ALLELOPATHIC EFFECT OF DIFFERENT WEED RESIDUES TO CONTROL WEEDS IN AMAN RICE FIELD

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CERTIFICATE

This is to certify that the thesis entitled, ***"ALLELOPATHIC EFFECT OF DIFFERENT WEED RESIDUES TO CONTROL WEEDS IN AMAN RICE FIELD"*** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfilment of the requirements for the degree of ***MASTER OF SCIENCE (M.S.) IN AGRONOMY,*** embodies the result of a piece of *bona fide* research work carried out by ***SUSHANTA KUMAR MAHATO,*** Registration No. ***05-01836*** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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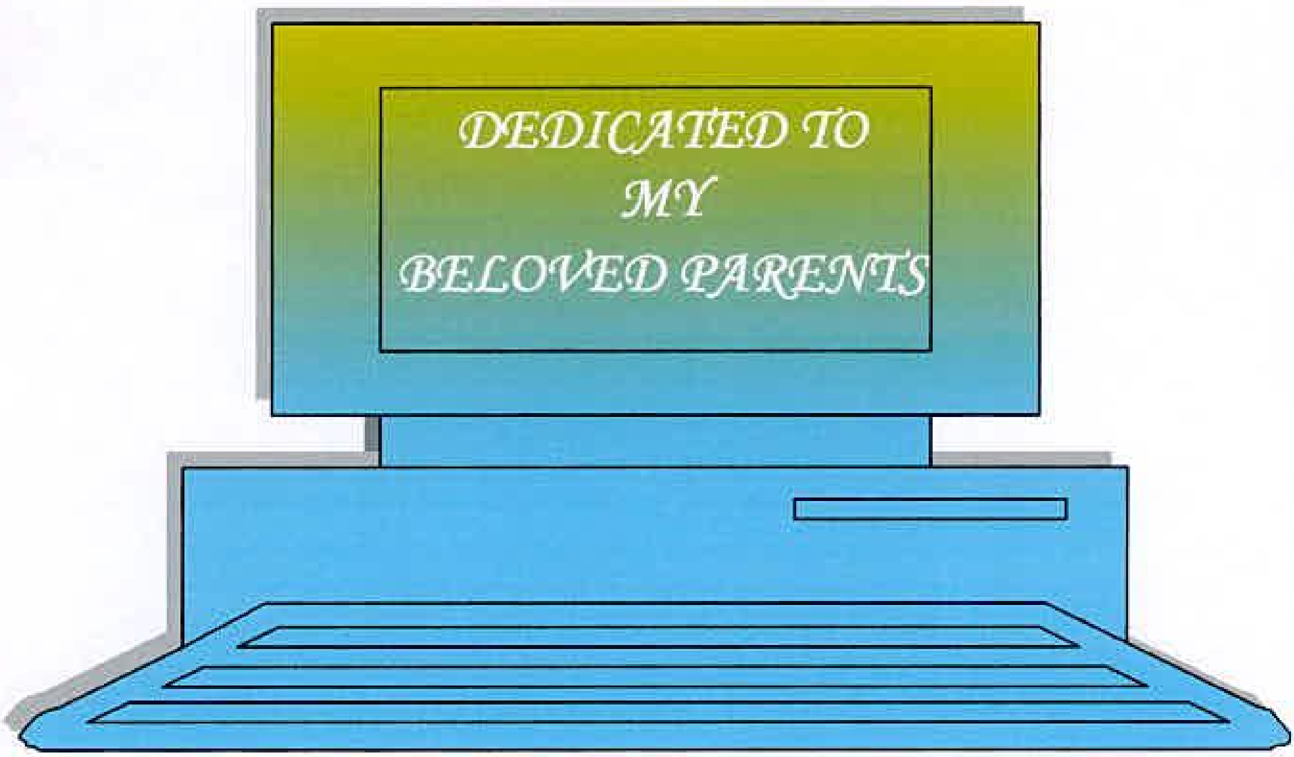
DEDICATED TO
MY
BELOVED PARENTS

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ALLELOPATHIC EFFECT OF DIFFERENT WEED RESIDUES TO CONTROL WEEDS IN AMAN RICE FIELD

ABSTRACT

A field experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University (SAU), during July to December, 2010 with a view to find out allelopathic (eco-friendly concept) effect of different weed residues to control weeds in Aman rice field. The experimental treatments included three T-aman rice varieties *viz.* BRRI dhan46, Guti Swarna and Ranzit variety and five different allelopathic materials *viz.*Control, *Lantena camera*, Goose weed, Ban sharisha and Araich. Results showed that rice cultivars differed significantly in all growth and yield contributing characters and Ranzit produced highest grain yield (5.35 t ha^{-1}). Among the treatments of allelopathic materials araich performed the best on all the parameter studied and gave highest grain yield (5.44 tha^{-1}). Interaction showed significantly higher grain yield, was given by Ranzit with allelopathic materials araich (6.51 t ha^{-1}). The higher grain yield was attributed to the higher effective tillers hill^{-1}(13.67), filled grains panicle^{-1}(256.00) and 1000-grain weight (23.83g).

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LIST OF ACRONYMS

AEZ	=	Agro- Ecological Zone
BARC	=	Bangladesh Agricultural Research Council
BBS	=	Bangladesh Bureau of Statistics
BINA	=	Bangladesh Institute of Nuclear Agriculture
BRRI	=	Bangladesh Rice Research Institute
cm	=	Centi-meter
cv.	=	Cultivar
DAT	=	Days after transplanting
^0C	=	Degree Centigrade
DF	=	Degree of freedom
et al.	=	and others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram
HI	=	Harvest Index
HYV	=	High yielding variety
hr	=	hour
IRRI	=	International Rice Research Institute
Kg	=	kilogram
LV	=	Local variety
LYV	=	Low yielding varieties
LSD	=	Least significant difference
m	=	Meter
m^2	=	meter squares
MPCU	=	Mussorie phos-coated urea
MV	=	Modern variety
mm	=	Millimeter
viz.	=	namely
N	=	Nitrogen
ns	=	Non significant
%	=	Percent
CV %	=	Percentage of Coefficient of Variance
P	=	Phosphorus
K	=	Potassium
ppm	=	Parts per million
PU	=	Prilled urea
SAU	=	Sher-e- Bangla Agricultural University
S	=	Sulphur
SCU	=	Sulphur coated urea
t ha^{-1}	=	Tons per hectare
UNDP	=	United Nations Development Program
USG	=	Urea supergranules
Zn	=	Zinc

Chapter 1

Introduction

Chapter I

INTRODUCTION

Rice (dhan) is a cereal food plant *Oryza sativa,* of the grass family *Gramineae*, extensively cultivated in warm climates, especially in East Asia, producing seeds that are cooked and used as food. The word *Ouliz* of the *Ningpo* dialect of old Chinese language became *Oruz* in Arabic and *Oryza* in Greek Language which were changed to *Ritz* and Rice. Origin of the words *dhan, dhanya* is not known. This crop has a wider adaptability and grows from sea level to a elevation of about 2600 metre (Jumla, Nepal). About 90 percent of the population of Bangladesh is rice eater. The Food Department of the Governmet of Bangladesh recommends 410 gms of rice /head/day. Rice is the rich in carbohydrates. The protein content is about 8.5 percent. Rice does not have C and A vitamins. The Thiamin and Riboflavin contents are 0.27 and 0.12 micrograms respectively. In Bangladesh total cultivable land is 90,98,460 hectare and near about 70 per cent of this land is occupied by Rice cultivation. In the year of 2011, total production of rice was 3,35,41,099 metric ton (BBS, 2011).

Rice is the staple food of about 140.6 million people of Bangladesh (BBS, 2006) and contributes 14.6% to the national GDP (BBS, 2004a) and supplies 71% of the total calories and 51% of the protein in a typical Bangladeshi diet (BBS, 1998). Bangladesh with its flat topography, abundant water and humid tropical climate constitutes an excellent habitat for the rice plant (BRRI, 1997a). In Bangladesh, 8.65 million hectare of arable land of which 75% is devoted to rice cultivation (BBS, 2004b). Rice is grown in the country under diverse ecosystem like irrigated, rainfed and deep water conditions in three distinct overlapping seasons namely *aus*, *aman* and *boro*. Among these three seasons, the monsoon rice, transplanted *aman* covers the largest area (50.58% of total rice area) and average yield of *aman* rice is 3.33 t ha^{-1} (BBS, 2005).

Different varieties of rice have different characters. Rice grain is categorized into coarse, medium coarse and fine with different colour based on physical properties. Some of them have special appeal for their aroma. There are two types of transplant aman rice viz. coarse and fine rice and some of the fine rices are aromatic. The major aromatic varieties indentified are Kalizira, Chinigura, Kataribhog, BR 5, Bashful, BRRI dhan34, BRRI dhan37 BRRI dhan38, Khaskani, Dudshagar, Tulsimala, Khishabhog, and Parbatjira.

Variety itself is a genetic factor which contributes a lot in producing yield and yield components of a particular crop. Yield components are directly related to the variety and neighboring environments in which it grows. Earlier literatures indicated that there were marked differences in yield and ancillary characteristics among rice varieties (Chodury and Bhuian, 1991 and Miah *et al.,* 1989). In the year 2005 among the *aman* rice varieties modern varieties covered 67.99% and yield was 2.3 t ha^{-1} on the other hand local varieties covered 31.91% and yield was 1.37 t ha^{-1} (BBS, 2005).

Subsistence farmers of the tropics spend more time and energy on weed control than any other aspects of rice cultivation. Manual weeding (hand weeding) is generally practiced in major area of rice cultivation in Bangladesh. But the availability of agricultural labourers has now decreased due to employment scope of the labourers in other sectors consequently in recent years for increased cost of agricultural labourers. To reduce the cost of rice production, it has been urgently needed to adopt alternative method of weed control viz. mechanical weed control, biological weed control, and chemical weed control in combination with manual weeding. Mechanical weeding and herbicides are the alternatives to hand weeding. Japanese rice weeder is use in some areas of the country. But due to some disadvantages to use it has not gained widespread popularity. Herbicides are now gaining popularity among the farmers. Now a number of pre-emergence herbicides are available in the market with different trade names. These herbicides are effective in controlling weeds along with hand weeding (Ahmed *et al.*, 2003).

Use of chemical herbicide in crop production is one of the important causes of environmental pollution. Nowadays, there is growing awareness among the scientists in various parts of the world regarding the problems of environmental pollution through the use of chemicals in crop production. As an alternative to chemicals, scientists in the developed nations are trying to develop various bio-fertilizers and biological weed control for reducing environmental pollution and for obtaining pollution free crop production. Use of weed residues to control of weed in rice production has many advantages over herbicide. Weed residues is an organic matter. Whitehead (1963) mentioned that organic manure saves the crop plants from adverse environment. Organic matter reduces soil erosion, increasing water holding capacity and physio-chemical and biological conditions of the soil.

Keeping all the points in mind mentioned above, the present piece of research work was under taken with the following objectives.

1. Compare the performance of three varieties of T. *aman* rice.
2. Find out the effective allelopathic materials to control weeds in rice field.
3. Find out interaction effect of cultivars, and allelopathic materials on the growth, yield and yield contributing characters of T. *aman* rice.

Chapter 2

Review of literature

Chapter II

REVIEW OF LITERATURE

Variety and allelopathic materials are an important factor that influence the plant population unit area^{-1}, availability of sunlight, nutrient competition, photosynthesis, respiration etc. which ultimately influence the growth and development of the crops. Research on effect of variety and allelopathic materials on crop plants are done in different parts of the world are reviewed in this chapter.

2.1 Effect of variety

Variety itself is the genetical factor which contributes a lot for producing yield and yield components. Different researcher reported the effect of rice varieties on yield contributing components and grain yield. Some available information and literature related to the effect of variety on the yield of rice are discussed below.

Om *et al.* (1998) in an experiment with hybrid rice cultivars ORI 161 and PMS 2A x IR 31802 found taller plants, more productive tillers, in ORI 161 than in PMS 2A x IR 31802.

BINA (1993) evaluated the performance of four rice varieties- IRATOM 24, BR14, BINA13 and BINA19. It was found that varieties significantly differed plant height.

BRRI (1991) reported that plant height significantly differed among BR3, BR11, BR14, Pajam and Zagali varieties in *boro* season.

Hossain and Alam (1991) found that the plant height in modern rice varieties in *boro* season BR3, BR11, BR14 and pajam were 90.4, 94.5, 81.3 and 100.7 cm respectively.

Miah *et al.* (1990) conducted an experiment where rice cv. Nizersail and mutant lines Mut. NSI and Mut. NSS were planted and found that the plant height were greater in Mut. NSI than Nizersail.

