MORPHO-PHYSIOLOGICAL AND REPRODUCTIVE PATTERN OF LATE SOWN WHEAT (*Triticum aestivum* L.)

BY

MUNMUN SHIRIN

Registration No. : 05-01789

A Thesis

Submitted to the Department of Agricultural Botany
Sher-e-Bangla Agricultural University, Dhaka, in partial
fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE
IN

AGRICULTURAL BOTANY

SEMESTER: JANUARY-JUNE, 2013

Approved by:

Prof. Dr. Kamal Uddin Ahamed
Supervisor

Dr. Md. Moinul Haque
Associate Professor
Co-Supervisor

Dr. Mohammad Mahbub Islam
Associate Professor
Chairman
Examination Committee

DEPARTMENT OF AGRICULTURAL BOTANY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207.

Memo No. SAU/Agricultural Botany/

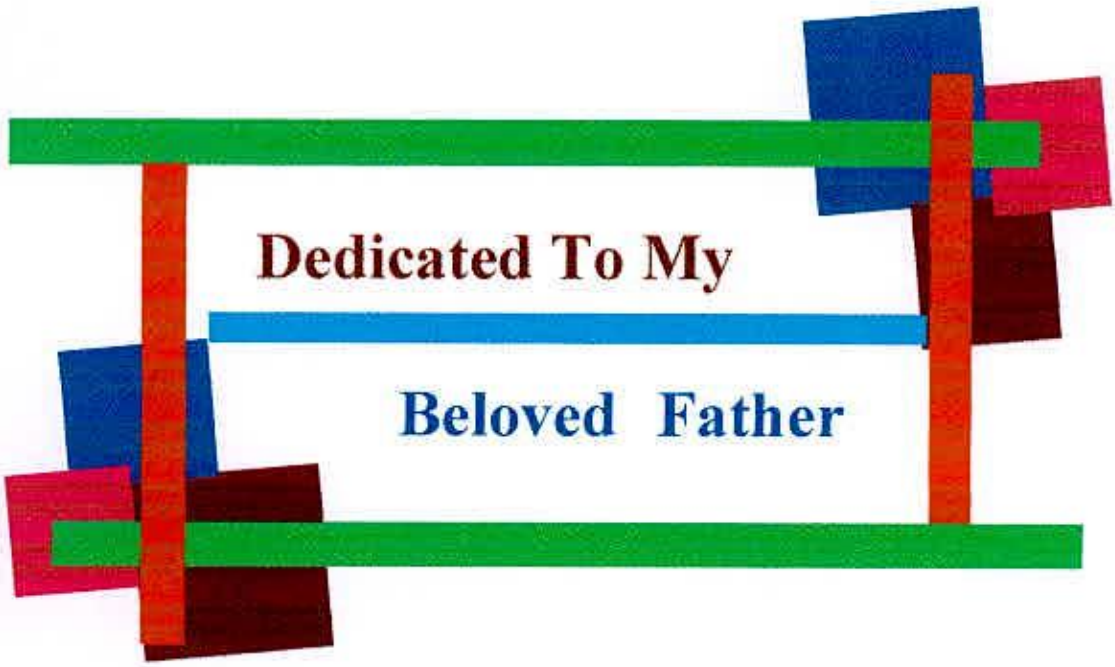
CERTIFICATE

This is to certify that the thesis entitled, **"MORPHO-PHYSIOLOGICAL AND REPRODUCTIVE PATTERN OF LATE SOWN WHEAT (*Triticum aestivum* L.)"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in AGRICULTURAL BOTANY**, embodies the result of a piece of bona fide research work carried out by **MUNMUN SHIRIN, Registration No. 05-01789** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2013
Dhaka, Bangladesh

Prof. Dr. Kamal Uddin Ahamed
Department of Agricultural Botany
Sher-e-Bangla Agricultural University
Supervisor


Dedicated To My
Beloved Father

ACKNOWLEDGEMENTS

All praises to almighty and kind full trust on to "Omnipotent Creator" for His never-ending blessing, the author deems it a great pleasure to express her profound thankfulness to her respected father, who entitled much hardship inspiring for prosecuting her studies, receiving proper education.

The author likes to express her deepest sense of gratitude to her respected supervisor Dr. Kamal Uddin Ahamed, Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh for his scholastic guidance, support, encouragement and valuable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in preparation of the manuscript writing.

The author also expresses her gratefulness to her respected Co-Supervisor, Md. Moinul Haque, Associate Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dkaka for his scholastic guidance, helpful comments and constant inspiration, inestimatable help, valuable suggestions throughout the research work and in preparation of the thesis.

The author expresses her sincere gratitude towards the sincerity of the chairman, Dr. Mohammed Mahbub Islam, Associate professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka for his valuable suggestions and cooperation during the study period. The author also expresses heartfelt thanks to all the teachers of the Department of Agricultural Botany, SAU, for their valuable suggestions, instructions, cordial help and encouragement during the period of the study.

The author expresses her gratefulness to HEQEP (Higher Education Quality Enhancement Project, Under University Grants commission of Bangladesh, Ministry of Education, People's Republic of Bangladesh) authority for providing her with the cost of MS research experiment.

The author expresses her sincere appreciation to her brother, sisters, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study period.

The Author

MORPHO-PHYSIOLOGICAL AND REPRODUCTIVE PATTERN OF LATE SOWN WHEAT (*Triticum aestivum* L.)

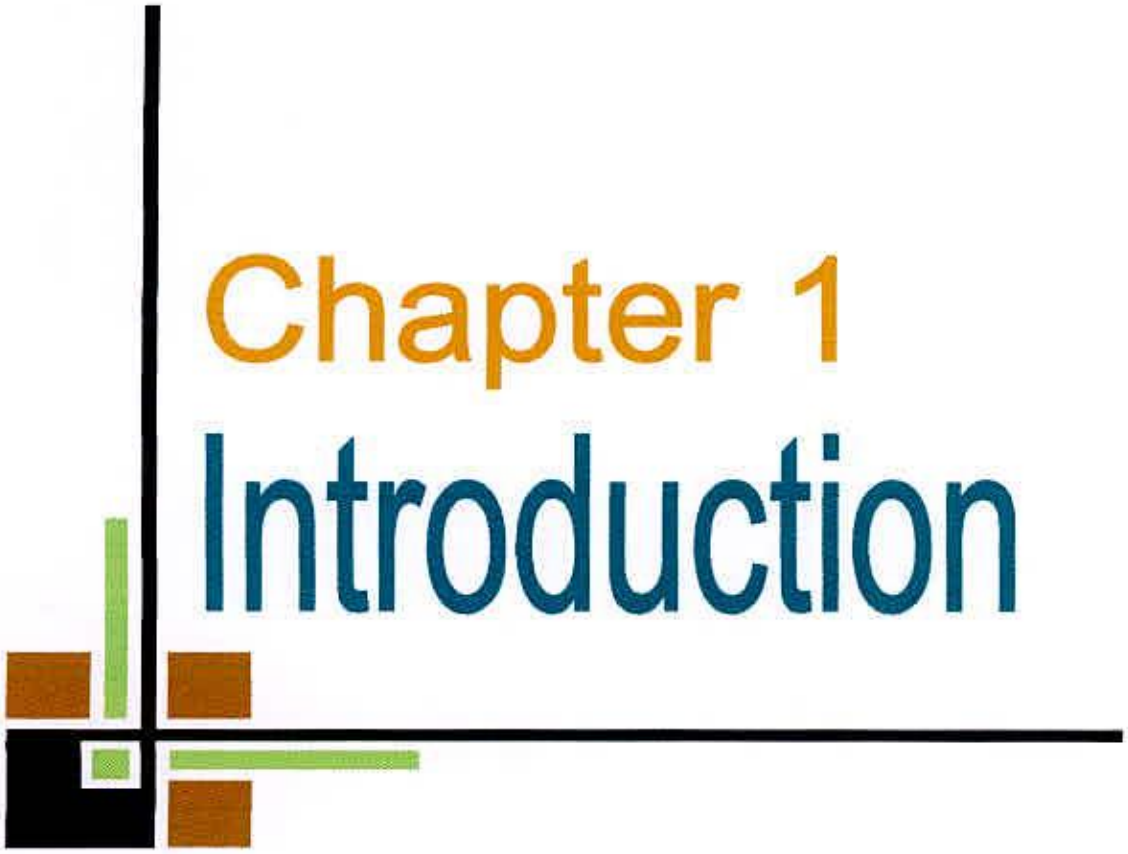
ABSTRACT

The experiment was carried out at experimental field of Sher-e-Bangla Agricultural University, Dhaka during December, 2011 to April 2012 to observe the effect of morpho-physiological and reproductive pattern of late sown wheat (*Triticum aestivum* L.) of some selected wheat varieties. The experiment comprised of two factors, viz, Factors A: sowing dates (2 sowing dates) S_1 (6 December, 2011) and S_2 (30 December, 2011) and factor B: Wheat varieties (7 wheat varieties)- V_1 (BAW-1104), V_2 (Prodip), V_3 (Gourab), V_4(Sufi), V_5 (Pavan-76), V_6(BL-1022), and V_7 (kalyan sona). The experiment was laid out in Randomized complete Block Design (RCBD) with three replications. Data on different yield contributing characters and yield were recorded where significant variation was recorded for sowing dates, wheat varieties, and their interaction effects. At 20DAS, 40DAS, 60DAS and at harvest the longest plant (20.07cm, 5401cm,82.42cm and 80.22cm) respectively was recorded from sowing on S_1 (6 December, 2011) and shortest plant (13.65cm, 29.64cm, 71.13cm and 84.223cm) from sowing on S_2 (30 December, 2011). At 20DAS, 40DAS, 60DAS, and harvest the longest plant (18.69cm, 46.67cm, 83.80cm and 85.14 cm) was recorded from wheat variety V_2 (Prodip) while shortest plant (15.42cm, 34.73cm, 71.93cm, and 79.03) was recorded from wheat variety V_6 (BL-1022), V_5(Pavan-76), V_3 (Gourab), maximum no. of tillers per plant (1.277, 5.833) was recorded from sowing, S_1 (6 December, 2011) and minimum no. of tillers per plant (1.060, 4.895, 6.91) was recorded from S_2 (30 December, 2011). The maximum no. of tillers per plant (1.456, 6.467, 9.17) was recorded from wheat variety V_5 (Pavan-76), minimum no. of tillers per plant (0.979, 4.83, 5.83) was recorded from wheat variety V_2 (Prodip). The longest ear length (14.31cm) was recorded from sowing S_1 (6 December, 2011) and shortest ear length (14.16cm) was recorded from sowing S_2 (30 December, 2011) while the miximum ear length (16.14cm) was recorded from variety V_5 (Pavan-76) and minimum ear length (13.02 cm) was recorded from variety V_2 (Prodip). The maximum no. of fertile florets per ear 27.714 was recorded from sowing S_1 (6 December, 2011); while minimum fertile florets per ear (27.52) was recorded from sowing S_2 (30 December, 2011) and the maximum no. of fertile florets (29) was recorded from the variety V_5 (Pavan-76), while the minimum no. of fertile florets per ear (25.83) was recorded from wheat variety V_2 (Prodip). The maximum no. of sterile florets per ear (26.767) was recorded from sowing S_2 (30 December, 2011) while the minimum sterile florets per ear (26.33) was recorded from sowing S_1 (6 December, 2011) and the maximum no. of sterile florets per ear (27.5) was recorded from variety V_5 (Pavan-76); while the minimum no. of sterile florets per ear (24.667) was recorded from variety V_2 (Prodip). The highest yield (1.42 t ha^{-1}) was recorded from sowing S_1 (6 December, 2011); while the minimum yield (1.35 t ha^{-1}) was recorded from sowing S_2 (30 December, 2011). The highest yield (1.79 t ha^{-1}) was recorded from the variety V_5 (Pavan-76), while the minimum yield (0.97 t ha^{-1}) was recorded from V_2 (Prodip). Among the sowing dates 6 December, 2011(S_1) sowing provided best yield for most of the varieties and the varieties V_5 (Pavan-76) provided better yield than the all other varieties. However, the variety V_5 (Pavan-76) provided comparatively steady and better yield than others varieties. But yield was reduced in case of late sowing (S_2, 30 December) which was true for all the varieties. Among the treatment combinations S_1V_5 produce the highest yield with most of the yield contributing character.

LIST OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES



Chapter 1
Introduction

CHAPTER I

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the leading cereals in the world. It belongs to the family Gramineae. It ranks first both in acreage and production among the grain crop of the world and wheat crop has the large acreage among all the field crops in world. In Bangladesh, it is the second most important cereal crop next to the rice that contributes to national economy by reducing the value of the food requirement of the country (Razzaque *et. al.*, 1992). On account of the peculiar physical and chemical qualities of the gluten of its grain, wheat makes more palaTable and better bread than any other cereal. Wheat grain is rich in food values containing. 12% protein, 1.72% Fat, 69.60% carbohydrate and 27.20% mineral's (BARI, 2006). Besides these, wheat straw is also used as animal feed. Wheat straw is also used as fuel or house building materials of the poor man of Bangladesh; straw is also used as mulch material to improve soil productivity and also used as bedding materials of poultry etc. In addition to this agricultural value, wheat straw is utilized in the manufacture of mattress, straw hats and paper.

Bangladesh is an overpopulated country. Total land area under food production has been decreasing each year to accommodate the different requirements of over increasing population. On the other hand, yield of rice, the major food crop of this country has been declining for the last two decades due to decreasing of soil fertility and crop production. Increasing agricultural production per unit area of land by applying modern cultivation knowledge and technologies is becoming the most important step to cope with the present population growth in Bangladesh. Wheat can be a good supplement of rice and it can play a vital role to feed this vast population. Besides from nutritional point of view, wheat is superior to rice for its higher protein content. In Bangladesh, the position of wheat is second in respect of total area (0.80 million hectares) and production (2.80 million ton) after rice and the average yield of wheat is only 3.44 t ha^{-1} (BBS 2010) and it can be increased up to 6.8 tha^{-1}. So, there is an ample opportunity to increase production of wheat per unit area through

adaptation of modern and improved agronomic practices such as optimum seed rate, timely sowing and judicious application of irrigation, fertilizer and other input's.

Wheat cultivation is simple and its adaptability to varying soils and climatic conditions is superior to that of any other plant. Wheat is grown in every country in Europe and Asia. The greatest wheat growing countries are Russia, the United States, India, France, Canada, Italy and Argentina, with the exception of France and Italy, all the country produce more than they require and they export the surplus to regions which do not grow enough for their needs. The great wheat producing areas of the world are found in the temperate regions between the parallel of latitude 30-60 ^{0}N and 27-40^0 S. Wheat has also a wide altitudinal range. In these countries it is grown from sea level up to about 600 feet. Further south in the Swiss ALPS and the Pyrenees spring wheat's can be grown at an elevation of 4000 feet and in the tropics their cultivation is carried on at an elevation of 8000-1000 feet in Mexico, Colombia and Abyssinia. Humboldt recorded its growth at an altitude of 14000-15000 feet in Tibet.

For the most satisfactory growth and development of grain a cool, moist, growing season followed by bright, dry and warm temperature of 18-19 ^{0}C (about 66 ^{0}F) is necessary. In regard to water supply essential for the wheat crop, an annual rainfall 50-75cm. The best time of sowing of wheat in Bangladesh is the second half of November that needed around 105 days to complete its life cycle.

Yield and quality of seeds and wheat are very low in Bangladesh, however it is not an indication of low yielding potential of this crop, but may be attributed to a numbers of reasons viz unavailability of quality seeds of high yielding genotypes, delayed sowing, fertilizer management, disease and insect infestation and improper irrigation facilities. Late planting of wheat is one of the major reasons of yield reduction, because about 60% of the wheat crop is cultivated at late sowing conditions after harvesting the transplanted *aman* rice (Badaruddin *et. al.*, 1994).

Photosynthesis in wheat is maximum between 22 to 25^0 C and decreases sharply above 35^0 C (Al-Khatib and Paulsen, 1990). But major wheat area under rice – wheat

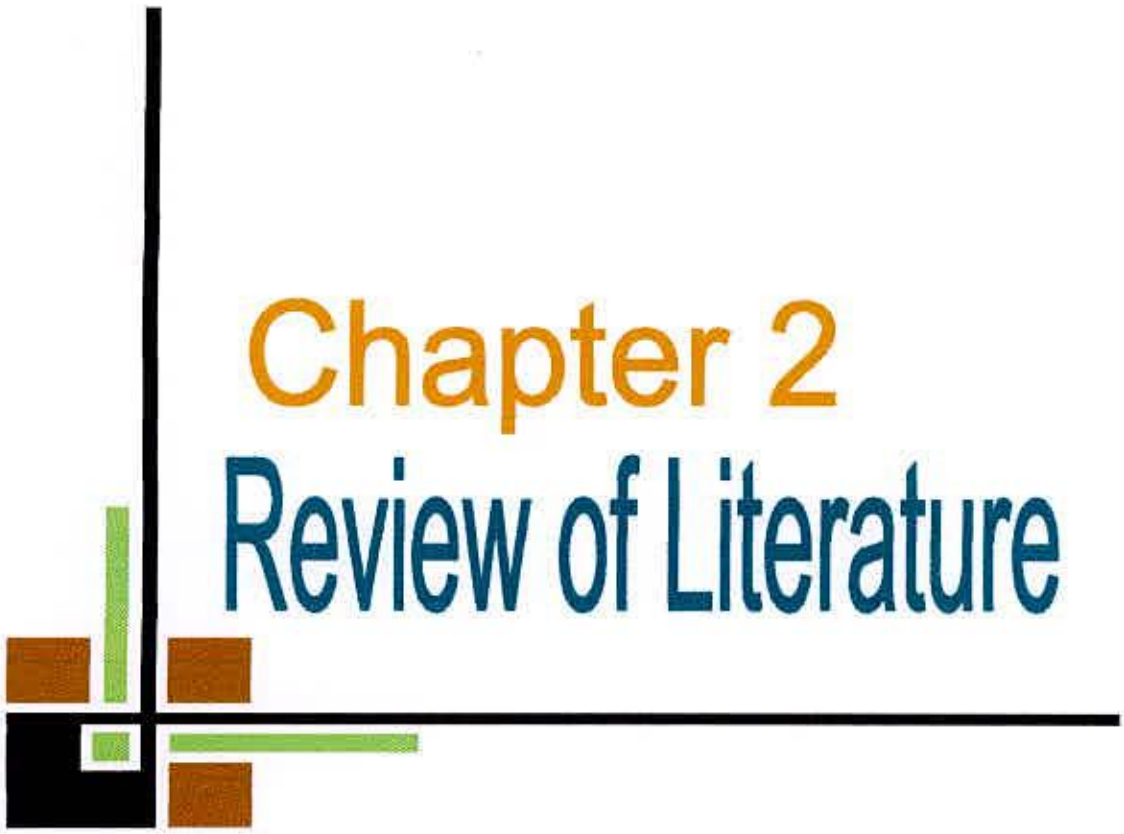
cropping system is late planted (Badruddin *et. al.*, 1994) including Bangladesh late planted wheat plants face a period of high temperature stress during reproductive stages causing reduced kernel number per spike (Bhatt *et. al.*, 1994, Islam *et. al.*, 1993) and reduced kernel weight (Acevedo *et al.*, 1991) and the net effect is the reduction of seed yield (Islam *et. al.*, 1993).

Varieties play an important role in producing higher yield and good quality wheat. Different varieties respond differently to input supply, cultivation practices and the prevailing environment during the growing season. Recently efforts were taken to increase the yield of wheat in Bangladesh by releasing a number of high yielding varieties.

In case of wheat, tiller mortality is greater at high plant density and the number of fertile spikelets per spike along with the yield components are mostly affected by plant density. Decreasing planting density increases the amount of photosynthetic assimilation and provides a canopy which gives increased physiological activities after anthesis, leading to decreased rate of photosynthetic assimilation and increased sink effect on grain yield.

Considering above mentioned situation the present research was undertaken with the following objectives –

1. To find out the reproductive behavior of late sown wheat.
2. To find the morphophysiological response of late sown wheat.
3. To find out the grain filling pattern of late sown wheat.
4. To assess the productivity of late sown wheat.



Chapter 2
Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Wheat is a important cereal crop which- Attracted less concentration in respect of various agronomic aspects especially than high yielding *boro* rice. One of the major reasons of about 60% yield reduction of wheat is due to the cultivation at late sowing condition after the harvesting of late transplanting *aman* rice. Selection of suiTable variety is another problem for wheat cultivation. Very limited research works related to growth, yield and development of wheat variety due to sowing time and genotypes have been carried out and the research work also so for done in Bangladesh is not adequate and conclusive. However, some of the important and information works and research findings related to the sowing time and wheat varieties or genotypes done at home and abroad have been reviewed under the following headings :

2.1 Effect of temperature on growth and yield of wheat

Temperature is one of the major environment factors' affecting grain yield and high temperature is generally considered as detrimental to yield. Hexaploid wheat is of temperate . The optimum temperature for wheat crop is about 20^0 C (Al-khalib and paulsen 1990).

Crop growth resource components like leaves area development (LAD) and tillering are determined during GS_1 phase (emergence to double ridge). Sensitivity to heat stress duress this. Phase is expressed as decreased duration of GS1, reduced LAD, number of leaves and spike bearing tillers (Spiller and Blum 1986). Mean temperature of 16 to 20^0C is favorable for tillering. Duration of GS1 was reduced by about 34d with concomitant loss (82%) of leaves area index and total spike 1 m^2 when mean seasonal temperature changed from 12.2 to 27°C (Acevedo *et. al.,* 1991). High Temperatures accelerate organ production without any increase in net photosynthesis (Begga and Rawson, 1977) resulting in smaller organs.

Chowdhury and ward law (1978) observed that temperature affected the rate of grain growth of sorghum independently of the duration of grain filling. The rate of grain growth increased to its maximum at the threshold mean temperature of 25 ^{0}C, while the rate of development (1/time from a thesis to maturity) continued to increased hierarchy with increasing temperature to 33.5 ^{0}C. Consequently, above 25 ^{0}c, both grain size and grain yield were reduced by high temperature. Kiniry and Musser (1988) similarly observed. In another phytofron study, that grain size and the duration of grain filling were reduced as temperature increased from 22.5 to 30 ^{0}C.

Bhatta *et. al.*, (1994) evaluated the variation of twelve spring wheat genotypes of similar maturity in grain yield, morpho-physiological characters, and the relationship between grain yield and plant traits over two planting periods. Most characters were altered when planting was delayed by one month from the normal seedling date. Declines in grain yield, kernels per spikelet, and 100 grain weight were relatively of small magnitude.

The stage of grain development most sensitive to high temperature was 7-12 days after anthesis (Tashiro and Wardlaw, 1989). The greatest reduction of individual grain weight in response to high temperature occurred of different times for different Spikelet and floret position. High temperature (up to 30/25^{0}C day/night) after anthesis reduced grain yield of wheat by reducing weight per grain, rather then grain number (Wardlaw *et. al.*, 1989)

Productivity of wheat and other temperature falls markedly at high temperatures (Bbullar and Jenner, 1983; Rawson, 1986; Shiler and Blum, 1986; Wardlaw *et. al.*, 1980) Genotypes within species differ in response to high temperature however indicating substantial genetic variability for the trait. Wheat genotypes for instance, incur differential injury from high temperatures during vegetative growth (Shpiler and Blum, 1986), reproductive growth (Bhullar and Jenner, 1983; Wardlaw *et. al.*, 1980), or both periods (Rawson, 1986). Many wheat genotypes can be considered high temperature tolerant (Rawson, 1986).

Grain number per ear is limited by the number of spikelet's per ear and the number of viable florets per spikelet (Tashiro and Warslaw, 1989). In general, number of outer floret grains was produced more by high temperature then the basal floret grains. Irrespective of their growth stage, Number of grains per spike is determined during GS2 phase (double ridge to anthesis). Shpiler and Blum (1986) observed that the cultivars that sustained the highest yield in hot environment were able to maintain the longest duration of GS2and had the highest number of grain per spike. This it the most sensitive stage and its duration is drastically reduced due to heat stress. There is a corresponding decrease in florets/spikelet number per spike and grain number per unit area. Assuming that grain number is solely controlled by prevailing temperature. Accevedo *et. al.*, (1991) observed a linear regression of grain number on the mean temperature from sowing to on anthesis. The regression shows a reduction of 5.5% in grain number for every 1 ^{0}C increase in temperature. Accevedo *et. al.*, (1991) observed detrimental effect of high temperature on grain number and the duration of spike development during GS2 stage.

Al-Khatib and Kaulesn (1990) evaluated the yield performance of 10 wheat varieties or genotypes grown under moderate (22/17 ^{0}C, day/night) and high (32/7 ^{0}C, day/night) temperature. Yield component of 10 genotypes at maturity reacted differently to high temperature. Spike per plant significantly decreased in 3 genotypes and increased in one genotype as the temperature increased where as kernel per spike decreased in four genotypes. Kernel weight decreased significantly in all genotypes, whereas the reduction range was about 10% to 30%. Grain yield means declined from 0.75 from 22/17 to 32/27 ^{0}C, temperature. Harvest Index of all 10 genotypes was affected little by temperature, but individual, genotypes responded very differently.
High temperature, (41 ^{0}c) causes a decrease in the potential photosynthetic rate in both heat resistant and susceptible varetics although the decrease was smaller are recovery ability higher in the resistance variety (Volkova and Koskin, 1984).

Kanani and Jadon (1985) assessed 110 wheat genotypes for ability to withstand high temperature when sown early to fit into a potation with groundnut 18, including Hindi

62, c306, K65, NP846, HJ 72-6, HJ72-50, HJ-65, H1617 and W6357, were superior. These genotypes had higher values for yield and 5 yield related traits when sown early then when sown late, for example, Hindi 62 yielded twice as much with earlier as with late sowing. Correlation studies indicate that flag leaves sheath length, extrusion length, plant height, spike length, kernel per spike and biological yield are important determinants of grain yield in wheat under los Banos condition (Fischer and Maurer 1979).

