INFLUENCE OF SEED TREATMENT AND SEED SOURCE ON GROWTH AND YIELD OF WHEAT

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CERTIFICATE

This is to certify that the thesis entitled, "**Influence of Seed Treatment and Seed Source on Growth and Yield of Wheat**" submitted to the Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in AGRONOMY embodies the result of a piece of bonafide research work carried out by Md. Faruquzzaman, Registration No. **08-03240** 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 been duly acknowledged by him.

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ABSTRACT

A laboratory and a field experiment was carried out at the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, during the rabi season from November 2009 to March 2010 to investigate the quality of wheat seeds as affected by seed treatment and different seed sources. Four seed sources considered as treated with Vitavax 200 and untreated consisted of 8 different combinations. The combinations were T_0S_1=No Treatment of Farmer seed, T_0S_2 = No Treatment of Local trader seed, T_0S_3 = No Treatment of BADC seed, T_0S_4 = No Treatment of BARI seed, T_1S_1 = Treated with Vitavax 200 of Farmer seed, T_1S_2 = Treated with Vitavax 200 of Local trader seed, T_1S_3 = Treated with Vitavax 200 of BADC seed and T_1S_4 = Treated with Vitavax 200 of BARI seed. Result showed that Farmers' seed source was found with 9.62% impurities and inert materials. The highest pure seed was recorded from BARI source which was the most pure compared to all other treatments. BARI seed showed the highest % germination both at laboratory condition (97.06%) and at field condition (92.56%). BADC seed had the lowest seedling emergence percentage. Plant height of Vitavax treated seed sources at 25, 50, 75 DAS and at harvest were the highest. The highest number of leaves plant^{-1} (6.55) at 25 DAS was recorded from vitavax 200 treated plots. Similar results was observed at 50, 75 DAS and at harvest. BARI seed source produced maximum number of leaves (7.05) at 25 DAS. Number of leaves at 50, 75 DAS and at harvest was found statistically similar where the highest number of leaves (23.85 at 50 DAS, 49.40 at 75 DAS and 89.25 at harvest) were also recorded from BARI seed source. The highest spikes m^{-2} (221. 50) was recorded in treated plots and BARI seed sources (237.5). BARI seed sources treated with vitavax 200 showed the highest spike lengths with awn (18.99 cm) and without awn (12.60 cm). At harvest the highest shoot weight (465.40 g m^{-2}), root weight (34.48 g m^{-2}) and total weight (499.88 g m^{-2}) was given by BARI seed source treated with vitavax 200 and the lowest dry weight of shoot (323.40 g m^{-2}), root weight (16.00 g m^{-2}) as well as total dry weight (339.40 g m^{-2}) was found in untreated seed collected from local traders. BARI treated seed source showed highest yield (4.16 t ha^{-1}). It was followed by BADC(3.61 t ha^{-1}) The higher grain yield (3.95 t ha^{-1}) was found with vitavax 200 that was 26.60% higher than the untreated seed sources. BARI seed source treated with vitavax 200 gave the highest 1000 grain weight (44.13g), grain yield (4.47 t ha^{-1}) and straw yield (4.64 t ha^{-1}) whereas the lowest performance was recorded form by the treated seeds of local traders and farmers.

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CHAPTER-I

INTRODUCTION

Seed means a reproductive unit which contains an alive e mbryo, 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 unhealthy 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). Although the seed system in Bangladesh is at a very rudimentary stage, a total of five lakh tons of seeds (including cereals and other crop seeds with vegetables) per year is required, out of which only 5% seeds are produced by different seed producers with special care but almost knowing nothing about the seed health status. The rest 95% of the seeds are produced and retained by the farmers remain uncertified with unknown quality and outside the supervision of the seed certification agency (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% seeds 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 pests. 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 Kernal bunt either fail to germinate or produce a greater percentage of abnormal seedlings (Singh and Krishna, 2002; Singh, 2000). In wheat, fungi (*Fusarium* spp., *Tilletia* spp., *Drechslera* spp., *Septoria* spp. and *Ustilago* spp.), bacteria (*Corynebacterium*, *Pseudomonas* and *Xanthomonas*) and nematodes (*Anguina tritici*) are the most important seed-borne diseases due to their worldwide distribution and losses they incur in crop production (Mamluk and van Leur, 2006; Diekmann, 2003).

Chemical seed treatment is one of the efficient and economic plant protection practices and can be used to control both external and internal seed infection. It protects young seedlings or adult plants against attack from seed-borne, soil-borne or airborne pests. It disinfects seed from pathogen, checks spread of harmful organisms, promotes seedling establishment, maintains and improves seed quality or minimizes yield losses. Selection of proper chemical depends on the target organisms. A wide range of chemicals (Diekmann, 2003) and equipment (Jeffs and Tuppen, 2006) are now available for such purposes. Some recent literature gives detailed information on the management of bunts and smuts and bacterial (Duveiller *et al*., 1997) seed-borne diseases of wheat. Meisner *et al*, (2004) indicated that Vitavax 200 (Carboxin [37.5 percent] and Thiram [37.5 percent]) is an effective broad spectrum seed treatment fungicide, both for externally and internally seed-borne diseases of wheat. Moreover, pre-harvest foliar application of chemicals can also reduce the internally seed-borne fungi and can be combined with seed treatment to produce healthy seed. Apart from disease control, seed treatment also has a positive effect on crop growth and yield. Ahmed (2006) reported that wheat seed treatment with systemic fungicides, such as Baytan, Raxil and Vitavax, significantly increased crop stand, grain yield and yield attributes. Meisner *et al*, (2004) reported about 10 percent increase in wheat yield due to seed treatment with Vitavax 200 against smuts. Seed production in disease-free areas or under effective disease control and field inspection schemes is very important to obtain disease-free seed. Crop production could be increased adopting appropriate seed sources and selecting suitable seed treatment materials, which demands intensive field research. Considering the above facts, the study was conducted to know the different quality attributes of seeds namely percentage of purity, germination, growth parameters, yield and other attributes of wheat seeds from various sources like Government organization sources (BARI, BADC) Local Seed Traders and local Farmers according to ISTA rule 1996.

Objectives: The objectives of the study were:

- To know the quality status of wheat seeds of different seed sources in Bangladesh.
- To observe seedling emergence of different seed sources at laboratory and in the field conditions.
- To observe the yield performance and other attributes of these seeds in the field conditions.

CHAPTER-II

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 treatments seeds with by vitavax 200, a world famous fungicide prior to sowing. In this chapter an attempt has been made to review research works related to present investigation.

2.1 Effect of seed sources

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 fulfil 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- forth 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.,* 1988). Production of either rice or wheat is low comparing with many other countries because of inappropriate crop, land and nutrient management practices.

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).

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 a*,1996). Even with these practices, farmers often use seeds that have impurity and contaminants and seeds that are infected with pathogens (Fujisaka *et a.*, 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 0, 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 farmerused 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 IRRl 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 froms 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-Ill 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).

2.2 Effect of seed treatment

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 a*, 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).

Increase germination and maintenance of healthy root system through seed treatment is an important criteria for wheat cultivation. The wheat seed when sown in the field are affected by large number of soil borne fungi causing seed and seedling rot at various stage of plant growth, which, directly influence the yield of crop. It is reported that wheat seed treated with Vitavax-200 was found to be a technology that resulted in a consistent 10% yield increase for wheat cultivation (Badaruddin *et al.*, 2002).

(Shahzad *et al*, 2007) conducted a study to ascertain a suitable planting time and seed treatment for wheat. The seed treatments were comprised of unsoaked, water soaked and 1% $NaHCO_3$ soaked seed. The water soaked and 1% $NaHCO_3$ seed treatments produced higher yield of 4.618 t ha^{-1} and maximum average grain yield of 5.09 t ha^{-1} was produced by sowing of wheat on November 15. Water soaked seeds sowing at November 15 was superior in all respect. Seed treatment with certain salts and water give high yield than untreated wheat seeds. The seed treatment enhances the yield by enhancing germination. Water soaked seeds gave higher yields (4283 kg ha^{-1}) as stated by Akram (2002).

Winter wheat, in Alabama, was grown throughout the state. Wherever wheat was grown, foliar fungal diseases could limit grain yields. Rust diseases were particularly limiting to yield, and those commonly found on winter wheat in Alabama were leaf rust, caused by *Puccinia recondita* (also known as *P. triticina*), and stripe rust, caused by *P. striiformis.* Septoria leaf blotch, caused by *Septoria tritici,* was another fungal disease that frequently occurs in the state. In studies done in Arkansas, grain yield losses in winter wheat were as high as 30 percent and 60 percent due to leaf rust and Septoria leaf blotch, respectively (Milus, 1994). On the other hand, Bowen and Burch (2007) described as cultivar resistance had a major role in the amount of disease seen on wheat and on the level of grain loss due to disease. However, fungicides remained an option when cultivar resistance to diseases proves inadequate.

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.

William (2000) said that fungicide seed treatments may be recommended for protecting winter wheat (Triticum aestivum L.) seedlings from seedborne pathogens. However, effects of these seed treatments on stand establishment (emergence) and grain yield under field conditions are not clear. A 3-year field study was conducted to determine the effects of various fungicide seed treatments on emergence and grain yield of several commercial winter wheat cultivars in the south-central Great Plains. The research was conducted at Hutchinson and Caldwell, Kansas. Treatments consisted of six cultivars (main plot) and six seed fungicide treatments (subplot). The split-plot analysis of variance revealed no interaction between seed treatment and cultivar. A non-significant trend toward reduced emergence of seedlings from treated seeds was evident across all cultivars. This trend, however, had no consistent effect on grain yield at either location. In areas of limited post-emergence disease pressure, plants in plots where the seed is treated may compensate for reductions in stand (reduced emergence), such that grain yields will be similar to those from untreated seed. Thus, seed treatments should be considered when seed/soil borne pathogens are suspected or seed with poor or low germination or a reduced seeding rate is used.

WRC (2002) conducted an experiment at the WRC, Dinajpur during 2000-2001 treated with viatvax-200, Bavistin, Carbendazim 50% WP and Raxil. Carbendazim 50% WP and Vitavax 200 were found equally effective in terms of seedling germination and higher yield which might be due to killing of pathogen on seeds and/or soil. The other chemicals such as Bavistin, Raxil etc. were not so effective in controlling the soil/seed borne diseases of wheat Untreated seeds gave the lowest plant population (46.6%) and yield. Foliar disease (BpLB) infection was more or less same in all the plots.

Sawinska and Malecka (2007) conducted experiments in 2001–2003 at the Experimental Station in Złotniki of the Agricultural University of Poznan (Poland). The impact of different fungicidal protection programs on occurrence and incidence of fungal diseases on leaf and ear as well as of diseases on stem base and roots of winter wheat was determined. Seed treatment with Latitude 125 FS reduced significantly take-all of winter wheat in comparison with the standard treatment (Raxil 060 FS). However, the seed treatments lowered only slightly the incidence of brown foot rot. The applied complex chemical protection program of winter wheat reduced successfully the infection of leaves and ears by fungal diseases.

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.

Schaafsma and Tamburic-Ilincic (2005) investigated the influence of variety, seeding rate, and seed treatment fungicides on the flowering period of winter wheat and their effect on Fusarium head blight (FHB) symptoms and deoxynivalenol (DON) accumulation. The seed of two winter wheat varieties (Pioneer 25W60 and Pioneer 25R57) was treated with Dividend XL (difeconazole+metalaxyl), Vitaflo 280 (thiram+ carbathiin), Raxil (tebuconazole), and Baytan 30 (triadimenol) and planted at 320, 480, and 640 seeds per m^2 for each treatment at Ridgetown, ON, Canada in 2000 and 2001. The plots were sprayed with tebuconazole at 50% anthesis and inoculated with *F. graminearum* 3 days later. All seed treatments, compared to nontreated controls, increased plant emergence and number of spikes per m2, and all except tebuconazole increased tillering and yield. Increased seeding rate decreased the length of flowering period.

