INFLUENCE OF SEED SOURCE AND STORAGE CONDITION ON GROWTH AND YIELD OF WHEAT

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CERTIFICATE

This is to certify that the thesis entitled, "**INFLUENCE OF SEED SOURCE AND STORAGE CONDITION ON GROWTH AND YIELD OF WHEAT**" 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** in **AGRONOMY,** embodies the result of a piece of *bona fide* research work carried out by **MD. IBRAHIM KHALIL KHAN** Registration No. **06-01903** 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.

Dated:

Place: Dhaka, Bangladesh

(Prof. Dr. A. K. M. Ruhul Amin)

Supervisor

DEDICATED TO MY BELOVED PARENTS

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INFLUENCE OF SEED SOURCE AND STORAGE CONDITION ON GROWTH AND YIELD OF WHEAT

ABSTRACT

An experiment was conducted at the Agronomy laboratory with storing wheat seed and subsequent study in Agronomy field ofSher-e-Bangla Agricultural University, Dhaka during May 2011 to March 2012 to find out the influence of different storage conditionson wheat seed and to evaluate on different seed source of the growth and yield performance of stored seeds. The experiment was carried out in randomized complete block design with two factors comprising three seed source *viz.*,i) S_1= BARI seed, ii) S_2= BADCseed and iii)S_3=Farmer seed, and four storage conditionslike i) C_1= Below 10^0C ii) C_2= Below 20^0C iii) C_3= Polybag (room temperature) iv) C_4=Tin container (room temperature) having three replications. Result showed that seed source, storage condition of seed and their combinations had significant effect on yield and harvest indexof wheat.BARI seed showed the highest grain yield (3.48 t ha^{-1}), straw yield (5.21 t ha^{-1}) and biological yield (8.69t ha^{-1}). Seed storedbelow 10^0C condition showed the highest grain yield (3.29 t ha^{-1}), straw yield (5.26 t ha^{-1})and biological yield (8.55 t ha^{-1}). Combination of $S_2 \times C_2$ (BADC seed×below20^0C) showed the highest number of tillers m^{-1} at 60DAS (97.87) and 75DAS (112.50). On the other hand, combination of $S_1 \times C_1$(BARI seed×below10^0C) gave the highest filled grains $spike^{-1}$ (40.25), 1000-grain weight (43.92 g), grain yield (3.67 t ha^{-1}),straw yield (5.57 t ha^{-1}) and biological yield (9.24 t ha^{-1}). Farmers seed was found poor from its yield point of view, even either any storage conditions could not improve its status.

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CHAPTER 1

INTRODUCTION

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world as well as in Bangladesh that provides about 20% of total food calories. About two third of the total world's population consume wheat as staple food (Majumder, 1991). It contains carbohydrate (78.1%), protein (14.7%), minerals (2.1%), fat (2.1%) and considerable proportion of vitamins (Peterson, 1965). The crop is grown under different environmental condition ranging from humid to arid, subtropical to temperate zone (Saari, 1998).

In Bangladesh, it covers 400,000 hectares of land with an annual production of 737,000 metric tons (BBS, 2008). While, wheat only accounts for about 12% of total cereal consumption, it is the second most important food in Bangladesh after rice. The wheat growing season overlaps with *boro* rice and other remunerative crops like corn, potato and winter vegetables. Given favorable weather conditions, the Market Year 2012-13 Bangladesh, wheat crop (planted in November/December and harvested in March/April) is estimated at 1.15 million tons from 410,000 hectares of land (Bangladesh Grain and feed annual, 2013). While wheat area has increased in response to high prices, the growing scarcity of water for irrigation has prompted farmers to shift some *boro* rice growing areas to wheat. However, wheat cultivation remains a preferred option particularly for non-irrigated land with low input use. Though wheat is an important cereal crop in Bangladesh, the average yield is very low compared to that of advanced countries. In order to meet the ongoing food deficit and to cope with the food demand for the increasing population, wheat production needs to be increased in Bangladesh. The scope of increasing the cultivated land is limited in Bangladesh due to occupation of land for accommodating the ever growing population. So, the only way to meet the food demand is to increase the total production as yield per unit area. There are many factors responsible for low yield, of which poor quality of wheat seed that reduces its yield if we not replace the diseased, poor quality, low vigour seed by good one.

Seed means a reproductive unit which contains an alive embryo, capable of producing new seedling or individual of its own type. Availability of high quality healthy seeds is the crying need of the day in all segments of agriculture to ensure sustainable good crops. It also necessary to aware farmers about the consequences of the crop losses with low quality seed. For obtaining desired harvest, effectiveness of other inputs such as fertilizer, irrigation, pest control measure etc, depend largely on the quality of seeds (Rashid and Fakir, 2000). Seed requirement of wheat during 2006-07 in Bangladesh was 78.00 thousand metric tons of which wheat only 12415 metric tons was distributed by BADC (BADC, 2007). Use of good seeds can contribute to increase the yield remaining all other factors of production as constant. Improved quality seed supply in Bangladesh constitutes only about 390 tons which is about 33% of the total requirement and rest 67% seed are met by farmers and local seed traders (Vossen, 1994). Usually the farmers or other seed producers don't provide appropriate measure to attain a good standard of seed quality. Seed health is an important attribute of quality, and seed used for planting should be free from pest. Seed infection may lead to low germination, reduced field establishment, severe yield loss or a total crop failure. For example, severely infected wheat grains with kernel bunt either fail to germinate or produce a greater percentage of abnormal seedlings (Singh and Krishna, 2002). In most cases seed health deteriorate due to poor storage condition of seed. Due to poor storage condition seed may be easily affected by stored grain insect or seed borne pathogen. Moreover, Seed deterioration associated with loss of viability during storage results in decreased early growth of roots and shoots and in increased variability of growth between plants. This early inhibition of growth-rate does not persist and there is some evidence that, under normal agricultural conditions, initial low rates of growth may be compensated at later stages of development.

If we provide appropriate storage condition with optimum temperature seed health may be more or less ensured. Crop production could be increased adopting appropriate seed source and selecting suitable seed storage condition with providing optimum temperature. Considering the above fact, the study was conducted to judge the effect of seed source and its storage condition with following objectives:

i. To compare the seeds of different sources.
ii. To study the importance of ideal seed storage condition.
iii. To determine the combining effect of seed source and storing condition for maximizing yield harvest of wheat.

CHAPTER 2
REVIEW OF LITERATURE

REVIEW OF LITERATURE

Wheat is an important crop of the world. Different seed sources play an important role on its growth, yield and quality. Many works have been done in the world on the effect of seed source variations, cultivar or genotype variations on wheat seed quality and their performances by different storage condition. In this chapter an attempt has been made to review research works related to present investigation.

2.1 Effect of seed sources

Salina *et al.* (2004) reported that high quality seed is the key to successful agriculture. Survey results have shown that 64% of Bangladeshi farmers use their own wheat seed year after year, or 26% purchase from other farmers in local markets. Only 10% of the seed is purchased from governments' seed suppliers. As a result, poor seed quality is a significant factor affecting wheat productivity at the farm level in Bangladesh. To quantify farmers' seed quality, wheat seeds were they collected wheat seeds from the same 44 farms in the Chuadanga region of southwestern Bangladesh during sowing and after harvest. Seed germination was compared between the standard blotter test and a soil assay on farmers' representative soil at Wheat Research Center, Bangladesh Agricultural Research Institute, Gazipur. Results indicated that the soil assay is an easy and accurate way for farmers to evaluate seed quality under their conditions. Good to best quality seed (>81% germination) during sowing in first week of December was 68% by the soil assay and 93% by the blotter test. After harvest in May, seeds from all farms germinated by blotter test, but only 9% of farmer seeds had >81% germination by soil assay. Infection of *Bipolaris sorokiniana* was found on harvested seed from 80% of the farms after storage in October. This and other seed-borne fungus demand for seed treatment to increase wheat production in Bangladesh.

Seed deterioration leading to reduction in viability of seed can affect the yield of a crop. Decreased germination can lead to a sub-optimal population of plants per unit area. In peas, beans and barley the storage condition, which reduced viability to about 50 percent, had no significant effect on final yield of grain or straw. Nevertheless, such treatments (storage conditions) do affect the early growth of the roots and shoots of the plants; some individuals are affected more than other so that the variability of the plants is increased. Eventually these early effects on the rate of growth tend to disappear and there is even some possibility of compensatory growth during the later stage of development, thus the early slower rates of growth may be of little consequence when it comes to final yield, unless the deterioration is so severe during storage that it leads to a drop in viability to below about 50 percent. These generalizations apply at least for peas, beans and barley but judging by the different relationship between viability and final yield would not hold for any which behaves like lettuce (Roberts 1972). To have good yield of wheat, it was suggested not to use wheat seed below 55 percent germination and seed having above 55 percent germination seed rate is to be increased to adjust germination around 80 percent (BARI, 1988).

Wheat (*Triticum aestivum* L) is one of the most important staple food crops of the world, occupying 17% (one sixth) of crop acreage worldwide, feeding about 40% (nearly half) of the world population and providing 20% (one fifth) of total food calories and protein in human nutrition (Gupta *et al*. 2008). Rice alone cannot fulfill the cereal demand. Wheat is the second important cereal crop in Bangladesh. Therefore, efforts are being made to increase the production of wheat. Total land acreage of wheat in Bangladesh was 0.39 million ha and the total production was 0.84 million metric tones with an average yield of 2.15 t ha^{-1} in 2007-08 (BBS, 2008). Wheat contains plenty of proteins (12.6%), vitamins and minerals. As a second cereal crop, its importance is high in Bangladesh and increasing day by day. In Bangladesh, wheat is grown in upland condition during the Rabi season (November-March). The monthly maximum and minimum temperature during this period ranges from 25.8 to 30.5°C and 13.8 to 20.3°C in the south east zone and from 24.9 to 32.3°C and 10.3 to 16.7°C in the north east zone respectively (Hossain *et al*. 2001). Currently about 12 million hectares of land in Pakistan, Nepal, India, and Bangladesh use this cropping pattern, accounting for nearly one-fourth of the region’s cereal production. After rice, wheat has become an important component of cropping pattern in Bangladesh. It is planted mostly after cultivation of Aman rice (Majid *et al.* 2003). Production of either rice or wheat is low comparing with many other countries because of inappropriate crop, land and nutrient management practices.

In case of rice no such work is available where germination percentage has been directly related to yield. But plant population and consequently panicle/sq. m considered as important factors contributing to yield. In case of direct seeded rice crop plant population may be affected due to low germination below certain and limit and thereby yield may be affected. Jute crop is seriously affected by low germination of seed. Poor germination capacity gives poor stand in the plot and consequently results in low yield for the plot (Khandakcr and Bradbeer, 1983).