Fokarb *et. al.*, (1998) observed significant variation among five wheat cultivars in the reduction in grain weight per ear, kernel number and single kernel weight number heat stress. Differences in grain weigh per ear among cultivars were ascribed to variation o variation in the reduction in both kernel number and kernel weight under heat stress. Grain yield of wheat deceases and grain protein increases with the increasing temperature stress duration (Ahmad *et. al.*, 1989)

Islam *et. al.*, (1993) evaluate the performance of the existing (Sonalika) and pleased wheat varieties (Ananda, kanchan, Barket, Akbar, Aghrani) seeded from 1 November to 15 January at 15 day's interval grain yield, spike/m^2, grain/spike and 1000 grain weight were significantly affected by sowing times and variety. The highest grain yield was obtained with variety Kanchan when sown on 15 November which was identical to Akbar and Barkat. Agrani performed better than all other varieties when sown in December and January. Sonalika variety also showed lower yield than other varieties when seeding was done in December and January. Different yield component of these 6 varieties at maturity rested differently to late seeded conditions.

Delay sowing caused significant reduction in grain weight due to higher temperature at grain filling stage. Evans et. al., (1975) and Mudhokar (1981) reported that higher temperature at grain filling stage was one of the important reasons for lower grain yield in wheat crop.

Chirpy (1947) compared grain weight per plant and 1000 grains weight of wheat varieties grouped into eight classes according to flowering time, which ranged from 90-100 to 160-170 days. With delay in flowering, grain developed at increasingly higher temperatures and lower humidity, with the consequence that both 1000 grain with and grain yield per plant diminished progressively. Pat and Butant (1947) also concluded that 1000 grain weight was reduced for late sowing because of the high temperature prevalent at the time of grain ripening. Clrinoy and Sharma (1957, 1958) found that external conditions such as temperature were mainly responsible for under developed or empty grain and not genetic factor as previously held.

Harvest index increased essentially linearly during grain growth and than planted at the maximum value with increasing temperature (Muchow, 1990) in sorghum. The increase in harvest index closely mirrored the increase in grain size. In a series of pot experiments Asana and Saini (1962) compared the 1000 grain weight for two varieties of wheat, cv. c. 281 and N.P. 720. The observed that 13.9 and 17.8% losses in grain weight for cv.c. 281 and N.P. 720 respectively for a 5 ^{0}C rise in the mean temperature and assuming that yield attribute is determined solely by temperature.

2.2 Effect of sowing times

The major non-monitory inputs for enhancing wheat production is optimum time of sowing which is the most important agronomic factor affecting the growth and development of plants. Research works done at home and abroad showed that delay in sowing after the optimum time which coincides with the onset of seasonal rains, consistently reduced yields. Yield of crop is the function of some yield contributing parameters. Sowing time has a remarkable influence on yield of wheat. The yield and yield parameters of wheat varied from location to location due to the prevailing weather situation during pre-anthesis and post-anthesis development. Some of the pertinent literatures regarding effect of sowing time in different location of the world have been presented below-

Plant height

In a trial with cultivar Balaka in Joydepur and Jessore, BARI (1984) reported that the tallest plant (76.83 cm) was obtained at Jessore when sowing was done on 20 November and shortest with 30 December sowing.

The plant height of barely was significantly influenced by date of sowing. In an experiment carried out by Moula (1999) to study the effect of sowing time on growth and development of barley varieties and reported that the tallest plant was recorded by November 25 sowing (111 8 cm) and the shortest plant was recorded by December 25 sowing (73 8 cm) Similar results have also been observed by Farid *et. al.*, (1993).

Chowdhury (2002) conducted an experiment with four sowing times and reported that delay in sowing decreased plant height. At the final harvest highest plant height was observed in November 1 sown plant. But at 60 DAS highest plant height was recorded in December 15 sown plants.

Haider (2002) reported that November 15 sown plants of all cultivars of wheat under each irrigation regimes were found to be taller than December 5 sown wheat plants.

Number of tillers per plant

In a trial with wheat in Joydebpur and Jessore, BARI (1984) reported that the highest number of effective tillers plant^{-1} was obtained by 20 November sowing similar finding were reported by Sarker *et. al.*, (1999).

The associations of yield and effective tiller were also reported by many scientists. Shrivastava *et. al.*, (1998) studied relationship between various traits of wheat. They reported that yield had significant positive correlation with effective tillers per plant. Chowdhury (2002) conducted an experiment with four sowing times and reported that the highest number of average tillers plant^{-1} were produced by November 15 sown wheat plants and the second highest number were produced by November 30 sown plants which was at par with November 1 sown plants. The lowest number of tillers plant^{-1} were produced by December 15 sown plants.

Spike length, grains spike^{-1} and 1000-grain weight

Zhao *et. al.*, (1985) conducted experiments on barley, in China under two different sowing times, viz., October 28 and November 17 in 1982-83 and November 7 and November 27 in 1983-84 They found that with delay in sowing tiller and ear number/10 plants decreased from 64 to 41 in 1982-83 and from 49 to 18 in 1983- 84. The full growth period was shortened with delay in sowing.

Sekhon *et. al.,* (1991) reported that early sowing decreased the number of spikelets spike-^{1}, grains spike^{-1} but increased 1000-grain weight and yield of wheat. They also reported that late sowing decreased 1000 grain weight and yield. Ryu *et. al.*, (1992) concluded that the highest grain weight of barley was reached at 40 days after heading in early and intermediated sowing and 35 days in late sowing.

Eissa *et. al.*, (1994) observed that spikes m^{-2} and grains spike^{-1} were significantly increased while grain weight non-significantly decreased as sowing times was delayed from November to December. Chowdhury (2002) conducted an experiment with four sowing times and reported that spike length, grains spike^{-1} and 1000-grain weight decreased with delay in sowing times from November 15 and the lowest spike length, grains spike^{-1} and 1000-grain weight were recorded in December 15 sown plants.
Haider (2002) reported that early sown plants (November 15) had the highest spike length, grains spike^{-1} and 100-grain weight and late sown plants (December 5) resulted the lowest values of these parameters of wheat.

Zende *et. al.*, (2005) conducted an experiment during the 2002/03 rabi season in Akola, Mahaiashtra, India, to evaluate the effects of sowing time (15 November, 1 December and 15 December) on the growth and yield of durum wheat (*Triticum durum*) and concluded that the growth, yield and yield attributes, except for the spike length, showed significant increases when durum wheat crops were sown on 15 November compared with those sown on 1 December and 15 December.

Yield

Hassain *et. al.*, (1990) observed that maximum grain yield was obtained when the wheat was sown November 20 due to higher number of grains spike^{-1}and the highest 1000-grain weight.

Farid *et. al.*, (1993) conducted an experiment on sowing times in 1987-88 having five sowing times started from November with 15 day intervals with three culrvars of barley viz. Centinella, AP-l-19 and AP-l-20. They observed Noember 5 was found to be the optimum time for AP-1-20 and November 5 to December 5 for Centinella and AP-1-20, respectively. In general, all the cultivars of barley performed better when sown on November 5. In all cases yield was reduced significantly with delayed sowing beyond December 20.

Comy (1995) concluded from two years study in Ireland on malting barley cv. Blenhiem sown on March, early April and late April that the earliest sown spring barley generally gave the highest yield and the best quality grain.

BARI (1997) reported from the study in Jamalpur during the rabi season of 1997- 98 on barley cv. conquest that among the five sowing times viz. November 5, November 20, December5, December 20 and January 5, the grain yield was statistically different among those sowings. The crop sown on December 20 produced the lowest grain yield which was closely followed by that of January 5 sowing. A drastic reduction in grain yield was observed when the crop was sown on December 5 or later.

A field experiment was conducted by Chowdhury (2002) at four sowing times viz. sown at November 1, November 15, November 30 and December 15 and reported that the highest grain yield was recorded in November 15 sown plants and the next highest value was recorded in November 30 sown plants and the lowest yield was recorded in December 15 sown plants.

Haider (2002) conducted experiment in 1998-1999 and 1999-2000 with two sowing times and reported that December 5 sown plants produced significantly higher grain yield in both years for all the irrigation regimes and varieties of wheat and the lowest yield was recorded in December 5 sown plants.

A field experiment was conducted by Ahmed *et. al.*, (2006) at Farming System Research and Development (FSRD) site, Chabbishnagar, Godari, Rajshahi under rainfed condition during rabi seasons of 2001-2002 and 2002-2003 to find out the suiTable variety (BARI Barley-1, BARI Barley-2 and local) and sowing time of barley (30 November, 15 December and 30 December). They concluded that grain and straw yields increased significantly with early sowing (30 November) in all varieties in both the years. The results show that early sowing (30 November) combined with BARI Barley-1gave the highest grain (2.55 t/ha) and straw yield (428 t/ha), where as the lowest grain yield (1.23 t/ha) and straw yield (3 .21 t/ha) was obtained from local variety with delay sowing.

Harvest index

Harvest index (HI) is the ratio of economic yield to biological yield and is a useful index of assessing the extent of phytomass converted into useful economic yield. The economic yield of barley is its grain and biological yield of a crop is the TDM at final harvest (Donald and Hamblim, 1976).Sharma (1993) conducted an experiment with eight spring wheat (*Triticum aestivum*) cultivars and 2 advanced breeding lines in Nepal and showed that due to delayed sowing harvest index was reduced and maximum harvest index of 41.1% occurred with the November 25 sowing.

Samuel *et. al.*, (2000) reported that late sowing condition (6 January, 1997) reduce the harvest index (36.1%) from (4 1.5%) of normal sowing condition (29 November, 1996) in wheat.Ehdaie *et. al.*, (2001) reported that early sowing decreased harvest index. They reported that greater N supply increased shoot biomass by 29%, grain yield by 16% and protein by 5% but decrease harvest index by 10%. Ram *et. al.*, (2004) found that the highest harvest index was obtained in November 20 sown wheat.

From the above review of literature it is evident that sowing time has a significant influence on yield and yield components of wheat. The literature suggests that early or delay sowing other than optimum time reduces the grain yield of wheat which is directly related with the temperature of the growing period of the crop. Reduction in grain yield is mainly attributed by the reduced number of spike plant^{-1}, grains spike^{-1} and thousand grain weights due to curtailment of period for development of these parameters.

2.3 Effect of genotypes

Maiksteniene *et. al.,* (2006) carried out a field experiment at the Lithuanian institute of Agriculture's Joniskelis Experimental Station during 2004-2005 to estimate the changes in productivity and quality indicators of winter wheat varieties. The tests involved: Ada and Bussard (with very good food qualities), Lars and Tauras (with satisfactory food qualities) varieties. The higher grain yield was produced in varieties with satisfactory food qualities compared with those with very good food qualities. The highest contents of protein for grain quality improvement at ripening stage without urea solution application were accumulated by the varieties.

Hossain (2006) reported that number of tiller plant^{-1} increased with increased number of irrigation. The highest effective tiller plant^{-1} was observed under three irrigations (irrigation at 25 DAS + 50 DAS + 75 DAS) which was statistically similar to that of two irrigations (irrigation at 25 DAS + 50 DAS) in contrast, the lowest number of effective tiller plant^{-1} was recorded rained plants.

Sulewska (2004) carried out an experiment with 22 wheat genotypes for comparing vegetation period, plant height, number of stems and spikes, yield per spike. He noticed a greater variability of plant and spike productivity and of other morphological characters due to variety. He also reported that the variety Waggershauser, Hohenh, Weisser, Kolben gave the highest economic value among the tested genotypes.

Jalleta (2004) conducted an experiment in farmer's level with a number of improved bread wheat varieties for production in the different climatic zones. Farmer identified

earliness, yield and quality as the main criteria for adaptation of wheat varieties and they found that the variety HAR-710 gave 2.56 t ha^{-1} and PAVON-76 gave 2.49 t ha^{-1}, grain yield.

BARI (2003) of Bangladesh conducted an experiment in the Wheat Research Centre Nashipur, Dinajpur to examine the performance of genotypes among various tillage operations and to understand the effects of interaction between genotypes and tillage operations. Two cultivation methods were applied in the main plot and 10 wheat genotypes (Kanchan, Gourav, Shatabdi, Sourav, BAW 1008, BAW 1006, BAW 1004, BAW 969, BAW 968 and BAW 966) were tested in the sub plots. The genotypes showed a wide range of variation for yield and related characters. Under bed condition, all the genotypes significantly produced higher grain yield except Gourav and Sourav. Variety Shatabdi produced maximum grain $spike^{-1}$ and 1000 grain weight.

BARI (2003) tested performance of different varieties of wheat and found Shatabdi produced the highest yield (2.72 t ha^{-1}) followed by Gourav (2.66 t ha^{-1}). The lowest yield was produced by Kanchan (2.52 t ha^{-1}).

Chowdhury (2002) conducted an experiment with four sowing times and reported that delay in sowing decreased plant height. At the final harvest highest plant height was observed in November 1 sown plant. But at 60 DAS highest plant height was recorded in December in 15 sown plants.

Haider (2002) reported that November 15 sown plants of all cultivars of wheat under each irrigation regimes were found to be taller than December 5 sown wheat plants.

Irrigation during the stage of grain filling caused the kernel weight to be as high as under three irrigations. The lowest value corresponded to the treatment with irrigation during grain filling and that under rainfed conditions. Similar finding were reported by Sarker *et. al.*, (1999).

Bazza et. al., (1999) conducted two experiments in Morocco on wheat and sugar beet with irrigation management practices through water-deficit irrigation. In the case of wheat, high water deficit occurred during the early stages. Irrigation during these

stages was the most beneficial for the crop. One water application during the tillering stage allowed the yield to be lower only than that of the treatment with three irrigations.

In a field trial on barley in India, Uppal *et. al.*, (1998) observed that two irrigations both at active tillering and heading stage produced higher yield than that of one irrigation at active tillering stage.

Litvinrnko *et. al.*, (1997) produced winter wheat with high grain quality for bread making in Southern Ukrame. Wheat breeding was started more than 80 years ago. Over this time, seven wheat varieties were selected where yield potential increased from 2.73 to 6.74 t ha^{-1}. Rahman (1997) reported that irrigated plants had always greater TDM $plant^{-1}$ than the rainfed plants.

BARI (1997) reported from the study in Jamalpur during the rabi season of 1996-97 on barley cv. conquest that among the five sowing times viz. November 5, November 20, December5, December 20 and January 5, the grain yield was statistically different among those sowings The crop sown on December 20 produced the lowest grain yield which was closely followed by that of January 5 sowing. A drastic reduction in grain yield was observed when the crop was sown on December 5 or later.

Samson *et. al.*, (1995) reported that among the different varieties the significant highest grain yield (3.5 t ha^{-1}) was produced by the variety Sowghat which was closely followed by the variety BAW-748. Other four varieties namely Sonalika, CB-84, Kanchan and Seri-82 yielded 2.70, 2.83, 3.08 and 3.15 t ha^{-1}, respectively. Gaffer (1995) reported that increased in TDM due to increased number of irrigation in millet.

Arbinda *et. al.*, (1994) observed that the grain yield was significantly affected by different varieties in Bangladesh. The genotypes CB-15 produced higher grain yield (3.7 t ha^{-1}) that was attributed to more number of spikes m^{-2} and grains $spike^{-1}$.

In varietal demonstration at different districts of Bangladesh BARI (1993) reported that mean yield of Kanchan, Akbar, Agrani and Sonalika were 3.59, 3.29, 3.12 and 2.81 t ha^{-1}, respectively. Variety Kanchan, Akbar, Aghrani showed 28, 17 and 12% higher grain yield over check variety Sonalika.

Islam *et. al.*, (1993) evaluate the performance of the existing (Sonalika) and released wheat varieties (Ananda, Kanchan, Barkat, Akbar and Aghrani) seeded from 1 November to 15 January at 15 days interval. Grain yield, spike/m^2, grain/spike and 1000-grain weight were significantly affected by sowing times and variety. The highest grain yield was obtained with variety Kanchan when sown on 15 November which was identical to Akbar and Barkat. Ahgrani performed better than all other varieties when sown in December and January. Sonalika variety also showed lower yield than the other varieties when seeding was done in December and January. Different yield component of these 6 varieties varied significantly under this experimental condition.

Torofder *el. al.*, (1993) observed that increase in total dry matter (TDM) production in barley was noticed clearly up to three irrigations as compare to one or two irrigation. They also found that increased in TDM due to irrigation compared to control (no irrigation).

Sharma (1993) conducted an experiment with eight spring wheat (*Triticum aestivum*) cultivars and 2 advanced breeding lines in Nepal and showed that due to delayed sowing harvest index was reduced and maximum harvest index of 41.1% occurred with the November 25 sowing.

The introduction of supplemental irrigarion to winter grown cereals can potentially stabilize and increase yields, as well as increasing water use efficiency received both from rainfall and from irrigation (Oweis *et. al.*, 1992).

Wheat variety HD 2428 and Kalyansona were compared by Shukia *et. al.*, (1992) for adaptability under pot culture by exposure to high temperature treatments (8°C above) ambient in week 1 though 4 after anthesis. Dry matter accumulation of rain in the top, middle and bottom spikelet's of the spike, at 7-grain locations was recorded in weeks 2 and 3. The treatments adversely affect grain weight for HD2428 at all 3 spikelet positions, with up to 35% reduction in the first 5 grain location. Kalyansona was only marginally affected this indicates that the characteristic adaptability of Kalyansona to different agro-climatic regions is associated with the tolerance of physiologically old grains to higher temperature.

Supply of irrigation water or moistures has dramatic effects on growth, development and yield of different wheat genotypes. Water deficit at various phases of crop growth has direct effect on crop yield. The reduction in growth of wheat was the result of water deficit. Crop yields under dry land condition are related to seasonal rainfall, water use efficiency can be substantially improved by crop management practices (Hams *et. al.*, 1991) Acevedo *et. al.*, (1991) observed detrimental effects of high temperature on grain number and the duration of spike development during GS2 stage.

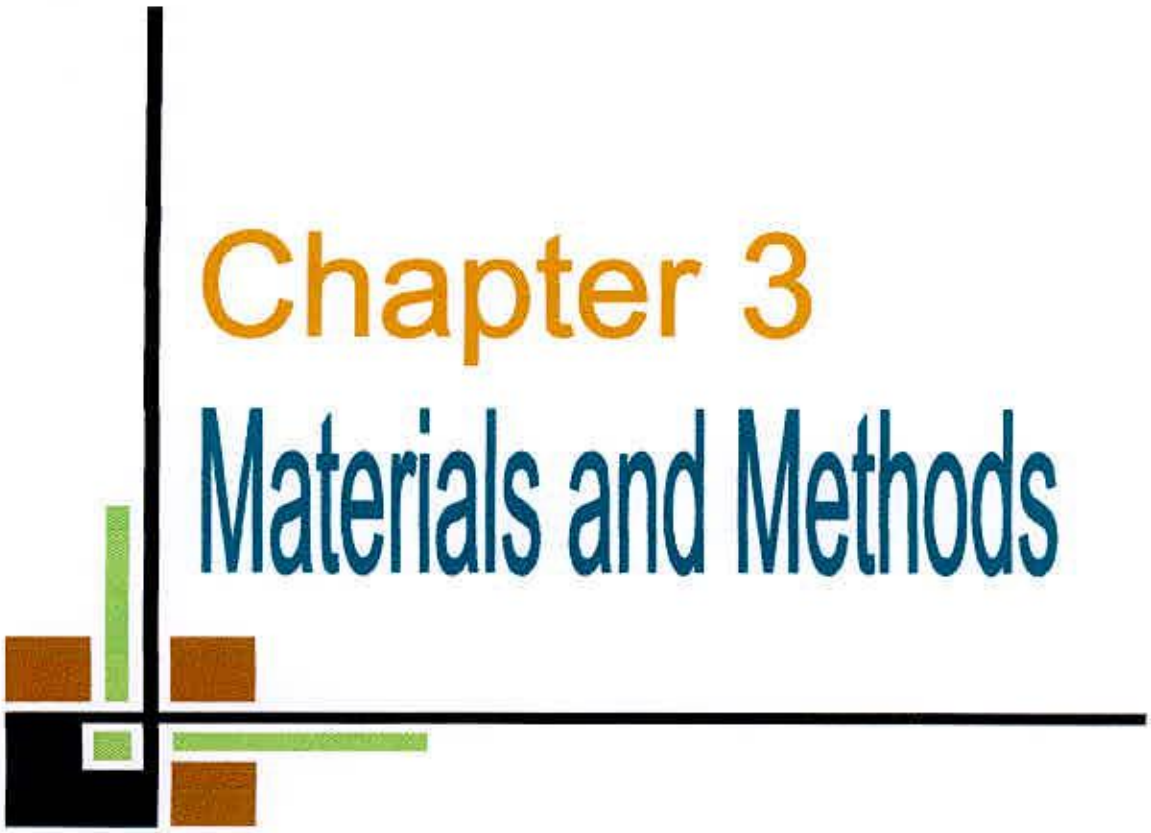
Al-Khatib and Paulesn (1990) evaluated the yield performance of 10 wheat genotypes grown under moderate (22/17°C, day/night) and high (32/7°C, day/night) temperature. Yield component of 10 genotypes at maturity reacted differently to high temperature. Spike per plant significantly decreased in 3 genotypes and increased in one genotype as the temperature increased where as kernel per spike decreased in four genotypes. Kernel weight decreased significantly in all genotypes, whereas the reduction range was about 10% to 30%. Grain yield means declined from 0.75 to 0.58 g per tiller or 23% from 22/17 to 32/27°C, temperature. Yields were constant for 3 genotypes and decreased> 40% for three genotypes. Harvest index of all 10 genotypes was affected little by temperature, but individual, but individual genotypes responded very differently.

Hossain *et. al.*, (1990) observed that maximum grain yield was obtained when the wheat was sown November 20 due to higher number of grains spike^{-1} and the best 1000-grain weight.

Grain number per ear is limited by the number of spikelet's per ear can the number of viable florets per spikelet (Tashiro and Warsiaw, 1989). In general, number of outer floret grains was reduced more by high temperature than the basal floret irrespective of their growth stage. Number of grains per spike is determined during GS2 phase (double ridge to anthesis).

Jhala and Jadon (1989) studied that grain growth rate (mg/spike per day) from the 1st to the 8th week after anthesis (WAA) in 15 wheat cultivars sown on 15 November (optimum date) or 30 November. There were significant differences among cultivars for grain growth rate especially during 1st W AA. Grain growth rate was the highest in the 3 and 2nd W AA for crop sown on 15 November and 3 November respectively. Grain growth rate was higher in crops sown on 15 1ovember than in those sown on 30 November. cv. Look 1, WH 147, 11-1784, Kalyansana and HJ 74-27 had initial higher grain growth rate and could be used for breeding cultivars suiTable for late sown conditions.

In a trial with cultivar Balaka in Joydepur and Jessore, BARI (1984) reported that the tallest plant (76.83 cm) was obtained at Jessore when sowing was done on 20 November and shortest with 30 December sowing.



Chapter 3
Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at Sher-e-Bangla Agricultural University experimental field, Sher-e-Bangla Nagar, Dhaka-1207 from December, 2011 to May, 2012 to observe reproductive and grain filling pattern of late sown wheat. The details of the materials and methods followed to conduct the study has been presented below under the following headings:

3.1. Description of experimental site

3.1.1. Location:

The experimental site is under the agro ecological zone of Modhupur Tract, AEZ-28, situated at $23^0$4' N latitude and $88^0$22' E longitude with an elevation of 8.2 meter from sea level.

3.1.2. Climate:

The geographical location of the experimental site was under the subtropical region, characterized by three distinct seasons, winter season from November to February and the pre monsoon period or hot season from March to April and monsoon period from May to October (Edris *et. al.*, 1979). Details of the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of experiment was collected from the weather station in Bangladesh at Sher-e-Bangla Nagar, presented in Appendix I.

3.1.3. Soil:

The soil belongs to "The Modhupur Tract", AEZ-28 (FAO, 1988). Top Soil was silty clay in texture, olive- gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and had organic carbon 0.45%. The experimental area was flat having available irrigation and drainage system and above flood level. The selected plot was medium high land. The details have been presented in Appendix II.

3.2 Experimental details

1. Name of crop: Wheat (*Triticum aestivum* L:)
2. No of Variety: 7
3. Experimental design: Randomized Complete Block Design (RCBD)
4. Sowing time (Factor A)
   a. First Sowing time (Sowing on 6 December, 2011) - S_1
   b. Second Sowing time (Sowing on 30 December, 2011) - S_2
5. Names of Varieties/genotypes (Factor B)

   V_1= BAW-1104

   V_2= Prodip

   V_3= Gourab

   V_4= Sufi

   V_5= Pavan-76

   V_6= BL-1022

   V_7= Kalyan Sona

6. Treatments combinations:14

S_1V_1	S_2V_1
S_1V_2	S_2V_2
S_1V_3	S_2V_3
S_1V_4	S_2V_4
S_1V_5	S_2V_5
S_1V_6	S_2V_6
S_1V_7	S_2V_7

7. (a) Plots for sowing :

(i) Plot size=2m x 1.5m

(ii) Each plot contains 8 lines of plants

(iii) Each line contains about 30 plants

(iv) Each plot contains about 240 plants

(v) Central $1m^2$ area of each plot contains about 80 plants

(vi) Row to row distance = 25 cm

(vii)Plant to plant distance=5 cm

8. No. of replication: 3 replication contain 42 plots

3.3. Growing of crops:

3.3.1. Seed collection:

The seed of different wheat genotypes and varieties were collected from Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Wheat Research Centre (WRC).

3.3.2. Preparation of main field:

The piece of land selected for the experiment was opened in the last week of November, 2011 with a power tiller, and was exposed to the sun for a week after which the land was harrowed, ploughed and cross ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and finally a desirable tilth of soil was obtained for sowing of seeds.

3.3.3. Application of fertilizers and manure:

The fertilizer N.P.K and S in the form of Urea, TSP, MP and Gypsum respectively were applied. The entire amount of TSP, MP Gypsum and 2/3 rd of Urea were applied during final land preparation and rest of Urea were top dressed after first irrigation (BARI, 2006). The dose and method of application of fertilizers are presented below:

Doses and method of application of fertilizer in wheat field

Fertilizers	Doses (kg ha^{-1})	Basal % of application	1st installment % of application
Urea	220	66.66	33.33
TSP	180	100	--
MP	50	100	--
Gypsum	120	100	--
Cow dung	10000	100	--

Source: Krishi Projukti Hatboi, BARI, Joydebpur, Gazipur, 2006.