Shamsuddin *et al.* (1988) conducted a field trial with nine different rice varieties and observed that plant height differed significantly among varieties.

Sawant *et al.* (1986) conducted an experiment with the new rice lines R-73-1-1, R-711 and the traditional cv. Ratna and reported that the traditional cv. Ratna was the shortest.

Devaraju *et al.* (1998) in a study with two rice hybrids such as Karnataka Rice Hybrid 1 (KRH1) and Karnataka Rice Hybrid-2(KRI42) using HYV IR20 as a check variety and found that KRH2 out yielded IR20. In IR20, the tiller number was higher than that of KRH2.

Islam (1995) in an experiment with four rice cultivars *viz.* BR10, BR11, BR22 and BR23 found that the highest number of non bearing tillers hill^{-1} was produced by cultivar BR11 and the lowest number was produced by the cultivar BR10.

Hossain and Alam (1991) found that the growth characters like total tillers hill^{-1} differed significantly among BR3, BR11, Pajam and Jaguli varieties in *boro* season.

Idris and Matin (1990) stated that number of total tillers $hill^{-1}$ was identical among the six varieties studied.

Amin *et al.* (2006) conducted a field experiment to find out the influence of variable doses of N fertilizer on growth, tillering and yield of three traditional rice varieties (*viz.* Jharapajam, Lalmota, Bansful Chikon) were compared with that of a modern variety (*viz.* KK-4) and reported that traditional varieties accumulated higher amount of vegetative dry matter than the modern variety.

Son *et al.* (1998) reported that dry matter production of four inbred lines of rice (low-tillering large panicle type), YR15965ACP33, YR17104ACP5, YR16510-B-B-B-9, and YR16512-B-B-B-10, and cv. Namcheonbyeo and Daesanbyeo, were evaluated at plant densities of 10 to 300 plants m^{-2} and reported that dry matter production of low-tillering large panicle type rice was lower than that of Namcheonbyeo regardless of plant density.

Devaraju *et al.* (1998) also reported that the increased yield of KRH2 was mainly attributed due to the higher number of productive tillers $plant^{-1}$.

Chowdhury *et al.* (1993) reported that the cultivar BR23 showed superior performance over Pajam in respect of yield and yield contributing characters i.e. number of productive tillers $hill^{-1}$.

Wang *et al.* (2006) studied the effects of plant density and row spacing (equal row spacing and one seedling $hill^{-1}$, equal row spacing and 3 seedlings $hill^{-1}$, wide-narrow row spacing and one seedling $hill^{-1}$, and wide-narrow row spacing and 3 seedlings $hill^{-1}$) on the yield and yield components of hybrids and conventional cultivars of rice. Compared with conventional cultivars, the hybrids had larger panicles, heavier seeds, resulting in an average yield increase by 7.27%.

Guilani *et al.* (2003) studied on crop yield and yield components of rice cultivars (Anboori, Champa and LD183) in Khusestan, Iran, during 1997. Grain number panicle^{-1} was not significantly different among cultivars. The highest grain number panicle^{-1} was obtained with Anboori. Grain fertility percentages were different among cultivars. Among cultivars, LD183 had the highest grain weight.

Ahmed *et al.* (1997) conducted an experiment to compare the grain yield and yield components of seven modern rice varieties (BR4, BR5, BR10, BR11, BR22, BR23, and BR25) and a local improved variety, Nizersail. The fertilizer dose was 60-60-40 kg ha^{-1} of N, P_2O_5 and K_2O, respectively for all the varieties and found that percent filled grain was the highest in Nizersail followed by BR25 and the lowest in BR11 and BR23.

BRRI (1994) studied the performance of BR14, BR5, Pajam, and Tulsimala and reported that Tulsimala produced the highest number of filled grains panicle^{-1} and BR14 produced the lowest number of filled grains penicle^{-1}.

BINA (1993) evaluated the performance of four varieties IRATOM 24, BR14, BINA13 and BINA19. They found that varieties differed significantly on panicle length and sterile spikelets panicle^{-1}. It was reported that varieties BINA13 and BINA19 each had better morphological characters like more grains panicle^{-1} compared to their better parents which contributed to yield improvement in these hybrid lines of rice.

BRRI (1991) reported that the filled grains penicle^{-1} of different modern varieties were 95-100 in BR3, 125 in BR4, 120-130 in BR22 and 110-120 in BR23 when they were cultivated in transplant *aman* season.

Idris and Matin (1990) also observed that panicle length differed among the six rice varieties and it was longer in IR20 than in indigenous high yielding varieties.

Singh and Gangwer (1989) conducted an experiment with rice cultivars C-14-8, CR-1009, IET-5656 and IET-6314 and reported that grain number panicle^{-1}, 1000 grain weight were higher for C-14-8 than those of any other three varieties.

Shamsuddin *et al.* (1988) also observed that panicle number hill^{-1} and 1000-grain weight differed significantly among the varieties.

Kamal *et al.* (1998) evaluated BR3, IR20, and Pajam2 and found that number of grain panicle^{-1} were 107.6, 123.0 and 170.9, respectively for the varieties.

Costa and Hoque (1986) studied during kharif-II season, 1985 at Tangail FSR site, Palima, Bangladesh with five different varieties of T. *aman* BR4, BR10, BR11, Nizersail and Indrasail. Significant differences were observed in panicle length and number of unfilled grains panicle^{-1} among the tested varieties.

BRRI (1979) reported that weight of 1000 grains of Haloi, Tilocha-Chari, Nizersail and Latisail were 26.5, 27.7, 19.6 and 25.0 g, respectively.

Swain *et al.* (2006) reported that the control cultivar IR64, with high translocation efficiency and 1000-grain weight and lowest spikelet sterility saw a grain yield of 5.6 t ha^{-1} that was at par with hybrid PA6201.

Molla (2001) reported that Pro-Agro6201 (hybrid) had a significant higher yield than IET4786 (HYV), due to more mature panicles m^{-2}, higher number of filled grains $panicle^{-1}$ and greater seed weight.

Patel (2000) studied that the varietal performance of Kranti and IR36. He observed that Kranti produced significantly higher grain and straw yield than IR36. The mean yield increased with Kranti over IR36 was 7.1 and 10.0% for grain and straw, respectively.

Julfiquar *et al.* (1998) reported that BRRI evaluated 23 hybrids along with three standard checks during *boro* season 1994-95 as preliminary yield trial at Gazipur and it was reported that five hybrids (IR58025A/IR54056, IR54883, PMS8A/IR46R) out yielded the check varieties (BR14 and BR16) with significant yield difference.

Julfiquar *et al.* (1998) also evaluated thirteen rice hybrids in three locations of BADC farm during the boro season of 1995-96. Two hybrids out yielded the check variety of same duration by more than 1 t ha^{-1}.

Rajendra *et al.* (1998) carried out an experiment with hybrid rice cv. Pusa 834 and Pusa HR3 and observed that mean grain yields of Pusa 834 and Pusa HR3 were 3.3 t ha^{-1} and 5.6 t ha^{-1}, respectively.

BRRI (1997b) reported that three modern upland rice varieties namely, BR 20, BR 21, BR 24 was suitable for high rainfall belts of Bangladesh. Under proper management, the grain yield was 3.5 ton for BR20, 3.0 ton for BR21 and 3.5 ton for BR24 ha^{-1}.

Nematzadeh *et al.* (1997) reported that local high quality rice cultivars Hassan Sarai and Sang-Tarom were crossed with improved high yielding cultivars Amol 3, PND160-2-1 and RNR1446 in all possible combinations and released in 1996 under the name Nemat, it gives an average grain yield of 8 t ha^{-1}, twice as much as local cultivars.

BRRI (1995) conducted an experiment to find out varietal performances of BR4, BR10, BR11, BR22, BR23 and BR25 varieties including to local checks Challish and Nizersail produced yields of 4.38, 3.18, 3.12, 3.12 and 2.70 5 t ha^{-1},respectively.

Chowdhury *et al.* (1995) studied on seven varieties of rice, of which three were native (Maloti, Nizersail and Chandrashail) and four were improved (BR3, BR11, Pasam and Mala). Straw and grain yields were recorded and found that both the grain and straw yields were higher in the improved than the native varieties. Liu (1995) conducted a field trial with new indica hybrid rice II-You 92 and found an average yield of 7.5 t ha^{-1} which was 10% higher than that of standard hybrid Shanyou 64.

In field experiments at Gazipur in 1989-1990 rice cv. BR11 (weakly photosensitive), BR22, BR23 and Nizersail (strongly photosensitive) were sown at various intervals from July to Sept. and transplanted from Aug. to Oct.

Among the cv. BR22 gave the highest grain yield from most of the sowing dates in both years (Ali *et al.,* 1993).

Chowdhury *et al.* (1993) also reported that the cultivar BR23 showed superior performance over Pajam in respect of yield and yield contributing characters i.e., grain yield and straw yield.

Suprihatno and Sutaryo (1992) conducted an experiment with seven IRRI hybrids and 13 Indonesian hybrids using 1R64 and way-seputih. They observed that TR64 was highest yielding, significantly out yielding IR64616H, IR64618, IR64610H and IR62829A/IR54 which in turn out yielded way-seputih. Chandra *et al.* (1992) reported that hybrid IR58025A out yielded the IR62829A hybrids and the three control varieties Jaya, IR36 and hybrids IR58025A x 9761-191R and IR58025A IR58025Ax 1R35366-62-1-2-2-3R.

Hossain and Alam (1991) studied farmers production technology in haor area and found that the grain yield of modern varieties of *boro* rice were 2.12, 2.18, 3.17, 2.27 and 3.05 t ha^{-1}, with BR14, BR11, BR9, IR8 and BR3, respectively.

In evaluation of performance of four HYV and local varieties-BR4, BR16, Rajasail and Kajalsail in *aman* season, BR4 and BR16 were found to produce more grain yield among four varieties (BRRI, 1985).

BRRI (1979) also reported that Haloi gave the highest yield (2.64 t ha^{-1}) which was not different from Nizersail (2.64 t ha^{-1}) and Latisail (2.74 t ha^{-1}).

2.2 Effect of allelopathic matarial

Venkatarman and Goplan (1995) observed that the most important weed speecies in transplanted low land rice in Tamil Nadu, India, were *Echinochloa crusgali, Cyperus difformis, Echinochloa colonum, Cyperus iria, Fimbristylis miliacea, Scirpus spp. Eclipta alba, Ludwigia parviflora, Marsilea quadrifolia* and *Monochoria vaginalis,*

Bari *et al.* (1995) observed 53 weed species to grow in transplanted rice field. In respect of abundance value the three most important weeds were *Fimbristylis milacea, Paspalum scrobiculaturm* and *Cyperus rotaundus*.

Mamun *et al.* (1993) identified 60 weed species in T. aman rice of which *Fimbristylis milacea, Lindrnia antipoda and Eriocaulen cinereesm* were the most important weed species.

Elliot *et al.* (1984) reported that in transplanted rice *Monchoria vaginalis* was the important weed and other weed species were *Ischaemum rogusum, Scirpus supinus, Cyperus difformis, Ipomoea aquatic* and *Marsilea minuta.*

Gogoi *et al.* (2000) from Assam reported that different weed control practices significantly reduced the dry matter accumulation of weed and increased the rice yield over the unweeded control in transplanted rice.

Singh *et al.* (1999) studied the effect of various weed management practices on the weed growth and yield and nitrogen uptake in transplanted rice and weeds and reported that weedy control until removed significantly higher amount of nitrogen through weeds (12.97 kg ha^{-1}) and reduced the grain yield of rice by 49% compared to that of weed free crop up to 60 DAT.

Sanjoy *et al.* (1999) observed that control of weeds played a key role in improving the yield of rice because of panicle m^{-2} increased 18% due to weed control over its lower level, number of filled grain panicle^{-1} increased 32% due to weed control over its lower level and significant yield increase was observed (43%) with weed control.

Thomas *et al.* (1997) reported that rice weed competition for moisture was maximum during initial stages and yield losses from uncontrolled weeds might be as high as 74%.

Belz (2007) said since varietal differences in allelopathy of crops against weeds were discovered in the 1970s, much research has documented the potential that allelopathic crops offer for integrated weed management with substantially reduced herbicide rates. Research groups worldwide have identified several crop species possessing potent allelopathic interference mediated by root exudation of allelochemicals. Rice, wheat, barley and sorghum have attracted most attention.

Jena *et al.* (2002) reported that all weed control treatment reduced weed density, dry matter and nutrient uptake increased thus rice yield increased. Oxadiazon had better weed control than Thiobencarb and the preemergence application of Oxadiazon supplemented with hand weeding at 45 DAT recorded the highest weed control efficiency, grain and straw yields and harvest index.

