SCREENING OF DIFFERENT ONION VARIETIES AGAINST "*Alternaria porri*" CAUSING PURPLE BLOTCH DISEASE

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CERTIFICATE

This is to certify that the thesis entitled "*SCREENING OF DIFFERENT ONION VARIETIES AGAINST "Alternaria porri" CAUSING PURPLE BLOTCH DISEASE*" 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 PLANT PATHOLOGY,*** embodies the result of a piece of bona fide research work carried out by ***MD. GOLAM KIBRIA REG NO- 08-03235,*** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma elsewhere.

I further certify that any help or sources of information availed during the course of this inquire have been duly acknowledged and the contents and style of the thesis have been approved and recommended for submission.

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Screening of different onion varieties against "*Alternaria porri*" causing Purple blotch disease

BY

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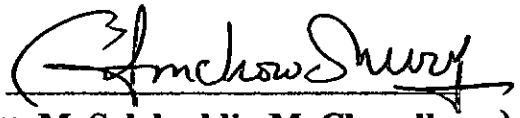

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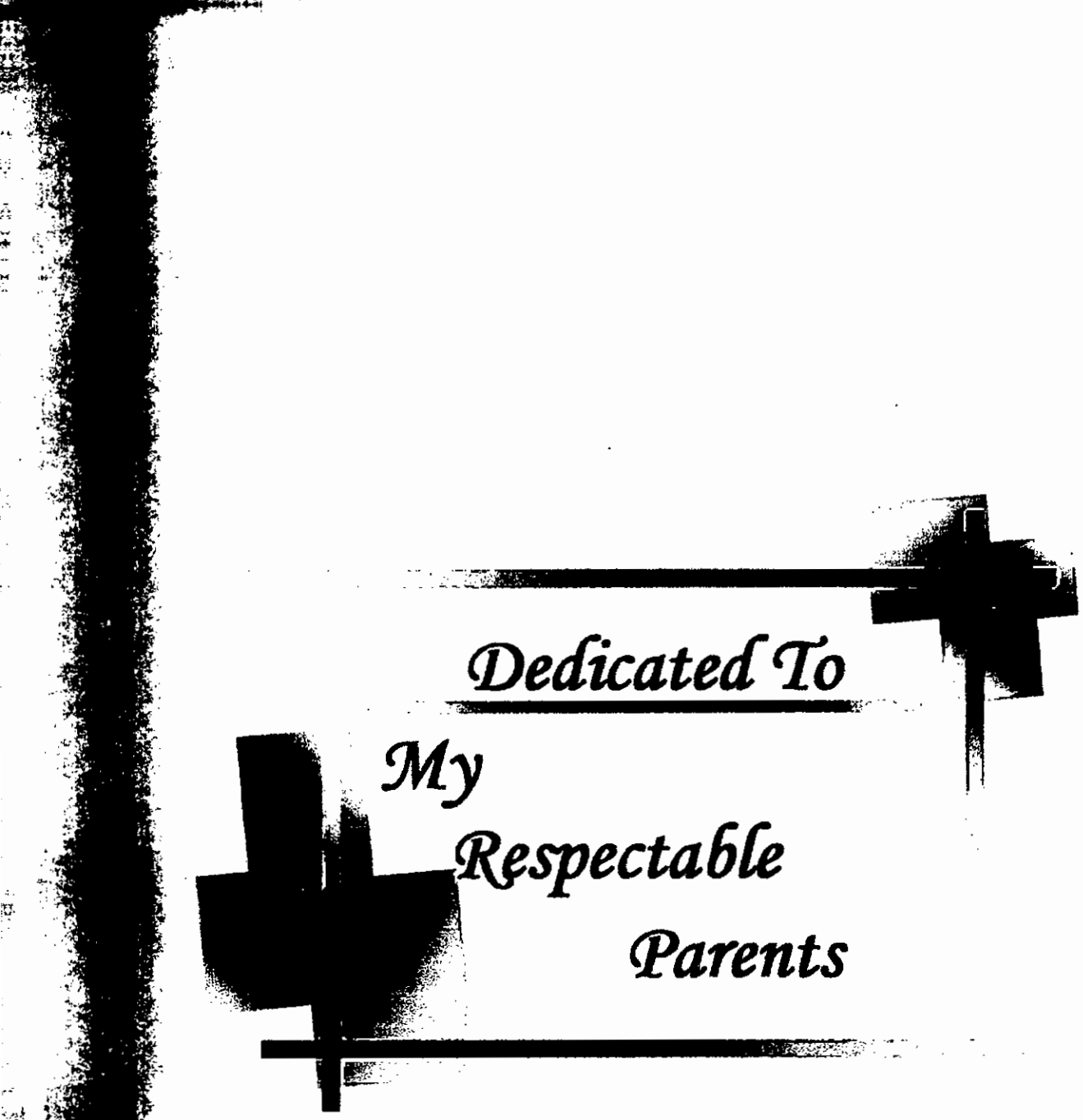
Dedicated To
My
Respectable
Parents

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Screening of different onion varieties against "*Alternaria porri*" causing Purple blotch disease

BY

MD. GOLAM KIBRIA

ABSTRACT

An experiment was conducted in the field of SAU (Sher-e-Bangla Agricultural University) farm, Dhaka to screen out the resistant cultivars of onion against purple blotch disease (*Alternaria porri*) during the period from October, 2009 to April, 2010. Nine onion cultivars viz. BARI Peas-1, BARI Peas-2, BARI Peas-3, Thakurgaon local, Faridpur local, Indian big, Manikgonj local, Taherpuri and Indian small were used as treatments. The screening of the varieties was done based on different parameters like disease incidence, disease severity and yield performance. The lowest disease incidence at 30 DAP, 45 DAP, 60 DAP, and 90 DAP respectively were found in BARI Peas-3, Indian small and Indian big with some extent. The highest disease incidence at 30 DAP, 45 DAP, 60 DAP, 75 DAP, and 90 DAP, were observed in case of local cultivars Taherpuri, Fridpur local, Thakurgaon local and Manikgonj local. The highest yield 12.67 t/ha was obtained from BARI Peas-3 followed by Indian small 10.33 t/ha and Indian big 9.84 t/ha. The lowest yield 4.34 t/ha was harvested from Taherpuri followed by Faridpur local 4.84 t/ha. In case of disease reaction 8.00% observed in BARI Peas-3 was graded as resistant followed by Indian small 10.00%, Indian big 11.00%, and 18.67% on BARI Peas-2 this cluster ranked as moderately resistant against Purple blotch . The local cultivars Taherpuri 37.67%, Faridpur local 35.00%, Thakurgaon local 34.33%, Manikgonj local 34.00% and BARI Peas-1 (25.00%) were graded as susceptible. BARI Peas-3 performed best in respect of all the parameters considered against Purple blotch of onion.

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ABBREVIATIONS USED

AEZ	=	Agro-Ecological Zone
@	=	At the rate
ANOVA	=	Analysis of variance
Anon.	=	Anonymous
B	=	Boron
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
CV	=	Co-efficient of variance
DAP	=	Days after planting
DMRT	=	Duncan's Multiple Range Test
eg.	=	Example
FAO	=	Food and Agricultural Organization
ha	=	Hectare
LAD	=	Leaf Area Diseased
LSD	=	Least Significant Difference
PDI	=	Percent Disease Index
RCBD	=	Randomized Complete Block Design
RH	=	Relative Humidity
SAU	=	Sher-e-Bangla Agricultural University
T	=	Treatment
t / ha	=	Ton per hectare
TSP	=	Triple Super Phosphate
wt.	=	Weight
w/v	=	weight per volume
Zn	=	Zinc
$ZnSO_4$	=	Zinc Sulfate
^0C	=	Degree Centigrade
%	=	Percent

Chapter 1

Introduction

INTRODUCTION

Onion (*Allium cepa L.*) is an important and widely used spice of Bangladesh. It is also used as vegetable all over the world. It is used as an important and popular vegetables in Australia, Belgium, India, Japan, United Kingdom, USA and many other countries. Spices are important constituents of food items in Bangladesh. It belongs to the family Alliaceae. It grows extensively during winter season in Bangladesh but at present it grows in the summer season also. Its commercial cultivation is concentrated in the greater districts of Faridpur, Comilla, Jessore, Pabna, Rajshahi, Dinajpur, Mymensingh, Dhaka and Rangpur (BBS, 2010).

Onion has manifold uses; such as spice, vegetable, salad-dressing etc. It is also used as condiments for flavoring a number of foods and medicines (Vohora et al., 1974, Hassan,2006). In terms of global vegetable production nearly 28 million tons per annum, next to tomatoes and cabbages bears importance (FAO, 1991). In the year 2007-08 the production of onion is nearly 889260 metric tons from 309309 acre of land (BBS, 2008).