3.3.4. After care:

After the germination of seeds, various intercultural operations such as thinning, gap filling, irrigation, drainage, weeding, top dressing of fertilizers and plant protection

measures were accomplished for better growth and development of wheat seedling as per recommendation of BARI (2006).

(i) Irrigation and drainage:

The flood irrigation at early stage of crop growth, tillering, stage and panicle initiation or ear emergence stage were provided. Proper drainage system was also developed for draining out excess water.

(ii) Thinning and gap filling:

About after 10 days of sowing thinning and gap filling were done.

(iii) Staking and tagging: Staking and tagging of selected seedlings were done. Mulching was practiced for 2 to 3 times.

(iv) Weeding:

Weeding was done to keep the plot free from weeds which ultimately ensured better growth and development of wheat seedlings. The newly emerged weeds were uprooted carefully at tillering (30 DAS) and booting and ear emergence stage (55 DAS) manually.

(v) Plant protection:

The crop was attacked by different kinds of infects during growing period. Diazinon 60ml/20L of water was applied on 30 January, 2012 and Sumithion 40 ml/20L of water was applied on 25 February, 2012 as plant protection measure.

3.4. Harvesting, threshing and cleaning:

The crop was harvested manually depending upon the maturity of plant from each plot starting from the first week of April, 2012. The harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken during threshing and cleaning period of wheat grain. Fresh weight of wheat grain and straw were recorded plot wise from 1 m^2 area. The grains were cleaned and weighed. The weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of wheat grain and straw per m^2 were recorded and converted to t ha^{-1}.

3.5. Data Collection:

3.5.1. Emergence of Seedlings:

The emergence of wheat seedlings in the experimental plots was recorded on the basis of visibility of emergence of wheat seedlings and expressed days to starting of emergence. Days to 50% and days to 100% emergence of seedlings were expressed in days and that were estimated by observing absolute visibility of seedlings of the experimental plots.

3.5.2. Plant height (cm):

The height of plant was recorded in centimeter (cm) at 20, 40 and 60 DAS (Days after Sowing) and at harvest. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot those were tagged earlier. The height was measured from the ground level to the tip of the plant by a meter scale.

3.5.3. Tillers per plant:

The number of tillers per plant was recorded at the time of 20, 40 and 60 DAS (Days after Sowing). Data were recorded by counting tillers from each plant and as the average of 5 plants selected at random from the inner rows of each plot.

3.5.4. Number of leaves per plant:

Number of leaves per plant was recorded at 20, 40 and 60 DAS (Days after Sowing) and at harvest. The total number of leaves per plant was found as the number of leaves from 5 randomly selected plants from each plot and average value was recorded.

3.5.5. Days to starting of booting:

Days to starting of booting was recorded by calculating the number of days from sowing to starting of booting by keen observation of the experimental plots.

3.5.6. SPAD- Reading from flag leaf:

SPAD- reading was recorded from flag leaf by the help of SPAD Meter at 6 days interval about 6 times by keen observation of the experimental plots during experimental period to observe the amount of chlorophyll present in the leaves.

3.5.7. Days to ear emergence:

Days required to emergence of ear was recorded by calculating the number of days from sowing to starting of ear emergence by keen observation of experimental plots during experimental period.

3.5.8. Length of flag leaves:

Length of flag leaves was measured as the average of 5 plants selected at random from the inner rows of each plot. The length was the inner row of each plot. The length was measured from base to tip of flag leaves.

3.5.9. Breadth of flag leaf:

Breadth of flag leaves was measured as average of 5 plants selected at random from the inner rows of each plot. The breadth was measured from the base to tip of flag leaves and the average of 3 measurements was calculated.

3.5.10. Leaf area of flag leaf:

The area per flag leaf was determined by multiplying the minimum flag leaf length with maximum breadth and with correction factor 0.75.

3.5.11. Days to anthesis:

Days to starting of anthesis was recorded by calculating the number of days from sowing to starting of anthesis by keen observation of experimental plot.

3.5.12. Fresh weight (g) of spike :

Fresh weight (g) of spike was weighted at 6 days interval taking 3 spikes from each experimental plot. Weight starting from first days after fertilization up to 31 days after fertilization at 6 days interval was recorded.

3.5.13.Days to maturity:

Days to starting of maturity was recorded by calculating the number of days from sowing to starting of maturity as spike become brown color by keen observation of experimental plots.

3.5.14. Days to ripening:

Days to starting of ripening was recorded by calculating the number of days from sowing to starting of repining as spikes become yellowish to yellow color by keen observation of experimental plots.

3.5.15. Days to harvesting:

Days to starting of harvesting was recorded by calculating the number of days from sowing to starting of harvesting time as spike become faded yellow color by keen observation of experimental plots.

3.5.16. Effective tillers per plant :

The total number of effective tillers per plant was counted as the number of ear bearing tillers per plant. Data on effective tillers per plant were counted from 10 selected plants at harvest and average value was recorded.

3.5.17. Non effective tillers per plant :

The total number of non effective tillers per plant was counted as the number of tillers per plant without spike. Data on non effective tillers per plant were counted from 10 selected plants at harvest and average value was recorded.

3.5.18. Total tillers per plant:

Total number of tillers per plant was recorded by adding effective and sterile tillers per plant. Data on total tillers per plant were counted from 10 selected plants at harvest and average value was recorded.

3.5.19. Fertile spikes per plant :

Total number of fertile spikes per plant was counted as if any spikelet of a spike are grained the spike was called fertile spike. Data on fertile spike per plant was counted from 10 selected plants at harvest and average value was recorded.

3.5.20. Sterile spikes per plant:

Total number of sterile spike per plant was counted as if all spikelets of a spike are grainless then that spike was called sterile spike. Data on sterile spike per plant was counted from 10 selected plants at harvest and average value was recorded.

3.5.21.Total number of spikes per plant:

Total number of spikes per plant was counted through counting both total fertile and sterile spikes from 10 selected plants at harvest and average value was recorded.

3.5.22. Ear length: (cm)

The length of ear was measured with a meter scale from selected spikes (both awned and awnless), and average value was recorded.

3.5.23. Spikelets per spike:

Total number of spikelets per spike was counted as the number of spikelets from spike of 10 selected plants from each plot and average value was recorded.

3.5.24. Ear or spike weight (g):

The weight of ear was weighted with sensitive balance from selected spikes and average value was recorded.

3.5.25. Stem weight (g):

Stem weight was measured with sensitive balance from 5 selected plants from each plot and average value was recorded.

3.5.26. Root weight (g):

Root weight (g) was weighted with sensitive balance from 5 selected plants from each experimental plot and average value was recorded.

3.5.27. Fertile florets per spikelet:

The number of fertile florets per spikelet was counted as the number of fertile florets was counted from each spikelet of some selected spikes and average value was recorded.

3.5.28. Number of sterile florets per spikelet:

The number of sterile florets per spikelet was counted as number of sterile florets from each spikelet of some selected spikes and average value was recorded.

3.5.29. Number of grains per spikelet:

The number of grains per spikelet was counted through counting fertile florets (fertile florets contain grain) from spikelet of some selected spike and average value was recorded.

3.5.30. Number of grains per plant :

Number of grains per plant was counted as calculating counted number of grains from each spike of a plant and average value was recorded.

3.5.31. Weight of grains per spikelet :

Weight of grain per spikelet was recorded as first fertile floret selected and grains separated then separated grains were weighted with sensitive balance from each fertile spikelet of some selected spikes. Thus weight of grains per spikelet and spike were taken and average value was recorded.

3.5.32. 1000(thousand) grain weight:

One thousand grain were counted randomly from the total cleaned harvested seeds of each individual plot and then weighed with sensitive balance and recorded.

3.5.33. Grain weight per $1m^2$ area of each plot:

Grains obtained from each unit plot were sun dried and weighed carefully. The dry weight of grains of central $1m^2$ was taken and converted this into t ha^{-1}.

3.5.34. Grain weight t ha^{-1} :

Grains obtained from 1 m^2 were converted into t ha^{-1}.

3.5.35. Straw yield per m^2:

Straw obtained from $1m^2$ from each unit plot were sun dried and weighed carefully. The dry weight of straw of central $1m^2$ of each experimental unit plot was used to record straw yield per m^2 and was converted this into t ha^{-1}.

3.5.36. Straw weight t ha^{-1}:

Straw obtained from 1 m^2 were converted into t ha^{-1}.

3.5.37. Biological yield:

Grain yield and straw yield together were regarded as biological yield of wheat. The biological yield was calculated with the following formula:

Biological yield = Grain yield + straw yield.

3.5.38. Harvest Index (%):

Harvest index was calculated from per hectare grain and straw yield that were obtained from each unit plot and expressed in percentage.

$$\text{Harvest Index (HI)} = \frac{\text{Economic yield (grain weight)}}{\text{Biological yield (total dry weight)}} \times 100$$

3.6. Statistical Analysis:

The data obtained for different characters were statistically analyzed to observe the significance difference among the sowing times and wheat genotypes and their interaction. The mean values of all the characters were calculated and analysis of variance was performed. The significance difference among the treatment means was estimated by the Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

Chapter 4
Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to study the effect of sowing times on reproductive and grain filling pattern of some selected wheat genotypes sown on late season. Data on different parameters were recorded. The analysis of variance (ANOVA) of the data on different parameters are presented in appendix (III-XIII). The results have been presented with the help of tables and possible interpretations were given under the following headings:

4.1 Plant height of different wheat genotypes sown at different times:

Statistically significant variation was observed in terms of plant height at 20 DAS 40 DAS, 60 DAS and at harvest for different sowing times (Table -1). The highest plant height was recorded from S_1 (6 December, 2011) sowing those were 20.07 cm at 20 DAS, 54.01 cm at 40 DAS 82.42 cm at 60 DAS and 84.22 cm at harvest. The shortest plant height was recorded from S_2 (30 December, 2011) sowing those were 13.65cm at 20 DAS and 80.22 cm at harvest respectively.

Statistically significant variation was observed in terms of plant height at 20 DAS, 40 DAS and at harvest for different wheat varieties. The highest or the longest plant height were recorded from wheat variety V_2 (Prodip) those were 18.69 cm. at 20 DAS, 46.77 cm at 40 DAS, 83.80 cm at 60 DAS and 85.14 cm at harvest respectively. While the shortest plant height was recorded from V_4 (Sufi) those were 15.92 cm at DAS, which was identical to V_6 (BL-IO22, 15.42 cm at 20 DAS, 34.37cm at 40 DAS and from V_5 (Pavan-76) that was 71.93cm at 60 DAS and from V_7 (Kalyan sona) that was 79.03 cm at harvest which was identical to V_4 (Sufi), that was 79.46 cm respectively (Table-2) different genotypes attained different plant height at different DAS on the basis of their varietal characters.

Statistically significant variation was observed for interaction between sowing times and different wheat varieties. The longest plant height was recorded from S_2V_7

(Kalyan sona) that was 22.06 cm at 20 DAS, from S_2V_1 (BAW-1104) that was 59.3cm at 40 DAS, from S_2V_2 (Prodip) that was 89.13 cm at 60 DAS and from S_1V_1 (BAW-1104) that was 89.91cm at harvest which was identical to S_1V_2 (Prodip) that was 89.41 cm at harvest. While the shortest plant height was recorded from S_1V_6 (BL-1022) that was 12 cm at 20 DAS, 28.73 cm at 40 DAS, 66.27 cm at 60 DAS and S_2V_3 (Gourab) that was 76.67 cm at harvest which was identical to S_2V_4 (Sufi) that was 77.83cm at harvest (Table -3) as treatment combination.

Table 01. Effect of sowing times on plant height of different wheat varieties at different DAS

Sowing Times	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	Harvest
S_1 (6 December, 2011)	20.07	54.01	82.42	84.22
S_2 (30 December, 2011)	13.65	29.64	71.13	80.22
$LSD_{0.05}$	4.21	10.32	6.13	3.14
CV%	7.94	10.42	14.8	9.18

Table 02. Effect of different wheat varieties on plant height of at different days after sowing

Varieties/Genotypes	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	Harvest
V_1 (BAW-1104)	16.87	44.22	81.60	85.74
V_2 (Prodip)	18.69	46.77	83.80	85.14
V_3 (Gourab)	17.69	41.50	73.73	79.03
V_4 (Sufi)	15.92	44.37	74.37	79.47
V_5 (Pavana-76)	16.07	43.13	71.93	82.83
V_6 (BL-1022)	15.42	34.73	73.23	84.32
V_7 (Kalyan sona)	17.36	38.03	78.77	79.04
$LSD_{0.05}$	2.64	4.66	4.70	7.76
CV%	7.94	10.42	14.8	9.18

Table 3. Interaction effect of different sowing times and different wheat varieties on the plant height at different DAS

Treatment combinations	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	Harvest
S_1V_1	19.84	59.3	87.8	82.83
S_1V_2	21.41	63.2	89.13	84.32
S_1V_3	21.35	53.93	78.4	84.22
S_1V_4	18.21	57.4	79.53	80.22
S_1V_5	18.81	56.53	76.47	82.83
S_1V_6	18.85	40.73	80.2	84.32
S_1V_7	22.06	46.93	85.4	79.04
S_2V_1	15.97	29.13	75.4	89.917
S_2V_2	13.9	30.33	78.47	84.22
S_2V_3	14.03	29.07	69.07	80.22
S_2V_4	13.63	31.33	69.2	85.74
S_2V_5	13.33	29.73	67.4	85.14
S_2V_6	12	28.73	66.27	79.03
S_2V_7	12.67	29.13	72.13	79.47
$LSD_{0.05}$	2.248	3.911	3.951	5.26
CV (%)	7.94	10.42	14.8	9.18

4. 2 Percentage of seedling emergence (%):

Statistically significant variation was observed in terms of percentage of seedling emergence (%) on different wheat genotypes and different sowing times (Table -4). The highest percentage of seedling emergence was recorded from S_1 (6 December, 2011) that was 97. 14% and the minimum percentage of seedling emergence was recorded from S_2 (30 December, 2011) that was 95.71%.

Statistically significant variation was observed for different wheat genotypes. The maximum percentage of seedling emergence was recorded from V_4 (Sufi) that was 100%; while the minimum percentage of seedling emergence was recorded from V_5 while is identical to V_6 and V_7 (Table-5).

Statistically significant variation was observed for interaction within sowing times and different wheat genotypes. The maximum percentage of seedling emergence was recorded from S_1V_3, S_1V_4, S_2V_1, and S_2V_4 those were 100%, while the minimum percentage of seedling emergence was recorded from S_2V_5, S_2V_6, S_2V_7 and S_2V_3 those were 93.33% (Table-6).

Table 4. Effect of different sowing times on percentage of seedling emergence of different wheat varieties

Sowing times	(%) of Seedling emergence
S_1 (6 December, 2011)	97.14
S_2 (30 December, 2011)	95.71
LSD $_{0.05}$	1.65
CV (%)	4.72

Table 5: Effect of different wheat varieties on percentage of seedling emergence

Varieties	(%) of Seedling emergence
V_1(BAW-1104)	96.67
V_2 (Prodip)	96.67
V_3 (Gourab)	96.67
V_4 (Sufi)	100.00
V_5 (Pavan-76)	95.00
V_6 (BL-1022)	95.00
V_7 (Kalyan sona)	95.00
LSD $_{0.05}$	3.12
CV (%)	4.72

Table 6. Interaction effect of different sowing times and different wheat varieties on percentage of seedling emergence

Treatment combinations	(%) of Seedling emergence
S_1V_1	97.33
S_1V_2	96.67
S_1V_3	100.00
S_1V_4	100.00
S_1V_5	96.33
S_1V_6	96.33
S_1V_7	96.33
S_2V_1	100.00
S_2V_2	96.67
S_2V_3	93.33
S_2V_4	100.00
S_2V_5	93.67
S_2V_6	93.67
S_2V_7	93.67
LSD $_{0.05}$	2.186
CV	4.72

4.3 Number of leaves per plant:

Statistically significant variation was observed in terms of number of leaves per plant for different sowing times. The maximum number of leaves per plant was recorded from S_1 (6 December, 2011) these were 5.05 at 20 DAS, 19.13 at 40 DAS, 22.82 at 60

DAS respectively, while the minimum number of leaves per plant was recorded from S_2 (30 December, 2011) those were 2.37 at 20 DAS, 9.07at 40 DAS, 20.76 DAS at 60 DAS (Table-7).

Statistically Significant variation was observed for different wheat genotypes in case of no. of leaves per plant. The maximum number of leaves per plant was recorded from V_5 that was 3.87 at 20 DAS respectively 17.90 at 40 DAS and 25.33 60 DAS, while the minimum number of leaves per plant was recorded from V_2 (Prodip) that was 3.53 at 20 DAS, 11.50 at 40 DAS, and 16.20 at 60 DAS (Table-8).

Statistically significant variation was observed for interaction effect of different sowing times and different wheat genotypes for the character leaves per plant. The maximum number of leaves per plant was recorded from S_2V_5 as 5.267 at 20 DAS, S_2V_2 as 20.47 at 40 DAS, S_2V_5 as 27.33 at 60 DAS respectively, while the minimum number of leaves per plant was recorded from S_2V_2 as 2.07 at 20 DAS, 7.73 at 40 DAS and 14 at 60 DAS respectively as treatment combination (Table -9).

Table 7. Effect of different sowing times on number of leaves per plant of different wheat genotypes at different DAS

Sowing times	Number of leaves per plant		
	20 DAS	40 DAS	60 DAS
S_1 (6 December, 2011)	5.05	19.13	22.82
S_2 (30 December, 2011)	2.37	9.07	20.76
$LSD_{0.05}$	2.10	5.31	0.98
CV (%)	11.01	15.01	21.09

Table 8. Effect of different genotypes on number of leaves per plant of wheat at different DAS

Varieties/Genotypes	Number of leaves per plant		
	20 DAS	40 DAS	60 DAS
V_1 (BAW-1104)	3.80	12.10	16.20
V_2 (Prodip)	3.53	11.50	16.20
V_3 Gourab)	3.63	14.35	22.83
V_4 (Sufi)	3.70	15.77	24.00
V_5 (Pavan-76)	3.87	17.90	25.33
V_6 (BL-1022)	3.77	12.50	18.67
V_7 (Kalyan sona)	3.67	13	25.00
$LSD_{0.05}$	0.26	4.29	2.11
CV (%)	11.01	15.23	21.09

Table 9. Interaction effect of different sowing times and wheat genotypes on number of leaves per plant at different DAS

Treatment/ combinations	Number of leaves per plant		
	20 DAS	40 DAS	60 DAS
S_1V_1	5.07	15.33	18.40
S_1V_2	4.93	20.47	21.33
S_1V_3	5.00	19.67	25.00
S_1V_4	4.93	22.33	24.67
S_1V_5	5.27	24. 40	27.33
S_1V_6	5.07	13.73	18.67
S_1V_7	5.07	18.00	24.33
S_2V_1	2.53	8.87	18.27
S_2V_2	2.07	7.73	14.00
S_2V_3	2.33	9.03	20.67
S_2V_4	2.47	11.40	23.33
S_2V_5	2.47	9.2	25.67
S_2V_6	2.47	9.27	18.67
S_2V_7	2.27	8.00	23.33
$LSD_{0.05}$	0.26	4.29	1.78
CV (%)	11.01	15.23	21.09

4.4 Number of tillers per plant:

Statistically significant variation was observed in case of number of tillers per plant for different sowing times. The maximum number of tillers per plant was recorded from S_1 (6 December, 2011) those were 1.28, 5.83 and 8.00, at 20 DAS, 40 DAS and 60 DAS respectively, while the minimum number of tillers per plant was recorded from S_2 (30 December, 2011), those were 1.06, 4.9 and 6.91 at 20 DAS, 40 DAS and 60 DAS respectively (Table-10).

Statistically significant variation was observed for different wheat varieties for this character, the highest number of tillers per plant was recorded from V_5 (Pravan-76) that was 1.45 at 20 DAS, 6.467 at 40 DAS and 9.17 at 60 DAS respectively, while minimum no. of tillers per plant was recorded from V_2 that was 0.97 at 20 DAS, 4.67 at 40 DAS and V_4 that was 5.83 at 60 DAS respectively (Table-11).

Statistically significant variation was observed for interaction effect of different sowing times and different wheat varieties. The highest number of tillers per plant was recorded from S_1V_5 (Pravan-76) that was 1.64 at 20 DAS, 6.83 at 60 DAS, and 9.67 at harvest respectively, while the minimum number of tillers per plant was recorded from S_1V_3 (Gourab) that was 0.9 at 20 DAS, S_1V_1 (BAW-1104) that was 3.933 at 60

DAS and from S_1V_2 & S_1V_4 those were 5.33 at harvest for both the genotypes as treatment combination (Table-12).

Table 10. Effect of different sowing times on number of tillers per plant of different wheat varieties/genotypes

Sowing times	Number of tillers per plant		
	20 DAS	40 DAS	60 DAS
S_1 (6 December, 2011)	1.277	5.833	8.00
S_2 (30 December, 2011)	1.060	4.895	6.91
$LSD_{0.05}$	0.18	0.71	1.05
CV (%)	1.22	2.12	10.46

Table 11. Effect of different varieties/genotypes of wheat on tillers per plant

Varieties/Genotypes	Number of tillers per plant		
	20 DAS	40 DAS	60 DAS
V_1 (BAW-1104)	1.42	4.67	7.33
V_2 (Prodip)	0.98	5.63	7.83
V_3 Gourab)	1.06	4.92	8.17
V_4 (Sufi)	1.05	5.28	5.83
V_5 (Pavan-76)	1.46	6.47	9.17
V_6 (BL-1022)	1.06	4.83	5.83
V_7 (Kalyan sona)	1.15	5.75	8.00
$LSD_{0.05}$	0.31	1.26	0.78
CV (%)	1.22	2.12	10.46

Table 12. Interaction effect of different sowing times and different wheat varieties/genotypes on number of tillers per plant

Treatment combinations	Number of tiller per plant		
	20 DAS	60 DAS	Harvest
S_1V_1	1.25	3.93	6.67
S_1V_2	1.27	4.63	5.33
S_1V_3	0.90	4.23	7.67
S_1V_4	0.97	5.60	5.33
S_1V_5	1.64	6.83	9.67
S_1V_6	1.00	4.80	7.00
S_1V_7	1.06	4.97	7.67
S_2V_1	1.6	5.40	8.00
S_2V_2	0.95	3.03	5.33
S_2V_3	1.22	5.60	8.67
S_2V_4	1.13	4.97	6.33
S_2V_5	0.97	6.10	8.67
S_2V_6	1.13	6.47	8.67
S_2V_7	1.23	6.53	8.33
$LSD_{0.05}$	0.28	1.68	0.652
CV (%)	1.22	2.12	10.46

4.5 Days to starting of booting:

Statistically significant variation was observed in terms of days to starting of booting for different sowing times. The maximum days to starting of booting was recorded form S_1 (6 December, 2011) that was 53.43 DAS, while the minimum days to starting of booting was recorded from S_2 (30 December, 2011) that was 53.38 DAS (Table-13).

Statistically significant variation was observed on days to starting of booting for different wheat genotypes, the maximum days to starting of booting was recorded from V_7 (Kalyan sona) that was 54.67 DAS, while the minimum days to starting of booting was recorded from V_4 (Sufi) that was 52.17 DAS (Table-14).

Statistically significant variation was observed for interaction effect of different sowing times and different wheat varieties, the maximum days to staring of booting was recorded from S_1V_1, S_1V_7 and S_2V_7 (Kalayan sona) that was 54.66 DAS for both which was identical to S_2V_6 (BL-1022) that was 54.66 DAS also, while the minimum number of days to starting of booting was recorded from S_2V_4 (Sufi) that was 51.67 DAS as treatment combination (Table-15).

4.6 Days to 50% booting:

Statistically significant variation was observed in terms of days to 50% booting for different sowing times. The maximum days for 50% booting was recorded form S_1 (6, December, 2011) that was 54.76 DAS while the minimum days to 50% booting was recorded from S_2 (30 December, 2011) that was 55. 29 DAS (Table-13).

Table 13. Effect of different sowing times on days required for booting in different wheat genotypes

Sowing times	Days required for		
	Starting of Booting	Days to 50% Booting	Days to 100% Booting
S_1 (6 December, 2011)	53.43	55.29	57.1
S_2 (30 December, 2011)	53.38	54.76	56.1
$LSD_{0.05}$	1.96	3.10	3.12
CV (%)	13.12	9.12	7.16

Table 14. Effect of different wheat genotypes on days required for booting

Varieties/Genotypes	Days required for		
	Starting of booting	Days to 50% booting	Days to 100% booting
V_1 (BAW-1104)	53.33	52.67	56.67
V_2 (Prodip)	53.17	56.33	55.17
V_3 Gourab)	53.17	56.17	56.17
V_4 (Sufi)	52.17	55.17	57.17
V_5 (Pavan-76)	53.17	55.17	57.17
V_6 (BL-1022)	54.17	54.67	55.67
V_7 (Kalyan sona)	54.67	55	55
$LSD_{0.05}$	1.16	2.17	1.96
CV (%)	13.12	9.12	7.16

Table 15. Interaction effect of different sowing times and different wheat varieties/ genotypes on days required for booting

Treatment combinations	Days to required for		
	Starting of booting	Days to 50% booting	Days to 100% booting
S_1V_1	54.67	52.67	56.67
S_1V_2	53.67	55.67	55.67
S_1V_3	52.67	56.67	55.67
S_1V_4	51.67	55.67	56.67
S_1V_5	52.67	55.67	57.67
S_1V_6	53.67	54.67	55.67
S_1V_7	54.67	56.67	54.67
S_2V_1	52.67	52.67	56.67
S_2V_2	52.67	57.00	54.67
S_2V_3	53.67	55.67	56.67
S_2V_4	52.67	54.67	57.67
S_2V_5	53.67	54.67	56.67
S_2V_6	54.67	54.67	55.67
S_2V_7	54.67	54	55.33
$LSD_{0.05}$	2.19	3.16	2.71
CV (%)	13.12	9.12	7.16

Statistically significant variation was observed for different wheat varieties. The maximum days to 50% of booting was recorded from V_3 (Gourab) that was 56.17 DAS which was identical to V_2 (prodip) that was 56.33, minimum days 50% booting was recorded form V_1 (BAN-1104) that was 52.67 DAS (Table-14).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The maximum days to 50% booting was recorded from S_2V_2 (Prodip) that was 57 DAS, while the minimum number of days to 50% of booting was recorded from S_1V_1 (BAW-1104) that was 52.67 DAS (Table-15).