Chapter 3

Materials and Methods

Chapter III

MATERIALS AND METHODS

This chapter presents a brief description about experimental period, site description, climatic condition, crop or planting materials, treatments, experimental design and layout, crop growing procedure, fertilizer application, uprooting of seedlings, intercultural operations, data collection and statistical analysis.

3.1 Experimental period

The experiment was conducted during the period from July to December, 2010 in T. *aman* season.

3.2 Site description

The experiment was conducted in the Sher-e-Bangla Agricultural University farm, Dhaka, under the agro-ecological zone of Modhupur Tract, AEZ-28. For better understanding the experimental site is shown in the Map of AEZ of Bangladesh in Appendix I.

3.3 Climate

The experimental area 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 (October-March). The weather data during the study period at the experimental site is shown in Appendix II.

3.4 Soil

The farm belongs to the General soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done at Soil Resource and Development Institute (SRDI), Dhaka. The physicochemical properties of the soil are presented in Appendix III.

3.5 Crop / planting material

Rice variety BRRI dhan46, Guti Swarna and Ranzit were used as the test crop.

3.5.1 Description of rice cultivars

BRRI dhan46

A high yielding variety of Aman rice BRRI dhan46 was used as a test crop. The variety BRRI dhan46 was developed from the Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh. The height of the variety is 115 cm; it is characterized by deep green and erect leaves. The life cycle of this variety ranges from140-145 days. Its grain size is medium coarse and color of kernel is white. The variety was released in 1994 for cultivation in *aman* season.

3.6 Seed collection and sprouting

Seeds of BRRI dhan46 was collected from BRRI, Joydebpur, Gazipur and Guti Swarna and Ranzit from local market of Sirajganj. Healthy seeds were selected following standard method. Seeds were immersed in water in a bucket for 24 hrs. These were then taken out of water and kept in gunny bags. The seeds started sprouting after 48 hrs which were suitable for sowing in 72 hrs.

3.7 Raising of seedlings

A common procedure was followed in raising of seedlings in the seedbed. The nursery bed was prepared by puddling with repeated ploughing followed by laddering. The sprouted seeds were sown as uniformly as possible. Irrigation was gently provided to the bed as and when needed. No fertilizer was used in the nursery bed.

3.8 Collection and preparation of initial soil sample

The initial soil samples were collected before land preparation from a 0-15 cm soil depth. The samples were collected by means of an auger from different location covering the whole experimental plot and mixed thoroughly to make a composite sample. After collection of soil samples, the plant roots, leaves etc. were and removed. Then the sample was air-dried and sieved through a 10-mesh sieve and stored in a clean plastic container for physical and chemical analysis.

3.9 Preparation of experimental land

The experimental field was first opened on 12 July, 2010 with the help of a power tiller, later the land was irrigated and prepared by three successive ploughings and cross-ploughings. Each ploughing was followed by laddering to have a good puddled field. All kinds of weeds and residues of previous crop were removed from the field. The field layout was made on 25 July, 2010 according to design immediately after final land preparation. Individual plots were cleaned and finally leveled with the help of wooden plank.

3.10 Fertilizer management

At the time of first ploughing cowdung at the rate of 10 t ha^{-1} was applied. The experimental plots were fertilized with @ 120, 100, 50, 62.5 and 10 kg ha^{-1} of N, P_2O_5, K_2O, S & Zn in the form of urea triple superphosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate, respectively before transplanting. The entire amounts of triple superphosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate were applied at final land preparation as basal dose. The urea fertilizer was top dressed in 3 equal installments at 10 DAT, maximum tillering (25 DAT) & before panicle initiation (35 DAT).

3.11 Experimental treatments

The experiment consisted of two factors; (A) three different varieties and (B) five different allelopathic materials. The levels of two factors were as follows:

Factor A: Different types of varieties, **Factor B:** five different allelopathic materials as-

Factor A

V_1:BRRI dhan46

V_2: Guti Swarna

V_3: Ranzit

Factor B

Mo: Control

M_1: *Lantena camera*

M_2: Goose weed (*Spehenoclea zelanica*)

M_3: Ban sharisha (*Brassica kaber*)

M_4: Araich (*Cassia tora*)

The experiment consisted of 15 treatment combinations and was laid out in split plot design with 3 replications. The area was divided into three main plots and rice varieties were placed in the main plots. Each main plot was divided into 5 subplots which received allelopathic materials. The size of subplots was $3m \times 3m = 9m^2$. The distance maintained between two subplots was 100 cm and between blocks was 150 cm.

3.12 Spreading of allelopathic materials

Dry mass of five different allelopathic materials @ 0.3 kgm^{-2} was applied in each plots as per design and incorporated to the soil before transplanting of rice seedlings.

3.13 Uprooting and Transplanting of seedlings

The seed beds were made wet by application of water in previous day before uprooting the seedlings. Thirty days old seedlings were uprooted carefully with minimum injury of roots. Seedlings were then transplanted maintaining spacing of 25 cm × 15 cm distance from row to row and hill to hill, respectively.

3.14 Intercultural operations

3.14.1 Gap filling

After one week of transplanting, a minor gap filling was done where it was necessary using the seedling from the same source.

3.14.2 Weeding

Two hand weedings were done at 20 and 40 DAT from which weed populations and weed dry matter was recorded.

3.14.3 Application of irrigation water

Irrigation water was added to each plot as and when needed.

3.14.4 Plant protection measures

Plants were infested with rice stem borer and leaf hopper to some extent which was successfully controlled by applying two times of Diazinone 60 EC on 25 August and 10 September, 2010. Crop was protected from birds during the grain filling period.

3.15 General observation of the experimental field

The field was investigated time to time to detect visual difference among the treatment and any kind of infestation by weeds, insects and diseases so that considerable losses by pest could be minimized. The field looked nice with normal green color plants. Incidence of stem borer, green leaf hopper, leaf roller was observed during tillering stage. But any bacterial and fungal disease was not observed. The flowering was not uniform.

3.16 Harvesting and post harvest operation

Maturity of crop was determined when 90% of the grains become golden yellow in color. The harvesting was done on 3 December 2010 with ten pre-selected hills from which different crop characters data were collected and 6 mid lines from each plot was separately harvested, bundled, properly tagged and then brought to the threshing floor. Threshing was done by pedal thresher. The grains were cleaned and sun dried to moisture content at 12%. Straw was also sun dried properly. Finally grain and straw yields plot^{-1} were recorded and converted to t ha^{-1}.

3.17 Recording of data

A. Crop growth characters

Plant height (cm) at 20, 40, 60, 80 DAT and at harvest

Number of tillers hill^{-1} at 20, 40, 60 and 80 DAT

Total dry mater weight at 30, 60 and 90 DAT

B . Weed data

Number of weeds per plot at 20 and 40 DAT

Dry weight of weeds at 20 and 40 DAT

C. Yield contributing and other crop characters

Number of effective tillers

Number of non effective tillers

Length of panicle

Number of filled grains panicle^{-1}

Number of unfilled grains panicle^{-1}

Weight of 1000- grain (g)

D. Yield

Grain yield (t ha^{-1})

Straw yield (t ha^{-1})

Biological yield (t ha^{-1})

Harvest index (%)

3.18 Experimental measurements

Experimental data collection began at 20 days after transplanting, and continued till harvest. The necessary data on agronomic characters were collected from ten selected hills from each plot at different growth stages.

Number of weed per plot

Number of weeds per plot was measured at 20 and 40 days after transplantation. Number of weeds per plot was counted from $1m^2$ area of each plot and then averaged.

Plant height

Plant height was measured 20 DAT at 20 days interval and continued up to harvest. The height of the plant was determined by measuring the distance from the soil surface to the tip of the leaf before heading, and to the tip of panicle after heading.

Number of tillers hill^{-1}

Number of tillers hill^{-1} were counted 20 DAT at 20 days interval up to harvest from pre selected ten hills and finally averaged as their number hill^{-1}. Only those tillers having three or more leaves were considered for counting.

Total dry matter

After harvesting the plants total dry matter was measured based on their weight of shoot and root in gram.

Dry weight of weeds per m^2

Weeds were collected from 1 m^2 in each plot and washed by tap water, oven dried for 24 hours at 70° C temperature and then weighed by eclectic balance.

Number of effective tillers hill^{-1}

Five hills from each plot were uprooted and effective tillers were counted and averaged to per hill basis. The panicles which had at least one grain was considered as effective tiller.

Number of non effective tillers hill^{-1}

Five hills from each plot were uprooted from which non effective tillers were counted and averaged to per hill basis. The tiller having no panicle was regarded as non effective tiller.

Panicle length

Measurement of panicle length was taken from basal node of the rachis to apex of each panicle. Each observation was an average of 10 panicles.

Number of fertile spikelets (filled grains) panicle^{-1}

Spikelet was considered to be fertile if any kernel was present there in. The number of total filled grains present on each panicle was recorded and finally averaged to per panicle basis.

Number of sterile spikelets (unfilled grains) panicle^{-1}

Sterile spikelet means the absence of any kernel inside in and such spikelets present on each panicle were counted and averaged to per panicle basis.

Weight of 1000-grains

One thousand cleaned dried seeds were counted randomly from each sample and weighed by using a digital electric balance at the stage the grain retained 12% moisture and the mean weight were expressed in gram.

Grain yield

Grain yield was determined from the central 5 m length of all 6 inner rows of the plot and expressed as t ha^{-1} on 12% moisture basis. Grain moisture content was measured by using a digital moisture tester.

Straw yield

Straw yield was determined from the central 5 m length of all 6 inner rows of each plot. After threshing, the sub-sample was oven dried to a constant weight and finally converted to t ha^{-1}.

Biological yield

The biological yield was calculated with the following formula-

Biological yield = Grain yield + Straw yield

Harvest index (%)

The harvest index denotes the ratio of economic yield to biological yield and was calculated with following formula (Gardner *et al.*, 1985).

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

3.19 Statistical analysis

The recorded data on various parameters were statistically analyzed. Using MSTAT-C statistical package programmed. The mean for all the treatments was calculated and analysis of variance for all the characters was performed by F-test. Difference between treatment means were determined by least significant difference (LSD) test according to Gomez and Gomes (1984).

Chapter 4
Results and Discussion

Chapter IV

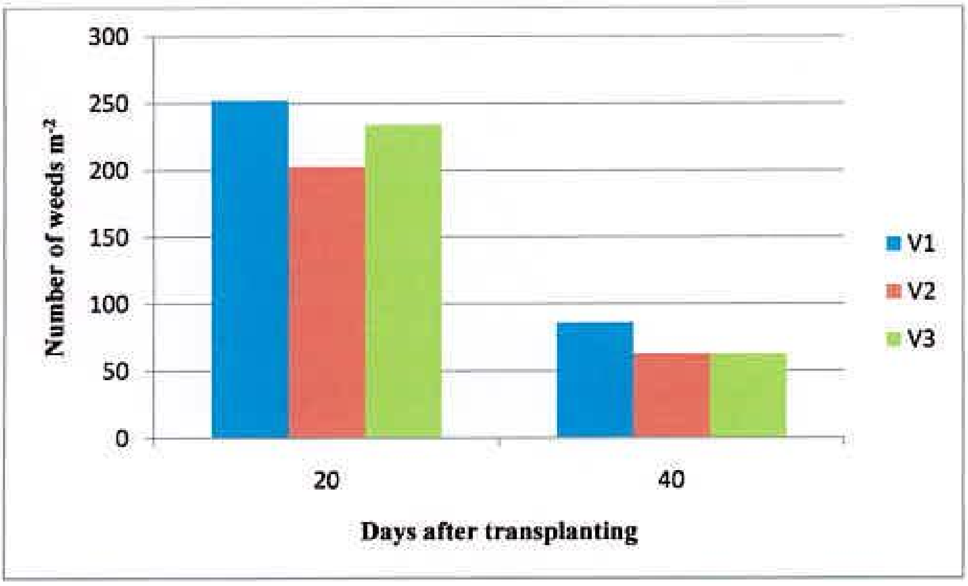
RESULTS AND DISCUSSION

The experiment was conducted to investigate the weed status morpho-physiological attributes and yield of three rice varieties and effectiveness of different weed residues to control weeds in *T. aman* season. Data on different parameters were analyzed statistically. The result of the present study have been presented and discussed in this chapter under the following heading.