There were significantly more emerged plants and spikes per m^2 in seed-treated plots. Gilbert and Tekauz (1995) 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.

On the basis of the above review of literature an experiment was undertaken at Agronomy field of Sher-e-Bangla Agricultural University with different levels of seed treatment as well as seed source to find out their effect on seed germination, seedling emergence, growth and yield of wheat.

CHAPTER-III

MATERIALS AND METHODS

A field experiment was conducted to investigate the quality of wheat seeds as affected by seed treatment and different seed sources along with some observations undertaken at laboratory to determine the quality of different seed sources in respect of their germination percentage and seedling emergence. This chapter provided a brief description on location, climate, soil, crop, fertilizer, experimental design, cultural operations, collection of plant samples, 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 December to March that was the main feature of the *rabi* season. The annual precipitation of the 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 12.20^0C to 29.2^0C. 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.

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 (1.34 %) and soil pH varies from 5.8–6. The land was above flood level and well drained. The initial morphological, physical and chemical characteristics of soil are presented in Appendix II.

3.4 Materials

Wheat seeds were collected from four different sources like Government organization sources like Bangladesh Agricultural Researches Institute (BARI), Bangladesh Agriculture Development Corporation (BADC), Local Seed Traders and local Farmers. Seeds from these sources were used as experimental materials for the investigation. Seed of same variety of seed namely, BARI gam 19 (Shourav) was collected and used in the experiment for all the seed sources.

3.4.1 BARI Source

During the period of 1973-74 to till date, the Wheat Research Centre (WRC) of Bangladesh Agricultural Researches Institute (BARI) developed and released a number e of wheat varieties like Sonora, Mexipak-65, Inia-66, Norteno-66, Sonalika, Tanori-71, Ananda (BAW-18), Kanchan (BAW-28), Barkat (BAW-39), Akbar (BAW-43), Aghrani (BAW-38), BARI gam-17 (Sawgat), BARI gam-18 (Protiva), BARI gam-19 (Saurav), BARI gam-20 (Gourav), BARI gam-21 (Satabdi) etc. The variety BARI gam-19 (Sourav) was collected from WRC of BARI, Joydebpur, Gazipur. BARI gam-19 (Shourav) is a high yielding variety of wheat. The variety was released by WRC of BARI in 1998. It is suitable for late sowing. It completes its life cycle within 102-110 days. The height of the plant is 90-100 cm. It produces 5-6 tillers plant^{-1}. The stem is hard and does not lodge in wind and storm. Leaves are flat, droopy and deep green. Flag leaf is wide and droopy in nature. The number of spikelet spike^{-1} is 42-48 and size of grains are medium to large and the color of the grains is white. The weight of 1000 seed is 40-45 g. Plant requires 60-70 days to emerge spike. It has ability to give 3.5-4.6 t ha^{-1} in favorable condition. This variety is tolerant to leaf spot and leaf rust diseases. This variety is heat tolerant that is why in case of late sowing it gives better yield. The variety gives 10-12% more yield than the traditional variety (BARI, 2005).

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 gam-19 (Shourav) were collected from Gabtali BADC office, Gabtali, Dhaka.

3.4.3 Local seed traders

Businessmen, who are mostly operating seed marketing not only at the village markets but also at the rural areas, are generally known as Local Seed Trader. They supply huge amount of seeds to the growers to fulfill the local demands. There are some authorized agents of seed merchants who are operating their business through joint ventures with foreign companies (HRDP, 1995). Seeds of the wheat variety BARI gam-19 (Shourav) for the experiment were bought from a local trader. Namly Rony Seed Vandar, Khalishpur, Jenaidah.

3.4.4 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 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 gam-19 (Shourav) for farmers' seed source were collected from a farmer named, Anwar Hossain of Ramchandrapur, Maheshpur, Jenaidah.

3.5 Methods and treatments of the experiment

3.5.1 Methods

There were two factors viz; A. Seed source and B. Seed treatment. There were four seed sources which were considered as 4 levels and seed treatment with vitavax 200 and no seed treatment i.e. 2 levels. Thus there were 8 treatment combinations. The experiment was laid out in a Randomized Block Design (RCRD) with the three replications.

3.5.2 Treatments

A. Seed treatment Levels-2

A) 1. No seed Treatment (T_0)

2. Treated with vitavax 200 (T_1)

B. Seed source

1. Farmers seed (S_1)
2. Local traders seed (S_2)
3. BADC seed (S_3)
4. BARI seed (S_4)

Thus the treatment combinations

T_0S_1 = No seed treatment of Farmers seed

T_0S_2 = No seed treatment of Local traders seed

T_0S_3 = No seed treatment of BADC seed

T_0S_4 = No seed treatment of BARI seed

T_1S_1 = Treated with vitavax 200 of Farmer seed

T_1S_2 = Treated with vitavax 200 of Local traders seed

T_1S_3 = Treated with vitavax 200 of BADC seed

T_1S_4 = Treated with vitavax 200 of BARI seed

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 01 November 2009. 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 10 November 2009. The layout was done as per experimental design on 10 November 2009.

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 Vitavax 200 @ 3 g kg^{-1} of seeds and sown in line on 11 November 2009 as per treatments. The recommended seed rates (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 Parameter studied

In the laboratory the following parameters were studied before field experimentation to record the following parameters.

1. Purity (%)

2. Germination (%)

3. 1000 seed weight (g)

3.7.1 Purity test

The purity test was done with the object of determining the composition by weight of the sample being tested, by inference, the composition of the seed lot. The components examined in purity analysis were: pure seeds, seeds of other species and inert matter. In purity analysis, all species of seed and each kind of inert matter present was identified as possible. For the determination of seed purity, the working sample was taken from the submitted sample by mixing and reducing in accordance with the ISTA procedure in the laboratory (Sen and Ghosh, 1999). The size of the working sample of the specified seed was 10 g for wheat (ISTA, 1996).

From the total sample of a specific crop, the seeds were separated according to pure seed, other seeds and inert matter and they were weighed (g) by an electric balance. Finally they were converted into percentage as follows:

$$\text{Purity (\%)} = \frac{\text{Weight of separated pure seed}}{\text{Weight of working sample}} \times 100$$

3.7.2 Germination test

Germination test at laboratory condition

Germination, a laboratory test, is the emergence and development from the seed embryo of those essential structures which, for the kind of seed being tested, indicate the ability to develop into a normal plant under favourable conditions in the soil (Agrawal, 1996).

Germination test was performed before sowing the seeds in the field. Filter papers were placed on four Petri dishes and the papers were soaked with water where 100 seeds were placed at random in each Petri dish. Data on germination were determined as percent basis by using the following formula:

$$\text{Germination test (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds set for germination}} \times 100$$

Apparatus:

- Petri-dishes
- Glassware
- Forceps
- Magnifiers
- Blotter paper
- Distill water
- Counting equipment etc

Procedure:

A minimum sample of 100 seeds was taken indiscriminately which is recommended by ISTA for a germination test (Agrawal, 1996). For conducting this test, three layered blotter paper (size 9 cm) was used in the glass Petri-dishes as growing media. By using sterilized forceps, the pre-soaked blotter paper was placed in the Petri-dishes. Then the seeds were placed on the blotter paper depending upon the respective seed size. For the selected seeds of wheat of different seed sources, (BARI, BADC, Local traders' and

Farmers' seed sources) 25 seeds were placed in each Petri-dishes because the seeds were small in size.

The number of germinated seeds were counted from it's commence to the completion by every day at a certain time (at 9 am) and by eye observation. As every variety had a total of 100 seeds in 4 Petri-dishes for the investigation, the data were recorded on the germinated seeds. Then they were converted into percentage according to the following equation:

$$\text{Germination (\%)} = \frac{\text{No of total germinated seed}}{\text{No of total seeds used for germination}} \times 100$$

Emergence test at field condition

The emergence of the seedling 4 days after sowing was counted from line a 50 cm of a line of every plot leaving first row from the left side of the plot. The number of total seeds sown in the 50 cm of the plot was calculated from seed rate and planting distance. The number of emergence seed and number of total seeds sown in the 50 cm were put in the above equation and emergence percentage at field condition was found.

3.7.3 Thousand (1000) seed weight (g)

Thousand (1000) seeds from every seed sources of each replication were taken apart for taking weight. Accordingly, they put on digital balance and weight was taken in gram.

3.8 Intercultural operations

3.8.1 Weeding

Weeds were controlled through two weeding at 05 December 2009, and 26 December 2009 just 25 and 45 days after sowing (DAS) i.e., with an interval of 21 days two weeding were done. The weeds identified were Kakpaya ghash (*Dactyloctenium aegyptium* L), Shama (*Echinocloa crussgalli*), Durba (*Cynodon dactylon*), Arail (*Leersis hexandera*), Mutha (*Cyperus rotundus* L), Bathua (*Chenopodiunm album*), Shaknatey (*Amaranthus viridis*), Foska begun (*Physalis beteophylls*), Titabegun (*Solanum torvum*) and Shetlomi (*Gnaphalium luteolabum* L).

3.8.2 Irrigation

Germination of seeds was ensured by light irrigation. Three irrigations were given at crown root initiation, maximum tillering and heading stages (20, 40 and 53 DAS). During irrigation care was taken so that water could not flow from one plot to another or overflow the boundary of the plots. Excess water of the field was drained out.

3.8.3 Harvesting and sampling

At full maturity, the wheat crop was harvested plot wise on 10 March 2010. Before harvesting 10 plants of wheat from each plot was selected randomly and uprooted. Those were marked with tags, brought to the threshing floor where seeds and straw were separated, cleaned and dried under sun for 4 consecutive days. Crop of each plot was harvested from 4m x1.4m area, separately leaving the border lines to record the seed yield which was converted into t ha^{-1}.

3.9 Growth parameters, yield and other attributes

Growth parameters data were taken on following

a) Plant height (cm) at 25, 50, 75 DAS and at harvest

b) No. of leaves/plant at 25, 50, 75 DAS and at harvest

c) Dry weight (g) per m^{-2}/plot at 25, 50, 75 DAS and at harvest

Yield and other attributes

a) Length of spike with awn and without awn

b) Number of spikes/m^{-2}

c) Weight of 1000 grains

d) Grain yield

e) Straw yield

3.9.1 Plant height (cm)

The heights of 10 selected plants were measured from the ground level to tip of either top leaf or spike and then averaged. It was taken at 25, 50, & 75 DAS (days after sowing) and at harvest. The plant height was taken from preselected (randomly) ten plants from second row of opposite side of the plot from where dry weight was taken.

3.9.2 No. of leaves plant^{-1}

Number of leaves of the 10 sampled same 10 plants from where plant height was taken at 25, 50, 75 DAS and at harvest from every experimental plot. It was then averaged to express as leaves plant^{-1}.

3.9.3 Dry weight (g) m^{-2} plot^{-1}

The plants with roots were collected at different days after sowing (25, 50 & 75 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. Finally it was converted into dry weight m^{-2} plot^{-1}. The dry weight was taken from 50 linear cm area of second row of each plot opposite side from where plant height was taken.

3.9.4 Length of spike with awn and without awn

Lengths of spike were measured from 10 plants at harvest and then averaged. This was taken from at harvest and expressed in cm.

3.9.5 Number of spikes/m^{-2}

The numbers of spikes m^{-2} were measured at random sampling from every plots of each replication during harvesting time.

3.9.6 Weight of thousand grains (g)

One thousand cleaned dried grains were counted randomly from each harvested sample and weighed by using digital electric balance. It was expressed in gram.