4.7 Days to 100% booting:

Statistically significant variation was observed on days to 100% booting for different sowing times. The maximum days to 100% booting was recorded from S_1 (6, December, 2011) that was 56.19 DAS while the minimum days to 100% booting was recorded from S_2 (30 December, 2011) that was 56.1 DAS (Table-13).

Statistically significant variation was observed for different wheat varieties. The maximum days to 100% booting was recorded from V_4 and V_5 (Pavan-76) that was 57.17 DAS. While the minimum days to 100% booting was recorded from V_7 (Kalyan sona) that was 55 DAS which was identical to V_2 (Prodip) that was 52.17 DAS (Table-14).

Statistically significant variation was observed for interaction effect of different sowing times and different wheat varieties. The maximum days to 100% booting was recorded from S_1V_5 (Pavan-76) and S_2V_4 (Sufi) that was 57.67 DAS, while the minimum days to 100% of booting was recorded from S_1V_7 (Kalyan sona) and S_2V_2 (Prodip) that was 54.67 DAS for both as treatment combination (Table-15).

4.8 Days to starting of ear emergence:

Statistically significant variation was observed in case of days to starting of ear emergence for different sowing times. The maximum days to starting of ear emergence was recorded from S_1 (6 December, 2011) that was 55.1 DAS while the minimum days to starting of ear emergence was recorded from S_2 (30 December, 2011) that was 54.29 DAS (Table-16).

Statistically significant variation was observed for different wheat varieties. The maximum days to starting of ear emergence was recorded from V_7 (Kalyan sona) that was 57.33 DAS. While the minimum days to starting of ear emergence was recorded from V_1 (BAW-1104) that was 52.67 DAS (Table-17).

Statistically significant variation was observed for interaction effect of different sowing times and different wheat varieties. The maximum days to starting of ear emergence was recorded from S_1V_7 that was 57.66 DAS which was identical to S_2V_7 that was 57 DAS, while the minimum days to starting of ear emergence was recorded from S_1V_1 and S_2V_1 that was 52.67 DAS for both as treatment combination (Table-18).

4.9 Days to 50% Ear emergence:

Statistically significant variation was observed on days to 50% of ear emergence for different sowing times and different wheat varieties. The maximum days to 50% ear emergence was recorded from S_1 (6 December, 2011) that was 58.524 DAS while the minimum days to 50% ear emergence was recorded from S_2 (6 December, 2011) that was 58.1 DAS (Table-16).

Statistically significant variation was observed for different wheat varieties. The maximum days to 50% ear emergence was recorded from V_5 (Pavan-76) that was 59.67 DAS. While the minimum days to 50% ear emergence was recorded from V_1 (BAW-1104) that was 57.33 DAS which was identical to V_3 (Gourba) that was 57.5 DAS (Table-17).

Statistically significant variation was observed for interaction within sowing times and different wheat varieties the maximum days to 50% ear emergence was recorded from S_1V_5 that was 60 DAS, while the minimum days to 50% ear emergence was recorded from S_1V_1 (BAW-1104) what was 56.33 DAS as treatment combination (Table-18).

4.10 Days to 100% ear emergence:

Statistically significant variation was observed on days to 100% ear emergence for different sowing times and different wheat varieties. The maximum days to 100% ear emergence was recorded from S_1 (6 December, 2011) that was 63.1 DAS, while the minimum days to 100% ear emergence was recorded from S_2 (30 December, 2011) that was 61.5 DAS (Table-16).

Statistically significant variation was observed for different wheat varieties. The maximum days to 100% ear emergence was recorded from V_4, V_6 and V_7 that was

62.67 DAS which was identical to 62.5 DAS. While the minimum days to 100% ear emergence was recorded from V_1 (BAW-1104) that was 60.66 DAS (Table-17). Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum days to 100% ear emergence was recorded from S_1V_1, S_1V_4, S_1V_7 and S_2V_6 that was 63.67 DAS. While the minimum days to100% ear emergence was recorded from S_2V_2 and S_2V_5 that was 60.67 DAS as treatment combination (Table-18).

Table 16. Effect of sowing times on days to ear emergence of different wheat varieties

Sowing times	Days required to		
	Starting of ear emergence	50% ear emergence	100% ear emergence
S_1 (6 December, 2011)	55.1	59.52	63.1
S_2 (30 December, 2011)	54.29	58.1	61.05
$LSD_{0.05}$	0.41	0.23	0.96
CV (%)	3.22	6.37	8.19

Table 17. Effect of different wheat varieties on days to ear emergence

Varieties/Genotypes	Days required for		
	Starting of ear emergence	50% ear emergence	100% ear emergence
V_1 (BAW-1104)	52.67	57.33	60.67
V_2 (Prodip)	53.33	58.00	61.67
V_3 Gourab)	54.17	57.50	62.50
V_4 (Sufi)	55.00	58.67	62.67
V_5 (Pavan-76)	54.17	59.67	61.67
V_6 (BL-1022)	56.17	58.33	62.67
V_7 (Kalyan sona)	57.33	58.67	62.67
$LSD_{0.05}$	3.22	1.69	1.32
CV (%)	3.22	6.37	8.19

Table 18. Interaction effect of sowing times and different wheat varieties on days required to ear emergence, 50% ear emergence and 100% ear emergence

Treatment combinations	Days required to		
	Starting of ear emergence	50% ear emergence	100% ear emergence
S_1V_1	52.67	56.33	63.67
S_1V_2	53.67	58.33	62.67
S_1V_3	54.67	58.00	63.67
S_1V_4	55.67	59.00	63.67
S_1V_5	54.67	60.00	62.67
S_1V_6	56.67	59.00	61.67
S_1V_7	57.67	59.00	6367
S_2V_1	52.67	58.33	57.67
S_2V_2	53.00	57.67	60.67
S_2V_3	53.67	57.00	61.33
S_2V_4	54.33	58.33	61.67
S_2V_5	53.67	59.33	60.67
S_2V_6	55.67	57.67	63.67
S_2V_7	57.00	58.33	61.67
$LSD_{0.05}$	2.17	3.00	1.20
CV (%)	3.22	6.37	8.19

4.11 Days to starting of anthesis:

Statistically significant variation was observed on days to starting of anthesis for different sowing times and different wheat varieties. The maximum days to starting of anthesis was recorded from S_1 (6 December, 2011) that was 57.71 DAS. While the minimum days to starting of anthesis was recorded from S_2 (30, December, 2011) that was 56.71 DAS (Table-19).

Statistically significant variation was observed for different wheat varieties. The maximum days to starting of anthesis was recorded from V_4 (Sufi) that was 58.33 DAS, while the minimum days to starting of anthesis was recorded form V_5 (Pavan-76) that was 56.167 DAS. Which was identical to V_2 (Prodip) that was 56.5 DAS (Table-20).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum days to starting of anthesis was recorded from S_1V_1 that was 58.33 DAS which was identical to S_2V_1, S_2V_4 that was 58 DAS for both as treatment combination (Table-21).

4.12 Days to 50% of anthesis:

Statistically significant variation was observed on days to 50% anthesis for different sowing times and different wheat varieties. The maximum days to 50% anthesis was recorded from S_1 (6 December, 2011) that was 65.52 DAS, while the minimum days to 50% of anthesis was recorded from S_2 (30, December, 2011) that was 65.04 DAS (Table-19). Statistically significant variation was observed for different wheat varieties. The maximum days to 50% anthesis was recorded from V_1 (BAW-1104) that was 65.67 DAS, which was identical to V_4 (Sufi) that was 65.5 DAS, while the minimum days to 50% anthesis was recorded from V_2 (Prodip) that was 64.67 DAS which was identical to V_5 (Pavan-76) that was 64.83 DAS (Table-20).

Statistically significant variation was observed for interaction effect of different sowing times and different wheat varieties. The maximum days for 50% anthesis was recorded from S_1V_1, S_2V_3, S_1V_4, S_1V_6, S_2V_1 that was 65.67 DAS for both, while the minimum days to 50% anthesis was recorded from S_2V_2, and S_2V_5 that was 64.33 DAS for both as treatment combination (Table21).

4.13 Days to 100% anthesis:

Statistically significant variation was observed on days to 100% anthesis for different sowing times and different wheat varieties. The maximum days to 100% anthesis was recorded from S_1 (6 December, 2011) that was 68.57 DAS. While the minimum days to 100% athesis was recorded from S_2 (30 December, 2011) that was 67.67 DAS (Table-19).

Statistically significant variation was observed for different wheat varieties. The maximum days to 100% anthesis was recorded from V_1 (BAW-1104), which was 69.17 DAS, while the minimum days to 100% anthesis was recorded from V_3 and V_7 that was 67.17 DAS for both (Table-20).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The maximum days to 100% anthesis was recorded from S_1V_1 and S_1V_5 that was 69.67 DAS, the minimum days to 100%

anthesis was recorded from S_2V_3 and S_2V_7 that was 66.67 DAS for both as treatment combination (Table-21).

Table 19. Effect of different sowing times on days required to anthesis of wheat Varieties

Sowing times	Days required to		
	Starting of anthesis	50% anthesis	100% anthesis
S_1 (6 December, 2011)	57.71	66.52	68.57
S_2 (30 December, 2011)	56.71	65.05	67.67
$LSD_{0.05}$	0.59	3.17	0.80
CV (%)	13.17	4.13	5.19

Table 20. Effect of different wheat varieties on days required to anthesis

Varieties/Genotypes	Days required to		
	Starting of anthesis	50% anthesis	100% anthesis
V_1 (BAW-1104)	58.17	65.67	69.17
V_2 (Prodip)	56.50	64.67	68.50
V_3 Gourab)	57.17	65.50	67.17
V_4 (Sufi)	58.33	65.50	68.00
V_5 (Pavan-76)	56.17	64.83	68.67
V_6 (BL-1022)	57.17	65.33	68.17
V_7 (Kalyan sona)	57.00	65.50	67.17
$LSD_{0.05}$	1.23	1.10	1.96
CV (%)	13.17	4.13	5.19

Table 21.Interaction effect within different sowing times and different wheat varieties on days required to starting of anthesis, 50% anthesis and 100% anthesis

Treatment combinations	Days to required to		
	Starting of ear anthesis	50% ear anthesis	100% ear anthesis
S_1V_1	58.33	65.67	69.67
S_1V_2	57.33	65.00	69.33
S_1V_3	57.67	65.67	67.67
S_1V_4	58.67	65.67	68.33
S_1V_5	56.67	65.33	69.67
S_1V_6	57.67	65.67	67.67
S_1V_7	57.67	65.67	67.67
S_2V_1	58.00	65.67	68.67
S_2V_2	55.67	64.33	67.67
S_2V_3	56.67	65.33	66.67
S_2V_4	58.00	65.33	67.67
S_2V_5	55.67	64.33	67.67
S_2V_6	56.67	65.00	68.67
S_2V_7	56.33	65.33	66.67
$LSD_{0.05}$	1.22	1.60	1.22
CV (%)	13.17	4.13	5.19

4.14 SPAD – reading from flag leaf:

Statistically significant variation was observed in case of SPAD Reading from flag leaves for different sowing times and different wheat varieties. The highest SPAD reading was recorded from S_1 (6 December, 2011) that was 52.19, while the minimum SPAD – reading was recorded from S_2 (30 December, 2011) that was 50.53 (Table-22).

Statistically significant variation was observed in case of SPAD- reading for different wheat varieties. The highest SPAD reading was recorded from wheat varieties V_5 (Pavan-76) that was 52.87, while the minimum value of SPAD – reading was recorded from V_2 that was 49.88 (Table-23).

Statistically significant variation was observed in case of SPAD –reading for interaction effect of different sowing times and different wheat varieties. The highest SPAD reading was recorded from S_1V_5 that was 53.57, while the minimum SPAD-reading was recorded form S_2V_2 that was 47.71 (Table-24).

Table 22. Effect of sowing times on SPAD reading of flag leaves of different wheat varieties.

Sowing time	SPAD reading
S_1 (6 December, 2011)	52.19
S_2 (30 December, 2011)	50.53
$LSD_{0.05}$	1.6
CV (%)	2.62

Table 23. Effect of different wheat genotypes on -SPAD reading of flag leaves

Genotypes	SPAD reading
V_1 (BAW-1104)	51.51
V_2 (Prodip)	49.88
V_3 Gourab)	51.85
V_4 (Sufi)	50.77
V_5 (Pavan-76)	52.87
V_6 (BL-1022)	51.61
V_7 (Kalyan sona)	51.04
$LSD_{0.05}$	1.55
CV (%)	2.62

Table 24. Interaction effect of sowing times and different wheat varieties on SPAD- reading of flag leaves

Treatment combinations	SPAD reading from
S_1V_1	50.69
S_1V_2	51.00
S_1V_3	48.44
S_1V_4	50.08
S_1V_5	53.17
S_1V_6	51.21
S_1V_7	50.13
S_2V_1	52.34
S_2V_2	47.71
S_2V_3	51.31
S_2V_4	51.45
S_2V_5	52.57
S_2V_6	52.00
S_2V_7	51.95
$LSD_{0.05}$	1.302
CV (%)	2.62

4.15 Days required to maturity:

Statistically significant variation was observed on days required to maturity in case of different sowing times and different wheat varieties. The maximum days required to maturity was recorded from S_1 (6 December, 2011) that was 76.33 DAS, while the minimum days required to maturity was recorded from S_2 (30 December, 2011) that was 73.25 DAS (Table-25).

Statistically significant variation was observed for different wheat varieties. The highest days to maturity was recorded from V_1 (BAW-1104), V_2 (Prodip) and V_6 (BL-1022) that was 75.33 DAS for both. While the minimum days required to maturity was recorded from V_5 (Pavan-76) that was 74.33 DAS which was identical to V_7 that was 74.5 DAS (Table-24).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The highest days required to maturity was recorded from S_1V_5 and S_1V_6, that was 78 DAS, while the minimum days required to maturity was recorded from S_2V_5 (70.667 DAS) as treatment combination (Table-27).

Table 25. Effect of sowing times on maturity and ripening of different wheat varieties

Sowing times	Days required to maturity	Days required to Ripening
S_1 (6 December, 2011)	76.33	91.05
S_2 (30 December, 2011)	73.25	90.38
$LSD_{0.05}$	2.17	0.57
CV (%)	6.17	9.2

Table 26. Effect of different wheat varieties on days required to maturity and ripening

Wheat varieties	Days required to maturity	Days required to Ripening
V_1 (BAW-1104)	75.33	88.67
V_2 (Prodip)	75.33	89.83
V_3 Gourab)	73.83	90.17
V_4 (Sufi)	75.00	91.00
V_5 (Pavan-76)	74.33	91.33
V_6 (BL-1022)	75.33	91.33
V_7 (Kalyan sona)	74.50	92.67
$LSD_{0.05}$	1.76	2.19
CV (%)	6.17	9.2

Table 27. Interaction effect of different sowing times and different wheat varieties on days to maturity and ripening

Treatment combinations	Days required to maturity	Days required to ripening
S_1V_1	75.33	93.67
S_1V_2	76.33	90.33
S_1V_3	74.67	90.67
S_1V_4	76.67	91.33
S_1V_5	78.00	92.67
S_1V_6	78.00	91.00
S_1V_7	75.33	92.67
S_2V_1	75.33	88.67
S_2V_2	74.33	89.33
S_2V_3	73.00	89.67
S_2V_4	73.33	90.67
S_2V_5	70.67	90.00
S_2V_6	72.67	91.67
S_2V_7	73.67	90.67
$LSD_{0.05}$	6.10	2.00
CV (%)	6.17	9.2

4.16 Days required to ripening:

Statistically significant variation was observed in case of days required to maturity for different sowing times and different wheat varieties. The maximum days required to ripening was recorded from S_1 (6 December, 2011) that was 91.048 DAS, while the minimum days required to ripening was recorded from S_2 (30 December, 2011) that was 90.38 DAS (Table-25).

Statistically significant variation was observed for different wheat varieties. The maximum days required to ripening was recorded from V_7 (92.67 DAS), while the minimum days required to ripening was recorded from V_1 (BAW-1104) that was 88.67 DAS (Table-26).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum days required to ripening was recorded from S_1V_1 that was 93.67 DAS. While the mimimum days required to repining was recorded from S_2V_1 that was 88.67 DAS (Table-27).

4.17 Length of Flag leaves:

Statistically significant variation was observed in case of length of flag leaves for different sowing times and different wheat varieties. The highest length of flag leaves was recorded from S_1 (6 December, 2011) that was 21.34 cm, while the minimum length of flag leaves was recorded from S_2 (30 December, 2011) that was 20.8 cm (Table-28).

Statistically significant variation was observed for different wheat varieties. The highest length of flag leaves was recorded from V_5 (Pravan-76) that was 24.48 cm, while the minimum length of flag leaves was recorded from V_2 (Prodip) that was 18.56cm (Table-29). Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The highest length of flag leaves was recorded from S_1V_5 that was 24.50 cm, while the minimum length of flag leaves was recorded from S_2V_2 that was 17.81 cm (Table-30).

4.18 Breadth of flag leaf:

Statistically significant variation was observed in case of breadth of flag leaves for different sowing time and different wheat varieties. The highest breadth of flag leaves was recorded from S_1 (6 December, 2011) that was 1.36 cm, while the minimum breadth of flag leaves was recorded form S_2 (30 December, 2011) that was 1.30 cm (Table-28).

Statistically significant variation was observed for different wheat varieties. The highest breadth of flag leaves was recorded from wheat variety V_5 (Pravan-76) that was 1.463 cm, while the minimum breadth of flag leaves was recorded from wheat variety V_2 (Prodip) that was 1.273 cm (Table-29).

Statistical significance variation was observed for interaction within different sowing times and different wheat varieties. The highest breadth of flag leaves was recorded from S_1V_5 that was 1.47cm, while the minimum breadth of flag leaves was recorded from S_2V_2 that was 1.3 cm (Table-30).

4.19 Area of flag leaves (cm):

Statistically significant variation was observed in case of area of flag leaves for different sowing times and different wheat varieties. The maximum area of flag leaves was recorded from S_1 (6 December, 2011) that was 28.56 cm^2, while the minimum area of flag leaves was recorded from S_2 (30 December, 2011) that was 28.078 cm^2 (Table-28).

Statistically significant variation was observed for different wheat varieties. The highest area of flag leaves was recorded from V_5 (Pravan-76) that was 33.01 cm^2, while the minimum area of flag leaves was recorded from V_2 (Prodip) that was 24.53 cm^2 (Table-29). Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The highest area of flag leaves was recorded from S_1V_5 that was 35.03 cm^2; while the minimum area of flag leaves was recorded from S_2V_2 that was 23.25 cm^2 as treatment combination (Table-30).

Table 28. Effect of sowing times length, breadth and area of flag leaves of different wheat varieties

Sowing times	Length of flag leaves (cm)	Breath of flag leaves (cm)	Area of flag leaves (cm^{-2})
S_1 (6 December, 2011)	21.34	1.37	29.56
S_2 (30 December, 2011)	20.8	1.34	28.08
$LSD_{0.05}$	0.50	2.17	1.70
CV (%)	4.17	2.17	3.29

Table 29. Effect of different wheat varieties on length, breadth and area of flag leaves

Varieties	Length of flag leaves (cm)	Breath of flag leaves (cm)	Area of flag leaves (cm-2)
V_1 (BAW-1104)	22.56	1.46	33.01
V_2 (Prodip)	18.56	1.2	24.53
V_3 Gourab)	21.45	1.31	25.81
V_4 (Sufi)	19.87	1.27	25.8
V_5 (Pavan-76)	24.48	1.41	34.90
V_6 (BL-1022)	20.54	1.32	27.29
V_7 (Kalyan sona)	20.06	1.33	26.89
$LSD_{0.05}$	2.19	0.10	3.10
CV (%)	4.17	2.17	3.29

Table 30. Interaction effect of sowing times and different wheat varieties on length, breadth and area of flag leaves

Treatment combinatons	Length of flag leaves (cm)	Breadth of flag leaves (cm)	Area of flag leaves area (cm^{-2})
S_1V_1	22.56	1.41	33.08
S_1V_2	21.43	1.18	23.23
S_1V_3	21.46	1.21	25.60
S_1V_4	18.75	1.24	24.65
S_1V_5	24.50	1.47	35.03
S_1V_6	24.45	1.40	34.77
S_1V_7	21.94	1.31	28.38
S_2V_1	22.56	1.46	32.94
S_2V_2	17.81	1.30	23.25
S_2V_3	22.35	1.33	29.94
S_2V_4	18.36	1.31	24.41
S_2V_5	18.74	1.31	24.64
S_2V_6	22.31	1.37	30.53
S_2V_7	17.81	1.30	23.23
$LSD_{0.05}$	4.12	0.15	5.13
CV (%)	4.17	2.17	3.29

4.20 Fresh weight (g) of spike:

Statistically significant variation was observed on fresh weight (g) of spike at 1 DAA (Days after anthesis), 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA, 33 DAA and harvest for different sowing times and different wheat varieties. The maximum fresh weight (g) of spike was recorded from S_1 (6 December, 2011) those were 1.78 g,1.98g, 2.16g, 2.37g, 2.61g, 2.78g, 3.04g at 1 DAA, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest respectively, while the minimum fresh weight (g) of spike was recorded from S_2 (30 December, 2011) those were 1.72g, 1.92g, 2.132g, 2.332g, 2.531g, 2.728g, and 2.928g at 1 DAA, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA, and at harvest respectively (Table-31).

Statistically significant variation was observed on fresh weight (g) of spike for different wheat varieties. The maximum weight was recorded from V_5 (Pravan-76) that was 1.872g at 1 days after anthesis, 2.137g, 2.277g, 2.60g2.80g and 2.95g at 7DAA, 13 DAA, 19 DAA, 25 DAA and 31 DAA respectively and 2.817g at harvest. While the minimum fresh weight of spike was recorded from V_2 (Prodip) that was 1.572g, 1.807g, 1.972g, 2.167g, 2.372g and 2.607g at 7DAA, 13DAA, 19DAA, 25DAA, 31DAA respectively and 2.07g at harvest (Table-32).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The highest fresh weigh of spike was recorded from S_1V_5 those were 1.927g, 2.147g, 2.427g, 2.647g, 2.857g,2.987g and 2.147g at 1 DAA, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest respectively. The minimum fresh weight (g) of spike was recorded from S_2V_2 those were 1.556g, 1.757g, 1.957g, 2.157g, 2.357g, 2.557g and 2.757g at 1 days after anthesis (DAA), 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest as treatment combination (Table-33).

Table 31. Effect of sowing time on fresh weight (g) of spike of different wheat varieties on different days after anthesis (DAA)

Sowing times	Fresh wt. of spike (g)						
	1 DAA	7 DAA	13 DAA	19 DAA	25 DAA	31 DAA	Harvest
S_1 (6 December, 2011)	1.78	2.00	2.16	2.38	2.61	2.79	3.04
S_2 (30 December, 2011)	1.73	1.93	2.13	2.32	2.53	2.73	2.93
$LSD_{0.05}$	3.17	0.05	0.05	0.32	0.06	0.06	0.10
CV (%)	6.17	3.12	9.17	13.12	3.19	4.22	8.17

Table 32. Effect of different wheat varieties on fresh weight (g) of spike on different days after anthesis

Varieties	Fresh wt. of spike (g)						
	1 DAA	7 DAA	13 DAA	19 DAA	25 DAA	31 DAA	Harvest
V_1 (BAW-1104)	1.617	1.817	1.978	2.175	2.417	2.617	2.817
V_2 (Prodip)	1.605	1.807	1.972	2.172	2.407	2.602	2.807
V_3 (Gourab)	1.927	2.137	2.377	2.602	2.807	2.957	3.0
V_4 (Sufi)	1.872	2.037	2.253	2.477	2.677	2.837	2.147
V_5 (Pavan-76)	1.892	2.233	2.442	2.732	2.832	2.877	3.808
V_6 (BL-1022)	1.572	1.807	1.972	2.167	2.372	2.607	2.807
V_7 (Kalyan sona)	1.857	2.070	2.257	2.462	2.687	2.853	2.102
$LSD_{0.05}$	0.16	0.22	0.19	0.23	0.19	0.12	0.51
CV (%)	6.17	3.12	9.17	13.12	3.19	4.22	8.17

Table 33. Interaction effect of sowing times and wheat varieties on fresh weight (g) of spike at different days after anthesis

Treatment	Fresh wt. of spike (g)						
	1 DAA	7 DAA	13 DAA	19 DAA	25 DAA	31 DAA	Harvest
S_1V_1	1.667	1.867	1.987	2.177	2.467	2.667	2.867
S_1V_2	1.647	1.857	1.987	2.187	2.457	2.647	2.857
S_1V_3	1.927	2.147	2.427	2.647	2.857	2.987	2.147
S_1V_4	1.917	2.047	2.247	2.527	2.727	2.847	2.267
S_1V_5	1.947	2.247	2.547	2.747	2.947	3.047	3.133
S_1V_6	1.587	1.857	1.987	2.177	2.387	2.657	2.857
S_1V_7	1.877	2.103	2.277	2.487	2.937	2.87	2.167
S_2V_1	1.567	1.767	1.970	2.173	2.367	2.567	2.767
S_2V_2	1.563	1.757	1.957	2.153	2.357	2.557	2.757
S_2V_3	1.927	2.127	2.327	2.557	2.757	2.927	2.127
S_2V_4	1.827	2.027	2.260	2.427	2.627	2.827	2.027
S_2V_5	1.817	2.020	2.217	2.417	2.617	2.827	2.023
S_2V_6	1.557	1.757	1.957	2.157	2.357	2.557	2.757
S_2V_7	1.837	2.037	2.237	2.437	2.637	2.837	3.037
$LSD_{0.05}$	0.15	0.35	0.22	0.19	0.10	0.25	0.53
CV (%)	6.17	3.12	9.17	13.12	3.19	4.22	8.17

4.21 Tiller height:

Table 34. Effect of sowing time on tiller height (cm) per plant of different wheat varieties

Sowing times	Each tiller height (cm)	
	40 DAS	60 DAS
S_1 (6 December, 2011)	58.79	78.64
S_2 (30 December, 2011)	56.97	74.42
$LSD_{0.05}$	1.02	2.00
CV (%)	9.17	11.13

Table 35. Effect of different wheat varieties/genotypes on tiller height (cm) at different days after sowing

Varieties	Each tiller height (cm)	
	40 DAS	60 DAS
V_1 (BAW-1104)	56.80	78.07
V_2 (Prodip)	60.07	78.31
V_3 Gourab)	56.33	74.43
V_4 (Sufi)	58.39	75.23
V_5 (Pavan-76)	57.30	77.14
V_6 (BL-1022)	60.39	79.20
V_7 (Kalyan sona)	55.86	73.32
$LSD_{0.05}$	2.33	3.19
CV (%)	9.17	11.13

Table 36. Interaction effect of different sowing times and different wheat varieties on tiller height (cm) at different days after sowing

Treatment combinations	Each tiller height (cm)	
	40 DAS	60 DAS
S_1V_1	58.42	81.15
S_1V_2	62.41	84.18
S_1V_3	57.73	75.40
S_1V_4	61.35	78.32
S_1V_5	57.85	77.84
S_1V_6	60.04	79.73
S_1V_7	53.71	73.83
S_2V_1	55.19	74.98
S_2V_2	57.73	72.43
S_2V_3	54.92	73.47
S_2V_4	55.42	72.13
S_2V_5	56.76	76.43
S_2V_6	60737	78.67
S_2V_7	58.00	72.80
$LSD_{0.05}$	3.17	6.99
CV (%)	9.17	11.13

Statistically significant variation was observed on tiller height per plant for different sowing times and different wheat varieties. The maximum tiller height was recorded from S_1 (6 December, 2011) that was 58.79 cm at 40 DAS and 78.64 cm at 60 DAS, while the minimum height of tillers per plant was recorded from S_2 (30 December, 2011) that was 56.97 cm at 40 DAS and 74.42 cm at 60 DAS respectively (Table-34).