4.1 Number of total weeds m^{-2}

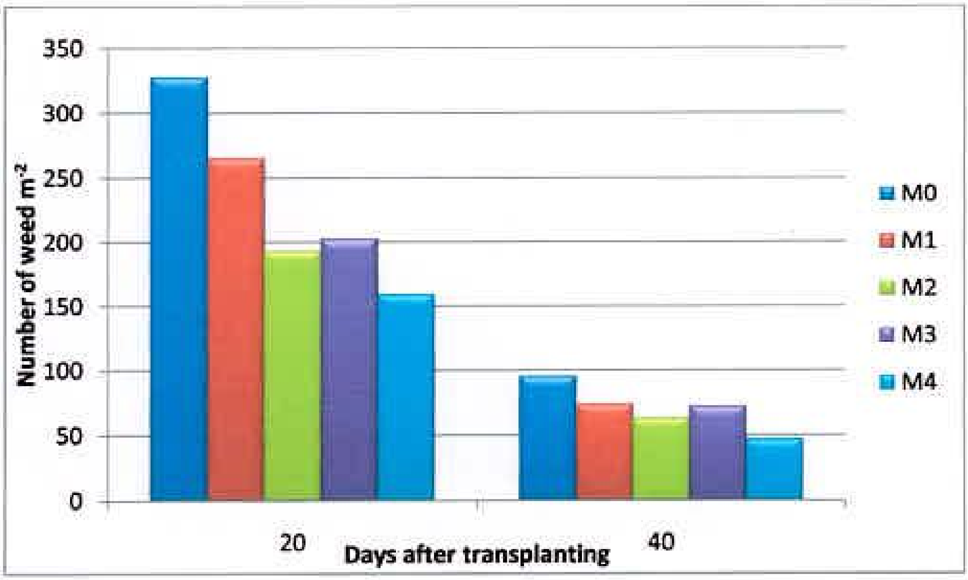
The number of total weeds m^{-2} was significantly influenced by variety at all stages of crop growth (Fig. 1). The V_1 variety grown with maximum weeds (252.3 and 86.20 at 20 and 40 DAT, respectively), where as in the case of V_2 minimum weeds (202.8 and 62.6 at 20 and 40 DAT, respectively) production was observed.

Statistically significant variation was recorded for number of total weeds m^{-2} at 20 and 40 DAT due to allelopathic materials. The maximum number of total weeds m^{-2} was obtained from M_0 (327.90 and 95.78 at 20 and 40 DAT, respectively) while the minimum number was recorded from M_4 (159.40 and 47.00 at 20, and 40 DAT, respectively) (Fig. 2). Premasthira and Zungsonthiporn (1999) indicated that the plant growth inhibitor in Goose weed was released in to the environment by root exudation and it was identified as Thiosulfinate and Secoiridoids glucoside..



V$_1$:BRRI dhan46 V$_2$: Guti Swarna V$_3$: Ranzit

Figure 1. Effect of variety on number of weeds m^{-2} of rice at different day after transplanting (LSD$_{(0.05)}$ =26.91&14.68 at 20 & 40 DAT, respectively).



Mo: Control M$_1$: *Lantena camera* M$_2$: Goose weed M$_3$: Ban shrisha M$_4$: Araich

Figure 2. Effect of different allelopathic materials on number of weeds m^{-2}of rice at different day after transplanting. (LSD$_{(0.05)}$ =53.58&28.63 at 20 & 40 DAT, respectively).

The effect of variety and different allelopathic materials on number of total weeds m^{-2} was statistically significant at different day after transplanting (Table 1). The maximum total number of total weeds m^{-2} (397.00 and 126.7 at 20 and 40 DAT, respectively) was found from V_1M_0 (BRRI dhan46 with control) and minimum number of total weeds m^{-2} (136.7 and 43.67 at 20 and 40 DAT, respectively) from V_3M_4 (Ranzit with araich).

4.2 Dry weight of weeds m^{-2}

It was evident from Figure 3 that irrespective of treatments dry weight of weeds m^{-2} of rice significantly varied at all sampling dates. V_1 associated with significant higher amount of dry weight of weeds m^{-2} (138.3 and 17.21 g m^{-2} at 20 and 40 DAT, respectively). Lower amount of dry weight of weeds (100.6, and 14.67 g m^{-2} at 20 and 40 DAT, respectively) production in V_2.

Different allelopathic materials showed statistically significant differences for dry weight of weeds m^{-2} at, 20 and 40 DAT. The maximum dry weight of weeds m^{-2} was recorded from M_0 (154.00 and 20.73 g at 20 and 40 DAT, respectively) (control), whereas the lowest was observed from M_4 (93.67 and 9.55 g) (Araich) (Fig. 4).

Table 1. Interaction effect of variety and different allelopathic materials on number of weeds and dry weight of weeds m^{-2} of rice at different days after transplanting

	Number of weeds m^{-2}				Dry weight of weeds m^{-2}			
	20DAT		40DAT		20DAT		40DAT	
V_1M_0	397.00	a	126.70	a	180.00	a	23.13	a
V_1M_1	354.70	b	98.67	b	153.30	b	21.13	b
V_1M_2	193.00	g	76.67	bcd	117.70	de	16.40	d
V_1M_3	178.30	h	85.33	bc	126.70	cd	15.03	e
V_1M_4	138.30	i	51.67	ef	113.70	ef	10.36	h
V_2M_0	290.00	c	94.00	b	132.00	c	20.67	b
V_2M_1	231.00	d	61.67	cf	103.70	fg	18.32	c
V_2M_2	150.00	i	55.00	df	103.70	fg	12.13	g
V_2M_3	206.30	fg	56.67	df	91.33	g	12.80	fg
V_2M_4	203.30	fg	45.67	f	72.33	h	9.45	hi
V_3M_0	296.70	c	66.67	cf	150.00	b	18.39	c
V_3M_1	211.00	ef	61.67	cf	95.00	g	16.43	d
V_3M_2	236.70	d	58.33	def	136.70	c	17.16	d
V_3M_3	223.30	de	75.00	be	136.70	c	13.66	f
V_3M_4	136.70	i	43.67	f	95.00	g	8.853	i
CV	10.29		9.04		10.17		11.82	
LSD(0.05)	12.91		21.43		11.93		1.011	

V_1:BRRI dhan46

V_2: Guti Swarna

V_3: Ranzit

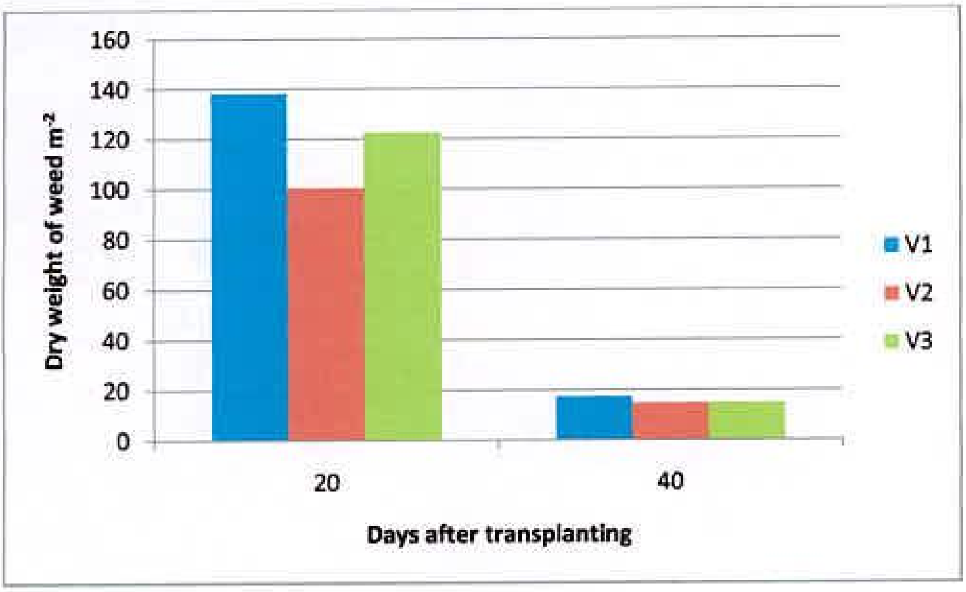
Mo: Control

M_1: *Lantena camera*

M_2: Goose weed

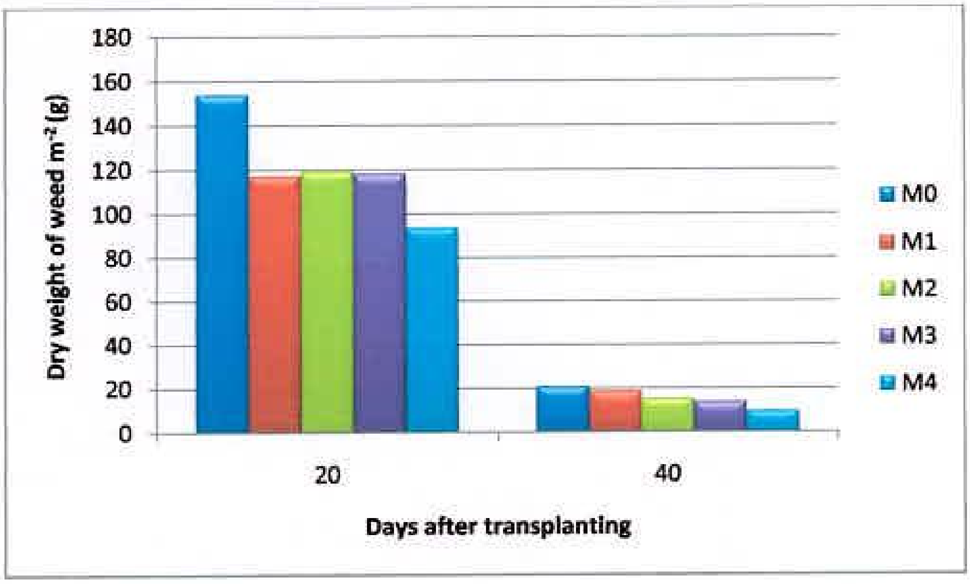
M_3: Ban shrisha

M_4: Araich



V_1:BRRI dhan46 V_2: Guti Swarna V_3: Ranzit

Figure 3. Effect of variety on dry weight of weeds m^{-2} of rice at different day after transplanting ($LSD_{(0.05)}$ =24.87&2.01at 20 & 40 DAT, respectively).



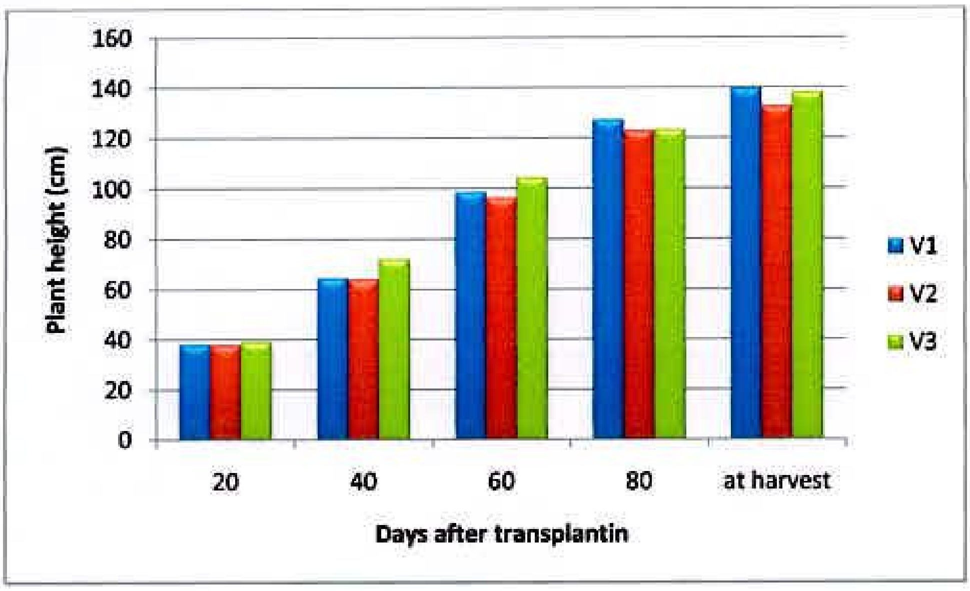
Mo: Control M_1: *Lantena camera* M_2: Goose weed M_3: Ban shrisha M_4: Araich

Figure 4. Effect of different allelopathic materials dry weight of weeds m^{-2} of rice at different day after transplanting ($LSD_{(0.05)}$ =16.05&1.36 at 20 & 40 DAT, respectively).

