EFFECT OF SOWING DATES ON GROWTH AND YIELD PERFORMANCE OF SOME SELECTED WHEAT (*Triticum aestivum* L.) GENOTYPES

BY

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CERTIFICATE

This is to certify that the thesis entitled **"Effect of Sowing Dates on Growth and Yield Performance of Some Selected Wheat (*Triticum aestivum* L.) Genotypes"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **Master of Science in Agricultural Botany**, embodies the results of a piece of bonafide research work carried out by **Gazi Ashraf Uddin Ahmad**, Registration number: **00914** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:
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DEDICATED
TO

MY BELOVED PARENTS

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EFFECT OF SOWING DATES ON THE GROWTH AND YIELD PERFORMANCE OF DIFFERENT GENOTYPES OF WHEAT (*Triticum aestivum* L.)

ABSTRACT

The experiment was carried out at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during November 2009 to March 2010 to observe the effect of sowing dates on growth and yield performance of some selected wheat genotypes. The experiment comprised of two factors, viz. Factor A: Sowing dates (4 sowing dates) - Sowing on 17 November, 2009; Sowing on 30 November, 2009; Sowing on 15 December, 2009 and Sowing on 30 December, 2009 and Factor B: Wheat genotypes (9 wheat genotypes)- BAW-1064, Sourab, Prodip, Fang-60, Gourab, Sufi, Shatabdi, Pavan-76 and Bijoy. The experiment was laid out in Two Factor Randomized Complete Block Design (RCBD) with three replications. Data on different yield contributing characters and yield were recorded and significant variation was recorded for sowing dates, wheat genotypes and their interaction effect. At 30, 40, 50, 60 DAS and harvest the longest plant (45.09 cm, 66.40 cm, 82.56 cm, 86.20 cm and 89.83 cm) was recorded from sowing on 30 November, 2009 and the shortest plant (40.78 cm, 59.51 cm, 74.99 cm, 77.87 cm and 80.65 cm) from sowing on 30 December, 2009. The highest grain yield ha^{-1} (3.64 ton) was found from sowing 30 November, 2009, whereas the lowest (3.15 ton) was recorded from sowing 30 December, 2009. At 30, 40, 50, 60 DAS and harvest the longest plant (45.36 cm, 66.34 cm, 82.77 cm, 86.84 cm and 90.50 cm) was obtained from Gourab, whereas the shortest plant (40.70 cm, 61.20 cm, 76.44 cm, 79.57 cm and 81.64 cm) was recorded from Bijoy. The highest grain yield ha^{-1} (3.67 ton) was found from Sourab and the lowest (3.10 ton) was observed from Bijoy. At 30, 40, 50, 60 DAS and harvest the longest plant (49.41 cm, 71.85 cm, 89.72 cm, 94.24 cm and 98.36 cm) was observed in sowing on 30 November, 2009 × Gourab, again the shortest plant (39.37 cm, 56.89 cm, 71.63 cm, 73.79 cm and 76.31 cm) was recorded from sowing on 30 December, 2009 × Bijoy. The highest grain yield ha^{-1} (4.15 ton) was found from sowing on 30 November, 2009 × Sourab, whereas the lowest (2.85 ton) from sowing on 30 December, 2009 × Shatabdi. The variety Gourab provided better and steady yield in case of first, second and third sowings whereas, Gourab and BAW-1064 provided better yield when sown on 30 November. However, the yield was reduced in case of all the varieties when sown on 30 December.

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CHAPTER I

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a staple food for two third of the total world's population (Majumder, 1991). It is an important protein containing cereal with high amount of carbohydrate which is cultivated throughout the world. The crop is grown under different environmental conditions ranging from humid to arid, subtropical to temperate zone (Saari, 1998). Dubin and Ginkel (1991) reported that the largest area of wheat cultivation in the warmer climates exists in the South-East Asia including Bangladesh, India and Nepal. In Bangladesh, wheat is the second most important cereal crop that contributes to the national economy by reducing the volume of import of cereals for fulfilling the food requirements of the country (Razzaque *et al.*, 1992). BARI (1997) reported that wheat supplies mainly carbohydrate (69.60%) and reasonable amount of protein (12%), fat (1.72%), and also minerals (16.20%).

In the environmental condition of Bangladesh wheat is a well adapted cereal crop for its vegetative growth and development. Though the crop was introduced in Bangladesh during the period of former East Pakistan in 1967, its reputation increased after 1975. Now the popularity of wheat as staple food is increasing day by day in our country. Wheat cultivation has been increased manifolds to meet up the food shortage in the country. But, in spite of its importance, the yield of the crop in the context of our country is low (2.2 t ha^{-1}) in comparison to other countries of the world (FAO, 1997). The area, production and yield of wheat have been increasing dramatically during the last two decades, but its present yield is too low in comparison to some developed countries like Japan, France, Germany and UK producing 3.76, 7.12, 7.28, and 8.00 tha^{-1}, respectively (FAO, 2000). At present about 707.56 thousand hectares of land in Bangladesh is covered by wheat with the annual production of 1,578 thousand tons (BBS, 2008).

Yield and quality of seeds of wheat are very low in Bangladesh. The low yield of wheat in Bangladesh however is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties, delayed sowing after the harvest of transplanted aman rice, fertilizer management, disease and insect infestation and improper or limited irrigation facilities. Among different factor 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 of the transplanted aman rice (Badaruddin *et al.*, 1994). Generally wheat is sown in November to ensure optimal crop growth and avoid high temperature. After that if wheat is sown in the field it faces high range of temperature for its growth and development as well as yield potential. Temperature is one of the major environmental factors that governs grain yields in wheat significantly. Photosynthesis in wheat is maximum between 22 and 25^0C (Kobza and Edwards, 1987) and decreases sharply above 35^0C (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 spike^{-1} (Bhatta *et al.*, 1994; Islam *et al.*, 1993) and reduced kernel weight (Acevedo *et al.*, 1991) as well as the reduction of seed yield (Islam *et al.*, 1993).

Good quality wheat variety for producing maximum yield plays an important and major role. In varietal demonstration at different districts of Bangladesh by BARI (1993) revealed that mean yield of Kanchan, Akbar, Agrani and Sonalika were 3.59, 3.29, 3.12 and 2.81 t ha^{-1}, respectively. Different varieties respond differently to sowing time, cultivation practices and the prevailing environment condition 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 Bangladesh although some varieties have been identified for late sowing condition also (Islam *et al.*, 1993 and Ahmed *et al.*, 1989).

In case of selection of superior variety with optimum sowing date, its productivity needs to be tested. Information on the effect of sowing dates and wheat genotypes on the aspects of yield is limited. Considering above mentioned situation the present piece of research work was undertaken with following objectives-

i. To find out the effect of sowing dates on growth and yield of wheat genotypes.

ii. To observe the growth and yield performance of different wheat genotypes;

iii. To investigate the interaction effect of sowing dates and different wheat genotypes on growth and yield.

CHAPTER II

REVIEW OF LITERATURE

One of the major reasons of yield reduction of wheat is that about 60% of the crop is cultivated at late sowing condition after harvesting the transplanted 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 far done in Bangladesh is not adequate and conclusive. However, some of the important and informative works and research findings related to the sowing time and wheat varieties/genotypes done at home and abroad have been reviewed under the following headings:

2.1 Effect of sowing date

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-antesis 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 dates 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.

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 in wheat. They reported that yield had significant positive correlation with effective tillers per plant.

Chowdhury (2002) conducted an experiment with four sowing dates 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 Chinaunder two different sowing dates, 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 date was delayed from November to December. Chowdhury (2002) conducted an experiment with four sowing dates and reported that spike length, grains spike^{-1} and 1000-grain weight decreased with delay in sowing date 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, Maharashtra, 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

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 highest 1000-grain weight.

Farid *et al.* (1993) conducted an experiment on sowing dates in 1987-88 having five sowing times started from November with 15 day intervals with three cultivars of barley viz. Centinella, AP-1-19 and AP-1-20. They observed that November 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 dates 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. Adrastic 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 dates 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 dates and reported that December 5 sown plants produced significantly higher grain yield in both the 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-1 gave the highest grain (2.55 t/ha) and straw yield (4.28 t/ha), whereas 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 (41.5%) 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 weight due to curtailment of period for development of these parameters.

2.2 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 in 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. Farmers 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.

Wheat Research Center (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 dates 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 Ukraine. 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 1997-98 on barley cv. Conquest that among the five sowing dates 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. Adrastic 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, 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 date 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 *et 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 irrigation 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 Shukla *et al.* (1992) for adaptability under pot culture by exposure to high temperature treatments (8^0C above) ambient in week 1 though 4 after anthesis. Dry matter accumulation of grain in the top, middle and bottom spikelets 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 can be substantially improved by crop management practices (Harris *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 ($22/17^0$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 to 0.58 g per tiller or 23% from 22/17 to $32/27^0$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 highest 1000-grain weight.

Grain number per ear is limited by the number of spikelets per ear can the number of viable florets per spikelet (Tashiro and Warslaw, 1989). In general, number of outer floret grains was reduced more by high temperature than the basal floret grains, 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 4 W AA. Grain growth rate was the highest in the 3rd and 2nd W AA for crop sown on 15 November and 30 November respectively. Grain growth rate was higher in crops sown on 15 November than in those sown on 30 November. Cv. Lok 1, WH 147, H-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 III

MATERIALS AND METHODS

The experiment was carried out at the Experimental field of Sher-e-Bangla Agricultural University, Dhaka during November 2009 to March 2010 to observe the effect of sowing dates on growth and yield performance of some selected wheat genotypes. The details of the materials and methods those were followed to conduct the study has been presented below under the following headings:

3.1 Description of the experimental site

3.1.1 Location

The present piece of research work was conducted in the experimental field of Agricultural Botany, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site was $23^0 74'$N latitude and $90^0 35'$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 climate, 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 the experiment was collected from the Weather Station of Bangladesh, Sher-e Bangla Nagar, presented in Appendix I.

3.1.3 Soil

The soil belonged 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

The experiment comprised of two factors

Factors A: Sowing dates (4 sowing dates)

i) S_1: Sowing on 17 November, 2009

ii) S_2: Sowing on 30 November, 2009

iii) S_3: Sowing on 15 December, 2009

iv) S_4: Sowing on 30 December, 2009

Factor B: Wheat genotypes (9 wheat genotypes):

Name and origin of these genotypes are:

Variety	Origin	Variety	Origin
V_1: BAW-1064	BARI	V_2: Sourab	BARI
V_3: Prodip	BARI	V_4: Fang-60	WRC
V_5: Gourab	BARI	V_6: Sufi	BARI
V_7: Shatabdi	BARI	V_8: Pavan-76	BARI
V_9: Bijoy	BARI		

There were in total 36 (4×9) treatment combinations such as S_1V_1, S_1V_2, S_1V_3, S_1V_4, S_1V_5, S_1V_6, S_1V_7, S_1V_8, S_1V_9,S_2V_1, S_2V_2, S_2V_3, S_2V_4, S_2V_5, S_2V_6, S_2V_7, S_2V_8, S_2V_9, S_3V_1, S_3V_2, S_3V_3, S_3V_4, S_3V_5, S_3V_6, S_3V_7, S_3V_8, S_3V_9, S_4V_1, S_4V_2, S_4V_3, S_4V_4, S_4V_5, S_4V_6, S_4V_7, S_4V_8 and S_4V_9.

3.2.2 Experimental design and layout

The experiment was laid out in Two Factor Randomized Complete Block Design (RCBD) with three replications. There were 108 plots having the size of 2 m × 1.5 m and 36 treatment combinations were randomly distributed in these plots.

3.3 Growing of crops

3.3.1 Seed collection

The seeds of different wheat genotypes and varieties were collected from Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur and Wheat Research Centre (WRC).

3.3.2 Preparation of the main field

The piece of land selected for the experiment was opened in the last week of October 2009 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 fertilizers N, P, K and S in the form of Urea, TSP, MP and Gypsum, respectively were applied. The entire amount of TSP, MP and Gypsum, 2/3rd of urea were applied during the final preparation of land. Rest of urea was top dressed after first irrigation (BARI, 2006). The dose and method of application of fertilizer are presented below-

Doses and method of application of fertilizers in wheat field

Fertilizers	Dose (per ha)	Application (%)	
		Basal	1st installment
Urea	220 kg	66.66	33.33
TSP	180 kg	100	--
MP	50 kg	100	--
Gypsum	120 kg	100	--
Cowdung	10 ton	100	--

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

3.3.4 After care

After the germination of seeds, various intercultural operations such as irrigation and drainage, weeding, top dressing of fertilizer and plant protection measures were accomplished for better growth and development of the wheat seedlings as per the recommendation of BARI (2006).

3.3.4.1 Irrigation and drainage

Three flood irrigations at early stage of crop growth, tillering stage and panicle initiation stage were provided. Proper drainage system was also developed for draining out excess water.

3.3.4.2 Weeding

Weedings were done to keep the plots 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 panicle initiation stage (55 DAS) manually.

3.3.4.3 Plant protection

The crop was attacked by different kinds of insects during the growing period. Triel-20 ml was applied on 5 January and sumithion-40 ml/20 litre of water was applied on 25 January 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 third week of March, 2010. 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 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 seedlings and expressed days to starting emergence. Days to 50% and 100% emergence of seedlings were expressed in days and that were estimated by observing absolute visibility of seedlings of the experimental plot.

3.5.2 Plant height

The height of plant was recorded in centimeter (cm) at 30, 40, 50, 60 DAS (Days After Sowing) and at harvest. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot that 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 plant^{-1}

The number of tillers plant^{-1} was recorded at the time of 30, 40, 50 and 60 DAS. Data were recorded by counting tillers from each plant and as the average of 10 plants selected at random from the inner rows of each plot.

3.5.4 Days to staring 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.

3.5.5 Days to ear emergence

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

3.5.6 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 the experimental plot.

3.5.7 Days to maturity

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

3.5.8 Leaves plant^{-1}

The total number of leaves plant^{-1} was counted as the number of leaves from 10 randomly selected plants from each plot and average value was recorded.

3.5.9 Length of flag leaf

The length of flag leaf was measured as the average of 10 plants selected at random from the inner rows of each plot. The length was measured from the base to tip of the flag leaf.

3.5.10 Breadth of flag leaf

The breadth of flag leaf was measured as the average of 10 plants selected at random from the inner rows of each plot. The breadth was measured from the base to tip of the flag leaf and the average of 3 measurements was calculated

3.5.11 Leaf area of flag leaf

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

3.5.12 Effective tiller splant^{-1}

The total number of effective tillers plant^{-1} was counted as the number of panicle bearing tillers plant^{-1}. Data on effective tillers plant^{-1} were counted from 10 selected plants at harvest and average value was recorded.

3.5.13 Non-effective tillers plant^{-1}

The total number of non-effective tillers plant^{-1} was counted as the number of tiller plant^{-1} without spike. Data on non-effective tillers plant^{-1} were counted from 10 selected plants at harvest and average value was recorded.

3.5.14 Total tillers plant^{-1}

The total number tillers plant^{-1} was recorded by adding effective and sterile tillers plant^{-1}. Data on total tiller shill^{-1} were counted from 10 selected plants at harvest and average value was recorded.

3.5.15 Ear length

The length of ear was measured with a meter scale from 10 selected panicles and the average value was recorded.

3.5.16 Spikelets spike^{-1}

The total number of spikelets spike^{-1} was counted as the number of spikelets from 10 randomly selected spikes from each plot and average value was recorded.

3.5.17 Fertile florets spikelets^{-1}

The number of fertile floret spikelets^{-1} was counted as the number of fertile floret from 10 randomly selected spikelets from each plot and average value was recorded.

3.5.18 Dry matter content

Data from ten sample plants from each plot were collected and gently washed with tap water, thereafter soaked with paper towel. Then fresh weight was taken immediately after soaking by paper towel. After taking fresh weight, the sample was oven dried at 70^{0}C for 72 hours. Then oven-dried samples were transferred into a desiccator and allowed to cool down to room temperature, thereafter dry weight of stem was taken. Dry matter content of stem was calculated using the following formula:

$$\text{Dry matter content of stem} = \frac{\text{Dry weight of stem (g)}}{\text{Fresh weight of stem (g)}} \times 100$$

As per the above procedure dry matter content of ear, seeds, husk, roots per plant and total dry matter was recorded.

3.5.19 Filled grains spike^{-1}

The total number of filled grains spike^{-1} was counted as the number of filled grains from 10 randomly selected spikes from each plot and average value was recorded.

3.5.20 Unfilled grains spike^{-1}

The total number of unfilled grains spike^{-1} was counted as the number of unfilled grains from 10 randomly selected spikes from each plot and average value was recorded.

3.5.21 Total grains spike^{-1}

The total number of grains spike^{-1} was counted by adding the number of filled and unfilled grains from 10 randomly selected spike from each plot and average value was recorded.

3.5.22 Total grains branch tiller^{-1}

The total number of grains branch tiller^{-1} was counted by adding the number of filled and unfilled grains from 10 randomly selected spike from each plot and average value was recorded.