Statistically significant variation was observed in case of tiller height of different wheat varieties. The highest tiller was recorded from V_6 (BL-1022) that was 60.39 cm at 40 DAS and 79.2 cm at 60 DAS respectively, while the minimum height of tiller was recorded from V_7 (kalian sona) that was 55.86 cm at 40 DAS and 73.32 cm at 60 DAS respectively (Table-35).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The highest tiller was recorded from S_1V_4 that was 61.35 cm at 40 DAS and from S_1V_2 that was 84.18 cm at 60 DAS respectively. While the minimum height of tillers per plant was recorded from S_1V_7 that was 53.71 cm at 40 DAS and S_2V_4 that was 72.13 cm at 60 DAS as treatment combination (Table-36).

4.22 Number of tillers per plant:

Statistically significant variation was observed in case of number of tillers per plant for different sowing times and different wheat varieties. The maximum number of tillers per plant was recorded from S_1 (6 December, 2011) that was 5.83 while the minimum number of tillers per plant was recorded from S_2 (30 December, 2011) that was 4.9. Statistically significant variation was observed for different wheat varieties. The maximum number of tillers per plant was recorded from V_5 (Pavan-76) that was 6.47. While the minimum number of tillers per plant was recorded from V_1 (BAW-1104) that was 4.67.

Statistically significant variation was observed for interaction effect of different sowing times and different wheat varieties. The maximum number of tillers per plant was recorded from S_1V_5, S_1V_6, S_1V_7 and S_2V_5 which were 6.83, 6.47, 6.53 and 6.1

respectively, while the minimum number of tillers per plant was recorded from S_2V_1 that was 3.93.

4.23 Number of fertile tillers per plant:

Statistically significant variation was observed in case of number of fertile tillers per plant for different wheat varieties and different sowing times. The maximum no. of fertile tillers per plant was recorded form S_1 (6 December, 2011) that was 4.43. The minimum number of fertile tillers per plant was recorded from S_2 (30 December, 2011) that was 3.38 (Table-37).

Statistically significant variation was observed for different wheat varieties for this character. The maximum number of fertile tillers per plant was recorded from V_5 (Pavan-76) that was 5, while the minimum number of fertile tillers per plant was recorded from V_2 (Prodip) that was 3.17, which was identical to V_1 (BAW-1104), V_3 (Gourab) and V_4 (Sufi) those were 3.33, 3.67, 3.83 respectively (Table-38).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum no. of fertile tillers per plant was recorded from S_1V_5 that was 5.33 which was identical to S_1V_6 and S_1V_7 that was 5 for both, while minimum was found from S_2V_1 & S_2V_3 that was 2.67 for both as treatment combination (Table-39)

4.24 Number of sterile tillers per plant:

Statistically significant variation was observed in case of number of sterile tillers per plant for different sowing times and different wheat varieties. The maximum no. of sterile tillers per plant was recorded from S_1 (6 December, 2011) that was 1, while the minimum no. of sterile tillers per plant was recorded from S_2 (30 December, 2011) that was 0.905 (Table-37).

Statistically significant variation was observed for different wheat varieties for this character. The maximum number of sterile tillers per plant was recorded from V_1, V_2, V_4, V_5, V_7, that was 1.While the minimum number of sterile tillers per plant was recorded from V_3 (Gourab) that was 0.667 (Table-38).

Statistically significant variation was observed in case of number of sterile tillers per plant for interaction within different sowing times and different wheat varieties. The maximum number of sterile tillers per plant was recorded from all the treatment combination except S_2V_3, which was 1, while the minimum number of sterile tillers per plant was recorded from S_2V_3 that was 0.33 as treatment combination (Table-39).

Table 37. Effect of sowing times on number of tillers per plant, number of fertile tillers per plant and number of sterile tillers per plant of different wheat varieties

Sowing times	No. of tillers per plant	No. of fertile tillers per plant	No. of sterile tillers per plant
S_1 6 (December, 2011)	5.83	4.43	0.91
S_2 (30 December, 2011)	4.9	3.38	1.0
$LSD_{0.05}$	0.53	0.57	0.05
CV (%)	6.17	8.11	9.17

Table 38. Effect of different wheat varieties on number of tillers per plant, no. of fertile tillers per plant and number of sterile tillers per plant

Varieties	No. of tillers per plant	No. of fertile tillers per plant	No. of sterile tillers per plant
V_1 (BAW-1104)	4.67	3.33	1.00
V_2 (Prodip)	4.83	3.17	1.00
V_3 Gourab)	4.92	3.67	0.67
V_4 (Sufi)	5.28	3.83	1.00
V_5 (Pavan-76)	6.47	4.30	0.30
V_6 (BL-1022)	5.63	4.17	1.00
V_7 (Kalyan sona)	5.75	4.17	1.00
$LSD_{0.05}$	1.22	1.00	0.12
CV (%)	6.17	8.11	9.17

Table 39. Interaction effect of sowing times and different wheat varieties on no. of tillers per plant, no. of fertile tillers per plant and no. of sterile tillers per plant

Treatment combinations	No. of tillers per plant	No. of fertile tillers per plant	No. of sterile tillers per plant
S_1V_1	5.4	4.00	1.00
S_1V_2	4.63	3.0	1.00
S_1V_3	4.23	4.67	1.00
S_1V_4	5.6	4.00	1.00
S_1V_5	7.1	6.67	0.43
S_1V_6	4.8	5.00	1.00
S_1V_7	4.97	5.00	1.00
S_2V_1	3.93	2.67	1.00
S_2V_2	3.33	2.33	1.00
S_2V_3	5.6	2.67	0.33
S_2V_4	4.97	3.67	1.00
S_2V_5	6.83	5.33	1.00
S_2V_6	6.47	3.33	1.00
S_2V_7	6.53	3.33	1.00
$LSD_{0.05}$	2.19	1.66	0.40
CV (%)	6.17	8.11	9.17

4.25 Number of spike per plant:

Statistically significant variation was observed in case of number of spikes per plant for different sowing times and different wheat varieties. The maximum number of spike per plant was recorded from S_1 (6 December, 2011) that was 3.857, while the minimum number of spike per plant was recorded from S_2 (30 December, 2011) that was 2.91.

Statistically significant variation was observed for different wheat varieties. The maximum number of spike per plant was recorded from V_5 (kalian sona) that was 3.83, while the minimum number of spike per plant was recorded from V_1 (BAW-1104) and V_2 (Prodip) that was 3.

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties for this character. The maximum number of spike per plant was recorded from S_1V_5 that was 4.667. While the minimum number of

spike per plant was recorded from S_2V_2 that was 2.33, which was identical to S_2V_1 (BAW-1104) that was 2.67 as treatment combination.

4.26 Number of fertile spike per plant:

Statistically significant variation was observed in case of number of fertile spike per plant for different sowing times and different wheat varieties. The maximum number of fertile spike per plant was recorded from S_1 (6 December, 2011) that was 3.43, while the minimum number of fertile spike per plant was recorded from S_2 (30 December, 2011) that was 2.76.

Statistically significant variation was observed in case of number of fertile spikes per plant for different wheat varieties. The maximum number of fertile spikes per plant was recorded V_2 (Kalian sona) that was 3.67, while the minimum number of fertile spikes per plant was recorded from V_1 (BAW-1104) and V_6 (BL-1022) that was 2.83.

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The maximum number of fertile spike per plant was recorded from S_1V_5 that was 4.67. The minimum number of fertile spike per plant was recorded from S_2V_2 that was 2.33 which was identical to S_2V_4, S_2V_5, S_2V6, S_2V_1, S_2V_5 and S_2V_7 that was 2.67 for before mentioned treatment combination.

4.27 Number of sterile spikes per plant:

Statistically significant variation was observed in case of number of sterile spikes per plant for different sowing times and different wheat varieties. Statistically significant variation was observed for different sowing times. The maximum number of sterile spike per plant was recorded from S_2 (30 December, 2011) that was 0.43, while the minimum number of sterile spike per plant was recorded from S_1 (6 December, 2011) that was 0.14 (Table-40).

Statistically significant variation was observed for different wheat varieties. The maximum number of sterile spike per plant was recorded from V_4 (Sufi) that was 0.83,

while the minimum number of sterile spike per plant was recorded from V_2 (Prodip) and V_3 (Gourab) that was zero (0) for both (Table-41).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum number of sterile spike per plant was recorded from S_2V_4 that was 1.0, while the minimum number of sterile spike per plant was recorded from S_1V_2, S_1V_3, S_1V_7, S_2V_1, S_2V_2, S_2V_3, S_2V_4 and S_2V_6 that was 0 for before mentioned treatment combination (Table-42).

Table 40. Effect of different sowing times on number of spike per plant, number of fertile spike per plant, number of sterile spike per plant of different wheat varieties

Sowing times	No. of spike per plant	No. of fertile spike per plant	No. of sterile spike per plant
S_1 (6 December, 2011)	3.86	3.43	0.14
S_2 (30 December, 2011)	2.91	2.76	0.43
$LSD_{0.05}$	0.50	0.37	0.90
CV (%)	12.13	7.12	6.11

Table 41. Effect of different wheat varieties on no. of spike per plant, no. of fertile spike per plant and no. of sterile spike per plant

Varieties	No. of spike per plant	No. of fertile spike per plant	No. of sterile spike per plant
V_1 (BAW-1104)	3.00	2.83	0.17
V_2 (Prodip)	3.00	3.00	0
V_3 Gourab)	3.33	3.33	0.17
V_4 (Sufi)	3.33	3.33	0.83
V_5 (Pavan-76)	3.97	3.67	0.30
V_6 (BL-1022)	3.50	2.83	0.33
V_7 (Kalyan sona)	3.83	3.67	0.56
$LSD_{0.05}$	0.51	0.53	0.39
CV (%)	12.13	7.12	6.11

Table 42. Interaction effect of sowing times and different wheat variety on no. of spike per plant, no of fertile spike per plant and no. of sterile spike per plant

Treatment combinations	No. of spike per plant	No. of fertile spike per plant	No. of sterile spike per plant
S_1V_1	3.33	3.00	0.33
S_1V_2	3.67	3.67	0
S_1V_3	3.67	3.67	0
S_1V_4	3.67	3.67	0
S_1V_5	4.70	4.67	0.03
S_1V_6	4.00	2.67	0.33
S_1V_7	4.67	4.67	0
S_2V_1	2.67	2.67	0
S_2V_2	2.33	2.33	0
S_2V_3	3.00	3.00	0
S_2V_4	3.00	3.00	1.00
S_2V_5	3.33	2.67	0.67
S_2V_6	3.00	3.00	0
S_2V_7	3.00	2.67	0.33
$LSD_{0.05}$	1.22	1.15	
CV (%)	12.13	7.12	

4.28 Number of leaves per tiller:

Statistically significant variation was observed in case of number of leaves per tiller for different sowing times and different wheat varieties. The maximum number of leaves per tiller was recorded from S_2 (30 December, 2011) that was 4.571, while the minimum number of leaves per tiller was recorded from S_1 (6 December, 2011) that was 4.48 (Table-43).

Statistically significant variation was observed in case of number of leaves per tiller for different wheat varieties. The maximum number of leaves per tiller was recorded from V_2 (Prodip) that was 4.83, while the minimum number of leaves per plant was recorded from V_4 (Sufi) that was 4.33 (Table-44).

Statistically significant variation was observed on number of leaves per tiller for interaction within different sowing times and different wheat varieties. The maximum number of leaves per tiller was recorded from S_1V_2 (Prodip) that was 5, while the

minimum number of leaves per tiller was recorded from S_1V_1, S_1V_3, S_1V_4, S_1V_5, S_1V_7, S_2V_4, S_2V_6 and S_2V_6 that was 4.33 for those as treatment combination Table-45).

4.29 Number of leaves per plant:

Statistically significant variation was observed in case of number of leaves per plant for different sowing times and different wheat varieties. The same number of leaves per plant was recorded from both S_1 (6 December, 2011) and S_2 (30 December, 2011) that was 17.90 for both (Table-43).

Statistically significant variation was observed in case of number of leaves per plant for different wheat varieties. The maximum number of leaves per plant was recorded from wheat variety V_5 that was 18.67, while the minimum number of leaves per plant was recorded from V_2 (Prodip) that was 16.67 (Table-44).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum number of leaves per plant was recorded from S_1V_5 that was 20 while the minimum number of leaves per plant was recorded from S_2V_2 that was 16 (Table-45).

Table 43. Effect of different sowing times on number of leaves per tiller and number of leaves per plant of different wheat varieties

Sowing times	No. of leaves per tiller	No of leaves per plant
S_1 (6 December, 2011)	4.48	17.91
S_2 (30 December, 2011)	4.57	17.91
$LSD_{0.05}$	0.06	0.98
CV (%)	3.17	2.19

Table 44. Effect of different genotypes of wheat on number of leaves per tiller and no. of leaves per plant

Varieties	No. of leaves per tiller	No of leaves per plant
V_1 (BAW-1104)	4.5	18.00
V_2 (Prodip)	4.47	16.67
V_3 Gourab)	4.50	18.00
V_4 (Sufi)	4.33	17.33
V_5 (Pavan-76)	4.83	18.67
V_6 (BL-1022)	4.5	18.00
V_7 (Kalyan sona)	4.5	18.00
$LSD_{0.05}$	0.17	0.91
CV (%)	3.17	2.19

Table 45. Interaction effect of different sowing times and different wheat varieties on number of leaves per tiller and number of leaves per plant

Treatment	No. of leaves per tiller	No of leaves per plant
S_1V_1	4.33	16.67
S_1V_2	4.33	20.00
S_1V_3	4.33	17.33
S_1V_4	4.33	17.33
S_1V_5	5.00	18.67
S_1V_6	4.67	17.33
S_1V_7	4.33	18.67
S_2V_1	4.67	17.33
S_2V_2	4.17	16.00
S_2V_3	4.67	18.67
S_2V_4	4.33	17.33
S_2V_5	4.67	18.67
S_2V_6	4.33	20.00
S_2V_7	4.67	17.67
$LSD_{0.05}$	0.36	2.33
CV (%)	3.17	2.19

4.30 Ear (spike) length (cm):

Statistically significant variation was observed in case of ear (spike) length for different sowing times and different wheat varieties. The largest ear (spike) length was recorded from S_1 (6 December, 2011) that was 14.31 (cm), while the shortest ear (spike) length was recorded from S_2 (30 December, 2011) that was 14.16cm (Table-46).

Statistically significant variation was observed for different wheat varieties. The highest ear length (cm) was recorded from V_5 (Pavan-76) that was 16.14 cm while the shortest ear length was recorded from V_7 that was 13.02 cm (Table-47). Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The largest ear length (cm) was recorded from S_1V_5 (Pavana-76) that was 16.45 cm. While the shortest Ear length was recorded from S_2V_6 and S_2V_7 that was 12.88 cm and 12.89 cm respectively (Table-48).

4.31 Ear weight (At harvest):

Statistically significant variation was observed in case ear weight for different sowing times and different wheat varieties. The highest ear weight was recorded from S_1 (6 December, 2011) that was 3.04g, while the minimum ear weight was recorded from S_2 (30 December, 2011) that was 2.93g (Table-46).

Statistically significant variation was observed for different wheat varieties for the character ear weight. The highest weight (g) was recorded from wheat variety V_5 (Pravan-76) that was 3.15 g, while the minimum ear weight was recorded from V_2 (Prodip) and V_6 (BL-1022) that was 2.81 g for both (Table-47).

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The highest ear weight was recorded from S_1V_5 that was 3.27 g, while the minimum ear weight was recorded from S_2V_2 and S_2V_6 that was 2.76 g (Table-48).

Table 46. Effect of different sowing times on ear (spike) length (cm) and ear weight (g) of different wheat varieties

Sowing times	Ear length (cm)	Ear weight (g)
S_1 (6 December, 2011)	14.31	3.04
S_2 (30 December, 2011)	14.16	2.93
$LSD_{0.05}$	0.10	1.07
CV (%)	8.26	3.22

Table 47. Effect of ear (spike) length and ear (spike) weight of different varieties of wheat

Varieties	Ear (spike) length (cm)	Ear (spike) weight (g)
V_1 (BAW-1104)	14.04	2.82
V_2 (Prodip)	15.87	2.81
V_3 Gourab)	13.47	3.14
V_4 (Sufi)	13.93	3.15
V_5 (Pavan-76)	16.14	3.08
V_6 (BL-1022)	13.17	2.81
V_7 (Kalyan sona)	13.02	3.10
$LSD_{0.05}$	2.35	0.23
CV (%)	8.26	3.22

Table 48. Interaction effect of different sowing times and different wheat varieties on spike length and spike weight

Treatment combinations	Spike length (cm)	Spike weight (g)
S_1V_1	13.98	2.87
S_1V_2	16.33	2.87
S_1V_3	13.62	3.15
S_1V_4	13.92	3.27
S_1V_5	16.45	3.13
S_1V_6	13.44	2.86
S_1V_7	13.17	3.17
S_2V_1	15.83	2.77
S_2V_2	15.41	2.66
S_2V_3	13.32	3.13
S_2V_4	13.95	3.03
S_2V_5	14.10	3.02
S_2V_6	12.88	2.76
S_2V_7	12.89	3.04
$LSD_{0.05}$	1.974	0.96
CV (%)	8.26	3.22

4.32 Culm weight (g):

Statistically significant variation was observed in case of culm weight (g) for different sowing times and different wheat varieties. The maximum stem weight (g) was recorded from S_1 (6 December, 2011) that was 53.54 (g), while the minimum stem weight (g) was recorded from S_2 (30 December, 2011) that was 53. 36 g (Table-49).

Statistically significant variation was observed in case of stem weight for different wheat varieties. The highest stem weight (g) was recorded from V_5 (Pravan-76) that was 57.58(g), while the lowest stem weight was recorded from V_2 (Pradip) that was 49.42 g (Table-50)

Statistically significant variation was observed for interaction within different sowing times and different wheat varieties. The maximum stem weight (g) was recorded from S_1V_5 that was 58.08g and the minimum stem weight (g) was recorded from S_2V_2 that was 49.36 g (Table-51).

4.33 Root weight (g):

Statistically significant variation was observed in case of root weight (g) for different sowing times and different wheat varieties. The maximum root weight (g) was recorded from S_1 (6 December, 2011) that was 1.39 (g), while the minimum root weight (g) was recorded from S_2 (30 December 2011) that was 1. 30 g (Table-49).

Statistically significant variation was observed in case of root weight (g) for different wheat varieties. The highest root weight (g) was recorded from V_5 (Pavan-76) that was 1.62(g), while the minimum root weight was recorded from V_3 (Gourab) that was 1.14 g (Table-50).

Statistically significant variation was observed in case of root weight for interaction within different sowing times and different wheat varieties. The highest root weight was recorded from S_1V_5 that was 1.67g, while the minimum root weight was recorded from S_1V_4, S_2V_3 that was 1.14g for both as treatment combination (Table-51).

Table 49. Effect of different sowing times on stem weight (g) and root weight (g) of different wheat varieties

Sowing times	Stem weight (g)	Root weight (g)
S_1 (6 December, 2011)	53.54	1.39
S_2 (30 December, 2011)	53.36	1.30
$LSD_{0.05}$	0.12	0.06
CV (%)	9.00	2.33

Table 50. Effect of different wheat varieties on stem weight and root weight

Varieties	Stem weight (g)	Root weight (g)
V_1 (BAW-1104)	51. 67	1.25
V_2 (Prodip)	49.42	1.15
V_3 Gourab)	50.67	1.14
V_4 (Sufi)	55.09	1.32
V_5 (Pavan-76)	57.58	1.62
V_6 (BL-1022)	54.42	1.52
V_7 (Kalyan sona)	55.40	1.42
LSD $_{0.05}$	3.15	0.15
CV (%)	9.00	2.33

Table 51. Interaction effect of different sowing times and different wheat varieties on stem weight (g) and root weight (g)

Treatment	Stem weight (g)	Root weight (g)
S_1V_1	51.67	1.34
S_1V_2	51.07	1.15
S_1V_3	49.48	1.14
S_1V_4	55.59	1.37
S_1V_5	58.08	1.67
S_1V_6	54.48	1.57
S_1V_7	54.44	1.47
S_2V_1	51.67	1.16
S_2V_2	49.36	1.15
S_2V_3	57.08	1.14
S_2V_4	54.59	1.27
S_2V_5	50.06	1.57
S_2V_6	54.37	1.47
S_2V_7	56.37	1.37
LSD $_{0.05}$	3.19	0.22
CV (%)	9.00	2.33

4.34 Number of spikelet per spike:

Statistically significant variation was observed in case of number of spikelet per spike for different sowing times and different wheat varieties. The maximum number of spikelets per spike was recorded from S_1 (6 December, 2011) that was 19.714, while the minimum number of spikelet per spike was recorded from S_2 (30 December, 2011) that was 19. 05 (Table-52). Statistically significant variation was observed in case of number of spikelet per spike for different wheat varieties. The highest number of spikelet per spike was recorded from V_5 (Prodip) that was 21.17, while the minimum

number of spikelets per spike recorded from V_2 that was 17.67, which was identical to V_3 (G) that was 18.67 (Table-53). Statistically significant variation was observed in case of number spikelets per spike for interaction within different sowing times and different wheat varieties. The maximum number of spikelets per spike was recorded from S_1V_5 that was 21 while the minimum spikelets per spike was recorded from S_2V_2 that was 17.67 as treatment combination (Table-54).

Table 52. Effect of different sowing times on number of spikelets per spike of different wheat varieties

Sowing times	Number of spikelets per spike
S_1 (6 December, 2011)	19.71
S_2 (30 December, 2011)	19.05
$LSD_{0.05}$	0.50
CV (%)	12.00

Table 53. Effect of different wheat varieties on number of spikelets per spike

Varieties	Number of spikelets per spike
V_1 (BAW-1104)	20.33
V_2 (Prodip)	17.67
V_3 Gourab)	18.67
V_4 (Sufi)	19.67
V_5 (Pavan-76)	21.17
V_6 (BL-1022)	19.67
V_7 (Kalyan sona)	18.50
$LSD_{0.05}$	1.31
CV (%)	12.00

Table 54. Interaction effect of different sowing times and different wheat varieties on number of spikelets per spike

Treatment combinations	number of spikelets per spike
S_1V_1	21.33
S_1V_2	17.67
S_1V_3	20.67
S_1V_4	20.00
S_1V_5	21.67
S_1V_6	20.00
S_1V_7	18.67
S_2V_1	19.33
S_2V_2	17.67
S_2V_3	19.67
S_2V_4	19.33
S_2V_5	18.67
S_2V_6	19.33
S_2V_7	18.33
$LSD_{0.05}$	2.10
CV (%)	12.00

4.35 Spikelet no. per spike:

Statistically significant variation was observed in case of number of spikelet per spike for different sowing times and different wheat varieties. The maximum number of spikelet per spike was recorded from S_1 (6 December, 2011) that was 20, while the minimum number of spiklets per spike was recorded from S_2 (30 December, 2011) that was 19.905 (Table-55).

Statistically significant variation was observed from different wheat varieties. The maximum spikelet number per spike was recorded from V_5 (Pravan-76) what was 20.67, while the minimum number of spikelet per spike was recorded from V_2 (Prodip) that was 19.00 (Table-56).

Statistically significant variation was observed in case of no. of spikelets per spike for interaction of different sowing times and different wheat varieties. The maximum number of spikelets per spike was recorded from S_1V_5 and lowest from rest of the treatment combination.

4.36 Number of empty glumes or bracts per spikelet:

Statistically significant variation was observed in case of number of empty glumes or bracts per spikelet for different sowing times and different wheat varieties. The maximum number of empty glumes or bracts per spikelet was recorded from S_1 (6 December, 2011) that was 2.05, while the minimum number of empty glumes or bracts per spikelet was recorded from S_2 (30 December, 2011) that was 2 (Table-55).

Statistically significant variation was observed from different wheat varieties. The maximum number of empty glumes or bracts per spikelet was recorded from V_5 (Pravan-76) was 2.17, while the minimum number of empty glumes or bracts per spikelet was recorded from rest of the varieties that was 2.00 (Table-56).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The number of empty glumes or bracts was recorded from S_1V_5 that was 2.333 while the minimum number of empty glumes or bracts was recorded from rest of the wheat varieties that was 2 for them (Table-57).

