliser (Prasad, 2000; Sujathamma, 2000 and Reddy, 2001). Premi (2003) revealed that combined use of inorganic and organic sources of N increased the organic carbon, N, P and K content in soil and decreased bulk density of the soil. Among organic sources, sunhemp green manuring proved significantly superior to FYM.

In rice-fallow-rice cropping sequence the first crop uses only 31-44% of the added urea, further he stated that incorporating *in situ* grown dhaincha into the soil had little effect on urea utilisation (Panda *et al.*, 1995). Each crop of the rice-greengram-rice sequence should be separately fertilized as per its need and the residual effect of green manuring was non existent (Mohanti *et al.*, 1998).

2.1.3.2 Farm yard manure (FYM) and nitrogen fertilizer

FYM application resulted significant increase in tiller production (Budhar *et al.*, 1991; Rajput and Warsi, 1991; Mathew *et al.*, 1994; Kumar *et al.*, 1998 and Prasad, 2000) and dry matter accumulation (Tripathi *et al.*, 1990). A significant increase in dry matter production in rice due to application of FYM in combination with inorganic nitrogen (Maskina *et al.*, 1985). Contrary to this, Sujathamma (1996) reported significant decrease in tiller number and dry matter of rice with 25 per cent N through FYM and 75 per cent through fertilizer compared to 100 per cent N through fertilizer alone.

Prasad (2000) reported significant increase in LAI and dry matter production of rice with 25 or 50 per cent N through FYM + remaining N through urea over inorganic fertilization. In contrary, Reddy (2001) recorded significant

decrease in LAI, tillers and dry matter with 75 per cent N through urea + 25 per cent N through FYM compared to 100 per cent N through urea.

Combined application of inorganic fertilizer and FYM increased the productive tillers hill⁻¹, number of grains per panicle and 1000 grain weight (Peeran and Sreeramulu, 1995), more number of panicles m⁻² (Sharma and Sharma, 1994). Sujathamma (1996) reported significantly higher 1000 grain weight with 25 per cent N through FYM + 75 per cent N through fertilizer over 100 per cent N through fertilizer. Application of 75 per cent N through inorganic source in conjunction with 10 t FYM ha⁻¹ resulted in higher number of panicles m⁻², grains panicle⁻¹ and 1000-grain weight of rainfed transplanted rice (Puste *et al.*, 1996). On the other hand, Reddy (2001) recorded significantly less panicles m⁻², filled grains per panicle and 1000 grain weight with 75 per cent N through urea + 25 per cent N through FYM compared to 100 per cent N through urea.

Mathew *et al.* (1994) and Talashilkar and Mehta (1998) reported that reducing the nitrogen dose by 25 per cent and supplemented through green manure or FYM did not decrease the rice yield as compared to 100% nitrogen through fertilizer. On the other hand, Selvam (2000) revealed that conjunctive use of 50 per cent fertilizer N + 25 per cent each through FYM N and green manure N has resulted in higher grain yield and economic returns over that of 100 per cent N through fertilizer.

Significantly higher yield with 25 or 50 per cent N through FYM + remaining N through urea was observed as compared to 100 per cent N through fertilizer only (Hegde, 1998, Prasad, 2000). Substitution of 50 per cent N through FYM resulted in significantly higher yield as compared to chemical fertilizer alone

(Khan *et al.*, 1986; Johnkutty and Anilkumaran, 1991; Gill *et al.*, 1994; Roy *et al.*, 1997). In contrary, Reddy (2001) recorded significantly lower yield with 25 per cent FYM-N + 75 per cent urea-N compared to 100 per cent N through urea. Application of FYM @ 5 t ha⁻¹ in addition to the recommended dose of fertilizer produced significantly higher grain and straw yields in rice (Rabeyakhanam *et al.*, 1997, Beena and Balachandran, 2002).

Higher NPK uptake was observed with the application of FYM (Brar *et al.*, 1995; Singh *et al.*, 1996; Dixit and Gupta, 2000 and Prasad, 2000) and it was greater at tillering stage when applied along with urea over that of urea alone (Khan *et al.*, 1986 and Rabeyakhanam *et al.*, 1997). Substitution of 25 per cent N through FYM particularly at higher rates increased the N uptake (Talashilkar and Mehta, 1998; Singh *et al.*, 1998), nitrogen and P uptake (Sujathamma, 1996; Jadhav *et al.*, 1997), NPK uptake (Jana and Ghosh, 1996) compared to the application of urea alone.

Activity of soil enzymes was more pronounced with FYM in combination with fertilizers (Singaram and Kamala Kumari, 1995). Improvement in N, P, K status of the soil was observed with the application of FYM to rice crop (Ganai and Singh, 1990 and Budhar *et al.*, 1991). Continuous addition of FYM along with NPK fertilizers resulted higher NPK content of the soil (Udayasooriyan and Paramasivam, 1991). Prasad (2000) found that application of 25 or 50 per cent N through FYM + remaining N as urea significantly improved the soil available NPK compared to 100 per cent N as urea.

Jadhav *et al.* (1997) reported higher retention of fertilizer N in the soil and the lowest N losses with the combined application of urea + FYM as

compared to urea alone. It was possible to substitute 25 to 50 per cent needs of *kharif* rice by FYM without any adverse effect on the total productivity of a rice based cropping system (Hegde and Dwivedi, 1993 and Hegde, 1996).

2.1.3.3 Vermicompost and fertilizer N

Increased growth particularly tillering was observed with vermicompost application (Prakash and Bⁿadoria, 2002). Jadhav *et al.* (1997) reported maximum dry matter production in rice at harvest with 25 per cent of recommended dose of nitrogen substituted with vermicompost. Significant improvement in LAI, dry matter, tillers m⁻² was observed with 25 or 50 per cent N through vermicompost + remaining N through fertiliser compared to 100 per cent N through fertilizer (Prasad, 2000).

Significantly lesser number of panicles m⁻² was recorded with either 25% or 50% substitution of fertilizer N with vermicompost over 100% fertilizer nitrogen. However, the 1000 grain weight of rice was significantly higher with vermicompost substituted at 25 per cent over 100 per cent N through mineral fertilizer (Sujathamma, 1996). In contrary, Prasad (2000) found no significant influence of vermicompost on 1000 grain weight but 25 or 50 per cent N substitution of fertilizer through vermicompost significantly improved number of panicles m⁻², filled spikelets per panicle compared to 100 per cent n through fertilizer.

Significantly higher number of panicles and grain yield was observed with vermicompost @ 25 per cent + 75 per cent N through fertiliser over 100 per cent N through fertilizer (Rajkhowa *et al.*, 2001). Supplying 1/4th to 1/3rd of N as vermicompost increased yield and yield components of rice compared to 100 per cent N through fertilizer (Rani and Srivastava, 2001).

Application of vermicompost resulted in higher grain and straw yields in rice (Senapathi *et al.*, 1985; Prakash and Badoria, 2002). Vermicompost applied @ 5 t ha⁻¹ along with recommended dose of fertilizers resulted significantly higher yields of rice than recommended dose of fertilizer (Vasanthi and Kumarswamy, 1996).

Significantly superior grain and straw yields of rice was obtained with conjunctive use of vermicompost and fertiliser nitrogen compared to 100 per cent N through fertiliser (Sujathamma, 1996, Rani and Srivastava, 1997 and Prasad, 2000).

Twenty five per cent nitrogen through vermicompost along with 75 per cent nitrogen through fertilizer resulted significantly higher phosphorus uptake (Sujathamma, 1996) higher NPK uptake (Jadhav *et al.*, 1997). Application of 50 per cent N through vermicompost + 50 per cent N through fertiliser significantly increased the N uptake over 75 per cent N fertiliser + 25 per cent vermicompost and 100 per cent N through fertiliser (Prasad, 2000).

Zachariah (1995) observed an increased potassium uptake in vermicompost applied plants due to increase in potassium availability in the soil by shifting the equilibrium among the forms of potassium, relatively unavailable forms to more available form.

Vermicompost application increased the soil available N, P and K (Kale and Bano, 1983; Jambhekar, 1992; Puspa, 1996; Prasad, 2000) total N content (Kale, 1992) and phosphorus availability in the soil (Syres and Springett, 1994). Higher soil N, P and K content was noticed with application of vermicompost +

NPK as compared to NPK alone (Vasanthi and Kumarswamy, 1999, Rajkhowa *et al.*, 2001).

2.1.3.4 Poultry manure and fertilizer N

Significant increase in dry matter production was observed with application of poultry manure in combination with fertilizer N (Maskina *et al.*, 1985). Combined application of poultry manure along with 75% RDFN recorded significantly the higher dry matter production at flowering as compared to FYM + 75% N through fertiliser and 100% RDFN (Vanaja and Raju, 2002). Application of poultry manure @ 25% RDFN along with 75% RDFN as inorganic nitrogen resulted more number of tillers, higher LAI and dry matter production as compared to 100% RDFN as mineral fertilizers, 25% N substituted through FYM or green manuring (Mahavishnan, 2001). Number of tillers m^{-2} was significantly higher with poultry manure application @ 5 t ha^{-1} (Budhar *et al.*, 1991).

Incorporation of poultry manure @ 5 t ha^{-1} to rice could not influence 1000 grain weight but produced more number of productive tillers (Budhar *et al.*, 1991). Application of 1/3rd to 1/4th of RDFN as poultry manure along with inorganic N resulted significantly higher number of panicles, grain and straw yields over 100% RDFN as inorganic N (Rani and Srivastava, 2001). Application of poultry manure @ 25% RDFN along with 75% RDFN as inorganic nitrogen resulted more number of panicles, more number of filled grains per panicle, higher 1000 grain weight and grain yield compared to 100% RDFN as mineral fertilizers, 25% N substituted with FYM or green manuring (Mahavishnan, 2001).

According to Gupta *et al.* (1995) the highest yield of rice was obtained with combined application of inorganic fertilizer and poultry manure, whereas Singh and Meelu (1995) reported that application of poultry manure @ 4 t ha⁻¹ along with 60 kg N ha⁻¹ produced rice yields similar to 120 kg N ha⁻¹ as urea. Chinnusamy *et al.* (1997) revealed that application of poultry manure @ 5 t ha⁻¹ along with 75% RDF to rice crop significantly increased the grain and straw yields of rice. Application of poultry manure (2 t ha⁻¹) along with 75% RDFN resulted higher grain and straw yields of rice over FYM substitution and 100% RDFN as fertilizer alone (Vanaja and Raju, 2002).

Maximum grain as well as straw yield of rice was obtained by substituting 25% N through poultry manure as compared to 100% RDFN as mineral fertilizer (Bhoite *et al.*, 2000). The grain yield and net profit increased significantly with application of poultry manure along with inorganic fertilizers and poultry manure over that of FYM (Singh *et al.*, 1996).

Combined application of poultry manure @ 2 t ha⁻¹ or enriched poultry manure @ 1 t ha⁻¹ along with 75% RDFN recorded higher nutrient uptake (N, P, K) at flowering as well as at maturity (Bhoite *et al.*, 2000, Vanaja and Raju, 2002). Substituted with poultry manure @ 25% RDFN resulted in higher NPK uptake by rice over sole fertilizer N application (Rani and Srivastava, 2001). The uptake of phosphorus by rice was maximum due to application of poultry manure @ 8 t ha⁻¹ (Datta and Banik, 1994). However, highest P uptake was recorded with combined application of inorganic P and poultry manure (Gupta *et al.*, 1995).

Application of poultry manure alone and its combined use with mineral fertilizers significantly increased the organic carbon and available nitrogen

of the soil (Singh *et al.*, 1996). The maximum yield of gram was obtained due to residual effect of poultry manure compared to other organic sources and mineral fertilizer application (Singh *et al.*, 1999).

There was higher amount of residual N, P and K in plots treated with poultry manure @ 5 t ha⁻¹ (Budhar *et al.*, 1991). The N mineralization in soil with poultry manure application was substantially faster than that from FYM due to narrow C:N ratio in poultry manure (Singh *et al.*, 1988).

2.1.4 Residual Effect of Nitrogen Sources

Nutrients applied to one crop in a cropping system are some times not fully utilized by the crop and enough cumulative residual effect is carried over to the second or third crop in sequence (Rao and Bhargdwaj, 1980 and Singh and Deka, 1990). Fertilizer needs of *rabi* could be reduced to the extent of 25% by substituting 25% N needs of *kharif* crop through FYM (Hegde, 1992). Reddy *et al.* (1980), Thimmegowda and Devakumar (1994) revealed that conjunctive use of nutrients partly through organic manures and inorganic fertilizers to *kharif* rice exhibited significant residual effect on the succeeding groundnut crop by increasing pod yield. The highest total and available N, P and K status in the soil after rice was recorded with 50 and 25 per cent substitution through organic manures (Sujathamma *et al.*, 2001).

Organic manuring of rice with locally available materials along with mineral fertilization of both the crops is essential for maintaining desired level of productivity of both rice-chickpea / wheat cropping system (Sharma and Mitra, 1990). Rathore *et al.* (1993) reported significantly higher residual effects of green

manure in combination with fertiliser N than fertiliser nitrogen alone to rice on the seed yield and nitrogen uptake of chickpea in rice-chickpea cropping system. Residual N fertility was highest when sunnhemp green manure was applied along with inorganic N, followed by FYM (Pandey *et al.*, 2001).

Application of 25 per cent N either through FYM or GM + 100 per cent N through urea had significant residual effect on wheat and groundnut uptake of NPK and available NPK in soil (Reddy, 2001). Rice crop received part of the nitrogen through FYM left a significant residual effect on succeeding wheat (Soni and Sikarwar, 1983), chickpea (Singh *et al.*, 1999). Purushotham *et al.* (1988) noticed residual effect of FYM applied to *kharif* rice on the succeeding *rabi* crop and indicated a possibility of saving on phosphorus and potassium in a crop sequence.

Use of FYM along with chemical fertilizers increased the fertilizer use efficiency and sustained the productivity of the system (Yadav and Alok Kumar, 1993). Paulraj and Velayudham (1995) reported the highest seed yield of blackgram succeeding rice due to residual effect of FYM and green manure. Application of 100% RDF and FYM @ 12.5 t ha⁻¹ (or) green manure @ 5 t ha⁻¹ to preceding rice crop significantly increased the grain yield, NPK uptake and available N, P, K status of soil after the succeeding (residual) blackgram (Selvi and Ramaswami, 1995 Santhi and Selvakumari, 1998).

Sujathamma *et al.* (1996) reported substitution of vermicompost at 50 per cent to fertilizer nitrogen to *kharif* rice resulted an appreciable residual effect on the succeeding groundnut in terms of number of pods per plant, pod weight and pod and haulm yield.

Poultry manure supplemented 25% of RDF to rice and to succeeding crops increased rice grain yield and had a significant residual influence on the productivity of the succeeding crops (Chinnusamy *et al.*, 1997). Application of FYM or poultry manure either alone or in combination with 50 per cent NPK had significant residual effect on the pod yield of cowpea and improved the soil available NPK.

Fertiliser applied at higher rate than the recommended dose to rice or potato in rice-potato system did not show significant residual effect on yields of succeeding greengram (Daliparthi *et al.*, 1993). On the other hand, there was residual effect on greengram with application of NPK at 100 per cent of the recommended or 75 per cent of the recommended dose with FYM. No significant residual effect was observed on succeeding crop due to combined application of green manures and fertilizer N to previous rice crop (Thakur *et al.*, 1995). Integrated use of organic and inorganic N had little effect on residual P_2O_5 and K_2O in the soil (Panda *et al.*, 1999). Residual fertility had no impact on build-up of nitrogen and potassium in the soil (Rathore *et al.*, 1995). Organic sources applied to the preceding rice, either alone or in combination with prilled urea did not change available N, P and K content of the soil (after harvest of each crop of rice-lentil) significantly (Sarvanan *et al.*, 1987; Singh *et al.*, 2001).

2.1.5 Interaction Between Ages and N Management Practices

Tiller production and dry matter accumulation of aged seedlings was compensated with higher N levels (Ramesh, 1986). Higher level of fertilizer application resulted significant increase in panicle number, filled grains per panicle, 1000-grain weight with aged seedlings (Ramesh, 1986).

Grain yield of aged seedlings increased significantly with increasing level of nitrogen (Sahani, 1984; Gill and Shahi, 1987). Singh *et al.* (1996) indicated 45 days old seedlings produced maximum grain yield at 120 kg N ha⁻¹.

Yield loss with aged seedlings (20.7%) at 60 kg N ha⁻¹ can be compensated upto 15.1 per cent with 120 kg N ha⁻¹ (Raju and Rao, 1984). Loss in grain yield of rice can be compensated to certain extent by resorting to higher doses of fertilization, when farmers have to transplant aged seedlings under late planting Murthy *et al.* (1985), Rao and Raju (1987). Similar grain yields were obtained with 25 day old seedlings at 75 kg N ha⁻¹, 35 day old seedlings at 100 kg ha⁻¹ and 45 day old seedlings at 125 kg ha⁻¹ (Wagh *et al.*, 1988).

Interaction effect between age of seedlings and N management practices on grain yield was not significant (Reddy *et al.*, 1987; Setty *et al.*, 1987; Singh *et al.*, 1999; Channabasappa *et al.*, 1988).

2.1.6 Economics of the Rice-Based Cropping Systems

The gross and net returns were higher with application of green manuring in conjunction with inorganic fertilizers as compared to that of FYM plus inorganic fertilizers (Ramana, 1994). Prasad (2000) recorded higher gross and net returns and benefit cost ratio with application of 50 per cent N through green manure + 50 per cent N through urea compared to 100 per cent N through urea. The higher gross and net returns and benefit cost ratio were obtained with 50 per cent N through GM + 50 per cent N through FYM to *kharif* rice and 100 per cent N through fertiliser to *rabi* groundnut compared to 100 per cent N through urea to rice and groundnut (Sujathamma, 2000).

Singh *et al.* (1996) revealed that net profits continued to increase significantly with the application of poultry manure alone or in combination with inorganic fertilizers in rice-wheat cropping system. Net returns and B:C ratio were maximum with 100 per cent NPK through chemical fertiliser to each crop in rice-wheat sequence as compared to substitution of 50 per cent NPK to rice by green manure (dhaincha) along with 100 per cent NPK to wheat (Patra *et al.*, 2000).

2.2 EFFECT OF FERTILIZATION ON GREENGRAM

Dry matter production of greengram increased with progressive increase in P level upto 50 kg P₂O₅ ha⁻¹ (Arya and Kalra, 1988; Banarsidas *et al.*, 1989; Shukla and Dixit, 1996; Upadhyaya *et al.*, 1999; Chowdhury *et al.*, 2000) and 60 kg P₂O₅ ha⁻¹ (Kalitha, 1989 and Thind *et al.*, 1990). Srivastava and Verma (1984) reported that application of 15 kg N ha⁻¹ resulted significant increase in dry matter production over control.

Application of 10 kg N ha⁻¹ resulted in appreciable improvement in yield attributes like pods plant⁻¹, seeds per pod and 1000 seed weight as well as seed yield (Sarkar and Banik, 1991). Application of 20 kg N ha⁻¹ resulted maximum number of pods per plant, seeds per pod (Krishnamurthy *et al.*, 1984; Ardesna *et al.*, 1993, Patel and Patel, 1994 and Yadav, 1990), 1000 seed weight (Singh *et al.*, 1975; Samiullah *et al.*, 1982).

Application of 50 kg P₂O₅ ha⁻¹ recorded significantly higher seed and haulm yield (Balaguravaiah *et al.*, 1989; Singh and Hiremath, 1990; Kushwaha and Singh, 1992; Gopala Rao *et al.*, 1993; Sarkar and Mukherjee, 1997 and Sharma *et al.*, 1997) and 1000 seed weight (Banerjee, 1997).

Uptake of N and P by greengram increased significantly with increasing 'P' levels up to 30 kg P₂O₅ ha⁻¹ (Singh *et al.*, 1994; Singh *et al.*, 1999). Gopala Rao *et al.* (1993) reported that P uptake was significantly enhanced upto 50 kg P₂O₅ ha⁻¹.

Total nitrogen left in the soil was highest in the field applied with 50 kg P₂O₅ ha⁻¹ to greengram (Arya and Kalra, 1988). Gunavardena *et al.* (1992) found enhanced N status of the soil with 'P' application to greengram.

Chapter - III

Materials and Methods

CHAPTER – III

MATERIALS AND METHODS

The materials used and the methods adopted during the course of investigation are presented in this chapter.

3.1 DETAILS OF THE EXPERIMENTAL SITE

3.1.1 Location

Field investigation titled “Studies on integrated nitrogen management and seedling ages in rice-greengram system” was conducted during two consecutive years (2000-2001 and 2001-2002) at College Farm, College of Agriculture, Rajendranagar, Hyderabad, Acharya N.G. Ranga Agricultural University (ANGRAU) situated at an altitude of 535 m above mean sea level, 17°19’ N latitude and 78°28’ E longitude.

3.1.2 Soils

The study was conducted during two consecutive years 2000-2001 and 2001-2002 at two different sites of College Farm, College of Agriculture, Rajendranagar, Hyderabad. Soil analysis was done initially prior to the start of the experiment and samples were drawn at random from 0-30 cm depth of the experimental field during both the years. The composite soil sample was analysed for different physico-chemical properties following standard methods (Table 3.1). After harvesting of rice and greengram samples were taken immediately from the individual plots of undisturbed layout.

The physico-chemical properties of the soils are furnished in Table 3.1.

Table 3.1: Physico-chemical properties of the soil of the experimental field

Particulars	2000-2001	2001-2002	Method adopted
(i) Mechanical analysis			
Coarse sand (%)	20.80	17.67	
Fine sand (%)	39.60	47.40	
Silt (%)	13.20	12.50	
Clay (%)	26.40	22.43	
Soil texture	Sandy clay loam	Sandy clay loam	Bouyoucos hydrometer method (Piper, 1966)
Bulk density (g cc ⁻¹)	1.46	1.43	Core sampler method (Black, 1965)
(ii) Chemical analysis			
Soil pH (1:2 soil water suspension)	8.10	7.72	Glass electrode pH meter (Jackson, 1973)
EC (dS m ⁻¹ at 25°C)	0.20	0.21	Conductivity bridge method (Jackson, 1973)
Organic carbon (%)	0.21	0.34	Walkley and Black (1934)
Available N (kg ha ⁻¹)	224.45	236.12	Subbaiah and Asija (1956)
Available P ₂ O ₅ (kg ha ⁻¹)	22.62	24.22	Olsen <i>et al.</i> (1954)
Available K ₂ O (kg ha ⁻¹)	227.37	235.70	Jackson (1973)

3.1.3 Cropping History of the Experimental Site

The cropping history for the three consecutive years preceding the present study.

Year	First year site		Second year site	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
1997-98	Rice	Rice	--	--
1998-99	Rice	Castor	Rice	Rice
1999-2000	Rice	Castor	Rice	Rice
2000-2001	Present experiment		Rice	Rice

3.2 WEATHER DURING THE CROP PERIOD

Weather data pertaining to the crop period recorded at Meteorological Observatory, Agricultural Research Institute (ARI), Rajendranagar are presented in Appendix -I and Fig. 3.1a & b.

3.2.1 *Kharif* rice

The weekly mean maximum temperatures during the crop period (20 June to 15 December 2000 and 20 June 2001 to 12 December 2001) ranged from 27.8° to 33.4°C with an average of 30.8°C during 2000 and 28.3 to 33.5°C with an average of 30.7°C during 2001, whereas the decennial mean maximum temperature for the corresponding period was 30.1°C. The weekly mean minimum temperatures ranged from 10.3 to 25.0°C with an average of 20.7°C during 2000 and 9.6 to 23.6°C with an average of 20.1°C during 2001, whereas the decennial mean minimum temperature for the corresponding period was 20.2°C. The weekly mean temperatures ranged from 19.4 to 28.9°C with an average of 25.5°C during 2000 and 19.7° to 28.4°C with an average of 24.4°C during 2001, the corresponding decennial average of mean temperature was 24.9°C.

The crop received 510 mm of rainfall in 29 rainy days during 2000; 558 mm of rainfall in 31 rainy days during 2001 and the corresponding decennial average was 723 mm in 38 rainy days. Weekly mean bright sunshine hrs day⁻¹ during crop period ranged from 1.7 to 10 with an average of 6.6 during 2000, 2.3 to 10.1 with an average of 6.3 hrs d⁻¹ during 2001 and the corresponding decennial average was 6.5 hrs d⁻¹. The weekly mean relative humidity (%) during crop period ranged from 52 to 84 per cent with an average of 68.1 per cent during 2000; 51 to 84 per cent with an average of 70 per cent during 2001 and the corresponding decennial

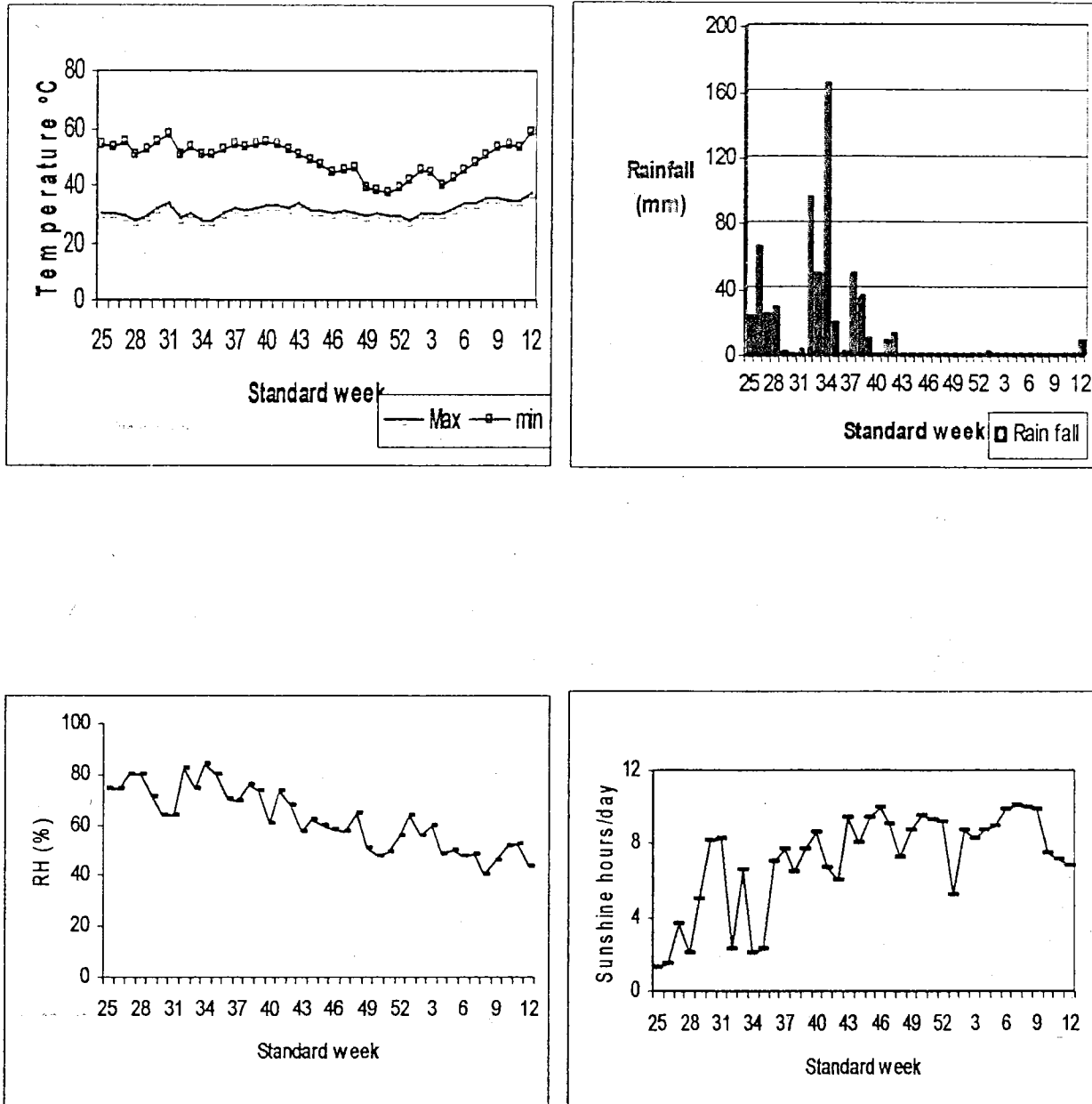


Fig 3.1 (a) Standard week-wise weather data during cropping system (2000-01)

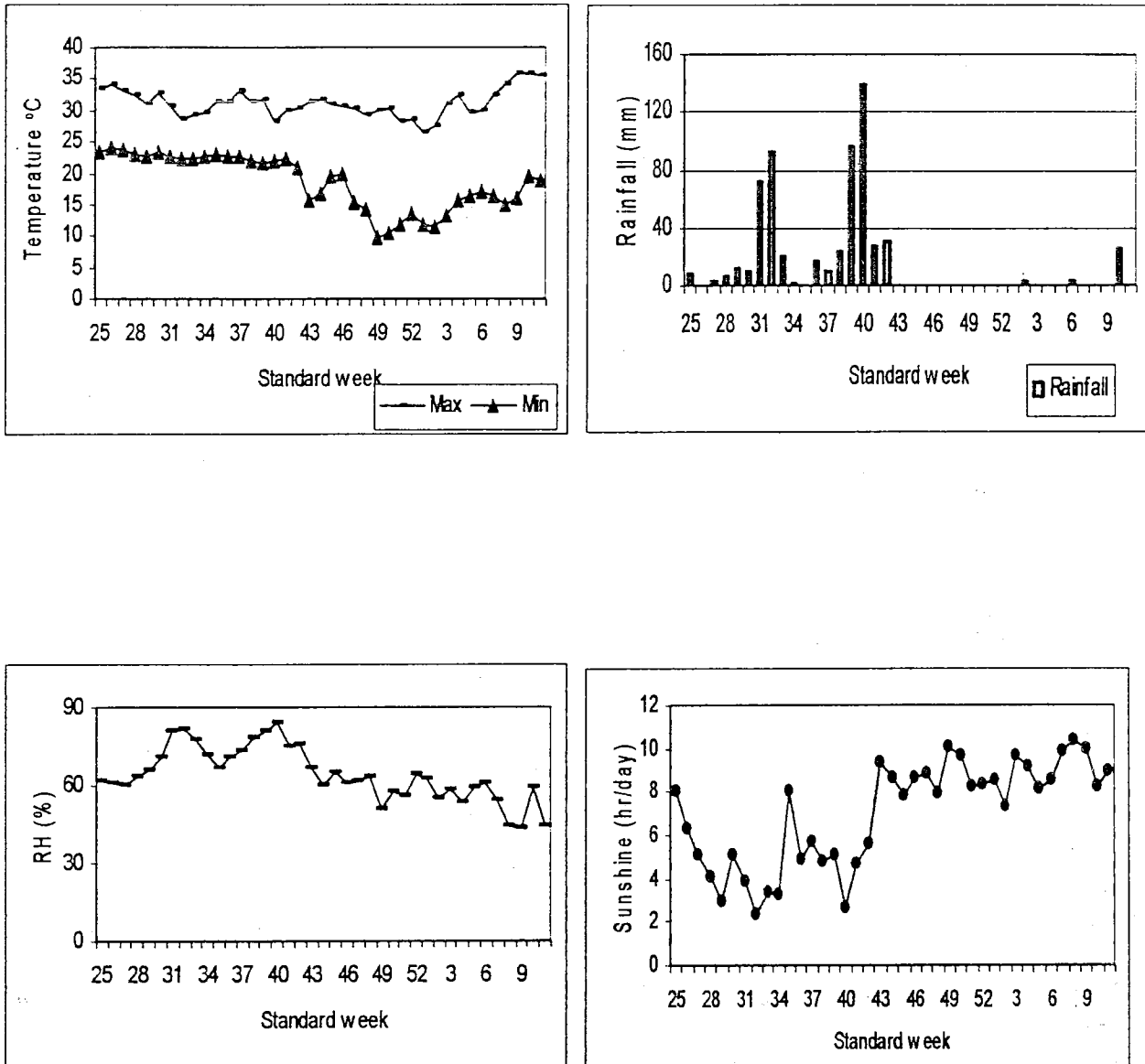


Fig 3.1 (b) Standard week-wise weather data during cropping system (2001-02)

average was 67.5 per cent. The mean evaporation (m.m.d^{-1}) during crop period was 3.8 and 3.9 during 2000 and 2001 respectively and the corresponding decennial average was 3.6.

3.2.2 *Rabi greengram*

The weekly mean maximum temperatures during the crop period (8 January 2001 to 19 March 2001 and 4 January 2002 to 18 March 2002) ranged from 30.4° to 37.1°C with an average of 33.5°C during 2001 and 26.6 to 35.7°C with an average of 31.9°C during 2002, whereas the decennial mean maximum temperature for the corresponding period was 31.8°C . The weekly mean minimum temperatures ranged from 9.7 to 21.8°C with an average of 15.2°C during 2001 and 11.6 to 19.6°C with an average of 15.6°C during 2002, whereas the decennial mean minimum temperature for the corresponding period was 15.4°C . The weekly mean temperatures ranged from 20.1 to 29.5°C with an average of 24.4°C during 2001 and 19.2° to 27.7°C with an average of 23.7°C during 2002, the corresponding decennial average of mean temperature was 23.6°C .

During 2001 the crop received no rainfall; while in 2002, 31.6 mm of rainfall in 3 rainy days was received. Weekly mean bright sunshine hrs day^{-1} during crop period ranged from 6.8 to 10.1 with an average of 8.8 during 2001, 7.3 to 10.4 with an average of 9.0 hrs d^{-1} during 2002. The weekly mean relative humidity (%) during crop period ranged from 40.0 to 59.5 per cent with an average of 49.3 per cent during 2001; 43 to 62 per cent with an average of 54 per cent during 2002. The mean evaporation (m.m.d^{-1}) during crop period was 5.2 and 4.9 during 2001 and 2002 respectively.

3.3 EXPERIMENTAL DETAILS

3.3.1 *Kharif* Rice

The experiment was laid out in split plot design replicated thrice. There were three main plot treatments comprising seedling ages and 9 sub plot treatments comprising organic sources of N and fertilizer combinations. The layout plan is given in the Fig. 3.2a. The treatment details are as follows:

Main plots (Age of seedlings): Three

A₁ – 30 days

A₂ – 45 days

A₃ – 60 days

Sub plots (N management practices): Nine

- N₁ - Sunhemp green manuring (GM) equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as Fertiliser N to rice.
- N₂ - FYM equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as Fertiliser N to rice.
- N₃ - Vermicompost (VC) equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as Fertiliser N to rice.
- N₄ - Poultry manure (PM) equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as Fertiliser N to rice.
- N₅ - GM equivalent to 25 kg N ha⁻¹ + FYM equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as Fertiliser N to rice.
- N₆ - GM equivalent to 25 kg N ha⁻¹ + vermicompost equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as Fertiliser N to rice.
- N₇ - GM equivalent to 25 kg N ha⁻¹ + PM equivalent to 25 kg N ha⁻¹ + 75% of the recommended dose as FN to rice.
- N₈ - 100% of the recommended dose of Fertiliser N (100 kg N ha⁻¹).
- N₉ - 125% of the recommended dose of Fertiliser N (125 kg N ha⁻¹).

<u>Plot size</u>	<u>Main plots</u>	<u>Sub-plots</u>
Gross :	48.6 m x 6.0 m	6 m x 5.4 m
Net	41.4 m x 5.1 m	5.1 m x 4.6 m
Spacing :	15 cm x 10 cm.	

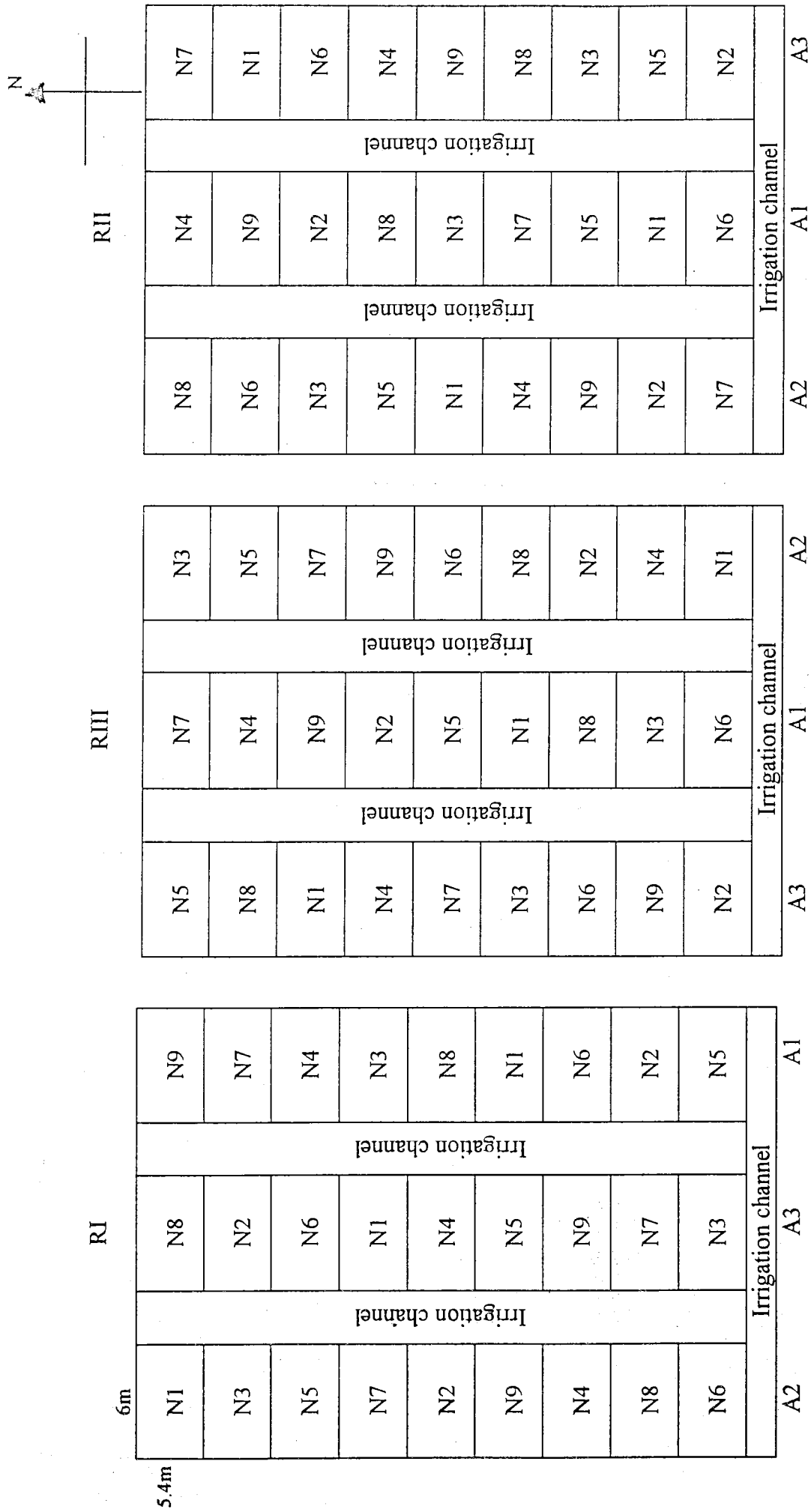


Fig. 3.2a: LAYOUT PLAN FOR KHARIF RICE

3.3.2 *Rabi* Greengram

The residual effect of different N management practices adopted to *kharif* rice with different seedling ages was studied on greengram raised subsequently during *rabi* season in the same undisturbed layout, by further subdividing each sub plot treatment into two plots to which two levels of fertilization were assigned (F_1 - 50% RDF to greengram and F_2 - 100% RDF to greengram).

The experiment was treated as split-split plot design with 3 main plots, 9 sub plots and 2 sub-sub plots as mentioned above with three replications. The layout plan is presented in Fig. 3.2b.

<u>Plot size</u>	<u>Main plots</u>	<u>Sub plots</u>	<u>Sub-sub plots</u>
Gross:	48.6 x 6.0 m	6.0 x 5.4 m	5.4 x 3.0 m
Net :	41.4 x 5.1 m	5.1 x 4.6 m	4.6 x 2.6 m
Spacing:	30 x 10 cm		

3.4 CULTIVATION DETAILS

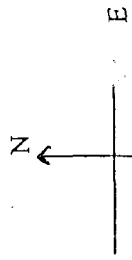
3.4.1 *Kharif* Rice

3.4.1.1 Variety

The variety BPT 5204 (a cross between GEB24 x T(N)1 double crossed with Mahsuri) a fine grain and good cooking quality having a duration of 140-145 days with yield potential of 5.5 – 6.0 t ha⁻¹ was grown.

3.4.1.2 Nursery

The nursery area was thoroughly puddled and leveled. The required quantity (seed rate of 50 kg ha⁻¹) of healthy rice seed was soaked in water for 24



RI				RII				RIII					
F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
1	1	8	8	5	5	7	7	8	8	3	3	8	8
3	3	2	2	8	8	4	4	5	5	9	9	6	6
5	5	6	6	1	1	9	9	1	1	7	7	3	3
7	7	1	1	4	4	2	2	4	4	9	9	5	5
2	2	4	4	7	7	5	5	6	6	8	8	1	1
9	9	5	5	3	3	1	1	3	3	8	8	4	4
4	4	9	9	6	6	8	8	2	2	2	2	9	9
8	8	7	7	9	9	3	3	4	4	1	1	7	7
6	6	3	3	2	2	6	6	1	1	2	2	5	5
Irrigation channel				Irrigation channel				Irrigation channel					
A2				A3				A1					

Fig. 3.2b: LAYOUT PLAN FOR RABI GREEN GRAM

hours and incubated for 48 hours to induce germination. The sprouted seeds were broadcasted uniformly over well prepared seed bed and nursery was irrigated whenever necessary. Nursery bed was fertilized @ 1.5 N, 0.5 P₂O₅ and 0.5 K₂O kg 100 m⁻² of nursery area. Three different nurseries were raised at 15 days interval to obtain 30, 45 and 60 days aged seedlings.

3.4.1.3 Main field preparation

The main field was ploughed, puddled under water with tractor and leveled with cattle drawn wooden plank. The field was laid out into plots of required size as per the layout plan, incorporated the organic manures as per the treatments and were micro-levelled before transplanting.

3.4.1.4 Manures

Four different organic sources (FYM, vermicompost, poultry manure and green manure) were used in the present investigation. The manures were analysed for their nutrient content before use (Appendix-V).

FYM, vermicompost and poultry manure was incorporated one week before planting according to the treatments and the sunhemp (*Crotalaria juncea*) was used as green manure, which was raised *in situ* according to the treatments incorporated at 40 days age and seven days before transplanting to supply 25% N in the respective treatments.

3.4.1.5 Fertilizer application

The recommended dose of fertilizer 100 kg N, 60 kg P₂O₅ and 40 kg K₂O ha⁻¹ was applied through urea, single superphosphate and muriate of potash, respectively. Uniform dose of entire P₂O₅ and K₂O was applied basally to all the

treatments. Fertilizer nitrogen was applied as per the treatments in three equal splits each at basal, active tillering and panicle initiation stages. Nutrient content in different organic sources was taken into consideration to supply 25% recommended N on equal nutrient basis.

3.4.1.6 Transplanting

All the three ages (30, 45 and 60 days) of seedlings were transplanted on August 20 in both the years 2000 and 2001 with a spacing of 15 cm x 10 cm using two seedlings hill⁻¹.

3.4.1.7 Weed management

Butachlor @ 1.5 kg a.i ha⁻¹ was mixed with sand @ 50 kg per hectare basis and broadcasted uniformly to all the plots on the third day of transplanting. Subsequently hand weeding was done at 20 and 40 days after planting of rice crop to keep the crop free from weeds.

3.4.1.8 Water management

A thin film of 2-3 cm of water was maintained at the time of planting, 5 cm of water level was maintained for first 3 days and thereafter 2 cm of water level was maintained till panicle initiation and then 5 cm of water level was maintained upto dough stage of the crop. The plots were drained at the time of top dressing of nitrogen and water was let in on the next day. Irrigation was withheld at about one week before harvesting of the crop.

3.4.1.9 Plant protection

Monocrotophos 36 WSC was applied @ 1.6 ml/l of water twice at 28 and 52 days after transplanting to control the incidence of leaf folder and stem borer.

Mancozeb @ 3 g/l of water was twice on 52 and 60 days after planting to control fungal disease cercospora leaf spot during first year.

3.4.1.10 Harvesting and threshing

First border rows from the four sides of the plot were harvested and bulked. Then the net plots were harvested. The harvested paddy shieves of the respective net plots were threshed and the produce was cleaned and dried in the sun. The weight of the grain and straw were recorded separately.

3.4.2 Rabi Greengram

3.4.2.1 Variety

The ML 267 matures in 65 days with an yield potential of 1200 – 1400 kg ha⁻¹ suitable for *kharif*, *rabi* and summer having long petioles, small leaflets, pods and seeds, seeds shining green and tolerant to yellow mosaic virus was the test variety.

3.4.2.2 Preparatory cultivation

Each sub-plot of *kharif* rice was ploughed four times with power tiller to obtain fine tilth and leveled with spades manually without disturbing the layout to take up the sowing of greengram.

3.4.2.3 Seeds and sowing

The seeds (2-3) were hand dibbled to a depth of 4 to 5 cm at a spacing of 30 cm x 10 cm. Irrigation was given immediately after sowing. Thinning and gap filling was done within seven days after sowing, retaining one seedling per hill to maintain a uniform plant population.

3.4.2.4 Fertilisers

The entire dose of fertilizer was applied basally at sowing as per the treatments in the form of urea and single superphosphate. The recommended RDF (100%) or greengram is 20 N and 50 kg P₂O₅ ha⁻¹.

3.4.2.5 Weed management

Hand weeding was done twice at 20 and 35 days after sowing to keep the crop weed free.

3.4.2.6 Water management

Irrigation was given at 10 days interval during crop growth period.

3.4.2.7 Plant protection

Greengram did not suffer from any major pest or disease attack.

3.4.2.8 Harvesting and threshing

The border and net rows were harvested separately and sun-dried. The sun-dried pods were beaten with sticks and the final produce was separated by winnowing.

3.5 BIOMETRIC OBSERVATIONS

3.5.1 *Kharif* Rice

3.5.1.1 Tiller number

Five plants from each net plot were chosen by random sampling and tagged, which were used for recording tiller number at 25, 40, 55 and 70 DAP. Total number of tillers hill⁻¹ were counted and expressed as tillers m⁻².

3.5.1.2 Leaf area index

Leaf area index was worked out at active tillering, panicle initiation and flowering stages. Leaf area from five destructively sampled plants from sampling rows earmarked was measured through LICOR Model LI-3100 area meter. The LAI was computed taking into account, the area occupied by each hill.

$$\text{LAI} = \frac{\text{Total leaf area}}{\text{Ground area}}$$

3.5.1.3 Dry matter production

Five plants at random from the sampling rows were destructively sampled at active tillering, panicle initiation, flowering and at harvest. These samples were air-dried and then oven dried at 60°C to a constant weight and expressed as kg ha⁻¹.

3.5.1.4 Days to 50 per cent flowering

Number of days taken for flowering of 50 per cent plant population was recorded and presented as days to 50 per cent flowering.

3.5.1.5 Days to maturity

Number of days taken for maturity was recorded and presented as days to maturity.

3.5.1.6 Productive tillers (panicles m⁻²)

The number of ear bearing tillers were counted from tagged plants, averaged to compute productive tillers hill⁻¹ and expressed as panicles m⁻².

3.5.1.7 Spikelets per panicle

The total number of spikelets in ten randomly selected panicles were counted, averaged and expressed as number of grains per panicle.

3.5.1.8 Filled spikelets per panicle

Average number of filled spikelets per panicle was calculated from 10 sample panicles after discarding the unfilled spikelets.

3.5.1.9 Spikelet sterility

The panicles selected for counting number of spikelets per panicle were used to calculate the spikelet sterility. The components required to calculate spikelet sterility viz., filled spikelets, unfilled spikelets and total number of spikelets were counted and spikelet sterility computed in percentage.

$$\text{Spikelet sterility} = \frac{\text{Number of ill filled spikelets per panicle}}{\text{Total number of spikelets per panicle}} \times 100$$

3.5.1.10 1000 grain weight

Thousand grains randomly drawn from the composite sample of grain yield of net plot in each treatment (dried to 14 per cent moisture content), were weighed and expressed in grams.

3.5.1.11 Grain yield

Grain from the net plot was thoroughly sun dried to 14 per cent moisture content, weighed and expressed in kg ha⁻¹.

3.5.1.12 Straw yield

Straw obtained from the net plot was thoroughly sun dried until a constant weight and expressed in kg ha⁻¹.

3.5.1.13 Harvest index

The relationship of economic yield to the total biological yield was expressed as harvest index (HI).

$$HI = \frac{\text{Grain yield}}{\text{Total biological yield}} \times 100$$

3.5.1.14 Milling per cent

A sample of five hundred grams of paddy was taken from each plot and milled with "Satake" grain testing husker and then polished to one minute (Ghosh, 1971).

$$\text{Milling \%} = \frac{\text{Weight of milled rice}}{\text{Weight of unhulled rice}} \times 100$$

3.5.1.15 L/B ratio

Ten randomly selected rice grains from each treatment was measured using dial micrometer, averaged and expressed in millimeters. L/B ratio was calculated by dividing length of the grain with breadth and expressed as L/B ratio.

3.5.2 *Rabi Greengram*

3.5.2.1 Dry matter production

At harvest, from the sampling rows, five plants were collected treatment wise and these plants were first air dried and then oven dried at 60°C to a constant weight and the DMP was expressed in kg ha⁻¹.

3.5.2.2 Number of pods plant⁻¹

The number of pods from five randomly tagged plants in each net plot were counted, averaged and expressed as number of pods plant⁻¹.

3.5.2.3 Number of seeds pod⁻¹

Five pods collected at random from each of the 5 tagged plants were split opened and the seeds were counted in each pod, averaged and expressed as number of seeds pod⁻¹.

3.5.2.4 Thousand seed weight

The weight of five samples of 1000 seeds drawn from each net plot was recorded, averaged and expressed as 1000 seed weight in grams.

3.5.2.5 Seed yield

The seed from the net plot of each treatment was dried to safe moisture content of 9% and expressed in kg ha⁻¹.

3.5.2.6 Haulm yield

Haulm obtained from the net plot of each treatment was thoroughly sun-dried, weighed to a constant weight and expressed as haulm yield in kg ha⁻¹.

3.6 PLANT ANALYSIS

Plant samples collected at active tillering, panicle initiation and flowering of rice as well as at harvest in greengram were dried, grind into fine powder and used for chemical analysis. Nitrogen was estimated by modified microkjeldahl method, phosphorus by calorimetric method using a Technicon autoanalyser and potassium by flame photometry (Jackson, 1973). The uptake of N, P and K in kg ha⁻¹ at different stages of crop growth in rice and at harvest in greengram was calculated by multiplying the nutritional content with the respective

dry matter production. The nutrient content of grain and straw was analysed separately and then multiplied with respective weights of grain and straw, which were summed up to present nutrient uptake at harvest.

3.7 SOIL FERTILITY DYNAMICS

Initial composite soil samples were collected from the field prior to the layout of the experiment and was analysed for organic carbon, available nitrogen, available phosphorus and available potassium.

Immediately after the harvest of rice and greengram crops, soil samples were collected from the individual plots and analysed for organic carbon (Walkley and Black, 1934), available nitrogen (Subbaiah and Asija, 1956), available phosphorus (Olsen *et al.*, 1954) and available potassium (Jackson, 1973).

3.8 ECONOMICS

Gross and net returns (Rs ha⁻¹) were computed considering the existing market price of the inputs and outputs. Benefit cost ratio (BCR) was worked out for different treatments by dividing the gross returns by corresponding cost of cultivation.

3.9 STATISTICAL ANALYSIS

The data recorded on various growth and yield parameters of both rice and greengram crops during the course of investigation were statistically analysed following the analysis of variance for split plot using the IRRISTAT programme. Wherever the treatmental differences were found significant ('F' test), critical difference was worked out at five per cent. Probability level and the values are furnished. Treatmental differences that were non-significant were denoted as NS. Correlation coefficients between various characters were worked out as per the procedure outlined by Snedecor and Cochran (1968).

Chapter - IV

Results

CHAPTER – IV

RESULTS

The findings of the trial “Studies on integrated nitrogen management and seedling ages in rice-greengram system” conducted for two years are presented in this chapter.

4.1 RICE (*Kharif*, 2000 and 2001)

4.1.1 Growth Parameters

4.1.1.1 Tillers m⁻²

Number of tillers m⁻² increased upto 40 DAT (Days after transplanting) irrespective of the age of seedlings, except during 2000 in the crop transplanted with 30 day old seedlings, where the tiller number increased upto 55 DAT and thereafter it decreased (Table 4.1 and Fig.4.1). Tillers m⁻² were significantly influenced by age of seedlings and N management practices at 25, 40, 55 and 70 DAT. The interaction between age of seedlings and N management practices was found significant only at 25 DAT during both the years.

During both the years, the crop transplanted with 30 day old seedlings produced significantly higher number of tillers over at 25, 40, 55 and 70 DAT, that of 60 and 45 day old seedlings and the latter two ages were comparable. However, at 25 DAT, the tiller number in the crop transplanted with 45 day old seedlings was significantly higher than that of 60 day old seedlings.

During both the years, the tillers m⁻² with application of 75% RDFN + 25 kg GM-N + 25 kg PM-N were comparable with that of the treatments which

Table 4.1 Influence of age of seedlings and N management practices on number of Tillers m⁻² in rice

Treatment	Days after transplanting							
	25		40		55		70	
	2000	2001	2000	2001	2000	2001	2000	2001
Seedling ages (days)								
A ₁	624	612	824	741	874	697	583	562
A ₂	578	548	737	709	696	648	527	532
A ₃	463	487	720	694	654	598	518	518
SEd ±	23	5	27	6	60	19	11	15
C.D (p=0.05)	63	13	74	16	164	51	29	41
N Management practices								
N ₁	523	519	691	670	714	634	524	532
N ₂	522	497	691	665	711	634	498	518
N ₃	502	511	681	669	725	634	521	520
N ₄	549	531	751	707	743	640	537	537
N ₅	560	564	806	776	769	665	575	550
N ₆	585	587	813	775	772	666	578	544
N ₇	602	598	841	800	775	677	585	559
N ₈	564	538	750	629	707	622	505	521
N ₉	587	598	826	740	758	658	560	542
SEd ±	23	12	24	9	27	13	17	12
C.D (p=0.05)	45	22	47	17	52	24	31	23
A x N								
SEd ±	28	15	77	17	119	37	106	31
C.D (p=0.05)	55	29	NS	NS	NS	NS	NS	NS

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

Table 4.1 (a) Interaction effect between age of seedlings and N management practices on number of tillers/m² at 25 DAT

	2000				2001			
	Age of seedlings							
	A ₁	A ₂	A ₃	Mean	A ₁	A ₂	A ₃	Mean
N management								
N ₁	613	551	404	523	576	502	478	519
N ₂	591	556	422	522	551	495	445	497
N ₃	582	506	471	502	567	497	469	511
N ₄	622	577	449	549	607	513	473	531
N ₅	649	591	440	560	639	559	496	564
N ₆	632	608	520	585	658	600	503	587
N ₇	667	631	507	602	665	622	507	598
N ₈	618	582	491	564	573	544	496	538
N ₉	644	600	517	587	671	604	518	598
Mean	624	578	463		612	548	487	
	SEd ±	CD (p=0.05)			SEd ±	CD (p=0.05)		
A	23	63			5	13		
N	23	45			11	22		
A×N	28	55			15	29		

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

supplied 125% RDN irrespective of source of N at all stages of crop growth. However, it was significantly greater than that received 75% RDFN + 25 kg GM-N + 25 kg FYM-N and 125% RDFN during 2000 at 25 DAT and during 2001 at 40 DAT respectively. The tiller production with application of 75% RDFN + 25 kg PM-N was on par with that of 75% RDFN + 25 kg GM-N + 25 kg FYM-N except at 25 DAT during 2001 and 40 DAT during both the years. The treatments which received 100% RDN through different sources were comparable in tiller production. On the other hand, at 25 DAT the crop supplied with 125% RDFN resulted in significantly higher tiller number over that of application of 75% RDFN + 25 kg VC-N and 75% RDFN + 25 kg FYM-N respectively during 2000 and 2001.

At active tillering during 2000, the crop transplanted with 30 day old seedlings in combination with 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted significantly higher tiller number than that of 75% RDFN + 25 kg FYM-N / VC-N of the same age. On the other hand, the tiller number in the former treatment was comparable to that of 45 day old seedlings which received 75% RDFN + 25 kg GM-N + 25 kg PM-N (Table 4.1a).

During 2001, the crop transplanted with 30 day old seedlings in combination with 125% RDFN produced significantly higher number of tillers over that of 100% RDN, 125% RDFN and 75% RDFN + 25 kg GM-N + 25 kg FYM-N. Irrespective of N management practice, lower number of tillers were observed when the crop transplanted with 60 day old seedlings compared to 45 and 30 day old seedlings except with 75% RDFN + 25 kg VC-N with 45 day old seedlings.

4.1.1.2 Leaf area index (LAI)

During both the years, LAI at active tillering, panicle initiation and flowering was significantly influenced by age of seedlings and N management practices (Table 4.2). On the other hand, interaction between age of seedlings and N management practices on LAI was not significant.

During both the years, the crop transplanted with 30 day old seedlings recorded significantly higher LAI over that of 60 day old seedlings. However, the LAI observed with transplanting 45 day old seedlings was comparable to that of 30 and 60 day old seedlings.

During both the years, the crop received 125% RDFN and 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded significantly higher LAI over that of application of 100% RDFN, 75% RDFN + 25 kg N ha⁻¹ through GM / FYM / VC / PM at active tillering and at panicle initiation and flowering stages respectively. However, the LAI observed with the application of 100% RDN through different sources was comparable throughout the crop growth.

4.1.1.3 Dry matter production (DMP) kg ha⁻¹

During both the years, DMP increased progressively with advancement of crop growth (Table 4.3). The DMP differed significantly with age of seedlings at active tillering, and at harvest. However, the N management practices had a significant influence on the DMP throughout the crop growth. The interaction between age of seedlings and N management practices was significant only at active tillering.



Table 4.2 Influence of age of seedlings and N management practices on LAI of rice at different stages

Treatment	Active tillering		Panicle initiation		Flowering	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	1.55	1.57	3.66	3.46	4.05	4.20
A ₂	1.51	1.45	3.24	3.28	3.93	4.19
A ₃	1.45	1.43	3.16	3.21	3.81	3.93
SEd ±	0.03	0.01	0.15	0.07	0.04	0.04
C.D (p=0.05)	0.09	0.03	0.42	0.21	0.12	0.12
N Management practices						
N ₁	1.46	1.44	3.20	3.27	3.82	3.85
N ₂	1.44	1.44	3.20	3.22	3.75	3.83
N ₃	1.46	1.43	3.21	3.27	3.84	3.86
N ₄	1.47	1.47	3.35	3.31	3.90	3.97
N ₅	1.51	1.50	3.42	3.36	4.03	4.37
N ₆	1.54	1.52	3.45	3.40	4.08	4.42
N ₇	1.57	1.53	3.52	3.43	4.14	4.47
N ₈	1.49	1.48	3.37	3.24	3.84	3.83
N ₉	1.57	1.54	3.50	3.40	3.96	4.35
SEd ±	0.02	0.04	0.10	0.09	0.05	0.05
C.D (p=0.05)	0.04	0.08	0.19	0.18	0.10	0.09
A x N						
SEd ±	0.02	0.05	0.12	0.11	0.06	0.13
C.D (p=0.05)	NS	NS	NS	NS	NS	NS

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

During both the years, at active tillering, the crop transplanted with 30 day old seedlings resulted in significantly higher DMP over that of 45 day old seedlings, which in turn produced significantly greater dry matter over that of 60 day old seedlings. At harvest, the crop transplanted with 45 day old seedlings gave significantly higher dry matter over that of 30 and 60 day old seedlings and the DMP observed in the latter two age of seedlings was comparable.

The crop received 125% RDFN recorded significantly higher DMP at active tillering over that of other N management practices except that of 75% RDFN + 25 kg GM-N + 25 kg PM-N during both the years and 75% RDFN + 25 kg GM-N + 25 kg VC-N during 2nd year. At other stages of crop growth, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted significantly higher DMP over that of application of 100% RDN through different sources. However, it was comparable to that of 75% RDFN + 25 kg PM-N and 100% RDFN at panicle initiation during 2000. Irrespective of source of N, the crop received 100% RDN produced comparable dry matter throughout the crop growth over that of 75% RDFN + 25 kg FYM-N at active tillering and at harvest during 2001 except that of 75% RDFN + 25 kg PM-N.

During both the years, the crop transplanted with 30 day old seedlings and received 125% RDFN recorded maximum DMP at active tillering (Table 4.3a). However, it was comparable to that of 30 day old seedlings which received 125% RDN through different sources, all other N management practices except 75% RDFN + 25 kg FYM-N during 2000 and 2001 respectively and 45 day old seedlings received 125% RDFN, 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N during 2001. During 2000, significantly lower DMP was obtained in the crop

Table 4.3 Influence of age of seedlings and N management practices on dry matter production (kg/ha) in rice

Treatment	Active tillering		Panicle initiation		Flowering		Harvest	
	2000	2001	2000	2001	2000	2001	2000	2001
Seedling ages (days)								
A ₁	1084	979	3959	3404	5491	5377	8857	8951
A ₂	960	923	3523	3299	5323	5306	9380	9230
A ₃	839	833	3374	3216	5209	5308	8671	8772
SEd ±	8	18	180	81	80	38	96	77
C.D (p=0.05)	21	51	NS	NS	NS	NS	268	215
N Management practices								
N ₁	946	872	3401	3173	5133	5135	8573	8465
N ₂	946	850	3405	3132	5076	5137	8527	8413
N ₃	948	881	3370	3131	5228	5200	8731	8565
N ₄	948	902	3540	3278	5245	5220	8827	8795
N ₅	973	917	3728	3450	5532	5518	9292	9397
N ₆	971	952	3776	3504	5574	5548	9423	9501
N ₇	989	962	3889	3604	5654	5600	9496	9687
N ₈	935	896	3560	3083	5209	5150	8545	8519
N ₉	992	974	3901	3401	5417	5466	9308	9517
SEd ±	10	17	205	61	86	80	251	164
C.D (p=0.05)	20	34	401	119	170	157	492	329
A x N								
SEd ±	16	37	251	74	106	98	308	238
C.D (p=0.05)	31	73	NS	NS	NS	NS	NS	NS
N management					Age of seedlings (days)			
N1= 75% RDFN+25 Kg N ha ⁻¹ Green manure					A1 = 30			
N2= 75% RDFN+25 Kg N ha ⁻¹ FYM					A2 = 45			
N3= 75% RDFN+25 Kg N ha ⁻¹ Vermicompost					A3 = 60			
N4= 75% RDFN+25 Kg N ha ⁻¹ Poultry manure								
N5= 75% RDFN+25 Kg N ha ⁻¹ Green manure + 25 Kg N ha ⁻¹ FYM								
N6= 75% RDFN+25 Kg N ha ⁻¹ Green manure + 25 Kg N ha ⁻¹ Vermicompost								
N7= 75% RDFN+25 Kg N ha ⁻¹ Green manure + 25 Kg N ha ⁻¹ Poultry manure								
N8=100% RDFN								
N9=125 % RDFN								

Table 4.3 (a) DMP (kg/ha) by rice at active tillering as influenced by interaction effect of age of seedlings and N management practices

	2000				2001			
	Age of seedlings							
	A ₁	A ₂	A ₃	Mean	A ₁	A ₂	A ₃	Mean
N management								
N ₁	1075	950	814	946	950	850	815	872
N ₂	1065	946	828	946	906	840	805	850
N ₃	1066	952	825	948	959	872	814	881
N ₄	1071	946	826	948	982	897	826	902
N ₅	1092	968	859	973	1001	914	836	917
N ₆	1087	977	850	971	1009	1010	837	952
N ₇	1108	996	865	989	1015	1013	859	962
N ₈	1076	911	820	935	967	892	829	896
N ₉	1117	996	863	992	1021	1020	880	974
Mean	1084	960	839		979	923	833	

	SEd ±	CD (p=0.05)	SEd ±	CD (p=0.05)
A	7.71	21	18.40	51
N	10.26	20	17.25	34
A×N	15.98	31	37.47	73

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

transplanted with 60 day old seedlings in combination with 75% RDFN + 25 kg GM-N compared to that of application of 125% RDN through different sources in combination with 60 day old seedlings and transplanting of 30 and 45 day old seedlings irrespective of N management practices. During 2001, significantly lower DMP was observed in the crop transplanted with 60 day old seedlings in combination of 75% RDFN + 25 kg FYM-N as compared to that transplanted with 60 day old seedlings in combination with 125% RDFN and 45 day old seedlings in combination with 125% RDN through different sources, 100% RDFN, 75% RDFN + 25 kg PM-N and 30 day old seedlings irrespective of N management practices.

4.1.1.4 Days to 50% flowering

During both the years, days to 50% flowering (planting onwards) decreased significantly with increase in the age of seedlings from 30 to 45 and 60 days (Table 4.4). The N management practices as well as their interaction with age of seedlings failed to influence days to 50% flowering.

During both the years days to maturity (sowing onwards) increased significantly with increase in the age of seedlings from 30 to 45 and 60 days (Table 4.4). Effect of N management practices as well as their interaction with age of seedlings on days to maturity was not significant.

4.1.2 Yield Attributes and Yield

4.1.2.1 Panicles m⁻²

During both the years, age of seedlings, N management practices and their interaction significantly influenced the number of panicles (Table 4.5). The crop transplanted with 30 day old seedlings had significantly higher number of panicles over that of 45 and 60 day old seedlings. On the other hand, the crop

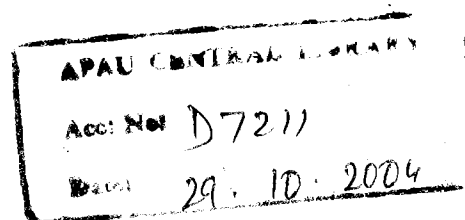


Table 4.4 Influence of age of seedlings and N management practices on days to 50% flowering and maturity in rice

Treatment	Days to 50% flowering		Days to maturity	
	2000	2001	2000	2001
Seedling ages (days)				
A ₁	81	81	147	146
A ₂	76	76	157	156
A ₃	73	74	168	168
SEd ±	0.5	0.2	0.9	0.6
C.D (p=0.05)	1.3	0.7	2.6	1.5
N Management practices				
N ₁	77	77	156	155
N ₂	77	77	156	155
N ₃	77	77	156	155
N ₄	77	77	156	156
N ₅	77	77	157	156
N ₆	77	77	157	156
N ₇	76	77	157	157
N ₈	77	77	156	156
N ₉	76	77	157	157
SEd ±	0.4	0.4	0.9	1
C.D (p=0.05)	NS	NS	NS	NS
A x N				
SEd ±	1	0.5	1	1
C.D (p=0.05)	NS	NS	NS	NS

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

transplanted with 45 day old seedlings recorded significantly more number of panicles over that of 60 day old seedlings during 2001 only.

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher number of panicles over that of rest of the N management practices and application of 100% RDN through different sources during 2000 and 2001 respectively. During both the years, regardless of source of N, the number of panicles observed with application of 125% RDN were comparable and significantly greater than that obtained with application of 100% RDN. The panicle number observed with application of 75% RDFN + 25 kg FYM-N was comparable with 75% RDFN + 25 kg GM-N during both the years and with 75% RDFN + 25 kg VC-N and 100% RDFN during 2001 and significantly lesser than application of 125% RDN through different sources during both the years.

During both the years, significantly higher panicle number was observed in the crop transplanted with 30 day old seedlings in combination with 75% RDFN + 25 kg GM-N + 25 kg PM-N (Table 4.5a). Crop transplanted with 30 day old seedlings in combination with 125% RDN through different sources, and 45 day old seedlings in combination with 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted comparable panicle number during 2000. Whereas, during 2001 the crop transplanted with 30 day old seedlings in combination with all the N management practices except 100% RDFN and 45 day old seedlings in combination with 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in comparable panicles m^{-2} . During both the years, significantly lower number of panicles m^{-2} was observed with transplanting of 60 day old seedlings in combination with 75% RDFN + 25 kg FYM-N.

Table 4.5 Influence of age of seedlings and N management practices on yield attributes in rice

Treatment	Panicle m ⁻²		Total spikelets panicle ⁻¹		Filled spikelets panicle ⁻¹		1000 grain weight (g)		Spikelet sterility (%)	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Age of seedlings (days)										
A ₁	440	469	101.0	106.2	71.3	78.8	13.2	13.6	29.5	25.8
A ₂	407	426	102.0	103.1	84.2	82.8	14.0	13.2	17.5	20.3
A ₃	381	403	100.5	102.4	82.8	81.4	13.5	13.1	17.6	20.5
SEd ±	10	7	1.3	1.8	1.4	1.1	0.3	0.4	-	-
C.D (p=0.05)	28	20	NS	NS	3.9	2.9	NS	NS	-	-
N Management practices										
N ₁	376	419	99.6	102.1	77.6	80.0	13.2	13.1	22.0	21.6
N ₂	366	411	99.6	101.2	77.0	79.6	13.2	13.0	22.6	21.1
N ₃	389	420	100.4	102.7	78.2	80.6	13.3	13.1	22.1	21.5
N ₄	397	426	101.3	103.8	79.1	81.1	13.5	13.2	21.9	21.8
N ₅	433	447	102.8	106.2	81.0	82.1	13.7	13.4	21.2	22.6
N ₆	436	451	103.1	107.1	82.0	82.3	13.9	13.4	20.4	23.1
N ₇	448	457	103.8	107.2	82.4	82.9	14.0	13.5	20.6	22.6
N ₈	400	418	98.7	101.0	77.1	79.6	13.3	13.1	21.8	19.8
N ₉	436	444	101.7	106.1	80.4	81.0	13.7	13.4	20.9	23.6
SEd ±	5.0	7	2.2	2.5	1.5	1.6	0.3	0.1	-	-
C.D (p=0.05)	10.0	13	4.3	5.0	4.2	3.2	0.5	0.2	-	-
A x N										
SEd ±	28	22	1.4	4.1	4.0	3.2	0.8	0.5	-	-
C.D (p=0.05)	60	47	NS	NS	NS	NS	NS	NS	-	-

N managementN1= 75% RDFN+25 Kg N ha⁻¹ Green manureN2= 75% RDFN+25 Kg N ha⁻¹ FYMN3= 75% RDFN+25 Kg N ha⁻¹ VermicompostN4= 75% RDFN+25 Kg N ha⁻¹ Poultry manureN5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYMN6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ VermicompostN7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

Table 4.5 (a) Panicle m^{-2} as influenced by interaction effect of age of seedlings and N management practices in rice

	2000				2001			
	Age of seedlings							
	A ₁	A ₂	A ₃	Mean	A ₁	A ₂	A ₃	Mean
N management								
N ₁	400	376	353	376	460	410	387	419
N ₂	387	362	349	366	451	408	373	411
N ₃	418	393	357	389	466	411	382	420
N ₄	424	398	368	397	467	420	391	426
N ₅	469	433	396	433	480	442	420	447
N ₆	485	429	395	436	487	444	422	451
N ₇	495	440	409	448	495	447	430	457
N ₈	407	393	400	400	445	416	395	418
N ₉	473	433	402	436	469	437	426	444
Mean	440	407	381		469	426	403	

	SEd ±	CD (p=0.05)	SEd ±	CD (p=0.05)
A	10	28	7	20
N	5	10	7	13
A x N	28	60	22	47

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

4.1.2.2 Spikelets per panicle

During both the years, the number of spikelets per panicle differed significantly only due to N management practices (Table 4.5).

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher number of spikelets per panicle over that of 100% RDFN during both the years and 75% RDFN + 25 kg GM-N / FYM-N during 2001. Application of 100% RDFN resulted in significantly lesser number of spikelets per panicle as compared to that of 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N during 2000 and to that of application of 125% RDN through different sources during 2001.

4.1.2.3 Filled spikelets per panicle

During both the years, seedling ages, N management practices showed significant variation in number of filled spikelets per panicle, whereas their interaction was not significant (Table 4.5).

The number of filled spikelets in the crop transplanted with 45 day old seedlings was comparable with that of 60 day old seedlings and significantly superior over that of 30 day old seedlings. The number of filled spikelets in latter two age of seedlings were comparable.

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher number of filled spikelets per panicle over that of 100% RDFN, 75% RDFN + 25 kg FYM-N during both the years and 75% RDFN + 25 kg GM-N during 2000. The number of filled spikelets per panicle was significantly lower with application of 75% RDFN + 25 kg FYM-N as compared to that of 75% RDFN + 25 kg GM-N + 25 kg VC-N during 2000 and 75% RDFN + 25 kg GM-N + 25 kg PM-N during both the years.

4.1.2.4 Spikelet sterility (%)

During both the years, transplanting 30 day old seedlings resulted higher spikelet sterility and was lower in the crop transplanted with 45 day old seedlings (Table 4.5). N management practices in rice influenced the spikelet sterility differently during both the years. During 2000, regardless of sources of N, application of 100% RDN resulted in higher spikelet sterility compared to application of 125% RDN. On the other hand, the trend was reverse in 2001, where the application of 125% RDN recorded higher spikelet sterility. However, the source of N supply in different treatments either within 100% RDN or within 125% RDN, treatments had no influence on spikelet sterility.

4.1.2.5 1000-grain weight (g)

During both the years, 1000-grain weight was significantly influenced by N management practices (Table 4.5). However, it was un-affected due to age of seedlings, and interaction between age of seedlings and N management practices.

During both the years, the crop received 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded significantly higher 1000-grain weight over that of 100% RDN through different sources and was comparable with that of all 125% RDN treatments.

Application of 125% RDN through different sources resulted comparable 1000-grain weight and were significantly higher to that of application of 75% RDFN + 25 kg GM-N / FYM-N.

4.1.2.6 Grain yield (kg ha^{-1})

During both the years, age of seedlings and N management practices significantly influenced the grain yield (Table 4.6). The interaction effect between age of seedlings and N management practices on grain yield was not significant.

During both the years transplanting of 45 day old seedlings resulted in significantly higher grain yield compared to that of 30 and 60 day old seedlings. The increase was 5.9 and 13.0 per cent during 2000; 3.6 and 13.4 per cent during 2001 compared to the crop planted with 30 and 60 day old seedlings respectively. On the other hand, the crop transplanted with 60 day old seedlings recorded significantly lower grain yield compared to that of 30 day old seedlings during both the years and the reduction was 7.5 and 10.1 per cent during 2000 and 2001 respectively.

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher grain yield over that of 100% RDFN, 75% RDFN + 25 kg GM-N / FYM-N / VC-N. On the other hand, application of 125% RDFN recorded significantly more grain yield compared to that of 75% RDFN + 25 kg GM-N / FYM-N during both the years and 100% RDFN during 2000. During both the years, application of 75% RDFN + 25 kg PM-N resulted comparable grain yield to that of application of 125% RDN through different sources. During both the years, application of 125% RDN through different sources resulted in comparable grain yield. Similarly, there was no significant variation in the grain yield of crop, received 100% RDN through different sources. Significantly lower grain yield was obtained with application of 75% RDFN + 25 kg FYM-N as compared to 125%

Table 4.6 Influence of age of seedlings and N management practices on grain and straw yield (kg/ha) in rice

Treatment	Grain yield		Straw yield		Harvest Index (%)	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	3144	3333	5291	5328	0.35	0.37
A ₂	3341	3459	5213	5225	0.36	0.38
A ₃	2908	2995	5092	4960	0.34	0.34
SEd ±	48	38	47	54	-	-
C.D (p=0.05)	134	105	132	151	-	-
N Management practices						
N ₁	2959	3108	4949	4938	0.34	0.37
N ₂	2918	3088	4909	4937	0.34	0.37
N ₃	3002	3131	4968	4981	0.34	0.36
N ₄	3058	3170	5034	5030	0.35	0.36
N ₅	3283	3388	5432	5347	0.35	0.37
N ₆	3320	3446	5477	5405	0.35	0.36
N ₇	3353	3478	5535	5457	0.35	0.36
N ₈	2968	3122	4984	4996	0.35	0.36
N ₉	3320	3426	5498	5445	0.36	0.36
SEd ±	165	169	87	154	-	-
C.D (p=0.05)	323	330	171	301	-	-
A x N						
SEd ±	201	207	101	177	-	-
C.D (p=0.05)	NS	NS	198	347	-	-

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure
 N2= 75% RDFN+25 Kg N ha⁻¹ FYM
 N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost
 N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure
 N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM
 N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost
 N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure
 N8=100% RDFN
 N9=125 % RDFN

Age of seedlings (days)

A1 = 30
 A2 = 45
 A3 = 60

RDFN, 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N during both the years and 75% RDFN + 25 kg GM-N + 25 kg FYM-N during 2000.

4.1.2.7 Straw yield (kg ha^{-1})

During both the years, age of seedlings, N management practices significantly influenced the straw yield, however, the interaction between age of seedlings and N management practices was not significant (Table 4.6).

During both the years, straw yield significantly decreased with increase in age of the seedlings from 30 to 60 days. On the other hand, the crop transplanted with 45 day old seedlings produced straw yield comparable to that of 30 day old seedlings and significantly greater than that of 60 day old seedlings.

During both the years, application of 125% RDN through different sources resulted comparable straw yield. However, these treatments were significantly superior to the crop that received 100% RDN through different sources. The straw yield obtained with application of 100% RDN among different sources was comparable.

4.1.2.8 Harvest index (%)

During both the years, age of seedlings, N management practices did not significantly influence the harvest index (Table 4.6).

4.1.3 Quality Parameters

During both the years, effect of age of seedlings, N management practices and their interaction on milling percentage and L/B ratio was not significant (Table 4.7).

Table 4.7 Influence of age of seedlings and N management practices on quality parameters in rice

Treatment	Milling percentage		L/B ratio	
	2000	2001	2000	2001
Age of seedlings (days)				
A ₁	70.4	71.4	3.12	3.17
A ₂	70.4	72.0	3.15	3.19
A ₃	70.3	72.2	3.13	3.17
SEd ±	0.41	0.48	0.01	0.02
C.D (p=0.05)	NS	NS	NS	NS
N Management practices				
N ₁	70.2	71.8	3.12	3.13
N ₂	70.7	72.0	3.10	3.16
N ₃	70.2	71.9	3.12	3.18
N ₄	70.9	71.9	3.13	3.20
N ₅	70.9	71.9	3.16	3.19
N ₆	70.9	72.1	3.14	3.21
N ₇	70.7	72.1	3.19	3.21
N ₈	70.2	71.6	3.12	3.14
N ₉	70.0	71.7	3.13	3.16
SEd ±	0.76	0.75	0.05	0.04
C.D (p=0.05)	NS	NS	NS	NS
A x N				
SE.d ±	1.06	1.40	0.05	0.04
C.D (p=0.05)	NS	NS	NS	NS

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

4.1.4 Nutrient Uptake (kg ha^{-1})

4.1.4.1 N uptake

During both the years, N uptake by rice increased with the advancement of crop growth. It was significantly influenced by age of seedlings and N management practices (Table 4.8). The interaction between age of seedlings and N management practices was not significant.

During both the years, N uptake at active tillering decreased significantly with increasing age of seedlings. The N uptake at panicle initiation and by straw was significantly higher in the crop transplanted with 30 day old seedlings than that of 45 and 60 day old seedlings. The crop transplanted with 30 day old seedlings at flowering recorded significantly greater N uptake as compared to that of 60 day old seedlings. On the other hand, the N uptake by grain was significantly higher in crop transplanted with 45 day old seedlings as compared to 30 and 60 day old seedlings and it was comparable in latter two ages of seedlings.

At active tillering, during both the years, application of 125% RDFN and 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted comparable N uptake and were significantly higher over that of application of 100% RDN through different sources. At panicle initiation, the N uptake was comparable with application of 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N. However, these treatments recorded significantly higher uptake to that of application of 100% RDN through different sources. At flowering, application of 125% RDN duly substituting 50 kg N ha^{-1} through organic sources resulted comparable N uptake. Nitrogen uptake by grain as well as by straw with application of 125% RDN through different sources were comparable and significantly higher to that of application of 100% RDN through different sources.

Table 4.8 Influence of age of seedlings and N management practices on N Uptake (kg.ha⁻¹) in rice

Treatment	Active Tillering		Panicle initiation		Flowering		Grain		Straw	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Age of seedlings (days)										
A ₁	26.51	23.52	41.12	34.12	49.73	47.91	36.62	34.81	28.34	28.91
A ₂	23.33	21.62	35.85	32.74	47.62	47.01	39.21	38.12	25.33	26.92
A ₃	19.71	19.42	33.51	31.44	46.15	46.84	34.77	34.32	24.31	24.71
SEd ±	0.28	0.46	1.78	0.81	0.84	0.35	0.82	0.86	0.74	0.34
C.D (p=0.05)	0.79	1.27	4.95	2.25	2.34	0.99	2.30	2.40	2.05	0.96
N Management practices										
N ₁	22.04	20.14	33.83	31.21	45.7	45.36	34.02	34.11	23.66	25.07
N ₂	22.2	19.38	33.4	30.6	45.01	45.04	33.42	33.88	23.53	24.9
N ₃	22.37	20.35	33.62	30.79	46.54	45.74	34.64	34.32	24.09	25.18
N ₄	22.85	21.2	35.92	32.24	47.06	46.28	35.11	34.86	24.67	25.63
N ₅	23.86	21.92	38.31	34.51	50.17	49.3	39.83	37.14	27.58	28.31
N ₆	23.79	22.94	39.05	35.06	50.74	49.93	40.54	37.91	28.33	28.62
N ₇	24.72	23.38	40.48	36.41	51.21	50.78	41.02	38.53	28.98	28.89
N ₈	22.44	21.24	36.33	29.73	45.84	44.98	33.64	34.22	24.44	25.56
N ₉	24.18	23.77	40.6	34.24	48.21	48.1	39.61	37.21	28.64	29.11
SEd ±	0.47	0.51	2.00	0.59	0.84	0.70	1.15	1.21	1.24	0.63
C.D (p=0.05)	0.91	1.01	3.91	1.16	1.65	1.34	2.30	2.40	2.43	1.23
A x N										
SEd ±	0.60	0.93	2.44	0.70	1.03	0.86	1.68	1.26	2.55	1.50
C.D (p=0.05)	NS	NS	NS	NS	NS	NS	3.60	2.70	5.44	3.21

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure
 N2= 75% RDFN+25 Kg N ha⁻¹ FYM
 N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost
 N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure
 N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM
 N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost
 N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure
 N8=100% RDFN
 N9=125 % RDFN

Age of seedlings (days)

A1 = 30
 A2 = 45
 A3 = 60

4.1.4.2 P uptake

During both the years, there was significant difference in P uptake due to age of seedlings and N management practices (Table 4.9). The interaction effect between age of seedlings and N management practices on P uptake was significant at only active tillering.

During both the years, at active tillering, P uptake decreased significantly with increase in age of seedlings from 30 to 45 and to 60 days. At panicle initiation, the crop transplanted with 30 day old seedlings recorded significantly higher P uptake over that of 45 and 60 day old seedlings. At flowering as well as at harvest in straw, the crop transplanted with 30 day old seedlings resulted significantly higher P uptake compared to that of 60 day old seedlings. On the other hand, the P uptake by grain was significantly higher in the crop transplanted with 45 day old seedlings compared to that of 30 and 60 day old seedlings and the difference in P uptake of the crop between the latter two ages of seedlings was not significant.

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher P uptake to that of 100% RDFN, 75% RDFN + 25 kg GM-N / FYM-N / VC-N and was comparable over that of 75% RDFN + 25 kg GM-N + 25 kg VC-N throughout the crop growth. Application of 125% RDN through different sources recorded comparable P uptake by grain as well as by straw. Application of 100% RDFN, 75% RDFN + 25 kg GM-N / FYM-N / VC-N resulted comparable P uptake by rice throughout its growth.

Table 4.9 Influence of age of seedlings and N management practices on P Uptake (kg.ha⁻¹) in rice

Treatment	Active tillering		Panicle initiation		Flowering		Grain		Straw	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Age of seedlings (days)										
A ₁	2.92	2.57	12.28	9.97	17.71	16.81	10.64	10.97	9.90	10.60
A ₂	2.55	2.34	10.40	8.92	16.30	16.05	12.30	13.20	8.58	9.20
A ₃	2.14	1.97	9.27	8.47	15.23	15.34	10.38	10.96	7.64	7.20
SEd ±	0.06	0.05	0.54	0.22	0.44	0.42	0.25	0.14	0.22	0.30
C.D (p=0.05)	0.16	0.13	1.49	0.61	1.23	1.17	0.69	0.38	0.62	0.84
N Management practices										
N ₁	2.43	2.16	9.67	8.68	15.41	14.89	10.26	10.78	7.93	8.26
N ₂	2.39	2.04	9.67	8.57	15.25	14.90	10.13	10.71	8.36	8.71
N ₃	2.50	2.18	9.81	8.66	15.84	15.60	10.90	11.13	8.14	8.52
N ₄	2.56	2.26	10.30	9.18	15.94	15.66	10.88	11.45	8.74	9.16
N ₅	2.63	2.36	11.23	9.90	17.05	16.93	11.67	12.31	9.43	9.84
N ₆	2.69	2.51	11.37	10.06	17.86	17.39	12.19	12.74	9.69	9.83
N ₇	2.73	2.54	11.83	10.34	18.11	17.56	12.31	12.86	10.17	10.32
N ₈	2.38	2.19	10.34	7.72	15.63	15.10	10.09	10.97	7.48	7.81
N ₉	2.52	2.41	11.60	8.96	16.62	16.58	11.54	12.45	8.43	8.95
SEd ±	0.09	0.04	0.58	0.17	0.55	0.72	0.61	0.61	0.36	0.52
C.D (p=0.05)	0.17	0.09	1.14	0.33	1.08	1.38	1.19	1.19	0.71	1.03
A x N										
SEd ±	0.12	0.05	0.71	0.20	0.68	0.87	0.74	0.74	0.41	0.60
C.D (p=0.05)	0.33	0.17	NS	NS	NS	NS	NS	NS	0.87	1.28

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

During both the years, at active tillering, the crop transplanted with 30 day old seedlings in combination with 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded maximum P uptake (Table 4.9a). However, the P uptake in this treatment was comparable to that of the crop transplanted with 30 day old seedlings in combination of any N management practice in 2000 and 125% RDN in 2001 and 45 day old seedlings in combination of 75% RDFN + 25 kg GM-N + 25 kg PM-N during 2000 and 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N during 2001.

4.1.4.3 K uptake

During both the years, K uptake by rice was significantly influenced by age of seedlings and N management practices throughout the crop growth (Table 4.10). The interaction effect between age of seedlings and N management practices was significant at active tillering and at harvest in straw only.

During both the years, the K uptake at active tillering significantly decreased with increase in age of seedlings. Crop transplanted with 30 day old seedlings recorded significantly higher K uptake at panicle initiation, flowering and by straw over that planted with 45 and 60 day old seedlings and the latter two ages resulted comparable K uptake. On the other hand, planting 45 day old seedlings recorded comparable K uptake in straw to that of 30 and 60 day old seedlings. The crop transplanted with 45 day old seedlings resulted in significantly higher K uptake by grain than that of 30 and 60 day old seedlings and the difference between latter two age of seedlings was also significant during 2001.

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded comparable K uptake to that of application of 125% RDN

Table 4.9 (a) P uptake (kg/ha) at active tillering as influenced by interaction between age of seedlings and N management practice in rice

	2000				2001			
	Age of seedlings							
	A ₁	A ₂	A ₃	Mean	A ₁	A ₂	A ₃	Mean
N management								
N ₁	2.79	2.47	2.03	2.43	2.47	2.12	1.87	2.16
N ₂	2.77	2.42	1.98	2.39	2.27	2.02	1.85	2.04
N ₃	2.87	2.48	2.15	2.50	2.49	2.18	1.87	2.18
N ₄	2.99	2.55	2.15	2.56	2.55	2.24	1.98	2.26
N ₅	2.95	2.69	2.24	2.63	2.71	2.37	2.01	2.36
N ₆	3.04	2.73	2.30	2.69	2.72	2.72	2.09	2.51
N ₇	3.07	2.79	2.33	2.73	2.74	2.73	2.15	2.54
N ₈	2.80	2.37	1.97	2.38	2.51	2.15	1.91	2.19
N ₉	3.02	2.46	2.07	2.52	2.65	2.55	2.02	2.41
Mean	2.92	2.55	2.14		2.57	2.34	1.97	

	SEd ±	CD (p=0.05)	SEd ±	CD (p=0.05)
A	0.06	0.16	0.05	0.13
N	0.09	0.17	0.04	0.09
A x N	0.12	0.33	0.05	0.17

N management

N₁ = 75% RDFN + 25 Kg N ha⁻¹ Green manure
 N₂ = 75% RDFN + 25 Kg N ha⁻¹ FYM
 N₃ = 75% RDFN + 25 Kg N ha⁻¹ Vermicompost
 N₄ = 75% RDFN + 25 Kg N ha⁻¹ Poultry manure
 N₅ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM
 N₆ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost
 N₇ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure
 N₈ = 100% RDFN
 N₉ = 125% RDFN

Age of seedlings (days)

A₁ = 30
 A₂ = 45
 A₃ = 60

through different sources and resulted in significantly higher K uptake over that of application of 100% RDN through different sources. Irrespective of source of N, application of 100% RDN recorded comparable K uptake and it was significantly lesser than that of application of 125% RDN through different sources. On the other hand, application of 75% RDFN + 25 kg GM-N + 25 kg FYM-N and 75% RDFN + 25 kg PM-N at active tillering and application of 75% RDFN + 25 kg PM-N and 125% RDFN and 75% RDFN + 25 kg GM-N + 25 kg FYM-N in grain resulted comparable K uptake.

During both the years, the crop transplanted with 30 day old seedlings in combination of 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded maximum K uptake at active tillering (Table 4.10a). However, it was comparable to that of 30 day old seedlings in combination with application of 125% RDN through different sources, 75% RDFN + 25 kg GM-N / VC-N / PM-N during 2000 and 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N / FYM-N with 30 day old seedlings, 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N and 125% RDFN with 45 day old seedlings during 2001. Significantly lower K uptake was obtained in the crop transplanted with 60 day old seedlings in combination with application of 75% RDFN + 25 kg GM-N during both the years.

Potassium uptake in straw was maximum in 75% RDFN + 25 kg GM-N + 25 kg PM-N in combination of 30 day old seedlings during both the years (Table ---). However, it was comparable to that of application of 125% RDN through different sources irrespective of age of seedlings except 75% RDFN + 25 kg GM-N + 25 kg VC-N / FYM-N in 60 day old seedlings during 2000 and it was comparable to that of application of 125% RDN through different sources in

Table 4.10 Influence of age of seedlings and N management practices on K Uptake (kg.ha⁻¹) in rice

Treatment	Active tillering		Panicle initiation		Flowering		Grain		Straw	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Seedling ages (days)										
A ₁	17.77	15.56	67.40	57.44	94.51	93.10	14.94	15.42	82.79	84.09
A ₂	15.56	14.52	58.90	54.88	90.74	90.27	16.65	16.97	80.24	81.00
A ₃	13.39	12.91	56.17	53.28	88.10	89.61	14.23	13.78	77.68	76.55
SEd±	0.24	0.27	3.06	1.20	1.37	0.78	0.34	0.26	1.80	1.90
C.D (P=0.05)	0.68	0.74	8.49	3.34	3.81	2.17	0.96	0.73	5.05	5.18
N Management practices										
N ₁	15.36	13.73	57.17	53.21	87.63	87.81	14.41	14.73	76.56	77.06
N ₂	15.37	13.30	57.02	52.43	86.31	87.33	14.01	14.36	75.45	76.54
N ₃	15.34	13.82	56.55	52.39	88.89	88.40	14.66	14.64	76.36	77.21
N ₄	15.35	14.14	59.40	54.85	89.37	88.91	14.98	15.02	77.54	78.15
N ₅	15.97	14.60	62.40	57.97	94.79	94.53	16.20	16.19	84.57	84.70
N ₆	15.82	15.12	64.00	59.01	95.51	95.25	16.51	16.68	85.09	84.53
N ₇	16.11	15.28	65.91	60.67	96.89	96.15	16.67	16.84	86.00	85.53
N ₈	15.07	13.95	59.24	50.00	88.21	87.40	14.05	14.16	76.10	76.94
N ₉	15.77	15.02	65.17	56.24	92.46	93.15	15.95	15.89	84.48	84.21
SEd±	0.34	0.29	3.37	1.06	1.46	1.31	0.83	0.78	3.36	2.85
C.D (p=0.05)	0.66	0.58	6.61	2.07	2.89	2.58	1.63	1.53	6.59	5.58
A x N										
SEd±	0.40	0.36	4.13	1.29	1.81	1.61	1.02	0.95	4.12	2.99
C.D (p=0.05)	0.81	0.71	NS	NS	NS	NS	NS	NS	8.07	5.86

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

Table 4.10 (a) K uptake (kg/ha) at active tillering as influenced by interaction between age of seedlings and N management practices in rice

Treatments	2000				2001			
	Age of seedlings							
	A ₁	A ₂	A ₃	Mean	A ₁	A ₂	A ₃	Mean
N management								
N ₁	17.63	15.49	12.95	15.36	15.21	13.35	12.63	13.73
N ₂	17.36	15.68	13.08	15.37	14.41	13.10	12.39	13.30
N ₃	17.48	15.43	13.12	15.34	15.24	13.68	12.53	13.82
N ₄	17.58	15.33	13.14	15.35	15.61	14.09	12.73	14.14
N ₅	18.03	16.14	13.74	15.97	16.31	14.44	13.04	14.60
N ₆	17.93	15.83	13.69	15.82	16.24	16.06	13.05	15.12
N ₇	18.28	16.13	13.92	16.11	16.34	16.10	13.41	15.28
N ₈	17.43	14.75	13.04	15.07	15.18	13.92	12.76	13.95
N ₉	18.21	15.31	13.81	15.77	15.52	15.92	13.63	15.02
Mean	17.77	15.56	13.39		15.56	14.52	12.91	

	SEd ±	CD (p=0.05)	SEd ±	CD (p=0.05)
A	0.24	0.68	0.27	0.74
N	0.34	0.66	0.29	0.58
A×N	0.40	0.81	0.36	0.71

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

Table 4.10 (b) K uptake (kg/ha) in straw as influenced by interaction between age of seedlings and N management practices in rice

Treatments	2000				2001			
	Age of seedlings							
	A ₁	A ₂	A ₃	Mean	A ₁	A ₂	A ₃	Mean
N management								
N ₁	79.46	76.03	74.20	76.56	80.07	77.42	73.68	77.06
N ₂	78.05	74.83	73.47	75.45	79.34	76.82	73.47	76.54
N ₃	79.28	75.23	74.57	76.36	80.10	77.30	74.25	77.21
N ₄	80.32	77.08	75.22	77.54	82.01	77.89	74.55	78.15
N ₅	87.60	85.25	80.87	84.57	90.27	85.26	78.57	84.70
N ₆	88.51	85.80	80.95	85.09	90.44	85.72	77.44	84.53
N ₇	89.46	86.75	81.80	86.00	90.75	87.29	78.55	85.53
N ₈	77.20	75.74	75.35	76.10	77.96	76.73	76.14	76.94
N ₉	85.27	85.48	82.70	84.48	85.82	84.55	82.26	84.21
Mean	82.79	80.24	77.68		84.09	81.00	76.55	

	SEd ±	CD (p=0.05)	SEd ±	CD (p=0.05)
A	1.80	5.05	1.90	5.18
N	3.36	6.59	2.85	5.58
A×N	4.12	8.07	2.99	5.86

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

combination with 30 and 45 day old seedlings except 125% RDFN in combination of 45 day old seedlings during 2001. During both the years, lower K uptake was associated with 60 day old seedlings in combination with 75% RDFN + 25 kg FYM-N.

4.1.5 The available N, P_2O_5 and K_2O in soil after rice ($kg\ ha^{-1}$)

During both the years, available N, P_2O_5 and K_2O status in soil was significantly influenced by N management practices and was unaffected by age of seedlings as well as their interaction (Table 4.11).

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher available N in the soil after rice over that of 100% RDFN (Table ----).

The available N in the soil after rice was observed to be with comparable application of 100% or 125% RDN through integrated manner. Application of 100% RDFN to rice resulted in significantly lower available N in the soil after rice as compared to that of application of 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N / FYM-N during 2000 and application of 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N during 2001.

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to rice resulted in significantly higher available P_2O_5 in the soil after rice over that of application of 100% RDN through different sources and 125% RDFN. However, in latter group of treatments the available P_2O_5 in the soil after rice was comparable. Application of 100% RDFN resulted in significantly lower P_2O_5 in the soil after rice as compared to application of 125% RDN through integrated manner.

Table 4.11 Influence of age of seedlings on available N, P₂O₅ and K₂O in the soil after rice (kg.ha⁻¹)

Treatment	Soil nitrogen		Soil P ₂ O ₅		Soil K ₂ O	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	243.8	253.1	27.00	27.82	237.8	246.7
A ₂	241.6	253.2	27.23	28.45	238.8	242.3
A ₃	248.4	253.3	27.84	28.84	241.5	249.5
SEd ±	3.92	2.70	0.37	0.48	1.50	3.88
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
N Management practices						
N ₁	240.9	251.4	25.59	27.83	241.2	243.0
N ₂	241.6	251.3	26.69	27.88	236.4	243.7
N ₃	242.3	251.6	26.80	27.94	236.6	244.1
N ₄	244.3	252.9	27.13	28.21	237.1	247.0
N ₅	249.8	256.2	28.14	29.44	241.7	250.1
N ₆	250.1	256.9	28.44	29.50	241.9	251.0
N ₇	251.0	257.4	28.80	29.61	242.9	251.9
N ₈	237.4	249.8	26.12	27.33	236.6	242.4
N ₉	244.2	250.8	27.48	27.58	240.0	242.3
SEd ±	6.08	3.61	0.65	0.64	2.60	4.13
C.D (p=0.05)	11.9	7.1	1.25	1.28	NS	8.10
A x N						
SEd ±	8.24	8.00	1.29	1.45	4.40	5.96
C.D (p=0.05)	NS	NS	NS	NS	NS	NS

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure
 N2= 75% RDFN+25 Kg N ha⁻¹ FYM
 N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost
 N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure
 N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM
 N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost
 N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure
 N8=100% RDFN
 N9=125 % RDFN

Age of seedlings (days)

A1 = 30
 A2 = 45
 A3 = 60

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to rice recorded in significantly higher K_2O in the soil after rice over that of application of 100% RDN through different sources during 2001 and application of 100% RDFN, 125% RDFN and 75% RDFN + 25 kg GM-N / FYM-N during 2001. The availability of K_2O in the soil after rice was significantly lower with application of 75% RDFN + 25 kg FYM-N as compared to 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N / FYM-N during 2000 and 125% RDFN compared to that of 75% RDFN + 25 kg GM-N + 25 kg PM-N / VC-N during 2001.

4.1.6 Economics

During both the years, gross returns, net returns and benefit cost ratio (BCR) of rice varied with age of seedlings and N management practices followed in rice (Table 4.12).

During both the years, the gross and net returns and BCR were maximum with transplanting 45 day old seedlings followed by 30 and 60 day old seedlings. Among different N management practices, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in higher gross returns but did not differ considerably from other N management practices (125% RDN). However, application of 125% RDN recorded higher gross returns as compared to the crop received 100% RDN irrespective of source of N. Not much variation was observed among 100% RDN treatments.

During both the years, application of 125% RDFN resulted in higher net returns and BCR followed by 75% RDF + 25 kg GM-N + 25 kg PM-N. Fertilization either with 100% or 125% N yielded better net returns and BCR over

Table 4.12 Economics of rice as influenced by age of seedlings and N management practices

	2000			2001		
	GR	NR	BCR	GR	NR	BCR
Age of seedlings						
A ₁	27303	12802	1.9	28656	14161	2.0
A ₂	28604	14104	2.0	29430	14934	2.0
A ₃	25451	10955	1.8	25922	11427	1.8
N management						
N ₁	25662	12267	1.9	26697	13302	2.0
N ₂	25335	11565	1.8	26555	12785	1.9
N ₃	25985	9215	1.6	26898	10128	1.6
N ₄	26440	12545	1.9	27195	13302	2.0
N ₅	28410	14015	2.0	29066	14671	2.0
N ₆	28712	11317	1.7	29529	12134	1.7
N ₇	29004	14484	2.0	29805	15285	2.1
N ₈	25771	12728	2.0	26853	13823	2.1
N ₉	28738	15448	2.2	29427	16137	2.2

GR-gross returns (Rs ha⁻¹), NR-net returns (Rs ha⁻¹), BCR-benefit cost ratio

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

that of respective integrated N management practices. Substitution with VC at both 100% and 125% RDN resulted in poor net returns as well as BCR as compared to similar level of N applications. Application of 75% RDFN + 25 kg GM-N + 25 kg VC-N recorded lesser net returns and BCR as compared to 100% RDFN, however among all the N management practices 75% RDFN + 25 kg VC-N resulted the lower net returns and BCR.

4.2 GREENGRAM

4.2.1 Dry Matter Production at Harvest (DMPH) (kg ha^{-1})

During both the years, DMPH in greengram differed significantly with residual effect of N management practices of preceding rice (Table 4.14). The residual effect of age of seedlings in rice, direct effect of fertilization to greengram and the interaction effects between various treatment combinations were not significant.

During both the years, application of 125% RDN to rice through different organic and inorganic sources resulted in significantly higher DMPH of greengram over that of application of 125% RDFN, 100% RDFN, and 25 kg N ha^{-1} substituted through organic sources in 100% RDN (Table 4.14).

Application of 75% RDFN + 25 kg PM-N to rice resulted comparable DMPH of greengram as that of 75% RDFN + 25 kg GM-N + 25 kg VC-N / FYM-N and 75% RDFN + 25 kg GM-N / FYM-N / VC-N. During both the years, application of 100% RDFN resulted in significantly lesser DMPH over that of 125% RDN supplied through integrated manner.

4.2.2 Yield Attributes

During both the years, residual effect of N management practices in rice significantly influenced pods per plant, seeds per pod but failed to influence 1000 seed weight in succeeding greengram (Table 4.13). On the other hand, during both the years residual effect of age of seedlings in rice, direct effect of fertilization to greengram and the interaction effects between various treatment combinations on yield attributing characters of greengram were not significant.

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to preceding rice recorded significantly higher number of pods per plant and seeds per pod over that of all the other N management practices except 75% RDFN + 25 kg GM-N + 25 kg VC-N / FYM-N. During both the years, application of 125% RDFN to rice resulted in significantly lower number of pods per plant as compared to the treatments which received 125% RDN with 50 kg N ha⁻¹ substitution through organic sources and 75% RDFN + 25 kg PM-N. Application of 75% RDFN + 25 kg GM-N to rice resulted significantly lower number of seeds per pod of succeeding greengram as compared to all the treatments which received 125% RDN through integrated manner during both the years and to that of 125% RDFN and 75% RDFN + 25 kg PM-N during second year.

4.2.3 Seed Yield (kg ha⁻¹)

During both the years, residual effect of N management practices significantly influenced the seed yield of succeeding greengram (Table 4.14). On the other hand, residual effect of age of seedlings in rice, direct effect of fertilization to greengram and the interaction effects between various treatment combinations were not significant.

Table 4.13 Yield attributes of greengram as influenced by residual and direct effect of fertilization

Treatment	Pods plant ⁻¹		Seeds pod ⁻¹		1000 seed Wt. (g)	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	6.33	7.08	8.69	8.74	33.73	33.55
A ₂	6.25	6.86	8.79	8.72	33.74	33.33
A ₃	6.56	7.12	9.12	8.82	34.17	33.29
SEd ±	0.12	0.11	0.18	0.11	0.37	0.34
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
N Management practices						
N ₁	6.10	6.65	8.62	8.48	33.41	33.44
N ₂	6.23	6.74	8.65	8.61	33.48	33.22
N ₃	6.31	6.73	8.74	8.58	33.45	33.35
N ₄	6.47	6.98	8.86	8.68	33.73	33.49
N ₅	6.70	7.48	9.04	8.99	34.42	33.34
N ₆	6.78	7.53	9.22	9.09	34.60	33.23
N ₇	6.87	7.78	9.25	9.14	34.80	33.41
N ₈	5.99	6.63	8.69	8.57	33.41	33.54
N ₉	5.97	6.50	8.75	8.69	33.63	33.47
SEd ±	0.18	0.21	0.18	0.09	0.70	0.52
C.D (p=0.05)	0.32	0.42	0.36	0.18	NS	NS
Fertilization to Greengram						
F ₁	6.32	6.93	8.77	8.61	33.52	33.29
F ₂	6.44	7.11	8.96	8.90	34.24	33.49
SEd ±	0.08	0.10	0.10	0.16	0.40	0.28
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x N						
SEd ±	0.14	0.23	0.28	0.36	1.25	1.24
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x F						
SEd ±	0.06	0.15	0.15	0.11	0.60	0.77
C.D (p=0.05)	0.13	0.40	NS	NS	NS	NS
N x F						
SEd ±	0.13	0.16	0.24	0.26	0.94	0.84
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x N x F						
SEd ±	0.12	0.22	0.26	0.31	1.14	1.19
C.D (p=0.05)	NS	NS	NS	NS	NS	NS

Table 4.14 Dry matter production at harvest and yield (kg/ha) of greengram as influenced by residual and direct effect of fertilization

Treatment	Dry matter		Seed yield		Haulm Yield	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	1350	1613	345	371	1023	1102
A ₂	1343	1597	341	366	981	1048
A ₃	1418	1667	352	371	1007	1087
SEd ±	1672	1761	3	3	12	12
C.D (p=0.05)	46	49	8	8	34	34
N Management Practices						
N ₁	1333	1588	343	366	920	1023
N ₂	1337	1609	344	367	929	1052
N ₃	1340	1606	345	367	953	1046
N ₄	1378	1636	347	369	999	1085
N ₅	1419	1680	351	375	1069	1134
N ₆	1418	1667	352	376	1121	1144
N ₇	1443	1689	353	378	1140	1166
N ₈	1324	1578	341	365	956	1025
N ₉	1340	1578	341	366	970	1035
SEd ±	27	25	5	4	18	24
C.D (p=0.05)	54	50	10	8	37	48
Fertilization to Greengram						
F ₁	1348	1607	344	366	951	1037
F ₂	1392	1644	347	374	1057	1120
SEd ±	12	14	3	2	8	9
C.D (p=0.05)	23	28	NS	4.4	16	19
A x N						
SEd ±	90	68	9	10	33	30
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x F						
SEd ±	22	32	7	7	16	17
C.D (p=0.05)	NS	NS	NS	NS	38	40
N x F						
SEd ±	59	48	8	7	25	26
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x N x F						
SEd ±	75	60	8	10	29	28
C.D (p=0.05)	NS	NS	NS	NS	NS	NS

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to preceding rice recorded significantly higher seed yield in succeeding greengram as compared to application of 100% and 125% RDN through fertilizer during both the years and 75% RDFN + 25 kg GM-N during 2001. Application of 100% RDFN to rice resulted in significantly lower seed yield of succeeding greengram as compared to 75% RDFN + 25 kg GM-N + 25 kg PM-N during both the years, 75% RDFN + 25 kg GM-N + 25 kg VC-N during first year.

4.2.4 Haulm Yield (kg ha^{-1})

During both the years, residual effect of N management practices in preceding rice, direct effect of fertilization to greengram significantly influenced the haulm yield of greengram (Table 4.14). On the other hand, the residual effect of age of seedlings in rice and interaction effects between various treatment combinations on haulm yield was not significant.

During both the years, among N management practices in rice application of 125% RDN through organic sources substituting 50 kg N ha^{-1} resulted in significantly higher haulm yield in succeeding greengram over that of application of 100% and 125% RDN through fertilisers and 25 kg N ha^{-1} substituted through organic sources in 100% RDN (Table 4.14).

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to rice recorded comparable haulm yield to that of 75% RDFN + 25 kg GM-N + 25 kg VC-N during both the years and 75% RDFN + 25 kg GM-N + 25 kg FYM-N during second year. Application of 75% RDFN + 25 kg GM-N to rice resulted in significantly lower haulm yield in succeeding greengram as compared to that of all

the treatments which received 125% RDN through integrated manner and 75% RDFN + 25 kg PM-N during both the years and 125% RDFN during first year.

During both the years, application of 100% RDF to greengram resulted significantly higher haulm yield in greengram over that of 50% RDF (Table 4.14).

4.2.5 Nutrient Uptake (kg ha^{-1})

During both the years, residual effect of N management to preceding rice, direct effect of fertilization to greengram on N, P and K uptake by greengram at harvest was significant (Table 4.15). N, P and K uptake was not significantly influenced by residual effect of age of seedlings in rice and interaction between various combination of treatments except the interaction effect between age of seedlings in rice and fertilization to greengram on N and K uptake.

During both the years, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to rice recorded significantly higher N, P and K uptake by succeeding greengram over that of treatments which supplied 100% RDN through different sources and 125% RDFN. Application of 75% RDFN + 25 kg PM-N to rice resulted in significantly higher N, P and K uptake over that of application of 100% and 125% RDFN and 75% RDFN + 25 kg GM-N. However, the latter treatments were comparable during both the years. During both the years, 75% RDFN + 25 kg GM-N, application of 100% and 125% RDFN to rice resulted comparable N, P and K uptake by succeeding greengram. During both the years, application of 100% RDF to greengram resulted significantly higher N, P and K uptake by greengram at harvest over that of 50% RDF (Table 4.15).

Table 4.15 N, P, K uptake (Kg/ha) by greengram as influenced by residual and direct effect of fertilization

Treatment	Nitrogen		Phosphorous		Potassium	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	25.99	33.76	3.08	4.15	20.40	23.72
A ₂	25.71	33.63	3.43	3.80	20.14	22.88
A ₃	27.30	34.38	3.98	4.93	21.40	24.83
SEd ±	0.59	0.57	0.10	0.18	0.46	0.24
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
N Management practices						
N ₁	25.17	32.90	2.77	3.93	19.81	23.21
N ₂	25.99	33.65	3.12	4.22	19.71	23.25
N ₃	25.86	33.45	3.21	4.08	19.98	23.40
N ₄	27.13	34.31	3.62	4.38	20.90	24.04
N ₅	28.95	35.22	3.99	4.70	21.99	24.80
N ₆	29.10	35.17	4.25	4.74	22.12	24.94
N ₇	29.58	35.77	4.36	4.97	22.77	25.35
N ₈	23.80	32.56	2.43	3.82	19.12	22.67
N ₉	24.30	32.42	2.56	3.83	19.40	22.62
SEd ±	0.66	0.69	0.19	0.18	0.48	0.42
C.D (p=0.05)	1.32	1.38	0.40	0.36	0.96	0.82
Fertilization to Greengram						
F ₁	23.99	32.30	3.11	3.75	19.01	22.45
F ₂	28.68	35.51	3.88	4.85	22.27	25.17
SEd ±	0.48	0.30	0.09	0.10	0.21	0.20
C.D (p=0.05)	0.98	0.60	0.19	0.20	0.42	0.40
A x N						
SEd ±	2.20	2.10	0.34	0.55	0.51	1.36
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x F						
SEd ±	0.76	1.02	0.16	0.30	0.75	0.36
C.D (p=0.05)	1.76	2.70	NS	NS	2.08	0.80
N x F						
SEd ±	1.64	1.30	0.28	0.50	0.92	0.92
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x N x F						
SEd ±	0.96	1.14	0.31	0.50	1.38	1.16
C.D (p=0.05)	NS	NS	NS	NS	NS	NS

Table 4.13a: Interaction effect of ages of rice in combination of fertilization to greengram on pods per plant in greengram

Fertilization to greengram	Age of seedlings in rice					
	2000-01			2001-02		
	A ₁	A ₂	A ₃	A ₁	A ₂	A ₃
F ₁	5.20	4.97	5.63	6.79	6.30	6.80
F ₂	5.46	5.33	6.08	7.56	7.23	7.44
SEd±		0.06			0.15	
CD (P=0.05)		0.13			0.40	

Table 4.15a: Interaction effect of ages of rice in combination of fertilization to greengram on N uptake (kg ha⁻¹) by greengram

Fertilization to greengram	Age of seedlings in rice					
	2000-01			2001-02		
	A ₁	A ₂	A ₃	A ₁	A ₂	A ₃
F ₁	24.04	23.06	24.87	32.37	31.62	32.91
F ₂	28.35	27.78	29.91	35.40	35.05	36.08
SEd±		0.76			1.02	
CD (P=0.05)		1.76			2.70	

Table 4.15b: Interaction effect of ages of rice in combination of fertilization to greengram on K uptake (kg ha⁻¹) by greengram

Fertilization to greengram	Age of seedlings in rice					
	2000-01			2001-02		
	A ₁	A ₂	A ₃	A ₁	A ₂	A ₃
F ₁	18.97	18.72	19.34	22.37	21.41	23.56
F ₂	23.01	21.30	23.50	25.07	24.34	26.11
SEd±		0.75			0.36	
CD (P=0.05)		2.08			0.80	

During both the years, transplanting 60 day old seedlings in preceding rice followed by application of 100% RDF to greengram recorded significantly higher N uptake by greengram over that of application of 50% RDF to greengram, irrespective of age of seedlings in rice and planting 45 day old seedlings in rice followed by application of 100% RDF to greengram (Table 4.15). Transplanting 45 day old seedlings in preceding rice followed by application of 50% RDF to greengram resulted significantly lower N uptake by greengram as compared to that of 100% RDF to greengram regardless of the age of seedlings in preceding rice.

During both the years, transplanting 60 day old seedlings in preceding rice, followed by 100% RDF to greengram resulted significantly higher K uptake by greengram over that of application of 50% RDF to greengram irrespective of age of seedlings in rice and transplanting 45 day old seedlings in rice in combination of 100% RDF to greengram (Table 4.15). Transplanting 60 day old seedlings in rice in combination of 50% RDF to greengram resulted comparable K uptake to that of transplanting 45 day old seedlings in rice in combination of 100% RDF to greengram. Transplanting 45 day old seedlings in rice followed by 50% RDF to greengram resulted significantly lower K uptake compared to that of 100% RDF to greengram, irrespective of age of seedlings during first year and that of all the remaining treatment combinations during second year.

4.2.6 Available N, P₂O₅ and K₂O in soil after greengram (kg ha⁻¹)

During both the years, except available P₂O₅ in soil, the available nutrient status in soil after greengram was unaffected by residual effect of age of

Table 4.16 Available N, P205, K20 in the soil (kg/ha) after greengram as influenced by residual and direct effect of fertilization

Treatment	Nitrogen		Phosphorous		Potassium	
	2000	2001	2000	2001	2000	2001
Seedling ages (days)						
A ₁	255	264	27.18	27.24	235	242
A ₂	242	262	27.81	26.61	232	230
A ₃	244	263	28.39	27.59	235	241
SEd ±	3.54	4.96	0.42	0.45	2.76	4.28
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
N Management practices						
N ₁	247	260	27.07	27.18	232	236
N ₂	249	260	27.32	27.03	232	234
N ₃	245	260	27.20	26.81	231	236
N ₄	245	262	27.42	27.02	233	236
N ₅	250	266	28.57	27.08	237	240
N ₆	250	266	28.71	27.32	237	240
N ₇	249	267	28.93	27.89	239	241
N ₈	243	258	26.80	26.68	231	235
N ₉	245	264	28.13	27.31	235	242
SEd ±	5.08	5.53	0.55	0.49	4.04	4.05
C.D (p=0.05)	NS	NS	1.10	1.01	NS	NS
Fertilization to Greengram						
F1	245	261	27.13	26.07	233	236
F2	249	265	28.45	28.22	235	240
SEd ±	2.05	2.32	0.21	0.24	1.49	2.00
C.D (p=0.05)	NS	NS	0.43	0.49	NS	NS
A x N						
SE.d ±	17.49	12.70	1.35	1.08	4.75	8.88
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x F						
SE.d ±	6.16	7.21	1.05	0.68	3.55	6.48
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
N x F						
SE.d ±	11.04	8.27	0.58	0.76	2.55	4.05
C.D (p=0.05)	NS	NS	NS	NS	NS	NS
A x N x F						
SE.d ±	15.10	11.93	1.42	1.05	4.88	8.97
C.D (p=0.05)	NS	NS	NS	NS	NS	NS

seedlings, N management practices in rice and direct effect of fertilization to greengram as well as by their interactions (Table 4.16).

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to rice resulted significantly higher available P_2O_5 in soil after greengram over that of application of 100% RDN through different sources during first year and application of 100% RDFN and 75% RDFN + 25 kg VC-N during second year in rice-greengram system. Application of 100% RDFN to rice recorded significantly lower available phosphorus in soil after greengram as compared to that of application of 125% RDN through different sources during first year and application of 75% RDFN + 25 kg GM-N + 25 kg PM-N during second year.

During both the years, application of 100% RDF to greengram recorded significantly higher available P_2O_5 in soil after greengram over that of application of 50% RDF to greengram in rice-greengram system.

4.2.7 Economics

During both the years, the gross returns, net returns and BCR of greengram were maximum after the rice crop when transplanted with 60 day old seedlings and it was followed by 30 and 45 day old seedlings (Table 4.17). Economic returns of greengram (gross returns, net returns and BCR) were higher after application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to rice and it was closely followed after rice receiving 75% RDFN + 25 kg GM-N + 25 kg VC-N / FYM-N. The lower gross returns, net returns and BCR in greengram were observed with application of 125% RDFN to rice. During both the years, the gross returns were higher with application of 100% RDF to greengram, but the net returns and BCR were higher with application of 50% RDF to greengram.

Table 4.17 Economics of greengram as influenced by residual and direct effect of fertilization

	2000			2001		
	GR	NR	BCR	GR	NR	BCR
Age of seedlings						
A ₁	5138	630	1.1	5516	1008	1.2
A ₂	5072	564	1.1	5441	933	1.2
A ₃	5242	734	1.2	5517	1009	1.2
N management						
N ₁	5078	570	1.1	5423	915	1.2
N ₂	5095	587	1.1	5453	945	1.2
N ₃	5114	606	1.1	5441	933	1.2
N ₄	5160	625	1.1	5492	984	1.2
N ₅	5235	727	1.2	5592	1084	1.2
N ₆	5262	754	1.2	5603	1095	1.2
N ₇	5284	776	1.2	5634	1126	1.3
N ₈	5072	564	1.1	5411	903	1.2
N ₉	5065	557	1.1	5370	862	1.2
Fertilization to greengram						
F ₁	5109	904	1.2	5434	1229	1.3
F ₂	5191	381	1.1	5548	738	1.2

GR-gross returns (Rs ha⁻¹), NR-net returns (Rs ha⁻¹), BCR-benefit cost ratio

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure
 N2= 75% RDFN+25 Kg N ha⁻¹ FYM
 N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost
 N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure
 N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM
 N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost
 N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure
 N8=100% RDFN
 N9=125 % RDFN

Age of seedlings (days)

A1 = 30
 A2 = 45
 A3 = 60

4.3 RICE-GREENGRAM SYSTEM

4.3.1 Rice equivalent yield (kg ha^{-1})

During both the years, rice equivalent yield of rice-greengram system was significantly influenced by age of seedlings and N management practices of rice (Table 4.20), whereas effect of fertilization to greengram and interaction between any of the factors was not significant.

During both the years, transplanting of 45 day old seedlings resulted in significantly higher rice equivalent yield compared to that of 30 and 60 day old seedlings. On the other hand, the crop transplanted with 60 day old seedlings recorded significantly lower rice equivalent yield compared to that of 30 day old seedlings.

During both the years application of 75% RDFN + 25 kg GM-N + 235 kg PM-N recorded significantly higher rice equivalent yield over that of application of 100% RDN through different sources. During both the years, application of 125% RDN through different sources resulted in comparable rice equivalent yield. Similarly there was no significant variation in the rice equivalent yield of rice greengram system which received 100% RDN through different sources.

4.3.2 Total NPK uptake (kg ha^{-1})

Total NPK uptake of rice-greengram system was not much influenced by age of seedlings in rice and fertilization to greengram but it was varied with different N management practices to rice (Table 4.20).

Table 4.20: Total productivity of rice-greengram system in terms of rice equivalent yield and total NPK uptake (kg ha⁻¹)

Treatments	Rice equivalent yield		N uptake at harvest		P uptake at harvest		K uptake at harvest	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Age of seedlings								
A ₁	3834	4075	90.76	97.45	23.62	25.72	118	123
A ₂	4023	4191	90.26	96.21	24.31	26.20	117	121
A ₃	3612	3737	87.62	94.76	22.00	23.09	113	115
SEd±	37	31	-	-	-	-	-	-
C.D (P=0.05)	102	86	-	-	-	-	-	-
N management								
N ₁	3645	3840	82.86	92.03	20.96	22.97	111	115
N ₂	3606	3822	82.94	92.35	21.61	23.64	109	114
N ₃	3692	3865	84.52	92.15	22.25	23.73	111	115
N ₄	3752	3908	87.00	93.85	23.26	24.99	113	117
N ₅	3985	4138	96.33	100.63	25.09	26.85	123	126
N ₆	4024	4198	97.93	101.63	26.13	27.28	124	126
N ₇	4059	4234	100.08	103.12	26.84	28.15	125	128
N ₈	3650	3852	81.80	92.13	20.00	22.60	109	114
N ₉	4002	4158	92.52	98.72	22.53	25.23	120	123
SEd±	117	127	-	-	-	-	-	-
C.D (P=0.05)	246	267	-	-	-	-	-	-
Fertilization to greengram								
F ₁	3819	3994	85.77	92.07	23.04	24.46	114	118
F ₂	3825	4010	93.34	100.50	23.81	25.56	118	121
SEd±	5	25	-	-	-	-	-	-
C.D (P=0.05)	NS	NS	-	-	-	-	-	-

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded the maximum total NPK uptake (Table 4.20) and it was closely followed by application of 25 kg VC-N / FYM-N along with 25 kg GM-N + 75% RDFN. Application of 100% RDFN recorded the lower total NPK uptake among all N management practices, however it was closely followed by the crop received 100% RDN through different sources.

4.3.3 Economics

During both the years, the gross returns were maximum in the crop transplanted with 45 day old seedlings followed by 30 and 60 day old seedlings (Table 4.18). Among N management practices, application of 75% RDFN + 25 kg GM-N + 25 kg PM-N recorded maximum gross returns followed by 75% RDFN + 25 kg GM-N + 25 kg VC-N, however the difference between the sources at each level of N (100% or 125%) was not considerable. Application of 125% RDN through different sources recorded higher gross returns over that of 100% RDN through various sources. Among fertilizer levels in greengram application of 100% RDF resulted higher gross returns as compared to 50% RDF. During both the years, the gross returns were maximum in the crop transplanted with 45 day old seedlings which received 75% RDFN + 25 kg GM-N + 25 kg PM-N. The lower gross returns were observed in the crop transplanted with 60 day old seedlings and application of 75% RDFN + 25 kg FYM-N to preceding rice and followed by 100% RDF to succeeding greengram.

The net returns and BCR of the system were higher in the crop transplanted with 45 day old seedlings followed by 30 and 60 day old seedlings. During both the years, application of 125% RDFN recorded higher net returns followed by 75% RDFN + 25 kg GM-N + 25 kg PM-N. Application of 50 kg N ha⁻¹

Table 4.18 Economics of rice-greengram system as influenced by age of seedlings and N management practices

	2000			2001		
	GR	NR	BCR	GR	NR	BCR
Age of seedlings						
A ₁	32436	13544	1.7	34173	15169	1.8
A ₂	33676	14674	1.8	34871	15869	1.8
A ₃	30695	11692	1.6	31439	12437	1.7
N management						
N ₁	30741	12839	1.7	32121	14219	1.8
N ₂	30430	12150	1.7	32009	13732	1.8
N ₃	31098	9821	1.5	32339	11062	1.5
N ₄	31608	13206	1.7	32689	14290	1.8
N ₅	33645	14743	1.8	34659	15757	1.8
N ₆	33974	12072	1.6	35132	13227	1.6
N ₇	34288	15261	1.8	35440	16413	1.9
N ₈	30833	13630	1.8	32263	14726	1.8
N ₉	33803	16006	1.9	34797	17000	2.0
Fertilization to greengram						
F ₁	32228	13524	1.6	33437	14736	1.6
F ₂	32310	13001	1.5	33551	14245	1.5

GR-gross returns (Rs ha⁻¹), NR-net returns (Rs ha⁻¹), BCR-benefit cost ratio

N management

N1= 75% RDFN+25 Kg N ha⁻¹ Green manure

N2= 75% RDFN+25 Kg N ha⁻¹ FYM

N3= 75% RDFN+25 Kg N ha⁻¹ Vermicompost

N4= 75% RDFN+25 Kg N ha⁻¹ Poultry manure

N5= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N6= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N7= 75% RDFN+25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N8=100% RDFN

N9=125 % RDFN

Age of seedlings (days)

A1 = 30

A2 = 45

A3 = 60

through different organic sources in 125% RDN was profitable than 25 kg N ha⁻¹ in 100% RDN substituted through organic sources. Among different organic sources green manuring was most profitable option followed by poultry manuring and FYM. However, during both the years irrespective of the age of seedlings sole mineral fertilizer application resulted in better economic returns over that of the organic sources of N. Vermicompost substitution was not an attractive option among all the sources of N as it recorded the lower net returns and BCR during both the years.

4.4 CORRELATION STUDIES

The relationship between growth, yield components as well as nutrient uptake by grain and grain yield of rice has been traced by working out correlation coefficients (r-values) (Table 4.19).

During both the years, regardless of the age of seedlings at planting, the yield components panicles m⁻², filled grains per panicle and 1000-grain weight positively correlated with grain yield and were highly significant. On the other hand, the spikelet sterility showed a negative relationship with filled spikelets per panicle as well as grain yield and was highly significant.

During both the years, LAI at flowering, tillers at 70 DAT, DMP at harvest, stage wise N uptake and N, P, K uptake by grain had positive correlation with grain yield and was highly significant. Among all the stages, N uptake by grain had significant positive relation with grain yield. Panicles m⁻² highly correlated with N uptake at active tillering and there was a clear association between total grains panicle⁻¹ with N uptake at panicle initiation. The relationship between number of filled grains per panicle and N uptake at flowering as well as test weight and N uptake by grain was also highly significant during both the years.

Table 4.19a: Relationship between yield attributes and grain yield for different ages in rice

Relationship	'r' values age-wise					
	2000			2001		
	Age of seedlings					
	A ₁	A ₂	A ₃	A ₁	A ₂	A ₃
Grain yield vs panicles m ⁻²	0.973**	0.955**	0.867**	0.981**	0.962**	0.950**
Grain yield vs filled grains	0.908**	0.977**	0.958**	0.890**	0.878**	0.726*
Spikelet sterility	-0.964**	-0.912**	-0.863**	-0.922**	-0.978**	-0.790*
Test weight	0.945**	0.849**	0.916**	0.953**	0.920**	0.948**

Table 4.19b: Relationship between grain yield and growth parameters, nutrient uptake by grain in rice

Relationship	'r' value	
	2000	2001
Grain yield vs LAI at flower	0.942**	0.995**
Grain yield vs tillers at 70 DAT	0.964**	0.890**
Grain yield vs DMPH	0.994**	0.996**
Grain yield vs N uptake by grain	0.994**	0.995**
Grain yield vs P uptake by grain	0.955**	0.991**
Grain yield vs K uptake by grain	0.981**	0.967**

Table 4.19c: Relationship between grain yield and stage-wise N uptake in rice

Relationship	'r' value	
	2000	2001
Grain yield vs N uptake by rice at AT	0.974**	0.927**
Grain yield vs N uptake at panicle initiation	0.941**	0.962**
Grain yield vs N uptake at flower	0.943**	0.967**
Grain yield vs N uptake by grain	0.994**	0.995**

Table 4.19d: Relationship between yield attributes and N uptake

Relationship	'r' value	
	2000	2001
Panicles vs N uptake by rice at AT	0.962**	0.907**
Total no. of grains vs N uptake at PI	0.913**	0.979**
Number of filled grains vs N uptake at flower	0.984**	0.964**
Test weight vs N uptake by grain	0.974**	0.971**

** Significant at 1% level.

* Significant at 5% level

Table 4.19e: Relationship between minimum temperatures at flowering and spikelet sterility in rice

Age of seedlings	'r' values	
	2000	2001
A ₁	-0.921**	-0.869**
A ₂	-0.706*	-0.720*
A ₃	-0.589	-0.711*

Table 4.19f: Relationship between minimum temperatures at the time of flowering to grain filling and filled spikelets per panicle in rice

Age of seedlings	'r' values	
	2000	2001
A ₁	0.936**	0.895**
A ₂	0.837**	0.806**
A ₃	0.780*	0.771*

Table 4.19g: Relationship between seed yield and yield attributes as well as nutrient uptake in greengram

Seed yield vs	'r' values	
	2000	2001
Number of pods per plant	0.831**	0.852**
Number of seeds per pod	0.911**	0.928**
N uptake at harvest	0.827**	0.831**
P uptake at harvest	0.865**	0.811**
K uptake at harvest	0.803**	0.833**

** Significant at 1% level

* Significant at 5% level

Chapter - V

Discussion

CHAPTER – V

DISCUSSION

The results of the influence of age of seedlings, N management practices on crop growth, yield attributes, yield, nutrient removal, soil health and income in rice-greengram system presented in the preceding chapter are discussed hereunder.

5.1 WEATHER

The weather, except rainfall during rice and greengram growth was normal (Fig.3.1a & b and Appendix Ia and b). As both the crops were grown under irrigated conditions, the rainfall variation did not affect the crop yields.

5.2 AGE OF SEEDLINGS IN RICE

Age of seedlings had a significant impact on growth, yield attributes, yield and nutrient uptake of rice during both the years. The crop transplanted with 45 day old seedlings resulted significantly higher grain yield over that of 30 and 60 day old seedlings (Table 4.6). The higher grain yield in former treatment was due to higher dry matter production at harvest, more number of filled spikelets per panicle as a result of higher N, P and K uptake as compared to that in latter age of seedlings (Table 4.3, 4.5 and 4.6). There was strong positive correlation between grain yield and dry matter production at harvest and filled spikelets per panicle indicating that the increase in these parameters improved the grain yield in the crop transplanted with 45 day old seedlings (Table 4.19a & b).

The N P K uptake at harvest was higher in the crop transplanted with 45 day old seedlings over that of 30 and 60 day old seedlings. This was due to better translocation of nutrients from source to sink in 45 day old seedlings as compared to 30 and 60 day old seedlings as it was less impaired by low temperature stress at the time of grain filling compared to 30 day old seedlings and due to early planting in less competitive environment (main field) as compared to 60 day old seedlings. Low temperatures below critical level coinciding with grain filling results reduced partitioning of photosynthates which ultimately led to poor nutrient uptake (Pramod Kumar, 2002).

Lower grain yield with 30 day old seedlings compared to that of 45 day old seedlings, inspite of better growth till flowering and more panicles m^{-2} was due to lesser number of filled spikelets per panicle as a result of higher spikelet sterility (29 and 26% during 2000 and 2001 respectively). The minimum temperature prevailed during flowering of crop transplanted with 30, 45 and 60 day old seedlings were 13.9, 15.0 and 17.4°C respectively during 2000 and 14.6, 15.7 and 16.8°C respectively during 2001. The minimum temperature less than 14°C at the meiotic stage of pollen mother cells causes very high sterility in rice (Satake, 1969 and Venkataraman, 1986). The minimum temperature around 14°C during flowering stage of crop transplanted with 30 day old seedlings has resulted in higher spikelet sterility (Table 4.5) and reduced filled grains per panicle than that of 45 and 60 day old seedlings (15 and 5% reduction during 2000 and 2001 respectively) (Table 4.5). There was strong negative correlation between minimum temperature at flowering and spikelet sterility (Table 4.19e) showing that the minimum temperature had considerably influenced the spikelet fertility which ultimately resulted lower

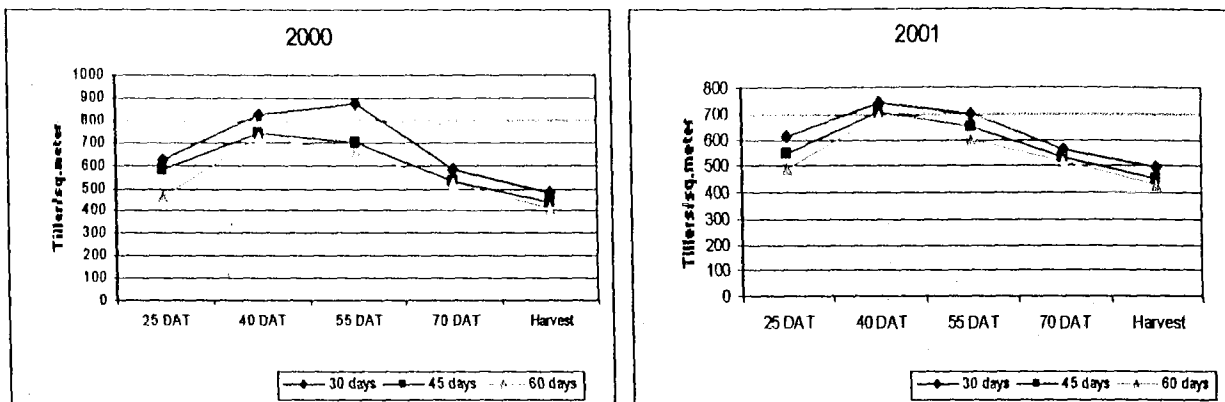


Fig 4.1 Tiller m⁻² as influenced by age of seedlings in rice

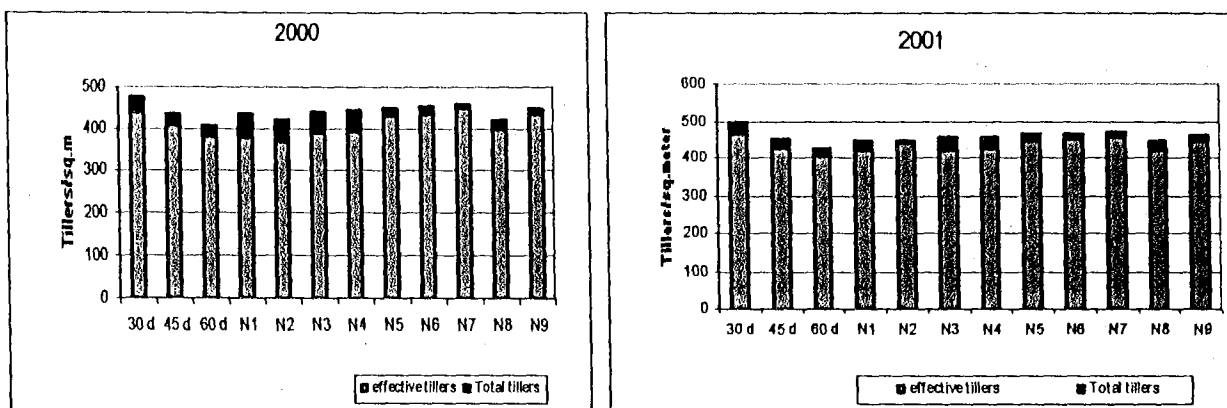


Fig 4.2 Total and effective tillers m⁻² in rice

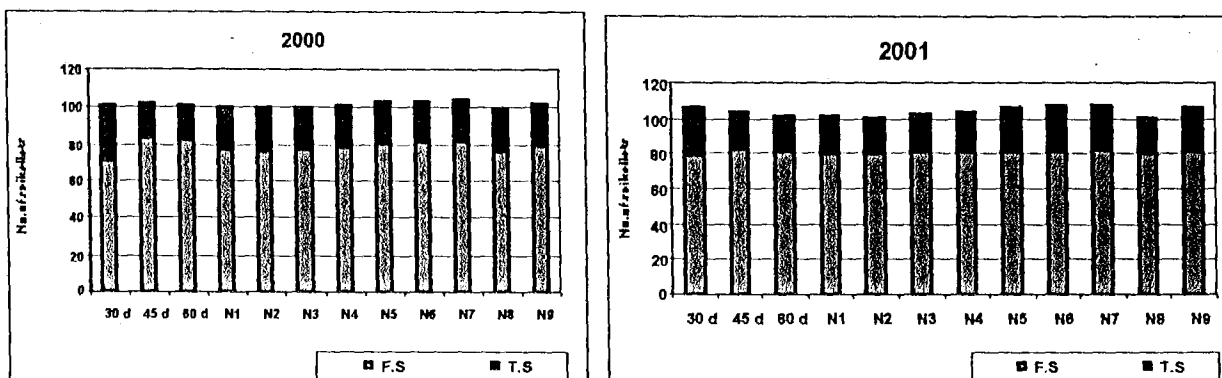


Fig 4.3 Total and filled spikelets panicle⁻¹ in rice

number of filled spikelets per panicle in the crop transplanted with 30 day old seedlings. There was strong negative correlation between spikelet sterility and grain yield (Table 4.19a).

The crop transplanted with 30 day old seedlings resulted in significantly higher grain yield over that of 60 day old seedlings during both the years (Table 4.6). The higher grain yield in the former treatment was due to more number of panicles m^{-2} (14%) over that of latter treatment. Rice transplanted at an early age, results in better establishment, healthy and sturdy growth with more number of tillers as well as panicles (Ghosh, 1982; Mandal *et al.*, 1984 and Raju and Rao, 1984). More number of tillers m^{-2} in the crop transplanted with 30 day old seedlings recorded more number of panicles m^{-2} and ultimately resulted higher grain yield as compared to 60 day old seedlings. There was positive correlation between grain yield and tillers m^{-2} and panicles m^{-2} in 30 day old seedlings indicating higher panicles m^{-2} improved the grain yield of crop (Table 4.19a).

The lower grain yield in the crop transplanted with 60 day old seedlings over that of 45 and 30 day old seedlings was due to reduction in panicle number by 14 and 6% respectively. Strong positive correlation between number of panicles m^{-2} and grain yield indicated that decrease in panicle number reduced the grain yield (Table 4.19a). Significantly lower number of panicles observed with 60 day old seedlings was due to initial vegetative stage (first 60 days age) spent in highly competitive environment (nursery) resulted in reduction in number of tillers as well as panicles m^{-2} . Tiller number inversely related to the age of seedlings at planting in rice (Raju and Rao, 1984 and Mannan *et al.*, 1990).

5.3 N MANAGEMENT

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher grain yield over that of 100% RDFN and 75% RDFN + 25 kg GM-N / FYM-N / VC-N (Table 4.6) due to higher DMP (Table 4.3), LAI (Table 4.2), panicles m^{-2} , filled spikelets panicle⁻¹, 1000-grain weight (Table 4.5) and nutrient uptake (Table 4.8, 4.9 & 4.10) as evident from strong positive correlation existed between these parameters and grain yield (Table 4.19a & b).

Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N resulted in significantly higher nutrient uptake as compared to that of the crop received 100% RDFN, 75% RDFN + 25 kg GM-N / FYM-N / VC-N due to higher availability of N, P₂O₅ and K₂O in the soil in former treatment as compared to latter treatments (Table 4.11). Rice crop supplied with adequate N produces more number of tillers, leaf area, DMP, yield attributes, and thereby higher grain yield (Blaise and Prasad, 1996). In the present study, there was significant increase in number of tillers, leaf area, DMP, panicles m^{-2} , total and filled spikelets per panicle, 1000 grain weight and N uptake with application of 75% RDFN + 25 kg GM-N + 25 kg PM-N over that of 100% RDFN, 75% RDFN + 25 kg GM-N / FYM-N / VC-N. Higher N uptake by rice crop during different growth stages manifests favourable growth and yield attributes resulting in higher yield. There was strong positive correlation between yield and yield attributes, N uptake (Table 4.19a & c) indicating that the increase in these parameters increased the grain yield of the crop received 75% RDFN + 25 kg GM-N + 25 kg PM-N.

During both the years, application of 125 and 100% RDN through different sources resulted in comparable grain yield within the applied nutrient level. This indicates there is possibility of substitution of 50 kg of 125% RDN and 25 kg

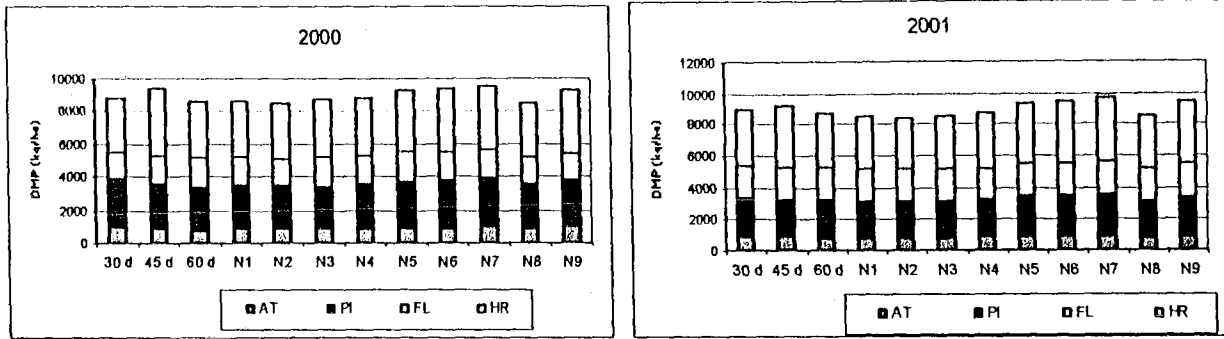


Fig 4.4 Dry matter production at different stages of rice (kg ha⁻¹)

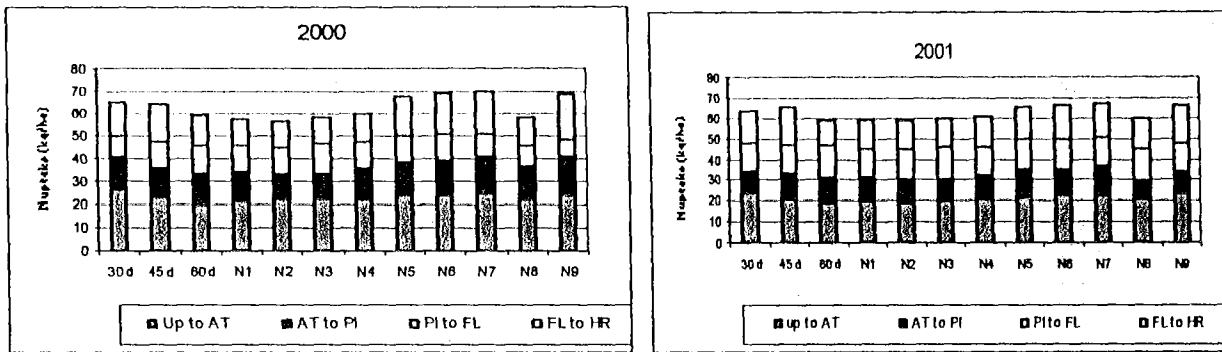


Fig 4.5 N uptake at different stages of rice (kg ha⁻¹)

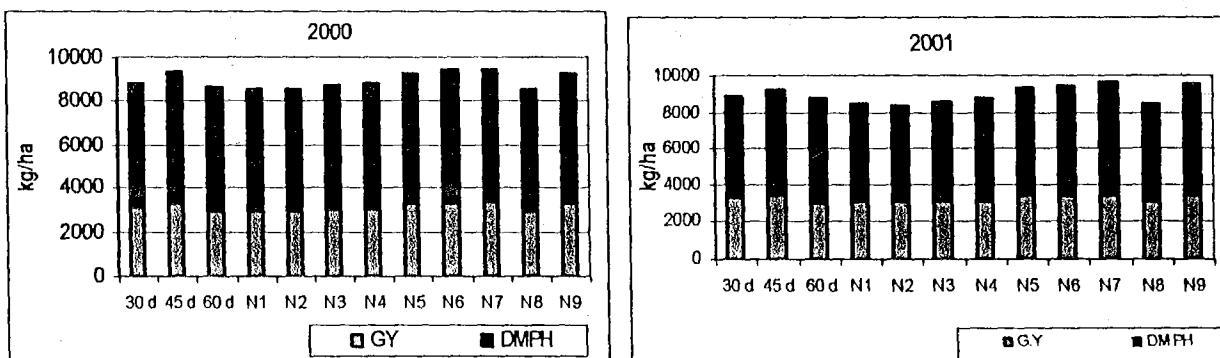


Fig 4.6 DMPH and grain yield (kg ha⁻¹) in rice

of 100% RDN through different organic sources. These results show the importance of realizing high yield by using a part of N requirement with farm available organic sources (Abrol and Katyal, 1990). All the organic sources brought similar improvement in yield.

Among N management practices, application of 75% RDFN + 25 kg FYM-N recorded significantly lower grain yield than that of application of 125% RDN through different sources. This may be due to slower decomposition of FYM than that of green manure, vermicompost, poultry manure owing to its wide C:N ratio (Singh, 1984). Further, the nutrients from FYM could not be available to the crop in the year of its application (Das, 1999). Generally 30 per cent of nitrogen, 60-70 per cent of phosphorus and 75 per cent of potassium become available to the first crop and rest available to subsequent crops. Hence, the grain yield with 75% RDFN + 25 kg N through FYM was lower than that of other treatments.

Application of 75% RDFN + 25 kg PM-N resulted comparable grain yield to that of application of 125% RDN through different sources (Table 4.6). Further, substitution of 25 kg N ha⁻¹ through poultry manure registered improved yield over FYM and green manuring in terms of growth, yield attributes, nutrient uptake of rice, but was on par to that of vermicompost (Rani and Srivastava, 2001). It has been reported that application of poultry manure was superior over FYM (Singh *et al.*, 1988, Singh *et al.*, 1996, Vanaja and Raju, 2002) and green manuring (Mahavishnan, 2001). The superiority of poultry manure over other organic sources due to faster N mineralization of poultry manure as compared to other organic sources due to its narrow C:N ratio (Singh *et al.*, 1988).

At active tillering, tillers m⁻², LAI, DMP were higher in inorganic N applied treatments as compared to integrated N supplied treatments, while panicle

initiation onwards both inorganic and integrated N supplied treatments recorded similar growth (Tables 4.1, 4.2 and 4.3). Vigorous growth of crop at initial stages with inorganic N compared to conjunctive use of organics indicates the importance of inorganic N through fertilizer, which makes the N in soil readily available in abundant quantities compared to slow mineralization of nitrogen from organic sources for early foliage development and cover. As crop growth advances, the N efficacy of organic and inorganic N enhances and thereby nutrient uptake increases as compared to sole fertilizer N application. This amply demonstrate that the slowly mineralisable nitrogen from integrated sources ensures adequate availability at greater level of absorption and translocation to the plant parts during growing period thereby increased quantities of N in rice grain. Similarly, the organic sources of N made P and K in available forms for longer period in soil which improved P and K uptake with integrated N supply. Organic acids produced during decomposition of organic manures solubilises insoluble P and increases P uptake (Ventural *et al.*, 1987). Organic manures on decomposition make K in available forms for longer period in soil (Bouldin, 1987).

Higher available nutrient status with integrated N management practices might be due to slow decomposition of organic components, the losses of N from these fractions may be minimized, in addition to synergistic effect on P and K transformation, the available nutrient status tend to improve slightly compared to the initial nutrient level. Judicious combination of organic and mineral sources has been known to mutually reinforce the efficiency of both these sources, resulting in higher productivity coupled with maintenance of soil fertility over long period in an eco-friendly manner (Mishra and Kapoor, 1992, Hegde and Dwivedi, 1993). The availability of major and micronutrients in the soil significantly increased with

combined application of organic and inorganic sources of nutrient supply (Bellaki *et al.*, 1998).

During both the years, interaction effect between age of seedlings and N management practices on grain yield was not significant as the crop response was more or less similarly to different sources of N regardless of the age of seedlings (Table 4.6).

5.4 RESIDUAL EFFECT

N management practices to rice had significant residual effect on yield and nutrient uptake of succeeding greengram in rice-greengram system (Table 4.14 and 4.15). Substitution of 50 kg N ha⁻¹ of 125% RDN through organic sources to rice showed residual effect on succeeding greengram as it recorded significantly higher seed and haulm yield over that of 100 and 125 per cent of recommended N supplied through fertilizer (Table 4.14). The nutrients applied through organic and inorganic forms to rice were not fully utilized and residual effect was carried over to the subsequent crops (Rao and Bhardwaj, 1980; Singh and Deka, 1984 and Thimmegowda and Devkumar, 1994). Further, application of organic manures decreases bulk density which helps in better root growth of test crops resulting in more absorption of nutrients and thereby higher yield of succeeding *rabi* crops (Boparai *et al.*, 1992; Badanur *et al.*, 1990 and Nanda and Roy, 1991). In the present study, higher nutrient status after rice was observed in the treatments where, 50 kg N ha⁻¹ was substituted through organic manures to rice. In these treatments, there was significantly higher nutrient uptake by greengram that succeeded rice as compared to application of 100% RDN through different sources and 125% RDFN. This ultimately resulted higher DMP, yield attributes and yield of greengram.

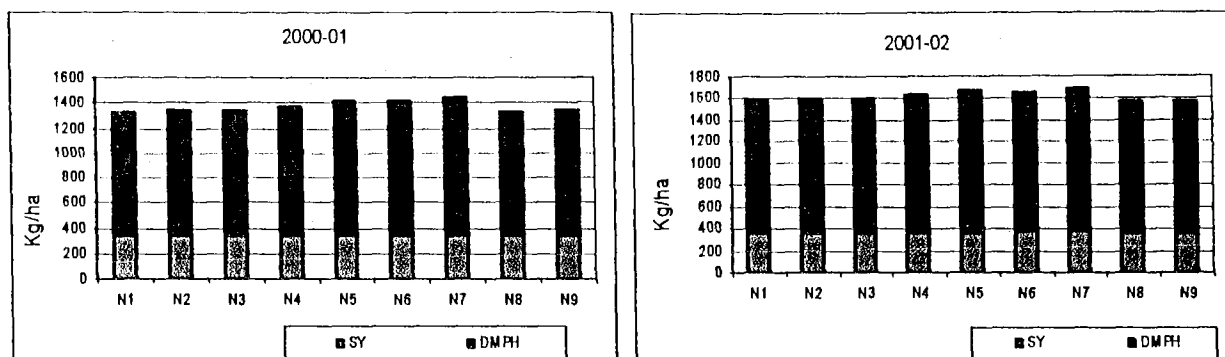


Fig 4.7 DMPH and seed yield (kg ha^{-1}) in greengram

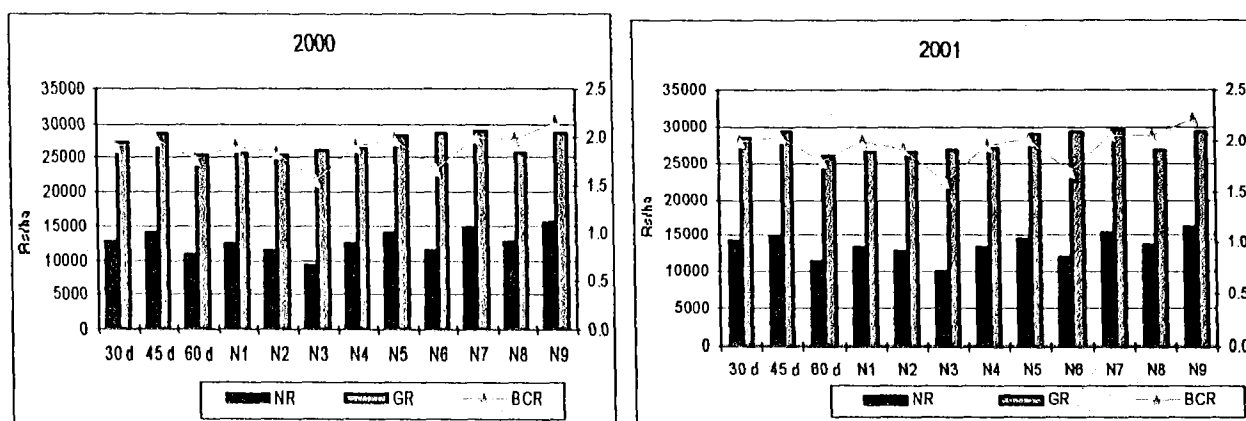


Fig 4.8 Net, gross returns and BCR of rice

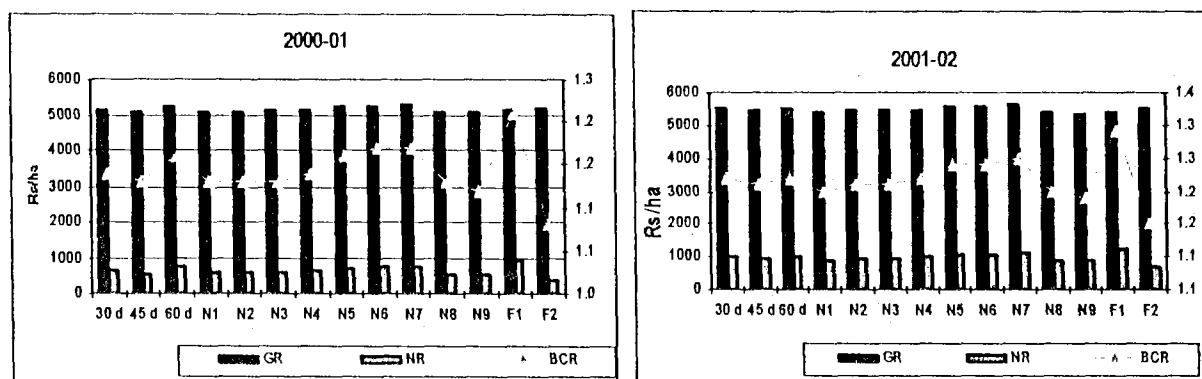


Fig 4.9 Net, gross returns and BCR of greengram

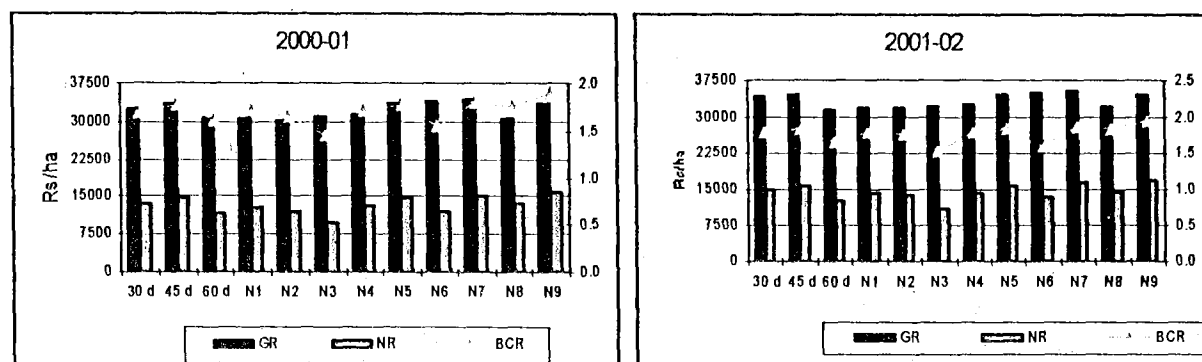


Fig 4.10 Net, gross returns and BCR rice-greengram system

Significant positive correlation between seed yield of greengram and yield attributes and nutrient uptake was observed indicating that increase in these parameters increased the seed yield (Table 4.19g).

There was no reduction in dry matter production at harvest, yield attributes and seed yield by reducing 50% RDF in greengram succeeding to rice which received nitrogen through integrated manner. These results indicates saving of 50% RDF to succeeding greengram and the fertilizer needs of *rabi* crops could be reduced by substituting at least 25% N needs of *kharif* crop through organic sources (Hegde, 1992).

5.5 ECONOMICS

Net returns and BCR of rice and rice-greengram system were maximum in the crop transplanted with 45 day old seedlings as compared to 30 and 60 day old seedlings (Table 4.16, 1.8 and Fig.4.8 & 4.10). Higher grain yield in the crop transplanted with 45 day old seedlings resulted in higher profit. On the other hand, net returns and BCR in greengram were higher in the crop that succeeded the crop transplanted with 60 day old seedlings, however it was not much varied from 30 and 45 day old seedlings (Table 4.17 and Fig.4.9).

The net returns and benefit cost ratio obtained with 125% RDFN was much higher compared to other N management practices. Since the cost of N through fertilizer was relatively cheaper than any other organic sources of N, the net returns and BCR realized with 125 and 100% RDFN were higher than integrated N management practices.

Substitution of 50 kg N ha⁻¹ of 125% RDN to rice by green manure, poultry manure or FYM or combination of these followed by application of 50% RDF to succeeding greengram resulted in higher net returns and BCR. This was due to higher seed yield of greengram in these treatments, which left considerable nutrient residues and reduced cost (50%) of fertilizer in greengram. Application of N through vermicompost to rice was un-economical due to its higher cost.

CONCLUSIONS

- In Telangana region of Andhra Pradesh, under late planted conditions, transplanting 45 day old seedlings results in higher grain yield of rice.
- Application of 75 kg N ha⁻¹ through fertilizer N + 50 kg N ha⁻¹ through green manure and poultry manure in 1:1 ratio gives higher yield in rice and leaves nutrient residues benefiting succeeding greengram crop.
- Substitution of 25 kg N ha⁻¹ through poultry manure of 100% RDN resulted comparable grain yield to that of application of 125% RDN through different sources indicates saving of 25 kg N ha⁻¹.
- Application of 75 kg N ha⁻¹ through fertilizer N + 50 kg N ha⁻¹ through organic sources to preceding rice and application of 50% of the recommended dose of fertilizer to greengram (10 kg N + 25 kg P₂O₅ ha⁻¹) recorded higher net returns and BCR in rice-greengram system.

FUTURE LINE OF WORK

A few areas of research worthy to investigate by future researchers are outlined hereunder.

- Under late planted conditions investigations have to be done on possibility of including a grain legume of profuse biomass production as a preceding crop to rice in the cropping system and the scope of turning down the crop residue after seed harvest.
- Precise apportioning of the contribution by different sources of N under integration is to be made by radio isotope techniques using labelled ^{15}N .
- Recycling of different crop residues and their possible inclusion in the INM package has to be researched.

Chapter - VI

Summary

CHAPTR – VI

SUMMARY

A field experiment was conducted during four consecutive seasons of 2000-01 and 2001-02 at College Farm, College of Agriculture, Rajendranagar, Hyderabad to study the effect of integrated nitrogen management and seedling ages in rice-greengram system. The study during kharif was laid out in split-plot design, replicated thrice with three seedling ages of rice (30, 45 and 60 day old seedlings) assigned to main plots and nine N management practices to rice (N_1 – 75% RDFN + Sunhemp GM @ equivalent to 25 kg N ha⁻¹; N_2 – 75% RDFN + FYM @ equivalent to 25 kg N ha⁻¹; N_3 – 75% RDFN + Vermicompost @ equivalent to 25 kg N ha⁻¹; N_4 – 75% RDFN + Poultry manure @ equivalent to 25 kg N ha⁻¹; N_5 – 75% RDFN + GM @ equivalent to 25 kg N ha⁻¹ + FYM @ equivalent to 25 kg N ha⁻¹; N_6 – 75% RDFN + GM @ equivalent to 25 kg N ha⁻¹ + vermicompost @ equivalent to 25 kg N ha⁻¹; N_7 – 75% RDFN + GM @ equivalent to 25 kg N ha⁻¹ + PM @ equivalent to 25 kg N ha⁻¹; N_8 – 100% RDFN and N_9 – 125% RDFN). The greengram was grown during *rabi* in the same undisturbed layout in split-split plot design by further subdividing each subplot into two to test the performance of greengram with two fertilizer levels (50% and 100% RDF of greengram). Residual effect of rice treatments were also studied on succeeding greengram. The results of the experiment are summarized hereunder.

- Age of seedlings significantly influenced the number of tillers, LAI, DMP, number of panicles, filled grains per panicle, grain and straw yield and NPK uptake in rice.

- The crop transplanted with 45day old seedlings in rice resulted in significantly higher dry matter production at harvest, filled spikelets, grain yield and NPK uptake at harvest as compared to that of 30 and 60 day old seedlings.
- The crop transplanted with 30 day old seedlings in rice resulted significantly higher growth, panicles m^{-2} and straw yield as compared to that of 45 and 60 day old seedlings.
- Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N (125% RDN) recorded significantly higher growth, yield attributes, grain and straw yield, NPK uptake, and available N, P_2O_5 and K_2O in the soil after rice over that of application of 100% RDFN and other 125% RDN treatments viz., 75% RDFN + 25 kg GM-N / FYM-N / VC-N. These parameters in the former treatment was comparable with that of application of 75% RDFN + 25 kg GM-N + 25 kg VC-N.
- Application of 75% RDFN + 25 kg PM-N (100% RDN) resulted comparable grain yield to that of application of 125% RDN through different source, thereby saving 25 kg N ha^{-1} .
- The interaction effects between age of seedlings and N management practices to rice was not significant on grain yield of rice.
- Application of 100% RDN or 125% RDN through different sources in the respective levels resulted in comparable growth, yield attributes, yield and nutrient uptake and the latter treatments were significantly superior over that of former treatments.

- Application of 75% RDFN + 25 kg GM-N + 25 kg PM-N to preceding rice resulted significantly higher dry matter production at harvest, number of pods per plant and seeds per pod, seed and haulm yield and NPK uptake at harvest in succeeding greengram as compared to that of 100 and 125% RDFN and was on a par with 75% RDFN + 25 kg GM-N + 25 kg VC-N / FYM-N.
- Application of 50 and 100% RDF to greengram resulted comparable dry matter production, yield attributes, seed yield and N, K₂O in the soil after greengram, indicating the residual effect of 'N' management practices of *kharif* rice.
- Transplanting of 45 day old seedlings, application of 125% RDFN to rice, application of 50% RDF to greengram and their combinations resulted in higher net returns and BCR.

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The pattern of 'Literature cited' presented above is in accordance with the 'Guidelines' for thesis presentation for Acharya N.G. Ranga Agricultural University, Hyderabad.

Appendices

(a) Weekly meteorological data recorded at ARI, Rajendranagar during 2000-01

Standard week	Period	Temp Max (°C)	Temp Min (°C)	Relative humidity (%)	Rain fall (mm)	No.of rainy days	Sunshine (hr/day)	Mean temp. (°C)	Evaporation (mm/day)
25	18-24 June,2000	30.2	23.8	74	23.8	2	1.3	27.0	2.9
26	25-1 July	29.9	23	74	66.1	4	1.5	26.4	3.3
27	2-8 July	29.7	25	80	25.2	2	3.6	27.4	3.1
28	9-15	27.9	23.1	80	29.1	2	2	25.5	3.6
29	16-22	29.6	23	71	1.9	0	5	26.3	4.7
30	23-29	31.7	23.3	64	0.6	0	8.2	27.5	5.1
31	30-5 Aug	33.6	24.1	64	2.7	1	8.3	28.9	5
32	6-12	28.4	22.7	82.5	95	4	2.3	25.5	3.2
33	13-19	30.2	23.3	74.5	49.7	3	6.6	26.8	3.8
34	20-26	28	23	84	164.9	4	2	25.5	3.4
35	27-2 Sept	27.8	22.7	80	19.9	3	2.3	25.3	2.8
36	3-9	30	22.8	70	1.2	0	7	26.4	3.8
37	10-16	31.7	22.2	69.5	48.6	4	7.7	27.0	4.2
38	17-23	30.9	22.6	75.5	35.6	2	6.5	26.7	4
39	24-30	31.8	22.4	73	10	1	7.7	27.1	3.9
40	1-7 Oct	33	21.8	60.5	0	0	8.6	27.4	4.4
41	8-14	32.5	21.4	73.5	8.4	1	6.7	27.0	2.9
42	15-21	31.6	21.1	67.5	12.8	2	6	26.3	3.4
43	22-28	33.4	17.6	57	0	0	9.4	25.5	4.7
44	29-04 Nov	31.4	17.5	62	0.8	0	8	24.5	3.4
45	5-11	31.3	16.2	60	0	0	9.4	23.7	4.1
46	12-18	30.4	13.7	58	0	0	10	22.0	3.8
47	19-25	31	14.4	57.5	0	0	9.1	22.7	3.5
48	26-02 Dec	30.2	16.3	64.5	0	0	7.2	23.2	3.5
49	3-9	29.6	9.2	51	0	0	8.7	19.4	4
50	10-16	30	8.1	47.5	0	0	9.5	19.0	3.7
51	17-23	29.5	8.2	49.5	0	0	9.3	18.8	3.9
52	24-31	29.4	9.8	56	0	0	9.2	19.6	3.6
1	1-7 Jan,2001	27.6	14.2	64	1	0	5.2	20.9	2.9
2	8-14	30.6	14.4	55.5	0	0	8.7	22.5	4.2
3	15-21	30.5	14.1	59.5	0	0	8.3	22.3	4.3
4	22-28	30.4	9.7	48	0	0	8.7	20.1	4.2
5	29-04 Feb	31.9	11.2	50	0	0	8.9	21.6	4.4
6	5-11	34.2	11.4	47.5	0	0	9.9	22.8	5.5
7	12-18	34.2	14.1	48.5	0	0	10.1	24.2	5.4
8	19-25	35.5	15.1	40	0	0	10	25.3	6.1
9	26-04 Mar	35.9	17.1	46	0	0	9.9	26.5	6.8
10	5-11	34.4	19.8	51.5	0	0	7.5	27.1	5.8
11	12-18	34.7	18.9	52.5	0	0	7.1	26.8	5.7
12	19-25 Mar	37.1	21.8	43.5	8.4	1	6.8	29.5	6.2

(b) Weekly meteorological data recorded at ARI, Rajendranagar during 2001-02

Standard week	Period	Temp Max (°C)	Temp Min (°C)	Relative humidity (%)	Rain fall (mm)	No. of rainy days	Sunshine (hr/day)	Mean temp. (°C)	Evaporation (mm/day)
25	18-24 June, 2000	33.4	23.4	61.5	8.2	1	8	28.5	7.2
26	25-1 July	34	24	60.5	0.8	0	6.3	29.0	7.4
27	2-8 July	33	23.8	60	3.7	1	5.1	28.4	6.4
28	9-15	32.3	23.1	63	6.2	1	4.1	27.7	6.6
29	16-22	30.8	22.5	66	11.2	2	2.9	26.7	5.1
30	23-29	32.8	23.3	70.5	10.9	1	5.1	28.1	5.1
31	30-5 Aug	30.6	22.5	80.5	72.2	3	3.9	26.6	4.1
32	6-12	28.5	22.3	82	93.2	2	2.3	25.4	3.6
33	13-19	29.3	22.3	77.5	21.4	2	3.4	25.8	3.7
34	20-26	29.7	22.6	72	1.4	0	3.3	26.1	3.9
35	27-2 Sept	31.4	22.8	66.5	0	0	8	27.1	5.3
36	3-9	31.3	22.5	71	17.4	2	4.9	26.9	4
37	10-16	33	22.6	73.5	10.5	2	5.7	27.8	4.3
38	17-23	31.4	22	78.5	23.4	4	4.8	26.7	3
39	24-30	31.5	21.6	80.5	96.4	5	5.1	26.5	2.5
40	1-7 Oct	28.3	21.8	84.5	139.6	4	2.6	25.0	2.2
41	8-14	29.8	22.2	75	27.4	2	4.7	26.0	2.1
42	15-21	30.4	21	76	31.1	2	5.6	25.7	3.1
43	22-28	31.2	15.7	67	0	0	9.4	23.5	3.7
44	29-04 Nov	31.8	16.6	60	0	0	8.6	24.2	3.9
45	5-11	31.1	19.4	65	0	0	7.8	25.3	4.2
46	12-18	30.6	19.9	61	0	0	8.6	25.3	4.4
47	19-25	30.2	15.4	62	0	0	8.8	22.8	3.5
48	26-02 Dec	29.1	14.1	63	0	0	7.9	21.6	3.4
49	3-9	29.8	9.6	51	0	0	10.1	19.7	3.5
50	10-16	30.4	10.3	57.5	0	0	9.7	20.4	3.4
51	17-23	28.3	11.7	55.5	0	0	8.2	20.0	2.4
52	24-31	28.4	13.4	64	0	0	8.3	20.9	1.8
1	1-7 Jan, 2001	26.6	11.8	62.5	0.2	0	8.5	19.2	3.1
2	8-14	27.6	11.6	55	3	1	7.3	19.6	3.1
3	15-21	31	13.3	58	0	0	9.7	22.2	3.7
4	22-28	32.5	15.5	53	0	0	9.2	24.0	4.8
5	29-04 Feb	29.5	16.3	59	0	0	8.1	22.9	4
6	5-11	30	17.2	60.5	3.7	1	8.5	23.6	4.9
7	12-18	32.5	16.2	54	0	0	9.9	24.3	5.2
8	19-25	34.1	14.9	44	0	0	10.4	24.5	6.3
9	26-04 Mar	35.7	16.1	43	0	0	10	25.9	6.6
10	5-11	35.7	19.6	59.5	25.7	1	8.2	27.7	5.8
11	12-18	35.4	18.7	44.5	0	0	9	27.0	6.2

(c) Weekly normal mean meteorological data of ARI, Rajendranagar (1988-99)

Standard week	Period	Temp Max (°C)	Temp Min (°C)	Relative humidity (%)	Rain fall (mm)	No.of rainy days	Sunshine (hr/day)	Mean temp. (°C)	Evaporation (mm/day)
25	18-24 June,2000	32.5	23.5	66	31.3	2	5.4	28.0	5.9
26	25-1 July	32.9	23.6	66	22.7	2	6.5	28.3	5.6
27	2-8 July	31.8	23.1	66	53.0	2	4.9	27.4	4.7
28	9-15	31.2	23.2	68	48.7	3	4.8	27.2	4.2
29	16-22	30.6	22.7	69	56.6	3	4.8	26.7	4.4
30	23-29	30.1	22.6	71	63.8	3	4.2	26.3	4.3
31	30-5 Aug	29.9	22.8	71	32.8	2	4.3	26.3	3.9
32	6-12	30.2	22.8	71	46.1	3	4.7	26.5	4.0
33	13-19	29.7	22.4	74	46.1	3	4.6	26.0	3.9
34	20-26	30.0	22.5	73	39.2	2	4.9	26.2	3.9
35	27-2 Sept	29.4	22.3	73	51.4	3	4.6	25.8	3.4
36	3-9	30.2	22.3	71	31.6	2	5.1	26.3	3.8
37	10-16	30.8	22.3	70	47.0	2	6.4	26.5	3.7
38	17-23	30.6	22.2	69	60.0	2	6.3	26.4	3.8
39	24-30	31.3	22.0	68	18.0	2	6.9	26.7	3.9
40	1-7 Oct	30.7	21.5	69	47.7	2	6.8	26.7	3.8
41	8-14	30.8	20.6	68	34.8	2	7.2	25.7	3.9
42	15-21	30.5	19.4	67	32.7	1	7.6	24.9	3.8
43	22-28	30.6	19.0	65	12.7	1	7.9	24.8	3.6
44	29-04 Nov	29.5	18.3	64	9.9	1	7.8	23.9	3.5
45	5-11	30.0	17.4	63	6.4	0	8.3	23.7	3.5
46	12-18	29.3	16.5	62	16.0	1	8.1	22.9	3.3
47	19-25	29.2	15.8	62	15.9	0	8.1	22.5	3.2
48	26-02 Dec	29.1	13.4	60	0.1	0	9.4	21.3	3.3
49	3-9	28.3	13.1	59	6.0	0	8.7	20.7	3.1
50	10-16	27.1	11.9	59	1.7	0	8.2	19.5	2.8
51	17-23	27.8	11.8	59	0.4	0	8.8	19.8	2.9
52	24-31	28.1	12.3	60	0.3	0	8.9	20.2	3.0
1	1-7 Jan,2001	27.9	12.4	59	1.2	0	9.2	20.1	3.2
2	8-14	28.6	13.4	59	0.2	0	8.9	21.0	3.2
3	15-21	29.4	14.0	57	5.9	0	9.1	21.7	3.3
4	22-28	30.3	13.5	56	0.0	0	9.8	21.9	3.6
5	29-04 Feb	30.9	13.7	54	0.8	0	10.1	22.3	4.1
6	5-11	31.5	15.2	53	0.0	0	10.0	23.3	4.1
7	12-18	32.4	15.7	51	2.7	0	10.3	24.1	4.4
8	19-25	33.1	15.8	49	0.3	0	10.5	24.5	4.9
9	26-04 Mar	34.1	17.0	48	2.5	0	10.4	25.6	5.2
10	5-11	35.1	18.7	47	2.5	0	11.4	26.9	5.3
11	12-18	36.0	19.6	45	1.2	0	10.3	27.8	5.7

APPENDIX-II

(a) CALENDAR OF OPERATIONS FOR RICE

Operation	2000	2001
Soaking of paddy seed for 1 st nursery	21-06-2000	20-06-2001
Sowing of 1 st nursery	24-06-2000	23-06-2001
Main field ploughing	27-06-2000	21-06-2001
Working with cultivator in main field	03-07-2000	22-06-2001
Working with disc harrow and levelling	05-07-2000	23-06-2001
Layout of main field for raising green manure	06-07-2000	24-06-2001
Sowing of green manure crop	06-07-2000	05-07-2001
Sowing of paddy seed for 2 nd nursery	06-07-2000	24-06-2001
First irrigation to green manure crop	07-07-2000	25-06-2001
Sowing of 2 nd nursery	09-07-2000	8-07-2001
Sowing of paddy seed for 3 rd nursery	21-07-2000	20-07-2001
Sowing of 3 rd nursery	24-07-2000	23-07-2001
2 nd irrigation to green manure crop	29-07-2000	25-07-2001
3 rd irrigation to green manure crop	08-08-2000	07-08-2001
1 st puddling of main field	10-08-2000	08-08-2001
2 nd puddling of main field	11-08-2000	10-08-2001
Final puddling and levelling	14-08-2000	12-08-2001
Layout and bunding of main field	15-08-2000	13-08-2001
Application of organic manures	15-08-2000	14-08-2001
Transplanting of main field	20-08-2000	20-08-2001
Pre-emergence herbicide application	25-08-2000	25-08-2001
ZnSO ₄ spraying	05-09-2000	--
Strengthening of bunds	06-09-2000	07-09-2001

Operation	2000	2001
1 st hand weeding	09-09-2000	08-09-2001
1 st top dressing of N to 60 day old seedlings	09-09-2000	09-09-2001
1 st top dressing of N to 30 day old seedlings	14-09-2000	13-09-2001
Spraying of monocrotophos 36 WSC	17-09-2000	20-09-2001
2 nd hand weeding	29-09-2000	28-09-2001
2 nd hand weeding	30-09-2000	--
2 nd top dressing of n to 60 day old seedlings	01-10-2000	01-10-2001
2 nd top dressing of N to 45 day old seedlings	03-10-2000	03-10-2001
2 nd top dressing of N to 30 day old seedlings	05-10-2000	04-10-2001
Spraying of mancozeb and monocrotophos	10-10-2000	15-10-2001
Spraying of mancozeb	18-10-2000	--
Harvesting of 60 day old seedling	06-12-2000	04-12-2001
Harvesting of 45 day old seedling	10-12-2000	07-12-2001
Harvesting of 30 day old seedling	15-12-2000	12-12-2001
Winnowing and drying of produce	16-12-2000	14-12-2001
Drying, weighing and bagging of produce	20-12-2000	19-12-2001

(b) CALENDAR OF OPERATIONS FOR GREENGRAM

Operation	2000	2001
Preparatory cultivation	23-12-2000	21-12-2001
Working with cultivar	26-12-2000	25-12-2001
Working with power tiller and levelling	30-12-2000	28-12-2001
Layout, bunding and micro-levelling	02-12-2000	30-12-2001
Sowing	08-01-2001	04-01-2002
1 st irrigation	09-01-2001	05-01-2002
Gap filling and thinning	15-01-2001 to 18-01-2001	12-01-2002 to 13-01-2002
2 nd irrigation	18-01-2001	15-01-2002
1 st hand weeding	27-01-2001 to 28-01-2001	23-01-2002 to 24-01-2002
3 rd irrigation	30-01-2001	28-01-2002
4 th irrigation	10-02-2001	07-02-2002
2 nd hand weeding	14-02-2001	10-02-2002
5 th irrigation	21-02-2001	19-02-2002
6 th irrigation	02-03-2001	01-08-2002
7 th irrigation	10-03-2001	--
Harvesting and threshing	19-03-2001	18-03-2002
Drying, winnowing and bagging	24-03-2001	24-03-2002

APPENDIX-III

(a) COST OF CULTIVATION (Rs ha⁻¹) IN RICE

Treatment	Cost of cultivation excluding fertilizer and organic manure	Cost of organic manure	Cost of fertilizer N	Cost of P & K	Total
75% RDFN + 25 kg GM-N	10500	625	780	1490	13395
75% RDFN + 25 kg FYM-N	10500	1000	780	1490	13770
75% RDFN + 25 kg VC-N	10500	4000	780	1490	16770
75% RDFN + 25 kg PM-N	10500	1125	780	1490	13895
75% RDFN + 25 kg GM-N + 25 kg FYM-N	10500	1625	780	1490	14395
75% RDFN + 25 kg GM-N + 25 kg VC-N	10500	4625	780	1490	17395
75% RDFN + 25 kg GM-N + 25 kg PM-N	10500	1750	780	1490	14520
100% RDFN (100 kg N ha ⁻¹)	10500	--	1040	1490	13030
125% RDFN (125 kg N ha ⁻¹)	10500	--	1300	1490	13290

Urea	: Rs.4.80 / kg	Green manure	: 0.10 / kg
SSP	: Rs.3.20 / kg	FYM	: 0.25 / kg
MOP	: Rs.4.30 / kg	Vermicompost	: 2.00 / kg
		Poultry manure	: 0.75 / kg

Cost of cultivation excluding manures and fertilizers in rice per hectare

Seeds	: Rs. 600/-
Nursery	: Rs. 350/-
Fertilization to nursery	: Rs. 100/-
Main field preparation	: Rs. 1200/-
Transplanting	: Rs. 1750/-
Weeding	: Rs. 1000/-
Plant protection	: Rs. 750/-
Irrigations	: Rs. 1000/-
Harvesting and threshing	: Rs. 1500/-
Drying and winnowing	: Rs. 750/-
Total	: Rs.10500/-

(b) COST OF CULTIVATION IN GREENGRAM (Rs ha⁻¹)

Item	50% RDF	100% RDF
Land preparation	500	500
Seeds and sowing	1150	1150
Fertilizers	605	1210
Weeding	550	550
Harvesting and drying	850	850
Irrigations	300	300
Total :	4205	4810

Appendix - IV

a) Influence of age of seedlings and N management practices on N content (%) in rice

Treatment	Active tillering		Panicle initiation		Flowering		Grain		Straw	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Age of seedlings (days)										
A ₁	2.45	2.41	1.04	1.02	0.82	0.99	1.04	1.12	0.53	0.54
A ₂	2.43	2.35	1.02	0.99	0.82	0.95	1.10	1.17	0.48	0.51
A ₃	2.35	2.33	1.00	0.93	0.78	0.92	1.15	1.17	0.48	0.53
N Management practices										
N ₁	2.33	2.31	0.99	0.97	0.78	0.96	1.10	1.15	0.48	0.51
N ₂	2.33	2.28	0.98	0.97	0.78	0.95	1.10	1.14	0.48	0.50
N ₃	2.36	2.31	1.00	0.95	0.78	0.95	1.10	1.15	0.49	0.50
N ₄	2.41	2.35	1.01	0.96	0.79	0.95	1.10	1.15	0.49	0.51
N ₅	2.43	2.39	1.03	1.00	0.81	0.95	1.10	1.16	0.51	0.52
N ₆	2.45	2.41	1.04	1.00	0.83	0.96	1.10	1.17	0.52	0.53
N ₇	2.50	2.43	1.05	1.00	0.83	0.96	1.11	1.17	0.52	0.53
N ₈	2.40	2.37	1.03	0.98	0.80	0.95	1.09	1.14	0.49	0.51
N ₉	2.48	2.44	1.05	0.98	0.85	0.96	1.09	1.15	0.52	0.54

N managementN₁ = 75% RDFN + 25 Kg N ha⁻¹ Green manureN₂ = 75% RDFN + 25 Kg N ha⁻¹ FYMN₃ = 75% RDFN + 25 Kg N ha⁻¹ VermicompostN₄ = 75% RDFN + 25 Kg N ha⁻¹ Poultry manureN₅ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYMN₆ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ VermicompostN₇ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manureN₈ = 100% RDFNN₉ = 125% RDFNAge of seedlings (days)A₁ = 30A₂ = 45A₃ = 60

b) Influence of age of seedlings and N management practices on P content (%) in Rice

Treatment	Active tillering		Panicle initiation		Flowering		Grain		Straw	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Age of seedlings (days)										
A ₁	0.44	0.46	0.31	0.29	0.27	0.26	0.40	0.39	0.19	0.20
A ₂	0.40	0.45	0.29	0.27	0.27	0.25	0.46	0.49	0.16	0.18
A ₃	0.39	0.41	0.30	0.26	0.25	0.24	0.45	0.48	0.15	0.14
N Management practices										
N ₁	0.41	0.43	0.29	0.27	0.25	0.24	0.43	0.43	0.16	0.17
N ₂	0.40	0.42	0.29	0.27	0.26	0.25	0.43	0.43	0.17	0.18
N ₃	0.40	0.43	0.30	0.28	0.26	0.25	0.44	0.44	0.16	0.17
N ₄	0.41	0.44	0.30	0.28	0.27	0.25	0.44	0.44	0.17	0.18
N ₅	0.42	0.46	0.31	0.29	0.27	0.26	0.45	0.47	0.17	0.18
N ₆	0.42	0.46	0.31	0.29	0.27	0.26	0.45	0.48	0.18	0.18
N ₇	0.42	0.47	0.31	0.29	0.28	0.27	0.45	0.49	0.18	0.19
N ₈	0.40	0.42	0.30	0.26	0.25	0.25	0.42	0.43	0.15	0.16
N ₉	0.40	0.42	0.30	0.26	0.26	0.25	0.43	0.47	0.15	0.17

N management

N₁ = 75% RDFN + 25 Kg N ha⁻¹ Green manure

N₂ = 75% RDFN + 25 Kg N ha⁻¹ FYM

N₃ = 75% RDFN + 25 Kg N ha⁻¹ Vermicompost

N₄ = 75% RDFN + 25 Kg N ha⁻¹ Poultry manure

N₅ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N₆ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N₇ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N₈ = 100% RDFN

N₉ = 125 % RDFN

Age of seedlings (days)

A₁ = 30

A₂ = 45

A₃ = 60

c) Influence of age of seedlings and N management practices on K content (%) in rice

Treatment	Active tillering		Panicle initiation		Flowering		Grain		Straw	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Age of seedlings (days)										
A ₁	3.72	3.64	2.33	2.28	2.10	2.08	0.48	0.40	2.12	2.11
A ₂	3.64	3.60	2.27	2.25	2.07	2.05	0.43	0.45	2.08	2.06
A ₃	3.55	3.58	2.20	2.22	2.04	2.06	0.43	0.41	2.04	2.04
N Management practices										
N ₁	3.62	3.60	2.25	2.23	2.05	2.05	0.43	0.41	2.08	2.07
N ₂	3.62	3.59	2.26	2.24	2.07	2.06	0.43	0.40	2.07	2.06
N ₃	3.62	3.60	2.26	2.24	2.07	2.06	0.43	0.41	2.07	2.07
N ₄	3.64	3.61	2.27	2.25	2.08	2.07	0.44	0.41	2.07	2.07
N ₅	3.65	3.62	2.29	2.26	2.09	2.08	0.47	0.43	2.09	2.08
N ₆	3.64	3.62	2.29	2.26	2.09	2.08	0.47	0.44	2.10	2.08
N ₇	3.66	3.63	2.30	2.27	2.10	2.09	0.47	0.44	2.10	2.08
N ₈	3.62	3.58	2.25	2.23	2.05	2.03	0.42	0.40	2.06	2.06
N ₉	3.63	3.59	2.26	2.24	2.06	2.04	0.45	0.43	2.06	2.06

N management

N₁ = 75% RDFN + 25 Kg N ha⁻¹ Green manure

N₂ = 75% RDFN + 25 Kg N ha⁻¹ FYM

N₃ = 75% RDFN + 25 Kg N ha⁻¹ Vermicompost

N₄ = 75% RDFN + 25 Kg N ha⁻¹ Poultry manure

N₅ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ FYM

N₆ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Vermicompost

N₇ = 75% RDFN + 25 Kg N ha⁻¹ Green manure + 25 Kg N ha⁻¹ Poultry manure

N₈ = 100% RDFN

N₉ = 125% RDFN

Age of seedlings (days)

A₁ = 30

A₂ = 45

A₃ = 60

(d) Nutrient content (%) in greengram at harvest

Treatment	Nitrogen		Phosphorous		Potassium	
	2000	2001	2000	2001	2000	2001
Seedling ages						
30 days	1.91	2.08	0.23	0.26	1.51	1.47
45 days	1.91	2.08	0.25	0.24	1.50	1.45
60 days	1.94	2.10	0.24	0.25	1.51	1.47
N Management practices						
N1	1.89	2.07	0.21	0.25	1.49	1.46
N2	1.94	2.09	0.23	0.26	1.47	1.44
N3	1.93	2.08	0.24	0.25	1.49	1.46
N4	1.97	2.10	0.26	0.27	1.52	1.47
N5	2.04	2.10	0.28	0.28	1.55	1.48
N6	2.05	2.11	0.30	0.28	1.56	1.50
N7	2.05	2.12	0.30	0.29	1.58	1.50
N8	1.80	2.06	0.18	0.24	1.44	1.44
N9	1.81	2.05	0.19	0.24	1.45	1.43
Fertilization to Greengram						
F1	1.78	2.01	0.23	0.23	1.41	1.40
F2	2.06	2.16	0.28	0.29	1.60	1.53

APPENDIX-V

NUTRIENT CONTENT (%) IN DIFFERENT ORGANIC SOURCES

Organic source	N	P	K
Green manure (Sunhemp)	2.1	0.51	1.78
FYM	0.9	0.36	0.45
Vermicompost	1.4	2.09	0.60
Poultry manure	2.7	0.71	0.40

APAU CENTRAL

Acc: No: D7211

Date: 29.10.2004