In 2008, the highest productivity of onion in world is of Korea Rep (67.25 MT/ha) followed by USA (53.91 MT/ha), Spain (52.06 MT/ha), Japan (47.55 MT/ha) and in Bangladesh the productivity is only 7.10 MT/ha (FAO 2008), which is quite low than other onion growing countries in the world. Our requirement of onion per year is around 14,00,000 tons/year (BBS, 2010). The BARI released varieties namely BARI-1, BARI-2, BARI-3 and local verities of Thakurgao, Faridpuri, Manikgonj, Tharpuri, and Kalasnagar are commonly grown in Bangladesh. Few imported varieties like Indian big, Indian small also

cultivated in Bangladesh. In Bangladesh, the demand of bulb onion as well as the seeds is increasing every year and the price the of bulb and true seeds remains fairly high in each season.

The 22 districts of onion growing areas of the country are Faridpur, Comilla, Manikganj, Dinajpur, Jessore, Pabna, Rajshshi, Mymensingh, Jamalpur, Patuakhali, Kishorganj, Tangail, Borishal, Bandarban, Khagrachari, Sylhet, Bogra, Rangamati, Kustia, Dhaka, Chittagong and Rangpur. The highest yield 2,08,935 metric ton was in Faridpur in 78,695 acre of land. (BBS, 2007).

As per the world literatures, onion crop is affected about 66 diseases including 38 fungal, 10 bacterial, 6 nematode, 3 viral, 1 mycoplasmal, 1 parasitic plant and 7 miscellaneous diseases and disorders (Hassan, *et al.*, 2006). In case of seed production of onion in Bangladesh, several major diseases become widespread and devastating to limit the production.

Purple blotch of onion is noted as a major disease throughout the world including Bangladesh (Ahmed and Hossain, 1985; Meah and Khan, 1987; Bose and Som, 1986 and Castellanos-Linares *et al.*, 1988). In India purple blotch of onion is a major destructive and widespread disease and causes serious yield reduction (Ahmed and Goyal, 1988). The disease is also a great threat for seed production of onion (Gupta *et al.*, 1986; Rahman *et al.* 1988 and Yazawa, 1993).

The purple blotch of onion is characterized with small water-soaked lesions initially produce on leaves and seed stalk that quickly develop grey centers. As lesions enlarge, they become zonate, brown to purple, surrounded by a yellow zone and extend upward and downward. Under

humid condition, the surface of the lesion may be covered with brown to dark gray structure of fungus. A few large lesions have been formed in a leaf or seed stalk which may coalesce and girdle the leaf or seed stalks and tissues. Usually the affected leaves or seed stalks break down and die within 4 weeks if the environment favours the disease (Gupta *et al.*, 1991).

About 20 to 25% losses in seed yield have been recorded in India (Thind and Jhooty, 1982) and 41-44% in Bangladesh (Hossain and Islam, 1993; Fakir, 2002; Hassan, *et al.*, 2006). In Bangladesh, two widely cultivated local varieties like Faridpuri and Taherpuri are susceptible to the disease (Rahman *et al.*, 1988). The BARI released varieties viz. BARI-1, BARI-2 and BARI-3 are said to be moderately resistant against purple blotch of onion but in the recent years these varieties are known to be affected by the disease. The cultivation area of onion is increasing but its rate of production per unit area in Bangladesh is gradually decreasing due to disease problem (BBS, 2006). As a result Bangladesh has to import a large quantity of onion bulb every year to fulfill the national demand at the cost of foreign currency. Thus, management of this disease needs to be addressed urgently.

Literature from home and abroad indicate that many researchers explored to find out suitable control measures of the disease, viz. use of resistant variety, manipulation date of planting, use of micronutrients and chemical fungicides (Shandhu *et al.*, 1983; Vishwakarma, 1986; Gupta and Pathak ,1987 ; Martinez – Reyes , 1987 ; Mishra *et al.*, 1989; Sugha *et al.*, 1993 and Srivastava *et al.*, 1995).

Several researchers found Rovral and Dithane M-45 effective against the disease (Ashrafuzzaman and Ahmed, 1976 and Rahman *et al.*, 1988 and

Rahman, 1990). However, fungicide increases costs of cultivers while environmental problems may be incurred to soil, water, air and ecological systems (West *et al.*, 2003). The chemical fungicide is non biodegradable and its residual effect remains for a long time. Control of plant diseases becomes successful and economical when the management approach involves several methods are employed including chemical means (Bakr, 1992) cultural practices (Rahman *et al.*, 1988) and use of resistant varieties (Ahamed, 1986). But no attempts have been made to screen out the resistant germplasm of onion against purple blotch of onion in the country.

Objectives:

Considering the above facts, the present piece of research is proposed to screen out the resistant cultivars of onion against ***"Alternaria porri"*** causing purple blotch disease.

Chapter 2

Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

Purple blotch of onion caused by *Alternaria porri*, is a common and most important disease throughout the country. It causes serious yield reduction of the crop. Now it is an acute problem in the country both for the researchers and the onion growers. Literatures in relation to the resistant source of onion against purple blotch of onion are presented in this chapter:

2.1. Varietal resistance and symptomology

Intensity of *Alternaria porri* infection w0as recorded by Bhangale and Joi (1985) on 74 cultivars of onion grown under field conditions. No resistant cultivars were observed, but Gujarat and 1003 were graded as moderately susceptible to the disease.

Alves (1983) studied the incidence of purples spot (*A. porri Ell. Cif.)* on onion cultivars. And hybrids in Manaus, Amazonia Plants were categorized into five classes on the basis of natural infection in the field. Incidence was 30-50% (class III) in most cases, only the hybrid Px76 having plants in class I (0-10%) was recorded.

Padule and Utikar (1982) tested 32 onion cultivars under field conditions against purple blotch and recorded all the cultivars to be susceptible.

Thirumalachar *et al.* (1953) reported about the existence of some varietal resistance and they stated that the fungus *Alternaria porri* (purple blotch) caused severe scorching of some onion varieties at the College of Agriculture Sabour; but the indigenous red variety had remained uninfected.

Sandhu *et al.* (1982) reported that none of 102 genotypes they screened was resistant to *Alternaria porri.* However, they could locate 12 genotypes which showed moderate resistance reaction. The genotypes that had flat erect leaves showed moderately resistance reaction. Whereas all those with curved, drooping leaves were susceptible.

Sixty-days-old onion plants (cv. Nasik Red) were most susceptible to the purple blotch pathogen (*Alternaria porri*) (Gupta and Pathak, 1986). Plants inoculated at high RH (100%) for 120 hours resulted in maximum disease severity and shortest incubation period.

Ariosa-Terry and Herrera-Isla (1986) measured the damage of onion due to purple blotch caused by *A. porri.* The first symptoms appeared 50 days after sowing and disease intensity was the highest at 110 days. White onions were more affected than red onions.

Basallote-Urebaa *et al.,(1999.)* Surveys between 1989 and 1993 in the major garlic production areas of Spain identified a new leaf spot disease,characterized by white and purple lesions followed by extensive necrosis. Isolation and pathogenicity tests with fungal isolates taken from these spots indicated that *Stemphylium vesicarium* was the causal agent. Pseudothecia of the teleomorph stage, *Pleospora* sp., were found on leaf debris from affected plants. Inoculation of garlic and onion plants with residues carrying mature pseudothecia, or with ascospore suspensions obtained from the pseudothecia, resulted in the development of white and purple leaf spots. Wetness periods longer than 24 h were required for symptom development under controlled conditions. Isolates of *S. vesicarium* from garlic, onion and asparagus caused disease in all three hosts. In garlic, cv. Blanco de Vallelado was most susceptible, while lines

B4P17 and B6P1, and cvs Iberose and Golourose were less susceptible to the disease.

2.2. Relevant information regarding the pathogen, epidemiology and its management

Fanceli and Kimati (1991) conducted an experiment in Brazil to determine the influence of culture media and light on the sporulation of *Alternaria dauci*. They noted that Czapek's and host leaf extract medium yielded better sporulation of the fungus compared to other tested media.

2.3 Epidemiology

Khare and Nema (1982) also reported that the temperature ranged between 22^0 C to 25^0 C was not only suitable for growth and sporulation of *Alternaria porri* but also optimum for spore germination as well as for infection in onion. They also argued that spore germination on leaves decreased with the increase of nitrogen doses to the host. They also reported that temperature, humidity and nutrients seemed to play important roles for ensuing infection of *Alternaria porri* in onion. Cent percent (100%) spore germination occurred in vitro within 4 hrs at 22^0 C, while maximum germination was recorded within 6 hrs at 25^0 C on the host surface.