3.5.23 Grain yield m^{-2}

Grains obtained from m^{-2} from each unit plot were sun-dried and weighed carefully. The dry weight of grains of central 1 m^{2} area used to record grain yield m^{-2} and converted this into t ha^{-1}.

3.5.24 Grain yield ha^{-1}

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

3.5.25 Straw yield m^{-2}

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

3.5.26 Straw weight ha^{-1}

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

3.5.27 1000 seeds weight

One thousand seeds were counted randomly from the total cleaned harvested seeds of each individual plot and then weighed in grams and recorded.

3.5.28 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.

3.5.29 Harvest index

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

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

3.6 Statistical Analysis

The data obtained for different characters were statistically analyzed to observe the significant difference among the sowing dates and wheat genotypes and their interaction. The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference among the treatment means was estimated by the Duncan Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to study the effect of sowing dates on growth and yield performance of some selected wheat genotypes. Data on different yield contributing characters and yield were recorded. The analyses of variance (ANOVA) of the data on different parameters are presented in Appendix III-XII. The results have been presented with the help of table and graphs and possible interpretations have been given under the following headings:

4.1 Days to starting of seedling emergence

Days to starting of seedling emergence showed statistically significant differences for different sowing dates under the present trial (Table 1). The maximum days to starting of seedling emergence (5.92) was recorded from S_4 (sowing on 30 December, 2009), whereas the minimum days (4.82) was observed from S_1 (sowing on 17 November, 2009) which was statistically identical (4.91 and 4.96) with S_3 (sowing on 15 December, 2009) and S_2 (sowing on 30 November, 2009), respectively. Seeds sowing at November 17 and 30 ensured the germination in shortest possible time and maximum germination than delayed sowing of seeds. Similar findings were reported by Nibedita (2009) for seed germination by sowing seeds on 30 November.

Statistically non-significant difference was observed for different wheat genotypes on days to starting of seedling emergence (Table 1). The maximum days to starting of seedling emergence (5.28) was found from V_2 (Sourab), again the minimum days (5.05) was recorded from V_1 (BAW-1064). Germination is a genetical character and different genotypes need different days to starting of seedling emergence but management factor, soil moisture content and weather condition influence days to starting of germination for different genotypes and all of these factors are governed by time of seed sowing.

Table 1. Main effect of different sowing dates on days to seedling emergence percentage of different wheat genotypes

Treatment	Percentage of seedling emergence (days)		
	Starting of emergence	50% emergence	100% emergence
Sowing date			
S_1	4.82 b	8.78 b	11.70 b
S_2	4.96 b	8.93 b	12.00 b
S_3	4.91 b	8.84 b	11.96 b
S_4	5.92 a	9.79 a	12.71 a
LSD (0.05)	0.160	0.311	0.488
Wheat genotypes			
V_1	5.05	9.03	12.11
V_2	5.28	9.14	12.03
V_3	5.22	9.19	12.19
V_4	5.00	8.88	11.75
V_5	5.19	9.32	12.10
V_6	5.08	8.94	12.16
V_7	5.21	9.03	11.93
V_8	5.19	8.94	12.24
V_9	5.18	9.26	12.30
LSD (0.05)	--	--	--
CV(%)	5.71	6.31	7.44

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9 : Bijoy

Interaction effect of sowing dates and wheat genotypes showed non-significant differences on days to starting of seedling emergence (Table 2). The maximum days to starting of seedling emergence (6.33) was observed from S_4V_4 (sowing on 30 December, 2009 and Fang-60), while the minimum days (4.33) from the treatment combination S_1V_4 (sowing on 17 November, 2009 and Fang-60).

4.2 Days to 50% seedling emergence

Different sowing dates showed statistically significant variation for days to 50% seedling emergence (Table 1). The maximum days to 50% seedling emergence (9.79) was found from S_4 (sowing on 30 December, 2009), while the minimum days (8.78) from S_1 (sowing on 17 November, 2009) which was statistically identical (8.84 and 8.93) with S_3 (sowing on 15 December, 2009) and S_2 (sowing on 30 November, 2009), respectively.

Days to 50% seedling emergence varied non-significantly for different wheat genotypes (Table 1). The maximum days to 50% seedling emergence (9.32) was recorded from V_5 (Gourab) and the minimum days (8.88) was recorded from V_4 (Fang-60).

Sowing dates and wheat genotypes showed non-significant differences for their interaction in terms of days to 50% seedling emergence (Table 2). The maximum days to 50% seedling emergence (10.00) was observed from S_4V_2 (sowing on 30 December, 2009 and genotype Sourab), again the minimum days (7.67) was obtained from S_1V_4 (sowing on 17 November, 2009 and genotype Fang-60).

4.3 Days to 100% seedling emergence

Statistically significant variation was recorded for days to 100% seedling emergence due to different sowing dates (Table 1). The maximum days to 100% seedling emergence (12.71) was found from S_4 (sowing on 30 December, 2009), whereas the minimum days (11.70) from S_1 (sowing on 17 November, 2009) which was statistically identical (11.96 and 12.00) with S_3 (sowing on 15 December, 2009) and S_2 (sowing on 30 November, 2009), respectively.

Table 2. Interaction effect of different sowing dates on days to seedling emergence percentage of different wheat genotypes

Treatment	Percentage of seedling emergence (days)		
	Starting of emergence	50% emergence	100% emergence
S_1V_1	4.67	8.67	11.00
S_1V_2	5.00	9.00	11.33
S_1V_3	5.00	8.67	11.33
S_1V_4	4.33	7.67	10.67
S_1V_5	5.00	9.33	11.33
S_1V_6	4.67	9.00	11.67
S_1V_7	4.87	8.33	12.67
S_1V_8	4.87	8.67	12.67
S_1V_9	5.00	9.67	12.67
S_2V_1	5.00	8.67	12.00
S_2V_2	5.00	8.67	12.33
S_2V_3	5.00	9.67	12.67
S_2V_4	4.67	9.00	11.00
S_2V_5	5.00	9.33	12.00
S_2V_6	5.00	8.33	12.67
S_2V_7	5.00	9.00	11.00
S_2V_8	5.00	8.67	11.67
S_2V_9	5.00	9.00	12.67
S_3V_1	4.67	8.90	12.33
S_3V_2	5.33	9.00	12.00
S_3V_3	5.00	8.67	12.33
S_3V_4	5.00	9.00	12.00
S_3V_5	5.00	8.84	11.67
S_3V_6	4.67	8.67	11.67
S_3V_7	5.00	9.00	11.33
S_3V_8	5.00	8.67	12.33
S_3V_9	5.00	9.00	11.67
S_4V_1	6.00	9.67	12.67
S_4V_2	6.00	10.00	12.33
S_4V_3	6.00	9.33	12. 67
S_4V_4	6.33	9.67	13.33
S_4V_5	6.00	9.67	13.67
S_4V_6	6.00	9.67	12.67
S_4V_7	6.00	9.67	12.67
S_4V_8	6.00	9.67	12.33
S_4V_9	5.67	9.33	12.00
LSD (0.05)	--	--	--
CV(%)	5.71	6.31	7.44

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

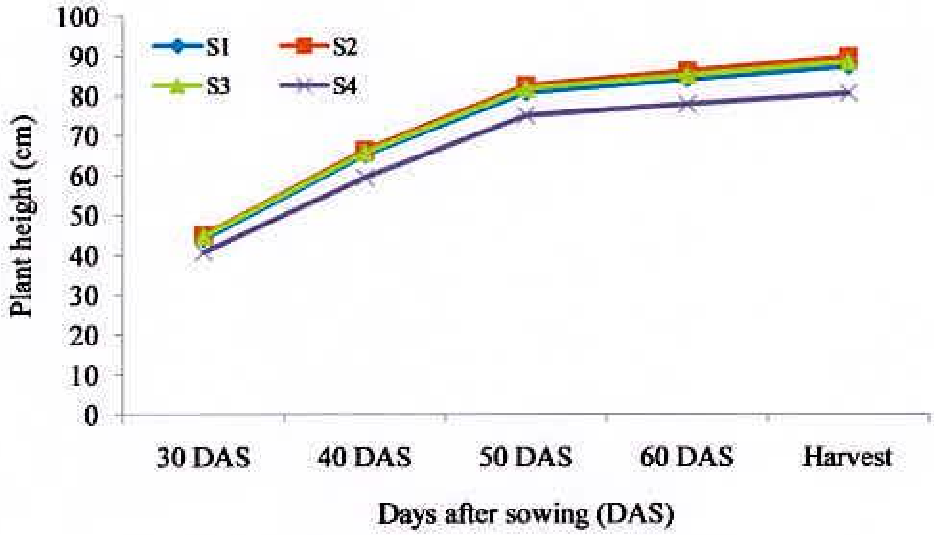
Statistically non-significant variation was recorded for different wheat genotypes on days 100% seedling emergence under the present trial (Table 1). The maximum days to 100% seedling emergence (12.30) was recorded from V_9 (Bijoy), again the minimum days (11.75) was observed from V_4 (Fang-60).

Interaction effect of sowing dates and wheat genotypes showed non-significant variation for days to 100% seedling emergence (Table 2). The maximum days to 100% seedling emergence (13.67) was recorded from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab), while the minimum days (11.33) was found from S_1V_5 (sowing on 30 November, 2009 and genotype Gourab) treatment combination.

4.4 Plant height

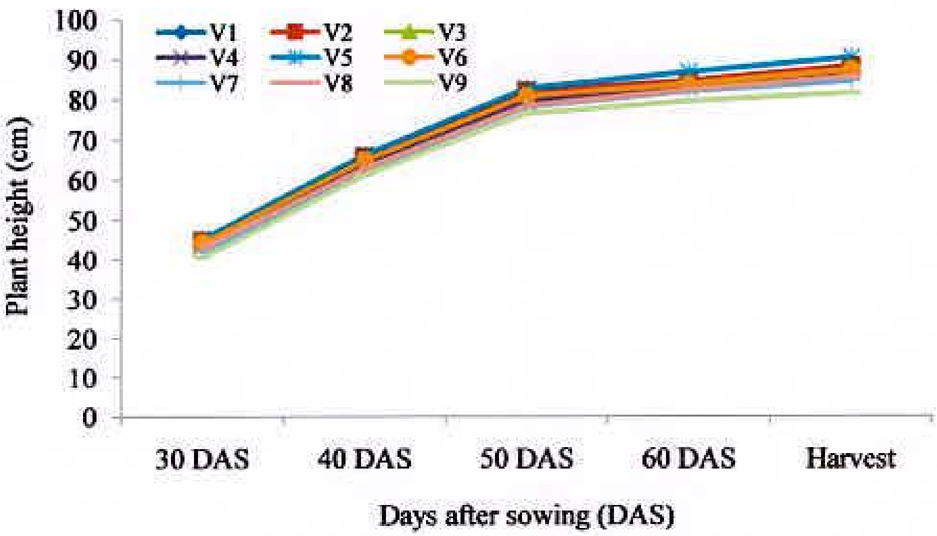
Different sowing dates showed statistically significant differences in terms of plant height at 30, 40, 50, 60 DAS and harvest (Figure 1). At 30, 40, 50, 60 DAS and harvest the longest plant (45.09 cm, 66.40 cm, 82.56 cm, 86.20 cm and 89.83 cm) was recorded from S_2 (sowing on 30 November, 2009) which was statistically identical (44.86 cm, 65.76 cm, 81.78 cm, 85.11 cm and 88.51 cm) to S_3 (sowing on 15 December, 2009). On the other hand, the shortest plant (40.78 cm, 59.51 cm, 74.99 cm, 77.87 cm and 80.65 cm) from S_4 (sowing on 30 December, 2009) for same date. Seeds sowing at November 30 ensured the tallest plant than early and delayed sowing of seeds. 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. Nibedita (2009) reported taller plants by sowing seeds in 30 November, 2008 in same area using different wheat varieties.

Plant height at 30, 40, 50, 60 DAS and harvest varied significantly for different wheat genotypes (Figure 2). At 30, 40, 50, 60 DAS and harvest the tallest plant (45.36 cm, 66.34 cm, 82.77 cm, 86.84 cm and 90.50 cm) was obtained from V_5 (Gourab), whereas the shortest plant (40.70 cm, 61.20 cm, 76.44 cm, 79.57 cm and 81.64 cm) was recorded from V_9 (Bijoy). Different genotypes produced different plant height on the basis of their varietal characters.



S_1: Sowing on 17 November, 2009 S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009 S_4: Sowing on 30 December, 2009

Figure 1. Effect of different sowing dates on plant height of wheat



V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-66 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Figure 2. Effect of different genotypes on plant height of wheat

Statistically significant variation was recorded due to the interaction effect of sowing dates and wheat genotypes on plant height at 30, 40, 50, 60 DAS and harvest (Table 3). At 30, 40, 50, 60 DAS and harvest the tallest plant (49.41 cm, 71.85 cm, 89.72 cm, 94.24 cm and 98.36 cm) was observed from S_2V_5 (sowing on 30 November, 2009 and genotype Gourab), again the shortest plant (39.37 cm, 56.89 cm, 71.63 cm, 73.79 cm and 76.31 cm) was recorded from S_4V_9 (sowing on 30 December, 2009 and genotype Bijoy) treatment combination.

4.5 Number of tillers plant^{-1}

Number of tillers plant^{-1} at 30, 40, 50 and 60 DAS showed statistically significant differences for different sowing dates under the present trial (Figure 3). At 30, 40, 50 and 60 DAS the maximum number of tillers plant^{-1} (3.29, 3.74, 4.44 and 4.90) was observed from S_2 (sowing on 30 November, 2009) which was statistically identical (3.23, 3.64, 4.35 and 4.78) to S_3 (sowing on 15 December, 2009) and (3.22, 3.67, 4.33 and 4.73) to S_1 (3.22, 3.67, 4.33 and 4.73), while the minimum number (2.65, 3.12, 3.70 and 3.93) was found from S_4 (sowing on 30 December, 2009) for same DAS. Seeds sowing at November 30 ensured the maximum tiller than early and delayed sowing of seeds. BARI (19984) reported that the highest number of effective tillers plant^{-1} was obtained by 20 November sowing and similar findings were reported by Sarker *et al.* (1999). Nibedita (2009) reported more number of tillers per hill by sowing seeds on 30 November, 2008 in same area using different wheat varieties in another experiment.

Statistically significant variation was recorded for different wheat genotypes in terms of number of tillers plant^{-1} at 30, 40, 50 and 60 DAS (Figure 4). At 30, 40, 50 and 60 DAS the maximum number of tillers plant^{-1} (3.22, 3.71, 4.43 and 4.85) was observed from V_5 (Gourab), whereas the minimum number (2.94, 3.30, 3.96 and 4.32) from V_9 (Bijoy). Management practices influence the number of tillers at different days after sowing but genotypes itself manipulated the number of tillers plant^{-1}.