4.37 Number of fertile floret per spikelet:

Statistically significant variation was observed in case of number of fertile floret per spikelet for different sowing times and different wheat varieties. The maximum number of fertile floret per spikelet was recorded from S_1 (6 December, 2011) that was 3.33, while the minimum number of fertile florets per spikelet was recorded from S_2 (30 December, 2011) that was 3.19 (Table-55).

Statistically significant variation was observed from different wheat varieties. The highest number of fertile florets per spikelet was recorded from V_5 what was 3.83, while the minimum number of fertile florets per spikelet was recorded from V_2, V_4, V_5, V_6 and V_7 that was 2 for them (Table-56).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The highest number of fertile florets per spikelet

was recorded from S_1V_5 and S_1V_7 that was 4.00, while the minimum number fertile floret per spikelet was recorded from S_1V_2, S_1V_4, S_1V_5, S_1V_6, S_2V_1, S_2V_2, S_2V_4, S_2V_5 and S_2V_6 that was 3.00 for those treatment combination (Table-57).

4.38 Number of sterile floret per spikelet:

Statistically significant variation was observed in case of number of sterile floret per spikelet for different sowing times and different wheat varieties. The same number of sterile florets per spikelet was recorded from both of sowing S_1 (6 December, 2011) and S_2 (30 December, 2011) that was 2.14 for them (Table-55).

Statistically significant variation was observed in case of number of sterile floret per spikelet for different wheat varieties. The same number of sterile floret per spikelet was recorded form V_5 that was 3 for both, while the minimum number of sterile floret per spikelet was recorded from V_1, V_2, V_3, V_4, V_5 and V_6 that was 2 for Them (Table-56).

Statistically significant variation was observed in case of number of sterile floret per spikelet for interaction of different sowing times and different wheat varieties. The highest number of sterile floret per spikelet was recorded from S_1V_5 and S_1V_7 that was 3.00, while the minimum number sterile floret per spikelet was recorded from S_1V_2, S_1V_4, S_1V_5, S_1V_6, S_2V_1, S_2V_2, S_2V_3, S_2V_4, S_2V_5 and S_2V_6 that was 2.00 for them as treatment combination (Table-57).

4.39 Number of grains per spikelet:

Statistically significant variation was observed in case of number of grains per spikelet for different sowing times and different wheat varieties. The highest number of grains per spikelet was recorded from S_1 (6 December, 2011) that was 3.29, while the minimum number of grains per spikelet was recorded for S_2 (30 December, 2011) that was 3.24 (Table-55).

Statistically significant variation was observed from different wheat varieties. The highest number of grains per spikelet was recorded from V_5 (Pravan-76) what was 3.83, while the minimum number of grains per spikelet was recorded from V_1V_2, V_5 and V_6 that was 3.0 (Table-56). In case of interaction the highest number of grains per spikelet was found from S_1S_5 and S_1 V_7 (4) and the lowest form S_1V_1, S_1V_2, S_1V_4, S_1V_6, S_2V_1, S_2V_2, S_2V_3, S_2V_5 and S_2V_6 which was 3.0 for those treatment combination (Table-57).

4.40 Weight of grains (g) per spikelet:

Statistically significant variation was observed in case of weight of grains per spikelet for different sowing times and different wheat varieties. The highest weight of grains per spikelet was recorded from S_1 (6 December, 2011) that was 0.149 g, while the minimum weight of grains per spikelet was recorded for S_2 (30 December, 2011) that was 0.106g (Table-55).

Statistically significant variation was observed from different wheat varieties. The highest weight of grains per spikelet was recorded from wheat varieties V_5 (Pravan-76) what was 0.248, while the minimum weight of grains per spikelet was recorded from V_1 (BLW-1104) and V_6 (BL-1022) that was 0.098 for them (Table-56).

4.41 Weight of husk (g) per spikelet:

Statistically insignificant variation was observed in case of weight the husk per spikelet for different sowing times and different wheat varieties and also their interaction spikelet was recorded from both of sowing S_1 (6 December, 2011) and S_2 (30 December, 2011) that was 0.29 g (Table-55). Statistically insignificant variation was observed for different wheat varieties. The same weight of husk per spike was recorded form V_1, V_2, V_3, V_4, V_5, V_6 and V_7 that was 0.29g Table-56).

Again statistically insignificant variation was observed on weight of husk per spikelet for interaction of different sowing times and different wheat varieties. The same weight of husk was recorded from all treatment combinations that was 0.29 g (Table-57).

Table 55. Effect of different sowing times on number of spikelets per spike, no. of. empty glumes or bracts per spikelet, no. of fertile florets per spikelet, no. of sterile florets per spikelet, no. of grains per spikelet, wt. of grains per spikelet and wt. of husk per spikelet of different wheat varieties

Sowing times	Spikelets Per spike	No. of empty glumes	No. of fertile florets spikelet	No. of sterile florets spikelet	No. of grains/ spikelet	Weight of grains/ spikelet	Weight of husk/ spikelet
S_1 (6 December, 2011)	20.00	2.10	3.33	2.24	3.65	0.21	0.38
S_2 (30 December, 2011)	19.91	2.00	3.19	2.14	3.29	0.15	0.29
$LSD_{0.05}$	0.06	0.96	0.09	0.96	0.04	0.39	0.31
CV (%)	6.33	1.99	4.33	1.32	6.77	3.22	2.11

Table 56. Effect of different wheat varieties on number of spikelets per spike, no. of. empty glumes or bracts per spikelet, no. of fertile florets per spikelet, no. of sterile floret per spikelet, no. of grains per spikelet, wt. of grains per spikelet and wt. of husk per spikelet

Varieties	Spikelets per spike	No. of empty glumes	No. of fertile florets spikelet	No. of sterile florets spikelet	No. of grains/ spikelet	Weight of grains/ spikelet	Weight of husk/ spikelet
V_1 (BAW-1104)	19.17	2.00	3.17	2.00	3.00	0.10	0.29
V_2 (Prodip)	19.00	2.00	3.00	2.00	3.00	0.097	0.29
V_3 Gourab)	20.50	2.00	3.00	2.00	3.00	0.12	0.29
V_4 (Sufi)	19.33	2.00	3.00	2.00	3.67	0.097	0.29
V_5 (Pavan-76)	20.69	2.17	3.83	2.00	3.83	0.397	0.29
V_6 (BL-1022)	20.67	2.00	3.00	2.00	3.00	0.25	0.29
V_7 (Kalyan sona)	20.33	2.00	3.00	2.00	3.83	0.13	0.29
$LSD_{0.05}$	0.50	0.09	0.49	0.39	0.67	0.16	0.37
CV (%)	6.33	1.99	4.33	1.32	6.77	3.22	2.11

Table 57. Interaction effect of different sowing times and different varieties on number of spikelets per spike, no. of empty glumes per spikelet, no. of fertile florets per spikelet, no. of sterile florets per spikelet , no. of grains per spikelet, wt. of grains per spikelet and wt. of husk per spikelet

Treatment	Spike Let/spike	No. of Empty glum /spikelet	No. of Fertile floret /spikelet	No. of Sterile floret Spikelet	No. of Grains/s pikelet	Wt. of grain/ spikelet	Wt. of husk/ spikelet
S_1V_1	19.00	2.00	3.33	2.00	3.0	0.097	0.29
S_1V_2	19.00	2.00	3.00	2.00	3.0	0.097	0.29
S_1V_3	20.33	2.00	4.00	2.00	4.0	0.13	0.29
S_1V_4	20.67	2.00	3.00	2.00	3.0	0.097	0.29
S_1V_5	20.67	2.33	4.00	3.00	3.67	0.17	0.29
S_1V_6	20.87	2.00	3.00	2.00	3.0	0.097	0.29
S_1V_7	20.33	2.00	3.00	2.00	3.00	0.13	0.29
S_2V_1	19.33	2.00	3.00	2.00	3.0	0.097	0.29
S_2V_2	19.00	2.00	3.00	2.00	3.0	0.086	0.29
S_2V_3	20.67	2.00	3.67	2.00	3.0	0.12	0.29
S_2V_4	20.67	2.00	3.00	2.00	3.33	0.097	0.29
S_2V_5	19.33	2.00	3.00	2.00	3.0	0.097	0.29
S_2V_6	20.67	2.00	3.00	2.00	3.0	0.399	0.29
S_2V_7	20.33	2.00	3.67	3.00	4.0	0.13	0.29
$LSD_{0.05}$	0.53	0.33	0.67	0.39	0.57	0.33	1.22
CV (%)	6.33	1.99	4.33	1.32	6.77	3.22	2.11

4.42 Number of fertile floret per spike:

Statistically significant variation was observed in case of number of fertile florets per spike for different sowing times and different wheat varieties. The highest number of fertile florets per spike was recorded from S_1 (6 December, 2011) that was 27.71, while the minimum number of fertile florets per spike was recorded from S_2 (30 December, 2011) that was 27.52(g) (Table-58).

Statistically significant variation was observed on number of fertile florets per spike of different wheat varieties. The highest number of fertile florets per spike was recorded from V_5 (Pavan-76) that was 29, while the minimum number of fertile florets per spike was recorded from wheat varieties V_2 (Prodip) that was 25.83 (Table-59).

Statistically significant variation was observed on number of fertile floret per spike for interaction of different sowing times and different wheat varieties. The highest

number of fertile floret per spike was recorded from S_1V_5 (Pavan-76) that was 29.67, while the minimum number of fertile florets per spike was recorded from S_2V_2 that was 25.67 as treatment combination (Table-60).

4.43 Number of sterile floret per spike:

Statistically significant variation was observed in case of number of fertile floret per spike for different sowing times and different wheat varieties. The highest number of sterile floret per spike was observed from S_1 (6 December, 2011) that was 26.76, while the minimum number of sterile floret per spike was recorded from S_2 (30 December, 2011) that was 26.33 (Table-58).

Statistically significant variation was observed in case of number of sterile floret per spike for different wheat varieties. The highest number of sterile floret per spike was recorded form V_5 (Pavan-76) that was 27.5, while the minimum number of sterile floret per spike was recorded from V_2 (Prodip) that was 24.67 (Table-59).

Statistically significant variation was observed for interaction of different wheat varieties and different sowing times. The highest number of sterile floret per spike was recorded from S_1V_5 (Pavan-76) that was 28.67, while the minimum number of sterile florets per spike was recorded from S_2V_2, (BAW-1104) that was 24.33 as treatment combination (Table-60).

Table 58. Effect of different sowing times on fertile florets per spikel, sterile florets per spike of different wheat varieties

Sowing time	No. of fertile florets per spike	No. of sterile florets per spike
S_1 (6 December, 2011)	27.71	26.76
S_2 (30 December, 2011)	27.42	26.33
$LSD_{0.05}$	0.13	0.26
CV (%)	11.33	9.77

Table 59. Effect of different wheat varieties times on number of fertile floret per spike and number of sterile floret per spike

Varieties	No. of fertile floret per spike	No. of sterile floret per spike
V_1 (BAW-1104)	26.67	24.67
V_2 (Prodip)	25.83	17.17
V_3 Gourab)	27.17	26.17
V_4 (Sufi)	28.33	27.33
V_5 (Pavan-76)	29.00	27.50
V_6 (BL-1022)	28.17	25.67
V_7 (Kalyan sona)	28.17	27.33
$LSD_{0.05}$	2.33	6.11
CV (%)	11.33	9.77

Table 60. Interaction effect of different sowing times and different wheat varieties on number of fertile florets per spike and number of sterile florets per spike

Treatment combinations	No. of fertile floret per spike	No. of sterile florets per spike
S_1V_1	27.33	26.33
S_1V_2	26.00	26.33
S_1V_3	27.00	26.00
S_1V_4	28.00	27.00
S_1V_5	29.67	28.67
S_1V_6	28.67	27.67
S_1V_7	29.00	28.00
S_2V_1	26.00	25.00
S_2V_2	25.67	24.33
S_2V_3	27.33	26.33
S_2V_4	28.67	27.67
S_2V_5	28.33	25.00
S_2V_6	27.67	26.67
S_2V_7	27.33	26.67
$LSD_{0.05}$	1.99	1.53
CV (%)	11.33	9.77

4.44 Number of grains per spike:

Statistically significant variation was observed in case of number of grains per spike for different sowing times and different wheat varieties. The highest number of grains per spike was recorded from S_1 (6 December, 2011) that was 25.14, while the minimum number of grains per spike was recorded from S_2 (30 December, 2011) that was 24.33 (Table-61).

Statistically significant variation was observed for different wheat varieties. The highest number of grains per spike was recorded form wheat varieties V_5 (Pravan-76) that was 26.17, while the minimum number of grains per spike was recorded from V_2 (Prodip) that was 21.17 (Table-62).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The highest number of grains per spike was recorded from S_1V_5 that was 27, while the minimum number of grains per spike was recorded from S_2V_2 that was 20.67 as treatment combination (Table-63).

4.45 Number of grains per plant:

Statistically significant variation was observed in case of number of grains per plant for different sowing times and different wheat varieties. The highest number of grains per plant was recorded from S_1 (6 December, 2011) that was 100.57, while the minimum number of grains per plant was recorded from S_2 (30 December, 2011) that was 99.76 (Table-61).

Statistically significant variation was observed in case of number of grains per plant of different wheat varieties. The highest number of grains per plant was recorded from wheat variety V_5 (Pavan-76) that was 107.67, while the minimum number of grains per plant was recorde from wheat variety V_2 (Prodip) that was 83.5 (Table-62).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The highest number of grains per plant was recorded from S_1V_5 that was 108.00, while the minimum number of grains per plant was recorded from S_2V_2 that was 82.67 as treatment combination (Table-63).

4.46 Weight of grains per spike:

Statistically significant variation was observed in case of weight of grains per spike for different sowing times and different wheat varieties. The highest number of weight of grains per spike was recorded from S_1 (6 December, 2011) that was 0.814g, while

the minimum weight of grains per spike was recorded from S_2 (30 December, 2011) that was 0.79 g (Table-61).

Statistically significant variation was observed for different wheat varieties. The highest weight of grains per spike was recorded from wheat variety V_5 (Pavan-76) that was 0.84 g, while the minimum weight of grains per spike was recorded from wheat variety V_2 (Prodip) that was 0.70 g (Table-62).

Statistically significant variation was observed for interaction of different wheat varieties and different sowing times. The highest weight of grains per spike was recorded from S_1V_5 that was 0.88, while the minimum weight of grains per spike was recorded from S_2V_2 that was 0.67 g (Table-63).

Table 61. Effect of sowing times on number of grains per spike, number of grains per plant, weight of grains per spike and weight of grains per plant of different wheat varieties

Sowing times	No. of grain/ Spike	No. of grains /Plant	Wt. of grain /Spike (g)	Wt. of grains/ Plant (g)
S_1 (6 December, 2011)	25.14	100.57	0.81	3.25
S_2 (30 December, 2011)	24.33	99.76	0.799	3.17
$LSD_{0.05}$	0.61	0.32	0.31	0.05
CV (%)	6.11	9.33	12.13	13.12

Table 62. Effect of different wheat varieties on number of grain per spike, number of grain per plant, weight of grains per spike and weight of grain per plant

Varieties	No. of grain/ Spike	No. of grains /Plant	Wt. of grain /Spike (g)	Wt. of grains/ Plant (g)
V_1 (BAW-1104)	21.17	93.67	0.77	2.97
V_2 (Prodip)	21.00	83.50	0.70	2.64
V_3 Gourab)	25.67	101.17	0.84	3.24
V_4 (Sufi)	26.00	105.33	0.84	3.41
V_5 (Pavan-76)	26.17	107.67	1.84	3.45
V_6 (BL-1022)	25.67	104.67	0.83	3.39
V_7 (Kalyan sona)	25.00	105.17	0.83	3.39
$LSD_{0.05}$	3.67	10.13	0.12	0.39
CV (%)	6.11	9.33	12.13	13.12

Table 63. Interaction effect of different sowing times and different wheat varieties on number of grains per spike, no. of grains per plant and wt. of grains per plant

Treatment combinations	No. of grain/ Spike	No.of grains /Plant	Wt. of grain /Spike (g)	Wt. of grains/ Plant (g)
S_1V_1	23.33	93.33	0.76	2.67
S_1V_2	23.67	94.00	0.78	3.01
S_1V_3	25.33	101.33	0.82	3.27
S_1V_4	26.67	106.67	0.86	3.45
S_1V_5	27.00	108.00	0.88	3.49
S_1V_6	26.67	106.67	0.86	3.45
S_1V_7	26.33	105.33	0.85	3.40
S_2V_1	21.67	84.33	0.73	2.93
S_2V_2	20.67	82.67	0.67	2.60
S_2V_3	26.00	101.00	0.85	3.20
S_2V_4	25.67	104.00	0.82	3.37
S_2V_5	25.00	107.33	0.81	3.40
S_2V_6	24.67	102.66	0.80	3.33
S_2V_7	23.67	105.00	0.80	3.37
$LSD_{0.05}$	3.19	7.33	0.16	0.35
CV (%)	6.11	9.33	12.13	13.12

4.47 Weight of grains (g) per plant:

Statistically significant variation was observed in case of weight of grains (g) per plant for different sowing times and different wheat varieties. The highest weight of grains (g) per plant was recorded from S_1 (6 December, 2011) that was 3.25, while the minimum weight of grains (g) per plant was recorded from S_2 (30 December, 2011) that was 3.17 g (Table-61).

Statistically significant variation was observed for different wheat varieties. The highest weight of grains (g) per plant was recorded from wheat variety V_5 (Pavan-76) that was 3.45 g, while the minimum weight of grains (g) per plant was recorded from wheat variety V_2 (Prodip) that was 2.64 g (Table-62).

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The highest weight of grains (g) per plant was recorded from S_1V_5 that was 3.49, while the minimum weight of grains (g) per plant was recorded from S_2V_2 that was 2.60g as treatment combination (Table-63).

4.48 1000-grain weight (g):

Statistically significant variation was observed in case of 1000-grain weight (g) for different sowing times and different wheat varieties. The maximum 1000-grain weight (g) was recorded from S_1 (6 December, 2011) that was 33.25g, while the minimum 1000-grain weight (g) was recorded from S_2 (30 December, 2011) that was 33.1 g (Table-64).

Statistically significant variation was observed for different wheat varieties. The maximum 1000-grain weight (g) was recorded from V_5 (BL-1022) that was 33.77 g, while the minimum 1000-grain weight (g) was recorded from wheat varieties V_2 (Prodip) that was 32.27g, which was identical to V_4 (Sufi) that was 32.90 g (Table-65)

Statistically significant variation was observed for interaction of different sowing times and different wheat varieties. The highest 1000-grain weight (g) was recorded from S_1V_5 that was 33.93, while the minimum 1000-grain weight (g) was recorded from S_2V_2 that was 32.27g for both as treatment combination (Table-66).

4.49 Grain weight (g) per $1m^2$ area:

Statistically significant variation was observed in case of grain weight (g) per $1m^2$ area for different sowing times and different wheat varieties (Table-64). The highest grain weight (g) per $1m^2$ area was recorded from S_1 (6 December, 2011) that was 141.67 (g), while the minimum grain weight (g) per $1m^2$ area was recorded from S_2 (30 December, 2011) that was135.24 g (Table-65).

Statistically significant variation was observed for different wheat varieties. The maximum grain weight (g) per $1m^2$ area was recorded from V_5 (Pavana-76) that was 178.70 g; while the minimum grain weight (g) per $1m^2$ area was recorded from V_2 (Prodip) that was 92.67 g.

Statistically significant variation was observed for interaction between different sowing times and different wheat varieties. The highest grain weight (g) per $1m^2$ area was recorded from S_1V_5 that was 181.7 g, while the minimum grain weight (g) per $1m^2$ area was recorded from S_2V_2 which was 93.67 g as treatment combination (Table-66).

4.50 Straw weight per $1m^2$ area:

Statistically significant variation was observed in case of straw weight per $1m^2$ area for different sowing times and different wheat varieties. The highest straw weight per $1m^2$ area was recorded from S_1 (6 December, 2011) that was 409.81 (g), while the minimum straw weight per $1m^2$ area was recorded from S_2 (30 December, 2011) that was 408.57 g (Table-64).

Statistically significant variation was observed on straw weight per $1m^2$ area for different wheat varieties. The maximum straw weight per $1m^2$ area was recorded from V_5 (Pravan-76) that was 450.67 g, while the minimum straw weight per $1m^2$ area was recorded from V_2 (Prodip) that was 360.33 g (Table-65).

Statistically significant variation was observed in case of straw weight per $1m^2$ area for interaction of different sowing times and different wheat varieties. The highest straw weight per $1m^2$ area was recorded from S_1V_5 that was 451.33 g; while the minimum straw weight per $1m^2$ area was recorded from S_2V_2 that was 360.33g as treatment combination (Table-66).

4.51 Grain weight per hectare (t ha^{-1}):

Statistically significant variation was observed on grain weight (t ha^{-1}) for different sowing times and different wheat varieties. The highest grain weight (t ha^{-1}) was recorded from S_1 (6 December, 2011) that was 1.42 (t /ha), while the minimum grain weight (t ha^{-1}) was recorded from S_2 (30 December, 2011) that was 1.35 (t ha^{-1}) (Table-64).

Statistically significant variation was observed in case of grain weight (t ha^{-1}) for different wheat varieties. The highest weight (t ha^{-1}) of grain was recorded from wheat variety V_5 (Pavan-76) that was 1.79 (t ha^{-1}), while the minimum weight (t ha^{-1}) of grain was recorded from wheat varieties V_2 (Prodip) that was 0.97 (t ha^{-1}) (Table-65).

Statistically significant variation was observed on grain weight (t ha^{-1}) for interaction within different sowing times and different wheat varieties. The highest grain weight (t ha^{-1}) was recorded from S_1V_5 that was 1.87 (t ha^{-1}), while the minimum grain weight (t ha^{-1}) was recorded from S_2V_2 that was 0.88 (t ha^{-1}), which was identical to S_2V_6 and

S_2V_7 that was 0.997 (t ha^{-1}) and 0.9767 (t ha^{-1}) respectively as treatment combination (Table-66).

4.52 Straw weight (t ha^{-1}):

Statistically significant variation was observed in case of straw weight (t ha^{-1}) for different sowing times and different wheat varieties. The highest straw weight (t ha^{-1}) was recorded from S_1 (6 December, 2011) that was 4.81 (t ha^{-1}), while the minimum straw weight (t ha^{-1}) was recorded from S_2 (30 December, 2011) that was 4.67 (t ha^{-1}) (Table-64).

Statistically significant variation was observed on straw weight (t ha^{-1}) for different wheat varieties. The highest weight of straw weight (t ha^{-1}) was recorded from wheat variety V_5 (Pravan-76) that was 5.33 (t ha^{-1}), while the minimum straw weight (t ha^{-1}) was recorded from wheat variety V_2 (Prodip) that was 4.33 (t ha^{-1}) (Table-65).

Statistically significant variation was observed on straw weight (t ha^{-1}) for interaction of different sowing times and different wheat varieties. The highest straw weight (tha^{-1}) was recorded from S_1V_5 that was 5.67 (t ha^{-1}), which was identical to S_1V_3 that was 5.00 ton/ha, while the minimum straw weight (t ha^{-1}) was recorded from S_2V_2 that was 4.33 (t ha^{-1}) for them as treatment combination (Table-66).

Table 64. Effect of different sowing times on 1000 grain weight, grain weight (g) per 1 m^2, straw weight (g) per 1 m^2, grain yield (t ha^{-1}) and straw yield (t ha^{-1}) different wheat varieties

Sowing times	1000 grain wt. (g)	Grain wt./m^2 (g)	Straw wt/ m^2 (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
S_1 (6 December, 2011)	33.25	141.67	409.81	1.42	4.81
S_2 (30 December, 2011)	33.10	135.24	408.57	1.35	4.67
$LSD_{0.05}$	0.10	4.89	0.50	0.50	0.10
CV (%)	9.13	5.89	13.22	6.78	4.33

Table 65. Effect of different wheat varieties on 1000 grain weight (g), grain weight per 1 m^2, straw weight per 1m^2, grain yield (t ha^{-1}), straw yield (t ha^{-1})

Varieties	1000grain Wt. (g)	Grain wt./m2 (g)	Straw wt./ m^2 (g)	Grain (t ha^{-1})	Straw wt. (t ha^{-1})
V_1 (BAW-1104)	32.90	174.20	390.67	1.74	4.67
V_2 (Prodip)	32.27	92.67	360.33	0.93	4.33
V_3 Gourab)	33.60	169.20	395.83	1.69	5.33
V_4 (Sufi)	33.27	156.70	431.00	1.570	4.67
V_5 (Pavan-76)	33.77	178.70	450.67	1.79	4.83
V_6 (BL-1022)	33.27	100.70	402.83	1.01	4.67
V_7 (Kalyan sona)	33.43	97.17	433.00	0.97	4.67
LSD $_{0.05}$	1.00	15.33	23.17	0.47	0.53
CV (%)	9.13	5.89	13.22	6.78	4.33

Table 66. Interaction effect of different sowing times and different whea varieties on 1000 grain weight (g), grain weight per 1 m^2, straw weight per 1 m^2, grain yield (t ha^{-1}) and straw yield (t ha^{-1})

Treatment	1000grain wt. (g)	Grain wt./ m^2 (g)	Straw wt. /m^2 (g)	Grain yield (t ha^{-1})	Straw wt. (t ha^{-1})
S_1V_1	32.27	171.7	360.33	1.72	4.333
S_1V_2	33.53	166.7	390.33	1.67	4.667
S_1V_3	33.27	175.7	450.00	1.76	5.667
S_1V_4	32.57	151.7	431.33	1.52	4.667
S_1V_5	34.10	181.12	451.33	1.82	5.000
S_1V_6	33.93	99.67	400.00	0.997	4.667
S_1V_7	32.93	171.7	432.00	0.94	4.667
S_2V_1	32.27	176.7	360.03	1.77	4.66
S_2V_2	32.27	93.67	321.00	0.88	4.333
S_2V_3	33.93	87.67	390.33	1.72	5.000
S_2V_4	33.23	161.7	431.00	1.62	4.667
S_2V_5	32.80	97.67	395.33	0.98	4.667
S_2V_6	33.60	101.7	405.67	1.02	4.667
S_2V_7	33.93	100.7	434.00	1.01	4.667
LSD $_{0.05}$	1.00	0.05	20.12	0.02	1.20
CV (%)	9.13	5.89	13.22	6.78	4.33

4.53 Biological yield (t/ ha):

Statistically significant variation was observed on biological yield (t ha^{-1}) for different sowing times and different wheat varieties. The maximum biological yield was recorded from S_1 (6 December, 2011) that was 6.16 (t ha^{-1}), while the minimum biological yield (t ha^{-1}) was recorded from S_2 (30 December, 2011) that was 6.09 (t ha^{-1}) (Table-67).