Generally farmers grow their own seeds or exchange seeds of available varieties with other farmers. It was also revealed that also stock own seed and use it for planting in the next season (Escalada *et al.* 1996). Even with these practices, farmers often use seeds that have impurity and contaminants and seeds that are infected with pathogens (Fujisaka *et al.* 1993). This state of affairs had been continuing since long and this is one of the most important reasons of low agricultural production in the country.

In study all fifty-three farmers' seed samples did not fulfill the minimum certification standard in respects of one or several quality attributes except germination percentage for which only four percent, the samples did not meet the minimum standard. Ninety seven percent samples had more off type ears, 4 percent samples had more number of affected by loose smut than the prescribed certified seed (Sharma *et al.* 1976). Samples of sixty farmers' saved seed of Sonalika wheat from different parts of Bihar state of India were analyzed for germination, physical and genetically purity. Among the farmers' seed 25 percent samples conformed to germination standard, 42 percent to physical purity and only 8.3 percent to genetic purity. In a sample, germination percentage was as low as 15 percent. Two samples were not Sonalika variety (Sinha, 1987).

Twenty-five seed samples each of gram and lentil were, collected from farmers of thirteen randomly selected villages of Patna district (Bihar, India). All the samples did not fulfill the minimum certification standards in respect of one or several quality attributes except germination percentage. The fungi *Aspergillus spp.* and *Botrytia Cinerea* were associated with gram, whereas *Aspergillus* and *Penicilium spp.* were observed in lentil along with *Fusarium Semitectum* (Jha *et al.* 1988).

A comparative study to find out the effect of use of certified seed and farmers' seed on the productivity of rice and wheat was conducted in Bangladesh. The study was conducted in the year of 1986 and 1987. Seed samples were tested for different quality components in the laboratory and evaluated in the field for yield and yield factors. Thirty one percent farmers' wheat seed samples of both

1986 and 1987 met the seed standards (moisture percentage, purity percentage and germination percentage). In case of farmers' rice seed samples 34 percent of 1987 and five percent of 1988 met the all seed standard. All the certified wheat and rice seed samples met the standards (Huda, 1990).

In India, majority of the farmers invariably use their own home saved seed for the production of all crops. Poor seed gives poor yield. Keeping in view these objectives, an effort was made in the study "comparative performance of different classes of seeds for quality parameters in laboratory and field in wheat. The different classes of seeds viz. nucleus, breeder, foundation and certified seeds from different seed producing agencies were compared with farmers owned saved seed in three wheat cultivars namely WH-147, Sonalika and HD-2009, Breeder seed gave the highest grain yield followed by foundation and certified classes, whereas the farmers' saved seed gave lowest yield consistently. Significant differences were not observed among the different sources within foundation and certified seed. It was conducted that the quality seed irrespective of sources should be used for planting instead of home saved seed to get maximum yield potential (Tyagi *et al.* 1985).

In a report comparative performance of certified seed and farmers' seed of wheat were described. Due to existing debate in India on the merits of use of certified seed for crop production comparative studies had been conducted. Seed samples of wheat variety Sonalika collected from farmers of different parts of the country in 1974, 1983 and 1984 were evaluated along with certified seed samples for seed quality characters and yield. An average of 42 percent farmers' seed samples. However, large percentage of samples (77%) showed significantly lower genetic purity than the certified seed. Studies of relationship between yield and quality characters in 1974-84 revealed significant negative correlation between genetic impurity and yield suggesting decrease of yield with an increase in the percentage of off-types and other crop plants in the farmers' seed samples. The study revealed a significant superiority of certified seed over the seed saved by farmers and thus justified the current emphasis on increasing the use of certified seed (Agrawal, 1988).

A farmer participatory research was conducted in two sites of Central Luzon to examine the impact of best quality seeds on farm yield. For each site 30 farmers collaborators planted their own seed and IRRI supplied seeds of the same variety in two subplots of a selected parcel. They followed their own management practices, which were monitored by the researchers. An analysis of seed health of the farmer used seeds showed a large portion were not fully filled and were discolored, 3 to 4% of the seeds having mixtures with off-types, 5% of the seeds with lethal seed infection, and seeds had around 96% purity level. The result of the experiment showed that plot planted with IRRI supplied seeds had 7% higher yield than the plot planted with farmer-kept seeds in the site where the yield level is already high. In the site where the yield level is low the yield difference between the plots was 20%. A large part of the increase in yield was due to lower weed and pest pressures achieved by the use of high quality seeds. A multivariate regression analysis of the determinants of rice yield showed that weeds and pests are important biotic constraints reducing rice yield nearly 25% (Daiz *et al.* 1998).

Farmer in Bangladesh has readily accepted the concept of on-farm storage of their own wheat seed requirements. This is undoubted due to the fact that they have had a tradition of storing their own rice seed. At, present, farmers do not pay particular attention to their wheat crops in respect to production of wheat seed. No plot is set aside for seed production. At the time of threshing, the farmer simply sets aside a quantity of his early harvested wheat to be stored throughout the summer for use or sale as seed during the subsequent season. Researchers, as well as farmers themselves, developed low cost technologies in the mid seventies which have by now, been adopted by most farmers in Bangladesh. The percentage of farmers maintaining germination percentage between 80%-100% was found to rise to 81 during the survey of 1983 from 71 in 1976. The technology suggested was that after threshing and winnowing, the wheat seed is sun dried 5-8 times to reduce the moisture content to approximately 13%. The seed is then cooled over night and placed in a suitable container. If the container is perfectly airtight, the seed may be left in the container until next planting season. For non-airtight container the seed is periodically to be dried throughout the monsoon season in order to maintain the 13% moisture level and to control insect infestations. Insecticides or insect repellents may also be used (Daiz *et al.* 1998).

In a survey of farmers' seed in 16 villages of Mymensingh district of Bangladesh, fifty farmers growing modern varieties were selected for interview and collection of seed samples. Purity analysis of the collected of seed samples showed that the pure seed was 98.84 ± 0.11 % while contamination with other varieties was 1.00 ± 0.37 %. Other crop and weed seed were nil. While the presence of inert matter was 0.25 ± 0.02%. The germination capacity of the collected seed samples was 86.57% ± 4.43%. It was concluded that farmers' seed was superior In comparison with the standard prescribed by National Seed Board, in terms of germination, pure seed, other crop seed, other varieties, weed seed and inert matter percentages (Hoda *et al.* 1994)

In Bangladesh 88% of rice seed used comes from own sources which are uncertified seed. Farmers in Bangladesh store their seeds in many different containers and sometimes use local plant materials to prevent insect infestation. Use of contaminated seeds can often results in poor seedling vigor and yielding unhealthy crop (Mew, 1994).

Fifteen seed samples of farmers saved seeds of paddy were collected of from farmers nearby villages of Dhariwal town of district Gurdaspur, Punjab. A sample of certified seeds variety, PR-III marketed by PUSSEED (Punjab State Seed Corporation Ltd.) was procured for comparison. Moisture content, physical purity, germination and seed health tests were conducted according to standard procedures and rules for testing and compared with the minimum standards prescribed by the Government of India. Seed quality testing of fifteen farmers saved seed samples revealed that four samples were found to be low-grade physical purity. Two samples' had inert matter more than the certification standard. The moisture content in fifteen samples ranged from 8.5-10.7% (oven method) and was within the prescribed limit. Two seed samples had germination percentage below than the prescribed standard 80%. The certified samples conformed to the seed standard. The results, therefore, show that the farmers saved seeds are indeed inferior to certified seed of the same crop, and the farmers lack awareness of using certified seeds and their sources of availability (Vig *et al.* 2001).

Effect of storage condition

Seeds were primed with polyethylene glycol (PEG-10,000) for 4 or 8 h, dried back and stored in sealed containers in a refrigerator for six months. For fresh priming, the seeds were subjected to hydro-and/ or osmopriming for 4 or 8 h and dried back. The fresh or stored primed seeds were compared with control for crop growth and development under field conditions. Osmopriming for 8 h fresh and 4 h stored resulted in more leaf area index, dry matter accumulation, crop growth rate and ultimately higher seed yield than all other treatments including control (Shahzad *et al*. 2003).

Seed potatoes of four cultivars were stored in darkness at 4 and 12°C during 1995-96 and at 4, 12 and 20°C during 1996-97. Cvs. Kufri Sindhuri and Kufri Bahar aged more rapidly while Kufri Lalima and Desiree aged less rapidly. The response of the Dutch cultivar Desiree to ageing was similar to that of Indian cultivars. Physiological ageing of seed tubers was more rapid at 12°C than at 20°C. The plants raised from seed tubers stored at 4°C were more vigorous with more number of stem and high ground cover, and produced more number of tubers and higher yield. Storage at 12 and 20°C reduced tuber number and yield significantly. Desprouting of seed tubers before planting had no significant effect on tuber number in both the years. However, its effect on tuber yield was significant during the first year but non-significant during the second year (Ezekiel, 2002).

Seeds of papaya (*Carica papaya* L.) stored for 12 months at 15°C with 7.9–9.4% moisture content maintained their original germination. In contrast, many seeds stored cooler or drier lost viability, the losses occurring more rapidly at −20°C than at either 0°C or 15°C. The results are not compatible with the definitions of either orthodox or recalcitrant seed storage behavior (Ellis *et al*. 1991).

Caladium is a plant which is sensitive to low temperatures, and when tubers were stored at temperatures below 20°C, subsequent sprouting rate was slowed.

Storing tubers at 2°C for longer than 7 days reduced yield of daughter tubers, but shorter storage resulted in an improved crop (Lavee *et al*. 1985).

May *et al*. (2010) depicted that in areas affected by Fusarium head blight, growers are concerned about planting seed infected with *Fusarium graminearum* and conducted a study to evaluate the effects of commercially available fungicidal seed treatments on the emergence, development, and grain yield of *Fusarium*-infected seed of common wheat (*Triticum aestivum* L.), durum wheat [*T. turgidum* L. ssp. *durum* (Desf.) Husn.] and barley (*Hordeum vulgare* L.). Infected seedlots were treated with 12 combinations of seed-applied fungicides; nine of these are currently registered in Canada. In addition, five experimental products were used. The experiment was conducted over three years (2003-2005) at four locations in eastern Saskatchewan. Common wheat was grown in all 3 yr, durum wheat in 2003 and 2004, and barley in 2004 and 2005. In the seed lot with the highest level of *F. graminearum* infection (63%), fungicidal seed treatments improved plant emergence and grain yield. In the three seed lots with moderate levels of infections (25 to 35%), seed treatments improved emergence, but did not significantly affect grain yield. In four seedlots with lower levels of *F. graminearum* infection (5 to 10%) seed treatments had no significant effect on emergence or grain yield. By adjusting the seeding rate, based on percent germination needed to achieve a target plant density of 200 plants m^{-2} reductions in grain yield were prevented except in the seed lot with the highest level of infection. However, actual plant density was often below the target plant density, which indicates that field seedling mortality was greater than the 5% assumed when determining the seeding rates. Seed treatments did not significantly affect the test weight in the harvested grain. In conclusion, fungicidal seed treatments did not consistently improve the agronomic performance of *F. graminearum*-infected common wheat, durum wheat, or barley seed in eastern Saskatchewan.