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

The crop was harvested randomly from 4 m x 1.4 m area of each plot leaving the border areas. Then the harvested wheat was threshed, cleaned and then sun dried up to a constant moisture level. The dried grains were then weighed and averaged. The grain yield was converted into t ha^{-1}.

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

Wheat was harvested randomly from 4 m x 1.4 m area of each plot. Then, the harvested wheat was threshed, cleaned and sun dried up to constant moisture level. The dried straw were then weighted and averaged. Then the straw yield was converted into t ha^{-1} basis.

3.10 Harvest Index (%)

Harvest index was determined by dividing the economic yield (seed yield) to the biological yield (seed + straw yield) from the same area and then multiplied by 100.

$$\text{Harvest Index (\%)} = \frac{\text{Seed yield (t ha}^{-1}\text{)}}{\text{Seed yield (t ha}^{-1}\text{) + Straw yield (t ha}^{-1}\text{)}} \times 100$$

3.11 Statistical analysis

Data collected from different parameters were compiled and tabulated in proper form. Appropriate statistical analysis was made by MSTATC computer package program and the treatment means were compared by least significance difference (LSD) at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER-IV

RESULTS AND DISCUSSION

A field experiment was conducted during the period from November 2009 to March 2010 to find out the quality of wheat seeds as affected by different seed sources of Bangladesh and treatment with Vitavax 200. This chapter provided a detailed description on the effect of different seed sources and seed treatment with vitavax 200 prior to seed sowing and in the field and statistical analyses of the data gathered.

4.1 Purity and seed weight of different sources

4.1.1 Purity percentage

Different seed sources showed variation in purity percentage. The farmers' seed source was found mixed with 16.62% impurities and inert materials. The maximum pure seed (97.45%) was recorded in BARI seed source which was followed by BADC seed source. The minimum percentage (83.28) of pure seed was recorded in farmers' seed (Table 1).

Table 1. Effect of different seed sources on percent purity of wheat seed

Treatments	Purity (%)
Farmers' seed	83.28
Local traders	94.28
BADC seed	96.45
BARI seed	97.45

4.1.2 Thousand seed weight

The different seed sources showed variation on 1000 seed wt. of wheat, the local traders' seed source was given the maximum 1000 seed wt. (47.10 g) which was superior to the other three sources. It was followed by BARI seed (44.97 g), BADC seed (43.56 g) and finally the minimum 1000 seed weight was recorded in farmers' seed source (39.76 g).

Table 2. Effect of different sources on thousand seed weight of different wheat seed

Treatments	1000 seed wt. (g)
Farmers' seed	39.76
Local traders	47.10
BADC seed	43.56
BARI seed	44. 97

4.2 Germination percentage at laboratory and emergence percentage at field conditions

4.2.1 Seed treatment

The germination percentage at laboratory conditions was recorded insignificant when treated with Vitavex 200 but it was significant at field condition. The maximum germination (96.25%) at laboratory condition was obtained with seed treatment by Vitavex 200. At field condition, significant variation was recorded in case of treated seeds (Table 3). Seed treatments could be a means of preventing or reducing the risks from 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).

Table 3. Effect of seed treatment on germination percentage at laboratory and emergence percentage at field conditions

Treatments	Germination at lab(%)	Emergence at field (%)
Untreated	86.45	83.60
Treated with vitavax	96.25	90.25
LSD $_{0.05}$	NS	*5.12*
CV (%)	*5.25*	*5.97*

4.2.2 Effect of seed sources

Effect of different seed sources on germination percentage at laboratory condition of wheat seeds was found significant where BARI seed performed the highest percent germination (93.06) at laboratory condition. Seeds collected from BADC performed the lowest germination percentage while the Farmers' seed source performed the second highest percentage of germination (Table 4).

Effect of different sources on emergence percentage at field condition of wheat seeds was also recorded significant. BARI seed performed the highest percent emergence (90.56) at field condition which was statistically similar to BADC seeds (87.39%) while the Farmers' seed source performed the lowest percent emergence (84.29%). The result was in agreement with the work of Hem and Splide (2010) that reported minimum emergence of good seed as hard red spring wheat 90%, durum wheat 85% and hard red winter wheat 90%.

Table 4. Effect of seed sources on germination percentage at laboratory and emergence percentage at field conditions of wheat seed

Treatments	Germination at lab (%)	Emergence at field (%)
Farmers' seed	92.39 ab	84.29 b
Local traders	88.47b	85.47 b
BADC seed	87.47 b	87.39 ab
BARI seed	93.06 a	90.56 a
LSD $_{(0.05)}$	*5.396*	*6.502*
CV (%)	*5.25*	*5.97*

4.2.3 Interaction effect of seed treatment and seed sources

The interaction effect of seed treatment and sources of seed on germination percentage at laboratory and emergence percentage at field conditions of wheat seeds was observed significant. Different sources of seed in both the conditions when untreated performed inferior germination compared to treated with Vitavax 200. Vitavax 200 treated BARI seed source gave the highest percent germination at laboratory condition and Treated BARI and BADC seed showed the statistically similar superior results of percent seedling emergence in field condition (Table 5). The result was as per of the work of Gilbert and Tekauz (1995), Helm and Splide (2010) and French *et al.* (2008).

Table 5. Interaction effect of seed treatment and sources of seed on germination percentage at laboratory and emergence percentage at field conditions of wheat seed

Treatments		Germination at lab (%)	Emergence at field (%)
Untreated	Farmers' seed	88.33 bc	78.29 c
	Local traders	82.67 c	80.67 bc
	BADC seed	80.67 c	85.33 abc
	BARI seed	94.12 ab	90.12 ab
Treated	Farmers' seed	96.45 ab	90.28 ab
	Local traders	94.28 ab	90.28 ab
	BADC seed	94.28 ab	91.45 ab
	BARI seed	96.00 a	93.00 a
$LSD_{(0.05)}$		*8.395*	*9.195*
CV (%)		*5.25*	*5.97*

4.3 Plant height

4.3.1 Effect of seed treatment

Plant height of at 25 and 75 DAS showed significant response to vitavax 200 treatments (Table 6). At 25 and 75 DAS the higher plant height 23.00 cm and 86.40 cm, respectively were recorded from plants treated with vitavax 200 than the untreated ones. The vitavax 200 treated plants were 10.21 % and 5.86% higher in height at 25 and 75 DAS, respectively than that of untreated plots.

Table 6. Effect of seed treatment on plant height of wheat

Treatments	Plant height (cm)			
	25 DAS	50 DAS	75 DAS	At harvest
Untreated	20.87	53.70	81.62	83.23
Treated	23.00	55.45	86.40	88.73
$LSD_{(0.05)}$	*1.254*	*(NS)*	*3.43*	*(NS)*
CV (%)	*4.96*	*3.64*	*2.82*	*4.11*

4.3.2 Effect of different seed sources

Different seed sources showed significant variation of plant height at different days after sowing (DAS). The highest plant height (24.10 cm) at 25 DAS was recorded from BARI seed source which was statistically similar to BADC seed source but superior to other two seed sources. The lowest plant height (19.80 cm) was found in farmers' seed source (Table 7). On the other hand, unlike to 25 DAS, the highest plant height (59.07 cm) was found in farmers' seed source and was statistically higher from all other seed sources. Similar trends of result was also recorded in 75 DAS and at harvest all the seed sources showed similar plant height except BADC seed that was the shortest plant height (84.25 cm). The growth of wheat plants emerged from different seed sources showed rapid growth up to 75 DAS but the growth stunted having reached at harvest stage (Table 7). These might be due to farmers' seed source was found mixed with the highest amount of impure seeds and/or inert materials. As the seeds of farmers' seed source treatment was highly mixed with other variety or impure or lack of varietal purity, unusual and highest plant height was found from the seed source. The reference holds well with the experiments of French *et al*. (2008) who also said that farmers should also be aware of the agronomic characteristics of the seed lot they select. After variety selection, the most emphasis must be put on obtaining and maintaining top quality planting seed.

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Table 7. Effect of different seed sources on plant height of wheat

Treatments	Plant height (cm)			
	25 DAS	50 DAS	75 DAS	At harvest
Farmers' seed	19.80 b	59.07 a	88.10 a	89.30 a
Local traders	20.73 b	50.83 c	83.01 b	84.80 ab
BADC seed	23.13 a	53.57 b	81.76 b	84.25 b
BARI seed	24.10 a	54.82 b	83.16 b	85.55 ab
$LSD_{(0.05)}$	*1.346*	*2.461*	*2.929*	*4.378*
CV (%)	*4.96*	*3.64*	*2.82*	*4.11*

4.3.3 Interaction effect of seed treatment and sources of seed

Interaction effect of seed treatment and sources of seed on plant height of wheat was significant at all the studied stages. Plants emerged from vitavax 200 treated wheat seed showed superiority to untreated plants in terms of height at different days after sowing (DAS) and at harvest stage. The tallest plant was detected at 25 DAS from BARI seed source treated with vitavax 200 which was superior to other treated or untreated seed sources and similar to BADC seed source treated with vitavax 200. The smallest plant height (19.00 cm) was recorded from untreated farmers' seed source that was similar to untreated local traders seed. But in case at 50, 75 DAS and at harvest the tallest plant was recorded from plots growing with farmers' seed source. The smallest plant was recorded from local traders seed at 50, 75 DAS and at harvest (Table 8). Schaafsma and Tamburic-Ilincic (2005) investigated the influence of variety, seeding rate, and seed treatment with fungicides on the flowering period of winter wheat and yield and yield contributing characters where they found similar results.

Table 8. Interaction effect of seed treatment and sources of seed on plant height of wheat

Treatments		Plant height (cm)			
		25 DAS	50 DAS	75 DAS	At harvest
Untreated	Farmers' seed	19.00 d	59.57 a	84.50 b	85.20 bc
	Local traders	19.20 d	49.29 c	79.95 c	81.10 c
	BADC seed	22.25 bc	52.39 bc	79.60 c	82.40 bc
	BARI seed	23.05 b	53.54 b	82.42 bc	84.20 bc
Treated	Farmers' seed	20.60 cd	58.56 a	91.70 a	93.40 a
	Local traders	22.25 bc	52.38 bc	86.07 b	88.50 ab
	BADC seed	24.00 ab	54.75 b	83.92 bc	86.10 bc
	BARI seed	25.15 a	56.10 ab	83.90 bc	86.90 bc
LSD $_{(0.05)}$		*1.904*	*3.480*	*4.142*	*6.191*
CV (%)		*4.96*	*3.64*	*2.82*	*4.11*

4.4 Number of leaves plant^{-1}

4.4.1 Effect of seed treatment

A significant variation of seed treatment on number of leaves plant^{-1} of wheat was found at 25 and 75 DAS and at harvest but insignificant at 50 DAS. The higher leaves plant^{-1} (6.55) was recorded from vitavax 200 treated plots at 25 DAS. Similar result was observed at 75 DAS and at harvest. The higher number of leaves plant^{-1} (49.85) was enumerated from plots when treated with vitavax at 75 DAS (Table 9).

Table 9. Effect of seed treatment on number of leaves plant^{-1} of wheat

Treatments	No of leaves plant^{-1}			
	25 DAS	50 DAS	75 DAS	At harvest
Untreated	6.00	18.93	39.93	45.53
Treated	6.55	21.33	49.85	*48.42*
LSD $_{(0.05)}$	*0.48*	(NS)	*4.124*	*2.343*
CV (%)	*6.64*	16.14	*8.20*	*2.71*

4.4.2 Effect of different seed sources

Different seed sources significantly influenced the number of leaves plant^{-1} of the wheat variety shown at different growth stages. Seed collected from BARI Wheat Research Centre gave the highest number of leaves plant^{-1} (7.05) at 25 DAS which was statistically superior to the other three seed sources. The Farmers' seed, local traders and BADC seed sources showed statistically similar number of leaves. Number of leaves at 50, 75 DAS and at harvest was found statistically similar where the highest number of leaves plant^{-1} (23.85 at 50 DAS, 49.40 at 75 DAS and 50.25 at harvest) were also recorded from BARI seed source that were similar to the seeds collected from BADC (Table 10). At 75 DAS and at harvest the leaves number were recorded almost same as senescence of leaves and dropping of old leaves after maturity occurred.