Statistically significant variation was observed for different wheat varieties. The highest biological yield (t ha^{-1}) was recorded from wheat variety V_5 (Pavana) that was 6.62 (t ha^{-1}), while the minimum biological yield was recorded from V_2 (Prodip) that was 5.64 (t ha^{-1}) (Table-68).

Statistically significant variation was observed in case of biological yield (t ha^{-1}) for interaction within different wheat varieties and different sowing times. The highest biological yield (t ha^{-1}) was recorded from S_1V_5 that was 7.42 (t ha^{-1}), while the minimum biological yield was recorded from S_2V_2 that was 6.10 (t ha^{-1}) which was identical to S_2V_7 that was 5.60 (t ha^{-1}) as treatment combination (Table-69).

Table 67. Effect of different sowing times on biological yield (t ha^{-1}) and harvest index (%) of different wheat varieties

Sowing times	Biological yield (t ha^{-1})	Harvest Index %
S_1 (6 December, 2011)	6.16	23.33
S_2 (30 December, 2011)	6.09	21.92
LSD $_{0.05}$	0.05	0.52
CV (%)	5.13	14.22

Table 68. Effect of different wheat varieties on biological yield (t ha^{-1}) and harvest index (%)

Varieties	Biological yield (ton/ha)	Harvest Index %
V_1 (BAW-1104)	6.07	27.03
V_2 (Prodip)	5.64	14.85
V_3 Gourab)	6.27	26.58
V_4 (Sufi)	6.24	25.17
V_5 (Pavan-76)	6.62	28.65
V_6 (BL-1022)	5.68	17.79
V_7 (Kalyan sona)	6.36	17.21
LSD $_{0.05}$	0.39	6.23
CV (%)	5.13	14.22

Table 69. Interaction effect of different sowing times and different wheat varieties on biological yield (t ha^{-1}) and harvest index %

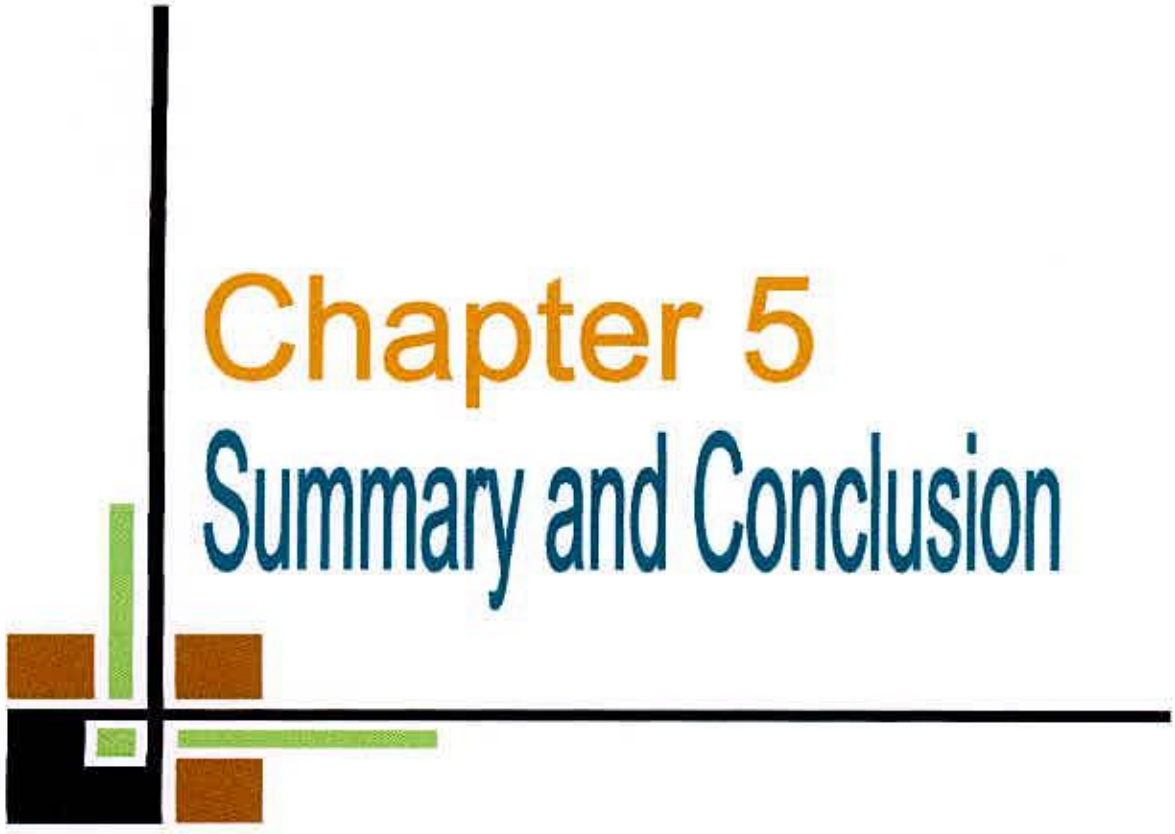
Treatment combinations	Biological yield (ton/ha)	Harvest index %
S_1V_1	6.05	28.38
S_1V_2	6.33	26.32
S_1V_3	5.88	23.66
S_1V_4	6.18	24.53
S_1V_5	7.42	28.97
S_1V_6	5.66	17.59
S_1V_7	5.60	17.19
S_2V_1	6.10	16.72
S_2V_2	5.64	14.91
S_2V_3	6.82	26.65
S_2V_4	6.28	25.73
S_2V_5	6.38	18.02
S_2V_6	5.68	26.87
S_2V_7	5.67	17.75
$LSD_{0.05}$	1.69	8.36
CV (%)	5.13	14.22

4.54 Harvest Index (%):

Statistically significant variation was observed on harvest index for different sowing times and different wheat varieties. The highest harvest Index was recorded from S_1 (6 December, 2011) that was 23.33(%), while the minimum harvest Index was recorded from S_2 (30 December, 2011) that was 21.92(%) (Table-67).

Statistically significant variation was observed in case of harvest index of different wheat varieties. The highest harvest index was recorded from wheat variety V_5 (Pravan-76) that was 28.65(%), while the minimum harvest index was recorded from wheat variety V_2 (Prodip) that was 14.85(t ha^{-1}) (Table-68).

Statistically significant variation was observed in case of harvest index for interaction between different sowing times and different wheat varieties. The highest harvest index was recorded from S_1V_5 that was 28.97(%), while the minimum harvest index was recorded from S_2V_2 that was 14.91(%) as treatment combination (Table-69).



Chapter 5
Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

Summary

The experiment was carried out at the Agricultural Botany experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period from "December, 2011 to April, 2012" to observe the effect of sowing times on morpho-physiological and reproductive pattern of late sown wheat of somes elected wheat varieties. The experiment comprised of two factors; Factor A: Sowing times (2 Sowing times)- S_1 (6 December, 2011) and S_2 (30 December, 2011. Factor B: Wheat varieties (7 wheat varieties) – V_1 (BAW-1104), V_2 (Prodip), V_3 (Gourab), V_4 (Sufi), V_5 (Pavan-76), V_6 (BL-1022), V_7 (Kalyan sona). The experiment was laid out in Randomized Complete Block Design (RCBD) with three (3) replications. Data on different parameters i.e. reproductive, yield contributing characters and yield were recorded and significant variation was recorded for sowing times, wheat varieties and their interaction.

The highest percentage of seeding emergence was recorded from S_1 (6 December, 2011) that was 97.14(%). The minimum percentage of seeding emergence was recorded from S_2 (30 December, 2011) that was 95.71(%). The highest plant height was recorded from S_1 that was 20.07cm at 20DAS, 54.01cm at 40DAS, 82.42cm at 60DAS and 84.22cm at harvest, while the shortest plant height was recorded from S_2 that was 13.65cm at 20DAS, 29.64 cm at 40DAS, 71.13cm at 60DAS and 80.22 cm at harvest respectively. The maximum number of leaves per plant was recorded from S_1 that was 5.05, 19.13 and 22.82 at 20DAS, 40DAS and 60DAS respectively, while the minimum number of leaves per plant was recorded from S_2 that was 2.37, 9.07 and 20.76 at 20DAS, 40DAS and 60DAS respectively. The maximum number of tillers per plant was recorded from S_1 that was 1.277, 5.833, 8.00 at 20DAS, 40DAS, 60DAS and at harvest respectively, while the minimum number of tillers per plant was recorded from S_2 that was 1.060 and 4.895, 6.91 at 20DAS, 40DAS and 60DAS respectively. The maximum days to starting of booting, 50% and 100% booting was recorded form S_1 that was 53.43DAS, 54.76DAS and 56.19DAS, while the minimum

days to starting of booting, 50% booting and 100% booting was recorded form S_2 that was 53.38DAS, 55.29DAS and 56.1DAS respectively.

The highest days to starting of ear emergence, 50% ear emergence and 100% ear emergence was recorded from S_1 that was 55.1 DAS, 58.52DAS and 63.1DAS respectively while the minimum days to starting of ear emergence, 50% ear emergence and 100% ear emergence was recorded from S_2 that was 54.29 DAS, 58.1 DAS and 61.05 DAS respectively. The minimum days required for staring of anthesis, 50% anthesis and 100% anthesis was recorded from S_2 that was 57.71 DAS, 65.52 DAS and 68.57 DAS respectively; while the minimum days required for starting of anthesis, 50% anthesis and 100% anthesis was recorded from S_2 that was 56.71 DAS, 65.05 DAS and 67.67 DAS respectively. The maximum SPAD- reading was recorded from S_1 that was 52.19; while the minimum SPAD-reading was recorded form S_2 that was 50.53.

The maximum days required for maturity and ripening was recorded from S_1 that was 76.33 DAS and 91.05 DAS respectively; while the minimum days to required for maturity and ripening was recorded from S_2 that was 73.29 DAS and 90.38 DAS respectively. The highest length, breadth and area of flag leaves was recorded from S_1 that was 21.34 cm, 1.32 cm and 28.56cm^2 respectively; while the minimum length, breath and area of flag leaves was recorded from S_2 that was 20.81cm, 1.34cm, 28.08 cm^2 respectively. The highest fresh weight of spike was recorded from S_1 that was 1.78, 1.99, 2.17, 2.38, 2.61, 2.79 and 3.04gm at 1 DAA, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest respectively, while minimum fresh weight of spike was recorded from S_2 that was 1.73, 1.93, 2.13, 2.33, 2.53, 2.73 and 2.93 at 1 DAA, 7 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest respectively. The maximum tiller height was recorded from S_1 that was 58.79 cm and 78.64 cm at 40 DAS and 60 DAS respectively, while the minimum height of tiller was recorded from S_2 that was 56.97cm and 74.47 cm at 40 DAS and 60 DAS respectively. The maximum number of tillers per plant, no. of fertile tillers per plant and minimum no. of sterile tiller per plant was recorded from S_1 that was 5.83, 4.43, 0.91 respectively, while the minimum number of tillers per plant, no. of fertile tillers per plant and maximum number of sterile tiller per plant was recorded from S_2 that was 4.9 and 3.38 respectively. The

maximum number of spikes per plant, no. of fertile spikes per plant and minimum no. of sterile spike per plant was recorded from S_1 that was 3.86, 3.43 and 0.43 respectively, while the minimum number of spikes per plant, number of fertile spikes or ears plant and maximum no. of sterile spikes per plant was recorded from S_2 that was 2.91, 2.76 and 1.14 respectively. The maximum no. of leaves per tiller and per plant was recorded from S_1 that was 4.57 and 17.91 respectively at harvest, while the minimum number of leaves per tiller and per plant was recorded from S_2 that was 4.48 and 17.91respectively at harvest. The maximum spike weight and spike length was recorded from S_1 that was 14.31cm while the minimum spike length and spike weight was recorded from S_2 that was 14.16cm. The maximum stem weight and root weight was recorded from S_1 that was 53. 54g and 1.39g, while the minimum stem weight and root weight that was S_2 that was 53.36g and 1.30g respectively. The maximum number of spikelet per spike was recorded from S_1 that was 19.72, while the minimum number of spikelets per spike was recorded from S_2 that was 19.05. The maximum number of spikelets per spike, no. of empty glumes or bracts, no. of fertile floret per spikelet, no. of sterile floret per spikelet, no. of grains per spikelet, wt. of grains per spikelet and wt. of husk per spikelet was recorded from S_1 those were 20, 2.05, 3.19, 2.14, 3.29, 0.15g, 0.29g respectively, while the minimum number of spikelets per spike, no. of fertile florets per spikelet, no. of sterile florets per spikelet, no. of grains per spikelet, wt. of grains per spikelet and wt. of husk per spikelet was recorded from S_2 those were 19.91, 2, 3.33, 2.14,3.24, 0.11 and 0.29g respectively. The maximum number of fertile florets per spike and sterile florets per spike was recorded from S_1 that was 27.71 and 26.76, while the minimum number of fertile florets per spikelet and sterile floret per spikelet was recorded from S_2 that was 27.52 and 26.33. The maximum number of grains per spike, no. of grains per plant, wt. of grains per spike and wt. of grains per plant was recorded from S_1 those were 25.14, 100.57, 0.81g and 3.25g respectively, while the minimum number of grains per spike, no. of grains per plant, wt. of grains per spike, wt. of grains per plant was recorded from S_2 that was 24.33, 99.76, 0.8g and 3.17g, respectively. The maximum weight of 1000- grain, grain weight m^{-2}, straw weight m^{-2}, grain yield t ha^{-1}, straw yield t ha^{-1} was recorded form S_1 that was 33.25 g, 141.67g, 409.81g, 1.42 (t ha^{-1}) and 4.67 (t ha^{-1}) respectively, while

the minimum weight of 1000-grain, grain weight m^{-2}, straw weight m^{-2}, grain yield t ha^{-1}, straw yield t ha-^{1} was recorded form S_2 that was 33.11, 135.24g, 408.57g, 1.35 (t ha^{-1}) 4.81 (t ha^{-1}) respectively. The maximum biological yield (t ha^{-1}) and harvest index was recorded from S_1 that was 6.16 (t ha^{-1}) and 23.33%, while the minimum biological yield and harvest index was recorded form S_2 that was 6.09 (t ha^{-1}) and 21.92%.

The maximum percentage of seedling emergence was recorded from V_4 (Sufi) that was 100%, while the minimum percentage of seedling emergence was recorded form V_1 (BAW-1104) V_2 (Prodip) and V_3 (Gourab) that was 96.67% for them. The highest plant height was recorded from wheat variety V_2 (Prodip) that was 18.69 cm, 46.77cm, 83.80 cm and 85.14 cm at 20 DAS, 40 DAS, 60 DAS and harvest respectively. While the minimum plant height was recorded from V_4 (Sufi) that was 15.92cm, at 20 DAS, which was indentical to V_6 (BL-1022) that was 15.42cm, at 20 DAS, 34.73 cm at 40 DAS and from V_5 (Pavan-76) which was 71.93cm, at 60 DAS, and from V_3 (Gourab) that was 79.03 cm at harvest, which was identical to V_4 (Sufi) that was 79.47 cm respectively. The maximum number of leaves per plant was recorded from V_5 that was 3.87, 17.90 and 16.20 at 20 DAS, 40 DAS and 60 DAS respectively, while the minimum number of leaves per plant was recorded from V_2 (Prodip) that was 3.53 at 20 DAS, 11.50 at 40 DAS and 16.20 at 60 DAS respectively. The maximum number of tillers per plant recorded from V_5 (Pravan-76) that was 1.46 at 20 DAS, 6.47 at 60 DAS and 9.17 at harvest respectively, while the minimum number of tillers per plant was recorded from V_2 that was 0.98, at 20 DAS, 4.83 at 40 DAS and 5.83 at harvest respectively. The maximum days required for starting of booting, 50% of booting and 100% of booting was recorded from V_7 that was 54.67 DAS, from V_2 that was 56.33 DAS and from V_4,V_5 that was 57.17 DAS, while the minimum days required for starting of booting 50% of booting and 100% of booting was recorded from V_4 that was 52.167 DAS and V_1 that was 52.67 DAS, V_7 that was 55 DAS. The minimum days required for starting of ear emergence, 50 % of ear emergence and 100% of ear emergence was recorded from V_7 that was 57.33 DAS, V_5 that was 59.67 DAS from V_4, V_6 and V_7 that was 62.67 DAS, while minimum days

required for ear emergence was recorded from V_1,V_4, V_6 and V_7 that was 57.33 DAS and 60.67 DAS respectively.

The maximum days required for starting of anthesis, 50% of anthesis and 100% of anthesis was recorded from V_4 that was 58.33 DAS, from V_1 that was 65.67 DAS and 69.17 DAS respectively, while the minimum days required for starting of anthesis, 50% of anthesis and 100% of anthesis was recorded from V_2 that was 56.5 DAS and 64.67 DAS, from V_3 that was 67.17 DAS respectively. The maximum days required for maturity and ripening was recorded from V_1,V_2, and V_6 that was 75.33 DAS, and from V_7 it was 92.67 DAS, while the minimum days required for maturity and ripening was recorded from V_3 which was 73.83 DAS and from V_1 it was 88.67 DAS. The maximum SPAD reading was recorded from V_5 that was 52.87; while the minimum SPAD reading was recorded from V_2 that was 49.88. The maximum length, breadth, and area of flag leaves was recorded from V_5 that was 24.48 cm, from V_1 that was 1.46 cm and 33.010 cm^2 respectively, while the minimum length, breadth and area of flag leaves was recorded from V_2 that was 18.56 cm, 1.27 cm and 24.53 cm^2 respectively. The maximum fresh weight of spike or ear was recorded from V_5 that were 1.87 g, 2.14g, 2.38g, 2.60 g, 2.807 g and 2.957g, at 1 DAA 7 DAA, 13 DAA, 19 DAA, 31 DAA at harvest respectively, while the minimum fresh weight of spike or ear was recorded from V_2 those were 1.57g, 1.81g, 1.97g 2.17g,2.37g, 2.61g and 2.8g at 1 DAS, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest respectively. The maximum number of leaves per tiller and per plant at harvest was recorded from V_5 that was 4.83 and 18.67 respectively, while the minimum number of leaves per tiller and per plant was recorded from V_2 that was 4.33 and 16.67 respectively. The height root weight, stem weight ear weight, ear length was recorded from V_5 those were 1.62g, 57.58g, 1.24g and 16.14 cm respectively, while the minimum root weight (g) , stem weight (g), ear weight (g) ear length (cm) was recorded from V_2 those were 1.14g, 49.42g, 0.74g and 13.02cm respectively. The maximum number of spikelets per ear was recorded from V_5 that was 20.33, while the minimum number of spikelets per ear was recorded from V_2 that was 18.5. The maximum no. of spikelets per ear, no. of fertile florets per spikelet, no of grains per spikelet, wt. of grains pre spikelet, wt. of husk per spikelet, minimum no. of empty glumes or bracts per spikelets, no. of sterile

florets per spikelet, was recorded from V_5. The minimum no of spikelet per ear, no of fertile florets per spikelet, no. of grains per spikelet, wt. of grains per spikelet, wt. of husk per spike, maximum no. of empty glumes or bracts, no. of sterile floret per spikelet was recorded from V_2 those were 19, 2, 3.0, 2 and 3.0.. The maximum no. of grains per spike, no. of grains per plant, wt. of grains per spike, wt. of grains per plant was recorded from V_5 those were 26.17, 105.33, 0.84g and 3.41g respectively. While the minimum no. of grains per spike, no. of grains per plant, wt. of grains per spike wt. of grains per plant was recorded from V_2 that was 21.17, 83.5, 0.71g and 2.64g respectively. The minimum weight of 1000-grain, grain weight m^{-2}, straw weight m^{-2}, grain yield t ha^{-1}, straw yield t ha^{-1} was recorded from V_2 that was 32.27g, 92.67g, 360.33g, 0.97 t ha^{-1}, 4.33 t ha^{-1} respectively, while the maximum weight of 1000-grain, grain weight m^{-2}, straw weight m^{-2}, grain yield t ha^{-1}, straw yield t ha^{-1} was recorded from V_5 that was 33.77g, 178.70g, 450.667g, 1.79 t ha^{-1} 5.33 t ha^{-1} respectively. The highest biological yield t ha^{-1}, was recorded from V_5 that was 6.62 t ha^{-1}, while the minimum biological yield t ha^{-1} was recorded from V_2 that was 5.64 t ha^{-1}. The highest harvest index was recorded from V_5 that was 28.65%, while the minimum harvest index was recorded from V_2 that was 14.85%.

The highest percentage of seedling emergence was recorded S_1 V_3, S_1 V_4, S_2V_1 and S_2V_4 those was 100% ; while the minimum percentage of seedling emergence was recorded from S_1V_1, S_2V_5, S_1V_6, S_1V_7 and S_2V_3 those was 93.33%. The highest plant height was recorded from S_2V_7 that was 22.06 cm at 20 DAS, from S_2V_1 that was 59.3 cm at 40 DAS, from S_2V_2 that was 89.13 cm at 60 DAS, from S_1V_1 that was 89.91 cm at harvest respectively, while the shortest plant height was recorded from S_1V_6 that was 12 cm at 20 DAS, 23.73 cm at 40 DAS; 66.27 cm at 60 DAS and S_2V_3 that was 76.67 cm at harvest. The highest number of leaves per plant was recorded from S_1V_5 that was 5.27 at 20 DAS, 20.47 at 40 DAS and 25.67 at 60 DAS respectively; while the minimum number of leaves per plant was recorded from S_2V_2 that was 2.07 at 20 DAS, 7.73 at 40 DAS and 14 at 60 DAS respectively. The maximum number of tillers per plant was recorded from S_1V_5 that was 1.64 at 20 DAS, 6.83 at 60 DAS and 9.67

at harvest respectively; while the minimum number of tillers per plant was recorded from S_2V_2 that was 0.9 at 20 DAS, 3.93 at 60 DAS, 5.33 at harvest respectively.

The maximum days required for starting of booting, 50% booting and 100% booting was recorded from S_1V_7 and S_2V_7 that was 54.67 DAS, from S_2V_2 that was 57 DAS, from S_1V_5 and S_2V_4 that was 57.67 DAS, while the minimum days required for starting of booting, 50% booting and 100% booting was recorded from S_2V_4 that was 51.67 DAS, from S_2V_1 and S_2V_1 that was 52.66 DAS, from S_2V_7 and S_2V_2 that was 54.67 DAS. The maximum days required for starting of ear emergence, 50% ear emergence and 100% of emergence was recorded from S_1V_7 that was 57.67 DAS, from S_1V_5 that was 60 DAS, from S_1V_1, S_1V_4 and S_1V_7 that was 63.67 DAS for them, while the minimum days required for starting of ear emergence, 50% of ear emergence and 100% ear emergence was recorded from S_2V_1 that was 52.67 DAS, from S_2V_2 and S_2V_5 that was 60.67 DAS respectively. The maximum days required for starting of anthesis, 50% anthesis and 100% anthesis was recorded from S_1V_1 those were 58.33 DAS, 65.67 DAS and 69.67 DAS respectively, while the minimum days required for starting of anthesis, 50% anthesis and 100% anthesis was recorded from S_2V_1 and S_2V_4 that was 58 DAS; from S_2V_2 and S_2V_5 that was 64.33 DAS, from S_2V_3 and S_3V_7 that was 66.67 DAS respectively. The maximum days required for maturity and ripening was recorded from S_1V_5 and S_1V_6 that was 78 DAS and from S_1V_7, S_2V_5 and S_2V_7 that was 92.67 DAS; while the minimum days required for maturity and ripening was recorded from S_2V_4 that was 70.67 DAS, from S_2V_1 that was 88.67 DAS. The maximum SPAD-reading was recorded from S_1V_5 that was 53.57, while the minimum SPAD reading was recorded from S_2V_2 that was 48.44. The highest length, breadth, area of flag leaves was recorded for S_1V_5 that was 24.5 cm, 1.410 cm and 35.027 cm^{-2} respectively; while the minimum length, breadth and area of flag leaves was recorded from S_2V_2 that was 17.81 cm, 1.3 cm and 23.247 cm^{-2} respectively. The maximum fresh weight of spike or ear was recorded from S_1V_5 that was 1.93g, 2.15g, 2.43g, 2.65g, 2.857g, 2.98g, 2. 15g at 1DAA, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA and at harvest respectively; while the minimum fresh weight of ear was recorded from S_2V_2 that was 1.55 g, 1.75g, 1.957g, 2.15g, 2.35g and 2.55g at 1DAA, 7 DAA, 13 DAA, 19 DAA, 25 DAA, 31 DAA harvest respectively. The

maximum tiller height at harvest was recorded from S_1V_4 that was 61.35 cm at 40 DAS and from S_1V_2 that was 84.18 cm at 60 DAS respectively. While the minimum height of tiller per plant was recorded from S_1V_7 that was 53.71 cm at 40 DAS and from S_2V_4 that was 72.13 cm at 60 DAS respectively. The maximum number of leaves per tiller and per plant was recorded from S_1V_5 that was 5 and 20 at harvest, while the minimum number of leaves per tiller and per plant was recorded form S_2V_2.