Ahmed *et al*. (2001) evaluated mixtures of imidacloprid and tebuconazole, for three consecutive growing seasons, to determine the effects on plant stand, aphid control and wheat grain yield. At rates of 1.05/0.04 and 0.7/0.04 g a.i of pesticide, respectively, per kg of seeds, plant stand per unit area increased compared with their respective untreated control. Both rates of imidacloprid efficiently controlled the maize aphid (*Melanaphis maidis*) and suppressed the green bug (*Schizaphis graminum*) for 6–8 weeks after sowing. There were substantial differences among the different treatments in the number of grains/ear and the 1000-grain weight. These differences were reflected in 90% and 30% average increase in the total grain yield of the wheat crop raised from seeds treated with the mixture relative to the corresponding untreated control and a standard mixture of lindane plus thiram, respectively. This strategy of using imidacloprid as seed dressing allowed easy application, gave adequate reliable control of aphids and less hazardous to the environment.

Gilbert and Tekauz (2005) also reported that fungicide seed treatments improved emergence. These seed treatments were meant to protect against seed- or soilborne pathogens, as suggested by Argyris *et al.* (2003). However, they did not take note which pathogens were responsible. Emergence was greatest after treatment with Vitaflo 280 (thiram+carbathiin), which agrees with Martin and Johnston (2002), who reported that Vitaflo 280 significantly increased germination in spring wheat. In addition, all seed treatments with the exception of Raxil (tebuconazole), compared to nontreated controls, increased the number of tillers. The results from the present study agreed with Gaska (2000), who reported that seed treatments in wheat increased winter survival and promoted tillering. Of the seed treatments, Raxil (tebuconazole) resulted in the fewest plants, tillers, and spikes. All seed treatments significantly increased yield compared to nontreated controls, with the exception of Raxil (tebuconazole). It was expected that the foliar application of Folicur (tebuconazole) decreased their influence and had a positive influence on grain yield across treatments.

The increase in percent germination (61%) and yield (14.8%) was obtained from wheat seeds treated with Carbendazim 50%. However, the increase of other fungicides treated and untreated seeds were different (Meisner *et al.* 2004). Seed treatments can be a means of preventing or reducing the risks of a number of soil borne and seed borne pathogens or insects. Seedling diseases tend to be more severe if poor quality seed is used and if conditions at planting are not favorable for quick germination and stand establishment. Seed treatments can improve stand establishment under poor growing conditions (French *et al*. 2008).

CHAPTER 3

MATERIALS AND METHODS

MATERIALS AND METHODS

This chapter provides a brief description on location, climate, soil, crop, fertilizer, experimental design, cultural operations, collection of plant samples and materials used in the experiment and the methods followed and statistical analyses.

3.1 Experiment site

The experimental field was located at 90.335^0 E longitude and 23.774^0 N latitude at a height of 1 (one) meter above the sea level (Appendix I).

3.2 Climate and weather

The climate was subtropical with low temperature and minimum rainfall during November to March that was the main feature of the *rabi* season. The annual precipitation of the experimental site was around 2200 mm and potential evapotranspiration was 1300 mm. The average maximum temperature was 30.34^0C and average minimum temperature was 21.21^0C. The average mean temperature was 25.17^0C. The experiment was done during the *rabi* season. Temperature during the cropping period ranged between 12.7^0C to 32.5^0C. The humidity varies from 73.52% to 81.2%. The day length was 10.5-11.0 hours only and there was no rainfall from the beginning of the experiment to harvesting (Appendix II).

3.3 Soil

The soil of the experimental field belongs to the Tejgaon soil series of the Madhupur Tract (AEZ-28). The general soil type of the experimental field was *Deep Red Brown Terrace* Soil. Topsoil was silty clay loam in texture. Organic matter content was very low (0.54 %) with low organic carbon (0.31%) and soil pH varies from 5.8–7.1. The land was above flood level and well drained. The initial morphological, physical and chemical characteristics of soil are presented in Appendix III.

3.4 Planting materials

BARI Gom-24 (Pradip) was used as the experimental material. Seeds were collected from three sources *viz*-Wheat Research Centre of BARI, BADC and farmers own seed.

The experimental material (BARI Gom-24) was collected on the month of May, 2011 (after the harvest of earlier season) and stored them in different condition as per treatment for 6 months in Agronomy laboratory at SAU.

Pradip (BARI Gom-24) is a modern wheat variety released by BARI in 2005. It is a semi-dwarf (95–100 cm) plant with good tillering ability. It produces generally 3-4 tillers plant^{-1}. The leaves are broad, recurved and light green in color. Flag leaves are also broad and droopy. The plants are light green in color with weak glaucosity in the spike, culm and flag leaf sheath. Lower glume beak is very long (>15.0 mm) and the lower glume shoulder shape is elevated and broad with numerous spicules on the beak. The total life duration ranges from

102-110 days. The grains are white and large with 1000-grain weight ranges from 48-55 g. The variety is resistant to leaf rust and highly tolerant to *Bipolaris* leaf blight. The variety is heat tolerant and is best suited under both optimum and late planting for rice-wheat cropping system. It is a high yielding variety, under normal environmental condition, the variety yields 4300-5100 kg ha^{-1}. It can out-yield the popular variety Kanchan both in optimum planting and late planting and can also be grown successfully throughout the country except in saline area.

3.4.1 BARI source

During the period of 1973-74 to till date, Wheat Research Centre (WRC) of Bangladesh Agricultural Research Institute (BARI) developed and released a number of wheat varieties. BARI Gom-24 (Pradip) is one of them. The seeds of Pradip variety were collected from WRC, BARI, Joydebpur, Gazipur.

3.4.2 BADC Source

Bangladesh Agricultural Development Corporation (BADC) under the Ministry of Agriculture fulfills the demand of seeds to the farmers to a lion’s share and for research purpose a little. It mainly has its own farms which collaborates nationally and locally and produces seeds for national demands at their stations and through contact farmers (HRDP, 1995). Seeds of the wheat variety BARI Gom-24 (Pradip) were collected from Gabtali BADC office, Gabtali, Dhaka.

3.4.3 Farmers' seed

Besides other crops, farmers produce abundant amount of wheat during winter season in our country. Farmers also take apart grain crop seeds for the emergency period or it is a conventional practice keeping seeds part of seeds that are produced by the farmers are immediately sold, part of them are kept apart for their convenient use. Sometimes, farmers take seeds from local seed trader and produce them in their field and again sell them to the local traders. They are the major source to supply seeds in the market. About 64% of the total requirement of major grain seeds is met by the farmers which are usually low in quality and are of indigenous varieties (HRDP,1995). Seeds of the wheat variety BARI GOM-24 (Prodip) for farmers' seed source were collected from a farmer named, Anwar Hossain of Savar, Dhaka.

Seeds of wheat were collected from different sources in the month of May, 2011. Collected seeds were stored in different conditions as mentioned in section 3.5.2. Moisture status and Germination percentage of seeds were recorded in every month from July to November, 2011.

Table 1. Moisture percentage and Germination percentage of seed at the end of storage (November)

	Seed moisture (%)	Seed germination (%)
BARI Seed		
Below 10^o C	9.35	89
Below 20^o C	10.32	87
Polybag	10.45	90
Tin container	9.75	83
BADC Seed		
Below 10^o C	9.14	88
Below 20^o C	10.19	86
Polybag	10.25	78
Tin container	10.07	76
Farmer's Seed		
Below 10^o C	9.2	82
Below 20^o C	10.08	80
Polybag	10.02	75
Tin container	10.51	70

3.5 Treatments of the experiment

3.5.2 Treatments

There were two factors *viz;* A. Seed source and B. storage condition of seed.

Factor A. Source of seed-3

i) S_1=BARI seed

ii) S_2= BADC seed

iii) S_3= Farmers seed

Factor B. Storage condition-4

i) C_1= Below 10^0C

ii) C_2= Below 20^0C

iii) C_3= Polybag (room temperature)

iv) C_4=Tin container (room temperature)

According to treatments, seeds were stored in refrigerators maintaining required temperatures, in polybags (room temperature) and in tin container (room temperature) at Agronomy laboratory, SAU.

As much there were 12 treatment combinations. The experiment was laid out in a Randomized Block Design (RCRD) with two factors having three replications. The unit plot size was 4m×2.5m, plot to plot and block to block distances were 0.5m and 1.0 m, respectively.

3.6 Details of the field operations

The cultural operations were carried out during the experimentation are presented below.

3.6.1 Land preparation

The experimental field was first ploughed on 15 November 2011. The land was ploughed thoroughly with a power tiller and then laddering was done to obtain a desirable tilth. The clods of the land were hammered to make the soil into small pieces. Weeds, stubbles and crop residues were cleaned from the land. The final ploughing and land preparation was done on 21 November 2011. The layout was done as per experimental design on 22 November 2011.The field was divided into three blocks each of which representing a replication. Each block was divided into 12 plots as per design of the experiment.

3.6.2 Fertilizer application

Fertilizers were applied at the rate of 100, 80, 30 and 20 kg ha^{-1} of NPK and S, respectively and 5 t ha^{-1}cowdung. The 2/3rd urea and whole amount of other fertilizers were applied as basal dose and rest 1/3rd urea was applied at crown root initiation stage (21 DAS) followed by an irrigation.

3.6.3 Seed treatment and sowing

Seeds were treated with Provex 200 @ 3 g kg^{-1} of seeds and sown in line on 22 November 2011 as per treatments. The recommended seed rate (125 kg ha^{-1}) of wheat variety was used. The seeds were placed in 20 cm apart lines as per treatments. After that the seeds were covered with loose friable soil.

3.7 Intercultural operations

3.7.1 Weeding

Weeds were controlled through two weeding at 17 December 2011, and 05 January 2012 just 25 and 45 days after sowing (DAS). The major weeds identified were Kakpayaghash (*Dactylocteniumaegyptium*L), Durba (*Cynodondactylon*), Mutha (*Cyperusrotundus* L), Bathua (*Chenopodiunm album*), Shaknatey (*Amaranthusviridis*), Foska begun (*Physalisbeteophylls*), Titabegun (*Solanumtorvum*), Shetlomi (*Gnaphaliumluteolabum* L) etc.