Table 10. Effect of different seed sources on number of leaves plant^{-1} of wheat

Treatments	No of leaves plant^{-1}			
	25 DAS	50 DAS	75 DAS	At harvest
Farmers' seed	5.90 b	18.85 b	44.05 b	45.55 bc
Local traders	5.95 b	17.25 b	41.15 b	43.45 c
BADC seed	6.20 b	20.55 ab	44.95 ab	47.66 ab
BARI seed	7.05 a	23.85 a	49.40 a	50.25 a
LSD $_{(0.05)}$	*0.5165*	*4.021*	*4.557*	*3.057*
CV (%)	*6.64*	*16.14*	*8.20*	*5.31*

4.4.3 Interaction effect of seed treatment and sources of seed

At different growth stages the number of leaves of wheat was significantly influenced by the effect of seed treatment with vitavax 200 and different sources of seed. Diverse seed sources when treated with vitavax 200 yielded in superior result than untreated seed sources. In all the cases in terms of number of leaves at different DAS, BARI seed treated with the vitavax 200 resulted in significantly higher number of leaves plant^{-1} (7.60 at 25 DAS, 25.60 at 50 DAS, 54.20 at 75 DAS and 52.20 at harvest). In case of untreated seed sources BARI seed invariably gave the highest number of leaves at all studied growth durations (Fig. 1). Similarly Gupta *et al*. (2002) also reported maximum number of leaves plant^{-1} from treated with fungicides and high yielding variety of bread wheat.

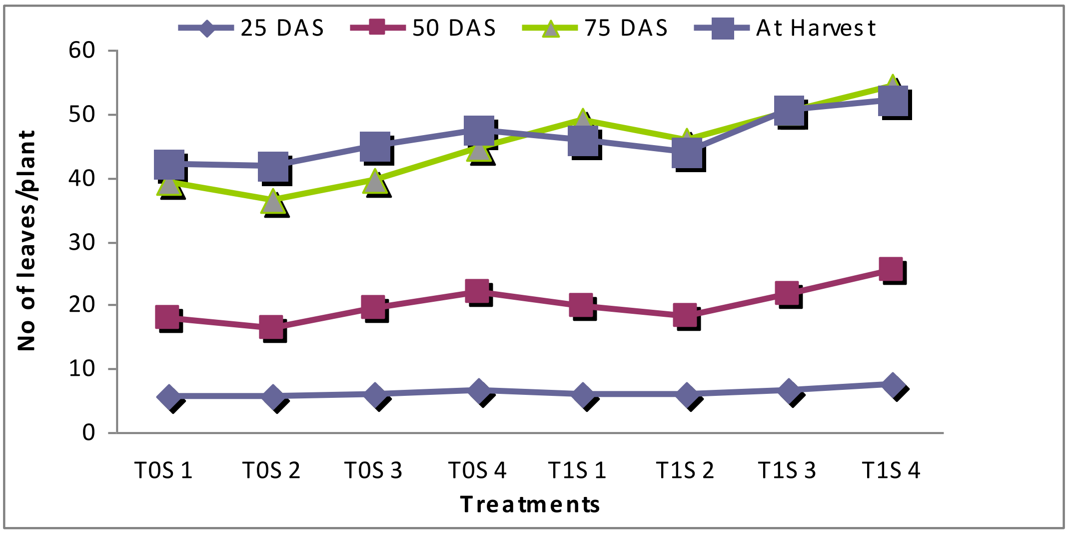

Fig. 1. Effect of seed treatment and sources of seed on number of leaves of wheat

4.5 Dry weight

4.5.1 Effect of seed treatment

Shoot and root dry weight m^{-2} at 25 DAS was found significant with the influence of vitavax 200. The higher shoot dry weight (25.86 g m^{-2}), root dry weight (22.26 g m^{-2}) and accordingly total dry weight (48.12 g m^{-2}) was weighed in the vitavex 200 treated plots (Table 11), compared to untreated plots that gave the dry weight of shoot (22.82 g m^{-2}), root (20.16 g m^{-2}) as well as total dry weight (42.98 g m^{-2}).

At 50 DAS a statistically significant influence of fungicidal treatment of wheat seeds with vitavax 200 was found on shoot and root dry weight of weheat. The higher shoot dry weight (77.10 g m^{-2}), root dry weight (37.07 g m^{-2}) and total dry weight (114.17 g m^{-2}) was weighed in the vitavax 200 treated plot compared the shoot (55.7 g m^{-2}), root (30.71 g m^{-2}) and total dry weight (85.88 g m^{-2}) of untreated plots. The total dry weight at 50 DAS was about 137.26% higher over dry matter of wheat harvested at 25 DAS (Table 11).

Table 11. Effect of seed treatment on dry weight of wheat plant at 25 and 50 DAS

Treatments	Dry weight at 25 DAS (g)			Dry weight at 50 DAS (g)		
	Shoot	Root	Total	Shoot	Root	Total
Untreated	22.82	20.16	42.98	55.17	30.71	85.88
Treated	25.86	22.26	48.12	77.10	37.07	114.17
LSD $_{(0.05)}$	*2.43*	*1.852*	*3.538*	*9.389*	*3.289*	*11.56*
CV (%)	*8.21*	*5.97*	*7.02*	*10.85*	*5.37*	*6.64*

The shoot, root and total dry weight m^{-2} at 75 DAS was found significant with the influence of fungicidal treatment with vitavax 200. The higher shoot dry weight (158.87 g m^{-2}), root dry weight (38.58 g m^{-2}) and accordingly dry weight in total (197.45 g m^{-2}) was assessed in the vitavex 200 treated plots (Table 12). Kumar *et al*. (1997) reported that the stem weight increased from initial stage till 75 and 105 days after sowing, respectively and declined later up to maturity irrespective of genotypes. And the total dry weight in the stem was increased progressively from sowing till the harvest in both *durum* and *aestivum* wheats under the normal irrigated condition.

A statistically significant influence of fungicidal treatment of wheat seeds with vitavax 200 was found on shoot, root and total dry weight m^{-2} at harvest. The higher shoot dry weight (395.92 g m^{-2}), root dry weight (30.31 g m^{-2}) and total dry weight (426.23 g m^{-2}) were weighed up in the vitavax 200 treated plots. The total dry weight at harvest was 115.87% higher over 75 DAS of wheat plant (Table 12). It seemed from the result that root dry weight decreased with the increasing senescence of wheat plant but shoot as well as total dry matter increased. Kumar *et al*. (1997) reported that the total dry weight increased progressively from sowing till harvest in both durum and aestivum wheats under normal irrigated conditions, while under rainfed conditions, the total dry weight of the plant increased up to maturity in durum wheat, whereas, in aestivum, it remained constant after 105 days till maturity.

Table 12. Effect of seed treatment on dry weight at 75 DAS and at harvest of wheat plant

Treatments	Dry weight at 75 DAS (g)			Dry weight at harvest (g)		
	Shoot	Root	Total	Shoot	Root	Total
Untreated	103.46	32.54	136.00	359.95	22.43	382.38
Treated	158.87	38.58	197.45	395.92	30.31	426.23
LSD $_{(0.05)}$	*17.73*	*2.39*	*18.04*	*38.19*	*3.022*	*37.18*
CV (%)	*10.92*	*5.43*	*8.74*	*8.16*	*9.26*	*7.43*

4.5.2 Effect of seed sources

Shoot, root and total dry weight m^{-2} at 25 DAS differed significantly due to different seed sources. The highest shoot dry weight (27.96 g m^{-2}), root dry weight (23.73 g m^{-2}) and thus total dry weight (51.69 g m^{-2}) was the height in the plots of BARI seed source. The second highest shoot, root and consequently total dry weight m^{-2} at 25 DAS was recorded from BADC seed source. The total dry weight at 25 DAS which was found from BARI seed was 24.61% higher over the farmers' seed source treatment that resulted the lowest dry weight (Table 13).

A statistically significant variation of different sources of wheat seeds was found on shoot, root and total dry weight m^{-2} at 50 DAS. The highest shoot dry weight (81.48 g m^{-2}), root dry weight (40.92 g m^{-2}) and in total dry weight (122.4 g m^{-2}) was observed in the BARI seed source (Table 13). The total dry weight at 50 DAS was 136.8% higher over 25 DAS sampling of dry matter of wheat plant. The lowest dry weight of shoot (47.48 g m^{-2}), root (29.38 g m^{-2}) and (76.86 g m^{-2}) at 50 DAS was recorded from farmers' seed source treatment. The total dry weight at 50 DAS that found from BARI seed source was 59.25% higher over the farmers' seed source treatment.

Table 13. Effect of different seed sources on dry weight at 25 and 50 DAS of wheat plant

Treatments	Dry weight at 25 DAS (g)			Dry weight at 50 DAS (g)		
	Shoot	Root	Total	Shoot	Root	Total
Farmers' seed	22.74 bc	18.74 d	41.48 c	47.48 c	29.38 c	76.86 d
Local traders	21.86 c	20.36 c	42.22 c	63.94 b	29.74 c	93.68 c
BADC seed	24.80 b	22.02 b	46.82 b	71.64 b	35.52 b	107.2 b
BARI seed	27.96 a	23.73 a	51.69 a	81.48 a	40.92 a	122.4 a
$LSD_{0.05}$	*2.475*	*1.568*	*3.958*	*8.883*	*2.254*	*8.220*
CV (%)	*8.21*	*5.97*	*7.02*	*10.85*	*5.37*	*6.64*

The shoot, root and total dry weight m^{-2} at 75 DAS was found significant with the influence of different seed sources. The highest shoot dry weight (161.5 g m^{-2}), root dry weight (42.25 g m^{-2}) and accordingly in-total dry weight (203.9 g m^{-2}) was found in the BARI seed sown plots. The second highest shoot, root and consequently total dry weight m^{-2} at 75 DAS was recorded from BADC seed source. The total dry weight at 75 DAS that was found from BARI seed was 40.33% higher over the farmers' seed source treatment which resulted in the lowest dry weight m^{-2} in the farmer's seed source. BARI seed source had shown its superiority over other three seed sources treatment (Table 14).

A statistically significant effect of different sources of wheat seeds was found on shoot, root and total dry weight m^{-2} at harvest. The highest shoot dry weight (433.9 g m^{-2}), root dry weight (31.60 g m^{-2}) and total dry weight (465.5 g m^{-2}) was weighed up in the BARI seed source plots. The highest shoot dry weight was found statistically similar to BADC seed source treatment. The total dry weight of BARI seed sources at harvest was 128.3% higher over 75 DAS sampling of dry matter of wheat plant (Table 14). The lowest total dry weight (352.4 g m^{-2}) at harvest was recorded from local traders seed source treatment. The total dry weight at harvest which was found from BARI seed was 25% higher over the farmers' seed source treatment. It seemed from the result that root dry weight decreased with the increasing senescence of wheat plant up to harvest but shoot as well as total dry matter increased (Table 14).