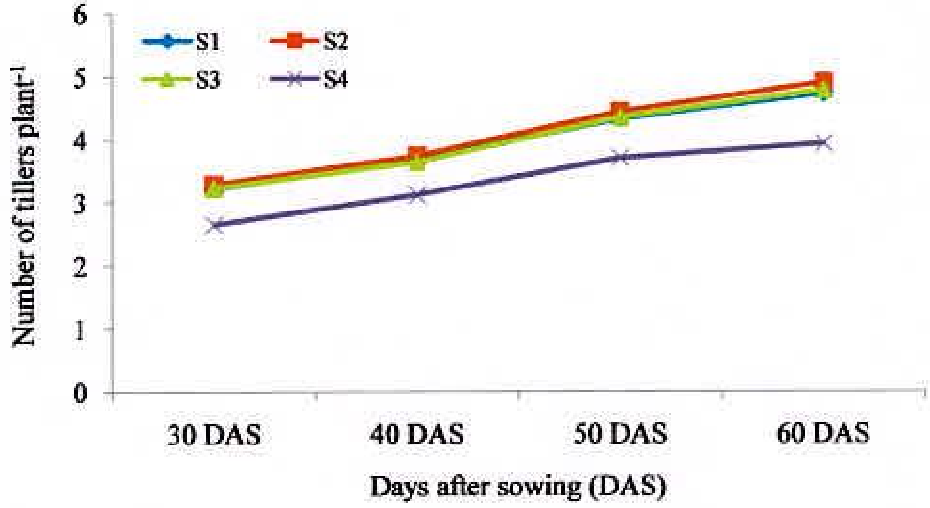
Table 3. Interaction effect of different sowing dates on plant height of different wheat genotypes

Treatment	Plant height (cm) at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
S_1V_1	42.09 f-l	62.20 e-l	76.51 h-n	75.14 k	78.51 l-n
S_1V_2	47.61 a-c	69.46 a-c	86.61 a-c	87.86 a-e	91.90 a-e
S_1V_3	44.34 c-h	65.29 a-i	80.63 c-l	83.74 d-i	87.54 c-k
S_1V_4	44.01 c-i	64.74 b-j	79.68 c-m	82.76 d-j	85.60 d-l
S_1V_5	44.02 c-i	64.72 b-j	80.04 c-m	85.24 d-i	88.91 c-j
S_1V_6	46.77 a-d	68.40 a-e	85.08 a-e	87.71 a-e	91.71 a-e
S_1V_7	46.99 a-d	68.95 a-d	86.15 a-d	93.47 ab	93.97 a-c
S_1V_8	43.17 d-k	62.57 d-l	77.18 g-n	82.88 d-j	86.94 c-k
S_1V_9	38.95 l	61.27 f-l	75.44 i-n	79.22 g-k	81.74 j-n
S_2V_1	48.80 ab	70.95 ab	88.60 ab	93.08 a-c	97.18 ab
S_2V_2	46.43 a-e	68.09 a-e	84.67 a-g	87.87 a-e	91.80 a-e
S_2V_3	45.36 a-g	66.50 a-h	82.44 a-i	85.89 d-h	89.71 b-i
S_2V_4	45.36 a-g	66.50 a-h	82.44 a-i	85.89 d-h	89.71 b-i
S_2V_5	49.41 a	71.85 a	89.72 a	94.24 a	98.36 a
S_2V_6	43.39 d-j	63.76 c-k	78.59 d-n	80.66 e-k	84.29 e-m
S_2V_7	39.97 i-l	60.02 h-l	74.79 j-n	77.99 i-k	81.55 j-n
S_2V_8	44.59 c-h	65.48 a-i	81.41 b-k	85.31 d-i	88.31 c-k
S_2V_9	42.50 e-l	64.47 b-j	80.36 c-m	84.85 d-i	87.54 c-k
S_3V_1	45.48 a-g	66.10 a-h	81.74 b-k	86.43 b-h	90.22 b-h
S_3V_2	46.77 a-d	68.40 a-e	84.95 a-f	89.11 a-d	93.06 a-d
S_3V_3	45.88 a-g	67.36 a-g	83.51 a-h	86.56 b-g	90.44 b-g
S_3V_4	44.80 b-g	65.77 a-i	81.40 b-k	85.02 d-i	88.80 c-k
S_3V_5	46.08 a-f	67.51 a-f	83.92 a-h	87.26 a-f	91.17 a-f
S_3V_6	44.74 b-g	65.45 a-i	81.06 c-k	84.08 d-i	87.85 c-k
S_3V_7	42.56 e-l	63.30 c-l	79.04 c-n	80.85 e-k	84.24 e-f
S_3V_8	45.39 a-g	65.80 a-i	82.05 b-j	86.23 c-h	89.82 b-h
S_3V_9	42.00 f-l	62.17 e-l	78.32e-n	80.44 e-k	80.95 k-n
S_4V_1	42.10 f-l	61.35 f-l	77.35 f-n	79.89 f-k	82.80 g-n
S_4V_2	39.12 kl	57.49 kl	72.05 n	74.21 k	76.79 mn
S_4V_3	41.85 g-l	60.80 g-l	76.99 h-n	79.52 g-k	82.37 h-n
S_4V_4	40.54 h-l	59.40 i-l	74.29 k-n	79.06 h-k	81.89 i-n
S_4V_5	41.94 f-l	61.29 f-l	77.38 f-n	80.61 e-k	83.56 f-n
S_4V_6	42.94 d-l	62.23 e-l	79.04 c-n	82.64 d-j	85.60 d-l
S_4V_7	39.42 j-l	57.78 kl	72.84 mn	75.88 jk	78.74 l-n
S_4V_8	39.74 j-l	58.31 j-l	73.31 l-n	75.20 k	77.81 l-n
S_4V_9	39.37 j-l	56.89 l	71.63 n	73.79 k	76.31 n
LSD (0.05)	3.397	5.422	6.182	6.038	6.470
CV(%)	7.77	5.18	8.74	9.45	6.59

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

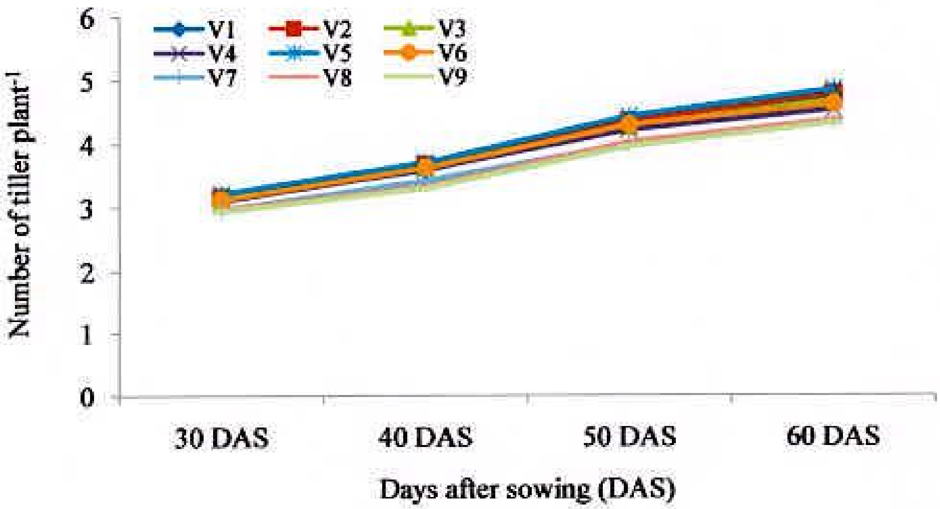
S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9 : Bijoy



S_1: Sowing on 17 November, 2009 S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009 S_4: Sowing on 30 December, 2009

Figure 3. Effect of different sowing dates on number of tillers plant^{-1} of wheat



V_1: BAW-1064	V_2: Sourab	V_3: Prodip
V_4: Fang-66	V_5: Gourab	V_6: Sufi
V_7: Shatabdi	V_8: Pavan-76	V_9: Bijoy

Figure 4. Effect of different genotypes on number of tillers plant^{-1} of wheat

Interaction effect of sowing dates and wheat genotypes showed significant differences on number of tillers plant^{-1} at 30, 40, 50 and 60 DAS (Table 4). At 30, 40, 50 and 60 DAS the maximum number of tillers plant^{-1} (3.60, 4.07, 5.03 and 5.67) was recorded from S_2V_5 (sowing on 30 November, 2009 and genotype Gourab), again the minimum number (2.57, 3.13, 3.60 and 3.77) was found from S_4V_7 (sowing on 30 December, 2009 and genotype Shatabdi).

4.6 Days to starting of booting

Days to starting of booting varied significantly for different sowing dates (Table 5). The maximum days to starting of booting (47.48) was recorded from S_1 (sowing on 17 November, 2009) which was closely followed (45.30 and 44.56) by S_2 (sowing on 30 November, 2009) and S_3 (sowing on 15 December, 2009), again the minimum days (40.96) from S_4 (sowing on 30 December, 2009).

Different wheat genotypes showed statistically significant variation in terms of days to starting of booting (Table 5). The maximum days to starting of booting (45.50) was observed from V_6 (Sufi), while the minimum days (43.75) from V_7 (Shatabdi). Days to starting of booting varied for different genotypes might be due to genetical and environmental influences as well as management practices.

Sowing dates and wheat genotypes showed significant interaction effect on days to starting of booting (Table 6). The maximum days to starting of booting (49.67) was observed from S_1V_8 (sowing on 17 November, 2009 and genotype Pavan-76), whereas the minimum days (38.67) from S_4V_9 (sowing on 30 December, 2009 and genotype Bijoy) treatment combination.

4.7 Days to starting of ear emergence

Different sowing dates varied significantly on days to starting of ear emergence (Table 5). The maximum days to starting of ear emergence (59.00) was found from S_1 (sowing on 17 November, 2009) which was closely followed (57.04 and 55.85) by S_2 (sowing on 30 November, 2009) and S_3 (sowing on 15 December, 2009), while the minimum days (51.78) from S_4 (sowing on 30 December, 2009).

Table 4. Interaction effect of different sowing dates on number of tillers plant^{-1} of different wheat genotypes

Treatment	Number of tillers plant^{-1} at			
	30 DAS	40 DAS	50 DAS	60 DAS
S_1V_1	3.03 e-h	3.37 d-h	3.97 f-l	4.50 d-k
S_1V_2	3.40 ab	3.97 a-c	4.77 a-c	5.17 a-c
S_1V_3	3.30 b-d	3.80 a-c	4.30 c-i	4.73 c-h
S_1V_4	3.23 b-f	3.77 a-d	4.33 c-i	4.57 c-j
S_1V_5	3.27 b-e	3.67 a-f	4.23 c-j	4.73 c-h
S_1V_6	3.37 a-c	3.93 a-c	4.70 a-d	4.97 c-e
S_1V_7	3.30 b-d	4.00 ab	4.67 a-d	5.07 b-d
S_1V_8	3.13 c-g	3.33 e-i	4.07 e-k	4.40 e-l
S_1V_9	2.97 gh	3.20 g-j	3.97 f-l	4.43 d-k
S_2V_1	3.57 a	4.03 ab	4.93 ab	5.60 ab
S_2V_2	3.37 a-c	3.90 a-c	4.63 a-e	5.07 b-d
S_2V_3	3.30 b-d	3.80 a-c	4.47 b-g	4.90 c-f
S_2V_4	3.30 b-d	3.80 a-c	4.47 b-g	4.87 c-f
S_2V_5	3.60 a	4.07 a	5.03 a	5.67 a
S_2V_6	3.17 b-g	3.60 b-g	4.13 d-k	4.57 c-j
S_2V_7	2.97 gh	3.17 h-j	3.77 i-m	4.17 g-n
S_2V_8	3.17 b-g	3.67 a-f	4.33 c-i	4.60 c-i
S_2V_9	3.13 c-g	3.60 b-g	4.23 c-j	4.70 c-i
S_3V_1	3.30 b-d	3.77 a-d	4.47 b-g	4.87 c-f
S_3V_2	3.40 ab	3.87 a-c	4.60 a-e	5.20 a-c
S_3V_3	3.37 a-c	3.80 a-b	4.53 a-f	5.00 b-e
S_3V_4	3.23 b-f	3.70 a-e	4.37 b-h	4.73 c-h
S_3V_5	3.30 b-d	3.83 a-c	4.53 a-f	4.93 c-f
S_3V_6	3.20 b-g	3.70 a-e	4.37 b-h	4.77 c-g
S_3V_7	3.07 d-g	3.37 d-h	3.97 f-l	4.40 e-l
S_3V_8	3.17 b-g	3.53 c-h	4.37 b-h	4.83 c-f
S_3V_9	3.00 f-h	3.23 g-i	3.97 f-l	4.30 f-m
S_4V_1	2.73 ij	3.20 g-j	3.87 h-m	4.10 h-n
S_4V_2	2.53 jk	2.93 ij	3.40 lm	3.70 mn
S_4V_3	2.73 ij	3.17 h-j	3.77 i-m	4.10 h-n
S_4V_4	2.67 ij	3.13 h-j	3.70 j-m	3.93 j-n
S_4V_5	2.73 ij	3.27 f-i	3.90 g-m	4.07 i-n
S_4V_6	2.80 hi	3.30 e-i	4.00 f-k	4.17 g-n
S_4V_7	2.57 i-k	3.13 h-j	3.60 k-m	3.77 l-n
S_4V_8	2.40 k	2.80 j	3.37 m	3.63 n
S_4V_9	2.67 ij	3.17 h-j	3.67 j-m	3.87 k-n
LSD (0.05)	0.212	0.357	0.475	0.533
CV(%)	10.25	6.18	6.94	7.14

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 5. Main effect of different sowing dates on days required for starting of booting, ear emergence, anthesis and maturity of different wheat genotypes

Treatment	Days required for			
	Starting of booting	Starting of ear emergence	Starting of anthesis	Starting of maturity
Sowing date				
S_1	47.48 a	59.00 a	76.37 a	89.19 a
S_2	45.30 b	57.04 b	74.04 a	87.22 ab
S_3	44.56 b	55.85 b	70.70 b	85.96 b
S_4	40.96 c	51.78 c	68.15 b	79.89 c
LSD (0.05)	0.863	1.277	2.625	2.579
Wheat genotypes				
V_1	44.58 ab	56.08 ab	71.92	86.50
V_2	44.00 ab	56.42 ab	74.50	86.00
V_3	44.67 ab	54.67 b	71.25	83.75
V_4	44.25 ab	55.42 ab	70.67	84.75
V_5	44.67 ab	57.17 a	73.75	87.17
V_6	45.50 a	54.25 b	69.92	82.83
V_7	43.75 b	55.92 ab	73.50	85.00
V_8	45.17 ab	56.17 ab	72.00	87.33
V_9	44.58 ab	57.17 a	73.33	86.75
LSD (0.05)	1.295	1.916	--	--
CV(%)	8.57	5.21	6.69	5.55

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 6. Interaction effect of different sowing dates on days required for starting of booting, ear emergence, anthesis and maturity of different wheat genotypes

Treatment	Days required for			
	Starting of booting	Starting of ear emergence	Starting of anthesis	Starting of maturity
S_1V_1	49.33 a	56.67 d-j	68.00 gh	87.33 a-g
S_1V_2	45.33 b-g	57.00 c-i	75.67 b-g	86.00 b-i
S_1V_3	47.67 a-c	57.67 b-g	79.67 b-e	84.00 c-i
S_1V_4	46.67 a-e	57.00 c-i	67.33 gh	87.00 a-h
S_1V_5	45.33 b-g	62.00 ab	81.33 a-d	92.00 a-c
S_1V_6	48.33 ab	60.67 a-d	82.67 a-c	92.00 a-c
S_1V_7	47.67 a-c	64.00 a	89.00 a	96.00 a
S_1V_8	49.67 a	57.00 c-i	70.67 e-h	89.33 a-d
S_1V_9	47.33 a-d	59.00 b-f	73.00 d-h	89.00 a-e
S_2V_1	43.67 e-j	60.33 a-c	78.33 b-f	93.67 ab
S_2V_2	44.67 c-h	61.33 a-c	84.00 ab	93.67 ab
S_2V_3	45.00 c-g	55.67 e-j	70.67 e-h	87.00 a-h
S_2V_4	44.67 c-h	56.00 e-j	70.67 e-h	85.00 b-i
S_2V_5	47.67 a-c	57.33 c-h	74.00 c-g	87.67 a-f
S_2V_6	47.67 a-c	53.33 g-k	66.67 gh	79.00 f-i
S_2V_7	44.33 d-h	52.67 h-l	69.00 f-h	78.00 g-i
S_2V_8	43.33 f-j	57.67 b-g	74.67 c-g	89.00 a-e
S_2V_9	46.67 a-e	59.00 b-f	78.33 b-f	92.00 a-c
S_3V_1	44.67 c-h	55.33 f-k	71.00 e-h	85.33 b-i
S_3V_2	43.67 e-j	56.33 d-j	71.67 e-h	86.67 a-h
S_3V_3	45.00 c-g	56.67 d-j	71.33 e-h	87.00 a-h
S_3V_4	44.67 c-h	55.00 f-k	71.67 e-h	83.00 c-i
S_3V_5	44.00 e-i	57.33 c-h	70.33 e-h	88.33 a-f
S_3V_6	45.00 c-g	54.33 f-k	67.00 gh	83.33 c-i
S_3V_7	43.00 f-k	54.67 f-k	68.67 f-h	86.00 b-i
S_3V_8	45.33 b-g	57.00 c-i	73.00 d-h	89.00 a-e
S_3V_9	45.67 b-f	56.00 e-j	71.67 e-h	85.00 b-i
S_4V_1	40.67 j-l	52.00 j-l	70.33 e-h	79.67 e-i
S_4V_2	42.33 g-k	51.00 kl	66.67 gh	77.67 hi
S_4V_3	41.00 i-l	48.00 l	63.33 h	77.33 i
S_4V_4	41.00 i-l	53.67 g-k	73.00 d-h	84.00 c-i
S_4V_5	41.67 h-k	52.00 j-l	69.33 f-h	80.67 d-i
S_4V_6	41.00 i-l	48.67 l	63.33 h	77.00 i
S_4V_7	40.00 kl	52.33 i-l	67.33 gh	80.00 d-i
S_4V_8	42.33 g-k	53.00 g-l	69.67 f-h	82.00 d-i
S_4V_9	38.67 l	54.67 f-k	70.33e-h	81.00 d-i
LSD (0.05)	2.590	3.832	7.876	7.737
CV(%)	8.57	5.21	6.69	5.55

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Statistically significant variation was observed for different wheat genotypes on days to starting of ear emergence (Table 5). The maximum days to starting of ear emergence (57.17) was obtained from V_5 (Gourab) and V_9 (Bijoy), again the minimum days (54.25) was found from V_6 (Sufi).

Days to starting of ear emergence showed significant differences due to interaction effect of sowing dates and wheat genotypes (Table 6). The maximum days to starting of ear emergence (64.00) was observed from S_1V_7 (sowing on 17 November, 2009 and genotype Shatabdi), again the minimum days (48.00) was recorded from the treatment combination S_4V_3 (sowing on 30 December, 2009 and genotype Prodip).

4.8 Days to starting of anthesis

Days to starting of anthesis showed statistically significant variation for different sowing dates under the present trial (Table 5). The maximum days to starting of anthesis (76.37) was observed from S_1 (sowing on 17 November, 2009) which was statistically identical (74.04) with S_2 (sowing on 30 November, 2009) and closely followed (70.70) by S_3 (sowing on 15 December, 2009), whereas the minimum days (68.15) from S_4 (sowing on 30 December, 2009).