The effect of variety and allelopathic materials on dry weight of weeds m^{-2} was statistically significant at different day after transplanting (Table 1). The maximum dry weight of weeds m^{-2} (23.13 and 7.71 g at 20 and 40 DAT, respectively) was found from V_1M_0 (BRRI dhan 46 with control) and minimum dry weight of weeds m^{-2} (8.85 and 1.84 g at 20 and 40 DAT, respectively) from V_3M_4 (Ranzit with allelopathic materials araich).

4.3 Plant height

Plant height of the cultivars was measured at 20, 40, 60 and 80 days after transplanting and at harvest. It was evident from Figure 5 that the height of the plant was not significantly influenced by variety at all the sampling dates. Irrespective of varieties, the height of rice plants increased rapidly at the early stages of growth and rate of progress in height was slow at the later stages. The V_3 variety produced the tallest plant (39.00, 71.93, 104.30, 123.30 and 139.5 cm at 20, 40, 60, 80 DAT and harvest, respectively) and V_2 produced shorter (37.96, 63.80, 96.13, 122.8 and 132.5 cm at 20, 40, 60 and 80 DAT, and harvest, respectively). Probably the genetic makeup of varieties was responsible for the variation in plant height. This confirms the reports of BINA (1992), BRRI (1991) and Shamsuddin *et al.* (1988) that plant height differed due to varietal variation.



V_1:BRRI dhan46 V_2: Guti Swarna V_3: Ranzit

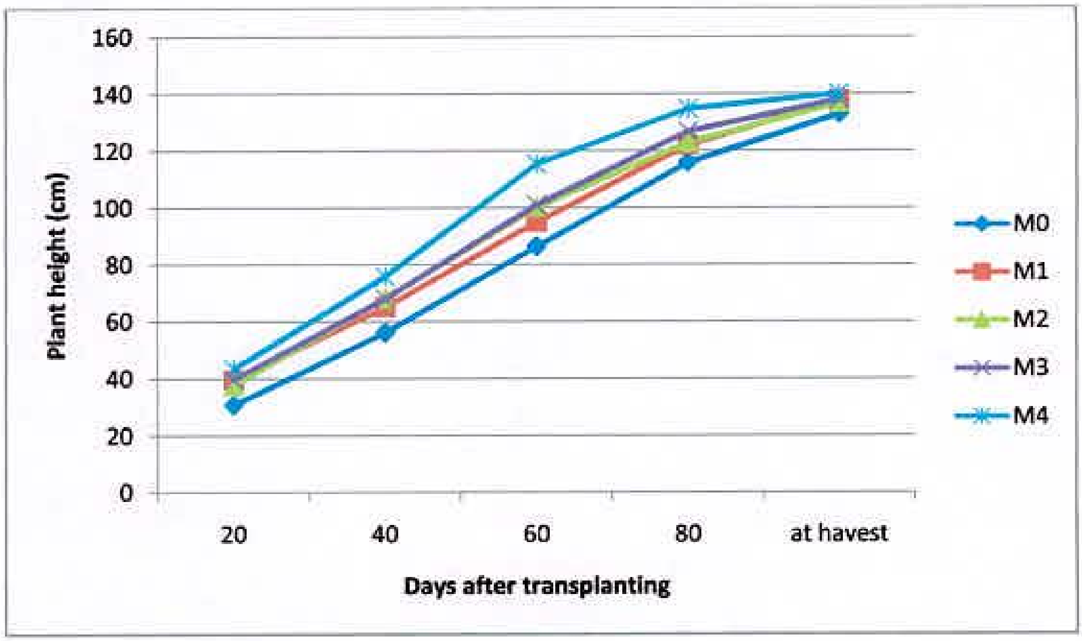
Figure 5. Effect of variety on plant height of rice at different days after transplanting ($LSD_{(0.05)}$=1.42,8.03,6.50&3.76 at 20,40,60 & 80 DAT, respectively).

Plant height of rice showed statistically significant differences at 20, 40, 60 , 80 DAT and harvest due to different allelopathic materials . The tallest plant was recorded from M_4 (43.53, 75.89, 115.4, 134.7 and 140.00 cm at 20, 40, 60, 80 DAT and harvest, respectively) treatment, while the shortest plant was observed from M_0 (30.89, 56.22, 86.44, 115.9 and 132.90 cm at 20, 40, 60 and 80 DAT and at harvest, respectively) (Fig. 6).

Plant height at different DAT was significantly affected by the interaction between variety and weeds management (Table 2). The tallest plant (44.4, 79.00, 133.00, 142.00 and 146.30 cm at 20, 40, 60 and 80 DAT and at harvest, respectively) was found from V_3M_4 and shortest plant (28.20, 49.33, 81.00, 113.00 and 129.00 cm at 20, 40, 60 and 80 DAT and at harvest, respectively) from V_2M_0.

4.4 Number of total tiller hill^{-1}

The number of total tillers hill^{-1} was significantly influenced by variety at all stages of crop growth (Fig. 7). The V_1 variety (BRRI dhan46) produced highest number of tiller hill^{-1} (8.60, 19.87, 13.60 and 12.93 at 20, 40, 60 and 80 DAT, respectively); where as in the case of V_2 minimum tiller (5.27, 14.47, 12.07 and 11.67 at 20, 40, 60 and 80 DAT, respectively) production was observed. The value decreased because some of the last emerged tillers died due to their failure in competing for light and nutrients. This revealed that during the reproductive and ripening phases the rate of tiller mortality exceeded the tiller production rate (Roy and Satter, 1992). Variable effect of variety on.



Mo: Control M_1: *Lantena camera* M_2: Goose weed M_3: Ban shrisha M_4: Araich

Figure 6. Effect of different allelopathic materials on plant height (cm) of rice at different day after transplanting ($LSD_{(0.05)}$ =2.23,3.92,1.29 & 1.86 at 20,40,60 & 80 DAT,respectively).

Table 2. Interaction effect of variety and different allelopathic materials on plant height (cm) of rice at different days after transplanting.

Treatment	Plant height (cm)									
	20DAT		40 DAT		60 DAT		80 DAT		At harvest	
V_1M_0	32.73	fg	53.33	ef	93.33	cde	117.7	de	138.30	cdef
V_1M_1	35.2	efg	60.67	de	90.67	cde	121	cde	133.30	fghi
V_1M_2	39.13	cde	64.67	cd	98.33	bcd	125.7	bcd	137.00	def
V_1M_3	40.2	abcd	67	bcd	101.00	bc	129.7	bc	136.00	defg
V_1M_4	42.53	abc	76	ab	109.3	b	130	bc	140.70	bcd
V_2M_0	28.2	h	49.33	f	8.00	e	113	e	129.00	i
V_2M_1	44	ab	64.67	cd	96.67	bcd	124.7	bcd	134.00	fgh
V_2M_2	37.67	de	68.33	bcd	97.67	bcd	120	cde	144.00	ab
V_2M_3	40.73	abcd	64	cd	101.30	bc	124.3	bcd	142.70	abc
V_2M_4	43.67	ab	72.67	abc	104.00	bc	132	b	137.30	def
V_3M_0	31.73	gh	66	cd	85.00	de	117	de	135.30	efgh
V_3M_1	39.53	bcde	70	abcd	97.67	bcd	120.3	cde	131.30	ghi
V_3M_2	36.47	def	71.67	abc	105.00	bc	123	bcde	139.30	bcde
V_3M_3	38.47	cde	73	abc	100.70	bc	126.3	bcd	131.00	hi
V_3M_4	44.4	a	79	a	133.00	a	142	a	146.30	a
CV (%)	4.023		8.644		12.73		9.478		4.405	
$LSD_{(0.05)}$	6.25		7.7		12.58		5.52		6.80	

V_1:BRRI dhan46

V_2: Guti Swarna

V_3: Ranzit

Mo: Control

M_1: *Lantena camera*

M_2: Goose weed

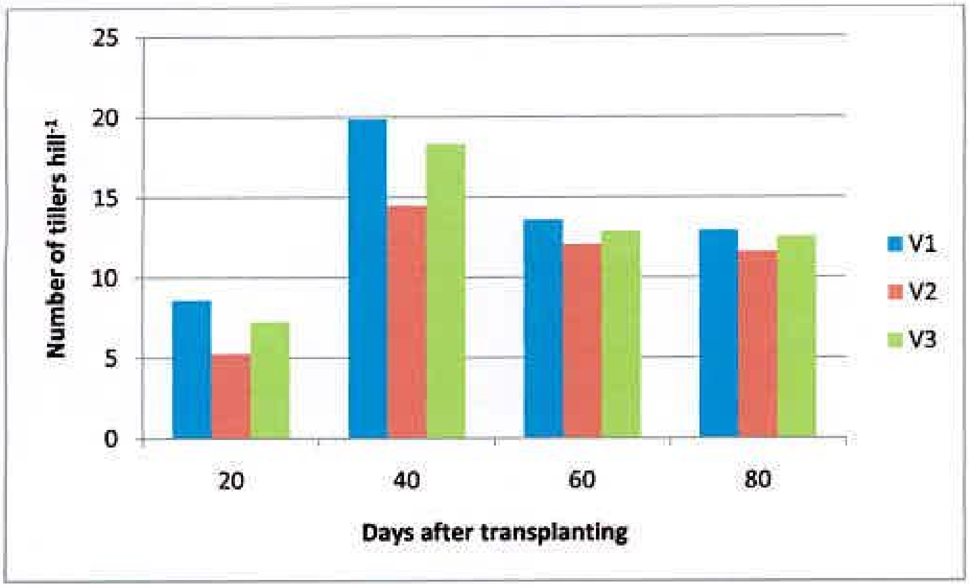
M_3: Ban shrisha

M_4: Araich

number of total tillers hill^{-1} was also reported by Hussain *et al.* (1989) who noticed that number of total tillers hill^{-1} differed among the varieties

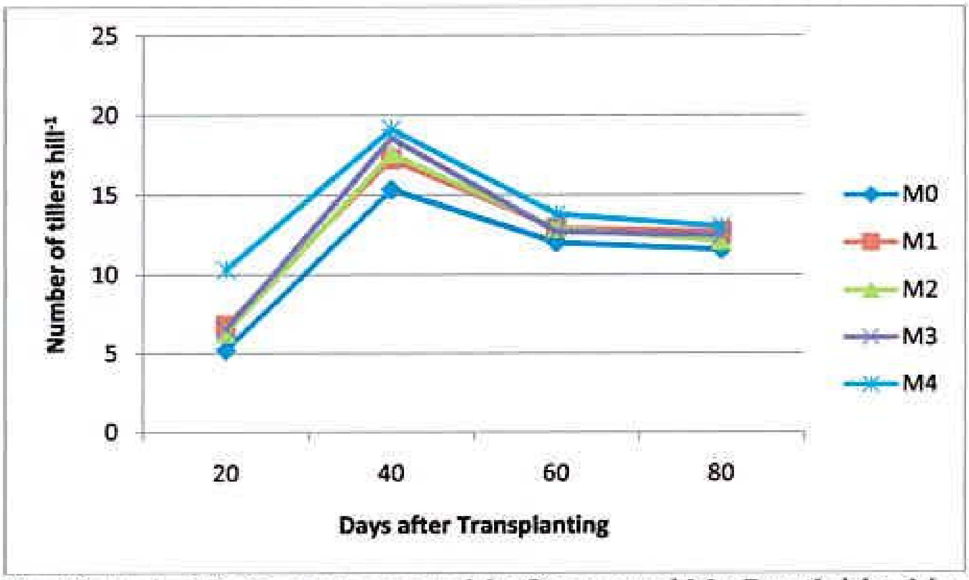
Statistically variation was recorded for number of tillers hill^{-1} at 20, 40, 60 and 80 days after transplanting due to the different allelopathic materials. The maximum number of tillers hill^{-1} was obtained from M_4 (10.33, 19.11, 13.78 and 13.00 at 20, 40, 60 and 80 DAT, respectively) while the minimum number was recorded from M_0 (5.22, 15.33, 12.00 and 11.56 at 20, 40, 60 and 80 DAT, respectively) (Fig. 8).

The effect of variety and allelopathic materials were statistically significant at different day after transplanting (Table 3). The highest total number of tillers hill^{-1} (12.00, 21.33, 16.67 and 13.67 at 20, 40, 60 and 80 DAT, respectively) was found from V_3M_4 (Ranzit with allelopathic materials araich) and the lowest total number of tillers hill^{-1} (3.33, 10.33, 10.00 and 10.00 at 20, 40, 60 and 80 DAT, respectively) from V_2M_0 (Guti swarna with no allelopathic material).



V_1:BRRI dhan46 V_2: Guti Swarna V_3: Ranzit

Figure 7. Effect of variety on total tiller hill^{-1} of rice at different days after transplanting ($LSD_{(0.05)}$ =2.23,3.91,1.29 & 1.87 at 20,40,60 & 80 DAT,respectively).



Mo: Control M_1: *Lantena camera* M_2: Goose weed M_3: Ban shrisha M_4: Araich

Figure 8. Effect of different allelopathic materials on total tiller hill^{-1} of rice at different days after transplanting ($LSD_{(0.05)}$ =2.73,2.52,1.20& 1.70 at 20,40,60 & 80 DAT,respectively).

Table 3. Interaction effect of variety and different allelpathic materials on Number of tiller hill^{-1} rice at different days after transplanting.

	Number of tiller							
Treatment	20DAT		40DAT		60DAT		80DAT	
V_1M_0	7.67	c	18.67	bcde	12.00	bc	11.33	ab
V_1M_1	8.67	bc	14.67	g	13.33	bc	13.00	ab
V_1M_2	7.33	c	14.00	g	13.00	bc	13.00	ab
V_1M_3	7.33	c	17.67	cdef	13.00	bc	12.00	ab
V_1M_4	10.00	ab	15.67	fg	13.00	bc	13.67	a
V_2M_0	3.33	e	10.33	h	10.00	c	10.00	b
V_2M_1	4.33	e	16.67	ef	13.33	abc	13.00	ab
V_2M_2	4.67	e	17.33	def	11.33	bc	10.67	ab
V_2M_3	5.00	de	19.33	abcd	12.67	bc	12.33	ab
V_2M_4	9.00	bc	19.67	abc	11.67	bc	13.33	a
V_3M_0	4.67	e	17.00	ef	14.00	ab	13.33	a
V_3M_1	7.33	c	20.33	ab	12.00	bc	12.00	ab
V_3M_2	7.00	cd	20.33	ab	14.33	ab	12.67	ab
V_3M_3	7.33	c	20.33	ab	12.33	bc	11.33	ab
V_3M_4	12.00	a	21.33	a	16.67	a	13.67	a
CV	10.09		9.30		11.31		13.52	
$LSD_{(0.05)}$	2.029		1.877		3.019		2.814	

V_1:BRRI dhan46

V_2: Guti Swarna

V_3: Ranzit

Mo: Control

M_1: *Lantena camera*

M_2: Goose weed

M_3: Ban shrisha

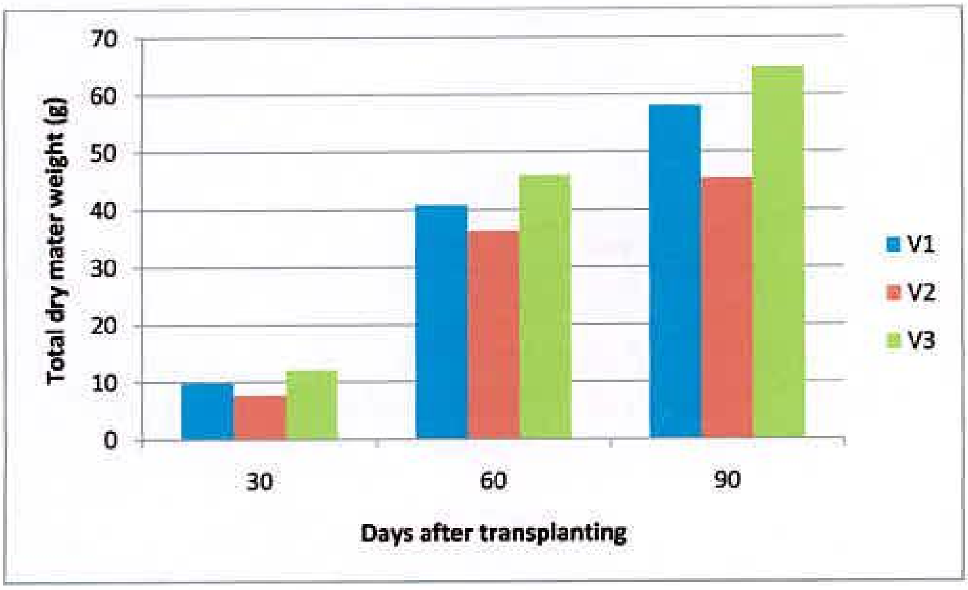
M_4: Araich

4.5 Total dry matter production

Total dry matter (TDM) production indicates the production potential of a crop. A high TDM production is the first perquisite for high yield. TDM of leaves, leaf sheath + stem and or panicles of used varieties data were measured at different days after transplanting. It was evident from Figure 9 TDM of rice variety significantly varied at all sampling dates. V_3 had significant highest amount of dry matter (12.14, 45.93, and 64.80 g hill^{-1} at 30, 60 and 90 DAT, respectively). The lowest amount of dry matter (7.73, 36.36, and 45.4 g hill^{-1} at 30, 60, and 90 DAT, respectively) production in Guti swarna might be due to lodging in heading stage. This confirms the reports of Amin *et al.* (2006) and Son *et al.* (1998) that total dry matter production differed due to varietal variation.

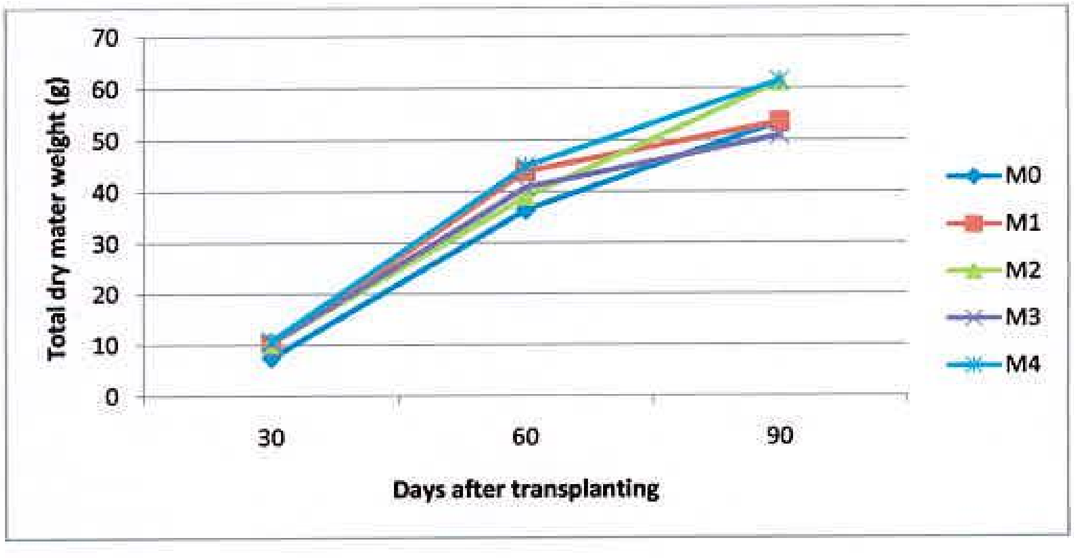
Different allelopathic materials showed statistically significant differences for dry matter plant^{-1} of rice at 30, 60 and 90 DAT. The highest dry matter plant^{-1} was recorded from M_4 (10.84, 44.91 and 61.44 g at 30, 60 and 90 DAT, respectively) (Araich), whereas the lowest was observed from M_0 (7.52, 36.44 and 53.44 g) (control) (Fig. 10).

The effect of variety and allelopathic materials on dry matter plant^{-1} was statistically significant at different days after transplanting (Table 4). The maximum dry matter plant^{-1} (15.87, 53.17 and 77.33 g at 30, 60 and 90 DAT, respectively) was found from V_3M_4 (Ranzit with allelopathic materials of araich) and minimum dry matter plant^{-1} (5.06, 30.42 and 35.33 g at 30, 60 and 90 DAT, respectively) from V_2M_0 (Guti sarma with control).



V$_1$:BRRI dhan46 V$_2$: Guti Swarna V$_3$: Ranzit

Figure 9. Effect of variety on total dry matter production of rice at days after transplanting (LSD$_{(0.05)}$ =3.72,4.78 & 11.63 at 30,60 & 90 DAT,respectively).



Mo: Control M$_1$: *Lantena camera* M$_2$: Goose weed M$_3$: Ban shrisha M$_4$: Araich

Figure 10. Effect of different allelopathic materials on total dry matter production of rice at days after transplanting (LSD$_{(0.05)}$ =4.40,3.09&7.50 at 30,60 & 90 DAT,respectively).

Table 4. Interaction effect of variety and different allelopathic materials on total dry matter weight of rice at different days after transplanting.

Treatment	Total Dry mater weight					
	30D		60D		90D	
V_1M_0	11.6	bc	36.6	e	56.33	efg
V_1M_1	8.68	efg	54.55	a	59	def
V_1M_2	5.773	hi	50.38	b	71.33	b
V_1M_3	8.74	efg	37.42	e	63.67	cd
V_1M_4	10.42	cde	50.7	b	40	i
V_2M_0	5.057	i	30.42	g	35.33	i
V_2M_1	11.02	cd	37.25	e	39.67	i
V_2M_2	9.643	cde	36.47	e	45.67	h
V_2M_3	9.16	def	34.9	ef	53.33	fg
V_2M_4	7.527	fgh	40.5	d	53	fg
V_3M_0	13.42	b	43.53	c	51	gh
V_3M_1	10.92	cd	39.92	d	61.67	cde
V_3M_2	7.113	gh	32.67	fg	66.67	bc
V_3M_3	13.36	b	37	e	67.33	bc
V_3M_4	15.87	a	53.17	a	77.33	a
CV	10.99		9.83		7.00	
LSD(0.05)	1.787		2.294		5.576	

V_1:BRRI dhan46

V_2: Guti Swarna

V_3: Ranzit

Mo: Control

M_1: *Lantena camera*

M_2: Goose weed

M_3: Ban shrisha

M_4: Araich

4.6 Number of effective tiller hill^{-1}

The number of effective tillers hill^{-1} was not significantly influenced by variety at harvest (Table 5). Varietal effects on the formation of number of effective tillers are shown in Table 5. V_2 (Guti swarna) produced maximum effective tiller (12.40), where as in the case of V_3 (Ranzit) minimum effective tiller (11.33) production was observed.

Statistically variation was recorded for number of effective tillers hill^{-1} at harvest for different allelopathic materials. The maximum number of effective tillers hill^{-1} was obtained from M_4 (14.67) while the minimum number was recorded from M_0 (8.78) (Table 5).

The effect of variety and weeds management effective tillers were statistically significant at harvest (Table 5). The maximum number of effective tiller hill^{-1} (15.33) was found from V_2M_4 (Guti swarna with allelopathic materials araich) and minimum number of effective tiller hill^{-1} (8.00) from V_3M_0 (Ranzit with control).

4.7 Number of non effective tiller hill^{-1}

The number of non effective tillers hill^{-1} was significantly influenced by variety at harvest (Table 5). V_3 (Ranzit) produced maximum non effective tiller (8.53), where as in the case of V_1 (BRRI dhan46) minimum non effective tiller (2.40) production was observed.

Table 5.Effect of variety and different allelopathic materials and their interaction on the effective tiller, non effective tiller, length of panicle, filled grain and unfilled grain panicle^{-1} of rice

Treatment	Effective tiller (no.)	Non effective tiller (no.)	Length of panicle (cm)		Filled grain panicle^{-1}(no)		Unfilled grain panicle^{-1}(no)	
Variety								
V_1	12.02	2.40	27.33		209.7	b	23.33	
V_2	12.4	5.93	25.73		209.5	b	21.27	
V_3	11.33	8.53	27.40		219.3	a	11.53	
LSD $_{(0.05)}$	NS	3.32	NS		4.941		NS	
Allelopathic materials								
M_0	8.778b	6.89a	25.44	b	195.4	e	34	a
M_1	11.56ab	5.67ab	27.33	ab	206.2	c	15.33	b
M_2	12.56a	5.00ab	26.78	ab	201.3	d	17.78	b
M_3	12.22ab	6.66a	26.78	ab	219.6	b	13.11	b
M_4	14.67a	4.00b	27.78	a	241.7	a	13.33	b
LSD $_{(0.05)}$	3.648	2.14	2.083		3.188		8.411	
Combined effect								
V_1M_0	8.67ef	1.67d	26.67	cde	184.7	j	12.67	efg
V_1M_1	11.00cde	3.67c	27.33	a-e	201.3	g	13.33	defg
V_1M_2	12.33a-d	1.67d	27.67	a-d	186	j	28	b
V_1M_3	13.67abc	4.30c	27.00	b-e	231.7	d	10.67	fg
V_1M_4	14.67ab	1.00d	28.00	abc	245	b	11.33	fg
V_2M_0	9.67def	9.00a	24.00	f	198.7	h	71.33	a
V_2M_1	12.33a-d	4.33c	26.00	de	236.3	c	21.33	c
V_2M_2	13.00abc	4.33c	26.0	de	191	i	19.33	cde
V_2M_3	11.67b-e	7.67ab	26.33	cde	197.3	h	17.67	cdef
V_2M_4	15.33a	4.33c	26.33	cde	224	f	20	cd
V_3M_0	8.00f	9.00a	25.67	e	203	g	12.67	efg
V_3M_1	11.33cde	9.00a	28.67	ab	181		11.33	fg
V_3M_2	12.33a-d	9.00a	26.67	cde	227	e	11.33	fg
V_3M_3	11.33cde	9.00a	27	b-e	229.7	d	11	fg
V_3M_4	13.67abc	6.67b	29	a	256	a	8.667	g
CV (%)	13.48	8.38	5.43		11.31		14.77	
LSD(0.05)	2.711	1.593	1.548		2.365		6.253	

Statistically variation was recorded for number of non effective tillers hill^{-1} at harvest. The maximum number of effective tillers hill^{-1} was obtained from M_0 (6.89) while the minimum number was recorded from M_4 (4.00) (Table 5).

The effect of variety and allelopathic materials on non effective tilizer was statistically significant at harvest (Table 5). The maximum number of non effective tiller hill^{-1} (9.00) was found from V_1M_0 (Ranzit with control) and minimum number of non effective tiller hill^{-1} (1.00) from V_1M_4 (BRRI dhan46 with allelopathic materials Araich).

4.8 Panicle length

The panicle length was not significantly varied due to variety shown in Table 5. It was observed that Ranzit produced numerically longer (27.40 cm) panicle than V_2 (25.73 cm). This disagreed the report of Ahmed *et al.* (1997) and Idris and Matin (1990) that panicle length was differed due to variety.

Length of panicle showed statistically significant differences due to the different allelopathic materials. The longest panicle was recorded from M_4 (27.28 cm) and the shortest panicle was observed from M_0 (25.44 cm) treatment (Table 5).

Panicle length was statistically influenced by the interaction of variety and different allelopathic materials (Table 5). The highest panicle length (29.00 cm) was observed from V_3M_4 and the lowest (24.00 cm) panicle length was produced form V_2M_0 treatment.

4.9 Number of filled grains panicle^{-1}

Table 5 showed that cultivars affected significantly in number of filled grains panicle^{-1}. The V_3 (Ranzit) gave highest number (219.30) of grains panicle^{-1} than V_2 (209.70). BRRI (1994) found that number of filled grains panicle^{-1} significantly differed with varieties.

Statistically significant variation was recorded for number of filled grains panicle^{-1} showed differences due to the different allelopathic materials (Table 5). The highest number of filled grains panicle^{-1} was obtained from M_4 (241.70) and the lowest number was recorded from M_0 (195.40) treatment. Interaction effect of variety and different allelopathic materials was found significant in filled grains panicle^{-1} (Table 5). It was observed that the highest (256.00) number of filled grains panicle^{-1} was found from the combination of V_3M_4. The lowest (198.7) filled grains panicle^{-1} was found from the combination of V_3M_1.

4.10 Number of unfilled grains panicle^{-1}

Among the traits made, number of unfilled grains panicle^{-1} plays a vital role in yield reduction. Results showed that variety had significant effect in respect of the number of unfilled grains panicle^{-1} (Table 5). The V_3 variety (Ranzit) produced the lowest number (11.53) of unfilled grains panicle^{-1} and V_1 produced highest number (23.33) of unfilled grains panicle^{-1} and this variation might be due to genetic characteristics. BINA (1993) and Chowdury *et al.* (1993) also reported differences in number of unfilled grains panicle^{-1} due to varietal differences.

Number of unfilled grains panicle^{-1} varied significantly for different allelopathic material (Table 5). The lowest number of unfilled grains panicle^{-1} was found from M_4 (13.11) treatment that statistically similar to all other allelopathic materials treated plosts and the highest number was recorded from M_0 (34.00) treatment (Table 5).

Interaction effect of variety and different allelopathic materialss showed significant response on unfilled grains panicle^{-1} (Table 5). It was observed that lowest (8.67) number of unfilled grains panicle^{-1} was observed from V_3M_4, and the highest (71.33) number of unfilled grains panicle^{-1} from V_2M_0.

4.11 1000-grain weight

Variety had significant effect on 1000-grain weight (Table 6). It revealed that 1000-grain weight of V_3 much heavier (22.63 g) than that of V_2 (16.10 g) and V_1 (16.42 g) which attributed to bold and larger grain size of this variety (Table 6).

Statistically significant difference was recorded for weight of 1000 grains for different allelopathic materials. The highest weight of 1000 grains was observed from M_4 (19.81 g), while the lowest weight was recorded from M_0 (16.72 g) treatment (Table 6).

Interaction effect of variety and different allelopathic materials showed significant effect on 1000-grain (Table 6). It was observed that the lowest (14.50 g) thousand seed weight was observed from V_2M_0, and the highest (23.83 g) thousand seed weight from V_3M_4.

Table 6. Effect of variety and different allelopathic materials and their interaction on different crop characters of rice

Treatment	Thousand seed weight (g)		Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (%)	
Variety										
V_1	16.42	b	5.17	a	10.67	a	16.01	a	33.47	ab
V_2	16.1	b	4.22	b	9.33	ab	13.55	b	31.52	b
V_3	22.63	a	5.35	a	8.61	b	13.78	b	37.23	a
LSD (0.05)	1.842		0.401		1.84		1.915		4.229	
Allelopathic materials										
M_0	16.72	c	4.65	b	8.51	c	13.16	c	35.15	a
M_1	18.06	b	4.91	b	9.01	bc	13.92	bc	35.45	a
M_2	18.61	ab	4.67	b	9.41	bc	14.07	bc	33.2	ab
M_3	18.72	ab	4.90	b	10.04	ab	14.82	b	32.32	b
M_4	19.81	a	5.44	a	10.72	a	16.29	a	34.25	ab
LSD (0.05)	1.189		0.259		1.184		1.236		2.729	
Combined effect										
V_1M_0	20.33	c	5.60	b	9.45	cd	15.04	b	37.37	bc
V_1M_1	22.83	b	4.84	de	9.64	c	14.48	bc	33.43	de
V_1M_2	22.83	b	5.45	bc	10.89	b	16.34	a	33.28	de
V_1M_3	23.33	ab	5.40	bc	11.52	ab	16.91	a	31.83	ef
V_1M_4	17.93	d	5.45	bc	11.84	a	17.29	a	31.46	efg
V_2M_0	14.50	h	3.79	h	8.47	defg	12.26	f	31.00	fg
V_2M_1	15.67	g	4.84	e	8.99	cdef	13.84	cd	35.32	cd
V_2M_2	15.67	g	4.18	g	9.11	cdef	13.28	de	31.60	efg
V_2M_3	16.17	fg	3.93	h	9.36	cde	13.29	de	30.19	fg
V_2M_4	17.67	d	4.37	fg	10.73	b	15.10	b	29.48	g
V_3M_0	15.33	gh	4.56	f	7.61	g	12.17	f	37.09	bc
V_3M_1	15.67	g	5.04	d	8.38	efg	13.42	de	37.59	b
V_3M_2	17.33	de	4.37	fg	8.23	fg	12.60	ef	34.73	d
V_3M_3	16.67	ef	5.37	c	9.26	cde	14.24	bcd	34.94	d
V_3M_4	23.83	a	6.51	a	9.59	c	16.48	a	41.81	a
CV (%)	5.85		8.08		8.60		7.40		7.45	
LSD (0.05)	0.884		0.1921		0.881		0.919		2.029	

4.12 Grain yield

Grain yield is a function of interplay of various yield components such as number of productive tillers, grains panicle^{-1} and 1000-grain weight (Hassan *et al.*, 2003). In present experiment variety had significant effect on grain yield (Table 6). It was evident that V_3 (Ranzit) produced the highest (5.35 t ha^{-1}) grain yield that similar to V_1 (5.17 t ha^{-1}) which was contributed from higher number of effective tillers hill^{-1}, higher number of grains panicle^{-1} and more weight of 1000-grain than V_2 (4.22 t ha^{-1}). Grain yield differences due to varieties were reported by Suprithatno and Sutaryo (1992), Alam (1988) and IRRI (1978) who recorded variable grain yield among tested varieties.

Grain yield per hectare of rice varied significantly for different allelopathic materials. The highest grain yield was found from M_4 (5.44 tha^{-1}) whereas the lowest yield was recorded from M_0 (4.65 tha^{-1}) treatment (Table 6).

From the table 6 it was evident that interaction of variety and different allelopathic materials significantly affected the grain yield. Significant highest (6.51 t ha^{-1}) grain yield was found from the combination of V_3M_4 (Ranzit with allelopathic materials araich) and the lowest (3.79 t ha^{-1}) from V_2M_0 (Guti swarna with control).

4.11 Straw yield

The yield of straw was observed to differ significantly due to varieties (Table 6). It was evident from the experimental results that the variety V_1 produced the highest (10.67 t ha^{-1}) straw yield compared to V_3 (8.61 t ha^{-1}). The variety V_1 was tall variety and produced higher straw yield compared to dwarf variety Ranzit. The result was in agreement with the findings of Panda and Leeuwrik (1971) who reported that the straw yield varied due to varieties.

Different allelopathic materials showed statistically significant differences on straw yield of rice. The highest straw yield was recorded from M_4 (10.72 tha^{-1}) that similar to M_3 (10.04 t ha-^{1}). On the other hand, the lowest yield was obtained from M_0 (8.51 t ha-^{1}) treatment (Table 6).

Interaction effect of variety and different allelopathic materials was observed significant on straw yield (Table 6). The highest (11.84 t ha^{-1}) straw yield was found from the combination of V_1M_4 and the lowest (7.61 t ha^{-1}) from the combination of V_3M_0.

4.12 Biological yield

Varieties differed significantly among themselves regarding biological yield (Table 6). It was found that rice variety of BRRI dhan46 produced the highest (16.01 t ha^{-1}) biological yield than V_2 (13.55 t ha^{-1}). Higher grain yield attributed to the higher biological yield and was supported by Singh and Ganger (1989).

Statistically significant difference was observed in biological yield per hectare due to the different allelopathic materials. The highest biological yield was observed from M_4 (16.29 t ha-^{1}) and the lowest yield was found from M_0 (13.16 t/ha) treatment (Table 6).

It was found that biological yield was affected significantly due to the interaction of variety and different allelopathic materials. The highest (17.29 t ha^{-1}) biological yield was obtained from the combination of V_1M_4 and the lowest (12.17 t ha^{-1}) from V_3M_0 (Table 6).

4.13 Harvest Index

It was found from Table 6 that variety had significant effect on harvest index. From the results it was evident that V_3 produced the highest (37.23%) harvest index that similar to V_1 (33.47%) than V_2 (31.52%).

Statistically significant difference was recorded in terms of harvest index for different allelopathic materials. The highest harvest index was found from M_1 (35.45%) while the lowest from M_3 (32.32%) treatment (Table 6).

There was significant effect on harvest index by the interaction of variety and different allelopathic materials. The higest (41.81%) harvest index was found from the combination of V_3M_4 and the lowest (29.48%) was found from the combination of V_2M_4.

Chapter 5
Summary and conclusion

CHAPTER V

SUMMARY AND CONCLUSIONS

A field experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University (SAU), during July to December, 2010 with view to find out allelopathic effect of different weed residues to control of weeds in aman rice fields. The experimental treatments included three *T-aman* rice varieties *viz*. BRRI dhan46, Guti Swarna and Ranzit variety and five different allelopathic materials *viz.* Control, *Lantena camera*, Goose weed, Ban sharisha and Araich. The experiment consisted of 15 treatment combinations and was laid out in split-plot design with 3 replications. An area was divided into three main plots and rice varieties were placed in the main plots. Each main plot was divided into 5 subplots which received allelopathic materials. The size of subplots was 3m × 3m =$9m^2$. The distance maintained between two subplots was 100 cm and between blocks was 150 cm. 30 days aged seedlings were transplanted with 25 cm spacing between lines and 15 cm spacing between hills. Intercultural operations such as gap filling, weeding, water management and pest management were done as and when recorded. Maturity of crop was determined when 90% of the grains become golden yellow in color. The harvesting was done on ten pre-selected hills from which data were collected and 6 mid lines from each plot was separately harvested, bundled, properly tagged and then brought to the threshing floor. Threshing was done by pedal thresher. The grains were cleaned and sun dried to moisture content of 12 %. Straw was also sun dried properly.