Table 14. Effect of different sources on dry weight at 75 DAS and at harvest of wheat plant

Treatments	Dry weight at 75 DAS (g)			Dry weight at harvest (g)		
	Shoot	Root	Total	Shoot	Root	Total
Farmers' seed	114.2 b	31.13 c	145.3 c	349.7 b	22.70 c	372.4 c
Local traders	116.7 b	31.67 c	148.4 c	329.4 b	23.02 c	352.4 c
BADC seed	132.3 b	37.00 b	169.3 b	398.7 a	28.16 b	426.9 b
BARI seed	161.5 a	42.25 a	203.9 a	433.9 a	31.60 a	465.5 a
LSD $_{(0.05)}$	*17.73*	*2.39*	*18.04*	*38.19*	*3.022*	*37.18*
CV (%)	*10.92*	*5.43*	*8.74*	*8.16*	*9.26*	*7.43*

4.5.3 Interaction effect of seed treatment and sources of seed

Interaction effect of seed treatment and sources of seed with vitavax 200 on dry weight at 25 DAS of wheat plant was found significant. BARI seed source when treated prior to seed sowing with vitavax 200 gave significantly the highest shoot (29.00 g m^{-2}), root (25.08 g m^{-2}) and total dry weight (54.08 g m^{-2}) at 25 DAS. The lowest shoot (20.36 g m^{-2}) from local traders seed source treatments and root (18.16 g m^{-2}) from farmers' seed source treatments (Table 15) and total dry weight (39.72 g m^{-2}) from farmers' seed source treatments (Fig 2) was recorded when sown without seed treatment with the fungicide.

Interaction effect of seed treatment with vitavax 200 and sources of seed on dry weight at 50 DAS of wheat plant was found significant. The highest and superior dry weight at 50 DAS of shoot (92.04 g m^{-2}), root (44.16 g m^{-2}) and later on total dry weight (136.20 g m^{-2}) was recoreded from the same treatment that was BARI seed with the treatment of vitavax 200 fungicide. Treated seed sources showed superiority over untreated seed sources also in terms of length of shoot, root and total dry weight at 50 DAS (Table 14).

The highest total dry weight at 50 DAS that was found in the treated BARI seed sources that was 105.24% higher over untreated farmers' seed sources treatment (Fig. 3).

Table 15. Interaction effects of seed treatment and sources of seed on dry weight at 25 and 50 DAS of wheat plant

Treatments		Dry weight at 25 DAS (g)		Dry weight at 50 DAS (g)	
		Shoot	Root	Shoot	Root
Untreated	Farmers' seed	21.56 d	18.16 e	38.44 e	27.92 de
	Local traders	20.36 d	19.68 de	50.32 de	25.80 e
	BADC seed	22.44 d	20.44 cde	61.00 cd	31.44 c
	BARI seed	26.92 abc	22.37 bc	70.92 bc	37.68 b
Treated	Farmers' seed	23.92 bcd	19.32 de	56.52 d	30.84 cd
	Local traders	23.36 cd	21.04 cd	77.56 b	33.68 c
	BADC seed	27.16 ab	23.60 ab	82.28 ab	39.60 b
	BARI seed	29.00 a	25.08 a	92.04 a	44.16 a
LSD $_{(0.05)}$		*3.50*	*2.22*	*12.56*	*3.188*
CV (%)		*8.21*	*5.97*	*10.85*	*5.37*

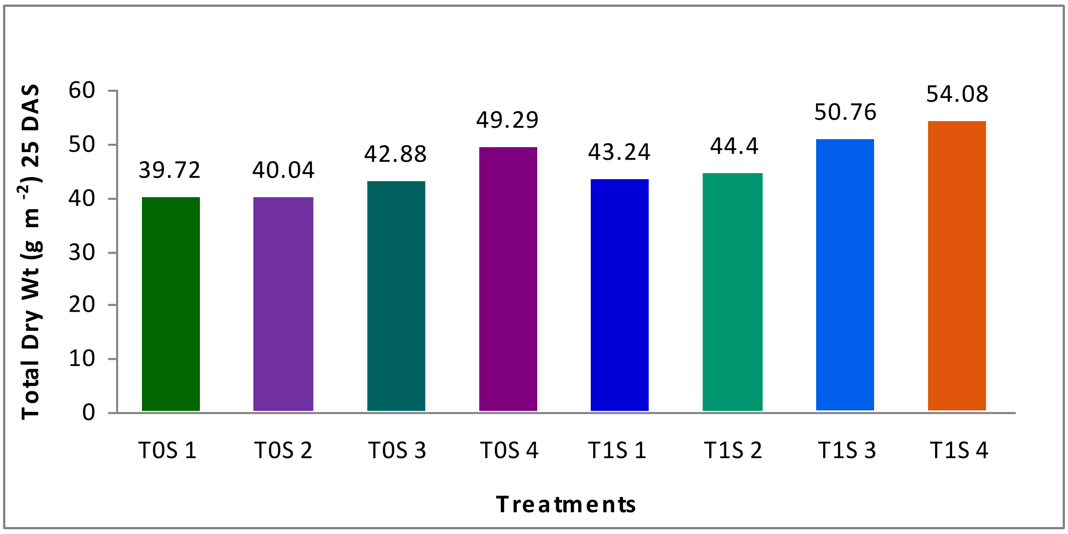

Fig. 2. Effect of seed treatment and different seed sources on total dry weight m^{-2} at 25 DAS of wheat plant

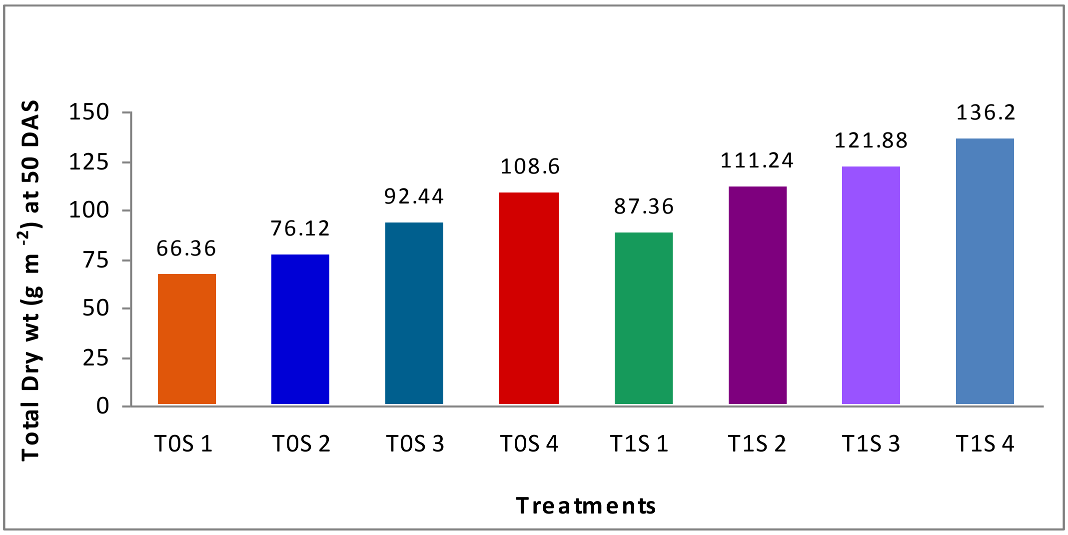

Fig. 3. Effect of seed treatment and different sources on total dry weight m^{-2} at 50 DAS of wheat plant

A significant interaction effect of sources of seed and seed treatment with vitavax 200 fungicides was found on dry weight m^{-2} at 25 DAS of wheat plant. Treated prior to seed sowing with vitavax 200, BARI seed source produced statistically significantly the highest shoot (198.52 g m^{-2}), root (45.91 g m^{-2}) and accordingly in-total dry weight (244.43 g m^{-2}). The lowest shoot (91.68 g m^{-2}) and root (27.80 g m^{-2}) and in total dry weight (119.48 g m^{-2}) from local traders seed source treatments was recorded when sown without seed treatment with the fungicide. Treated seed sources showed superiority over untreated seed sources also in terms of length of shoot and root and in total dry weight (Fig. 4). The highest total dry weight at 75 DAS recorded from BARI seed source with vitavax treatment was 94.49% higher than farmers' seed source treatment. Treated BARI seed source showed superiority over other seed sources either treated or untreated.

Interaction effect of sources of seed and seed treatment with vitavax 200 fungicides on dry weight m^{-2} at harvest of wheat plant was found significant. The highest dry weight at harvest of shoot (465.40 g m^{-2}), root (34.48 g m^{-2}) and total dry weight (499.88 g m^{-2}) was observed from the same treatment that was BARI seed with the treatment of vitavax 200 fungicide. Treated BARI seed source showed superiority over other seed sources either treated or untreated (Table 16 and Fig. 5). Treated seed sources showed superiority over untreated seed sources also in terms of shoot, root and accordingly in-total dry weight at harvest. The highest total dry weight at harvest that was found in the treated BARI seed sources treatment was 42.28% higher over untreated local traders' seed sources treatment (Table 16).

Table 16. Interaction effect of seed treatment and sources of seed on dry weight at 75 DAS and at harvest of wheat plant

Treatments		Dry weight at 75 DAS (gm^{-2})		Dry weight at harvest (gm^{-2})	
		Shoot	Root	Shoot	Root
Untreated	Farmers' seed	95.76 e	29.92 de	347.72 cd	19.48 d
	Local traders	91.68 e	27.80 e	323.40 d	16.00 d
	BADC seed	102.00 de	33.44 cd	366.36 cd	25.52 c
	BARI seed	124.40 cd	39.00 b	402.32 bc	28.72 bc
Treated	Farmers' seed	132.60 c	32.33 cd	351.76 cd	25.92 c
	Local traders	141.76 bc	35.54 c	335.40 d	30.04 abc
	BADC seed	162.60 b	40.56 b	431.12 ab	30.80 ab
	BARI seed	198.52 a	45.91 a	465.40 a	34.48 a
$LSD_{(0.05)}$		*25.08*	*3.382*	*54.01*	*4.274*
CV (%)		*10.92*	*5.43*	*8.16*	*9.26*

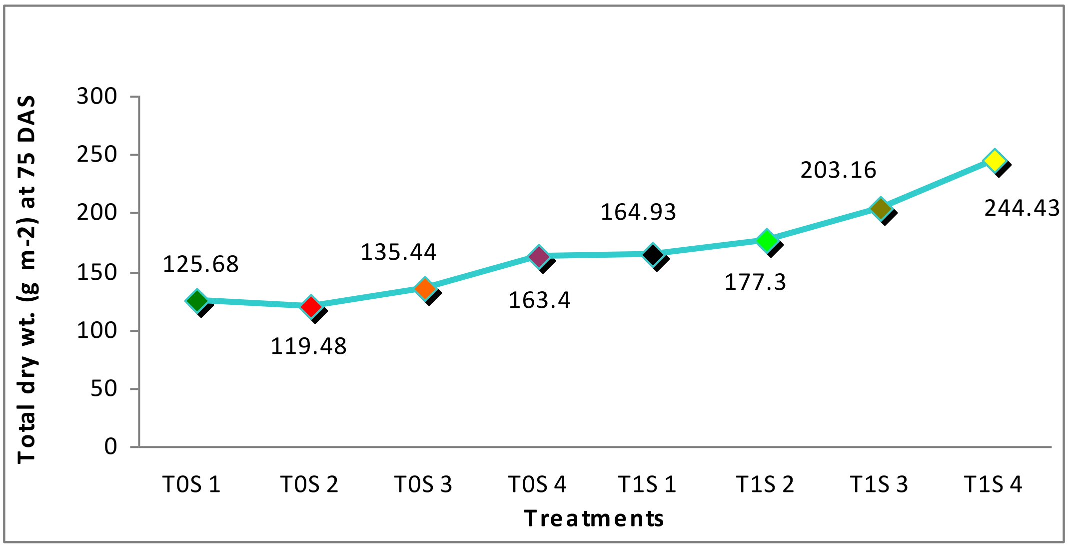

Fig. 4. Effect of seed treatment and different sources of seeds on dry weight m^{-2} at 75 of wheat plant