Statistically non-significant variation was recorded for different wheat genotypes on days to starting of anthesis (Table 5). The maximum days to starting of anthesis (74.50) was observed from V_2 (Sourab) and the minimum days (69.92) was recorded from V_6 (Sufi).

Interaction effect of sowing dates and wheat genotypes showed significant differences on days to starting of anthesis (Table 6). The maximum days to starting of anthesis (89.00) was observed from S_1V_7 (sowing on 17 November, 2009 and genotype Shatabdi), while the minimum days (63.33) from S_4V_6 (sowing on 30 December, 2009 and genotype Sufi) treatment combination.

4.9 Days to starting of maturity

Statistically significant variation was recorded for days to starting of maturity showed for different sowing dates (Table 5). The maximum days to starting of maturity (89.19) was attained from S_1 (sowing on 17 November, 2009) which was statistically identical (87.22) with S_2 (sowing on 30 November, 2009) and closely followed (85.96) by S_3 (sowing on 15 December, 2009), again the minimum days (79.89) was recorded from S_4 (sowing on 30 December, 2009).

Statistically non-significant difference was recorded for different wheat genotypes in terms of days to starting of maturity (Table 5). The maximum days to starting of maturity (87.33) was observed from V_8 (Pavan-76), whereas the minimum days (82.83) was found from V_6 (Sufi).

Interaction effect of sowing dates and wheat genotypes varied significantly on days to starting of maturity (Table 6). The maximum days to starting of maturity (96.00) was observed from S_1V_7 (sowing on 17 November, 2009 and genotype Shatabdi), again the minimum days (77.00) was recorded from S_4V_6 (sowing on 30 December, 2009 and genotype Sufi) treatment combination.

4.10 Leaf plant^{-1}

Leaf plant^{-1} showed significant differences for different sowing dates under the present trial (Table 7). The maximum number of leaf plant^{-1} (5.58) was recorded from S_2 (sowing on 30 November, 2009) which was statistically identical (5.44) with S_3 (sowing on 15 December, 2009) and closely followed (5.26) by S_1 (sowing on 17 November, 2009), whereas the minimum number (4.97) was recorded from S_4 (sowing on 30 December, 2009).

Significant variation was observed for different wheat genotypes in terms of number of leaf plant^{-1} (Table 7). The maximum number of leaf plant^{-1} (5.48) was observed from V_2 (Sourab), while the minimum number (5.07) was found from V_9 (Bijoy).

Table 7. Main effect of different sowing dates on leaf plant^{-1}, length, breadth and area of flag leaf of different wheat genotypes

Treatment	Leaf plant^{-1} (No.)	Length of flag leaf (cm)	Breadth of flag leaf (cm)	Area of flag leaf (cm^2)
Sowing date				
S_1	5.26 b	18.90 b	1.22 b	23.24 b
S_2	5.58 a	20.32 a	1.36 a	27.92 a
S_3	5.44 a	20.05 a	1.33 a	26.93 a
S_4	4.97 c	17.81 c	1.14 c	20.37 c
LSD (0.05)	0.161	1.012	0.054	1.881
Wheat genotypes				
V_1	5.44 a	20.52 a	1.29 ab	26.92 a
V_2	5.48 a	20.35 a	1.31 a	27.25 a
V_3	5.37 a	19.41ab	1.26 abc	24.70 a-c
V_4	5.30 ab	19.34 ab	1.29 ab	25.19 ab
V_5	5.36 a	20.45 a	1.33 a	27.64 a
V_6	5.27 ab	19.02 ab	1.30 a	24.83 a-c
V_7	5.21 ab	18.46 b	1.20 cd	22.19 b-d
V_8	5.32 ab	18.08 b	1.21 bcd	21.98 cd
V_9	5.07 b	17.77 b	1.17 d	20.82 d
LSD (0.05)	0.241	1.519	0.081	2.821
CV(%)	5.59	9.68	7.78	14.08

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Interaction effect of sowing dates and wheat genotypes showed significant differences on number of leaf plant^{-1} (Table 8). The maximum number of leaf plant^{-1} (6.27) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab). On the other hand the minimum number of leaf plant^{-1} (4.55) was found from S_4V_9 (sowing on 30 December, 2009 and genotype Bijoy).

4.11 Length of flag leaf

Length of flag leaf showed statistically significant variation for different sowing dates under the present trial (Table 7). The longest flag leaf (20.32 cm) was recorded from S_2 (sowing on 30 November, 2009) which was statistically identical (20.05 cm) with S_3 (sowing on 15 December, 2009) and closely followed (19.90 cm) by S_1 (sowing on 17 November, 2009), again the shortest (17.81 cm) from S_4 (sowing on 30 December, 2009).

Statistically significant difference was found for different wheat genotypes on length of flag leaf (Table 7). The longest flag leaf (20.52 cm) was observed from V_1 (BAW-1064), while the shortest (17.77 cm) was observed from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes varied significantly on length of flag leaf (Table 8). The longest flag leaf (25.74 cm) was observed from S_2V_1 (sowing on 30 November, 2009 and genotype BAW-1064), whereas the shortest (16.12 cm) was attained from S_1V_9 (sowing on 17 November, 2009 and genotype Bijoy) treatment combination.

4.12 Breadth of flag leaf

Different sowing dates varied significantly in terms of breadth of flag leaf (Table 7). The highest breadth of flag leaf (1.36 cm) was recorded from S_2 (sowing on 30 November, 2009) which was statistically identical (1.33 cm) with S_3 (sowing on 15 December, 2009) and closely followed (1.22 cm) by S_1 (sowing on 17 November, 2009), again the lowest breadth of flag leaf (1.14 cm) from S_4 (sowing on 30 December, 2009).

Table 8. Interaction effect of different sowing dates on leaf plant^{-1}, length, breadth and area of flag leaf of different wheat genotypes

Treatment	Leaf plant^{-1} (No.)	Length of flag leaf (cm)	Breadth of flag leaf (cm)	Area of flag leaf (cm^2)
S_1V_1	4.90 e-h	18.17 c-h	1.04 lm	18.84 k-m
S_1V_2	5.00 d-h	18.41 c-h	1.08 j-m	19.84 i-m
S_1V_3	5.20 b-f	17.82 d-h	1.07 k-m	18.98 j-m
S_1V_4	5.30 b-e	21.76bc	1.28 d-i	27.91 c-f
S_1V_5	5.57 b-d	21.77bc	1.41 a-f	30.72bc
S_1V_6	5.40 b-e	18.84 c-h	1.45 a-d	27.28 c-h
S_1V_7	5.47 b-e	19.81 b-h	1.30 c-i	25.72 c-k
S_1V_8	5.50 b-d	17.37 d-h	1.14 i-m	19.91 i-m
S_1V_9	5.03 d-h	16.12 h	1.24 e-k	19.98 i-m
S_2V_1	6.20 a	25.74 a	1.49 a-c	38.35 a
S_2V_2	6.27 a	25.12 a	1.52 a	38.25 a
S_2V_3	5.47 b-e	18.92 c-h	1.37 a-h	25.95 c-i
S_2V_4	5.47 b-e	18.40 c-h	1.37 a-h	25.78 c-j
S_2V_5	5.53 b-d	19.90 b-g	1.39 a-g	27.60 c-g
S_2V_6	5.10 c-h	18.43 c-h	1.22 f-l	22.48 f-m
S_2V_7	5.13 c-g	18.47 c-h	1.27 d-j	23.59 d-m
S_2V_8	5.43 b-e	18.76 c-h	1.39 a-g	25.88 c-j
S_2V_9	5.60 b-d	19.16 c-h	1.22 f-m	23.36 e-m
S_3V_1	5.54 b-d	19.67 c-h	1.41 a-f	27.76 c-g
S_3V_2	5.48 b-e	20.87 b-e	1.45 a-d	30.28 b-d
S_3V_3	5.60 b-d	20.42 b-f	1.43 a-e	29.37 b-e
S_3V_4	5.33 b-e	18.88 c-h	1.34 a-i	25.43 c-k
S_3V_5	5.79 ab	23.28 ab	1.50 ab	34.96 ab
S_3V_6	5.30 b-e	20.98 b-d	1.31 b-i	27.54 c-g
S_3V_7	5.19 c-f	17.96 d-h	1.17 i-m	20.96 g-m
S_3V_8	5.68 bc	19.77 b-h	1.24 e-k	24.42 c-l
S_3V_9	5.08 c-h	18.60 c-h	1.16 i-m	21.61 f-m
S_4V_1	5.13 c-g	18.51 c-h	1.22 f-m	22.72 e-m
S_4V_2	5.17 c-f	16.99 f-h	1.21 g-m	20.63 h-m
S_4V_3	5.21 b-f	20.49 b-f	1.18 h-m	24.49 c-l
S_4V_4	5.09 c-h	18.34 c-h	1.18 h-m	21.64 f-m
S_4V_5	4.57 gh	16.84 f-h	1.02 m	17.25 m
S_4V_6	5.27 b-e	17.85 d-h	1.23 e-k	22.03 f-m
S_4V_7	5.07 d-h	17.61 d-h	1.05 k-m	18.49 lm
S_4V_8	4.68 f-h	16.43 gh	1.07 k-m	17.70 lm
S_4V_9	4.55 h	17.19 e-h	1.07 k-m	18.34 lm
LSD (0.05)	0.483	3.037	0.163	5.642
CV(%)	5.59	9.68	7.78	14.08

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Breadth of flag leaf varied significantly for different wheat genotypes (Table 7). The highest breadth of flag leaf (1.33 cm) was recorded from V_5 (Gourab) and the lowest (1.17 cm) was attained from V_9 (Bijoy).

Significant variation was recorded due to the interaction effect of sowing dates and wheat genotypes in terms of breadth of flag leaf (Table 8). The highest breadth of flag leaf (1.52 cm) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab) whereas the lowest (1.02 cm) was recorded from the treatment combination of S_4V_5 (sowing on 30 December, 2009 and genotype Gourab).

4.13 Area of flag leaf

Area of flag leaf showed significant differences for different sowing dates under the present trial (Table 7). The highest area of flag leaf (27.92 cm^2) was recorded from S_2 (sowing on 30 November, 2009) which was statistically identical (26.93 cm^2) with S_3 (sowing on 15 December, 2009) and closely followed (23.24 cm^2) by S_1 (sowing on 17 November, 2009) whereas the lowest (20.37 cm^2) was recorded from S_4 (sowing on 30 December, 2009).

Statistically significant variation was recorded for different wheat genotypes on area of flag leaf (Table 7). The highest area of flag leaf (27.64 cm^2) was observed from V_5 (Gourab), again the lowest (20.82 cm^2) was recorded from V_9 (Bijoy).

Sowing dates and wheat genotypes showed significant differences on area of flag leaf for their interaction effect (Table 8). The highest area of flag leaf (38.35 cm^2) was observed from S_2V_1 (sowing on 30 November, 2009 and genotype BAW-1064), whereas the lowest (17.25 cm^2) was recorded from S_1V_5 (sowing on 17 November, 2009 and genotype Gourab) treatment combination.

4.14 Effective tillers hill^{-1}

Effective tillers hill^{-1} showed statistically significant variation for different sowing dates under the present trial (Table 9). The highest number of effective tillers hill^{-1} (4.78) was observed from S_2 (sowing on 30 November, 2009) which was closely followed (4.46 and 4.43) by S_3 (sowing on 15 December, 2009) and S_1 (sowing on 17 November, 2009), while the lowest number (3.77) was recorded from S_4 (sowing on 30 December, 2009). Chowdhury (2002) conducted an experiment with four sowing dates 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 similarly with November 1 sown plants.

Statistically significant variation was recorded for different wheat genotypes on effective tillers hill^{-1} (Table 9). The highest number of effective tillers hill^{-1} (4.60) was found from V_1 (BAW-1064), again the lowest (4.16) was attained from V_8 (Pavan-76).

Interaction effect of sowing dates and wheat genotypes varied significantly in terms of effective tillers hill^{-1} (Table 10). The highest number of effective tillers hill^{-1} (5.60) was recorded from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest (3.32) was observed from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab).

4.15 Non-effective tillers hill^{-1}

Statistically significant variation for different sowing dates was recorded in terms of non-effective tillers hill^{-1} (Table 9). The lowest number of non-effective tillers hill^{-1} (0.73) was observed from S_2 (sowing on 30 November, 2009) which was closely followed (0.78 and 0.77) by S_4 (sowing on 30 December, 2009) and S_3 (sowing on 15 December, 2009), while the highest number (0.89) was recorded from S_1 (sowing on 17 November, 2009).

Statistically significant variation was found for different wheat genotypes for non-effective tillers hill^{-1} under the present trial (Table 9). The lowest number of non-effective tillers hill^{-1} (0.75) was found from V_2 (Sourab), again the highest (0.83) was recorded from V_8 (Pavan-76) and V_9 (Bijoy).

Table 9. Main effect of different sowing dates on number of effective, non-effective, total tillers hill^{-1} and dry matter content plant^{-1} of different wheat genotypes

Treatment	Number of tillers hill^{-1}		
	Effective	Non-effective	Total
Sowing date			
S_1	4.43 b	0.89 a	5.31 b
S_2	4.78 a	0.73 c	5.51 a
S_3	4.46 b	0.77 b	5.23 b
S_4	3.77 c	0.78 b	4.54 c
LSD (0.05)	0.193	0.038	0.184
Wheat genotypes			
V_1	4.60 a	0.76 bc	5.35 a
V_2	4.54 a	0.75 c	5.29 ab
V_3	4.29 ab	0.78 a-c	5.07 ab
V_4	4.46 ab	0.78 a-c	5.24 ab
V_5	4.28 ab	0.78 a-c	5.06 ab
V_6	4.54 a	0.81 ab	5.35 a
V_7	4.18 b	0.82 ab	5.00 b
V_8	4.16 b	0.83 a	4.99 b
V_9	4.17 b	0.83 a	5.01 b
LSD (0.05)	0.290	0.058	0.276
CV(%)	8.17	9.18	6.57

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 10. Interaction effect of different sowing dates on number of effective, non-effective, total tillers hill^{-1} and dry matter content plant^{-1} of different wheat genotypes

Treatment	Number of tillers hill^{-1}		
	Effective	Non-effective	Total
S_1V_1	3.73 m-q	0.97 a	4.70 i-n
S_1V_2	4.13 h-p	0.93 ab	5.07 e-k
S_1V_3	3.63 n-q	0.93 ab	4.57 k-n
S_1V_4	5.13 a-d	0.83 a-g	5.97 ab
S_1V_5	4.20 f-o	0.87 a-d	5.07 e-k
S_1V_6	4.50 d-l	0.90 a-c	5.40 b-h
S_1V_7	5.20 a-c	0.83 a-g	6.03 ab
S_1V_8	4.40 e-m	0.87 a-d	5.27 d-j
S_1V_9	4.90 b-f	0.87 a-d	5.77 a-d
S_2V_1	5.53 ab	0.60 ij	6.14 a
S_2V_2	5.60 a	0.53 j	6.13 a
S_2V_3	4.87 c-g	0.77 c-h	5.63 a-f
S_2V_4	4.17 g-p	0.77 c-h	4.94 g-l
S_2V_5	4.67 c-j	0.73 d-i	5.40 b-h
S_2V_6	5.10 a-d	0.83 a-g	5.93 a-c
S_2V_7	4.20 f-o	0.83 a-g	5.03 e-k
S_2V_8	4.67 c-j	0.77 c-h	5.43 b-h
S_2V_9	4.23 f-n	0.73 d-i	4.97 f-l
S_3V_1	4.82 c-h	0.72 e-i	5.54 a-g
S_3V_2	4.62 c-j	0.77 c-h	5.38 b-h
S_3V_3	4.78 c-i	0.70 g-i	5.48 b-g
S_3V_4	4.20 f-o	0.81 b-g	5.01 e-l
S_3V_5	5.02 a-e	0.66 hi	5.68 a-e
S_3V_6	4.52 c-k	0.77 c-h	5.29 c-i
S_3V_7	3.81 l-q	0.83 a-g	4.64 i-n
S_3V_8	4.27 f-n	0.85 a-f	5.12 d-k
S_3V_9	4.08 i-p	0.86 a-d	4.94 g-l
S_4V_1	4.30 f-n	0.74 d-h	5.04 e-k
S_4V_2	3.81 l-q	0.76 d-h	4.57 k-n
S_4V_3	3.90 k-q	0.71 f-i	4.61 j-n
S_4V_4	4.33 e-n	0.70 g-i	5.03 e-k
S_4V_5	3.22 q	0.86 a-e	4.08 n
S_4V_6	4.02 j-p	0.76 d-h	4.78 h-m
S_4V_7	3.51 o-q	0.77 c-h	4.28 mn
S_4V_8	3.32 q	0.83 a-g	4.15 mn
S_4V_9	3.49 pq	0.87 a-d	4.361 mn
LSD (0.05)	0.580	0.115	0.552
CV(%)	8.17	9.18	6.57

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Interaction effect of sowing dates and wheat genotypes showed significant differences on non-effective tillers hill^{-1} (Table 10). The lowest number of non-effective tillers hill^{-1} (0.53) was recorded from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the highest (0.97) was found from the treatment combination of S_1V_1 (sowing on 17 November, 2009 and genotype BAW-1064).

4.16 Total tillers hill^{-1}

Total tillers hill^{-1} varied significantly for different sowing dates under the present trial (Table 9). The highest number of total tillers hill^{-1} (5.51) was recorded from S_2 (sowing on 30 November, 2009) which was closely followed (5.31 and 5.23) by S_1 (sowing on 17 November, 2009) and S_3 (sowing on 15 December, 2009), again the lowest number (4.54) was recorded from S_4 (sowing on 30 December, 2009). Seeds sowing at November 30 ensure the more tillers per plant than semi delay sowing of seeds. Nibedita (2009) reported maximum number of total tillers by sowing seeds in 30 November, 2008 in same area of wheat varieties in another experiment.

Total tillers hill^{-1}showed statistically significant differences for different wheat genotypes (Table 9). The highest number of total tillers hill^{-1} (5.35) was observed from V_1 (BAW-1064) and V_6 (Sufi) and the lowest (4.99) was recorded from V_8 (Pavan-76).

Interaction effect of sowing dates and wheat genotypes varied significantly in terms of total tillers hill^{-1} (Table 10). The highest number of total tillers hill^{-1} (6.14) was observed from S_2V_1 (sowing on 30 November, 2009 and genotype BAW-1064), while the lowest number (4.08) was observed from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab) treatment combination.

4.17 Ear length

Ear length showed statistically significant variation for different sowing dates under the present trial (Table 11). The longest ear (14.91 cm) was found from S_3

(sowing on 15 December, 2009) which was statistically identical (14.86 cm) with S_2 (sowing on 30 November, 2009) and closely followed (13.68 cm) by S_1 (sowing on 17 November, 2009), whereas the shortest ear (12.62 cm) from S_4 (sowing on 30 December, 2009). Chowdhury (2002) conducted an experiment with four sowing dates and reported that ear length decreased with delay in sowing date from November 15 and the lowest ear length were recorded in December 15 sown plants. Nibedita (2009) reported longer ear by sowing seeds in 30 November, 2008 in same area using wheat varieties in another experiment.

Statistically significant variation was recorded for different wheat genotypes on ear length (Table 11). The longest ear (14.93 cm) was recorded from V_2 (Sourab), again the shortest ear (12.26 cm) was found from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes showed significant differences on ear length (Table 12). The longest ear (17.01 cm) was recorded from S_2V_1 (sowing on 30 November, 2009 and genotype BAW-1064), again the shortest (10.69 cm) was found from S_4V_9 (sowing on 30 December, 2009 and genotype Bijoy) treatment combination.

4.18 Spikelets spike^{-1}

Different sowing dates varied significantly in terms of spikelets spike^{-1} under the present trial (Table 11). The highest number of spikelets spike^{-1} (20.78) was recorded from S_2 (sowing on 30 November, 2009) which was statistically identical (20.50) to S_3 (sowing on 15 December, 2009) and closely followed (19.31) by S_1 (sowing on 17 November, 2009), whereas the lowest number (18.05) from S_4 (sowing on 30 December, 2009).

Number of spikelets spike^{-1} varied significantly for different wheat genotypes under the present trial (Table 11). The highest spikelets spike^{-1} (20.62) was observed from V_2 (Sourab) and the lowest (17.77) was recorded from V_9 (Bijoy). Nibedita (2009) also reported similar results by using 5 wheat varieties.

Table 11. Main effect of different sowing dates on ear length, spikelets spike^{-1} and fertile florets spikelet^{-1} of different wheat genotypes

Treatment	Ear length (cm)	Spikelets Spike^{-1}	Fertile florets Spikelet^{-1}
Sowing date			
S_1	13.68 b	19.31 b	2.02 b
S_2	14.86 a	20.78 a	2.59 a
S_3	14.91 a	20.50 a	2.49 a
S_4	12.62 c	18.05 c	1.89 c
LSD (0.05)	0.357	0.562	0.099
Wheat genotypes			
V_1	14.75 a	20.27 ab	2.40 a
V_2	14.93 a	20.62 a	2.43 a
V_3	14.55 a	19.54 bc	2.31 a
V_4	14.41 a	20.32 ab	2.31 a
V_5	14.60 a	20.47 ab	2.33 a
V_6	14.45 a	20.30 ab	2.30 a
V_7	13.36 b	19.13 cd	2.06 b
V_8	12.83 c	18.55 de	2.03 b
V_9	12.26 d	17.77 e	2.04 b
LSD (0.05)	0.520	0.843	0.148
CV(%)	4.56	5.27	8.05

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9 : Bijoy

Table 12. Interaction effect of different sowing dates on ear length, spikelets spike^{-1} and fertile florets spikelet^{-1} of different wheat genotypes

Treatment	Ear length (cm)	Spikelets Spike^{-1}	Fertile florets Spikelet^{-1}
S_1V_1	12.95 i-k	17.83 k-n	1.77 i-l
S_1V_2	13.94 f-i	18.27 i-n	1.90 h-l
S_1V_3	13.75 f-i	16.50 n-p	1.93 h-k
S_1V_4	14.02 f-i	20.30 c-i	2.03 g-j
S_1V_5	14.52 c-g	21.60 a-d	2.23 e-h
S_1V_6	14.32 d-h	21.97 a-c	2.07 f-i
S_1V_7	14.14 e-i	20.83 a-h	2.23 e-h
S_1V_8	12.99 i-k	18.93 h-m	2.00 g-j
S_1V_9	12.44 jk	17.57 l-n	2.00 g-j
S_2V_1	17.01 a	21.97 a-c	3.10 a
S_2V_2	16.98 a	22.63 a	3.17 a
S_2V_3	15.32 b-e	21.03 a-g	2.60 b-d
S_2V_4	15.32 b-e	21.07 a-f	2.60 b-d
S_2V_5	15.59 bc	21.23 a-e	2.63 b-d
S_2V_6	14.49 c-g	18.93 h-m	2.40 c-f
S_2V_7	13.38 g-j	19.43 e-l	2.07 f-i
S_2V_8	13.16 h-j	20.23 c-i	2.20 e-h
S_2V_9	12.48 jk	20.50 b-h	2.50 b-e
S_3V_1	15.59 bc	21.37 a-e	2.70 bc
S_3V_2	15.38 b-d	21.77 a-d	2.60 b-d
S_3V_3	15.70 bc	21.63 a-d	2.67 bc
S_3V_4	14.94 b-f	20.53 b-h	2.53 b-e
S_3V_5	16.02 ab	22.40 ab	2.77 b
S_3V_6	15.24 b-e	20.23 c-i	2.53 b-e
S_3V_7	14.00 f-i	19.10 f-m	2.23 e-h
S_3V_8	13.92 f-i	19.37 e-l	2.30 d-g
S_3V_9	13.41 g-j	18.13 j-n	2.10 f-i
S_4V_1	13.46 g-j	19.90 d-j	2.03 g-j
S_4V_2	13.42 g-j	19.80 d-k	2.07 f-i
S_4V_3	13.45 g-j	19.00 g-m	2.03 g-j
S_4V_4	13.36 g-j	19.37 e-l	2.07 f-i
S_4V_5	12.28 j-l	16.63 n-p	1.70 j-l
S_4V_6	13.77 f-i	20.07 c-j	2.20 e-h
S_4V_7	11.94 kl	17.17 m-o	1.70 j-l
S_4V_8	11.24 lm	15.67 op	1.60 kl
S_4V_9	10.69 m	14.87 p	1.57 l
LSD (0.05)	1.040	1.687	0.296
CV(%)	4.56	5.27	8.05

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Sowing dates and wheat genotypes showed significant differences due to the interaction effect in terms of spikelets spike^{-1} (Table 12). The highest spikelets spike^{-1} (22.63) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest number (14.87) was recorded from S_4V_9 (sowing on 30 December, 2009 and genotype Bijoy).

4.19 Fertile florets spikelet^{-1}

Fertile florets spikelet^{-1} showed significant difference for different sowing dates under the present trial (Table 11). The highest number of fertile florets spikelet^{-1} (2.59) was found from S_2 (sowing on 30 November, 2009) which was statistically identical (2.49) with S_3 (sowing on 15 December, 2009) and closely followed (2.02) by S_1 (sowing on 17 November, 2009), whereas the lowest number (1.89) was recorded from S_4 (sowing on 30 December, 2009).

Statistically significant variation was recorded for different wheat genotypes on fertile florets spikelet^{-1} (Table 11). The highest fertile florets spikelet^{-1} (2.43) was observed from V_2 (Sourab), again the lowest (2.03) from V_8 (Pavan-76).

Fertile florets spikelet^{-1} showed significant differences due to interaction effect of sowing dates and wheat genotypes (Table 12). The highest fertile florets spikelet^{-1} (3.17) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest number (1.57) was attained from the treatment combination of S_4V_9 (sowing on 30 December, 2009 and genotype Bijoy).

4.20 Dry matter content of stem plant^{-1}

Dry matter content of stem plant^{-1} showed statistically significant variation for different sowing dates under the present trial (Table 13). The highest dry matter content of stem plant^{-1} (2.33 g) was obtained from S_2 (sowing on 30 November, 2009) which was statistically identical (2.25 g) with S_3 (sowing on 15 December, 2009), while the lowest (2.15 g) from S_1 (sowing on 17 November, 2009) which was statistically similar (2.22 g) with S_4 (sowing on 30 December, 2009).

Statistically significant variation was recorded for different wheat genotypes on dry matter content of stem plant^{-1} (Table 13). The highest dry matter content of stem plant^{-1} (2.37 g) was observed from V_1 (BAW-1064) and V_2 (Sourab) and the lowest (2.05 g) was recorded from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes showed significant differences on dry matter content of stem plant^{-1} (Table 14). The highest dry matter content of stem plant^{-1} (2.90 g) was recorded from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the lowest (1.92 g) was found from S_4V_8 (sowing on 30 December, 2009 and genotype Pavan-76) treatment combination.

4.21 Dry matter content of ear plant^{-1}

Statistically significant variation was recorded in terms of dry matter content of ear plant^{-1} for different sowing dates (Table 13). The highest dry matter content of ear plant^{-1} (5.30 g) was found from S_2 (sowing on 30 November, 2009) which was closely followed (5.01 g) by S_3 (sowing on 15 December, 2009), whereas the lowest (4.70 g) from S_1 (sowing on 17 November, 2009) which was statistically similar (4.89 g) with S_4 (sowing on 30 December, 2009).

Significant variation was observed for different wheat genotypes on dry matter content of ear plant^{-1} (Table 13). The highest dry matter content of ear plant^{-1} (5.30 g) was recorded from V_2 (Sourab), again the lowest (4.64 g) was observed from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes showed significant differences on dry matter content of ear plant^{-1} (Table 14). The highest dry matter content of ear plant^{-1} (6.72 g) was recorded from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest (4.07 g) was observed from S_1V_1 (sowing on 17 November, 2009 and genotype BAW-1064).

Table 13. Main effect of different sowing dates on stem, ear, seed, husk, root and total dry matter content plant^{-1} of different wheat genotypes

Treatment	Dry matter content plant^{-1} (g)				
	Stem	Ear	Seed	Husk	Root
Sowing date					
S_1	2.15 b	4.70 c	3.48 a	2.05 b	1.56 b
S_2	2.33 a	5.30 a	3.34 b	2.18 a	1.67 a
S_3	2.25 ab	5.01 b	3.40 b	2.12 ab	1.60 ab
S_4	2.22 b	4.89 bc	3.38 b	2.10 b	1.12 c
LSD (0.05)	0.102	0.278	0.071	0.069	0.077
Wheat genotypes					
V_1	2.37 a	5.29 a	3.43 a	2.21 a	1.56 a
V_2	2.37 a	5.30 a	3.47 a	2.20 a	1.58 a
V_3	2.27 a	5.05 ab	3.53 a	2.14 ab	1.56 a
V_4	2.22 ab	4.91 ab	3.55 a	2.10 ab	1.53 ab
V_5	2.27 a	5.06 ab	3.51 a	2.14 ab	1.58 a
V_6	2.21 ab	4.89 ab	3.55 a	2.10 ab	1.52 ab
V_7	2.26 a	4.98 ab	3.50 a	2.13 ab	1.43 bc
V_8	2.07 b	4.67 b	3.02 b	1.98 c	1.37 c
V_9	2.05 b	4.64 b	3.04 b	2.03 bc	1.25 d
LSD (0.05)	0.152	0.417	0.106	0.103	0.115
CV(%)	8.40	10.28	7.87	6.01	9.50

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 14. Interaction effect of different sowing dates on stem, ear, seed, husk, root and total dry matter content plant^{-1} of different wheat genotypes

Treatment	Dry matter content plant^{-1} (g)					
	Stem	Ear	Seed	Husk	Root	Total
S_1V_1	1.92 h	4.07 k	3.73 a-c	1.90 jk	1.51 c-g	13.13 g-k
S_1V_2	1.95 gh	4.18 i-k	3.75 ab	1.91 jk	1.55 c-g	13.34 f-k
S_1V_3	1.99 f-h	4.36 f-k	3.78 a	1.94 h-k	1.62 b-f	13.68 e-i
S_1V_4	2.13 c-h	4.68 c-k	3.61 a-g	2.04 d-k	1.66 a-e	14.11 d-h
S_1V_5	2.32 b-g	5.20 b-i	3.48 c-i	2.17 b-i	1.74 a-c	14.91 b-e
S_1V_6	2.18 c-h	4.85 c-k	3.59 a-h	2.07 c-k	1.68 a-e	14.37 b-g
S_1V_7	2.61 ab	5.94 ab	3.27 i-k	2.37 ab	1.61 c-f	15.80 b
S_1V_8	2.17 c-h	4.66 c-k	3.02 kl	2.07 c-k	1.60 c-f	13.52 e-j
S_1V_9	2.06 d-h	4.38 e-k	3.08 kl	2.03 d-k	1.07 k	12.61 i-k
S_2V_1	2.86 a	6.59 a	3.13 j-l	2.54 a	1.90 ab	17.02 a
S_2V_2	2.90 a	6.72 a	3.13 j-l	2.57 a	1.93 a	17.26 a
S_2V_3	2.29 b-h	5.09 b-k	3.47 d-i	2.15 b-j	1.70 a-e	14.69 b-f
S_2V_4	2.29 b-h	5.09 b-k	3.49 c-i	2.15 b-j	1.70 a-e	14.72 b-f
S_2V_5	2.33 b-f	5.21 b-h	3.46 e-i	2.18 b-h	1.72 a-d	14.90 b-e
S_2V_6	2.02 e-h	4.38 e-k	3.68 a-e	1.97 f-k	1.59 c-f	13.63 e-i
S_2V_7	2.05 d-h	4.45 e-k	3.66 a-f	1.98 e-k	1.58 c-f	13.72 d-i
S_2V_8	2.00 f-h	4.66 c-k	3.01 l	1.92 i-k	1.43 e-i	13.02 g-k
S_2V_9	2.17 c-h	5.54 b-d	3.00 l	2.11 c-k	1.53 c-g	14.36 b-g
S_3V_1	2.36 b-f	5.25 b-f	3.43 e-i	2.20 b-g	1.72 a-d	14.95 b-e
S_3V_2	2.28 b-h	5.08 b-k	3.50 b-i	2.14 b-j	1.70 a-e	14.71 b-f
S_3V_3	2.41 b-d	5.40 b-e	3.41 f-i	2.23 b-e	1.74 a-c	15.19 b-d
S_3V_4	2.17 c-h	4.80 c-k	3.59 a-h	2.07 c-k	1.66 a-e	14.28 c-h
S_3V_5	2.50 bc	5.66 bc	3.38 g-i	2.29 bc	1.79 a-c	15.62 bc
S_3V_6	2.17 c-h	4.77 c-k	3.58 a-h	2.07 c-k	1.65 b-f	14.24 c-h
S_3V_7	2.09 d-h	4.56 d-k	3.63 a-g	2.01 e-k	1.44 d-h	13.74 d-i
S_3V_8	2.19 c-h	5.14 b-j	3.03 kl	2.06 c-k	1.38 f-j	13.80 d-i
S_3V_9	2.04 d-h	4.43 e-k	3.06 kl	2.02 e-k	1.30 g-k	12.84 h-k
S_4V_1	2.35 b-f	5.26 b-f	3.45 e-i	2.19 b-h	1.12 jk	14.37 b-g
S_4V_2	2.34 b-f	5.23 b-g	3.47 c-i	2.18 b-h	1.13 jk	14.36 b-g
S_4V_3	2.39 b-e	5.37 b-f	3.45 e-i	2.22 b-f	1.20 h-k	14.63 b-f
S_4V_4	2.28 b-h	5.07 b-k	3.52 b-i	2.14 b-j	1.11 k	14.12 d-h
S_4V_5	1.95 gh	4.17 jk	3.73 a-d	1.91 jk	1.07 k	12.83 h-k
S_4V_6	2.48 bc	5.56 b-d	3.34 h-j	2.28 b-d	1.17 i-k	14.83 b-e
S_4V_7	2.29 b-h	4.96 b-k	3.43 e-i	2.15 b-j	1.08 k	13.91 d-i
S_4V_8	1.92 h	4.21 g-k	3.02 kl	1.88 k	1.08 k	12.11 k
S_4V_9	1.94 h	4.19 h-k	3.04 kl	1.95 g-k	1.08 k	12.20 jk
LSD (0.05)	0.305	0.834	0.212	0.206	0.230	1.199
CV(%)	8.40	10.28	7.87	6.01	9.50	5.18

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

4.22 Dry matter content of seed plant^{-1}

Dry matter content of seed plant^{-1} varied significantly for different sowing dates under the present trial (Table 13). The highest dry matter content of seed plant^{-1} (3.48 g) was recorded from S_1 (sowing on 17 November, 2009), whereas the lowest (3.34 g) was recorded from S_2 (sowing on 30 November, 2009) which was statistically similar (3.38 g and 3.40 g) with S_4 (sowing on 30 December, 2009) and S_3 (sowing on 15 December, 2009),

Different wheat genotypes showed statistically significant variation in terms of dry matter content of seed plant^{-1} (Table 13). The highest dry matter content of seed plant^{-1} (3.55 g) was found from V_4 (Fang-60) and V_6 (Sufi) and the lowest (3.02 g) was recorded from V_8 (Pavan-76).

Significant difference was recorded on dry matter content of seed plant^{-1} due to the interaction effect of sowing dates and wheat genotypes (Table 14). The highest dry matter content of seed plant^{-1} (3.78 g) was observed from S_1V_3 (sowing on 15 November, 2009 and genotype Prodip), while the lowest (3.01 g) was recorded from S_2V_8 (sowing on 30 November, 2009 and genotype Pavan-76) treatment combination.

4.23 Dry matter content of husk plant^{-1}

Dry matter content of husk plant^{-1} showed significant differences for different sowing dates (Table 13). The highest dry matter content of husk plant^{-1} (2.18 g) was observed from S_2 (sowing on 30 November, 2009) which was statistically similar (2.12 g) with S_3 (sowing on 15 December, 2009). On the other hand, the lowest (2.05 g) was found from S_1 (sowing on 17 November, 2009) which was statistically similar (2.10 g) with S_4 (sowing on 30 December, 2009).

Statistically significant variation was recorded for different wheat genotypes on dry matter content of husk plant^{-1} (Table 13). The highest dry matter content of husk plant^{-1} (2.21 g) was recorded from V_1 (BAW-1064), again the lowest (1.98 g) from V_8 (Pavan-76).

Interaction effect of sowing dates and wheat genotypes showed significant differences on dry matter content of husk plant^{-1} (Table 14). The highest dry matter content of husk plant^{-1} (2.57 g) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the lowest (1.88 g) from S_4V_8 (sowing on 30 December, 2009 and genotype Pavan-76).

4.24 Dry matter content of root plant^{-1}

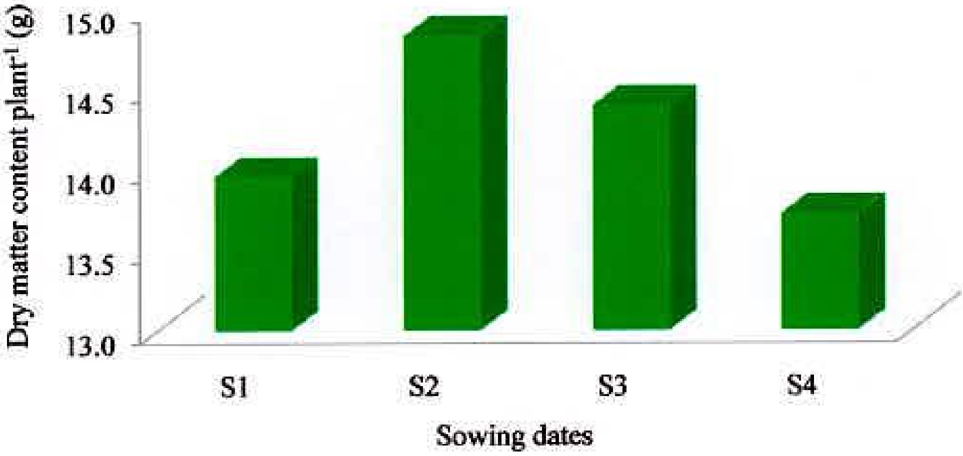
Different sowing dates varied significantly on dry matter content of root plant^{-1} (Table 13). The highest dry matter content of root plant^{-1} (1.67 g) was observed from S_2 (sowing on 30 November, 2009) which was statistically similar (1.60 g) with S_3 (sowing on 15 December, 2009), again the lowest (1.12 g) from S_4 (sowing on 30 December, 2009) which was closely followed (1.56 g) with S_1 (sowing on 17 November, 2009).

Significant variation was recorded for different wheat genotypes on dry matter content of root plant^{-1} (Table 13). The highest dry matter content of root plant^{-1} (1.58 g) was recorded from V_2 (Sourab) and V_5 (Gourab), again the lowest (1.25 g) was attained from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes showed significant differences on dry matter content of root plant^{-1} (Table 14). The highest dry matter content of root plant^{-1} (1.93 g) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the lowest (1.07 g) was recorded from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab) treatment combination.

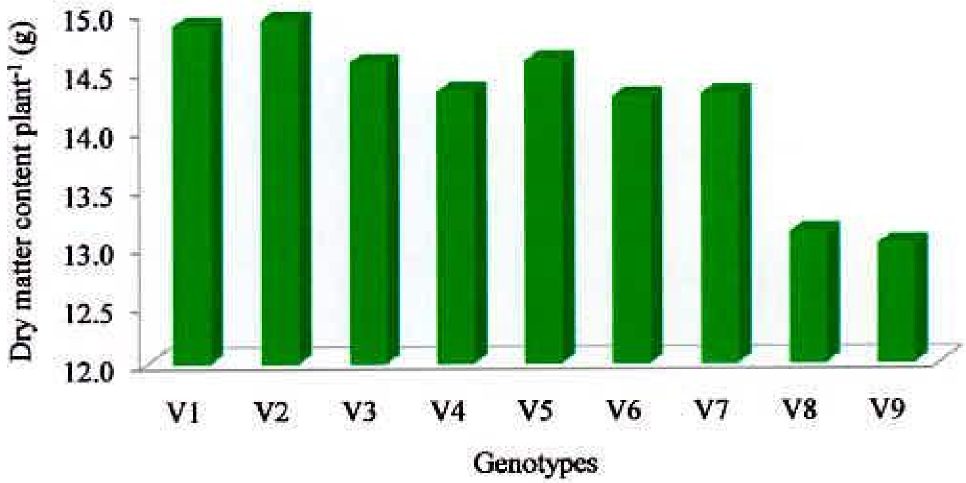
4.25 Dry matter content plant^{-1}

Dry matter content plant^{-1} showed statistically significant variation for different sowing dates (Figure 5). The highest dry matter content plant^{-1} (14.81 g) was found from S_2 (sowing on 30 November, 2009) which was closely followed (14.38 g) by S_3 (sowing on 15 December, 2009). On the other hand, the lowest (13.71 g) was recorded from S_4 (sowing on 30 December, 2009) which was statistically identical (13.94 g) with S_1 (sowing on 17 November, 2009).



S_1: Sowing on 17 November, 2009 S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009 S_4: Sowing on 30 December, 2009

Figure 5. Effect of different sowing dates on dry matter content plant^{-1} of wheat



V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-66 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Figure 6. Effect of different genotypes on dry matter content plant^{-1} of wheat

Statistically significant variation was recorded for different wheat genotypes on dry matter content plant^{-1} (Figure 6). The highest dry matter content plant^{-1} (14.92 g) was observed from V_2 (Sourab) and the lowest (13.01 g) from V_9 (Bijoy).

Sowing dates and wheat genotypes showed significant interaction effect of on dry matter content plant^{-1} (Table 14). The highest dry matter content plant^{-1} (17.26 g) was found from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest (12.11 g) was recorded from S_4V_8 (sowing on 30 December, 2009 and genotype Pavan-76).

4.26 Number of filled grains spike^{-1}

Statistically significant variation was recorded for number of filled grains spike^{-1} for different sowing dates the present trial (Table 15). The highest number of filled grains spike^{-1} (42.77) was observed from S_2 (sowing on 30 November, 2009) which was statistically identical (42.20 and 40.42) with S_3 and S_1 (sowing on 17 November, 2009), whereas the lowest number (37.40) from S_4 (sowing on 30 December, 2009).

Number of filled grains spike^{-1} showed statistically significant variation for different wheat genotypes on (Table 15). The highest number of filled grains spike^{-1} (44.50) was observed from V_2 (Sourab), again the lowest number (36.11) was found from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes showed significant variation in terms of number of filled grains spike^{-1} (Table 16). The highest number of filled grains spike^{-1} (57.23) was attained from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest number (28.10) was found from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab) treatment combination.

Table 15. Main effect of different sowing dates on no. of filled, no. of unfilled and no. of total grains per spike of different wheat genotypes

Treatment	No. of filled grains spike^{-1}	No. of unfilled grains spike^{-1}	No. of total grains spike^{-1}	No. of total grains branch tiller^{-1}
Sowing date				
S_1	40.42 a	4.47 ab	44.89 a	7.92 b
S_2	42.77 a	4.07 c	46.84 a	8.27 a
S_3	42.20 a	4.27 bc	46.47 a	7.91 b
S_4	37.40 b	4.50 a	41.90 b	6.99 c
LSD (0.05)	2.923	0.204	2.804	0.214
Wheat genotypes				
V_1	43.12 ab	4.18 bc	47.29 ab	8.04 a
V_2	44.50 a	4.01 c	48.51 a	7.99 a
V_3	39.83 a-c	4.21 bc	44.04 abc	7.72 abc
V_4	41.36 ab	4.20 bc	45.56 ab	7.86 abc
V_5	42.22 ab	4.23 bc	46.45 ab	7.70 abc
V_6	41.01 ab	4.37 ab	45.38 ab	7.95 ab
V_7	39.11 bc	4.57 a	43.68 bc	7.57 c
V_8	39.02 bc	4.63 a	43.65 bc	7.62 bc
V_9	36.11 c	4.58 a	40.69 c	7.51 c
LSD (0.05)	4.385	0.306	4.206	0.321
CV(%)	13.23	8.68	11.47	5.06

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 16. Interaction effect of different sowing dates on no. of filled, no. of unfilled and no. of total grains per spike of different wheat genotypes

Treatment	No. of filled grains spike^{-1}	No. of unfilled grains spike^{-1}	No. of total grains spike^{-1}	No. of total grains branch tiller^{-1}
S_1V_1	29.87 jk	5.00 a	34.87 i-k	7.13 j-n
S_1V_2	33.40 g-k	4.53 a-g	37.93 g-k	7.53 f-k
S_1V_3	29.83 jk	4.67 a-f	34.50 jk	7.17 i-n
S_1V_4	40.60 c-i	4.07 c-h	44.67 d-j	8.60 a-c
S_1V_5	47.50 a-c	4.23 b-h	51.73 a-e	7.83 c-k
S_1V_6	45.03 b-f	4.30 a-h	49.33 b-f	8.07 b-g
S_1V_7	51.13 a-c	4.23 b-h	55.37 a-c	8.73 ab
S_1V_8	45.97 b-f	4.63 a-f	50.60 b-f	7.97 b-h
S_1V_9	40.43 c-j	4.60 a-f	45.03 d-i	8.27 b-f
S_2V_1	54.67 ab	3.30 ij	57.97 ab	9.20 a
S_2V_2	57.23 a	3.03 j	60.27 a	9.23 a
S_2V_3	42.93 c-g	4.16 c-h	47.09 c-g	8.33 b-e
S_2V_4	42.97 c-g	4.17 c-h	47.13 c-g	7.63 e-k
S_2V_5	44.03 c-g	4.07 c-h	48.10 b-g	8.13 b-g
S_2V_6	33.33 g-k	4.63 a-f	37.97 g-k	8.47 b-d
S_2V_7	35.80 f-k	4.60 a-f	40.40 f-k	7.60 e-k
S_2V_8	36.90 e-k	4.70 a-f	41.60 e-k	8.13 b-g
S_2V_9	37.07 e-k	4.00 f-h	41.07 f-k	7.73 d-k
S_3V_1	45.50 b-f	4.13 d-h	49.63 b-f	8.27 b-f
S_3V_2	44.50 b-f	4.17 c-h	48.67 b-f	8.10 b-g
S_3V_3	46.07 b-f	3.83 g-i	49.90 b-f	8.23 b-f
S_3V_4	39.90 d-j	4.47 a-g	44.37 d-j	7.63 e-k
S_3V_5	49.27 a-d	3.63 h-j	52.90 a-d	8.53 a-c
S_3V_6	39.87 d-j	4.23 b-h	44.10 d-j	7.90 c-j
S_3V_7	36.17 f-k	4.67 a-f	40.83 f-k	7.20 h-m
S_3V_8	43.10 c-g	4.50 a-g	47.60 c-g	7.93 c-i
S_3V_9	35.43 f-k	4.83 a-d	40.27 f-k	7.43 g-l
S_4V_1	42.43 c-g	4.27 a-h	46.70 c-g	7.57 e-k
S_4V_2	42.87 c-g	4.30 a-h	47.17 c-g	7.10 k-n
S_4V_3	40.47 c-j	4.20 c-h	44.67 d-j	7.17 i-n
S_4V_4	41.97 c-h	4.10 d-h	46.07 c-h	7.57 e-k
S_4V_5	28.10 k	4.97 ab	33.07 k	6.30 o
S_4V_6	45.80 b-f	4.30 a-h	50.10 b-f	7.37 g-l
S_4V_7	33.33 g-k	4.77 a-e	38.10 g-k	6.77 l-o
S_4V_8	30.10 i-k	4.70 a-f	34.80 jk	6.43 no
S_4V_9	31.50 h-k	4.90 a-c	36.40 h-k	6.60 m-o
LSD (0.05)	8.770	0.611	8.412	0.641
CV(%)	13.23	8.68	11.47	5.06

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

4.27 Number of unfilled grains spike^{-1}

Number of unfilled grains spike^{-1} showed statistically significant variation for different sowing dates under the present trial (Table 15). The lowest number of unfilled grains spike^{-1} (4.07) was observed from S_2 (sowing on 30 November, 2009) which was statistically identical (4.27) with S_3 (sowing on 15 December, 2009), while the highest number (4.50) was recorded from S_4 (sowing on 30 December, 2009) which was statistically similar (4.47) with S_1 (sowing on 17 November, 2009).

Significant variation was recorded for different wheat genotypes on number of unfilled grains spike^{-1} (Table 15). The lowest number of unfilled grains spike^{-1} (4.01) was observed from V_2 (Sourab) and the highest number (4.63) was recorded from V_8 (Pavan-76).

Interaction effect of sowing dates and wheat genotypes varied significantly on number of unfilled grains spike^{-1} (Table 16). The lowest number of unfilled grains spike^{-1} (3.30) was found from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the highest number (5.00) was recorded from the treatment combination of S_1V_1 (sowing on 17 November, 2009 and genotype BAW-1064).

4.28 Number of total grains spike^{-1}

Statistically significant variation was recorded for number of total grains spike^{-1} for different sowing dates under the present trial (Table 15). The highest number of total grains spike^{-1} (44.89) was recorded from S_1 (sowing on 17 November, 2009) which was statistically identical (46.84 and 46.47) with S_2 (sowing on 30 November, 2009) and S_3 (sowing on 15 December, 2009), while the lowest number (41.90) was found from S_4 (sowing on 30 December, 2009). Chowdhury (2002) conducted an experiment with four sowing dates and reported that grains spike^{-1} decreased with delay in sowing date from November 15 and the lowest grains spike^{-1} were recorded in December 15 sown plants.

Number of total grains spike^{-1} varied significantly for different wheat genotypes on (Table 15). The highest number of total grains spike^{-1} (48.51) was observed from V_2 (Sourab), again the lowest number (40.69) from V_9 (Bijoy). Wheat Research Center (2003) reported that the variety Shatabdi produced maximum grain spike^{-1}.

Sowing dates and wheat genotypes showed significant interaction effect on number of total grains spike^{-1} (Table 16). The highest number of total grains spike^{-1} (60.27) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest number (33.07) was recorded from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab).

4.29 Number of total grains branch tiller^{-1}

Number of total grains branch tiller^{-1} varied significantly for different sowing dates under the present trial (Table 15). The highest number of total grains branch tiller^{-1} (8.27) was found from S_2 (sowing on 30 November, 2009) which closely followed (7.92 and 7.91) by S_1 (sowing on 17 November, 2009) and S_3 (sowing on 15 December, 2009), again the lowest number (6.99) from S_4 (sowing on 30 December, 2009).

Different wheat genotypes varied significantly for number of total grains branch tiller^{-1} (Table 15). The highest number of total grains branch tiller^{-1} (8.04) was found from V_1 (BAW-1064) and the lowest number (7.51) was recorded from V_9 (Bijoy).

Significant variation was recorded due to the interaction effect of sowing dates and wheat genotypes in terms of number of total grains branch tiller^{-1} (Table 16). The highest number of total grains branch tiller^{-1} (9.23) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the lowest number (6.30) was obtained from S_4V_5 (sowing on 30 December, 2009 and genotype Gourab) treatment combination.

4.30 Grain yield m^{-2}

Grain yield m^{-2} showed statistically significant variation for different sowing dates under the present trial (Table 17). The highest grain yield m^{-2} (363.89 g) was observed from S_2 (sowing on 30 November, 2009) which was statistically identical (357.19 g) to S_3 (sowing on 15 December, 2009) and closely followed (351.64 g) by S_1 (sowing on 17 November, 2009), while the lowest (314.85 g) was found from S_4 (sowing on 30 December, 2009).

Statistically significant difference was recorded for different wheat genotypes on grain yield m^{-2} (Table 17). The highest grain yield m^{-2} (367.45 g) was observed from V_2 (Sourab), again the lowest (310.11 g) was obtained from V_9 (Bijoy).

Interaction effect of sowing dates and wheat genotypes showed significant differences on grain yield m^{-2} (Table 18). The highest grain yield m^{-2} (414.85 g) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest (285.17 g) was found from S_4V_7 (sowing on 30 December, 2009 and genotype Shatabdi).

4.31 Grain yield ha^{-1}

Statistically significant variation was recorded for grain yield ha^{-1} for different sowing dates under the present trial (Table 17). The highest grain yield ha^{-1} (3.64 ton) was found from S_2 (sowing on 30 November, 2009) which was statistically identical (3.57 ton) with S_3 (sowing on 15 December, 2009) and closely followed (3.52 ton) by S_1 (sowing on 17 November, 2009), whereas the lowest (3.15 ton) was recorded from S_4 (sowing on 30 December, 2009). Wheat sown in November to ensure optimal crop growth and avoid high temperature and after that if wheat is sown in the field it faces high range of temperature for its growth and development as well as yield potential. Islam *et al.*, (1993) reported that late planted wheat plants face a period of high temperature stress during reproductive stages causing reduced kernel number $spike^{-1}$ as well as the reduction of seed yield. Nibedita (2009) reported more yield by sowing seeds in 30 November, 2008 in another experiment.

Table 17. Main effect of different sowing dates on grain and straw yield of different wheat genotypes

Treatment	Grain		Straw	
	Yield (g m^{-2})	Yield (t ha^{-1})	Yield (g m^{-2})	Yield (t ha^{-1})
Sowing date				
S_1	351.64 b	3.52 b	430.31 b	4.30 b
S_2	363.89 a	3.64 a	470.53 a	4.71 a
S_3	357.19 ab	3.57 ab	447.65 b	4.48 b
S_4	314.85 c	3.15 c	386.10 c	3.86 c
LSD (0.05)	9.670	0.097	19.79	0.197
Wheat genotypes				
V_1	363.27 a	3.63 a	463.65 a	4.64 a
V_2	367.45 a	3.67 a	460.02 a	4.60 a
V_3	361.77 a	3.62 a	442.21 ab	4.42 ab
V_4	357.88 a	3.58 a	432.71 a-c	4.33 a-c
V_5	361.73 a	3.62 a	443.14 ab	4.43 ab
V_6	356.71 a	3.57 a	432.10 a-c	4.32 a-c
V_7	324.20 b	3.24 b	403.78 c	4.04 c
V_8	318.92 b	3.19 b	413.80 bc	4.14 bc
V_9	310.11 b	3.10 b	411.44 bc	4.11 bc
LSD (0.05)	14.50	0.146	29.68	0.297
CV(%)	5.14	5.14	8.41	8.41

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 18. Interaction effect of different sowing dates on grain and straw yield of different wheat genotypes

Treatment	Grain		Straw	
	Yield (g m^{-2})	Yield (t ha^{-1})	Yield (g m^{-2})	Yield (t ha^{-1})
S_1V_1	339.70 e-j	3.40 e-j	389.18 g-k	3.89 g-k
S_1V_2	351.50 d-i	3.52 d-i	392.44 g-k	3.92 g-k
S_1V_3	361.35 c-h	3.61 c-h	400.54 f-k	4.01 f-k
S_1V_4	365.13 c-g	3.65 c-g	428.45 c-i	4.28 c-i
S_1V_5	379.46 b-d	3.79 b-d	466.79 b-f	4.67 b-f
S_1V_6	371.23 c-e	3.71 c-e	439.58 b-h	4.40 b-h
S_1V_7	360.85 c-h	3.61 c-h	506.09 b	5.06 b
S_1V_8	332.53 g-k	3.33 g-k	446.33 b-h	4.46 b-h
S_1V_9	303.00 kl	3.03 kl	403.33 e-k	4.03 e-k
S_2V_1	409.09 ab	4.09 ab	572.38 a	5.72 a
S_2V_2	414.85 a	4.15 a	573.22 a	5.73 a
S_2V_3	373.82 c-e	3.74 c-e	461.06 b-g	4.61 b-g
S_2V_4	373.82 c-e	3.74 c-e	461.06 b-g	4.61 b-g
S_2V_5	377.80 b-d	3.78 b-d	469.65 b-f	4.70 b-f
S_2V_6	356.18 c-i	3.56 c-i	407.82 e-j	4.08 e-j
S_2V_7	323.67 i-k	3.24 i-k	386.92 h-k	3.87 h-k
S_2V_8	313.33 j-l	3.13 j-l	431.34 c-i	4.31 c-i
S_2V_9	332.43 g-k	3.32 g-k	471.34 b-f	4.71 b-f
S_3V_1	376.44 b-d	3.76 b-d	474.34 b-e	4.74 b-e
S_3V_2	374.61 cd	3.75 cd	459.04 b-h	4.59 b-h
S_3V_3	380.74 b-d	3.81 b-d	485.25 b-d	4.85 b-d
S_3V_4	367.75 c-f	3.68 c-f	437.88 b-h	4.38 b-h
S_3V_5	389.89 a-c	3.90 a-c	498.04 bc	4.98 bc
S_3V_6	365.53 c-g	3.66 c-g	437.77 b-h	4.38 b-h
S_3V_7	327.12 h-k	3.27 h-k	387.84 g-k	3.88 g-k
S_3V_8	327.67 h-k	3.28 h-k	442.05 b-h	4.42 b-h
S_3V_9	305.00 j-l	3.05 j-l	406.67 e-j	4.07 e-j
S_4V_1	327.85 h-k	3.28 h-k	418.69 d-i	4.19 d-i
S_4V_2	328.82 h-k	3.29 h-k	415.38 d-i	4.15 d-i
S_4V_3	331.16 g-k	3.31 g-k	421.98 d-i	4.22 d-i
S_4V_4	324.83 i-j	3.25 i-k	403.43 e-k	4.03 e-k
S_4V_5	299.77 kl	3.00 kl	338.06 jk	3.38 jk
S_4V_6	333.90 f-k	3.34 f-k	443.23 b-h	4.43 b-h
S_4V_7	285.17 l	2.85 l	334.28 k	3.34 k
S_4V_8	302.14 kl	3.02 kl	335.47 k	3.35 k
S_4V_9	300.00 kl	3.00 kl	364.42 i-k	3.64 i-k
LSD (0.05)	29.01	0.291	59.36	0.594
CV(%)	5.14	5.14	8.41	8.41

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

The variety Gourab provided better and steady yield when sown on 17 November (3.79 t ha^{-1}), 30 November (3.78 t ha^{-1}) and 15 December (3.90 t ha^{-1}), whereas Sourab (4.15 t ha^{-1}) and BAW-1064 (4.09 t ha^{-1}) showed better yield on 30 November sowing. Prodip also provided steady yield on 17 November (3.61 t ha^{-1}), 30 November (3.74 t ha^{-1}) and 15 December (3.8 t ha^{-1}). Yield of Sufi was more or less steady in case of different sowing dates (3.71, 3.56, 3.66 and 3.34 t ha^{-1}). However, the yield was least in case of different varieties when sown on 30 December. The lowest yield was provided by the varieties Bijoy (3.03 t ha^{-1}), Pavan (3.13 t ha^{-1}) and Shatabdi (2.85 t ha^{-1}) in all sowing (17 and 30 November and 15 & 30 December). The yield was reduced in case of all the varieties when sown on 30 December.

Different wheat genotypes showed statistically significant variation for grain yield ha^{-1} (Table 17). The highest grain yield ha^{-1} (3.67 ton) was found from V_2 (Sourab) and the lowest (3.10 ton) was observed from V_9 (Bijoy). Grain yield varied for different genotypes might be due to genetical and environmental influences as well as management practices. BARI (1993) revealed that mean yield of wheat variety Kanchan, Akbar, Agrani and Sonalika were 3.59, 3.29, 3.12 and 2.81 t ha^{-1}, respectively. 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 $spike^{-1}$.

Interaction effect of sowing dates and wheat genotypes showed statistically significant variation on grain yield ha^{-1} (Table 18). The highest grain yield ha^{-1} (4.15 ton) was found from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the lowest (2.85 ton) was recorded from S_4V_7 (sowing on 30 December, 2009 and genotype Shatabdi) treatment combination.

4.32 Straw yield m^{-2}

Straw yield m^{-2} showed statistically significant variation for different sowing dates under the present trial (Table 17). The highest straw yield m^{-2} (470.53 g) was observed from S_2 (sowing on 30 November, 2009) which was closely followed (447.65 g and 430.31 g) by S_3 (sowing on 15 December, 2009) and S_1 (sowing on 17 November, 2009), while the lowest (386.10 g) was found from S_4 (sowing on 30 December, 2009).

Statistically significant variation was recorded for different wheat genotypes on straw yield m^{-2} (Table 17). The highest straw yield m^{-2} (460.02 g) was found from V_2 (Sourab), again the lowest (403.78 g) was recorded from V_7 (Shatabdi).

Interaction effect of sowing dates and wheat genotypes showed significant differences on straw yield m^{-2} (Table 18). The highest straw yield m^{-2} (573.22 g) was attained from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest (334.28 g) from S_4V_7 (sowing on 30 December, 2009 and genotype Shatabdi).

4.33 Straw yield ha^{-1}

Statistically significant variation was recorded for straw yield ha^{-1} showed due to different sowing dates (Table 17). The highest straw yield ha^{-1} (4.71 ton) was recorded from S_2 (sowing on 30 November, 2009) which was closely followed (4.48 ton and 4.30 ton) by S_3 (sowing on 15 December, 2009) and S_1 (sowing on 17 November, 2009), whereas the lowest (3.86 ton) was found from S_4 (sowing on 30 December, 2009).

Straw yield ha^{-1} showed statistically significant differences for different wheat genotypes (Table 17). The highest straw yield ha^{-1} (4.60 ton) was observed from V_2 (Sourab), again the lowest (4.04 ton) was obtained from V_7 (Shatabdi).

Sowing dates and wheat genotypes showed significant interaction effect on straw yield ha^{-1} (Table 18). The highest straw yield ha^{-1} (5.73 ton) was found from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), again the lowest (3.34 ton) was recorded from the treatment combination of S_4V_7 (sowing on 30 December, 2009 and genotype Shatabdi).

4.34 1000 seeds weight

Statistically significant variation was recorded in terms of 1000 seeds weight for different sowing dates under the present trial (Table 19). The highest 1000 seeds weight (46.31 g) was obtained from S_2 (sowing on 30 November, 2009) which was statistically similar (45.52 g) to S_3 (sowing on 15 December, 2009). On the other hand, the lowest (44.87 g) was found from S_1 (sowing on 17 November, 2009), which was statistically identical (44.90 g) to S_4 (sowing on 30 December, 2009). Chowdhury (2002) conducted an experiment with four sowing dates and reported that 1000-grain weight decreased with delay in sowing date from November 15 and the lowest 1000-grain weight were recorded in December 15 sown plants.

Different wheat genotypes varied significantly for 1000 seeds weight (Table 19). The highest 1000 seeds weight (46.73 g) was found from V_2 (Sourab), again the lowest (443.65 g) was recorded from V_7 (Shatabdi).

Interaction effect showed significant differences on 1000 seeds weight due to sowing dates and wheat genotypes (Table 20). The highest 1000 seeds weight (51.59 g) was observed from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), whereas the lowest (40.31 g) was observed from S_1V_1 (sowing on 17 Novemmber, 2009 and genotype BAW-1064) treatment combination.

4.35 Biological yield ha^{-1}

Biological yield ha^{-1} varied significantly for different sowing dates under the present trial (Table 19). The highest biological yield ha^{-1} (8.34 ton) was found from S_2 (sowing on 30 November, 2009) which was closely followed (8.05 ton and 7.82 ton) by S_3 (sowing on 15 December, 2009) and S_1 (sowing on 17 November, 2009), again the lowest (7.01 ton) was recorded from S_4 (sowing on 30 December, 2009).

Table 19. Main effect of different sowing dates on 1000 seeds weight, biological yield and harvest index of different wheat genotypes

Treatment	1000 seeds weight (g)	Biological yield (t ha^{-1})	Harvest Index (%)
Sowing date			
S_1	44.87 b	7.82 b	45.02 a
S_2	46.31 a	8.34 a	43.73 b
S_3	45.52 ab	8.05 b	44.44 ab
S_4	44.90 b	7.01 c	45.10 a
LSD (0.05)	1.227	0.257	1.010
Wheat genotypes			
V_1	46.02 ab	8.27 a	44.15 ab
V_2	46.73 a	8.27 a	44.60 ab
V_3	45.95 ab	8.04 a	45.14 a
V_4	45.79 ab	7.91 a	45.35 a
V_5	45.96 ab	8.05 a	45.13 a
V_6	45.47 a-c	7.89 a	45.27 a
V_7	43.65 c	7.28 b	44.69 ab
V_8	44.91 a-c	7.33 b	43.73 ab
V_9	44.10 bc	7.22 b	43.07 b
LSD (0.05)	1.841	0.386	1.515
CV(%)	4.98	6.07	4.17

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Table 20. Interaction effect of different sowing dates on 1000 seeds weight, biological yield and harvest index of different wheat genotypes

Treatment	1000 seeds weight (g)	Biological yield (t ha^{-1})	Harvest Index (%)
S_1V_1	40.31 j	7.29 g-k	46.60 a-c
S_1V_2	42.09 h-j	7.44 f-k	47.25 a
S_1V_3	44.10 c-j	7.62 d-j	47.43 a
S_1V_4	45.72 c-i	7.94 c-j	46.02 a-d
S_1V_5	47.33 b-e	8.46 b-e	44.84 a-h
S_1V_6	45.55 c-i	8.11 b-g	45.80 a-e
S_1V_7	48.48 a-c	8.67 bc	41.59 gh
S_1V_8	46.06 b-i	7.79 c-j	42.77 d-h
S_1V_9	44.19 c-j	7.06 j-l	42.90 b-h
S_2V_1	50.47 ab	9.81 a	41.69 gh
S_2V_2	51.59 a	9.88 a	41.99 f-h
S_2V_3	45.96 c-i	8.35 b-f	44.78 a-h
S_2V_4	45.96 c-i	8.35 b-f	44.94 a-h
S_2V_5	46.58 b-h	8.47 b-d	44.62 a-h
S_2V_6	43.10 d-j	7.64 d-j	46.65 ab
S_2V_7	40.33 j	7.11 i-l	45.53 a-f
S_2V_8	45.14 c-i	7.45 f-k	42.06 e-h
S_2V_9	47.64 a-d	8.04 b-i	41.30 h
S_3V_1	46.74 b-g	8.51 b-d	44.26 a-h
S_3V_2	46.16 b-i	8.34 b-f	44.94 a-h
S_3V_3	47.09 b-f	8.66 bc	44.05 a-h
S_3V_4	44.95 c-i	8.06 b-h	45.72 a-f
S_3V_5	48.25 a-c	8.88 b	44.05 a-h
S_3V_6	44.96 c-i	8.03 b-i	45.65 a-f
S_3V_7	42.71 f-j	7.15 h-l	45.74 a-e
S_3V_8	45.93 c-i	7.70 d-j	42.65 d-h
S_3V_9	42.88 e-j	7.12 h-l	42.86 c-h
S_4V_1	46.56 b-h	7.47 f-k	44.04 a-h
S_4V_2	47.07 b-f	7.44 f-k	44.21 a-h
S_4V_3	46.64 b-g	7.53 e-k	44.32 a-h
S_4V_4	46.55 b-h	7.28 g-k	44.72 a-h
S_4V_5	41.70 ij	6.38 lm	47.00 a
S_4V_6	48.28 a-c	7.77 c-j	42.99 b-h
S_4V_7	43.08 e-j	6.19 m	45.90 a-d
S_4V_8	42.51 g-j	6.38 lm	47.44 a
S_4V_9	41.68 ij	6.64 k-m	45.24 a-g
LSD (0.05)	3.682	0.772	3.030
CV(%)	4.98	6.07	4.17

In a column, mean values having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

S_1: Sowing on 17 November, 2009
S_2: Sowing on 30 November, 2009
S_3: Sowing on 15 December, 2009
S_4: Sowing on 30 December, 2009

V_1: BAW-1064 V_2: Sourab V_3: Prodip
V_4: Fang-60 V_5: Gourab V_6: Sufi
V_7: Shatabdi V_8: Pavan-76 V_9: Bijoy

Statistically significant variation was recorded for different wheat genotypes on biological yield ha^{-1} (Table 19). The highest biological yield ha^{-1} (8.27 ton) was obtained from V_1 (BAW-1064) and V_2 (Sourab), while the lowest (7.22 ton) was found from V_9 (Bijoy).

Sowing dates and wheat genotypes showed interaction effect on biological yield ha^{-1} (Table 20). The highest biological yield ha^{-1} (9.88 ton) was recorded from S_2V_2 (sowing on 30 November, 2009 and genotype Sourab), while the lowest (6.19 ton) was found from S_4V_7 (sowing on 30 December, 2009 and genotype Shatabdi) treatment combination.

4.36 Harvest index

Harvest index showed statistically significant variation for different sowing dates under the present trial (Table 19). The lowest harvest index (43.73%) was obtained from S_2 (sowing on 30 November, 2009) which was statistically similar (45.10%) to S_4 (sowing on 30 December, 2009), whereas the highest (45.10%) was found from S_4 (sowing on 30 December, 2009) which was statistically similar (45.02%) to S_1 (sowing on 17 November, 2009). Samuel *et al.* (2000) reported that late sowing condition (6 January 1997) reduce the harvest index (36.1%) from (41.5%) normal sowing condition (29 November 1996) in wheat.

Significant variation was observed for different wheat genotypes on harvest index (Table 19). The lowest harvest index (43.07%) was observed from V_9 (Bijoy), while the highest (45.35%) was recorded from V_4 (Fang-60).

Interaction effect of sowing dates and wheat genotypes showed significant differences in terms of harvest index (Table 20). The lowest harvest index (41.30%) was observed from S_2V_9 (sowing on 30 November, 2009 and genotype Bijoy), again the highest (47.44%) from treatment combination of S_4V_8 (sowing on 30 December, 2009 and genotype Pavan-76).

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out at the Agricultural Botany experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2009 to March 2010 to observe the effect of sowing dates on growth and yield performance of some selected wheat genotypes. The experiment comprised of two factors; Factors A: Sowing dates (4 sowing dates)- S_1: Sowing on 17 November, 2009; S_2: Sowing on 30 November, 2009; S_3: Sowing on 15 December, 2009 and S_4: Sowing on 30 December, 2009 and Factor B: Wheat genotypes (9 wheat genotypes)- V_1: BAW-1064, V_2: Sourab, V_3: Prodip, V_4: Fang-60, V_5: Gourab, V_6: Sufi, V_7: Shatabdi, V_8: Pavan-76 and V_9: Bijoy. The experiment was laid out in Two Factors Randomized Complete Block Design (RCBD) with three replications. Data on different yield contributing characters and yield were recorded and significant variation was recorded for sowing dates, wheat genotypes and their interaction effect.

The maximum days to starting of seedling emergence (5.92) was recorded from S_4, whereas the minimum days (4.82) from S_1. At 30, 40, 50, 60 DAS and harvest the longest plant (45.09 cm, 66.40 cm, 82.56 cm, 86.20 cm and 89.83 cm) was recorded from S_2 and the shortest plant (40.78 cm, 59.51 cm, 74.99 cm, 77.87 cm and 80.65 cm) from S_4. At 30, 40, 50 and 60 DAS the maximum number of tillers plant^{-1} (3.29, 3.74, 4.44 and 4.90) was observed from S_2, while the minimum number (2.65, 3.12, 3.70 and 3.93) from S_4 for same DAS. The maximum days to starting of booting (47.48) was recorded from S_1, again the minimum days (40.96) from S_4. The maximum days to starting of ear emergence (59.00) was found from S_1, while the minimum days (51.78) from S_4. The maximum days to starting of anthesis (76.37) was observed from S_1, whereas the minimum days (68.15) from S_4. The maximum days to starting of maturity (89.19) was obtained from S_1, again the minimum days (79.89) from S_4.

The maximum number of leaf plant^{-1} (5.58) was recorded from S_2, whereas the minimum number (4.97) from S_4. The longest flag leaf (20.32 cm) was recorded from S_2 again the shortest (17.81 cm) from S_4. The highest breadth of flag leaf (1.36 cm) was recorded from S_2, again the lowest breadth of flag leaf (1.14 cm) from S_4. The highest area of flag leaf (27.92 cm^2) was recorded from S_2 whereas the lowest (20.37 cm^2) from S_4. The highest number of effective tillers hill^{-1} (4.78) was observed from S_2, while the lowest number (3.77) from S_4. The lowest number of non-effective tillers hill^{-1} (0.73) was observed from S_2, while the highest number (0.89) from S_1. The highest number of total tillers hill^{-1} (5.51) was recorded from S_2, again the lowest number (4.54) from S_4. The longest ear (14.91 cm) was found from S_3, whereas the shortest ear (12.62 cm) from S_4. The highest number of fertile florets spikelet^{-1} (2.59) from S_2, whereas the lowest number (1.89) from S_4. The highest dry matter content plant^{-1} (14.81 g) was found from and the lowest (13.71 g) from S_4. The highest number of filled grains spike^{-1} (42.77) was observed from S_2, whereas the lowest number (37.40) from S_4. The lowest number of unfilled grains spike^{-1} (4.07) was observed from S_2, while the highest number (4.50) from S_4. The highest number of total grains spike^{-1} (44.89) was recorded from S_1, while the lowest number (41.90) from S_4. The highest number of total grains branch tiller^{-1} (8.27) was found from S_2, again the lowest number (6.99) from S_4. The highest grain yield ha^{-1} (3.64 ton) was found from S_2, whereas the lowest (3.15 ton) from S_4. The highest straw yield ha^{-1} (4.71 ton) was recorded from S_2, whereas the lowest (3.86 ton) from S_4. The highest 1000 seeds weight (46.31 g) was obtained from S_2 and the lowest (44.87 g) from S_1. The lowest harvest index (43.73%) was obtained from S_2, whereas the highest (45.10%) from S_4.

The maximum days to starting of seedling emergence (5.28) was found from V_2, again the minimum days (5.05) from V_1. At 30, 40, 50, 60 DAS and harvest the longest plant (45.36 cm, 66.34 cm, 82.77 cm, 86.84 cm and 90.50 cm) was obtained from V_5, whereas the shortest plant (40.70 cm, 61.20 cm, 76.44 cm, 79.57 cm and 81.64 cm) from V_9. At 30, 40, 50 and 60 DAS the maximum number of tillers plant^{-1} (3.22, 3.71, 4.43 and 4.85) was observed from V_5, whereas the minimum number (2.94, 3.30, 3.96 and 4.32) from V_9. The maximum days to starting of booting (45.50) was observed from V_6, while the minimum days (43.75) from V_7. The maximum days to starting of ear emergence (57.17) was obtained from V_5 and V_9, again the minimum days (54.25) from V_6. The maximum days to starting of anthesis (74.50) was observed from V_2 and the minimum days (69.92) from V_6. The maximum days to starting of maturity (87.33) was observed from V_8, whereas the minimum days (82.83) from V_6.

The maximum number of leaf plant^{-1} (5.48) was observed from V_2, while the minimum number (5.07) from V_9. The longest flag leaf (20.52 cm) was observed from V_1, while the shortest (17.77 cm) from V_9. The highest breadth of flag leaf (1.33 cm) was recorded from V_5 and the lowest (1.17 cm) from V_9. The highest area of flag leaf (27.64 cm^2) was observed from V_5, again the lowest (20.82 cm^2) from V_9.The highest number of effective tillers hill^{-1} (4.60) was found from V_1, again the lowest (4.16) from V_8. The lowest number of non-effective tillers hill^{-1} (0.75) was found from V_2, again the highest (0.83) from V_8 and V_9. The highest number of total tillers hill^{-1} (5.35) was observed from V_1 and V_6 and the lowest (4.99) from V_8. The longest ear (14.93 cm) was recorded from V_2, again the shortest ear (12.26 cm) from V_9. The highest fertile floret spikelets^{-1} (2.43) was observed from V_2, again the lowest (2.03) from V_8. The highest dry matter content plant^{-1} (14.92 g) was observed from V_2 and the lowest (13.01 g) from V_9. The highest number of filled grains spike^{-1} (44.50) was observed from V_2, again the lowest number (36.11) from V_9. The lowest number of unfilled grains spike^{-1} (4.01) was observed from V_2 and the highest number (4.63) from V_8. The highest number of total grains spike^{-1} (48.51) was observed from V_2, again the lowest number (40.69) from V_9. The highest number of total grains branch tiller^{-1} (8.04) was found from V_1 and the lowest number (7.51) from V_9. The highest grain yield ha^{-1} (3.67 ton) was found from V_2 and the lowest (3.10 ton) from V_9. The highest straw yield ha^{-1} (4.60 ton) was observed from V_2, again the lowest (4.04 ton) from V_7. The highest 1000 seeds weight (46.73 g) was found from V_2, again the lowest

(443.65 g) V_7. The lowest harvest index (43.07%) was observed from V_9, while the highest (45.35%) from V_4.

The maximum days to starting of seedling emergence (6.33) was observed from S_4V_4, while the minimum days (4.33) from the treatment combination S_1V_4. At 30, 40, 50, 60 DAS and harvest the longest plant (49.41 cm, 71.85 cm, 89.72 cm, 94.24 cm and 98.36 cm) was observed from S_2V_5, again the shortest plant (39.37 cm, 56.89 cm, 71.63 cm, 73.79 cm and 76.31 cm) from S_4V_9. At 30, 40, 50 and 60 DAS the maximum number of tillers plant^{-1} (3.60, 4.07, 5.03 and 5.67) was recorded from S_2V_5, again the minimum number (2.57, 3.13, 3.60 and 3.77) from S_4V_7. The maximum days to starting of booting (49.67) was observed from S_1V_8, whereas the minimum days (38.67) from S_4V_9. The maximum days to starting of ear emergence (64.00) was observed from S_1V_7, again the minimum days (48.00) from S_4V_3. The maximum days to starting of anthesis (89.00) was observed from S_1V_7, while the minimum days (63.33) from S_4V_6. The maximum days to starting of maturity (96.00) was observed from S_1V_7, again the minimum days (77.00) from S_4V_6.

The maximum number of leaf plant^{-1} (6.27) was observed from S_2V_2 and the minimum number of leaf plant^{-1} (4.55) from S_4V_9. The longest flag leaf (25.74 cm) was observed from S_2V_1, whereas the shortest (16.12 cm) from S_1V_9. The highest breadth of flag leaf (1.52 cm) was observed from S_2V_2 whereas the lowest (1.02 cm) from S_4V_5. The highest area of flag leaf (38.35 cm^2) was observed from S_2V_1, whereas the lowest (17.25 cm^2) from S_1V_5. The highest number of effective tillers hill^{-1} (5.60) was recorded from S_2V_2, while the lowest (3.32) from S_4V_5. The lowest number of non-effective tillers hill^{-1} (0.53) was recorded from S_2V_2, whereas the highest (0.97) from S_1V_1. The highest number of total tillers hill^{-1} (6.14) was observed from S_2V_1, while the lowest number (4.08) from S_4V_5. The longest ear (17.01 cm) was recorded from S_2V_1, again the shortest (10.69 cm) was found from S_4V_9.

The highest number of spikelets spike^{-1} (20.78) was recorded from S_2, whereas the lowest number (18.05) from S_4. The highest fertile floret spikelets^{-1} (3.17) was observed from S_2V_2, while the lowest number (1.57) from S_4V_9. The highest dry matter content plant^{-1} (17.26 g) was found from S_2V_2, while the lowest (12.11 g) from S_4V_8. The highest number of filled grains spike^{-1} (57.23) was attained from S_2V_2, while the lowest number (28.10) from S_4V_5. The lowest number of unfilled grains spike^{-1} (3.30) from S_2V_2, whereas the highest number (5.00) from S_1V_1. The highest number of total grains spike^{-1} (60.27) was observed from S_2V_2, while the lowest number (33.07) from S_4V_5. The highest number of total grains branch tiller^{-1} (9.23) was observed from S_2V_2, whereas the lowest number (6.30) from S_4V_5. The highest grain yield ha^{-1} (4.15 ton) was found from S_2V_2, whereas the lowest (2.85 ton) from S_4V_7. The highest straw yield ha^{-1} (5.73 ton) was found from S_2V_2, again the lowest (3.34 ton) from S_4V_7. The highest 1000 seeds weight (51.59 g) was observed from S_2V_2, whereas the lowest (40.31 g) from S_1V_1. The lowest harvest index (41.30%) was observed from S_2V_9, again the highest (47.44%) from S_4V_8.

From the above results it can be concluded that 30 November sowing provided best yield for most of the varieties and the varieties Sourab and Gourab provided better yield than the other varieties. However the variety Gourab provided steady and better yield in earlier three sowings. But yield was reduced in case of late sowing (30 December) which was true for all the varieties.

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 sowing times and
3. More experiments may be carried out with different wheat genotypes.

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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 (°c)		*Relative humidity (%)	*Rainfall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
November, 2009	21.7	14.2	77	00	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 – 1212

Appendix II. Characteristics of experimenatl field soil (the soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, 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	Above 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 (me/100 g 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 dates 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 date (A)	3	7.148**	6.039**	4.997**
Genotypes (B)	8	0.098	0.291	0.346
Interaction (A×B)	24	0.072	0.438	1.269
Error	70	0.087	0.329	0.810

**: Significant at 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 dates 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 date (A)	3	108.574**	274.478**	319.363**	378.244**	451.084**
Genotypes (B)	8	26.389**	33.955**	49.783**	47.459**	74.198**
Interaction (A×B)	24	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} as influenced by different sowing dates and wheat genotypes**

Source of variation	Degrees of freedom	Mean square			
		Number of tillers plant^{-1} at			
		30 DAS	40 DAS	50 DAS	60 DAS
Replication	2	0.002	0.025	0.017	0.048
Sowing date (A)	3	2.423**	2.172**	3.188**	5.360**
Genotypes (B)	8	0.134**	0.277**	0.338**	0.491**
Interaction (A×B)	24	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 dates 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 date (A)	3	198.14**	251.07**	354.33**	434.06**
Genotypes (B)	8	3.509	12.083*	28.704	29.850
Interaction (A×B)	24	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 leaf plant^{-1}, length, breadth and area of flag leaf as influenced by different sowing dates and wheat genotypes

Source of variation	Degrees of freedom	Mean square			
		Leaf plant^{-1} (No.)	Length of flag leaf (cm)	Breadth of flag leaf (cm)	Area of flag leaf (cm^2)
Replication	2	0.071	0.438	0.003	2.131
Sowing date (A)	3	1.870**	35.989**	0.290**	325.54**
Genotypes (B)	8	0.185*	12.776**	0.039**	73.520**
Interaction (A×B)	24	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 dates and wheat genotypes

Source of variation	Degrees of freedom	Mean square		
		Number of tillers hill^{-1}		
		Effective	Non-effective	Total
Replication	2	0.035	0.002	0.050
Sowing date (A)	3	4.876**	0.125**	4.780**
Genotypes (B)	8	0.368**	0.012*	0.289**
Interaction (A×B)	24	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, spikelets spike^{-1} and fertile floret spikelet^{-1} as influenced by different sowing dates and wheat genotypes

Source of variation	Degrees of freedom	Mean square		
		Ear length (cm)	Spikelets Spike^{-1}	Fertile floret Spikelet^{-1}
Replication	2	0.201	0.405	0.001
Sowing date (A)	3	32.045**	42.094**	3.221**
Genotypes (B)	8	10.954**	11.827**	0.305**
Interaction (A×B)	24	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 dates 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	0.001	0.025	0.002	0.001	0.001	0.030
Sowing date (A)	3	0.148**	1.717**	0.093**	0.067**	1.711**	6.473**
Genotypes (B)	8	0.153**	0.667**	0.538**	0.064**	0.159**	5.780**
Interaction (A×B)	24	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 dates 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	2.166	0.060	2.745	1.420	0.086
Sowing date (A)	3	157.77**	1.069**	136.921**	57.713**	8.228**
Genotypes (B)	8	75.523**	0.573**	64.758*	4.238**	0.450**
Interaction (A×B)	24	170.92**	0.487**	155.70**	7.449**	0.966**
Error	70	29.002	0.141	26.683	1.645	0.155

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

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

Source of variation	Degrees of freedom	Mean square			
		Grain		Straw	
		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 date (A)	3	34454.59**	1.300**	12998.64**	3.445**
Genotypes (B)	8	5311.47**	0.600**	5999.600**	0.531**
Interaction (A×B)	24	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 dates 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 date (A)	3	12.340	8.847**	10.887*
Genotypes (B)	8	11.886*	2.129**	7.315*
Interaction (A×B)	24	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