The data on crop growth characters like plant height, number of tillers hill^{-1} and dry mater, number of weed m^{-2}, dry weight of weed m^{-2} were recorded at different days after transplanting and yield as well as yield contributing characters like number of effective tillers hill^{-1}, panicle length, percent filled and unfilled grains, 1000-grain weight, grain and straw yield were recorded after harvest. Finally grain and straw yields plot^{-1} were recorded and converted to t ha^{-1} and data of all parameter analysed using MSTAT-C statistical package program. The mean differences among the treatments were compared by least significant difference (LSD) test at 5 % level of significance.

Results of the experiment showed that variety had significant difference for all the characters, like plant height, total tillers hill^{-1}, total dry matter production, filled grains panicle^{-1}, 1000-grain weight, grain yield, biological yield and harvest index. Variety of rice, Ranzit gave the tallest plant height (39.00, 71.93, 104.30, 123.30 and 139.50 cm at 20, 40, 60 and 80 DAT and at harvest, respectively) the highest total dry matter (12.14, 45.93, and 64.80 g hill^{-1} at 30, 60 and 90 DAT, respectively), the longest panicle length (27.40 cm) and the highest number of filled grains panicle^{-1} (219.30) & 1000 grain weight

(22.63 g) thus produced highest grain yield (5.35 t ha^{-1}). The variety of rice BRRI dhan46 gave the highest number of tillers hill^{-1} (8.60, 19.87, 13.60 and 12.93 at 20, 40, 60 and 80 DAT, respectively), number of weed (252.3 and

86.20 g m^{-2} at 20 and 40 DAT, respectively) and the highest dry weight of weed m^{-2} (138.3 and 17.21 g $plot^{-1}$ at 20 and 40 DAT, respectively). Straw yield (10.67 t ha^{-1}), biological yield (16.01 t ha^{-1}) unfilled grains panicle $^{-1}$ (23.33) were highest in BRRI dhan46.

Allelopathic materials significantly differed the growth characters like plant height, total number of tiller $hill^{-1}$ and total dry matter production. Among the yield contributing and other parameters like panicle length, filled grains $panicle^{-1}$ was affected significantly for different allelopathic materials. Grain yield, straw yield as well as biological yield and harvest index significantly influenced by allelopathic materials.

The M_4 (Allelopathic materials araich) gave the highest plant height (43.53, 75.89, 115.4, 134.7 and 146.30 cm at 20, 40, 60 and 80 DAT and at harvest, respectively), number of tillers $hill^{-1}$ (10.33, 19.11, 13.78 and 13.00 at 20, 40, 60 and 80 DAT, respectively), total dry mater (10.84, 44.91 and 61.44 g at 30, 60 and 90 DAT, respectively) and longest panicle length (27.78 cm). As a result M_4 (Allelopathic materials of araich) contributed to the highest filled grain $panicle^{-1}$ (241.70) grain yield (5.44 t ha^{-1}), straw yield (10.72 t ha^{-1}), biological yield (16.29 t ha^{-1}). On the other hand M_0 (control) gave the maximum unfilled grains $panicle^{-1}$ (34.00). The highest number of total weed m^{-2} was obtained from M_0 (327.90 and 95.78 at 20 and 40 DAT, respectively) the highest dry weight of weed m^{-2} was recorded from M_0 (154 and 20.73 g at 20 and 40 DAT, respectively) (control).

Interaction effect of variety and allelopathic materials affected significantly in all growth, yield and yield contributing characters, grain yield, straw yield, biological yield and even harvest index. The highest grain yield recorded from V_3M_4 (Ranzit with allelopathic matrial araich) (6.51 t ha^{-1}) and the lowest (3.79 t ha^{-1}) from V_2M_0 (Guti swarna with control).

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.
2. Studies could be done with other allelopathic materials and with varieties.

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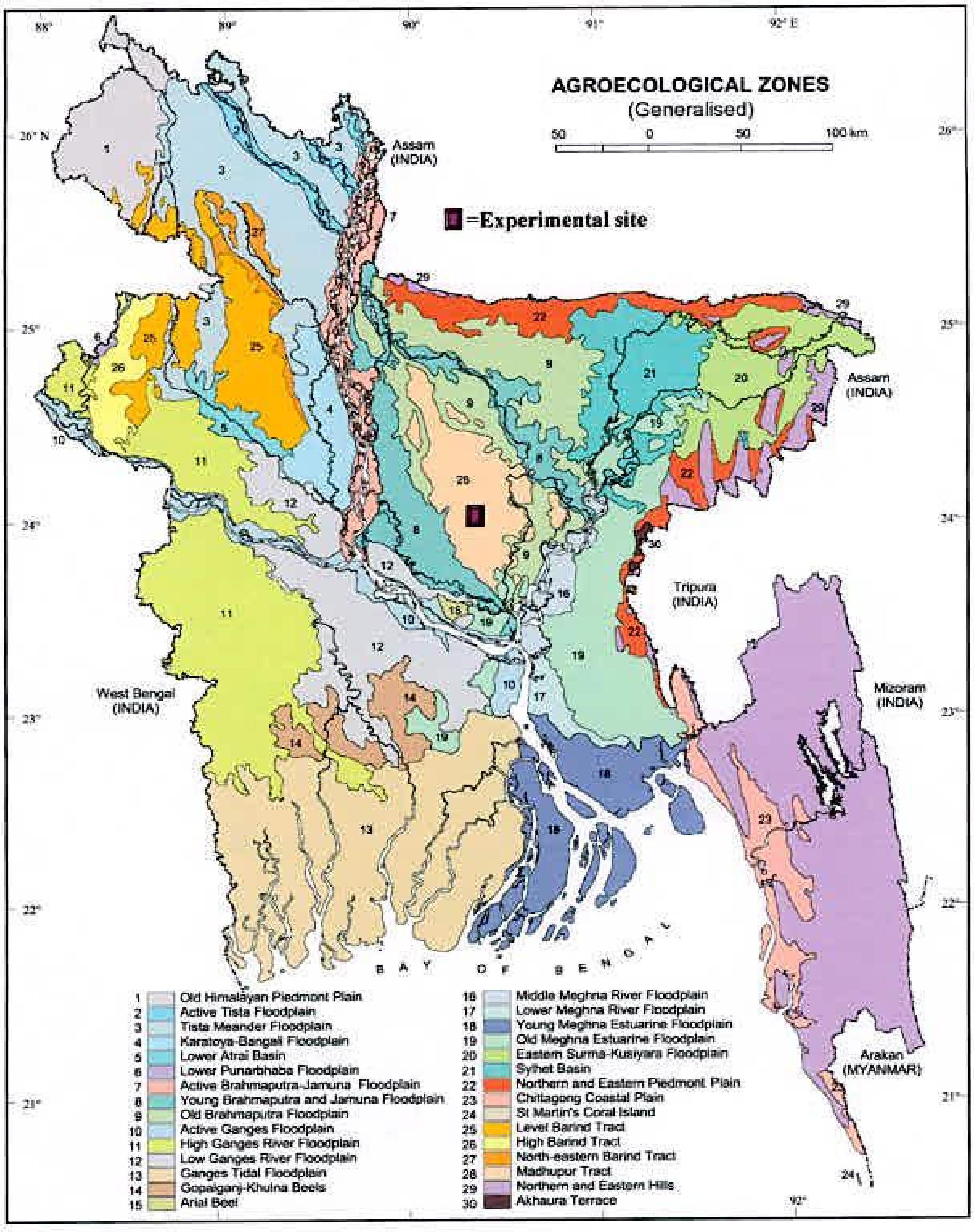
Appendices

APPENDICES

Appendix I. Experimental location on the map of Agro-ecological Zones of Bangladesh



Appendix II. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from July to December 2010

Month	Air temperature (^0C)			RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
July	33.00	27.40	30.20	77.00	167
August	33.10	27.00	30.05	78.00	340
September	32.50	26.60	29.55	79.00	169
October	32.40	25.00	28.70	74.00	174
November	30.00	20.90	25.45	68.00	0
December	26.0027	15.40	20.70	66.00	81

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix III. The physical and chemical characteristics of soil of the experimental site as observed prior to experimentation (0- 15 cm depth).

Constituents	Percent
Sand	26
Silt	45
Clay	29
Textural class	Silty clay

Chemical composition:

Soil characters	Value
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total nitrogen (%)	0.07
Phosphorus	22.08 µg/g soil
Sulphur	25.98 µg/g soil
Magnesium	1.00 meq/100 g soil
Boron	0.48 µg/g soil
Copper	3.54 µg/g soil
Zinc	3.32 µg/g soil
Potassium	0.30 µg/g soil

Source: Soil Resources Development Institute (SRDI), Khamarbari, Dhaka

Appendix IV. Analysis of variance of the data on plant height of rice as influenced by variety and allelopathic materials.

Source of variance	Degrees of freedom	Plant height			
		20 DAT	40 DAT	60 DAT	80 DAT
Replication	2	13.09	66.82	14.16	11.29
Factor A	2	8.82*	310.49*	261.96*	86.49*
Error	4	4.62	54.36	117.52	18.69
Factor B	4	3.64*	451.69*	1007.47*	430.94*
AB	8	8.04*	28.07*	166.07*	29.71*
Error	24	2.11	26.34	157.07	31.64

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on number of tiller per plant of rice as influenced by varity and allelopathic materials

Source of variance	Degrees of freedom	Number of Tiller per plant			
		20 DAT	40 DAT	60 DAT	80 DAT
Replication	2	2.96	2.76	13.09	1.42
Factor A	2	42.22*	116.16*	8.82*	7.02*
Error	4	4.49	10.02	4.62	12.56
Factor B	4	33.64*	19.06*	3.64*	2.74*
AB	8	1.53*	7.99*	8.04*	3.41*
Error	24	1.45	7.21	2.11	2.79

* = Significant at 5% level of probability

Appendix VI. Analysis of variance of the data on number of weeds and dry weight of weeds m^{-2} as influenced by variety and allelopathic materials

Source of variance	Degrees of freedom	Number of weeds m^{-2}		Dry weight of weeds m^{-2}	
		20 DAT	40 DAT	20 DAT	40 DAT
Replication	2	605.36	26.76	44.82	7.87
Factor A	2	9398.29*	2776.96*	5372.69*	29.61*
Error	4	892.86	234.76	48.56	5.55
Factor B	4	40328.86*	2830.92*	4182.42*	169.48*
AB	8	7766.79	597.96	793.44	7.90
Error	24	558.66*	161.73*	150.12*	5.36*
Replication	2	1.45	7.21	2.11	2.79

* = Significant at 5% level of probability

Appendix VII. Analysis of variance of the data on total dry mater weight of rice as influenced by variety and allelopathic materials

Source of variance	Degrees of freedom	Total dry mater weight		
		30 DAT	60 DAT	90 DAT
Replication	2	15.01	420.73	566.16
Factor A	3	72.79*	344.25*	1455.36*
Error	2	10.57	61.78	33.56
Factor B	6	16.36*	108.51*	216.13*
AB	22	19.67*	168.33*	326.88*
Error		4.73	149.85	90.95

* = Significant at 5% level of probability

Appendix VIII. Analysis of variance of the data on length of panicle, Filled grains, unfilled grains of rice as influenced by variety and allelopathic materials

Source of variance	Degrees of freedom	Effective tillers	Non effective tillers	Length of panicle	Filled grains panicle $^{-1}$	Unfilled grains panicle $^{-1}$
Replication	2	2.02	5.089	0.96	753.80	631.02
Factor A	2	4.82	142.156	20.69^{NS}	1430.47	595.62 ^{NS}
Error	4	9.92	3.422	3.36	1231.07	629.89
Factor B	4	40.41	12.367	4.39*	526.91*	689.20*
AB	8	1.46	5.683	2.52*	2019.41*	764.90*
Error	24	2.59	0.894	0.84	1.98	13.77

* = Significant at 5% level of probability
NS = Non Significant

Appendix IX. Analysis of variance of the data on thousand seed weight, grain yield, straw yield, biological yield and harvest index of rice as influenced by variety and allelopathic materials

Source of variance	Degrees of freedom	Thousand seed weight	Grain yield	Straw yield	Biological yield	Harvest Index
Replication	2	0.61	1.22	11.57	19.26	18.23
Factor A	2	203.48*	5.49*	18.43*	31.22*	128.19*
Error	4	0.09	0.74	3.37	3.57	43.68
Factor B	4	11.41*	0.92*	2.58*	0.94*	61.17*
AB	8	1.10*	0.99*	0.56*	2.24*	16.42*
Error	24	0.28	0.41	0.34	2.12	1.92

* = Significant at 5% level of probability