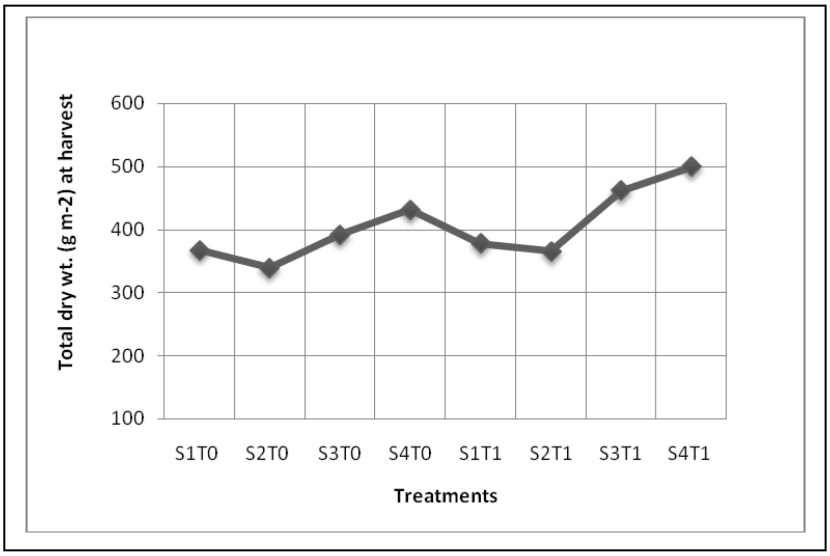

Fig. 5. Effect of different seed treatment and sources of seeds on dry weight m^{-2} at harvest of wheat plant

4.6 Spike characteristics

4.6.1 Effect of seed treatment

Spikes m^{-2}

Spikes m^{-2} of wheat was found significantly affected by seed treatment with vitavax 200 (Table 17). Higher spikes m^{-2} (221. 50) was recorded in treated plots compared to that of untreated plots (206.75).

Length of spike

Data on length of spike with awn and without awn was taken randomly as an average of ten plants from every replication and it showed that treated seeds gave rise to the higher length of spike either with awn (18.24 cm) or without awn (11.99 cm) compared to untreated plots (Table 17).

Table 17. Effect of seed treatment on spike characteristics of wheat

Treatments	Spikes m^{-2}	Length of spike (cm)	
		With awn	Without awn
Untreated	206.75	16.90	10.98
Treated	221.50	18.24	11.99
LSD $_{(0.05)}$	*7.943*	*0.587*	*0.454*
CV (%)	*2.73*	*2.19*	*3.69*

4.6.2 Effect of different seed sources

Spikes m^{-2}

A statistically significant influence on spike m^{-2} of wheat of different seed sources was found. The highest spike m^{-2} (237.50) was recorded from BARI seed source which was followed by the sequence BADC seed> Farmers' seed> Local traders seed source and they were statistically different from each other (Table 18). Gilbert and Tekauz (2005) reported that there were significantly more emerged plants and spikes per m^2 in seed-treated plots.

Length of spike

BARI seed source and BADC seed source gave statistically similar and significantly longest spike with awn (18.42 cm). The shortest spike (16.67 cm) was recorded from Local traders' seed source. In case of length of spike without awn BARI seed source produced the longest spike (12.12 cm) without awn which was statistically superior to all the three seed sources treatment (Table 18).

Table 18. Effect of different seed sources on spike characteristics of wheat

Treatments	Spike m^{-2}	Length of spike (cm)	
		With awn	Without awn
Farmers' seed	205.50 c	17.23 b	11.20 b
Local traders	194.00 d	16.67 c	11.16 b
BADC seed	219.50 b	17.96 a	11.46 b
BARI seed	237.50 a	18.42 a	12.12 a
LSD $_{(0.05)}$	*7.234*	*0.478*	*0.5254*
CV (%)	*2.73*	*2.19*	*3.69*

4.6.3 Interaction effect of seed treatment and sources of seed on spike characteristics of wheat

Spikes m^{-2}

A statistically significant effect of seed treatment with vitavax 200 and different seed sources was found on spikes m^{-2} of wheat. The highest number of spikes m^{-2} (248) was recorded from BARI seed source when treated with the fungicide which was followed by treated BADC seed (229) and untreated BARI seed (227). Treated seed sources showed superiority over untreated seed sources (Table 19). The lowest number of spikes m^{-2} (190) of wheat was recorded from plants of untreated local traders' seed.

Length of spike

BARI seed source when treated prior to seed sowing with vitavax 200 gave significantly the longest spike with awn (18.99 cm) that was similar to treated seeds of BADC (18.61

cm). The shortest spike (16.14 cm) was recorded from untreated local traders' seed source. In case of length of spike without awn BARI seed source with treated seeds produced the longest spike (12.60 cm) that was similar to treated BADC seeds which was superior to all the other treatments (Table 19). Martin and Johnston (2002) reported that Vitaflo 280 treatment and different genotypes significantly varied in length of spike of wheat.

Table 19. Interaction effect of seed treatment and sources of seed on spike characteristics of wheat

Treatments		Spikes m^{-2}	Length of spike (cm)	
			With awn	Without awn
Untreated	Farmers' seed	200 de	16.30 e	10.82 de
	Local traders	190 e	16.14 e	10.54 e
	BADC seed	210 cd	17.31 d	10.93 cde
	BARI seed	227 b	17.84 cd	11.64 bc
Treated	Farmers' seed	211 c	18.15 bc	11.58 bcd
	Local traders	198 e	17.19 d	11.79 b
	BADC seed	229 b	18.61 ab	11.99 ab
	BARI seed	248 a	18.99 a	12.60 a
LSD $_{(0.05)}$		*10.23*	*0.676*	*0.743*
CV (%)		*2.73*	*2.19*	*3.69*

4.7 Weight of 1000 grains

4.7.1 Effect of seed treatment

A significant influence of seed treatment on 1000 grain weight of wheat was found where the higher grain weight (42.69 g) weight of thousand seed was recorded from vitavax 200 treated plots as compared to untreated one (Table 20) which was lower weight (39.06 g).

4.7.2 Effect of sources of seed

A statistically significant influence on 1000 grain weight of wheat of different seed sources was found as showed in the Table 21. The highest 1000 grain weight of wheat (42.48 g) was recorded from BARI seed source which was statistically different and followed by the sequence BARI seed> BADC seed> Local traders seed > Farmers' seed source.

4.7.3 Interaction effect of seed treatment and sources of seed

Thousand seed weight of wheat with the interaction effect seed treatment and sources of seed was statistically significant (Table 22). Treated BARI seed source (44.13 g) and treated BADC seed source (43.39 g) gave statistically similar and the highest 1000 seed weight. 1000 seed weight of untreated set of seed sources was inferior to treated set of seed sources as showed in the (Table 22). The lowest 1000 seed weight (37.54 g) was found in the farmers' seed source plots when sown without seed treatment.

4.8 Grain yield

4.8.1 Effect of seed treatment

Grain yield (t ha^{-1}) at field condition was recorded significant when treated with vitavex 200. On average higher grain yield was found (3.95 t ha^{-1}) with treated seeds of all source and was 26.60% higher than the untreated seed sources (Table 20). Gaska (2000) reported that seed treatments in wheat increased winter survival and promoted tillering and thereby increased yield.

4.8.2 Effect of sources of seed

Grain yield of wheat was found statistically significantly influenced by different seed sources (Table 21). The highest grain yield (4.16 t ha^{-1}) was recorded from BARI seed sources whereas the yield variations were found in the range of 3.10 to 4.16 t ha^{-1}. The lowest grain yield (3.10 t ha^{-1}) was counted in the plots of farmers' seed source treatment. BARI seed source treatment gave 34.19% yield increase over farmers' seed source. It was followed by BADC source (3.61 t ha^{-1}) (Table 21). BARI seed source produced the highest yield and it might be due to its varietals purity and other superior characters of the variety and hence the highest yield was obtained. It was reported that BARI gam-19 had ability to give 3.5-4.6 t ha^{-1} yield in favorable condition (BARI, 2005). In the present study the yield was 4.16t ha^{-1} which supported this results.

4.8.3 Interaction effect of seed treatment and sources of seed

BARI seed source when treated prior to seed sowing with vitavax 200 produced statistically dissimilar and significantly the highest grain yield ha^{-1} (4.47 t). This was statistically superior to all other treatments. The lowest yield (2.63 t ha^{-1}) was recorded from local traders' seed source when sown without seed treatment with the fungicide, vitavax 200. Among the untreated seed sources, BARI seed source produced the highest yield of wheat ha^{-1} (3.82 t) (Table 22). Treated seed sources showed superiority over untreated seed sources in terms of grain yield ha^{-1}.

4.9 Straw yield

4.9.1 Effect of seed treatment

The effect of seed treatment on straw yield of wheat was significant. Comparatively higher straw yield was found with the treated seeds (4.03 t ha^{-1}) and was 23.24% higher than the untreated seed sources (Table 20).

Table 20. Effect of seed treatment on yield contributing characteristics of wheat

Treatments	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Untreated	39.06	3.12	3.27
Treated	42.69	3.95	4.03
$LSD_{0.05}$	*1.85*	*0.34*	*0.623*
CV (%)	*3.22*	*6.65*	*11.31*

4.9.2 Effect of sources of seed

Different sources of seed produced significantly variable straw yields that are presented in Table 21. BARI seed source treatment performed superior result than the other seed sources. The highest straw yield (4.17 t ha^{-1}) was acquired in the BARI seed source (Table 21) which was 25.60% higher over farmers' seed source and local traders' seed source treatments (Fig. 6).

Table 21. Effect of different seed sources on grain weight, yield grain and straw of wheat

Treatments	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Farmers seed	38.92 c	3.10 c	3.32 b
Local traders	40.64 b	3.27 c	3.32 b
BADC seed	41.45 ab	3.61 b	3.81 ab
BARI seed	42.48 a	4.16 a	4.17 a
LSD $_{(0.05)}$	*1.63*	*0.29*	*0.512*
CV (%)	*3.22*	*6.65*	*11.31*

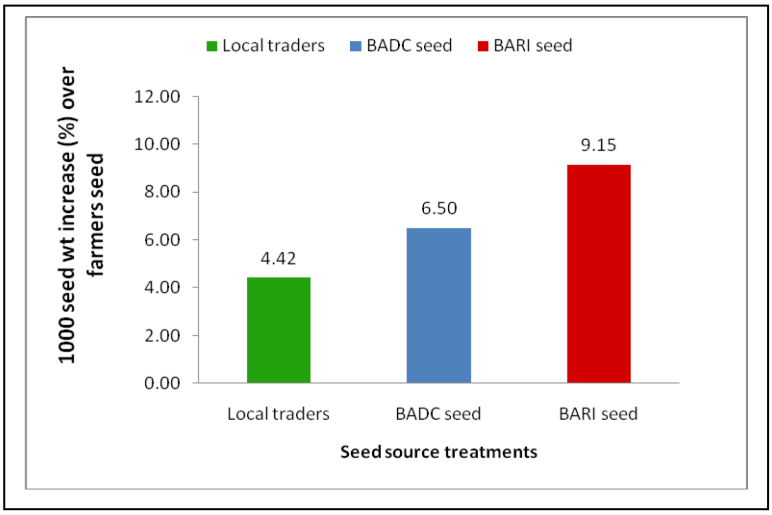

Fig.6. Thousand seed weight increase over farmers' seed as influenced by different seed sources

4.9.3 Interaction effect of seed treatment and sources of seed

The interaction effect of seed treatment and sources of seed on straw yield was observed significant. Different sources of seed when untreated performed inferior result to different seed sources when treated with Vitavex 200. Fungicidel vitavax 200 treated BARI seed source gave the highest straw yield (4.64 t ha^{-1}) which was followed by treated BADC seed (4.39 t ha^{-1}) and untreated BARI seed source (3.70 t ha^{-1}) treatments (Fig.7). Untreated local traders seed source gave statistically the lowest straw yield.

Table 22. Interaction effect of seed treatment and sources of seed on grain weight and yield of wheat

Treatments		1000 grain wt (g)	Grain yield (t ha^{-1})
Untreated	Farmers' seed	37.54 e	2.81 de
	Local traders	38.34 de	2.63 e
	BADC seed	39.51 cde	3.20 cd
	BARI seed	40.83 bc	3.82 b
Treated	Farmers' seed	40.30 cd	3.39 c
	Local traders	42.94 ab	3.90 b
	BADC seed	43.39 a	4.02 b
	BARI seed	44.13 a	4.47 a
LSD $_{(0.05)}$		*2.305*	*0.411*
CV (%)		*3.22*	*6.65*

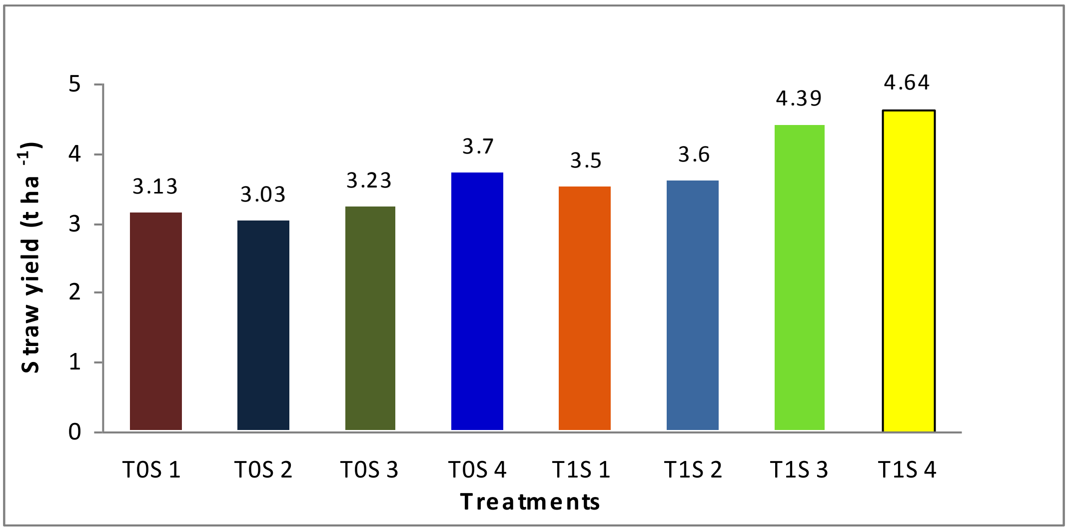

Fig. 7. Effect of seed treatment and sources of seed on straw yield of different wheat seed

4.10 Harvest Index

4.10.1 Effect of seed treatment

The harvest index was recorded insignificant when treated with Vitavex 200. However, the numerically higher harvest index (49.71%) was obtained with seed treatment by Vitavex 200 (Table 23) compared to untreated seeds (48.23 %).

Table 23. Effect of seed treatment on harvest index of wheat

Treatments	Harvest index (%)
Untreated	48.23
Treated	49.71
LSD $_{(0.05)}$	*NS*
CV (%)	*5.33*

4.10.2 Effect of different seed sources

Effect of different seed sources on harvest index of wheat was found insignificant. Data in Table 24 showed that BARI seed source was given the maximum (49.87 %) HI. The lowest HI was recorded from farmer's seed source (48.07%).

Table 24. Effect of different seed sources on harvest index of wheat

Treatments	Harvest index (%)
Farmers' seed	48.07
Local traders	49.04
BADC seed	48.90
BARI seed	49.87
LSD $_{(0.05)}$	*(NS)*
CV (%)	*7.82*

4.10.3 Interaction effect of seed treatment and sources of seed

The interaction effect of seed treatment and sources of seed on harvest index of wheat was observed significant as the data presented in Table 25. The highest harvest index (52.00%) was recorded from local traders' seed source when treated with vitavax 200 that similar to all other treatments except the untreated seeds of local traders' that resulted the lowest harvest index (46.47 %).

Table 25. Interaction effect of seed treatment and sources of seed on harvest index of wheat

Treatments		Harvest index (%)
Untreated	Farmers' seed	47.31 ab
	Local traders	46.47 b
	BADC seed	49.77 ab
	BARI seed	50.80 ab
Treated	Farmers' seed	49.20 ab
	Local traders	52.00 a
	BADC seed	47.80 ab
	BARI seed	49.07 ab
$LSD_{(0.05)}$		*4.568*
CV (%)		*5.43*

CHAPTER-V

SUMMARY AND CONCLUSIONS

A laboratory and a field experiment was carried out at Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka (Modhupur Tract, AEZ 28), during the rabi season from November 2009 to March 2010 to investigate the quality of wheat seeds as affected by seed treatment and different seed sources of Bangladesh. Four seed sources considered as treated and untreated seeds consisted of 8 different treatment combinations i.e., Untreated (T_0), Treated with vitavax 200 (T_1) and Farmer seed (S_1), Local trader seed (S_2), BADC seed (S_3) and BARI seed (S_4). So, the treatment combinations were 1. T_0S_1 = No treatment of Farmer seed, 2. T_0S_2 = No treatment of + Local trader seed, 3. T_0S_3 = No treatment of BADC seed, 4. T_0S_4 = No treatment of BARI seed, 5. T_1S_1 = Treated with vitavax 200 of Farmer seed, 6. T_1S_2= Treated with vitavax 200 of Local trader seed, 7. T_1S_3= Treated with vitavax 200 of BADC seed and 8. T_1S_4 = Treated with vitavax 200 of BARI seed.

The effect of different seed sources on purity percentage of wheat seed was found significant. Farmers' seed source was found mixed with 16.62% impurities and inert materials. The higher pure seed was recorded from BARI seed source which was also superior in percent purity to all other treatments. Percent germination both at field and laboratory conditions was recorded significant when treated with Vitavex 200. The highest germination percentage (92.25) at laboratory condition was obtained with seed treatment by Vitavex 200. BARI seed performed the highest percent germination (93.06) at laboratory condition which was statistically superior to all the other three sources of seed. Seeds collected from BADC performed the lowest seedling emergence percentage.

BARI seed performed the highest percent emergence (90.56) at field condition which was statistically superior to all the other three sources of seed.

Plant height of different seed sources showed response to fungicidal treatment with vitavax 200 up to harvest. At 25, 50, 75 DAS and at harvest the higher plant height 23.00, 55.45, 86.40 and 88.73 cm, respectively were recorded from plots where seeds of different sources were sown treated with vitavax 200.

Different seed sources available in Bangladesh illustrated significantly variable plant height at different days after sowing (DAS). The highest plant height (24.10 cm) at 25 DAS was recorded from BARI seed source which was statistically similar to BADC seed source but superior to other two seed sources. The lowest plant height (19.80 cm) was found in farmers' seed source at 50 DAS. On the other hand, unlike to 25 DAS, the highest plant height (59.07 cm) was recorded from farmers' seed source at 50 DAS and was statistically higher from all other seed sources. Similar trends of result were noticed at 75 DAS and at harvest stage of wheat plant. The growth of wheat plants emerged from different seed sources showed rapid growth up to 75 DAS but the growth stunted having reached at harvest stage.

Seven (approx.) leaves was recorded from vitavax 200 treated plots at 25 DAS which were higher than control. It was observed that not treated plot produced higher no. of leaves at 50, 75 DAS and at harvest. The highest number of leaves (48.42) at harvest was enumerated from plots of treated with fungicides seed sources.

Seed collected from BARI Wheat Research Centre produced the maximum number of leaves (7.05) at 25 DAS which was statistically superior to the other three seed sources on same day. Number of leaves at 50, 75 DAS and at harvest was found statistically similar where the highest number of leaves (23.85 at 50 DAS, 49.40 at 75 DAS and 50.25 at harvest) were also recorded from BARI seed source.

Significant variations were observed in shoot, root and total dry weight m^{-2} at 25, 50, 75 DAS and at harvest significant with of fungicide vitavax 200 treated one and also with the different seed sources.

The total dry weight at 75 DAS from BARI seed was 40.33% higher over the farmers' seed source while the later resulted in the lowest dry weight m^{-2}. BARI seed source was found superior to other three seed sources. More over, BARI seeds treated with vitavax 200 gave the highest dry weight at all samplings.

The higher spikes m^{-2} (221. 50) was recorded in treated plots of different seed sources. The highest spikes m^{-2} (237.50) was recorded from BARI seed source, the sequence of which BARI seed> BADC seed> Farmers' seed> Local traders seed but all showed significant variations.

Treated seed sources gave rise to the higher length of spike either with awn (18.42 cm) or without awn (12.12 cm). BARI seed source and BADC seed source gave statistically similar and significantly longer spike with awn (18.42 cm and 17.96 cm, respectively). In case of length of spike without awn BARI seed source produced the longer spike (12.12 cm).

A significant influence of seed treatment and seed sources on 1000 grain weight of wheat was found. The higher weight of thousand seed (42.69 g) was recorded from vitavax 200 treated plots whereas the highest 1000 grain weight of wheat (42.48 g) was recorded from BARI seed source which was statistically different, Treated seeds of BARI and BADC gave higher 1000 grain weight whereas the farmers' seed resulted in lower 1000 grain weight.

Seed sources and treatment with vitavax 200 influenced statistically and significantly the yields of and straw of wheat. Comparatively the higher grain yield (3.95 t ha^{-1}) was given by treated plots. The highest grain yield (4.16 t ha^{-1}) was recorded from BARI seed sources and the lowest grain yield (3.10 t ha^{-1}) was counted in the plots of farmers' seed source treatment. BARI seed source gave 34.19% higher yield over farmers' seed source. It was followed by (3.61 t ha^{-1}) BADC seed source. BARI seeds treated with vitavax 200 showed the highest grain yield (4.47 t ha^{-1}) of wheat. The highest straw yield (4.03 t ha^{-1}) was found from treated plots. The highest straw yield (4.17 t ha^{-1}) was obtained in the BARI seed source which was 25.60% higher over farmers' seed source and local traders' seed source.

The following conclusions can be made based on the results of the present study:

i) Purity and germination percentage:

Different seed sources varied significantly of seed. The highest pure seed was recorded from BARI seed source. Percent germination both at field and laboratory conditions was recorded significant when treated with Vitavex 200 and with the BARI seed source at laboratory (43.06 %) and at field condition (40.56 %).

ii) Qualitative characteristics:

Different seed sources and treatment with vitavax 200 illustrated significant variation on plant height at different DAS. BARI seed source gave rise to the maximum number of leaves. Farmers', Local traders and BADC seed sources showed statistically similar number of leaves $plant^{-1}$.

Yield characteristics like spike m^{-2}, spike length with awn or without awn were found the highest in BARI seed source when treated with vitavax 200 and it was statistically close to BADC seed source. The lowest was recorded from untreated farmers' seed source.

iii) Quantitative characteristics

Shoot, root and total dry weight m^{-2} at 25, 50, 75 DAS and at harvest was found significant with vitavax 200 treatment and also with the seed source. The highest shoot dry weight, root dry weight and total dry weight was recorded in the BARI seed source plots. The second highest shoot, root and total dry weight m^{-2} at 25 DAS, 50, 75 DAS and at harvest was recorded from BADC seed source.