Nuchart Joglaekha *et al.* (1982) observed that most of the conidia produced germ tubes and penetrated wounds on leaves within 8 hrs. after inoculation. The conidia were club shaped with cross and longitudinal septa. This fungus produces spores when the temperature lies between 18-26^0C.

Raju and Metha (1982) demonstrated an experiment on certain nutritional aspects of *Alternaria porri* (Ellis) Ciferri on onion in vitro and summarized that potato dextrose agar, having P^H 6, was the best to culture the fungus. Temperature ranging 22-25^{0}C was optimum for mycelial growth and sporulation of *Alternaria porri*.

Miller (1983) reported that measurements of infected leaves were taken weekly from bulb initiation to bulb maturity. They observed that the leaf damage levels were significantly lowered on younger than older leaves. Leaves emerging 9, 8, 7, 6 and 5 week before bulbing maturity required $5^1/_2$, 5, $4^1/_2$, $3^1/_2$ and $2^1/_2$ weeks respectively to reach 50% damage.

Khare and Nema (1984) conducted an experiment to determine the effect of temperature and humidity of the development of symptoms of purple blotch of onion incited by *Alternaria porri* and noted that temperature between 22^0 to 25^0 C and relative humidity 90% are the best for the development of leaf blotch symptom.

Gupta and Pathak (1988) reported that bulb and seed yields and 1000 seed weight of Nashik Red onion were significantly reduced by *Alternaria porri* infection. Disease severity was computed in terms of the co-efficient of disease index (Codex). A linear relationship was found between yield and Codex.

Srivastava *et al.* (1996) conducted *in vitro* studies to determine the role of infected plant debris and soil in the perpetuation of disease and air borne spore of purple blotch (*Alternaria porri*) and Stemphylium blight (*S. vesicarium*) on onions in Haryana, India, in order to establish a forecasting system for effective control measures. The pathogens remained viable for 4 months on diseased plant debris, 3 months at soil in depths of 2.5, 5.0 and 7.5 cm and for 2 months at soil in depths of 10.0

and 15.0 cm. It was suggested that the inoculum load of *Alternaria porri* and *Stemphylium vesicarium* during ploughing of infected soil was higher during the winter.

Lakra (1999) conducted an experiment at the Choudhury Charan Singh Haryana Agricultural University, Hisar, India, found that numerous purple spots / blotchs were observed on older leaves and scapes when fortnightly dew fall was >1.0 mm, mean maximum relative humidity > 75% and mean maximum temperature 20-30^0 C with > 18 hr favourable temperature (10-30) duration. Exposure of leaf and/or scape to wetness for 8 hr was a pre-requisite for conidial germination with increasing disease intensity, every tield component was adversely affected; the most severe infection reduced the number of scapes/plant, the height of scape, the number of umblets/umbel, the number of seeds/umblet, 1000-grain weight, number of seeds/plant and the seed yield/plant by 28.7, 74.5, 89.9, 41.7, 35.7, 95.7 and 97.3% respectively compared with healthy plants.

Evert and Lacy (1990, examined formation of conidia by *Alternaria porri* under variable dew duration and controlled relative humidity (RH). Viable conidia produced on lesions after 9 hrs of dew to 38 hrs and conidia formed during 16 hrs of dew duration caused typical lesions. Conidia were formed at all RHs tested (75-100%); numbers were very low at 75-85% RH but increased with increasing RH. Conidia formed on lesions on senescent leaves when incubated in dew chamber at 25^{0}C and conidia formed repeatedly (up to eight cycles) on lesions to alternating low RH (35-50%) and high (100%) RH.

The intensity and dynamics of *Alternaria porri* conidial germination were studied by Rodriguez *et al.* (1994) in different temperatures (5-40^{0}C) and RH (76-100%). Conidia developed at 5-37.5^{0}C, with an optimum temperature of 30^{0}C. Germination started within 1 hr of incubation at 20-35^{0}C and 50% of the conidia had germinated at 4 hrs of incubation.

Srivastava *et al.* (1994) reported the high incidence (2.5 - 87.8%) of purple blotch (*Alternaria porri*) in both the kharif and robi onions, when high humidity prevailed, during the 5 years of the survey (1988-93).

Everts and lacy (1996) studied the factors influencing infection of onion leaves by *Alternaria porri* and subsequent lesion expansion. Conidia deposited on onion leaves formed single to several germ tubes and appressoria and often penetrated at more than one locus under conditions favorable. After 3 hrs in the dew chamber at 24^0 C following inoculation of onion leaves, 73% of conidia had germinated and 5% had formed appressoria. Infection hyphae were not observed until 6 h following inoculation, at which time 2% of conidia had formed infection hyphae and 0.5% of conidia had caused visible lesions. Length of dew period was significantly and positively correlated with lesion numbers but not with lesion size.

Gupta *et al.* (1996) stand that purple blotch (*Alternaria porri*) and stemphylium blight (*Stemphylium vesicarium*) is important diseases causing considerable damage to onion crops in India. The diseases are severe during the rainy seasons especially when thrips are also associated with the crops.

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

This chapter described the materials and methods that were used in carrying out the experiment. It included a description of screening of onion varieties in the net house and in field conditions. These comprised collection of germplasms from major onion growing area, isolation and identification of "*Purple blotch*" from infected onion plant, conduction of field experiments and recording compilation and analysis of data.

3.1. Experimental site

The in vitro research was conducted in the MS lab, the Depertment of Plant Pathology and the field experiment was conduct at the farm of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, during the period from October , 2009 to April, 2010. The experimental field is located at $90^0 33'$ E longitude and $23^0 77'$ N latitude at a height of 9 meter above the sea level. (Fig.1).The land was medium high and well drained.

3.2. Climate

The experimental area was under the sub-tropical climate which characterized by the comparatively low rainfall, low humidity, low temperature, relatively short day during October to March, and high rainfall, high humidity, high temperature and long day period during April to September.

The annual precipitation and potential evapotranspiration of the site were 2152 mm and 1297 mm, respectively. The average maximum and minimum temperature was 30.34^0C and 21.21^0C, respectively with mean temperature of 25.17^0C. (Appendix- II)

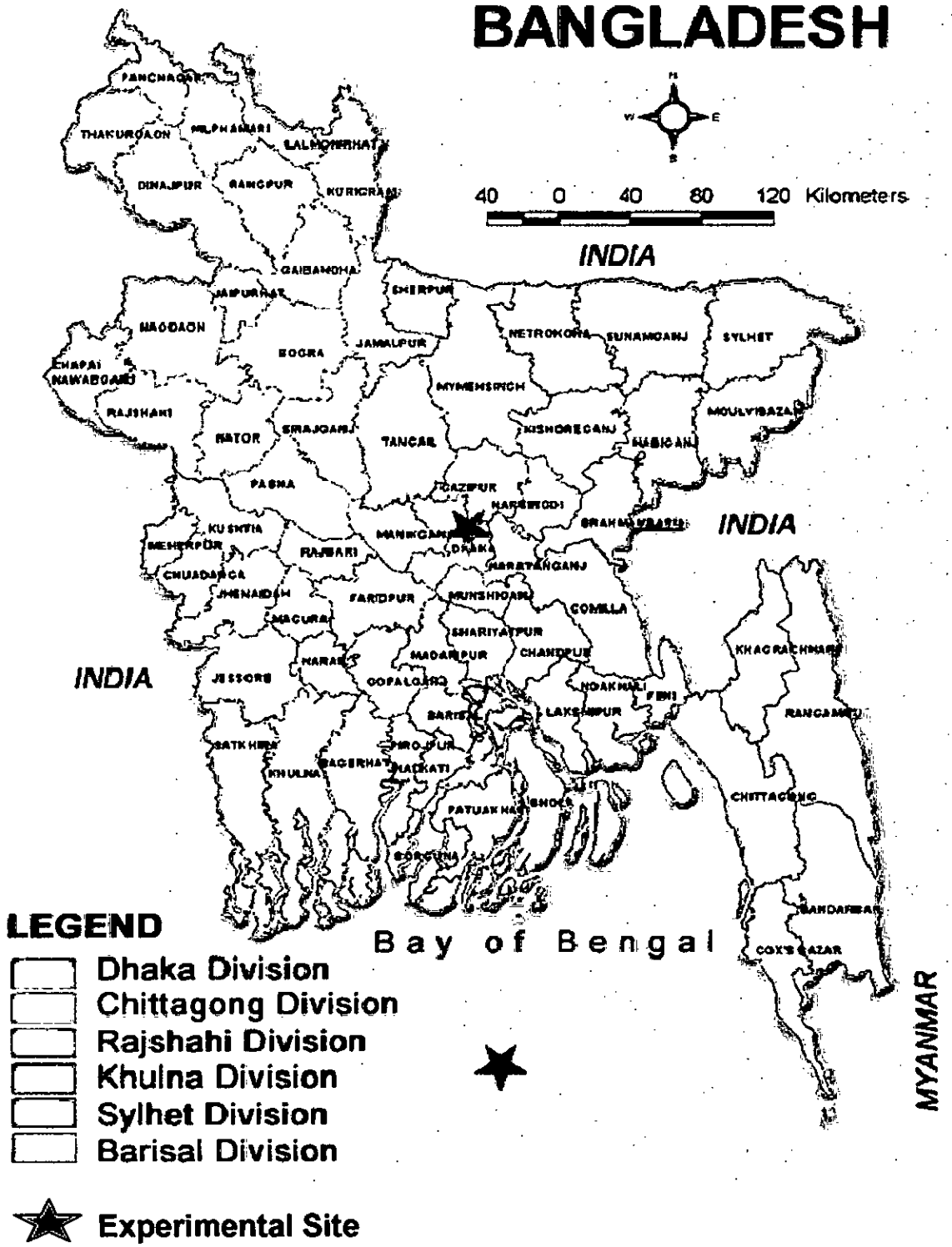

Fig. 1. Map showing the experimental site under study

Temperature during the cropping period ranged between 12.2^{0}C to 31.2^{0}C. The humidity varied from 73.52% to 81.2%. The day length ranged between 10.5-11.0 hours only and there was 250-300 mm rainfall during the last part of the experiment.

3.3. Soil type

The soil of the experimental site belongs to the Agro-Ecological Region of "Madhupur Tract" (AEZ No. 28). It was Deep Red Brown Terrace soil and belongs to "Nodda" cultivated series. The top soil is slightly clay loam in texture. Organic matter content was very low (0.82%) and soil pH varied from 5.47-5.63. The information about AEZ 28 is given below:

Characteristics of AEZ-28

Land type	Medium high land
General soil type	Non-Calcareous Dark gray floodplain soil
Soil series	Tejgaon
Topography	Upland
Elevation	8.45 m
Location	SAU Farm, Dhaka
Field Level	Above flood level
Drainage	Fairly good
Firmness (consistency)	Compact to friable when dry

3.4. Land preparation

The experimental field was ploughed with power tiller drawn rotovator. After ploughing the field it was left to nature for 10 days for sun and nature to work upon. Subsequent cross ploughing was done followed by laddering to make the land level. Then the soil clods were broken by a wooden hammer and all weeds, stubbles and residues were removed from the field. Later, Cowdung @ 10 ton/ha and chemical fertilizer like Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MoP) was mixed with soil during final land preparation.

3.5. Fertility status of the field soil:

The soil of experimental site was analyzed in Soil Resource Development Institute (SRDI), Dhaka and found as loamy soil which contains total Nitrogen 0.061(%), Phosphorus 35022 microgram per gram of soil, Sulphur 22.60 microgram per gram of soil, Potassium 0.030 miliequivalent per 100gram soil and Calcium-2.67 miliequivalent per 100 gram soil.

Physical and chemical properties of the experimental soil

Soil properties	Value
Soil texture	clay loam
Soil pH	5.8
Organic matter (%)	1.35
Total N (%)	0.08
C : N ratio	10 : 1
Available P (ppm)	35
Exchangeable K (me/100g soil)	0.18
Available S (ppm)	40

3.6. Fertilizer application

The experimental field was fertilized with Nitrogen (in the form of Urea), Phosphorus (in the form of Triple Super Phosphate -TSP), Potassium (in the form of Muriate of Potash (MoP), Gypsum, ZnO and Boric powder. As per the treatment whole quantity of TSP, MP, Gypsum, ZnO, Boric powder and one fourth of Urea were applied at final plot preparation. The rest third fourth Urea was applied later in three installments on (40, 60 and 80 days after planting). Fertilizer was applied as recommended doses (BARC, 1997). Applied doses were as follows:

Name of the Fertilizer	**Fertilizer dose (kg/ha)**	**Fertilizer applied during final land preparation (kg/183.75 m^2 land)**	**Rest installments (Urea) (kg/183.75 m^2 land)**		
			1st	**2nd**	**3rd**
Urea	320	1.47	1.47	1.47	1.47
TSP	415	7.62	-	-	-
MP	168	3.08	-	-	-
Gypsum	100	1.83	-	-	-
ZnO	5	0.09	-	-	-
Boric powder	5	0.09	-	-	-

3.7. Experimental design

The experimental plots were arranged in Randomized Complete Block Design (RCBD) with three (3) replications (Appendix-I). The experiment details were given bellow:

- Total area : 183.75 m^2
- No. of plot : 27
- Plot size : (2 × 1.5) m^2
- Block to block distance : 1.0 m
- Plot to boundary distance : 1 m
- Plot to plot distance (Length wise) : 0.5 m
- Plot to plot distance (Breath wise) : .0.5 m
- Plant to plant spacing : 15 cm
- Row to row spacing : 20 cm

3.8. Treatments of experiment

Treatments used in the experiment: The local cultivars and the onion verities released by Bangladesh Agricultural Research Institute were used as the treatments. Altogether there were nine (9) different onion varieties as stated bellow.

Treatments

T_1 = BARI Peas-1

T_2 = BARI Peas-2

T_3 = BARI Peas-3

T_4 = Thakurgaon local

T_5 = Faridpur local

T_6 = Indian big

T_7 = Manikgonj local

T_8 = Taherpuri

T_9 = Indian small

3.9. Growing of onion

3.9.1. Raising of Seedlings: Seedlings were raised in plastic tray from the collected germplasms in the net house with proper care and management. Trays were prepared by mixing soil sand and well decomposed cowdung in the proportion of 2:1:1. The prepared soil was heaped like a square block. Formalin solution (4%) @ 200ml/cft soil was mixed with the soil heap and the soil was covered by a polythene sheet for 48 hours for sterilization. After 7 days surface sterilized trays of (45x20) cm^2 were filled up with the sterilized soil (Islam, 2005). Then seeds were sown in the trays and labeled by marker pen. Watering was done to maintain the soil moisture. Shade was provided to save the young and delicate seedlings from heavy showering and scorching sunlight.

3.9.2. Transplantation of seedlings

Before transplantation, the top of seedling's leaves, at length of 5 to 6 cm were cut with a sharp knife, the roots were also cut at a 2 cm from the base (a usual practice followed by farmers which may help decreased transpiration and faster root development). The prepared seedlings were transplanted, as per design and spacing in the evening and watered on the next following days up to establishment of seedlings. A good number of seedlings were transplanted at the border for later use as gap fillers.

3.10. Intercultural operation:

3.10.1 Irrigation

Irrigation was normally done after each weeding. The young plants were irrigated by a watering can. Subsequence irrigation was done as per requirements.

3.10.2. Gap filling

The dead seedlings were replaced by healthy seedlings within 10 days after transplanting.

3.10.3. Weeding and mulching

Weeding and mulching were done when required to keep the crop free from weeds, for better soil aeration and conserve soil moisture. The common weeds were *Cynodon dactylon* L. (Durba grass), *Cyperus rotundus* L. (Mutha) etc. Weeding was done carefully keeping the delicate young plants undisturbed.

3.11. Isolation and identification of pathogens from leaf tissue

The diseased leaves were cut into pieces (4 mm diameter) and surface sterilized with $HgCl_2$ (1:1000) for 30 seconds. Then the cut pieces were washed in sterile water thrice and were dried in keeping untreated blotting paper then placed on to acidified PDA in petridish. The plates containing leaf pieces were placed at room temperature for seven days. When the fungus grew well, and sporulated, then the slide was prepared and was identified under microscope with the help of relevant literature.

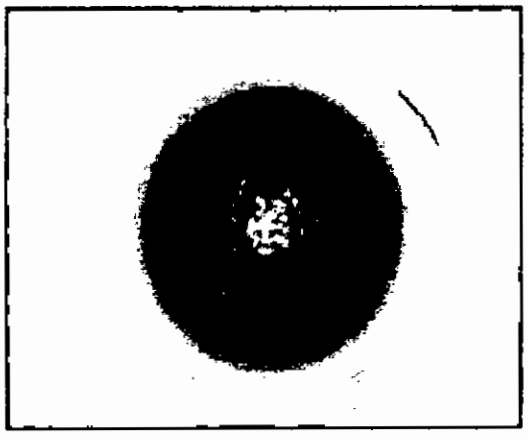

Figure 2. Pure culture of *Alternaria porri*

Figure 3. Conidia of *Alternaria porri*

Figure 4. Photograph showing typical symptom of purple blotch of onion.

3.12. Data collection

Twenty one plants were selected randomly for each unit plot and tagged for data collection from total no of plant 42 in six rows and seven collumn. Data collection was started thirty days after transplanting and continued up to 90 days with 15 days intervals.

3.12.1. No. of infected leaf/plant of different treatment

Number of leaf infected per plant were recorded and used for calculation of disease incidence. The leaf with characteristic white colored spot or blighted tip was denoted as diseased leaf.

Calculation of disease incidence of different treatment

The percent disease incidence was calculated using the following formula.

$$\% \text{ leaf infection} = \frac{\text{Number of infected leaf}}{\text{Total number of inspected leaf}} \times 100$$

3.12.2. Leaf Area Diseased (LAD)/plant in different treatment: Leaf area diseased of the ten selected plants in each plot against each treatment were measured and recorded by conversion to percentage. Mean percentage of leaf area diseased was calculated by dividing number of total observation and used for PDI (percent disease index) estimation.

3.12.3. Estimation of PDI

Evalution of leaf blotch severity: The percent disease area index (PDI) was using by the following formula.

$$PDI = \frac{\text{Sum of total disease ratting} \times 100}{\text{Total number of observation} \times \text{Highest grade in the scale}}$$

The following disease scoring scale (0-5 scale) was used to estimate the disease severity (PDI) of purple blotch disease of onion for each germplasm.(Hasan,2008)

0 = No disease symptoms (Resistant)

1 = A few spots towards the tip, covering less than 10% area. (Resistant)

2 = Several spots covering less than 20% area. (Moderately resistant)

3 = Several patches with pale outer zone covering up to 40% leaf area. (Susceptible)

4 = Long streaks covering up to 75% leaf area or breaking of leaves/stem from the center. (Highly Susceptible)

5 = Complete blighting of the leaves/stem or breaking of the leaves/steam from the base. (Highly Susceptible)

3.13. Harvesting

Harvesting of the bulbs

Onion bulbs were harvested on 13th April, 2010, at which the plants had been showing the sign of drying out of most leaves. After harvesting the bulbs dried and kept separately for weighing.

3.14. Weight of bulb per plot

Weight of onion bulbs per plot were recorded individually for each treatment.

3.15. Yield of onion per hectare

Yield of onion was calculated as ton per hectare.

3.16. Analysis of Data/Statistical Analysis

Data were analyzed statistically using MSTAT Computer Program. Means of treatments were compared using Duncan's Multiple Range Test (DMRT), (Gomez and Gomez, 1984).

3.17. Weather report

The monthly average data on temperature, rainfall and humidity during experimental period were collected from the authority of Bangladesh Metrological Department, Agargoan, Dhaka which are presented in Appendix (II).

Figure 5. Purple blotch severity of onion leaf.

Chapter 4

Results

CHAPTER 4

RESULTS

This chapter includes the experimental results. Different cultivar viz. BARI Pias-1, BARI Pias-2, BARI Pias-3, Thakungaon local, Faridpur local Manikgonj local, Taherpuri , Indian big and Indian small were assessed against Purple blotch causing purple blotch of onion under natural condition. Results were compiled based on disease incidence and disease severity of Purple blotch at seedling stage to maturity in net house as well as in field condition at different days after transplanting (DAP) and presented in this chapter.

4.1. Incidence of Purple blotch of onion cultivars on onion seedling in the net house

The incidence of Purple blotch of onion cultivars on onion seedlings against *Alternaria porri* in the net house is presented in Table-1. At seedling stage (30 days old) the different cultivars showed significant difference in respect of disease incidence among themselves. No disease incidence were recorded in case of BARI Peas-3, Indian small and Indian big. The highest disease incidence (24.00%) was recorded in case of Manikgonjn local which was statistically indifferent with Tharpuri(23.00%). The moderate incidence was recorded in Thakurgaon local (14.67%), BARI Peas-1 (14.67 %), and Faridpur local (11.67%) while the incidence of BARI Peas-2 was 10.33%.

Table 1. Incidence of Purple blotch of onion cultivars on onion seedling in the net house

Treatment		Disease Incidence in onion seedling (%)
T_1	BARI Peas-1	14.67 b
T_2	BARI Peas-2	10.33 b
T_3	BARI Peas-3	0.00 c
T_4	Thakurgaon local	14.67 b
T_5	Faridpur local	11.67 b
T_6	Indian big	0.00 c
T_7	Manikgonj local	24.00 a (Highest incedence)
T_8	Tharpuri	23.00 a
T_9	Indian small	0.00 c
CV(%)		36.30
LSD		6.865

4.2. Incidence of Purple blotch of onion cultivars at different days after transplanting (DAP) in the fields

The incidence of Purple blotch on onion cultivars recorded at different days after planting (DAP) are presented in Table-2. The different onion varieties showed significant variation in respect of disease incidence at different days after transplanting. Data were recorded with 15 days interval staring from 30 days after transplanting. At 30 DAP, no disease incidence were observed in case of onion cultivars BARI Peas-3, Indian big and Indian small. The second lowest (16.98 %) incidence was recorded in case of onion cultivars BARI-2 followed by Faridpur local (21.67%) which was statistically identical with the local cultivars of Thakurgaon (24.52 %) and BARI Peas-1 (24.52 %) . The highest disease incidence was noted in Manikgonj local (32.78%) that was statistically similar with Taherpuri (31.19%).

At 45 DAP, the incidence of Purple blotch on onion varieties varied significantly. The lowest (0.0%) disease incidence was recorded in case of Indian small which was statistically indifferent with and variety BARI Peas-3 (4.760%) and Indian big (5.553%) and followed by BARI Peas-2 (21.74 %) that was statistically identical with BARI Peas-1 (24.52%). The highest disease incidence was noted in Manikgonj local (46.67%) that was statistically indifferent with Taherpuri. Moderate incidence was observed in case of local cultivar Thakurgao (35.95%) that was statistically identical with Faridpur local (35.00%).

At 60 DAP the onion cultivars evaluated against Purple blotch also differed significantly regarding disease incidence. The lowest disease incidence was recorded Indian small (10.31%) which was statistically identical with BARI peas-3 (11.43%) and Indian big (12.22%). The

moderate disease incidence was recorded in case of BARI Peas-2 (44.27%) and BARI Peas-1 (44.28%). The highest disease incidence was recorded in Manikgonj local (58.89%) which was statistically indifferent/similar to Taherpuri (55.71%), Thakurgaon local (55.71%) and Faridpur local (56.67%). It was observed that the disease incidence of Purple blotch of onion was gradually increased with the age of the crops.

At 75 DAP, the disease incidence of Purple blotch of onion in the test varieties differed significantly. The lowest disease incidence was recorded in case of BARI Peas-3 (18.09%) which was statistically identical with cultivars Indian big (26.11%). The second lowest incidence was recorded in case of onion cultivars Indian small (27.30%). Statistically the highest disease incidence were noted in case of Manikgonj local (79.44%), Tharpuri (75.47%), Thahurgaon local (75.47%) and Faridpur local (78.33%), preceded by BARI Peas-1(68.97%) and BARI Peas-2(66.02)

In 90 DAP when the crops was in mature stage, the cent percent (100%) disease incidence was recorded in case of Tharpuri, Thahurgaon local, Faridpur local and Manikgonj local. The lowest disease incidence (36.19%) was recorded in case of BARI Peas-3 which was statistically identical with cultivars Indian big (44.28%) and Indian small (38.72%) followed by BARI Peas-2 (83.00%) and BARI Peas-1(88.57%).

Table 2. Incidence of Purple blotch of onion cultivars recorded at different days after transplanting (DAP) in the fields

Treatment	Disease incidence (%)				
	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP
T_1	24.52ab	24.52bc	44.28b	68.97bc	88.57b
T_2	16.98b	21.74c	44.27b	66.02c	83.00b
T_3	0.00c	4.76d	11.43c	18.09e	36.19c
T_4	24.52ab	35.95ab	55.71ab	75.47ab	100a
T_5	21.67b	35.00ab	56.67ab	78.33a	100a
T_6	0.00c	5.553d	12.22c	26.11de	44.28c
T_7	32.78a	46.67a	58.89a	79.44a	100a
T_8	31.19a	44.28a	55.71ab	75.47ab	100a
T_9	0.00c	0.00d	10.31c	27.30d	38.72c
CV(%)	27.22	26.69	18.15	8.24	6.54
LSD	7.939	11.21	12.20	8.163	8.694

Treatments:

T_1 = BARI Peas-1

T_2 = BARI Peas-2

T_3 = BARI Peas-3

T_4 = Thakurgaon local

T_5 = Faridpur local

T_6 = Indian big

T_7 = Manikgonj local

T_8 = Taherpuri

T_9 = Indian small

4.3. Severity of Purple blotch of onion cultivars at different days after transplanting (DAP) in the fields

The severity of Purple blotch of onion cultivars recorded at different days after planting (DAP) are presented in Table-3. The different onion varieties showed significant variation in respect of disease severity recorded at different days after transplanting. Data were recorded with 15 days interval staring from 30 days after transplanting. At first 30 DAP, the lowest disease severity was observed in case of onion variety BARI Peas-3 (2.333%) which was statistically identical with Indian small (3.667%). The second lowest severity was recorded in case of Indian big (5.000%) which was statistically similar with BARI Peas -2 (6.00%). The higher disease severity was recorded in case of Thaerpuri (20.00%) which was statistically identical with Faridpur local (19.00%) followed by Thakurgaon local (16.67%) and Manikgonj local (17.67%).

2_{nd} At 45 DAP, the severity of Purple blotch on onion varieties varied significantly. The lowest disease severity was recorded in case of BARI released variety BARI Peas -3 (3.667%) followed by Indian small (5.667%) that was statistically similar with the cultivar Indian big (6.333%). The second lowest severity (10.00%) was recorded in case of BARI Peas-2. The highest severity was observed in the local cultivar Taherpuri (25.00%) which was followed by the cultivar Faridpur local (23.00%) that was statistically identical with the cultivar of Manikgonj local (22.00%). The second highest severity was noted in case of Thakurgaon local (20.33%) followed by Bari Peas-1 (12.67 %).

3_{rd} At 60 DAP, the onion cultivars evaluated against Purple blotch were also differed significantly regarding disease severity. The lowest disease severity was recorded in BARI Peas-3 (5.00%) followed by Indian small

(7.333%) which was statistically identical with Indian big (7.667%). The moderate disease severity was recorded in case of BARI Peas-2 (13.00%). The highest disease severity was recorded in case of local cultivar Taherpuri (29.00%) which was statistically similar to Faridpur local (27.00%) followed by Thakurgaon local (25.00%) and Manikgonj local (26.00%). It was observed that the disease severity of purple blotch of onion was gradually increased with the age of the crops.

4_{th} At 75 DAP, the disease severity of Purple blotch of onion in the test varieties differed significantly. The lowest disease severity was recorded in case of BARI Peas-3 (6.333%) which was statistically identical with Indian small (9.000%). The second lowest severity was noted in case of Indian big (9.333%). The highest disease severity was noticed in case of Taherpuri (33.67%) which was statistically similar with Faridpur local (31.33%) and preceded by Thakurgaon local (30.00%) and Manikgonj local (30.00%). The moderate disease Severity was recorded in case of BARI Peas-2 (15.67%) and BARI Peas-1 (22.00%).

5_{th} In 90 DAP, when the crop was in matured stage the lowest severity was recorded in case of BARI Peas-3 (8.00%), which was statistically identical with the cultivar Indian small (10.00%) followed by Indian big (11.00%). The second lowest severity was noted in case of BARI released variety BARI Peas-2 (18.67%) followed by BARI Peas-1 (25.00%). The highest disease severity was observed in the local cultivar Taherpuri (37.67%) which was statistically identical with the cultivar Faridpur local (35.00%) preceded by Thakurgaon local (34.33 %) and Manikgonj local (34.00%). Based on the disease reaction in critical disease coordination (at 90 DAP). The cultivar BARI Peas-3 was graded as resistant, BARI Peas-2, Indian big and Indian small graded as moderate resistant and rest of the local cultivars were graded as susceptible.

Table 3. Severity of Purple blotch of onion cultivars at different days after transplanting (DAP) growth in the fields

Treatments	Disease severity (PDI- Percent disease index)				
	30 DAP	45 DAP	60 AP	75 DAP	90 DAP
T_1	8.333 d	12.67d	17.67c	22.00 c	25.00 c
T_2	6.000 e	10.00e	13.00d	15.67d	18.67d
T_3	2.333 g	3.66g	5.000e	6.333f	8.000 f
T_4	16.67 c	20.33c	25.00b	30.00b	34.33b
T_5	19.00 ab	23.00b	27.00ab	31.33ab	35.00 ab
T_6	5.000 ef	6.333f	7.667e	9.333e	11.00e
T_7	17.67 bc	22.00bc	26.00b	30.00b	34.00b
T_8	20.00 a	25.00a	29.00a	33.67a	37.67a
T_9	3.667 fg	5.667f	7.333 e	9.000ef	10.00ef
CV (%)	9.29	7.89	8.53	7.94	6.84
LSD	1.763	1.953	2.585	2.860	2.809

Treatments:

T_1 = BARI Peas-1

T_2 = BARI Peas-2

T_3 = BARI Peas-3

T_4 = Thakurgaon local

T_5 = Faridpur local

T_6 = Indian big

T_7 = Manikgonj local

T_8 = Taherpuri

T_9 = Indian small

4.4. Yield performance of different onion cultivars against Purple blotch of onion

Yield performance of different test varieties against Purple blotch is presented in Table-4. The different varieties varied significantly in respect of yield. The highest yield performance was obtained in case BARI released variety BARI Peas-3 (12.67 ton/ha). The second highest yield (10.33 t/ha) was obtained in case of the cultivar Indian small which was statistically identical with the cultivar Indian big (9.84 t/ha). Moderate yield performance was obtained in case of BARI Peas-2 (9.00 t/ha). The lowest yield performance was obtained in case of the local cultivar Taherpuri (4.34 t/ha) which was statistically similar with the local cultivar Faridpur local (4.84 t/ha). The second lowest yield (5.67 t/ha) was noted in Takurgaon local which was statistically identical with local cultivar Manikgonj local (6.17 t/ha).

Table 4: Yield performance of different onion cultivars against Purple blotch of onion

Treatments		Yield(t/ha)
T_1	Bari-1	7.00d
T_2	Bari-2	9.00c
T_3	Bari-3	12.67a
T_4	Thakurgaon local	5.67e
T_5	Faridpur local	4.84f
T_6	Indian big	9.84b
T_7	Manikgonj local	6.17e
T_8	Tharpuri	4.34f
T_9	Indian small	10.33b
CV (%)		5.72
LSD		0.6783

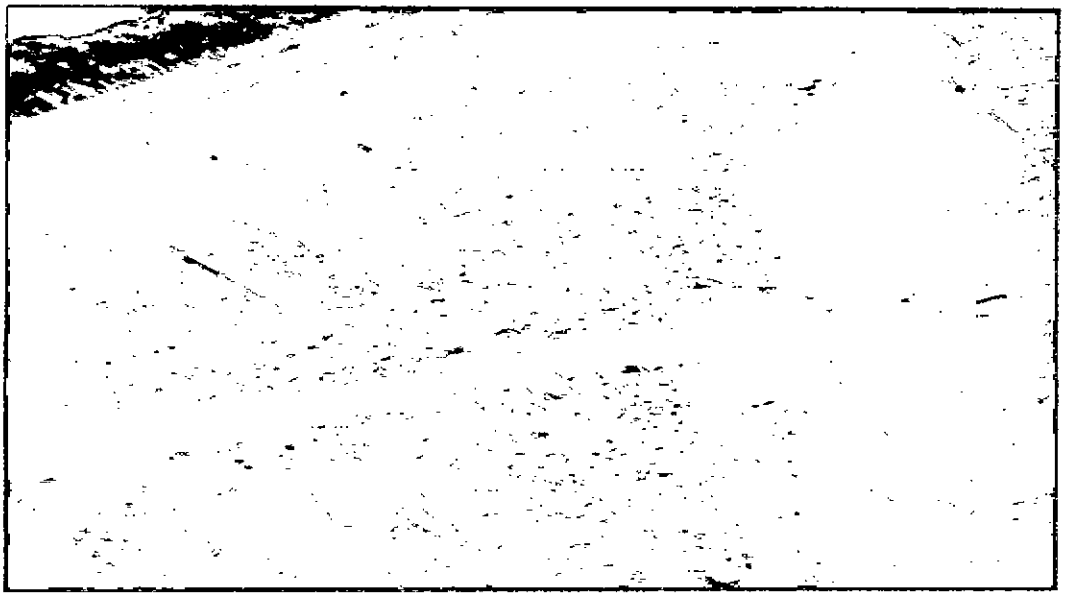

Figure 9. A view of the experimental field.

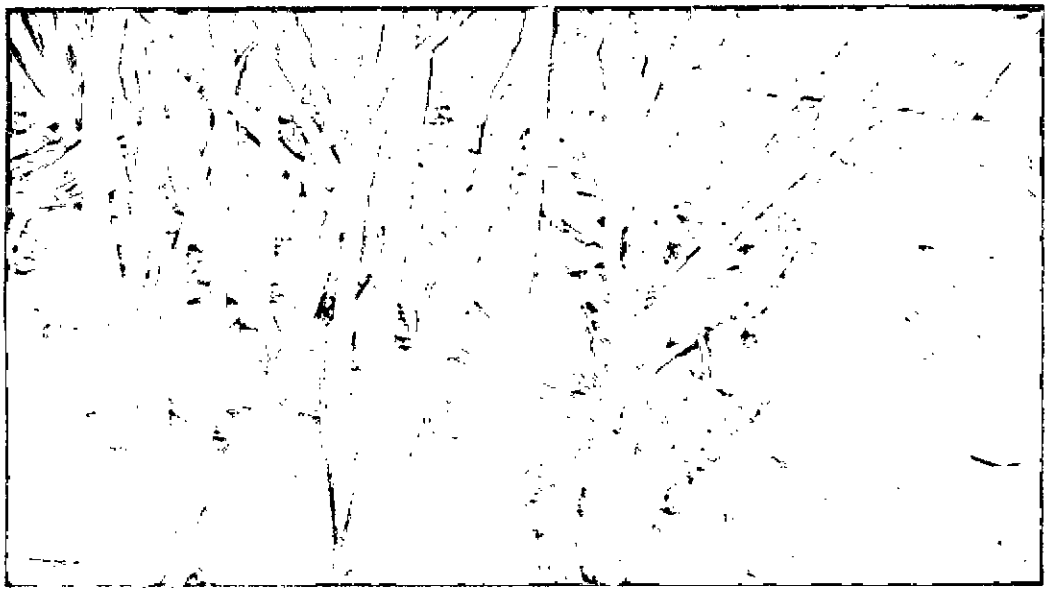

Figure 10. A view of the experimental field showing healthy plant

Figure 11. A view of the experimental field showing infected plant

Figure 12. A view of the experimental field showing healthy plant

BARI Peas-3

Chapter 5

Discussion

CHAPTER 5

DISCUSSION

Onion (*Allium cepa*) is a popular vegetable grown for its pungent bulbs and flavorful leaves. Onion is an important spice as well as vegetable crops grown in many countries in the world including Bangladesh. The yearly onion production is 889260 metric ton from 309309 acre of land. (BBS, 2008). In Bangladesh, the production of onion is 7.1 M/ha which is quite lower in comparison to the world average such as Koreya (67.25 mt/ha), USA (53.91 mt/ha), Spain (52.06 mt/ha) and Japan (47.77 mt/ha) (FAO, 2008). Purple blotch complex of onion is supposed to be the major constrain for the lower yield of onion in the country. The present experiment was conducted in the net house of the department of plant pathology and in the field of SAU farm during November, 2009 to April, 2010. To screen out the onion cultivars available in Bangladesh against Purple blotch complex (*Alternaria porri*). The cultivars used in the experiment were BARI Peas-1, BARI Peas-2, BARI Peas-3, Indian big Indian small, Taherpuri, Manikgonj local, Thakurgaon local and Faridpur local collected from HRC, BARI and major onion growing areas in the countries.

5.1. Net house experiment

In the net house using the collected seeds of onion cultivars Seedling were raised in a temporary constructed net house using plastic tray arranged in RCBD designe with three replications. At the age of 22-25 days old seedlings the incidence of purple blotch were observed. No disease incidence was found in case of BARI Peas-3, Indian small and Indian big. While the local varieties Faridpur, Taherpuri, Manikgonj and Thakurgaon showed disease incidence (Table-1). The highest seedling incidence was found in case of Manikgonj local followed by Taherpuri

,Thakurgaon local and Faridpur local. No previous report on seedling incidence of onion cultivars against purple blotch disease of onion is reported in the country. However it is reported the indigenous red variety of India found to be uninfected against purple blotch complex of onion (*Alternaria porri*).

5.2. Field experiment

The onion seedlings raised in the net house transplanted to the field after one month of seed sowing. The incidence and severity was recorded starting from 30 days after transplanting (DAP) with 15 days intervals. In case of disease incidence it is reveals that different cultivars showed significantly different reaction against purple blotch of onion. Initially at 30 DAP no disease incidence was found in BARI released variety BARI Peas-3 and two Indian variety Indian big and Indian small while the rest of the varieties were infected by the disease. The result showed that with the increase of the age of the crops the incidence of the disease increased gradually and reached to the high at 90 DAP in maturity. At 90 DAP the BARI Peas-3, Indian small and Indian big were also scored significantly the lowest incidence (36.19%, 38.72% and 44.28%) respectively. While Thakurgaon local Faridpur local Manikgonj local and Taherpuri showed 100% disease incidence. BARI Peas -2 and BARI Peas -1 scored 83.00%, and 88.57% disease incidence respectively. On the basis of the response of the cultivars regarding disease incidence against purple blotch complex of onion it is reveals that BARI released variety BARI Peas-3, Indian big and Indian small seem to be resistant. While the local varieties are found to be highly susceptible. (Padule and Utikar,1982). Screen of twenty two onion cultivars under field condition against purple blotch and white blotch and reported all the cultivars to be susceptible. Thirumalachar *et al* (1953).While searching varietals resistant against

purple blotch onion reported that the indigenous red variety showed resistant reaction. No reports on the screening of local onion varieties in Bangladesh are available in Bangladesh. In the present experiment disease severity as PDI (Percent disease index), while recorded at different days after transplanting of seedling starting from 30 DAP to 90 DAP with 15 days intervals. It was noticed that a remarkable difference on disease severity was observed from 30 days after transplanting of seedling and the difference of severity appeared to be more distinct among the treatments with the progress of time and the severity counts reached to be highest stage of the crops. On the basis of disease severity or disease reactions, the cultivars were graded following the proposed severity scales ((Basak 1997). As per severity scale the BARI released variety BARI Peas-3 was found to be resistant (PDI-8.00%), cultivars Indian small (PDI-10.00%), Indian big (PDI-11.00%) and BARI Peas-2 (PDI-18.67%) were graded as moderately resistant, Rest of the local cultivars including BARI Peas-1 (PDI range from 25-37%) were graded as susceptible. No research report are available in the literature on the disease reaction of onion cultivars both local and hybrid against purple blotch of onion in the country.

At mature stage, the crops were harvested and bulb yield was counted and recorded separately for each test varieties. The highest yield performance was recorded in case of BARI released variety BARI Peas-3 (12.67 t/ha) followed by Indian small (10.33 t/ha), Indian big (9.84 t/ha), BARI Peas-2 (9.00 t/ha) and BARI Peas-1 (7.00 t/ha). The yield performance of Indian big and Indian small was also significantly identical. Significantly the lowest yield was recorded in case of Faridpur local and Taherpuri. The yield performance of Thakurgaon local and

Manikgonj local were also significantly identical where the yield were 5.67 t/ha and 6.17 t/ha respectively.

From the result, it is raveled that yield performance of BARI released variety and the imported Indian varieties were higher than the indigenous local varieties. The better performances regarding the yield of BARI released varieties and two imported Indian variety Indian big and Indian small might be due to the resistant reaction of the varieties against purple blotch disease. Because purple blotch disease reduce the yield up to 41-44% in Bangladesh (Hossain and Islam, 1993, Fakir, 2002). The present finding agree with the report of (Rahman *et al.*,1988), who reported that two widely cultivated local variety in Bangladesh like Faridpur, and Taherpuri are susceptible to purple blotch complex of onion that affects the bulb seriously.

Chapter 6
Summary and Conclusion

CHAPTER 6

SUMMARY AND CONCLUSION

Onion (*Allium cepa*) is the one of the most important vegetable/spices in Bangladesh. Onion suffers from many diseases of which Purple blotch is common and devastating for its bulb yield and quality of seeds.

The present piece of research work was conducted in the Department of Plant Pathology and in the field of SAU (Sher e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, to screen out the resistant varieties of onion against Purple blotch disease (*Alternia porri*) during the period from October 2009 to April 2010. Nine onion varieties viz. BARI Peas-1, BARI Peas- 2, BARI Peas-3, Thakurgaon local, Faridpur local, Manikgonj local, Taherpuri, Indian big and Indian small were evaluated in the experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

The onion varieties differed significantly among themselves in respect of incidence at seedling stage. No disease incidence was observed in case of BARI Peas-3, Indian small and Indian big. The highest disease incidence (24.00%) in seedling was recorded in case of Manikgonjn local which was statistically indifferent with Taherpuri (23.00%) followed by Thakurgaon local, BARI Peas-1 and Faridpur local.

In the field condition, the disease incidence and disease severity were recorded in different days after transplanting (DAP) with 15 days intervals starting from 30 DAP. The disease incidence and severity of different onion cultivars against Purple blotch (*Alternia porri*) differed

significantly at different days after planting (DAP). The lowest disease incidence at 30 DAP, 45 DAP, 60 DAP, and 90 DAP respectively were found in BARI Peas-3, Indian small and Indian big with some extent. The highest disease incidence at 30 DAP, 45 DAP, 60 DAP, 75 DAP, and 90 DAP, were observed in case of local cultivars Taherpuri, Fridpur local, Thakurgaon local and Manikgonj local.

In case of disease severity the lowest PDI (Percent disease index) was recorded in case of BARI Peas-3 irrespective of different days after transplanting (DAP) followed by Indian small and Indian big. The local cultivars Taherpuri, Manikgonj local Thakurgaon local and Manikgonjn local showed higher PDI irrespective of different DAP.

On the basis of yield performance the highest yield (12.67 t/ha) was found in BARI Peas-3 followed by Indian small (10.33 t/ha) that was statistically identical with Indian big (9.84 t/ha). The lowest yield performance was found in Taherpuri (4.34 t/ha) followed by Faridpur local (4.84 t/ha).

On the basis of disease reactions in critical stage at 90 DAP BARI Peas-3 (8.00%) was graded as resistant against Purple blotch. Cultivars Indian big (11.00%), Indian small (10.00%) and BARI released variety BARI Peas-2 (18.67%) categorized into moderately resistant. The local cultivars Taherpuri (37.67%), Faridpur local (35.00%), Thakurgaon local (34.33%), Manikgonj local (34.00%) and BARI Peas-1 (25.00%) were graded as susceptible.

Considering the performance of onion cultivars it may be concluded that BARI Peas-3 was graded as resistant against Purple blotch disease of

onion Indian small, Indian big and BARI Peas -2 were moderately resistant and the local cultivars Taherpuri, Faridpur local, Thakurgaon local and Manikgonj local were susceptible against Purple blotch of onion (*Alternaria porri*) among the varieties used in the experiment. However, screening program need to carryout for consecutive years in different agro ecological zones of the country to justify the present findings.

Chapter 7
Literature Cited

CHAPTER 7

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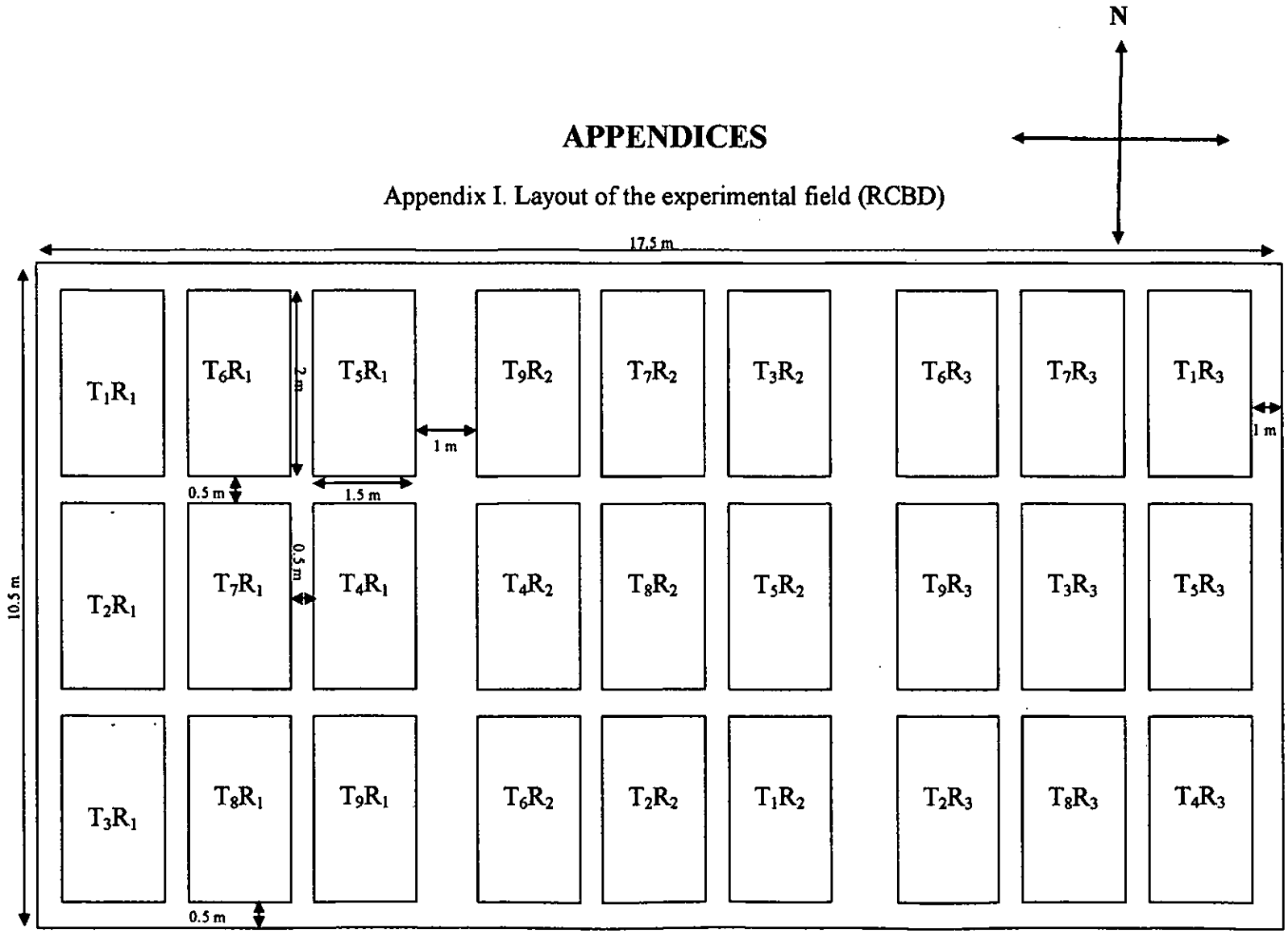
Appendices

APPENDICES

Appendix I. Layout of the experimental field (RCBD)



Total area= 17.5 x 10.5=183.75 m^2

Fig. 2. Layout of the field experiment showing treatment assigned

APPENDICES

Appendix II. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from November, 2009 to april, 2010.

Month	Air temperature (0C)			RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
November, 2009	29.0	19.8	24.40	73.90	3.0
December, 2009	27.0	15.7	21.35	62.79	0.0
January, 2010	24.9	13.2	19.05	67.5	3.0
February, 2010	28.1	17.8	22.95	61.5	4.0
March, 2010	32.5	22.6	27.55	66.6	155.0
April, 2010	33.74	23.87	28.81	69.41	250

Source: Bangladesh Metrological Department (Climate division), Agargoan, Dhaka-1207.

Appendix III. Analysis of variance of the data on the incidence of purple blotch at seedling stage

Source of variance	Degree of freedom	Mean square
Replication	2	8.48
Treatments	8	263.89
Error	16	15.73

Significant at 0.05 level of probality.

Appendix IV. Analysis of variance of the data on the incidence of purple blotch after different days of transplanting

Source of variance	Degree of freedom	Mean square				
		30 DAP	45 DAP	60 DAP	75 DAP	90 DAP
Replication	2	3.22	107.84	114.49	82.58	6.468
Treatments	8	544.52	930	1358.29	1955.83	2432.44
Error	16	21.04	41.971	49.66	22.24	25.23

Significant at 0.05 level of probality.

Appendix V. Analysis of variance of the data on the severity of purple blotch after different days of transplanting

Source of variance	Degree of freedom	Mean square				
		30 DAP	45 DAP	60 DAP	75 DAP	90 DAP
Replication	2	3.37	5.48	4.15	1.82	1.93
Treatments	8	156.95	209.29	272.85	357.59	436.65
Error	16	1.04	1.28	2.23	2.73	2.64

Significant at 0.05 level of probality.

Appendix VI. Analysis of variance of the data on the yield of different treatments

Source of variance	Degree of freedom	Mean square
Replication	2	0.009
Treatments	8	24.13
Error	16	0.197

Significant at 0.05 level of probality.