3.7.2 Irrigation

Germination of seeds was ensured by light irrigation. Three flood irrigations were given at crown root initiation, maximum tillering and heading stages (21, 42 and 53 DAS).

3.7.3 Pest management

Zinc phosphide was applied several times to control rat. Special attentions were undertaken to protect the crop from the attack of parrots, pigeons and other birds.

3.8 Harvesting and sampling

At full maturity, the wheat crop was harvested plot wise on 06 March 2012. Before harvesting 10 plants of wheat from each plot was selected randomly and uprooted. Yield components data were recorded from that plant. Crop of each plot was harvested from $4m^2$area leaving the border lines to record the seed yield which was converted into t ha^{-1}.

3.9 Recording of data

The following data were collected during the study period:

Data regarding different crop characters and yield of wheat

A. Growth data

- i. Plant height (cm)
- ii. Number of tillers m^{-1} (linear)
- iii. Dry weight $plant^{-1}$ (g)

B. Yield contributes data

- i. Spike length (cm)
- ii. Number of spikelets $spike^{-1}$
- iii. Number of filled grains $spike^{-1}$
- iv. 1000-grain weight (g)

C. Yield data

- i. Grain yield (t ha^{-1})
- ii. Straw yield (t ha^{-1})
- iii. Biological yield(t ha^{-1})
- iv. Harvest index (%)

Growth data

Ten plants of each plot were selected randomly and marked with sticks. All the growth data were collected from selected 10 plants.

3.9.1 Plant height (cm)

The height of wheat plant was recorded in centimeter (cm) at 30, 45, 60, 75, 90 days after sowing (DAS) and during harvest from the same pre-selected plants. The height was measured from base of soil surface to tip of the plant and mean height was recorded.

3.9.2 Number of tillers m^{-1} (linear)

Number of tillers was counted from a line measuring 1 m and tillers were counted from plants.

3.9.3 Dry weight $plant^{-1}$

The plants with roots were collected at different days after sowing (30, 45, 60, 75, 90 DAS and at harvest) from each plot and then oven dried at 70^0 C for 72 hours. The dried samples were then weighed and averaged. The dry weight was taken from 10 plants collected from inner rows of each plot.

3.9.4 Spike length (cm)

The length of spike was measured by using a meter scale. The measurement was taken from base to tip of the spike. Average length of spike was taken from ten randomly selected spikes from inner rows plants of each plot. Data was recorded at harvest time. Mean data was expressed in centimeter (cm).

3.9.5 Number of spikelet spike^{-1}

Data on the total number of spikelet spike^{-1} was counted. Ten spike bearing plants were randomly selected and the average data were collected from the inner rows of each plot except harvest area during the time of harvest.

3.9.6 Number of filled grains spike^{-1}

The total number of filled grains spike^{-1} was counted. Average data were recorded randomly from ten spike bearing plants taken randomly in each plot during the time of harvest.

3.9.7 1000-grain weight (g)

Thousand seeds were counted from the seed sample and weighed at about 12% moisture level using an electric balance and recorded as per.

3.9.8 Grain yield (t ha^{-1})

Inner 4m^2 area at each plot was harvested for recording yield data. After threshing, proper drying (12% moisture level) and cleaning, yield of each sample plot was recorded and values were converted to t ha^{-1}.

3.9.9 Straw yield (t ha^{-1})

Inner 4m^2 area at each plot was harvested from which straw weight was determined after threshing and drying and finally converted them into t ha^{-1}.

3.9.10 Biological yield (t ha^{-1})

Biological yield was determined by addition of grain yield and straw yield of same area according to the following formula.

Biological yield (t ha^{-1}) = Grain yield (t ha^{-1}) + Straw yield (t ha^{-1})

3.9.11 Harvest index (%)

Harvest index was determined by dividing the economic (grain) yield by the total biological yield (grain yield + straw yield) from the same area and multiplying by 100 (Gardner *et al.,* 1985).

$$\text{Harvest index} = \frac{\text{Grain yield (t ha}^{-1}\text{)}}{\text{Biological yield (t ha}^{-1}\text{)}} \times 100$$

3.10 Statistical analysis

The collected data were analyzed by MSTAT–C software program. The mean values for all recorded data were calculated the analyses of variance of all characters were performed. The mean differences were evaluated by Duncan's Multiple Range Test (DMRT) at 0.05 level of probability (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

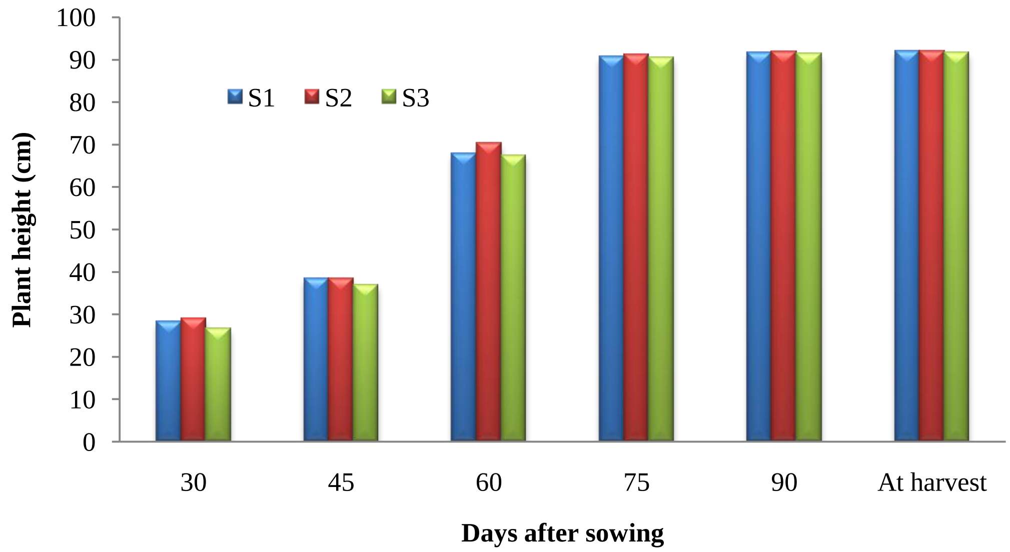
The present experiment was conducted to study the influence of seed source and storage condition on growth and yield of wheat. The analysis of variance data on different crop and yield contributing characters as well as yield of wheat as influenced by different sources of seed and storage conditions has been presented and interpreted in this chapter. The results on main and combined effect of seed source and storage conditions are also presented and discussed under this section.

4.1 Effect on growth parameter

4.1.1Plant height

4.1.1.1Effect of seed source

Plant height of wheat increased with the advancement of plant age. There was no significant different observed on plant height for different sources of seed (Fig. 1). Though statistically seed source showed non-significant effect but numerically the tallest plant (28.99, 38.45, 70.25,91.06, 91.81 and 92.15 cm at 30, 45, 60, 75, 90 DAS and at harvest, respectively) observed for the BADC seed followed by BARI seed. Numerically farmer’s seed showed the shortest plant throughout the growth period.

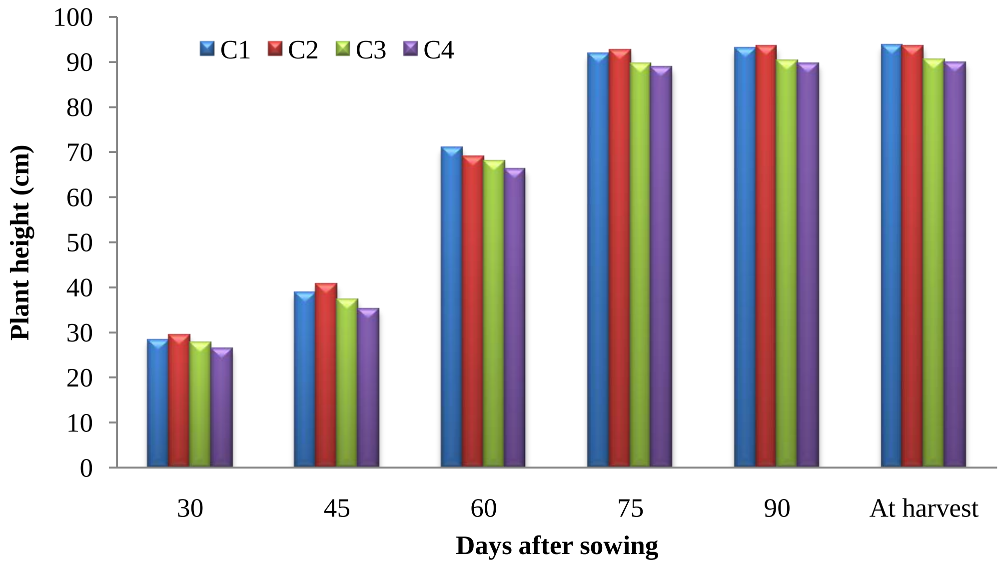


S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed

Fig. 1 Effect of source of seed on plant height of wheat [$S\bar{x}$= NS, NS, NS, NS, NS and NS at 30, 45, 60, 75, 90 DAS and at harvest, respectively]

4.1.1.2 Effect of storage condition

Plant height of wheat increased with the advancement of plant age. Plant height showed non-significant variation for all storage condition of seed except 45 DAS (Fig. 2). However, numerically the tallest plant was recorded from C_2 treatment (below 20^0C) at 30, 75 and 90 DAS. The C_1 treatment (below 10^0C) showed numerically tallest plant at 60 DAS and at harvest. Storage of seed in tin container at room temperature showed shortest plant throughout the growth period. At 45 DAS C_2treatment (below 20^0C) showed the tallest plant (40.63 cm) which is statistically similar with C_1andC_2 treatment and C_4 treatment showed the shortest plant.



C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)

Fig. 2 Effect of storage condition of seed on plant height of wheat [$S\overline{x}$= NS, 2.09, NS, NS, NS and NS at 30, 45, 60, 75, 90 DAS and at harvest, respectively]

4.1.1.3 Combined effect of seed source and storage condition

Combined effect of seed source and storage condition showed non-significant effect on plant height for all sampling dates except at 45 DAS(Table 1). At 45 DAS the highest plant height (43.14 cm) was recorded for the combination of $S_1 \times C_1$ (BARI seed×storagebelow 20^0C) which was statistically similar with combination of $S_1 \times C_1$, $S_2 \times C_1$, $S_2 \times C_2$, $S_2 \times C_3$, $S_3 \times C_1$ and$S_3 \times C_2$. The shortest plant (34.77 cm) was recorded from the combination of $S_3 \times C_4$ treatment which was statistically similar with the combination of $S_1 \times C_3$, $S_1 \times C_4$, $S_2 \times C_4$, $S_3 \times C_3$. During harvest,$S_1 \times C_1$ combination showed highest plant height (94.48 cm) and $S_1 \times C_4$ combination showed lowest plant height (89.31 cm).

Table 2. Combined effect of seed source and storage condition of seed on plant height of wheat

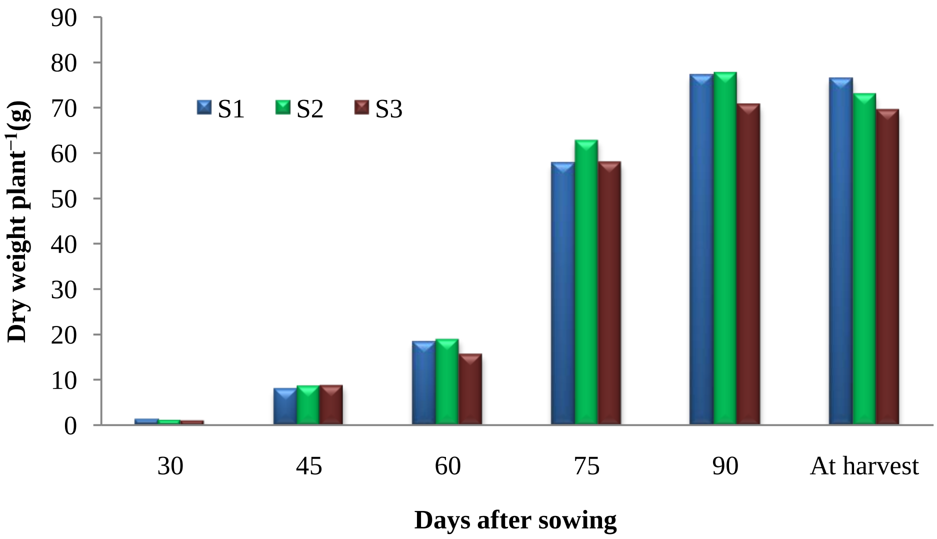
Treatments	Plant height (cm) at different days after sowing					
	30	45	60	75	90	At harvest
$S_1 \times C_1$	28.67	39.12 ab	72.15	92.73	94.21	94.48
$S_1 \times C_2$	29.66	43.14 a	63.21	93.73	94.27	94.46
$S_1 \times C_3$	28.03	36.33 b	68.47	88.55	89.47	89.61
$S_1 \times C_4$	26.78	35.12 b	67.60	87.86	88.80	89.31
$S_2 \times C_1$	29.51	39.31 ab	71.60	91.89	92.71	93.62
$S_2 \times C_2$	29.69	39.34 ab	72.13	92.73	93.59	93.66
$S_2 \times C_3$	29.29	39.39 ab	69.79	89.97	90.67	90.84
$S_2 \times C_4$	27.46	35.77 b	67.49	89.64	90.27	90.50
$S_3 \times C_1$	26.95	37.77 ab	69.03	90.84	92.20	92.91
$S_3 \times C_2$	28.72	39.41 ab	71.85	91.67	92.47	92.59
$S_3 \times C_3$	25.91	35.92 b	65.53	90.28	90.81	91.06
$S_3 \times C_4$	24.93	34.77b	63.64	88.89	89.90	90.12
CV (%)	10.97	9.49	12.19	4.60	4.62	4.55
$S\bar{x}$	NS	2.09	NS	NS	NS	NS

S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed
C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)
NS-Non significant

4.1.2 Plant dry weight

4.1.2.1 Effect of seed source

Plant dry weight of wheat showed an increasing trend with the advancement of plant age. Source of seed statistically showed no significant differences on plant dry weight (Fig.3). Numerically, the highest plant dry weight at 30 DAS (1.28 g plant^{-1}), 60 DAS (19.06 g plant^{-1}), at 75 DAS (62.75 g plant^{-1}) and 90 DAS (77.66 g plant^{-1}) was recorded from BADC seed. BARI seed source showed the second highest dry weight for all sampling dates except at harvest.However,Farmers seed showed the lowest plant dry weight at 30, 60, 90 DAS and at harvest.

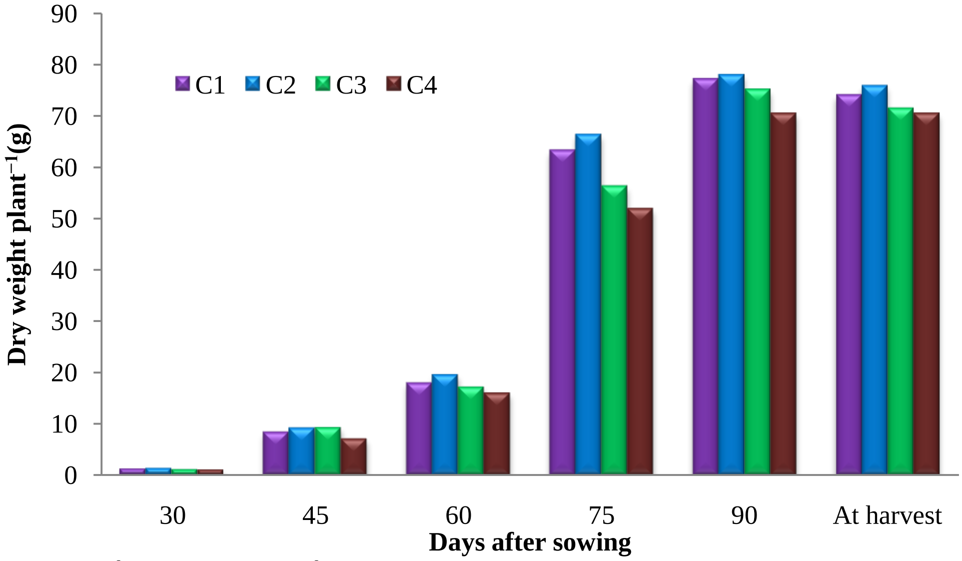


S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed

Fig.3Effect of source of seed on plant dry weight of wheat [$S\bar{x}$= NS, NS, NS, NS, NS and NS at 30, 45, 60, 75, 90 DAS and at harvest, respectively]

4.1.2.2 Effect of storage condition of seed

Storage condition of seed showed non-significant variation on plant dry weight throughout the life cycle except 75 DAS (Fig. 4). At 75 DAS storage of seed in below 20^0C (C_2) showed the highest plant dry weight (66.37 g plant^{-1}) which is statistically similar with C_1(Stored in below 10^0C) and C_3(Polybag) treatments. Storage of seed in tin container at room temperature (C_4) showed significantly the lowest plant dry weight at 75 DAS (51.99 g plant^{-1}). It can be inferred from the result that seed stored in tin container showed lower level of plant dry weight for all sampling dates than other three storage conditions.



C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)

Fig.4 Effect of storage condition of seed on plant dry weight of wheat [$S\bar{x}$= NS, NS, NS, 7.46, NS and NS at 30, 45, 60, 75, 90 DAS and at harvest, respectively]

4.1.2.3 Combined effect of seed source and storage condition

Plant dry weight at 45 DAS varied significantly for the variation of seed source and storage condition combination (Table 2). In this stage,the highest plant dry weight (12.14 g plant^{-1}) recorded from $S_3 \times C_3$ combination which was statistically similar with $S_1 \times C_1$, $S_2 \times C_1$,$S_2 \times C_2$, $S_3 \times C_2$ treatment combinations. The lowest plant dry weight (7.03 g plant^{-1}) at 45 DAS recorded from $S_2 \times C_4$treatment which is statistically similar with $S_1 \times C_1$, $S_1 \times C_2$, $S_1 \times C_3$, $S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_3$, $S_3 \times C_1$ and $S_3 \times C_2$ treatment combinations. At 60,75 and 90 DAS the combination of $S_2 \times C_2$ showed numerically the highest dry weight but at harvest $S_1 \times C_2$ combination showed numerically the highest plant dry weight.

Table 3. Combined effect of seed source and storage condition on plant dry weight of wheat

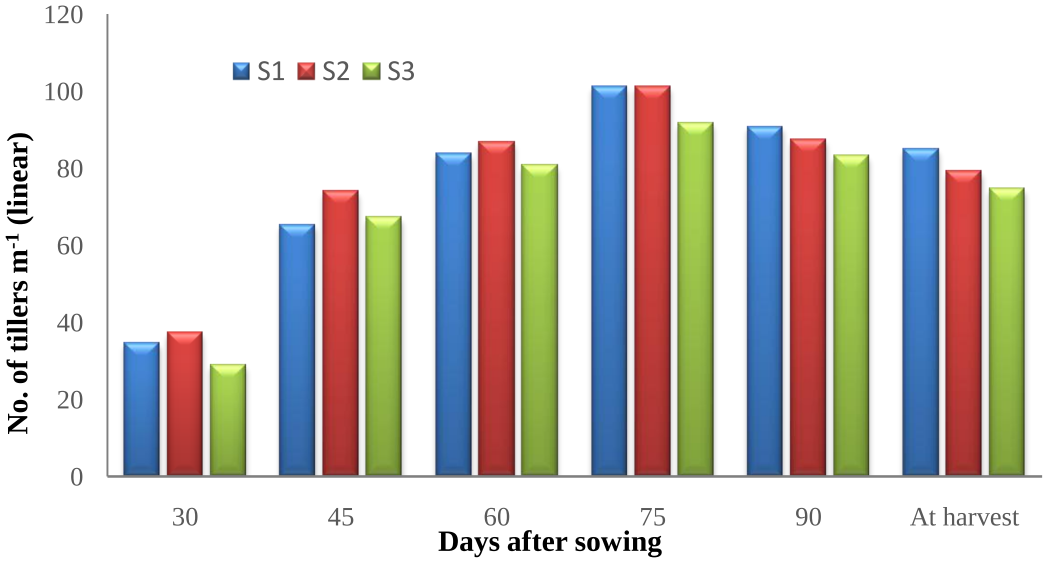
Treatments	Dry weight plant^{-1}(g) at different days of sowing					
	30	45	60	75	90	At harvest
$S_1 \times C_1$	1.33	8.94 a-c	17.65	59.62	77.85	77.92
$S_1 \times C_2$	1.37	7.61c	20.39	67.45	78.78	81.87
$S_1 \times C_3$	1.14	7.91 bc	18.35	58.13	76.74	73.47
$S_1 \times C_4$	1.13	7.23 c	17.04	45.86	75.49	72.65
$S_2 \times C_1$	1.27	8.86 a-c	20.00	67.01	78.85	73.81
$S_2 \times C_2$	1.55	11.43 ab	21.79	68.13	79.76	74.38
$S_2 \times C_3$	1.20	7.97 bc	17.91	57.93	76.85	72.37
$S_2 \times C_4$	1.09	7.03 c	16.53	57.94	75.19	71.46
$S_3 \times C_1$	1.18	7.50 c	16.31	63.13	74.68	70.36
$S_3 \times C_2$	1.30	8.78 a-c	16.65	63.53	75.37	71.37
$S_3 \times C_3$	1.07	12.14 a	15.33	52.78	71.53	68.35
$S_3 \times C_4$	0.98	7.18c	14.62	52.17	60.77	67.37
CV (%)	10.97	9.49	12.19	4.60	4.62	4.55
$S\bar{x}$	NS	1.30	NS	NS	NS	NS

S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed
C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)
NS-Non significant

4.1.3. Tillers m^{-1}(Linear)

4.1.3.1 Effect of seed source

No significant variation on number of tillersm^{-1}was observed for all sampling dates (Fig.5). The highest number of tillers m^{-1}(85.07) at harvest wasrecorded from BARI seed followed by BADC seed. The lowest number of tillers m^{-1} (74.73)at harvest was recorded from farmer’s seed. BADC seed showedits superiority by producing higher number of tillers m^{-1} for all sampling dates except 75, 90 DAS and at harvest. But after 60 DAS, BARI seed showed higher number of tillers m^{-1}.

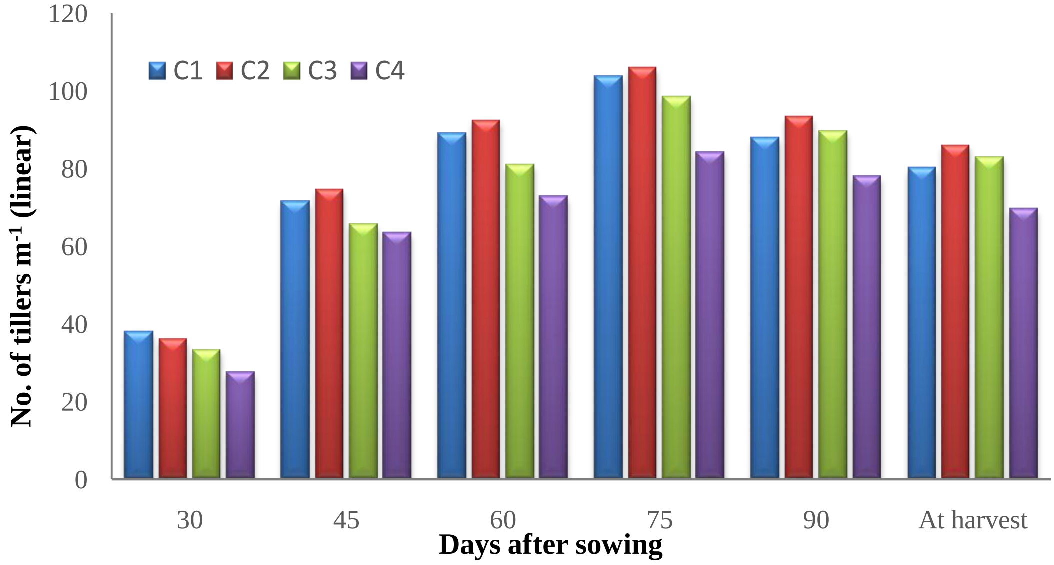


S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed

Fig.5Effect of source of seed on tillers m^{-1} of wheat[$S\bar{x}$= NS, NS, NS, NS, NS and NS at 30, 45, 60, 75, 90 DAS and at harvest, respectively]

4.1.3.2 Effect of storage condition

Tillers m^{-1} due to storage condition presented in Fig. 6 showed an increasing trend with advancement of plant ages upto 75 DAS, after that the trend slightly reduced upto at harvest irrespective of storage conditions. Seed stored in below 20^0C temperature condition gave highest number of tillersm^{-1} followed by stored in below 10^0C and polybag (at room temperature) for all sampling date except 30 DAS. Seed stored in tin container (at room temperature) showed the lowest number of tillers m^{-1} for all sampling dates.



C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)

Fig. 6 Effect of storage condition of seed on tillersm^{-1} of wheat [$S\overline{x}$= 6.77, 6.18, 5.43, 7.80, 7.32 and 5.37 at 30, 45, 60, 75, 90 DAS and at harvest, respectively]

4.1.3.3 Combined effect of seed source and storage condition

Combination of seed source and storage condition showed significant effect on tillering pattern at 60, 75DAS and at harvest (Table 3). The highest number of tillers m^{-1}97.87 and 112.50 was found at 60and 75DAS, respectively were recorded from the combination of S_2×C_2 treatment. Combination of S_3×C_4 showed lowest number of tillers m^{-1}67.27,80.13and62.07 was observedat 60, 75 DASand at harvest. During harvest combination of S_1×C_2 showed highest number of tillers m^{-1} (95.33) which was statistically similar with the combination of S_1×C_1, S_1×C_3, S_2×C_2, S_2×C_3, S_3×C_1 andS_3×C_3.

Table 4.Combined effect of seed source and storage condition on tillers m^{-1} of wheat

Treatments	Tillers m^{-1}(no.) at different days after sowing (DAS)					
	30	45	60	75	90	At harvest
$S_1 \times C_1$	41.33	66.53	86.60 a-c	105.30ab	86.93	83.60 ab
$S_1 \times C_2$	41.20	73.33	93.33 ab	109.30 a	99.20	95.33 a
$S_1 \times C_3$	32.00	61.40	78.67 b-d	103.40ab	95.60	86.00 ab
$S_1 \times C_4$	23.93	60.07	76.67 b-d	87.20 ab	81.60	75.33 bc
$S_2 \times C_1$	37.47	79.87	90.67 a-c	104.70ab	86.07	73.33 bc
$S_2 \times C_2$	42.53	80.93	97.87 a	112.50 a	99.20	87.33 ab
$S_2 \times C_3$	37.40	69.33	84.07 a-d	102.10ab	87.53	84.67 ab
$S_2 \times C_4$	31.93	65.47	74.73 cd	85.27 ab	76.93	71.33 bc
$S_3 \times C_1$	34.67	68.07	89.67 a-c	100.70ab	90.40	83.33 ab
$S_3 \times C_2$	24.00	69.40	86.00 a-c	95.93 ab	81.27	75.33 bc
$S_3 \times C_3$	30.67	66.27	80.00 a-d	90.20 ab	85.73	78.20 a-c
$S_3 \times C_4$	26.67	64.93	67.27 d	80.13 b	75.20	62.07 c
CV (%)	34.86	15.56	11.23	14.12	14.55	11.68
$S\bar{x}$	NS	NS	5.43	7.80	NS	5.37

S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed
C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)
NS=Non significant

4.2 Effect on yield contributing parameters

4.2.1 Spike length

4.2.1.1 Effect ofseed source

No significant variation was observed on spike length for different sources of seed (Table 4). BARI seed source numerically showed the highest spike length (17.03 cm) and that oflowest (16.63 cm) recorded from Farmers seed.

4.2.1.2 Effect ofstorage condition

Spike length showed non-significant variation due to different storage condition of seed (Table 5). Numerically, the highest spike length (17.02 cm) recorded from C_2 treatment (below 20 ^{0}C) and the lowest spike length (16.73) recorded from C_3 treatment (stored in polybag).

4.2.1.3 Combined effect of seed source and storage condition

The variation of treatment combination of seed source and storage condition significantly affects the spike length of wheat (Table 6). The highest spike length (17.34 cm) observed for the combination of S_1 and C_2 treatment combination which was statistically similar with $S_1{\times}C_3$, $S_1{\times}C_1$, $S_1{\times}C_4$, $S_2{\times}C_1$, $S_2{\times}C_2$, $S_2{\times}C_2$, $S_2{\times}C_3$, $S_2{\times}C_4$, $S_3{\times}C_1$, $S_3{\times}C_2$ and $S_3{\times}C_4$. The lowest spike length (16.22 cm) observed in S_3 and C_3 treatment combination which was statistically similar with $S_1{\times}C_1$, $S_1{\times}C_4$, $S_2{\times}C_1$, $S_2{\times}C_2$, $S_2{\times}C_2$, $S_2{\times}C_3$, $S_2{\times}C_4$, $S_3{\times}C_1$, $S_3{\times}C_2$ and $S_3{\times}C_4$ treatment combination.

4.2.2Totalgrains spike^{-1}

4.2.2.1Effect ofseed source

Source of seed showed no significant variation on total grainsspike^{-1} (Table 4). Numerically, the highest number of grain spike^{-1} (41.13) was recorded from BARI seed and the lowest number of grain (40.13) was found from BADC seed.

4.2.2.2 Effect ofstorage condition

Statistically no significant variation was observed on total number of grains spike^{-1} for different storage conditions (Table 5). Numerically, thehighest number of total grains spike^{-1} (41.02) recorded from C_1 treatment and that of lowest (39.93) recorded from C_2 treatment.

4.2.2.3 Combined effect of seed source and storage condition

Number of total grains spike^{-1}was significantly varied for the combination effect of seed source and storage condition of seed (Table 6). The highest number of total grains spike^{-1} (42.07) was observed in $S_1 \times C_3$ combination which was statistically similar with $S_1 \times C_1$, $S_1 \times C_2$, $S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_2$, $S_2 \times C_4$, $S_3 \times C_1$, $S_3 \times C_3$ and $S_3 \times C_4$ treatment combinations. The lowest number of grains spike^{-1} (38.27) obtained from $S_2 \times C_3$ treatment combination which was statistically similar with $S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_2$, $S_3 \times C_2$ and $S_3 \times C_4$ treatment combinations.

4.2.3Filled grains spike^{-1}

4.2.3.1 Effect of seed source

Statistically no significant variation was observed on number of filled grain spike^{-1} for different seed source (Table 4). Numerically, the highest number of filled grains spike^{-1} (39.08) was observed in BARI seed and lowest number (38.42) from BADC seed.

4.2.3.2 Effect of storage condition

The variation in filled grains spike^{-1} is insignificant for different storage conditions (Table 5). Numerically, the highest number of filled grains spike^{-1} (39.38) was found from C_3treatment and the lowest number of grains spike^{-1} (38.18) recorded from C_2 treatment.

4.2.3.3 Combined effect of seed source and storage condition

Statistically significant variation was observed on filled grains spike^{-1} for the combination of seed source and storage condition of seed (Table 6). The highest number of filled grains spike^{-1} (40.25) was obtained from the combination of $S_1 \times C_1$ treatment which was statistically similar with $S_1 \times C_2$, $S_1 \times C_3$,$S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_3$, $S_2 \times C_4$, $S_3 \times C_1$, $S_3 \times C_2$and $S_3 \times C_3$. The lowest number of filled grains per spike (36.73) obtained from S_2 and C_2 treatment combination which was statistically similar with $S_1 \times C_2$,$S_1 \times C_4$, $S_2 \times C_1$, $S_3 \times C_1$and $S_3 \times C_4$ treatment combinations.

4.2.41000 grain weight (g)

4.2.4.1 Effect of seed source

Anon-significant variation was observed on 1000 grain weight for seed source (Table 4). Numerically, the highest 1000 grain weight (41.03 g) recorded from BARI seed and the lowest value (40.34 g) recorded from farmers seed that was 0.69 g higher than the lowest one.

4.2.4.2 Effect of storage condition

Storage condition of seed has no significant variation on 1000 grain weight (Table 5). Numerically, the highest thousand grain weight (41.71 g) observed on C_2 treatment (below 20^0C) and lowest thousand grain weight (40.14 g) recorded from C_4 treatment.

4.2.4.3 Combined effect of seed source and storage condition

Seed source and storage condition showed significant effect on 1000 grain weight (Table 6). The highest 1000 grain weight (43.92 g) was found from the combination of S_1 and C_1 which was statistically similar with $S_1 \times C_2$, $S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_3$, $S_2 \times C_4$, $S_3 \times C_2$, $S_3 \times C_3$ and $S_3 \times C_4$combinations. The lowest 1000 grain weight (37.69 g) was found from $S_1 \times C_3$ which was statistically similar with $S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_2$, $S_2 \times C_4$, $S_3 \times C_1$, $S_3 \times C_3$and $S_3 \times C_4$combinations.

Table 5.Effect of source of seed on yield parameters of wheat

Treatments	Spike length (cm)	Total grains spike^{-1} (no.)	Filled grains spike^{-1} (no.)	1000 grain weight (g)
S_1	17.03	41.13	39.08	41.03
S_2	16.83	40.13	38.42	40.87
S_3	16.63	40.43	38.82	40.34
CV (%)	3.28	3.69	3.28	5.46
$S\bar{x}$	NS	NS	NS	NS

S_1= BARI seed, S_2= BADC seed, S_3= Farmers seed
NS= Non significant

Table 6. Effect of storage condition of seed on yield attributes of wheat

Treatments	Spike length (cm)	Total grains spike^{-1}(no.)	Filled grains spike^{-1}(no.)	1000 grain weight (g)
C_1	16.81	41.02	39.02	40.68
C_2	17.02	39.93	38.18	41.71
C_3	16.73	40.71	39.38	40.47
C_4	16.77	40.60	38.51	40.14
CV (%)	3.28	3.69	3.28	5.46
$S\bar{x}$	NS	NS	NS	NS

C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)
NS= Non significant

Table 7. Combined effect of seed source and storage condition on yield attributes of wheat

Treatments	Spike length (cm)	Total grains spike^{-1}(no.)	Filled grains spike^{-1}(no.)	1000 grain weight (g)
$S_1×C_1$	16.88 ab	41.07 ab	40.25 a	43.92 a
$S_1×C_2$	17.34 a	40.87 ab	38.13 a-c	42.88 ab
$S_1×C_3$	17.25 a	42.07 a	39.47 ab	37.69 c
$S_1×C_4$	16.67 ab	40.53 a-c	38.47 a-c	39.64 a-c
$S_2×C_1$	16.90 ab	40.73 a-c	38.13 a-c	40.00 a-c
$S_2×C_2$	17.06 ab	40.20 a-c	36.73 c	39.04 bc
$S_2×C_3$	16.71 ab	38.27 c	39.67 ab	43.30 ab
$S_2×C_4$	16.67 ab	41.33 a	39.13 ab	41.15 a-c
$S_3×C_1$	16.66 ab	41.27 ab	38.67 a-c	38.11 c
$S_3×C_2$	16.65 ab	38.73 bc	39.67 ab	43.22 ab
$S_3×C_3$	16.22 b	41.80 a	39.00 ab	40.41 a-c
$S_3×C_4$	16.98 ab	39.93 a-c	37.93 bc	39.62 a-c
CV (%)	3.28	3.69	3.28	5.46
$S\bar{x}$	0.36	0.89	0.78	1.29

S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed
C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)

4.3 Effect on yield

4.3.1Grain yield

4.3.1.1 Effect ofseed source

Statistically significant variation was observed on grain yield due to different source of seed (Table 7). The highest grain yield (3.48t ha^{-1}) observed on BARI seed source which was statistically similar to BADC seed source (3.26 t ha^{-1}). The lowest grain yield was recorded from Farmers seed (2.40 t ha^{-1}). The table indicates that BARI seed source out yielded by 0.22 and 1.08 t ha^{-1} than BADC and farmer's seed source of wheat.

4.3.1.2 Effect of storage condition

Variation of grain yield varied significantly due to different storage condition (Table 8). The highest grain yield (3.29t ha^{-1}) was observed in C_1 treatment (below 10^0 C) which was statistically similar with C_2 treatment(below 20^0 C)(3.18t ha^{-1}) and C_3 (polybag condition). The lowest grain yield (2.71 t ha^{-1}) observed in C_4 treatment which was statistically similar with C_3 treatment.

4.3.1.3 Combined effect of seed source and storage condition

The variation of seed source and storage condition treatment showed significant effect on grain yield of wheat (Table 9). The highest grain yield (3.67 t ha^{-1}) obtained from the combination of $S_1 \times C_1$ which was statistically similar with$S_1 \times C_2$, $S_1 \times C_3$, $S_2 \times C_2$and $S_2 \times C_3$treatment combinations. The lowest grain yield was (1.88 t ha^{-1}) observed on $S_4 \times C_4$ treatment.

4.3.2Straw yield

4.3.2.1 Effect of seed source

Straw yield showed significant variation for different seed source (Table 7). The highest straw yield (5.21 t ha^{-1}) recorded from BARI seed which is statistically similar with BADC seed. The lowest straw yield (4.79 t ha^{-1}) was recorded from farmer's seed which was statistically at par with BADC seed source.

4.3.2.2 Effect of storage condition

Storage condition of seed exerted significant variation on straw yield of wheat (Table 8). The highest straw yield (5.26 t ha^{-1}) was observed in C_1 treatment which was statistically at par with C_2 treatment (4.96 t ha^{-1}) and lowest straw observed in C_4 treatment (4.13 t ha^{-1}).

4.3.2.3 Combined effect of seed source and storage condition

Combination of seed source and storage condition treatment showed significant effect on straw yield (Table 9). The highest straw yield (5.57 t ha^{-1}) was recorded from $S_1 \times C_1$ combination which was statistically similar with $S_1 \times C_2$, $S_1 \times C_3$,$S_1 \times C_4$, $S_2 \times C_1$ and $S_2 \times C_2$combinations. The lowest straw yield (3.83 t ha^{-1}) was recorded from $S_4 \times C_4$combination.

4.3.3Biological yield

4.3.3.1 Effect of seed source

Significant variation was observed on biological yield for different source of seed (Table 2). The highest biological yield (8.69 t ha^{-1}) was recorded from BARI seed which was statistically similar with BADCseed(8.05 t ha^{-1}). The lowest biological yield (6.67 t ha^{-1}) was recorded from farmer's seed source.

4.3.3.2 Effect of storage condition

Biological yield varied significantly for storage condition of seed (Table 8). The highest biological yield (8.55 t ha^{-1}) was recorded from C_1 treatment which was statistically similar with C_2treatment (8.14 t ha^{-1}). The lowest biological yield recorded from C_4treatment (6.84 t ha^{-1}).

4.3.3.3 Combined effect of seed source and storage condition

Statistically significant variation was observed on biological yield of wheat for the combination of seed source and storage condition (Table 9). The highest biological yield (9.24 t ha^{-1}) was obtained from $S_1 \times C_1$ treatment which was statistically similar with $S_1 \times C_2$, $S_1 \times C_3$and$S_2 \times C_2$combinations. The lowest biological yield (5.22 t ha^{-1}) recorded from $S_3 \times C_4$ treatment.

4.3.4Harvest index

4.3.4.1 Effect of seed source

Source of seed showed significant variation on biological yield (Table 7). The highest harvest index (40.07%) was recorded from BARI seed which was statistically at par with BADC seed source (40.64%) and lowest harvest index (35.99%) recorded from farmer’s seed.

4.3.4.2 Effect of storage condition

Non-significant variation exerted on harvest index for different storage condition of seed (Table 8). Numerically, the highest harvest index recorded from C_4 treatment (39.31%) and lowest harvest index was recorded from C_1treatment (38.38%).

4.3.4.3 Combined effect of seed source and storage condition

There was significant variation on harvest index for seed source and different storage condition (Table 9). Numerically, the highest harvest index (42.49%) was observed in $S_2 \times C_4$ treatment which was statistically at par with $S_1 \times C_1$, $S_1 \times C_2$, $S_1 \times C_3$, $S_1 \times C_4$, $S_2 \times C_1$, $S_2 \times C_2$ and $S_2 \times C_3$and lowest harvest index (35.27%) obtained from $S_4 \times C_4$ treatment.

Table 8. Effect of source of seed on yield and harvest index of wheat

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
S_1	3.48 a	5.21a	8.69a	40.07 a
S_2	3.26a	4.79ab	8.05a	40.64 a
S_3	2.40b	4.27 b	6.67 b	35.99 b
CV (%)	6.93	8.23	6.09	5.80
$S\bar{x}$	0.11	0.20	0.24	1.13

S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed

Table 9.Effect of storage condition of seed on yield and harvest index of wheat

Treatments	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
C_1	3.29 a	5.26 a	8.55 a	38.38
C_2	3.18 a	4.96 a	8.14ab	38.95
C_3	2.99 ab	4.67 ab	7.66 b	38.97
C_4	2.71 b	4.13 b	6.84 c	39.31
CV (%)	6.93	8.23	6.09	5.80
$S\bar{x}$	0.12	0.23	0.27	NS

C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)
NS=Non significant

Table 10. Combined effect of seed source and storage condition on yield and harvest index of wheat

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
$S_1\times C_1$	3.67 a	5.57 a	9.24 a	39.58 a-d
$S_1\times C_2$	3.60 ab	5.33 a-c	8.93ab	40.34 a-c
$S_1\times C_3$	3.40 a-c	5.07 a-c	8.47 a-c	40.18 a-c
$S_1\times C_4$	3.23 bc	4.84 a-d	8.07 b-e	40.19 a-c
$S_2\times C_1$	3.46 a-c	5.44 ab	8.90ab	38.89 a-e
$S_2\times C_2$	3.38 a-c	4.89 a-d	8.27 b-d	40.92 ab
$S_2\times C_3$	3.13 c	4.65 cd	7.78 c-e	40.27 a-c
$S_2\times C_4$	3.06cd	4.16 d	7.22 ef	42.49 a
$S_3\times C_1$	2.75 de	4.76 b-d	7.51 d-f	36.66 b-e
$S_3\times C_2$	2.57 e	4.66 cd	7.23 ef	35.59 de
$S_3\times C_3$	2.45 e	4.28 d	6.73 f	36.45 c-e
$S_3\times C_4$	1.83 f	3.38 e	5.22 g	35.27 e
CV (%)	6.93	8.23	6.09	5.80
$S\bar{x}$	0.12	0.66	0.27	1.30

S_1= BARI seed, S_2= BADC seed and S_3= Farmers seed
C_1 = Below 10^0C, C_2 = Below 20^0, C_3= Polybag (room temperature) and C_4=Tin container (room temperature)

CHAPTER 5

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

An experiment was conducted at the Agronomy laboratory with storing wheat seed and subsequent study to find out the influence of seed source and storage condition of seed on growth and yield of wheat. The treatment of the experiment consisted of three seed source *viz.* i) S_1= BARI seed, ii) S_2= BADC seed, iii) S_3= Farmer seed and four storage conditions, e.g. i) C_1= Below 10^0C ii) C_2= Below 20^0C iii) C_3= Polybag (room temperature) iv) C_4= Tin container (room temperature). The experiment was laid out in Randomized complete block design following the principles of randomization with three replications. The sowing date was on November 22, 2011. The unit plot size was 4m×2.5m =10 m^2.

Observations were made on plant height, dry weight plant^{-1}, number of tillers m^{-1}, spike length, number of grain spike^{-1}, filled grains pike^{-1}, weight of 1000 seeds, grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index.

The findings showed that BARI seed recorded the highest grain yield (3.48 t ha^{-1}), straw yield (5.21 t ha^{-1}) and biological yield (8.69 t ha^{-1}) which was statistically similar with BADC seed. Stored seed in polybag below 20^0 C showed highest plant height (40.63 cm) at 45 DAS, plant dry weight (66.37 g plant^{-1}), number of tillers at 60 DAS (86.83).

Combination of BADC seed source and stored in polybag below 20^0C showed highest number of tillers m^{-1} at 60 DAS (97.87) and 75 DAS (112.50) but at harvest, BARI seed source and stored in polybag below 20^0C showed highest number of tillers m^{-1} (95.33). BARI seed stored in polybag below 10^0C gave the highest number of filled grain per spike (40.25), 1000 grain weight (43.92 g) and grain yield (3.67 t ha^{-1}). The highest grain yield (3.67 t ha^{-1}), straw yield (5.57 t ha^{-1}) and biological yield (9.24 t ha^{-1}) were recorded from the combination of BARI seed and stored in polybag below 10^0C ($S_1 \times C_1$) combination.

In short, BARI and BADC seed showed better result than farmer's seed. Storage of seed at below 10^0C and 20^0C temperature showed better performance. So combination of BARI and BADC seed and stored them comparatively lower temperature provide better growth and yield of wheat. However, to reach a specific recommendation, more research work on wider range of seed source and storage condition effect on growth and yield of wheat should be done over different agro-ecological zones of the country.

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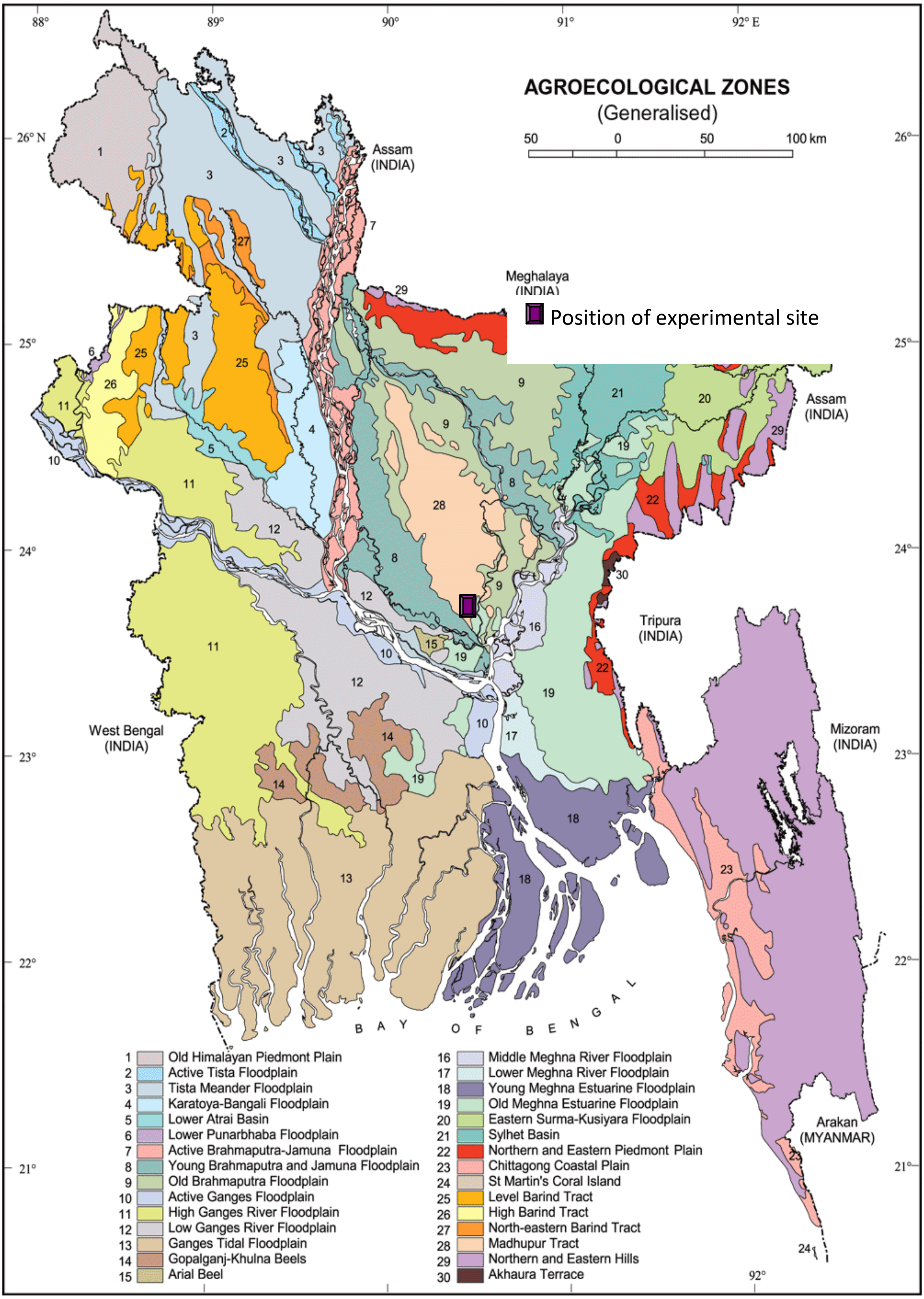
APPENDIX

APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II.Monthly average relative humidity, maximum and minimum temperature, rainfall and sunshine hour of the experimental period (October 2011 to May 2012)

Month	Average RH (%)	Average Temperature (ºC)		Total Rainfall (mm)	Average Sunshine hours
		Min.	Max.		
October	78	23.8	31.6	172.3	5.2
November	77	19.2	29.6	34.4	5.7
December	69	14.1	26.4	12.8	5.5
January	68	12.7	25.4	7.7	5.6
February	68	15.5	28.1	28.9	5.5
March	64	20.4	32.5	65.8	5.2
April	69	23.6	33.7	165.3	4.9
May	81	24.5	32.9	339.4	4.7

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1207.

Appendix III. Physiochemical properties of soil of the experimental field

Characteristics	**Value**
Partical size analysis	
% Sand	25.68
% Silt	53.85
% Clay	20.47
Textural class	silty-loam
pH	5.8-7.1
Organic carbon (%)	0.31
Organic matter (%)	0.54
Total N (%)	0.027
Phosphorus(µg/g soil)	23.66
Exchangeable K (me/100 g soil)	0.60
Sulphur (µg/g soil)	28.43
Boron (µg/g soil)	0.05
Zinc (µg/g soil)	2.31

Source: Soil Resources Development Institute (SRDI), Dhaka-1207

Appendix IV. List of plates

Plate 1. Seeds stored in refrigerator

Plate 2. Seeds stored in polybag

Plate 3. Seeds stored in tin container

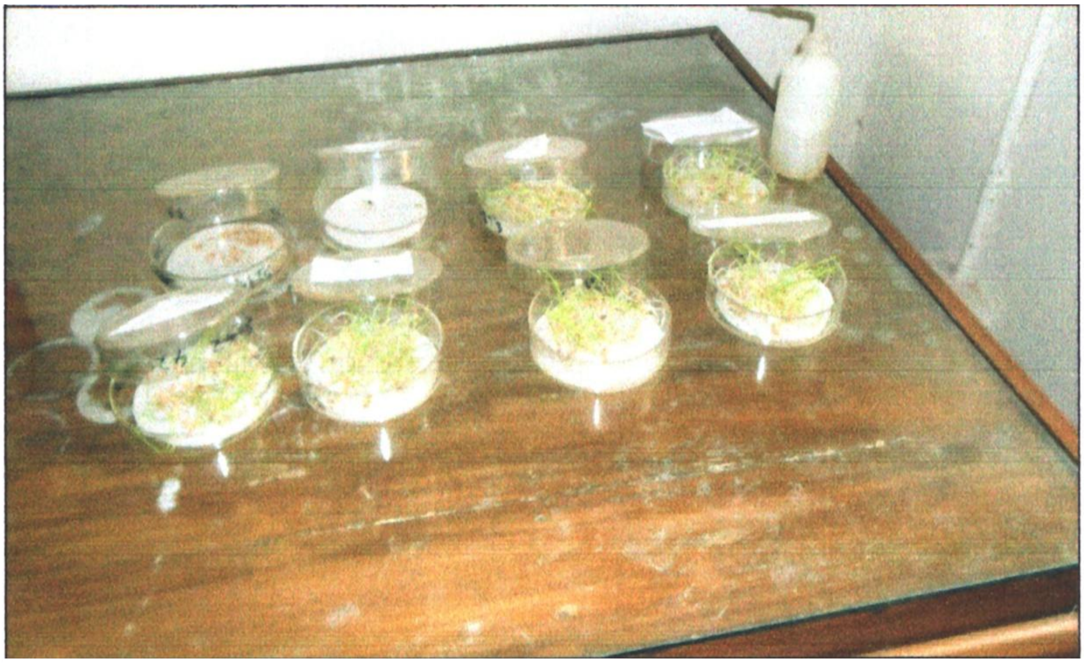


Plate 4. Seeds set for germination

Plate 5. Field view of the experimental plot

Plate 6. Field view of the experimental plot