Grain and straw yields of wheat influenced significantly by different seed sources and seed treatment with vitavax 200 fungicide. BARI seed source when treated with vitavax 200 performed superior result in case of yield and other characteristics. It was followed by BADC SEED source either treated or not.

However, to reach a complete and valid recommendation such type of experiment should be conducted in different regions of the country for several years and with different seed treating chemicals and with more seed sources.

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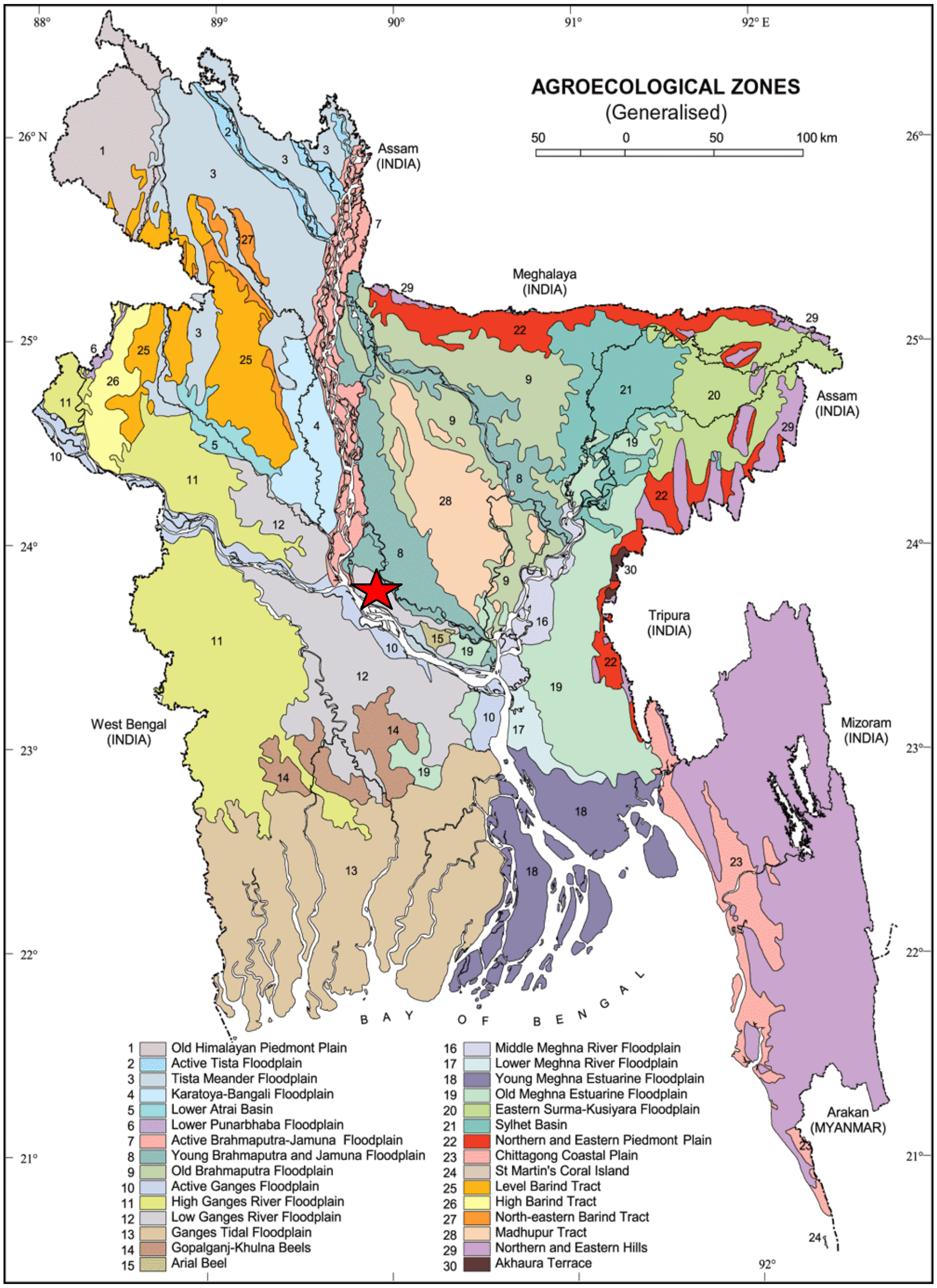
APPENDICES

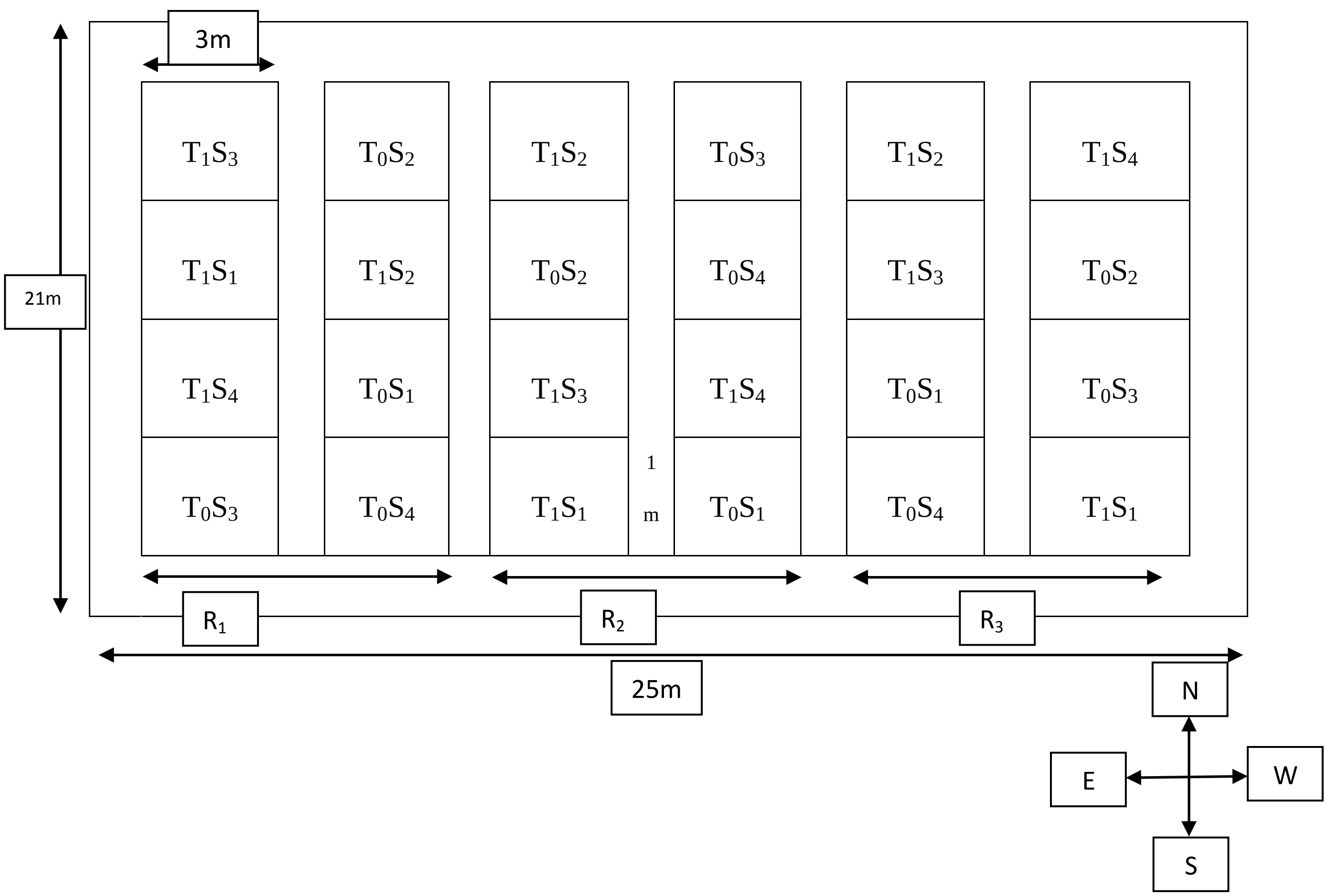
Appendix I. Map showing the experimental site under study



Appendix II. Morphological characteristics of experimental field

Morphological Features	Characteristics
Location	Sher-e- Bangla Agril. University Farm, Dhaka
AEZ No. and name	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Topography	Fairly leveled
Depth of inundation	Above flood level
Drainage condition	Well drained
Land type	High land

Appendix III. Layout of experimental field



Appendix IV. Mean square values for purity, seed weight and germination percentage of different sources

Sources of variation	*df*	Mean square values for purity, seed weight and germination percentage of different sources		
		Purity (%)	1000 Seed weight (g)	Germination (%)
Replication	2	4.020	0.198	100.962
Seed treatment	1	23.864**	-	448.935**
Seed source	3	-	27.219**	85.763
Seed treatment x seed source	3	-	-	13.285
Error	14	3.193	0.546	27.568

* Significant at 5% level
** Significant at 1% level

Appendix V. Mean square values for plant height of wheat at different days after sowing/transplanting

Sources of variation	*df*	Mean square values at different days after sowing/transplanting			
		25	50	75	Harvest
Replication	2	143.990	505.302	631.190	1030.580
Seed treatment	1	27.094*	18.375*	137.090*	181.500*
Seed source	3	24.251*	70.435*	47.026*	31.185*
Seed treatment x seed source	3	0.636	5.221	9.377	10.990
Error	14	1.182	3.949	5.593	12.500

* Significant at 5% level
** Significant at 1% level

Appendix VI. Mean square values for leaves plant^{-1} of wheat at different days after sowing/transplanting

Sources of variation	*df*	Mean square values at different days after sowing/transplanting			
		25	50	75	Harvest
Replication	2	23.805	42.781	926.651	1947.504
Seed treatment	1	1.815**	34.560	591.034**	21.546
Seed source	3	1.705**	47.895*	70.074*	38.222**
Seed treatment x seed source	3	0.245	0.820	0.644	0.524
Error	14	0.174	10.544	13.540	5.510

* Significant at 5% level
** Significant at 1% level

Appendix VIIa. Mean square values for dry matter weight of wheat at different days after sowing/transplanting

Sources of variation	*df*	Mean square values at different days after sowing/transplanting					
		25			50		
		Shoot	Root	Total	Shoot	Root	Total
Replication	2	297.43	206.96	1000	3203	563	6452.479
Seed treatment	1	55.45	26.397*	158.3*	2885*	242.698*	4801.944*
Seed source	3	44.053	27.609*	133.81*	1237*	179.281*	2256.850*
Seed treatment x seed source	3	2.104	1.463	5.431	22.049	8.699	50.796
Error	14	3.994	1.604	10.214	51.464	3.314	44.060

VIIb

Sources of variation	*df*	Mean square values at different days after sowing/transplanting					
		75			Harvest		
		Shoot	Root	Total	Shoot	Root	Total
Replication	2	7895.218	639.031	13026.595	31310.026	419.920	38981.905
Seed treatment	1	18421.608*	219.252*	22660.301*	7763.044*	372.566	11536.937*
Seed source	3	2832.447*	168.832*	4369.430**	13422.117*	110.497*	15915.801*
Seed treatment x seed source	3	375.127	8.995	464.353	1578.951	25.637	1370.585
Error	14	205.119	3.730	212.348	951.028	5.957	901.724

* Significant at 5% level
** Significant at 1% level

Appendix VIII. Summary of analysis of variance for crop characters, yield and yield components of wheat

Sources of variation	*df*	Mean square values			
		1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Replication	2	343.351	3.892	3.277	6.183
Seed treatment	1	79.279**	4.133**	3.466**	13.291
Seed source	3	13.568**	1.279**	1.041**	3.266
Seed treatment x seed source	3	0.935	0.144	0.190	16.829
Error	14	1.732	0.055	0.171	6.804

* Significant at 5% level
** Significant at 1% level