The maximum number of tillers per plant, no. of fertile tillers per plant, minimum no. of. sterile tiller per plant was recorded form S_1V_5 which was 6.83, 5.33 and 1 respectively. While the minimum number of tillers per plant, no. of fertile and maximum no. of sterile tiller per plant was recorded from S_2V_2 that was 3.93, 2.67 and 0.33 respectively. The maximum no. of ears per plant, no. of fertile ear per plant, minimum no. of sterile ear per plant was recorded form S_1V_5 that was 4.67, 4.00 and 0.67, while the minimum no. of ear per plant, no. of fertile ear per plant, maximum no. of sterile ear per plant was recorded from S_2V_2 that was 2.33, 2.33 and 1.67 respectively. The maximum weight of stem, root weight, ear length was recorded from S_1V_5 that was 58.08g, 1.67g, and 16.45 cm respectively. While the minimum stem weight, root weight, ear length was recorded from S_2V_2 that was 49.37g, 1.14g and 12.88 cm respectively. The maximum number of spikelet per ear was recorded from S_1V_5 that was 21.33, while the minimum number of spikelets per spike was recorded from S_2V_2 that was 17.67. The maximum no. of spikelet per ear, no. of fertile florets per spikelets, no. of grains per spikelet, wt. of grains per spikelet, wt. of husk per spikelet, minimum no. of empty glumes or bracts and sterile florets per spikelet, was recorded from S_1V_5 that was 20.33, 2, 0.129g, 0.29g ,4 ,4 , 2 respectively; while the minimum no. of spikelet per spike, , no. of fertile florets per spikelet, no. of sterile florets per spikelet, no. of grains per spikelet, wt. of grains per spikelet, wt. of husk per spikelet, no. of empty glumes or bracts per spikelet, no. of sterile floret per spikelet was recorded from S_2V_2 that was 19, 2.3, 2, 3, 0.11g and 0.29g respectively. The maximum no. of grains per spike, no. of grains per plant, wt. of grains per spike, wt. of grains per plant was recorded from S_1V_5 that was 27, 11, 0.88g, 3.49 g respectively. While the minimum no. of grains $spike^{-1}$, no. of grains $plant^{-1}$, wt. of grains per spike , wt. of grains per plant was recorded form S_2V_2 that was 20.67, 82.67,

0.67 g, 2.67g respectively. The maximum weight of 1000-grain, grains weight m^{-2} and straw weight m^{-2} were recorded form S_1V_5 those were 33.93, 181.7g and 451g respectively, while the minimum weight of 1000-grain, grain wt. m^{-2} and straw wt. m^{-2} was recorded from S_2V_2 that was 32.27g, 93.67g and 360.33g respectively.

The maximum grain yield tha^{-1} and straw yield t ha^{-1} were recorded form S_1V_5 those were 1.82 t ha^{-1}, 5 t ha^{-1} respectively, while the minimum grain yield t ha^{-1} and straw t ha^{-1} was recorded from S_2V_2 that was 0.88 t ha^{-1} and 4.33 t ha^{-1} respectively. The maximum biological yield was recorded from S_1V_5 that was 7.42t ha^{-1}, while the minimum biological yield was recorded from S_2V_2 that was 6.10 t ha^{-1}. The maximum harvest index was recorded form S_1V_5 that was 28.97% and the minimum harvest index was recorded from S_2V_2 that was 14.91%.

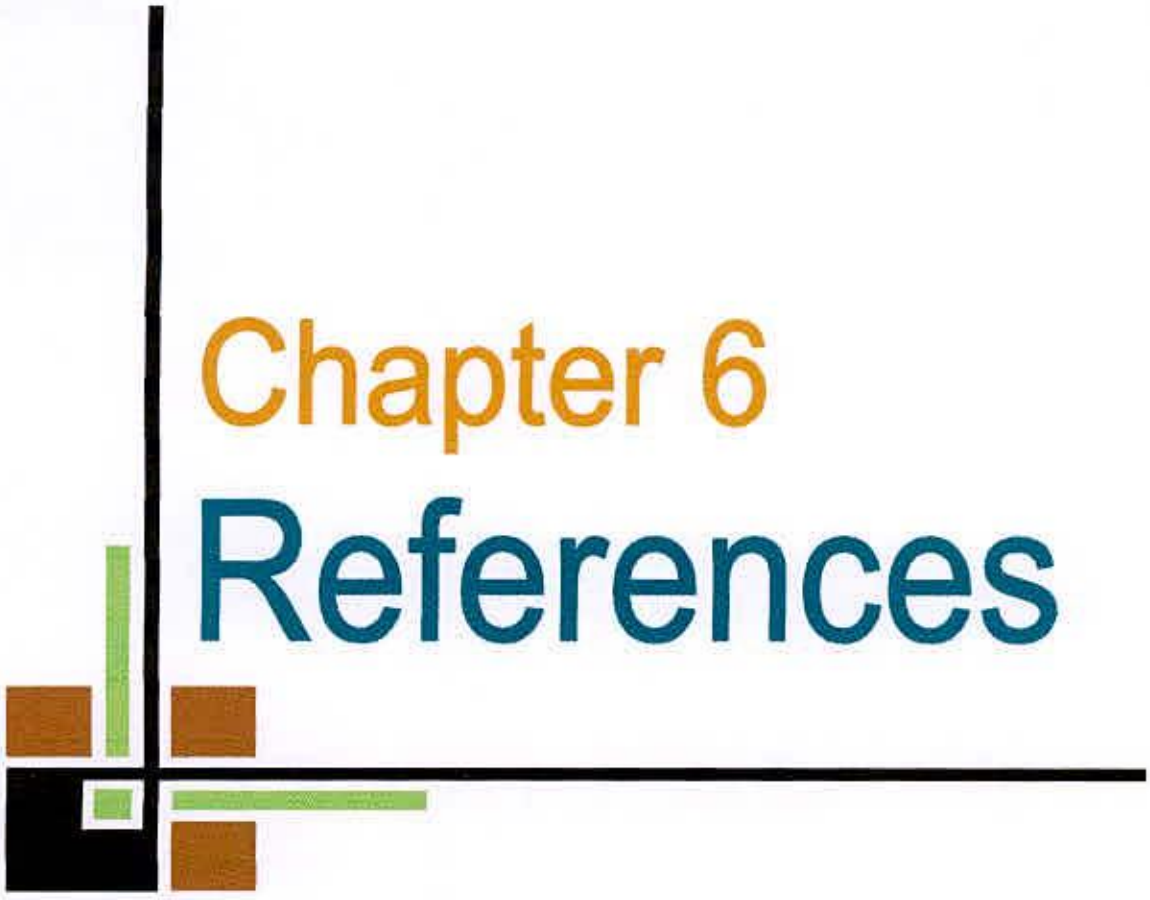
Conclusions

From the above results it can be concluded that 6 December, 2011(S_1) sowing provided best yield for most of the varieties and the varieties V_5 (Pavan-76) provided better yield than the all other varieties. However, the variety V_5 (Pavan-76) provided comparatively steady and better yield than others varieties. But yield was reduced in case of late sowing (S_2, 30 December) which was true for all the varieties. Among the treatment combinations S_1V_5 produce the highest grain that was 1.82 t ha^{-1} with most of the yield contributing character.

Fresh weight of spike suggested more increasing rate of weight in case 6 December sowing than 30 December sowing following higher weight in the earlier sowing.

Considering the results obtained from the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different Agro-ecological Zones (AEZ) of Bangladesh for regional compliance and other performances.
2. More experiments may be carried out with different wheat varieties.



Chapter 6
References

REFERENCES

Acevedo, F., Nachit, M. and Ferrana, G. 0. (1991). Effects of heat stress on wheat and possible selection tools for use in breeding for tolerance. pp. 40 1-420. In: D. A. Saunders (ed.) Wheat for the non-traditional warm areas. CIMMYR. Mexico D.F.

Ahmad, S, Ahmes N, Alimed, R and Haimd, M (1989) Effect of high temperature stress on wheat reproductive growth. I Agric. Res. 27: 307-313.

Ahmed, S., Islam, M, S., Salam, A. and Hossain, M. F. (2006). Effect of sowing time on the yield attributes of barley in High Barind Tract. Bangladesh J. Agril. Res. 31(2): 231-239.

Al-Kliatib, K. and Paulesn, G. M. (1990). Photosynthesis and productivity during high temperature stress of wheat genotypes from major world regions. Crop Sd. 30: 1127-1132.

Arbinda, S. Begur, S. N, Raliman, A. K. M. and Salahuddin, A. B. M. (1994) Influence of sowing time on the performance of different wheat genotypes. Ami. Cent. Res. Agron. Div., Bangladesh Agril. Res. Inst., Joydebpur, Gazipur. pp. 45-49.

Badruddm, M, Sauders, D. A., Siddique, A. B, Hossam, M. A, Abmed, M. A, Raliman, M. M. and Parveen, S (1994) Determining yield constraints for wheat production of Bangladesh. pp. 265-271.

BARI (Bangladesh Agricultural Research Institute) (1984) Annual Report 1981- 82 Joydebpur, Gazipur pp. 12-20

BARI (Bangladesh Agricultural Research Institute). (2006). Krishi Projukti Hat Boi BARI Joydevpur, Gazipur p. 14.

BARL (1993). Annual Report (1991-92). Bangladesh Agril. Res. Inst. Joydebpur, Gazipur. pp. 19-33.

BARI. (1997). Increase wheat cultivation and decrease irrigation cost (A folder in Bengali). Wheat Res. Centre. Bangladesh Agril. Res. Inst. Nashipur, Dinajpur. pp. 12-15.

BARI. (2003). Annual Report (2002-2003). Bangladesh Agril. Res. Inst. Joydebpur, Gazipur. pp. 17-23.

Bazza, M. J., Sadaria, S. G., Patel, J. C. (1999). Wheat and sugar beet with irrigation management practices through water-deficit irrigation. Indian I Agril. Sd., 69(13): 43 1-435.

BBS (Bangladesh Bureau of Statistics). (2008). Monthly Statistical Bulletin, Bangladesh. Statistics Division. Ministry of Planning. Government of the Peoples Republic of Bangladesh. Dhaka. pp. 64.

BBS (Bangladesh Bureau of Statistics). (2010). Monthly Statistical Bulletin, Bangladesh. Statistics Division. Ministry of Planning. Government of the Peoples Republic of Bangladesh. Dhaka. pp. 56.

Bhatta, M. R., Hernandez, J. E. and Lales, J. S. (1994). Possibilities of selecting wheats with fast grain filling rate for warmer areas. Pp. 3 75-378. In D.A. Saunders and G. P. Hatel (ed.) Wheat in Heat-stressed Environments: Irrigated. Dry Areas and Rice-wheat Farming System. CIMMYT. Mexico D.F.

Chowdhury, M. Z. R. (2002). Effect of different sowing times on morphopysiological feature yield and yield contributing characters of three modem wheat varieties. M. S. thesis, Dept. of crop botany, H. S. T. U, Dinajpur.

Cormy, M. 3. (1995). A note on the effect of sowing times and fertilizer on the yield, grain nitrogen and screening content of spring-sown malting baeley. Irish J. Agrial. And Food Res. 34(1): 69-73.

Donald, C. M, and Hamblin, J. (1976). The biological yield and harvest index of cereals as agrononue and plant breeding criteria. Adv. Agron. 28: 36 1-405.

Dubin, Y. P. and Ginkel, P. M. (1991). Wheat cultivation in the warmer climates exists in the South-East Asia including Bangladesh. Indian I Agrii. Sci., 58(1) 131-135.

Edns,K. M., Tslam,A.T.M.T., Chowdhury, M.S and Haque, A. K. M. M. (1979). Detailed Soil Survey of Bangladesh Agricultural University Farm, Mymensingh, Dept Soil Survey, Govt People's Republic of Bangladesh P.118..

Ehdaie, B. Skakiba, M R and Wames, J. G. (2001) Sowmg date and nitrogen mput influence nitrogen use efficiency m sprmg bread and durum wheat genotypes J. Plant Nutri 24(6) 899-919.

Eissa, A M, Eldm, T M S and Dawood, A M (1994) Planting rate m relation to yield and components of wheat m AL-Qassim region ArabGulf Sci Res12(3) 449-464.

FAO. (1988) Production Year Book Food and Agricultural of the United Nations Rome, Italy 42 190-193.

FAO. (1997) Production Year Book Food and Agricultural of the United Nations Rome, Italy 49 201-212.

FAO. (2000) Production Year Book Food and Agricultural of the United Nations Rome, Italy 54 176-186.

Fand, S. M, Hosam, A and Salahuddm, A B M (1993) Sowmg date effects on the yield of three cultivars of barley Bangladesh J. Agril Sci 20(1) 41-45.

Gaffer, M. A (1995) Development of management practices of inillets for higher prodution BAU Res, Frog Report 9 30-33.

Gales, K. and Wilson, N. J. (1979). Effect of water shortage on growth and yield of winter wheat. Agril. Res. Council Letcombe Laboratory, Wantage, UK. pp. 44-45.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedure for Agricultural Research (2nd edn). Int. Rice Res. Inst. A Willey int. Sci., pp. 28-192.

Haider. S. A. (2002). Effect of water stress on the physiology and grain yield of four bread wheat (*Triticum aestivum* L.) cultivars. Ph. D. thesis, Dept. of Botany, University of Rajshahi, Rajshalti, Bangladesh.

Harris, H. C., Copper, P. 1. M. and Pala, M. (1991). Soil and crop management for improved water use efficiency in rainfed area. Proc. Intl. Workshop. Ankara, tukey, 15-19 May, 1989. ICARDA, Aleppo, Syria.

Hossain, M. A., Maniruzaman, A. F. M. and Farid, S. M. (1990). Effect of date sowing and rate of fertilizers on the yield of wheat under irrigated condition. Bangladesh J. Agrii. 15(2): 105-113.

Hossain, M. J. (2006). Growth and development of barley as affected by irrigation frequency. M. S. thesis, Dept. of crop botany, H. S. T. U. Dinajpur.

Islam, N., Alimed, S. M., Ra.zzaque, M. A., Sufian, A. and Hossain, M. A. (1993). A study on the effect of seeding dates on the yield of wheat varieties. Bangladesh. J. Agril. Res. 18(1): 102-107.

Jalleta, T. (2004). Participatory evaluation of the performance of some improved bread wheat (Triticum aestivum) varieties. Exp. Agric. 40(1): 89-97.

Jhala, P. C. and Jadon, M. (1989). Effect of sowing time on different wheat genotypes. Indian I Agron. 34(1): 321-325.

Kobza, S. N. and Edwards, R. K. (1987). Response of wheat (Trilicum aestivum L.) to irrigation and fertilizer mixture under late condition. Bhartiya Krishi Anusandhan Patrika. 2(1): 31-36.

Litvinrnko,N. A., Braun, H. Y., Altay, F., Kronstad, W. E., Bemwal, S. P. S. and Nab (1997). Breeding intensive winter bread wheat varities for southern Vkranie. Wheat Prospects for global improvement proceedmgs of the 5th mtemational wheat conference, Anhara Turkey, 10-14 June, 1996.

Maikstemene, S, Kristaponyte, 1 and Arlauskiene, A (2006) Gram quality mdicators of wmter vaneties as affected by urea application through leaves. Zembirbyste, Moksol Darbai 93(3) 14 1-157 [Wheat, Barley and Tnticale Abst 2007]

Majumder, A R (1991) Assessment of yield loss caused by common root rot m wheat a cultivar m Queensland (Bipolaris sorokiniana) Australian J Agril Res (Ausiraha) 13(3) 143-151.

Moula, M. G (1999) Effect of date of planning and irrigation on the growth and yield of barley M Sc (Ag) Thesis, Dept. Agron Bangladesh Agril. Univ, Mymensingh

Nibedita, D (2009) Morphological performance of five selected wheat vanities. A Practicum Report of Internship Program College of Agricultural Sciences International University of Business Agriculture and Technology (RJBAT) 107. pp

Oweis, T., Zeidan, H. and Taimch, A (1992) Modeling approach for optimizing supplemental irrigation management Proc int Conf On Supplemental Imation and Drought water Management, Ban, Italy 1 Agron Mediterraneo, Bari.

Rahman, M. M. (1997). Effect of different levels of irrigation and nitrogen on the yield and yield contributing characters of foxtail millet M Sc (Ag) thesis, Dept Agron, Bangladesh Agril. Univ. Mymensingh.

Razzaque, A., Das, N., and Roy, S., (1992). Wheat is the most important cereal crop that contributes to the national economy. Indian J Agron. 26(1): 35-39.

Ryu, Y. H., Lee, C. G. and Ha, Y. W. (1992). The effects of sowing times on grain filling and related traits in winter barley. Korean J. Crop Sd. 37(1): 93-103.

Saari E. E. (1998). Leaves Blight Diseases and Associated Soil Borne Fungal Pathogens of Wheat in North and South East Asia. In: Helminthosporium Blights of Wheat: Spot Blotch and Tan Spot (eds.) by Duveiller E, Dubin HJ, Reeves J and Mc Nab A, CIMMYT, Mexico, D.F. pp. 37-51.

Samson, N. B., Arabinda, S. and Saifuzzaman, M. (1995). Study of the growth stage of Newly developed wheat varieties. Aim. Central. Res. BARI. Joydebpur. Gazipur. pp. 19-21.

Samuel, S. R., Deshmukh, P. S., Sairam, R. K. and Krshwaha, S. R. (2000). Influence of benzyl adenine application on yield and yield components in wheat genotypes under normal and late planning condition. Indian J. Agril. Sci. 23(1): 81-86.

Sarker, S., Singh, S. K., Singh, S. R. and Singh, A. P. (1999). Influence of initial profile water status and nitrogen doses on yield and evapotranspiration rate of dryland barley. I Indian Soc. Soil Sd. 47(1): 22-28.

Sekhon, N. G., Singh, K. K., Dhir, 1. S. and Chark, K. S. (1991). Effect of sowing time and growth regulators on wheat productivity. New trends in plant physiology. Proceeding, national symposium on growth and differentiation in plants.pp. 193-199.

Sharma, R. C. (1993). Growth periods in relation to seedling time and performance of soring wheat. I Inst. Agric.Animal Sd. 14: 23-29.

Shrivastava, R.B, Singh, V.P and Singh, D. (1998) Component characters of grain yield and harvest index m wheat Indian I Agric Res: 2(2), 65-74

Shukia, R, Singh, G. and Bhalla, Y (1992) Differential response of wheat genotype to moisture stress for good germination and early seedling growth Indian J. Agril Res: 28(2). 99-104.

Sulewska, H (2004) Characterization of 22 spelt (Triticum aestivum sp.Spelta) genotypes relating to some features Biuletyn Instytutu Hodowli Aklzmatyzacji Roslin 231. 43-53.

Tashiro, K. and Warslaw, H. (1989) Response of late sown wheat, barley and lentil to irrigation levels Haiyana J. Agron 5(1) 52-56.

Torofder, G.S, Hossain, M.A and Alam, M.M (1993) Effect of tillage and irrigation on the yield of barley Bangladesh J. Agric. Sci, 20: 6 1-67.

Uppal, H. S., Cheema, S. S. and Singh, S. (1998) Response of barley varieties to different levels of irrigation and introgen Crop Imp. 15: 142-145.Wheat Research Center (WRC). (2003). Annual Report. 2002-2003. Wheat Res. Centre, Bangladesh Agril. Res. Inst. Nashipur, Dinajpur. pp. 6-36.

Zende, N. B., Seth, H. N., Karunakar, A. P. and Jiotode, D. J. (2005). Effect of sowing time and fertility levels on growth and yield of durm wheat genotypes. Res.Crops. 6(2): 190-191.

Zhao, I. Q., Lu, M. and Li, G. (1985). Influence of sowing times on the growth and development of barley cv. Zhepi. Zhejiang Agril. Sci. 5: 217-221.

APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity and sunshine of the experimental site during the period from November 2009 to March 2010

Month	*Air Temperature (^{0}C)		*Relative Humidity (%)	*Rainfall (mm) (Total)	*Sunshine (hr)
	Maximum	Minimum			
November, 2009	21.7	14.2	77	0	6.7
December, 2009	22.4	13.5	74	00	6.3
January, 2010	24.5	12.4	68	00	5.7
February, 2010	27.1	16.7	67	30	6.7
March, 2010	31.4	19.6	54	11	8.2

* Monthly Average,

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka-1207.

Appendix II. Characteristics of experimental field soil (the soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmagate, Dhaka.

A. Morphological Characteristics of the experimental field

Morphological features	Characteristics
Location	Central Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
%Sand	27
%Silt	43
%Clay	30
Textural class	Silty-Clay
pH	5.6
Organic Carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (mc/100g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix III. Analysis of variance of the data on days to seedling emergence as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Mean square		
		Percentage of seedling emergence (Days)		
		Starting of emergence	50% emergence	100% emergence
Replication	2	0.091	0.352	0.025
Sowing times (A)	1	7.148**	6.039**	4.997**
Genotypes (B)	6	0.098	0.291	0.346
Error	70	0.087	0.329	0.810

** Significant a 0.01 level of probability; * Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on plant height as influenced by different sowing times and wheat genotypes

Source of Variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Replication	2	1.160	0.392	1.684	0.687	5.572
Sowing times (A)	1	1.8.574**	274.478**	319.363**	378.244**	451.084**
Genotypes (B)	6	26.389**	33.955**	49.783**	47.459**	74.198**
Interaction (AxB)	23	12.032**	18.987*	35.234**	57.377**	54.759**
Error	70	4.351	11.084	14.411	13.746	15.787

**: Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on number of tillers plant^{-1} influenced by different sowing times and wheat genotypes

Source of Variation	Degrees of freedom	Mean square			
		Days			
		30 DAS	40 DAS	50 DAS	60 DAS
Replication	2	0.002	0.025	0.017	0.048
Sowing times (A)	1	2.423**	2.172	3.188**	5.360**
Genotypes (B)	6	0.134**	0.277**	0.338**	0.491**
Interaction (AxB)	23	0.053**	0.146**	0.241**	0.269**
Error	70	0.017	0.048	0.085	0.107

**: Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on days required for starting of booting, ear emergence, anthesis and maturity as influenced by different sowing times and wheat genotypes

Source of Variation	Degrees of freedom	Mean square			
		Days required for			
		Starting of booting	Starting of ear emergence	Starting of anthesis	Starting of maturity
Replication	2	0.454	6.194	9.009	6.954
Sowing times (A)	1	198.14**	251.07**	354.33	434.06**
Genotypes (B)	6	5.509	12.083*	28.704	29.850
Interaction (AxB)	23	5.914**	17.015**	88.222**	46.649**
Error	70	2.530	5.537	23.390	22.573

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on leaves plant^{-1}, length, breadth and area of flag leaves as influenced by different sowing times wheat genotypes

Source of variation	Degrees of freedom	Mean square			
		leaves plant^{-1} (No.)	Length of flag leaves (cm)	Breadth of flag leaves (cm)	Area of flag leaves (cm^2)
Replication	2	0.071	0.438	0.003	2.131
Sowing times (A)	1	1.870**	35.989**	0.290**	3258.54**
Genotypes (B)	6	0.1856*	12.776**	0.039**	73.520**
Interaction (A×B)	23	0.301	12.025**	0.044**	59.891**
Error	70	0.088	3.479	0.010	12.002

**: Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on number of effective, non-effective, total tillers hill^{-1} as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Mean square		
		Effective	Non-effective	Total
Replication	2	0.035	0.002	0.050
Sowing times (A)	1	4.876**	0.125**	4.780**
Genotypes (B)	6	0.68**	0.12*	0.289**
Interaction (A×B)	23	0.820**	0.017**	0.649**
Error	70	0.127	0.005	0.115

** Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data on ear length, spikelet's spike^{-1} and fertile floret spikelet^{-1} as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Ear length (cm)	mean square	
			Spikelet's Spike^{-1}	Fertile floret Spikelet^{-1}
Replication	2	.0201	0.405	0.001
Sowing times (A)	1	32.045**	42.094**	3.221**
Genotypes (B)	6	10.954**	11.827**	0.305**
Interaction (A×B)	23	1.581**	7.148**	0.165**
Error	70	0.408	1.073	0.033

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix X. Analysis of variance of the data on stem, ear, seed, husk, root and total dry matter content plant^{-1} as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Mean Square					
		Dry matter content plant^{-1} (g)					
		stem	Ear	seed	Husk	Root	Total
Replication	2	0.0011	0.025	0.002	0.001	0.001	0.030
Sowing times (A)	1	0.148**	1.717**	0.0093**	0.067**	1.711**	6.473**
Genotypes (B)	6	0.153**	0.667**	0.538**	0.064**	0.159**	5.780**
Interaction (A×B)	23	0.180**	1.312**	0.076**	0.087**	0.045**	2.956**
Error	70	0.035	0.262	0.017	0.016	0.020	0.542

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix XI. Analysis of variance of the data on no. of filled, no. of unfilled and no. of total grains spike^{-1} as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Mean square				
		No. of filled grains spike^{-1}	No. of unfilled grains spike^{-1}	No. of total grains spike^{-1}	No. of total grains plant^{-1}	No. of total grains branch tiller^{-1}
Replication	2	25.166	0.060	2.745	1.420	0.086
Sowing times (A)	1	157.77**	1.069**	136.921**	57.713**	8.228**
Genotypes (B)	6	75.523**	0.573**	64.758**	4.238**	0.450**
Interaction (A×B)	23	1702.92**	0.487	155.70**	7.449	0.966**
Error	70	29.002	0.141	26.683	14.645	0.155

**: Significant at 0.01 level of probability; * Significant at 0.058 level of probability

Appendix XII. Analysis of variance of the data grain and straw yield as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Mean square			
		Grain			
		Yield (g m^{-2})	Yield (t ha^{-1})	Yield (g m^{-2})	Yield (t ha^{-1})
Replication	2	1002.711	0.017	167.740	0.100
Sowing times (A)	1	34454.59**	1.300**	12998.64**	3.445**
Genotypes (B)	6	5311.47**	0.600**	5999.600**	0.531**
Interaction (A×B)	23	7078.41**	0.103**	1026.133**	0.708**
Error	70	1328.76	0.032	317.344	0.133

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix XIII. Analysis of variance of the data on 1000 seeds weight, biological yield and harvest index as influenced by different sowing times and wheat genotypes

Source of variation	Degrees of freedom	Mean square		
		1000 seeds weight (g)	Biological yield (t ha-1)	Harvest Index (%)
Replication	2	1.004	0.149	3.197
Sowing times (A)	1	12.340	8.887**	10.887*
Genotypes (B)	6	11.886**	2.129**	7.315*
Interaction (A×B)	23	24.502**	1.268**	9.467**
Error	70	5.113	0.225	3.462

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability