STUDY OF DIFFERENT RETRANSPLANTING DATES ON YIELD AND NUTRIENT CONTENT OF LATE AMAN RICE (BR 22)

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CERTIFICATE

This is to certify that the thesis entitled **"STUDY OF DIFFERENT RETRANSPLANTING DATES ON YIELD AND NUTRIENT CONTENT OF LATE AMAN RICE (BR 22)"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE IN AGRICULTURAL CHEMISTRY*** embodies the result of a piece of *bonafide* research work carried out by **Moudud Ahmed**, Registration No. **01055/2000-2001** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma in any other institutes.

I further certify that such help or sources of information, as have been availed during the course of this investigation have duly been acknowledged.

Dated:
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Dedicated to

My Beloved Parents

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STUDY OF DIFFERENT RETRANSPLANTING DATES ON YIELD AND NUTRIENT CONTENT OF LATE AMAN RICE (BR 22)

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ABSTRACT

An experiment was carried out at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during August'08 to January'09 to evaluate the effect of retransplanting dates (16 September, 26 September, 6 October and 16 October) on yield of T. Aman Rice cv. BR 22 (kiron). The retransplanting dates were assigned in the plots in a Randomized Complete Block Design (RCBD) with 4 replications. The effect of transplanting and retransplanting dates were significant in respect to yield attributing characters like plant height, effective tillers/hill, ineffective tillers/hill, grains/panicle, sterile grains/panicle and thousand seed weight and also the nutrient uptake of rice plant. The first Transplanting on 16th September have significantly highest grain yield (4.725 t/ha) whereas the lowest yield (3.375t/ha) was found in the last retransplanting on 16 October.

LIST OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

%	=	Percent
@	=	At the rate
°C	=	Degree Centigrade
AEZ	=	Agro Ecological Zone
Anon.	=	Anonymous
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cv.	=	Cultivar (s)
DAI	=	Days After Inoculation
DMRT	=	Duncan's Multiple Range Test
e.g.	=	For example
et al.	=	And Others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram
hr	=	Hour (s)
i.e.	=	That is
IRRI	=	International Rice Research Institute
ISTA	=	International Seed Testing Agency
kg	=	Kilogram
LSD	=	Least Significant Difference
no.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
T	=	Treatment
t/ha	=	Ton per Hectare
T. Aman	=	Transplanting Aman
UNDP	=	United Nation Development Program
$^{w}/_{v}$	=	Weight per Volume
$^{w}/_{w}$	=	Weight per Weight
wt.	=	Weight
BCR	=	Benefit cost ratio
BE (%)	=	Biological efficiency (%)
MCC	=	Mushroom Culture Centre
FAO	=	Food and Agricultural Organization
Conc.	=	Concentration
g	=	Gram
RCBD	=	Randomized Complete Block Design
DAT	=	Days After Transplanting

CHAPTER 1
INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal crop in Bangladesh and it is also our staple food. Approximately 75% of the total cultivated land covering about 11.58 million hectares (ha) produces approximate 30 million tons of rice annually BBS (2008). The largest part of the total production of rice comes from Aman rice. Bangladesh earns about 31.6% of her gross domestic product (GDP) from agriculture (BBS, 2008) in which rice is the main crop. Agriculture in Bangladesh is characterized by intensive crop production with rice based cropping systems. Rice is also the principal commodity of trade in our internal agricultural business. The average yield of rice in our country is around 2.45 t/ha which is less than the world average (3.1 t/ha) and frustratingly below the highest yield recorded (9.65 t/ha) in Australia (FAO, 2008).

Horizontal expansion of rice area in Bangladesh is not possible due to limited land resources, as land availability for crop production has been declining day by day because of population pressure. So, the only avenue left is to increase the production of rice through increasing crop intensity. Although the soil and climate of Bangladesh are favorable for rice cultivation through out the year but per hectare yield of this crop is much below the potential yield level. The reasons are manifolds, some are varietals, some are technological and some are ecological. Modern high yielding varieties require higher price of seeds, fertilizers, irrigation and pesticides. Our farmers are poor, so they can not always afford their costs. Hence, special attention should be given for increasing the yield per unit area by applying improved management practices. On the contrary every year thousands of hectares of lands are bared and remain uncultivated due to different reasons, we can increase our rice production by utilizing these lands. But flash flood in Aman season is one of the main reason for remain uncultivation. These lands become water free in the late season of the Aman. In this aspect late variety of Aman rice and re-transplanting of rice seedling can help the farmers of Bangladesh.

In Bangladesh when the photosensitive Aman rice varieties were transplanted in the late season during September-October their sensitivity to flowering in the months of October-December mostly depends on the planting dates. The phenological events of photosensitive varieties depend on the particular air temperature. BRRI (1989) and Yoshida (1981) reported that rice plants require a particular temperature for its phenological affairs such as panicle initiation, flowering, panicle exertion from flag leaf sheath and maturity and these are much influenced by the planting dates during transplanting (T) Aman season. Deviation from the optimum planting time may cause incomplete and irregular panicle exertion, increased spikelet sterility (Mangor, 1984). The optimum planting time of T. Aman rice is in August. But sometimes transplanting is delayed due to various causes such as rainfall, flood and socioeconomic factors. This late planting exposes the reproductive phases as well as phonological events of crop in an unfavorable temperature regime thereby causing high spikelet sterility and poor growth of the plant (BRRI, 1989). Halappa *et al.* (1974) reported that the performance of rice is greatly influenced by the date of transplanting due to the effect of cold hazard and incidence of biotic stress. Faria and Folegatt (2001) reported that grain yield was high for sowing in October (5.4 to 6.0 t/ha) and lower for sowing in December (1.6 to 4.8 t/ha) due to the low temperature at seed filling stages, mostly for the late cultivar. However, information regarding the effect of late planting in Aman rice is not adequate and re-transplanting is a newer idea in which rice seedling is uprooted from the seed bed and transplanted in another flood free land with 3-4 cm soil and under the soil layer a polyethylene sheet is provided for aerostation of root growth towards lower soil. No works have yet been done with this idea and this idea if successfully implemented can generate a huge opportunity in the flood prune area of Bangladesh reducing the seedling need of farmers of flooded area.

Keeping these views in mind, the present study was designed and conducted with the following objectives:

1. To determine a suitable date of late transplanting and re-transplanting for highest yield of Aman rice, and
2. To analyze the nutrient content of the rice straw as affected by the different late re-transplanting date.

CHAPTER 2

REVIEW OF LITERATURE

Growth and development of rice plants are greatly influenced by the environmental factors *i.e.* air, day length or photoperiod, temperature etc., variety used and agronomic practices like transplanting time, spacing, number of seedlings, depth of planting, fertilizer management etc. Among the factors, which are responsible for the yield of rice, late transplanting of Aman rice is one of them. Many research works on different aspects of rice cultivation have been done within and out side the country for the improvement of rice yield. Research works related to late transplanting on the growth, yield and yield components of Aman rice have been reviewed in this chapter.

Halappa *et al.* (1974) reported that the performance of rice is greatly influenced by the date of transplanting due to the effect of cold hazard and incidence of biotic stress.

Mangor (1984) reported that deviation from the optimum planting time may cause incomplete and irregular panicle exertion, increased spikelet sterility.

Haque (1988) says that spikelet sterility induced by low temperature at the reproductive stage of rice increased further with the increase of nitrogen supply. Spikelet sterility in Fujisaka-5 did not increase due to low temperature when nitrogen supply was increased from 10 to 40 ppm and at 80 ppm nitrogen supply it was less affected than IR36. Total nitrogen content in the leaves increased with the increase of nitrogen supply and was forced to be associated with the spikelet sterility induced by low temperature. Based on auricle distance between the last two leaves, the most sensitive stage to low temperature damage differed in Fujisaka-5 and IR36. Spikelet sterility induced by low temperature for 10 days was very high in both the varieties and the effect of nitrogen was not clear. The effect of phosphorus on the spikelet sterility induced by low temperature at reproductive stage was not clear except that at the highest phosphorus (p) level (10ppm) the spikelet sterility increased both in fujisaka-5 and IR36. Spikelet sterility induced by low temperature at the reproductive stage of rice decreased with the increase of Potassium (K) supply in both Fujisaka-5 and IR36. With an increase of potassium supply, nitrogen (N) content decreased in the leaves and panicles and spikelet sterility induced by low temperature decreased with an increase of the K to N ratio in the leaves and panicles. The results suggest that potassium might play a major role to counteract the low temperature damage at the reproductive stage of rice.

BRRI (1989) and **Yoshida (1981)** reported that rice plants require a particular temperature for its phenological affairs such as panicle initiation, flowering, panicle exertion from flag leaf sheath and maturity and these are much influenced by the planting dates during T. Aman season.

BRRI (1989) further reported that the optimum planting time of T. Aman rice is in August. But sometimes transplanting is delayed due to various physical and socioeconomic factors. This late planting exposes the reproductive phases as well as phonological events of crop in an unfavorable temperature regime thereby causing high spikelet sterility and poor growth of the plant.

Islam (1989) concluded that time between 15th July and 20th August is the optimum for transplanting of Aman rice especially in case of photosensitive rice varieties.

Chowdhury *et al.* (1993) reported that grain and straw yields gradually decreased after 10th August plantation.

Mia (1993) reported that plant height differed significantly among BR3, BR11, BR22, Nizershail, Pajam, and Badshabhog varieties in Aman season (Jul-Dec). Tiller number varied widely among the varieties and the number of tillers/plant at the maximum tiller number stage ranged between 14.3 and 39.5 in 1991 and 12.2 and 34.6 in 1992.

Brohi *et al.* (1998) carried out on split plot design experiment with four replications under greenhouse conditions. The pots containing 5 kg of soil which is collected from the 0-20 cm depth of artificial silation area made with silty water of Kelkit River were used for this study. Nitrogen at the rates of 0, 60, 120, 180 and 240 kg/ha as urea and phosphorus at the rates of 0, 50, 100 and 150 kg P_2O_5/ha as triple super phosphate was applied to the soil before sowing. Additionally potassium was applied at 40 kg K_2O/ha level as K_2SO_4 per pot for normal plant growth. Straw dry matter and grain yields were recorded and macro-nutrient (N, P & K) and micro-nutrient (Fe, Cu, Zn & Mn) content of straw and grain were analyzed. Macro-nutrient (N, P & K) and micro-nutrient (Fe, Cu, Zn & Mn) contents of straw and grain were significantly affected by N-fertilization, whereas only NPK content of straw and grain and only Mn content of grain were affected.

Biswas *et al.* (2001) in their experiments in Bangkok clay soil tried to investigate the influence of planting date, tiller separation and plant density on the yield and yield attributes of parent and clone plants of two transplanted rice varieties. The 15th July transplanting of mother crop and collected vegetative tillers and retransplanting on 15th August showed significantly high grain yield (3·8 t/ha). The photoperiod-insensitive variety RD23 gave higher yield (3·8 t/ha) than the photoperiod-sensitive variety KDML105 (3·0 t/ha). Tiller separation upto 4 tillers/hill did not adversely affect the mother crop. Vegetative tillers transplanted with 2–4 tillers/hill gave a similar yield as the mother crop in both the seasons. Vegetative tillers gave a higher yield than nursery seedlings transplanted on the same date. The yield components, *i.e.* weight of 1000 grains, grains/panicle and percent filled grains, showed better responses with early transplanting of KDML105 in the mother crop and vegetative tillers except for panicle number and panicle length of vegetative tillers with RD23. The results suggest that in some flood-prone lowlands, where the transplanted crop is damaged by natural hazards, vegetative propagation using tillers separated (maximum 4/hill) from the previously established transplanted crop is beneficial for higher productivity.

Faria and Folegatt (2001) reported that grain yield was high for sowing in October (5.4 to 6.0 t/ha) and lower for sowing in December (1.6 to 4.8 t/ha) due to the low temperature at seed filling stages, mostly for the late cultivar.

Pal *et al.* (2002) conducted an experiment to find out the effect of method of planting (row and haphazard) and five hill arrangements [1 (25x12 cm^2), 2 (25x6 cm^2), 3 (25x4 cm^2), 4 (25x3 cm^2) and 5 (25x2.4 cm^2)] on the yield of late transplanted Aman rice (cv. BR23) grown under different planting dates (1^{st} , 15^{th} and 30^{th} Sept.). Yield components namely number of effective tillers m^{-2}, number of grains $panicle^{-1}$ and that of total spikelets $panicle^{-1}$, weight of 1000 grains were notably decreased with the delay in transplanting which in turn resulted in the decreased grain yield. The grain yield gradually decreased from 1^{st} September transplanting onwards and became the lowest when the crop was transplanted on 30^{th} September.

Ahmed *et al.* (2005) conducted a field experiment that was carried out during Aman season, 2003 at the experimental field of Agrotechnology Discipline, Khulna University, Khulna to study the effect of nitrogen on different characteristics of transplanted local Aman rice variety, Jatai .The levels of nitrogen used in this study were 0, 20, 40, 60 and 80 kg/ha. Results of this study reveled that different agronomic characteristics varied significantly among the treatments. Higher N dose produced higher plant height. The highest effective tiller/hill, panicle length, filled grains/panicle, 1000-grain weight and grain yield was obtained with 40 kg N/ha. The highest and lowest biological yield was produced with 40 kg N/ha and 0-kg N/ha respectively.

Rahman *et al.* (2007a) conducted an experiment at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during T. Aman season 2002, to investigate the effect of number of seedling/hill and nitrogen level on growth and yield component of BRRI dhan32.The treatments were the variation numbers of seedling/hill viz. 1, 2, 3 and 4 seedling/hill and four levels of nitrogen viz 0, 60, 80 and 100 kg N/ha. Number of seedlings/hill significantly influenced growth and yield components except 1000-grain weight. It was found that the highest number of grains/panicle (100.92) and grain yield (5.37 t/ha) were resulted from transplanting of 3 seedlings/hill and the lowest grain yield (4.38 t/ha) was obtain from the transplanting of 1 seedling/hill. The highest straw yield (7.02 t/ha) was obtain from the transplanting of 4 seedlings/hill and the lowest one (5.64 t/ha) from the transplanting of 1 seedling/hill. Nitrogen level significantly influenced growth and yield components. The maximum grains/panicle (100.80) and highest grain yield (5.34 t/ha) were obtained with 80 kg N/ha. The highest straw yield (6.98 t/ha) was obtained at the highest nitrogen level (100 kg N/ha). Result showed that 3 seedlings/hill and 80 kg N/ha was optimum to produced maximum yield of BRRI dhan32.

Rahman *et al.* (2007_b) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during T. Aman season, 2002 to study the effect of different level of nitrogen on growth and yield of transplant Aman rice. The experiment included four treatments viz. 0, 60, 80 and 100 kg N/ha. Nitrogen level significantly influenced growth and yield components. The highest number of effective tillers/hill (9.20), maximum grains/panicle (100.80) and highest grain yield (5.34 t/ha) were obtained with 80 kg N/ha. The highest straw yield (6.98 t/ha) was obtained at the highest nitrogen level (100 kg N/ha). The highest harvest index (44.50%) was observed at 80 kg N/ha. Results showed that 80 kg N/ha was optimum to produce maximum yield of transplant Aman rice cv. BRRI dhan32.

Deepa *et al.* (2008) assessed the nutrient composition and physicochemical properties of Njavara, a medicinal rice. De-husked Njavara rice consisted of 73% carbohydrates, 9.5% protein, 2.5% fat, 1.4% ash and 1628 kJ per 100 g of energy. The cooked rice of Njavara was slimy in nature, probably due to the presence of non-starch polysaccharides.

Islam *et al.* (2008) conducted a field experiment to find out the effect of nitrogen levels and transplanting dates on the yield and yield components of aromatic rice cv. Kalizira. The experiment was laid out in a randomized complete block design with three replications using four(0, 50, 100, and 150 kg N/ha) levels of nitrogen and three transplanting dates (10^{th} August, 22^{nd} August and 04^{th} September, 2007) along with the basal doses of triple super phosphate (TSP), muriate of potash (MOP) and gypsum. The study revealed that most of the yield and yield contributing characters with few exceptions were significantly influenced by nitrogen levels and transplanting dates. They had significant positive effect on tillers, tillers grains/panicle and straw yield. The highest grain yield (2.63 t/ha) was observed in 100 kg N/ha with 10th August transplanting treatment and straw yield (6.43 t/ha) was found highest in 150 kg N/ha with same date of transplanting and the lowest grain (1.83 t/ha) and straw yields (5.14 t/ha) were found in N control treatment with transplanting date of 04 September. The highest grain length (4.68 mm), grain breadth (2.49 mm) and imbibition ratio (6.93) were observed with 100 kg/ha N rate coupled with 10th August transplanting and for length-breadth ratio, the same rate recorded the highest result but with different transplanting date *i.e.* 22nd August.

Pal *et al.* (2008) carried out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during July to December 2006 to study the root growth of four Transplant Aman rice varieties as influenced by NPKS fertilization. The experiment was laid out in a split-plot design with three replications. The experiment consisted of four varieties viz. BRRI dhan30, BRRI dhan3l, BRRI dhan40 and BRRI dhan4l; and four levels of fertilizers viz. 0, 50%, 100% and 150% of the recommended dose of NPKS. BRRI dhan4l had better performance in all root parameters. All root parameters except number of roots/hill performed better at high level of fertilizer. The interaction effect between variety and fertilizer level was significant in respect of number of roots/hill, fresh weight of root (except at 30 days after transplanting (DAT) and 90 DAT), dry weight of root, fresh weight of above ground plant part (except at 30 DAT and 90 DAT) and dry weight of above ground plant part (except at 90 DAT).

Nahar *et al.* (2009) in a field experiment during the Aman (monsoon) season of 2008 studied the effect of low temperature stress influenced by date of transplanting on yield attributes and yields of two rice varieties. The experiment consisted of two varieties (BRRI dhan46 and BRRI dhan31) and 4 transplanting dates (01, 10, 20 and 30 September, 2008). BRRI dhan46 had significantly higher values of yield attributes (effective tillers hill^{-1}, panicles hill^{-1}, panicle length, spikelets panicle^{-1}, filled grains panicle^{-1} and 1000-grain weight) and yields than the BRRI dhan31 in late transplanted conditions. There were significant reductions in yield attributes and yields after delayed transplanting. Spikelet sterility was increased by late transplanting due to low temperature at panicle emergence stage. Yield reduction of BRRI dhan46 due to late transplanting at 10 September, 20 September and 30 September were 4.44, 8.88 and 15.55%, respectively compared to 01 September transplanting. In case of BRRI dhan31 the reduction was more significant which were 6.12, 20.48 and 36.73%, respectively.

Ali *et al.* (2010) conducted an experiment at multilocation testing (MLT) site, Sujanagar, Pabna during the year of 2003-2004 to find out a soil test based economically viable fertilizer recommendation for the cropping pattern Boro-T. Aman. Six treatments viz., moderate yield goal (MYG), high yield goal (HYG), integrated plant nutrient system (IPNS), recommended fertilizer (RF) of Fertilizer Recommendation Guide' 97 (BARC), farmers' practice (FP), and absolute control were employed for the study. The grain yield of Boro and T. Aman rice increased 18 and 14%, respectively, by IPNS compared to farmers' practice. Total grain yield of rice was increased by about 16% in the IPNS fertilizer package compared to farmers' practice. Fertilizer nutrients supplied both from organic and inorganic sources in adequate amount have a positive effect on productivity of soil. On an average it was found that highest grain yields of Boro rice (5.37 t/ha) and T. Aman (4.49 t/ha) were obtained from integrated plant nutrient system (IPNS) where farmers' practice gave yield of 4.55 and 3.94 t/ha. The highest average gross margin (70385 Tk./ha) and marginal benefit cost ratio (3.78) was also obtained from IPNS plots.

Bahmanyar *et al.* (2010) conducted a research work to investigate the effects of different rates of nitrogen (N) and potassium (K) top dressing on grain yield and yield components of rice (*Oryza sativa cv. Tarrom*) and to investigate N and K content of upper leaves analyzed at ten different times. A pot experiment was carried out on a completely randomized design with seven replications under greenhouse conditions at the Experiment Station of Sari Agricultural Sciences and Natural Resources University, Iran, during the growing season in 2008. Nitrogen was applied in the form of urea (46% N) at the rates of 0, 23 and 46 kg N/ha and potassium in the form of potassium chloride (60% K_2O) at the rates of 0, 30 and 60 kg/ha K_2O. Results indicated that panicle length, plant height, number of tiller, number of grain per panicle, hollow grain percentage, grain and biological yield were significantly affected by N and K fertilization. Maximum grain yield (75.46 g/pot) occurred at 23 kg N/ha and 30 kg/ha K_2O. At flowering stage, K content of stems were higher than leaves and N content in flag leaves was higher than other plant parts.

Oko and Onyekwere (2010) investigated the proximate chemical compositions and mineral element contents of five new lowland rice varieties viz: IR77384-12-17-3-18-2-B, IR68, PSBRc50, IR77647-3B-8-2-2-14-4 and IR75395-2B-1-1-2.4 with a view to recommending them to farmers and consumers in Ebonyi state and its environs. For the analysis, data were collected to determine percentage proximate composition (moisture, crude protein, fat, crude fiber, ash and carbohydrate) and mineral element contents (nitrogen, phosphorus, potassium, calcium, magnesium and sodium). The results were obtained as mean and standard deviation of the values expressed in percentage as follows; 11.50 ± 9.8 moisture 25 ± 0.8 fat, 5.8 ± 1.2 crude protein, 1.6 ± 0.3 crude fiber, 0.9 ± 0.2 ash, 78.0 ± 13.2 carbohydrate, 09± 0.04 nitrogen, 0.11±0.05 calcium, 0.21±0.002 potassium, 0.13 ± 0.00 sodium, 0.53 ± 0.03 phosphorus and 0.17 ± 0.02 magnesium. Based on the percentages of the various chemical components of these five rice varieties, we therefore persuade farmers and consumers in Ebonyi state and its environs to accept these rice varieties.

From the above reviews it is cleared that late transplanting has profound influence on the yield and yield contributing characters of Aman rice. Thus there may have enough scope investigating the effect of transplanting date in favour of yield improvement of Aman rice cv. BR22 (Kiron).

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the experimental field of the Sher-e-Bangla Agricultural University (SAU), during the period from August to December 2008. This chapter deals with a brief description of the site, soil, land preparation, layout, design, intercultural operations, data recording and procedure of statistical analysis etc.

3.1 Description of experimental site

3.1.1. Location and sites

The experimental field was located at agronomical farm of SAU. The experimental area belongs to Modhupur Tract (Agro-Ecological Zone 28). The land area was situated at 23º41' N latitude and 90º22' E longitude at an altitude of 8.6 meter above the sea level.

3.1.2 Soil

The soil of the experimental field belongs to the general soil type, shallow red brown terrace soil under Tejgaon series. Top soils were clay loam in texture, olive gray with common fine medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period.

3.1.3 Climate

The experimental area was under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (November-March). The weather data during the period of the experimental site has shown in Appendix I.

3.2.1 Planting material

Rice variety BR22 (Kiron) was taken for this experiment. The variety is Transplant Aman in type. The plant grows up to 125 cm height. Seed to seed duration is 150 days. The appropriate time for seed sowing is late June to late July, and transplanting should be done within late September. The variety is harvested from Mid November to Mid December and approximate yield is 5.5 t/ha (BRRI, 2007).

3.2.2 Experimental treatment

The treatments included in the experiment are as follows:

Transplanting and Re-transplanting Dates

T_1 : 16 September (First Transplanting in the main field and beside the main field)

T_2 : 26 September (Retransplanting)

T_3 : 06 October (Retransplanting)

T_4 : 16 October (Retransplanting)

3.3 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Each replication was divided into four plots. The total numbers of unit plots were 16. The plot size was 4.0 m x 3.0 m. The distances between plot to plot and replication to replication were 1 m and 0.5 m, respectively. The layout of the experimental plot has been shown in appendix 2.

3.4 Raising of seedlings

Seeds of BR22 (Kiron) were collected from BRRI, Gazipur. The seedlings were raised at the wet seed bed in SAU farm. The seeds were sprouted by soaking for 72 hours. The sprouted seeds were sown uniformly in the well-prepared seed bed on 14 August, 2008.

3.5 Land preparation

The experimental field was opened with a tractor drawn rotary plough and later on, the land was ploughed and cross-ploughed three times by country plough followed by laddering to obtain the desirable tilth. The corners of the land were spaded. All kinds of weeds and stubbles were removed from the field and the land was made ready. Whole experimental land was divided into sub plots. Finally basal doses of Phosphorus, Potassium, Sulfur and Zinc fertilizers were applied in sub plots and the plots were made ready by thorough spading and leveling before transplantation.

3.6 Fertilizer application

At the time of first ploughing cow dung at the rate of 1 t/ha was applied. All the plots were fertilized with 120, 80, 72, 16 and 3 kg/ha N, P_2O_5, K_2O, S and Zn applied in the form of urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate respectively (BARC, 1997). All the fertilizer except urea was incorporated with the soil one day before transplanting.

3.6.1 Split application of urea

Prilled urea was applied in three splits in equal ratios in each plot. The first split was applied on 7 days after transplanting (DAT), the second split as top dressing at active tillering stage on 21 DAT and the third split at panicle initiation stage on 45 DAT.

3.7 Transplanting of seedlings

3.7.1 Uprooting and transplanting of seedlings on polythene sheet

Five weeks old seedlings were uprooted from the seed bed carefully and transplanted at the main field according to T_1 treatment with row to row distance 25 cm and hill to hill distance 15 cm. Also on that day a small plot (17m×1m) beside the main experimental field was prepared by keeping a thick polythene sheet and spreading 3-4 cm soil on the polythene. Therefore, seedling was transplanted on that plot with 5 cm and 5 cm row to row and plant to plant distance respectively.

3.7.2 Uprooting and re-transplanting of seedlings in main plot

From the polythene based hills were uprooted again and re-transplanted in the main field as per treatments (T_2, T_3 & T_4) with row to row distance 25 cm and hill to hill distance 15 cm.

3.8 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the crop.

3.8.1 Weed control

During plant growth stage hand weeding were done according to needs.

3.8.2 Irrigation and drainage

Irrigation water was applied keeping a standing water about 2-3cm during the whole growing period. Water was drained out when 80% panicles were golden yellow.

3.8.3 Plant protection measure

During the growing period some plants were infested by rice stem borer (*Scirpophaga incertulus*) which was successfully controlled by applying Diazinon 60 EC @ 20 ml per 10 liter of water for spraying in 5 decimal of land beside this. No prominent infestation of insect-pests and diseases were observed in the field.

3.9 General observation

Regular observation was made to identify the growth stages in the crops so that nitrogenous fertilizer as urea could be top dressed in relation to growth stages. Seedlings showed a little bit pale green or yellowish was observed at the time of next urea application. When urea was applied it turned into green colour again within 6-7 days.

3.10 Harvest and post harvest operation

The crop was harvested on 31st December 2008 at maturity. The grains were threshed, cleaned and sun dried to record grain yield/plot.

3.11 Sampling and data collection

Data collections from the experiment on different growth stages were done under the following heads as per experimental requirements.

3.11.1 Data collection on crop characters and chemical composition

Ten hills from each plot were selected at random prior to harvesting and were labeled with tags for recording morphological and yield attributes. From the harvested hills the following data were taken:

1. Plant height at harvest (cm)
2. Number of effective tillers/hill
3. Number of ineffective tillers/hill
4. Number of spikelet/panicle
5. Number of filled grain/panicle
6. Number of unfilled grain/panicle
7. Shoot dry weight (g)
8. Thousand grain weight (g)
9. Grain yield (t/ha)
10. Nitrogen content
11. Phosphorus content
12. Potassium content

3.11.2 Data collection procedure

The procedures of data collection are given below:

Plant height (cm)

The heights of the pre-selected 10 hills were taken by measuring the distance from base of the plant to the tip of the flag leaf after heading. The collected data were finally averaged.

Tillers/hill: The number of effective and non-effective tillers was counted from 10 preselected hills.

Filled grains and unfilled grains/panicle: Number of filled grains and unfilled grains were counted from each of ten hills. Lack of any food materials inside the spikelets were denoted as unfilled grains.

Thousand grain weight: One thousand grains were randomly collected from each plot and were sun dried and weighed by an electronic balance.

Grain yield (t/ha): Twelve square meter (m^2) area were harvested at random from undisturbed area of each plot. The grains were threshed, cleaned, dried and then weighed.

Determination of total Nitrogen from rice straw

Nitrogen contents of the rice straw were determined by micro kjeldahl method after digestion with conc. H_2SO_4, digestion tablet ($CuSO_4$+ Selenium mixture) and then distillation with 40% NaOH solution. The ammonia distilled over was absorbed in H_3BO_3 indicator solution and titrated with 0.01N H_2SO_4. The results were expressed in percentage (Baker and Thompson, 1992).

Calculation

% N in the supplied straw sample = $\frac{(T - B) \times N \times 1.401}{g}$

Where,

T = ml of sample titrated

B = ml of blank titrated

N = acid normality

g = powder of rice straw used for the analysis

Determination of Phosphorus (P) and Potassium (K) from rice straw

1 g of dry rice straw was digested with 10 ml 2:1 nitric-perchloric acid mixture. After the preliminary digestion and the temperature was raised to 235°C. After the condensation of vapors, the volume was brought to the mark with deionized water (Issac and Johnson, 1992).

Determination of Phosphorus (P) in the digest

The phosphorus in the digest was determined by developing the yellow color by adding ammonia molybdate, ammonia vanadate (Barton's solution) and measuring the color with the help of a spectrophotometer at 440 mu. The results were expressed in percentage (Issac and Johnson, 1992).

Calculation

Decant the supernatant liquid and analyze Phosphorus (P) by Spectro Photophotometry

$$\% P = ppm\ P \times \frac{R}{Wt} x \frac{100}{1000}$$

Where,

R = Ratio between total volume of the digest/aliquot and the digest /aliquot volume used for measurement

Wt = Weight of dry plant (g)

Determination of Potassium (K) in the digest

Potassium content in rice straw was determined with the help of flam photometer. The results were expressed in percentage (Issac and Johnson, 1992).

Calculation

Decant the supernatant liquid and analyze Potassium (K) by Flame Photophotometry

$$K\ ppm = (ppm\ in\ extract\text{-}blank) \times \frac{A}{Wt}$$

Where,

A = Total volume of the extract (ml)

Wt = Weight of dry plant (g)

3.12. Statistical Analysis

The data were compiled and tabulated in proper form and were subjected to statistical analysis. Analysis of variance was done following the computer package MSTAT-C program. The mean differences among the treatments were adjusted by Duncan's Multiple Range Test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

This chapter comprises of presentation and discussion of the results obtained from the study to see the effect of retransplanting dates on the yield of BR22 (Kiron). Effects of different treatments on yield attributes and yield are presented in Figures 1 through 9 and Appendices 1 through 6.

4.1 Plant height (cm)

Transplanting and retransplanting dates had significant influence on plant height (Figure 1 and Appendix 3). The tallest plant (90.68 cm) was obtained from T_1 (16 September). Whereas retransplanted on 16 October produced the shortest one (76.00 cm). BRRI (1989) further reported that the optimum planting time of T. Aman rice is in August. But sometimes transplanting is delayed due to various physical and socioeconomic factors. This late planting exposes the vegetative and reproductive phases as well as phonological events of crop and poor growth of the plant. Matsushima *et al.* (1966) noted that low temperature is not favorable for the elongation of tillers.

4.2 Number of tillers /hill

Retransplanting date had significant influence on number of tillers /hill (Figure 2 and Appendix 3). The highest number of tillers/hill (39.92) was obtained from retransplanting in 16 October whereas transplanted on 16 September produced the lowest number of tillers/hill (17.42). Nahar *et al.* (2009) found significant reductions in yield attributes after delayed transplanting. In case of BRRI dhan31 the reduction was more significant.

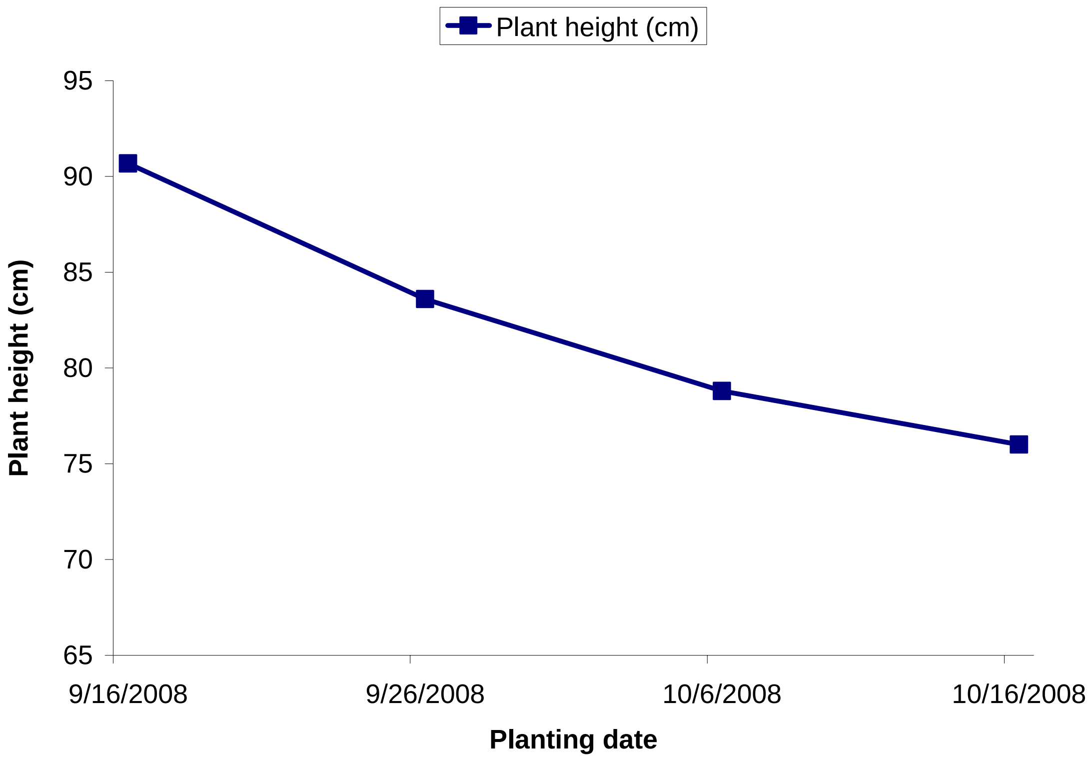

Figure 1. Effect of different planting dates on plant height of transplanted Aman rice cv. BR22 (Kiron)

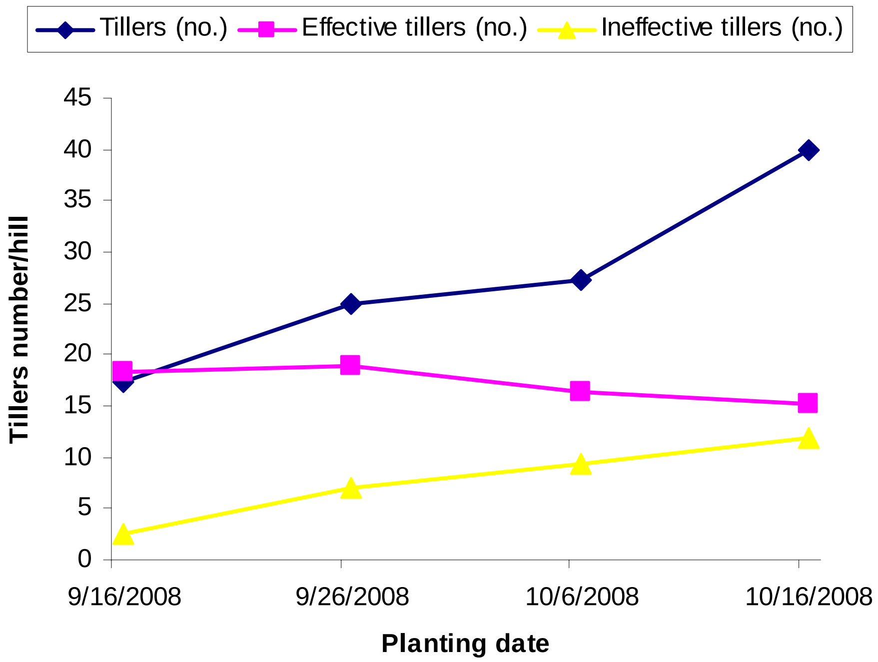

Figure 2. Effect of different planting dates on total number of tillers/hill, total numbers of effective tillers/hill, total number of ineffective tillers/hill of transplanted Aman rice cv. BR22 (Kiron)

4.3 Number of effective tillers /hill

Transplanting and retransplanting dates had significant influence on number of effective tillers/hill (Figure 2 and Appendix 3). The highest number of effective tillers/hill (18.88) was obtained from T_2 (26 September). Whereas retransplanted on 16 October produced the lowest number of effective tillers/hill (15.20). The result of the present study corroborates with the study of Nahar *et al.* (2009). In a field experiment during the Aman (monsoon) season of 2008 they found that low temperature stress had significantly lower values of yield attributes such as effective tillers hill^{-1} in the BRRI dhan31 in late transplanted conditions.

4.4 Number of ineffective tillers/hill

Transplanting and retransplanting dates had significant influence on number of ineffective tillers/hill (Figure 2 and Appendix 3). The highest number of ineffective tillers/hill (11.95) was obtained from T_4 (16 October). Whereas transplanted on T_1 (16 September) produced the lowest number of ineffective tillers/hill (2.47). The present study keep in with the study of Mangor (1984) who reported that deviation from the optimum planting time may cause incomplete vegetative stage and irregular panicle exertion. Therefore the number of ineffective tiller may increase.

4.5 Length of panicle (cm)

Transplanting and retransplanting dates had significant influence on length of panicle (Figure 3 and Appendix 4). The highest length of panicle (22.41 cm) was obtained from T_1 (16 September). Whereas retransplanted on 6 October produced the shortest one (20.60 cm). Hasanuzzaman *et al.* (2009) in a study found that the length of panicle in late transplanted Aman rice ranged from 23.59cm to 21.3 cm which matched with the present study.

4.6 Number of spikelet/panicle

Transplanting and retransplanting dates had significant influence on number of spikelet/panicle (Figure 4 and Appendix 4). The highest number of spikelet/panicle (117.3) was obtained from T_1 (16 September). Whereas retransplanted on T_4 (16 October) produced the lowest number of spikelet/panicle (107.0). Pal *et al. in* (2002) found that the number of spikelet/ panicle gradually decreased with the late in transplanting date. Therefore the present study matches with the result of Pal *et al. in* (2002).

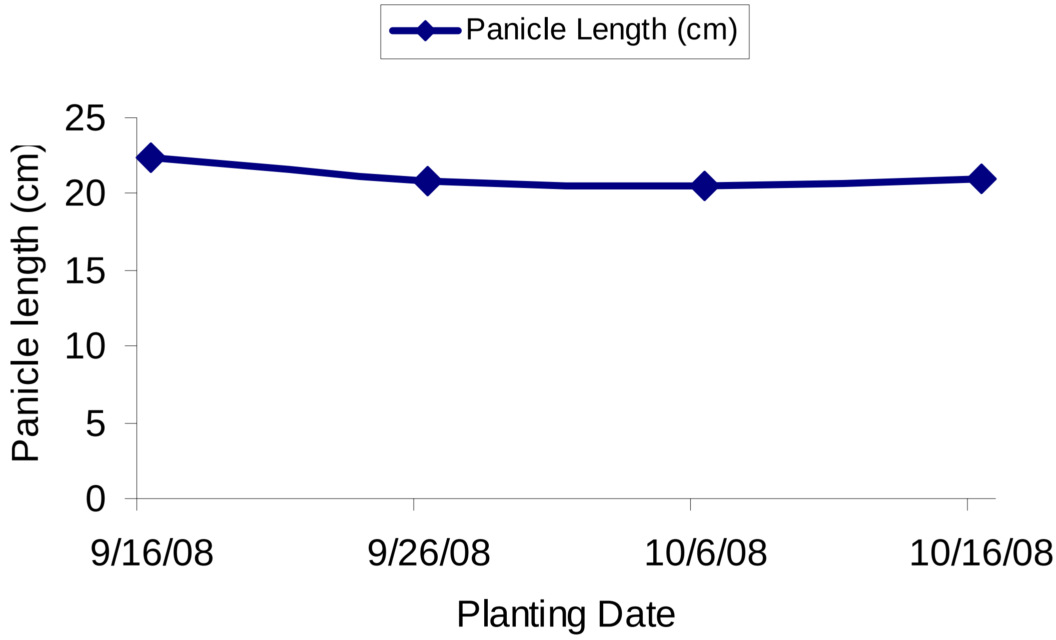

Figure 3. Effect of different planting dates on panicle length (cm) of transplanted Aman rice cv. BR22 (Kiron)

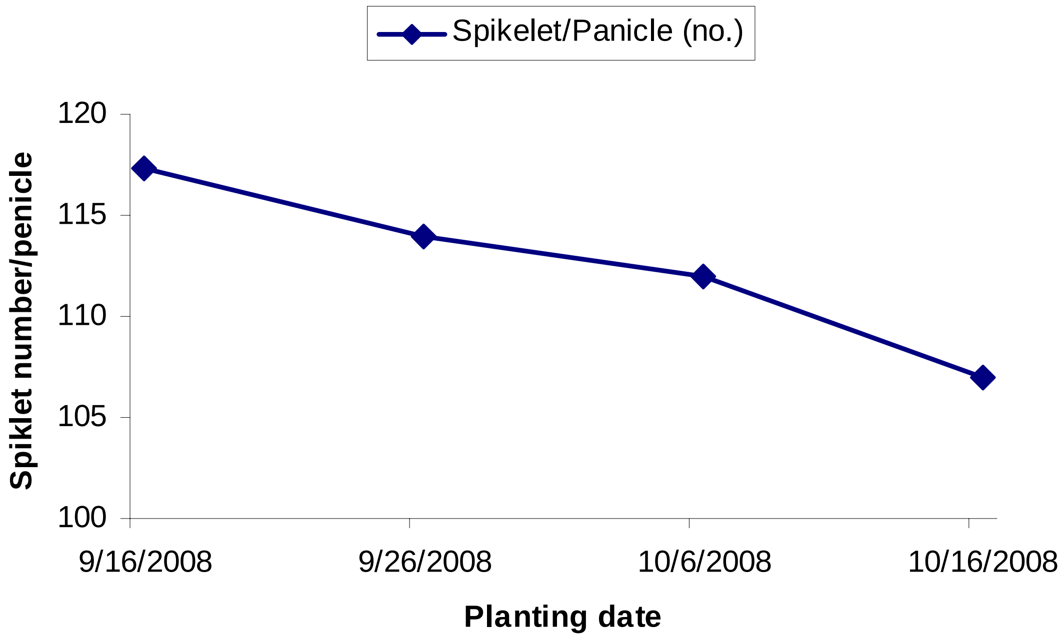

Figure 4. Effect of different planting dates on spikelet/panicle (no.) of transplanted Aman rice cv. BR22 (Kiron)

4.7 Number of filled grain/panicle

Transplanting and retransplanting dates had significant influence on number of filled grain/panicle (Figure 5 and Appendix 5). The highest number of filled grain/panicle (110.5) was obtained from T_1 (16 September). Whereas retransplanted on T_4 (16 October) produced the lowest number of filled grain/panicle (93.75). Nahar *et al.* (2009) found low temperature causes various types of injuries in rice plants, but the most important one is spikelet sterility. In their experiment they found, production of filled grains decreased with the delay of transplanting which was due to occurrence of low temperature at anthesis and spikelet primordial formation.

4.8 Number of unfilled grain/ panicle

Transplanting and retransplanting dates had significant influence on number of sterile or unfilled grain/panicle (Figure 5 and Appendix 5). The highest number of unfilled grain/panicle (13.25) was obtained from T_4 (16 October). Whereas transplanted on T_1 (16 September) produced the lowest number of unfilled grain/panicle (6.75). Shimizu and Kumo (1967) reported a wide range of abnormal spikelets, all of which were induced under the low temperature treatments at the young panicle primordium differentiation stage. As the temperature in Bangladesh is lower in December, it induced in increased sterile grain.

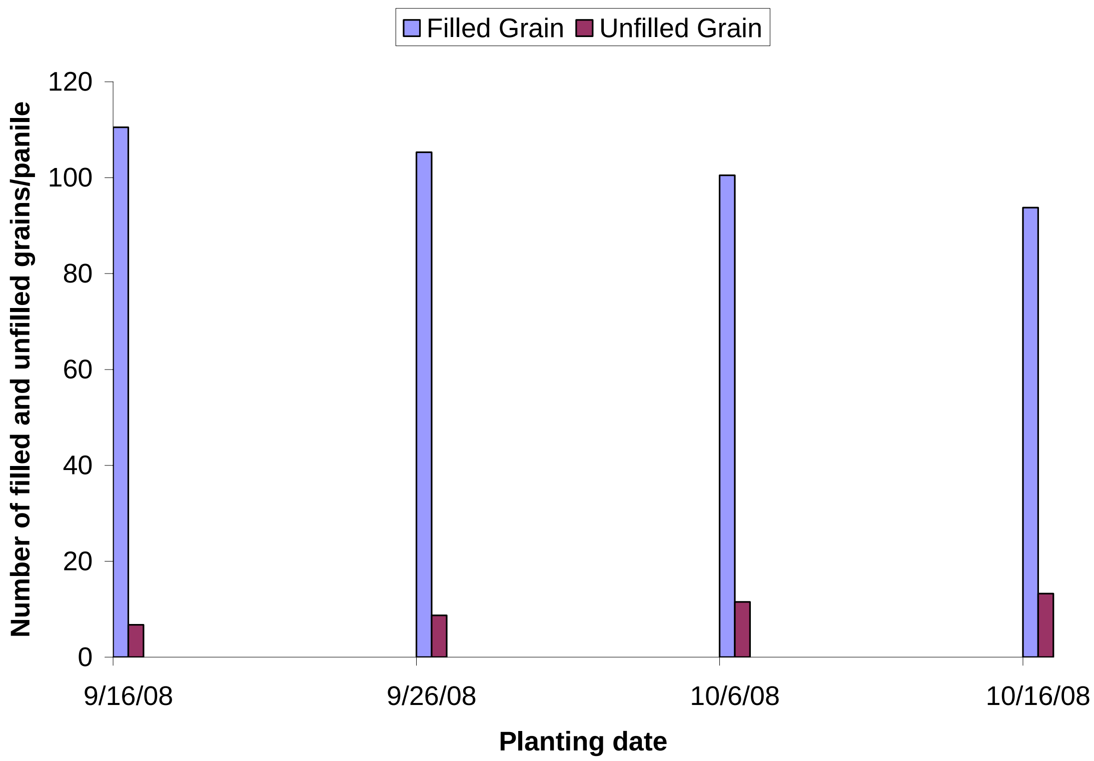

Figure 5. Effect of different planting dates on number of filled and unfilled grain/panicle of T. Aman rice cv.BR22 (Kiron)

4.9 Shoot dry weight (g)

Transplanting and retransplanting dates had significant influence on shoot dry weight per hill (Figure 6 and Appendix 5). The highest shoot dry weight per hill (57.65g) was obtained from T_4 (16 October). Whereas transplanted on T_1 (16 September) produced the lowest shoot dry weight per hill (32.47g). Aslam *et al.* (1994) found similar types of result.

4.10 Weight of 1000-grains (gm)

Transplanting and retransplanting dates had significant influence on weight of 1000-grains (Figure 7 and Appendix 5). The highest weight of 1000-grains (19.87) was obtained from T_1 (16 September). Whereas retransplanted on T_4 (16 October) produced the lowest weight of 1000-grains (17.42). Nahar *et al.* (2009) found late transplanting of rice plant reduced the grain weight due to interruption in grain formation mediated by low temperature. They found 1000 grain weight was reduced to 2.57, 13.97, 24.26% due to 10 September, 20 September and 30 September transplanting compared to 01 September transplanting.

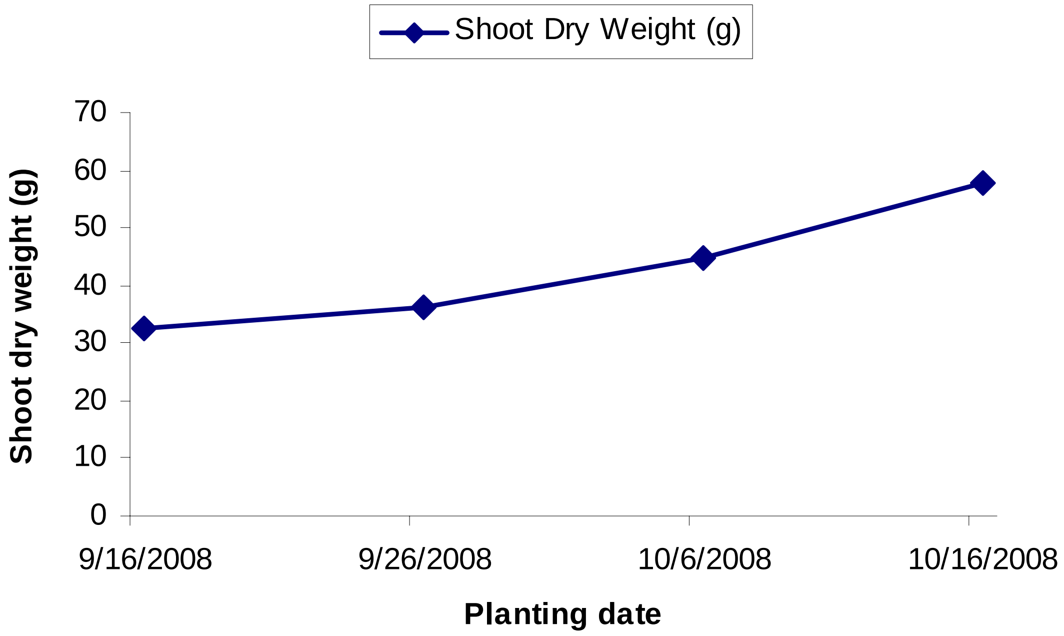

Figure 6. Effect of different planting dates on shoot dry weight (g) of T. Aman rice cv.BR22 (Kiron)

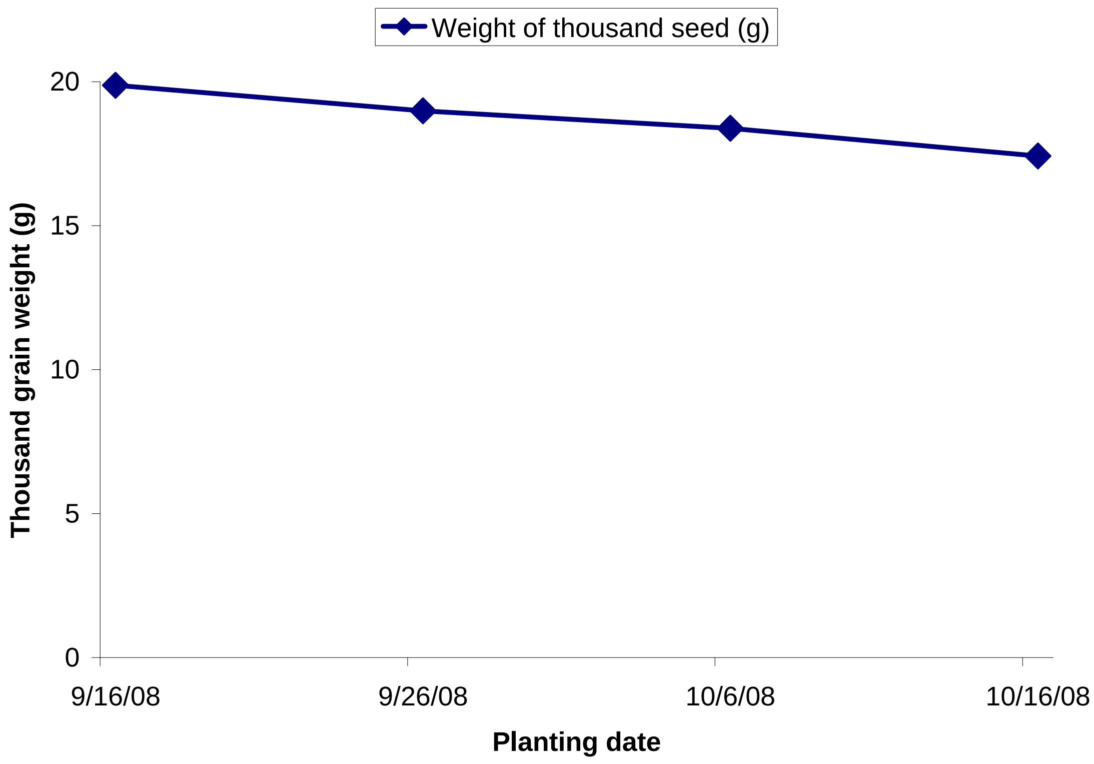

Figure 7. Effect of different planting dates on thousand seed weight (g) of T. Aman rice cv.BR22 (Kiron)

4.11 Grain yield (t/ha)

Transplanting and retransplanting dates had significant influence on grain yield (Figure 8 and Appendix 5). The highest grain yield (4.72 t/ha) was obtained from T_1 (16 September) whereas retransplanted on T_4 (16 October) produced the lowest grain yield (3.37 t/ha). The present study matches with the previous authors (Halappa *et al.*, 1974; Faria and Folegatt, 2001). Halappa *et al.* (1974) reported that the performance of rice is greatly influenced by the date of transplanting due to the effect of cold hazard and incidence of biotic stress. Faria and Folegatt (2001) reported that grain yield was high for sowing in October (5.4 to 6.0 t/ha) and lower for sowing in December (1.6 to 4.8 t/ha) due to the low temperature at seed filling stages, mostly for the late cultivar.

4.12 Chemical Composition

Chemical composition of rice rain was greatly influenced by the retransplanting dates (Figure 9 and Appendix 6). Results revealed that the highest nitrogen (1.375%) and potassium (2.362%) content was found when seedling was retransplanted on 26 September whereas the lowest Nitrogen (1.128%) and potassium (1.945%) was found on retransplanting on 16 October. But phosphorus content showed slightly dissimilarity as compared to N and K content. Significantly the highest phosphorus content (0.2505%) was produced when seedling was retransplanted on 16 October whereas the lowest one (0.1920%) was found on transplanting on 16 September. The result of the present study matches with the result of Oko and Onyekwere (2010). Their result of the mineral elements content showed some variations among the different varieties the values for phosphorus and nitrogen content ranged from 0.51 – 0.55% and 0.64 and 1.27% respectively. The nitrogen content had been correlated to the crude protein and had also been shown to be the highest mineral content.

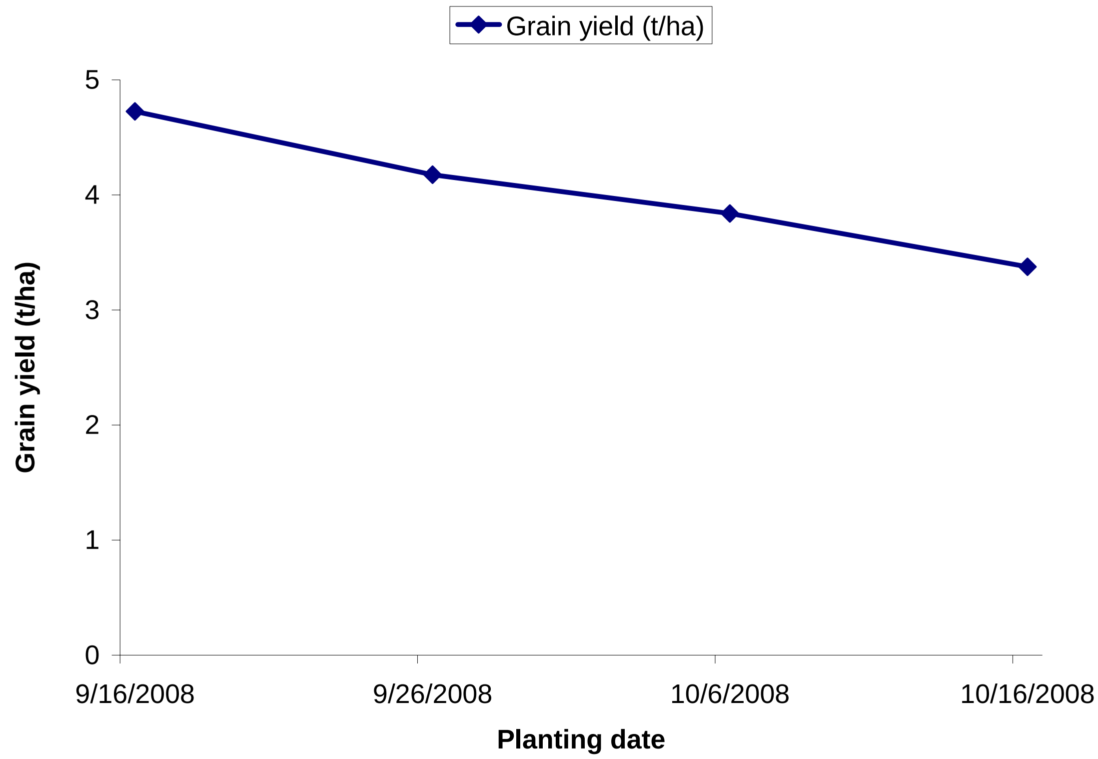

Figure 8. Effect of different planting dates on grain yield (t/ha) of T. Aman rice cv.BR22 (Kiron)

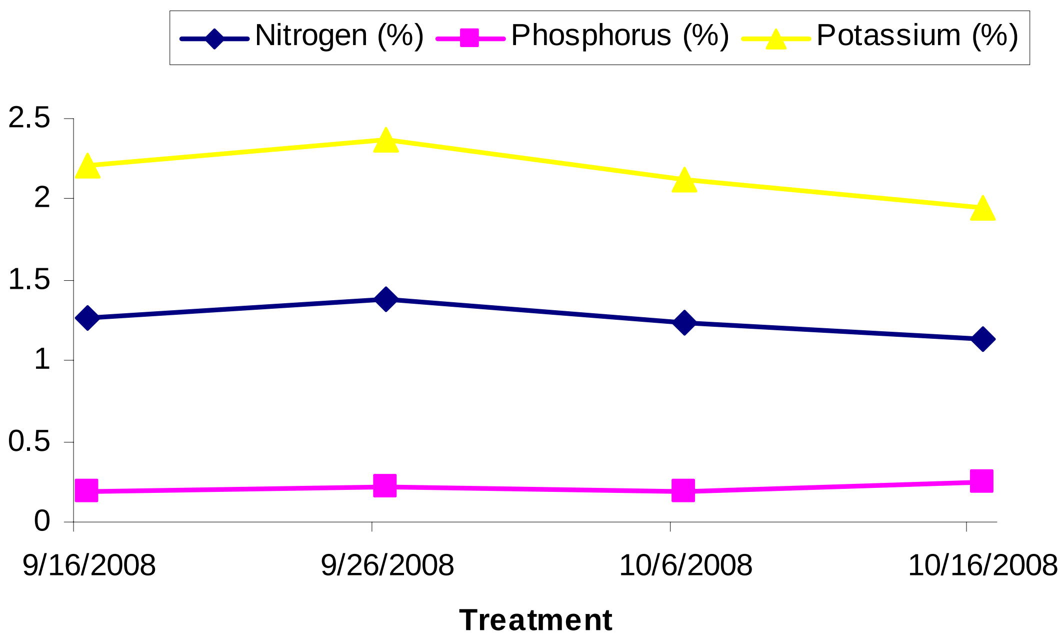

Figure 9. Effect of different planting dates on chemical composition (Nitrogen, Phosphorus and Potassium) content (%) in straw of T. Aman rice cv.BR22 (Kiron)

CHAPTER 5
SUMMARY AND CONCLUSION

The present piece of work was conducted at the experimental farm of Sher-e-Bangla Agricultural University (SAU) during the period from August to December, 2008 to find out the effect of late transplanting on the yield and nutrient content of T. Aman rice cv. BR22. The experiment consisted of 4 treatments (1 transplanting and 3 retransplanting dates). The experiment was laid out in a RCBD design with four replications.

Transplanting and retransplantings dates had significant influence on yield and yield contributing characters of late transplanted Aman rice viz. plant height, total number of tillers, number of effective tillers/hill, number of ineffective tillers/hill, panicle length, spikelet/panicle, number of filled grain/panicle, number of unfilled grain/panicle, shoot dry weight, weight of thousand seed and grain yield. Transplanting on 16 September achieves highest plant height, panicle length spikelet/panicle, filled grain/panicle, weight of thousand seed and grain yield. Whereas retransplanting on 26 September achieves highest effective tillers/hill and retransplanting on 16 October achieves highest number of tillers/hill, number of ineffective tillers/hill, number of unfilled grain/panicle and shoot dry weight.

On the other hand transplanting on 16 September achieves lowest number of tillers/hill, ineffective tillers/hill, unfilled grain/panicle and lowest shoot dry weight. Lowest panicle length was obtained from retransplanting on 06 October. Whereas retransplanting on 16 October gives lowest plant height, effective tillers/hill, spikelet/panicle, filled grain/panicle and weight of thousand seed grain yield.

For late transplanting or retransplanting low temperature at the pollen development stage is a great problem and may cause a sharp decline in fertile or filled spikelets particularly in the photoinsensitive cultivars. Thus, for late retransplanting in 16 October is another cause of decline in yield. Among the planting dates 16 September transplanting provided the best results where 06 October transplanting provided the worst results. In this study harvest indices were not observed but it may also be affected by planting dates.

In case of chemical contents, retransplanting on 26 September provides highest nitrogen and potassium content. But 16 October gives highest phosphorus content. On the other hand transplanting on 16 September achieves lowest phosphorus content and retransplanting on 16 October achieves lowest nitrogen and potassium content.

It appeared from the result that transplanting and retransplanting date had significant effect on yield contributing characters, yield and chemical composition of T. Aman rice and as the promising practice in terms of increasing yield of Aman rice cv. BR22, farmer should transplant Aman rice before 06 October for better vegetative growth and yield. This result will be beneficial for the flood prone areas of Bangladesh. Further more investigation is required on this topic with other photosensitive T.Aman varieties as well as in different agroecoloical zone of Bangladesh.

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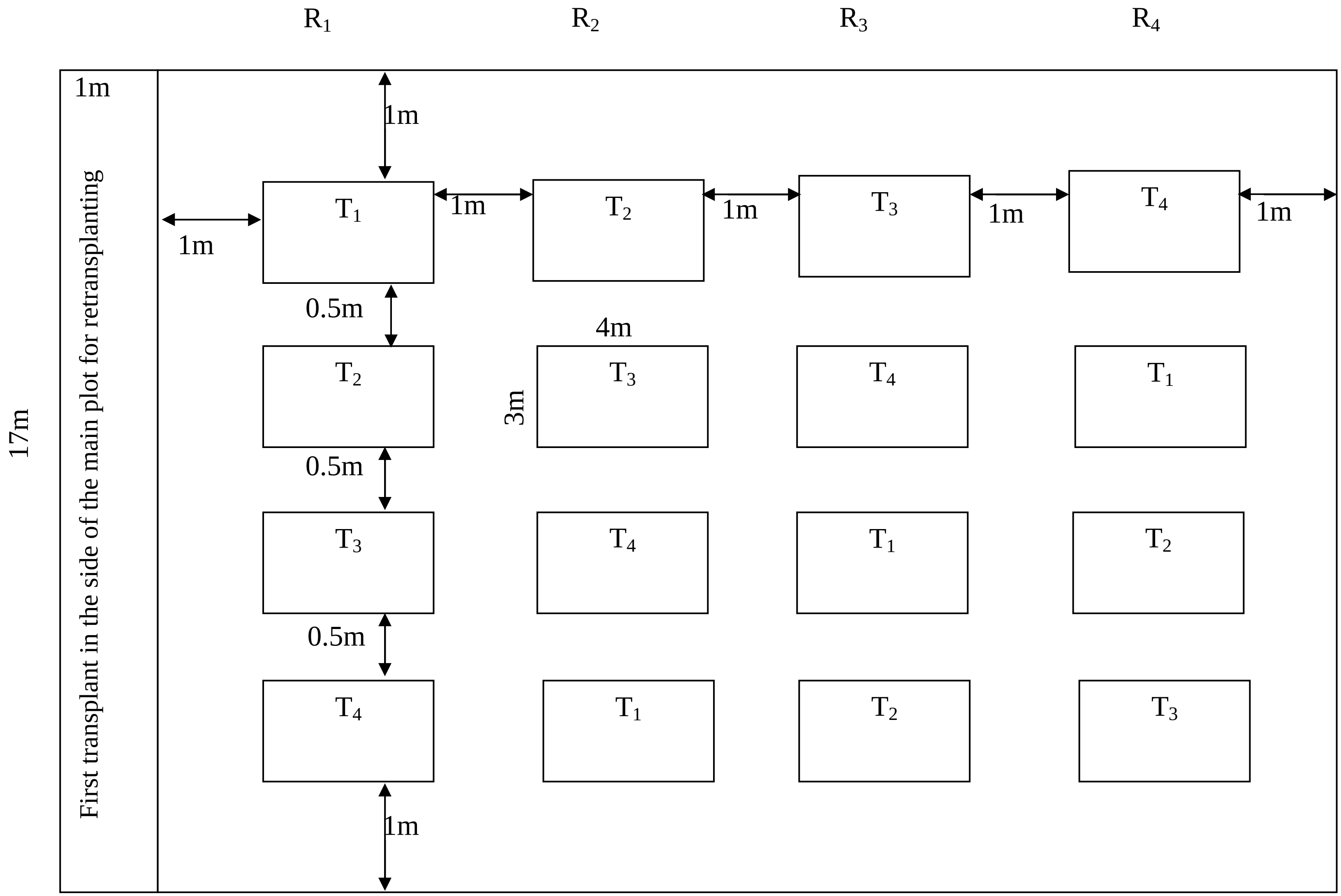
APPENDICES

Appendix 1. Monthly average temperature, relative humidity and rainfall of the experimental site

Month	Temperature (°C)			Relative humidity (%)	Rain fall (mm)
	Minimum	Maximum	Average		
Aug’08	19.9	29.0	24.45	77	111
Sep’08	15.0	25.8	20.4	69	0
Oct’08	12.4	24.5	18.45	68	0
Nov’08	16.7	27.1	21.9	68	30
Dec’08	19.6	31.4	25.5	54	11
Jan’09	23.6	33.6	28.6	69	163

Source: Bangladesh Meteorological Directorate, Bangladesh

Appendix 2. Layout of the experimental field



Appendix 3. Effect of different transplanting and retransplanting dates on Plant height, number of tillers/hill, number of effective tillers/hill, number of ineffective tillers/hill, weight of thousand seed and grain yield of T. Aman rice cv. BR22 (Kiron)

Treatment	Plant height (cm)	Tillers (no.)	Effective tillers (no.)	Ineffective tillers (no.)	Weight of thousand seed (gm)	Grain Yield (t/ha)
T_1 = 16 September	90.68a	17.42d	18.38a	2.475d	19.87a	4.725a
T_2 = 26 September	83.60b	24.85c	18.88a	6.925c	18.99ab	4.175b
T_3 = 06 October	78.80c	27.30b	16.33b	9.425b	18.38bc	3.838c
T_4 = 16 October	76.00c	39.92a	15.20b	11.95a	17.42c	3.375d
LSD	4.109	0.8412	1.201	1.77	1.135	0.2517
CV%	2.17	1.34	3.04	10.01	2.65	2.7
Level of significance	1%	1%	1%	1%	1%	1%

In column the figures having common letters do not differ significantly where as figures having dissimilar letters at 5% and 1% level of significance according to DMRT

NS=Not significant

Appendix 4. Effect of different transplanting and retransplanting dates on effective tillers/hill, ineffective tillers/hill, panicle length and spikelet/panicle of T. Aman rice cv. BR22 (Kiron)

Treatment (Re-transplanting date)	Effective tillers/hill (no.)	Ineffective tillers/hill (no.)	Panicle length (cm)	Spikelet/panicle (no.)
T_1 = 16 September	18.38a	2.475d	22.41a	117.3a
T_2 = 26 September	18.88a	6.925c	20.84b	114.0b
T_3 = 06 October	16.33b	9.425b	20.60b	112.0b
T_4 = 16 October	15.20b	11.95a	20.94b	107.0c
LSD	1.201	1.77	0.8781	2.175
CV%	3.04	10.01	1.8	0.84
Level of significance	1%	1%	1%	1%

In column the figures having common letters do not differ significantly where as figures having dissimilar letters at 5% and 1% level of significance according to DMRT

NS=Not significant

Appendix 5. Effect of different transplanting and retransplanting dates on filled grain/panicle, unfilled grains/panicle, shoot dry weight, weight of thousand seed (g) and grain yield (t/ha) of T. Aman rice cv. BR22 (Kiron)

Treatment (Re-transplanting date)			Filled Grain/panicle (no.)	Unfilled Grain/panicle (no)	Shoot dry weight (gm)	Weight of thousand seed (gm)	Grain Yield (t/ha)
T_1	=	16 September	110.5a	6.750b	32.47d	19.87a	4.725a
T_2	=	26 September	105.3b	8.750b	36.40c	18.99ab	4.175b
T_3	=	06 October	100.5c	11.50a	44.94b	18.38bc	3.838c
T_4	=	16 October	93.75d	13.25a	57.65a	17.42c	3.375d
LSD			2.917	2.548	3.509	1.135	0.2517
CV%			1.24	11.02	3.56	2.65	2.7
Level of significance			1%	1%	1%	1%	1%

In column the figures having common letters do not differ significantly where as figures having dissimilar letters at 5% and 1% level of significance according to DMRT
NS=Not significant

Appendix 6. Effect of different transplanting and retransplanting dates on chemical composition (Nitrogen, Phosphorus and Potassium) content (%) in content in rice straw of T. Aman rice cv. BR22 (Kiron)

Treatment (Re-transplanting date)			N (%)	P (%)	K (%)
T_1	=	16 September	1.260b	0.1920c	2.203b
T_2	=	26 September	1.375a	0.2250b	2.362a
T_3	=	06 October	1.232b	0.1950c	2.128c
T_4	=	16 October	1.128c	0.2505a	1.945d
LSD			0.1028	0.02298	0.07267
CV%			3.63	5.68	1.67
Level of significance			1%	1%	1%

In column the figures having common letters do not differ significantly where as figures having dissimilar letters at 5% and 1% level of significance according to DMRT

NS=Not significant