**Evaluation of Yield Attributing Character of Genotype under Timely and Late Sowing Condition,Bhairahawa, Nepal**

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**Abstract:**

Wheat (*Triticum aestivum*) is the third most important cereal crop in Nepal after rice and maize. . The research was carried out during the winter season in the agronomic field of the Institute of Agriculture and Animal Science (IAAS), Bhairahawa, Nepal. The research was carried out in two (timely and late sowing) environmental conditions. Timely sowing and late sowing was carried out 28th November 2020 and 24th December 2020 on alpha lattice design with two replication of twenty wheat genotype respectively. In the late sowing condition, these results show all genotype's performance was decreased. The genotypes were evaluated in the field in timely and late sown conditions. In the late sowing condition, these results show all genotype's performance was decreased. Under late sown condition, High temperatures reduced the days to booting (15.64%),days to heading (14.97%), days to maturity (14.16%), chlorophyll content (15.99%), plant height (8.59%), spike length (7.03%), number of spikelet per spike(9.21%), number of grain per spike(10.6%), spike weight(15.32%), effective tiller/m2 (9.92%),thousand kernel weight (10.3%) and grain yield(22.5%). NL 1420 and BL 1407 show higher yield and early maturity in late sowing and timely sowing condition. In a combined environment, maximum grain yield was recorded in NL1420.

Keywords: Grain yield, Heat stress, Late sowing, Timely sowing, Trait, Wheat

**Introduction**

Wheat is the most important cereal crop of the world with a larger area under cultivation (215.9 million hectares) and production (765.76 million tons) with a productivity of 3.54 tons/hectare (*FAOSTAT*, 2019). Until 2050, there is necessary to increase the production of wheat by 77% to meet the growing demand for food and there will be a need for an additional 198 million tons of wheat (Sharma et al., 2015). Wheat is a good source of nutrients and minerals which contains 60-70% carbohydrate, 6-26% protein, 2.1% fat, 2.1% minerals, and vitamins (Kumar et al., 2011). In the context of Nepal, wheat is the third most important cereal crop after rice and maize. It is cultivated in 0.7 million hectares of land and production is 2 million tons (Krishi Dayari, 2077). The productivity of wheat is 2.85tons/hectare in Nepal which is lower than the world's production. According to (MoALMC, 2018) in Nepal, the productivity of wheat in the irrigated and rainfed area was 2.71 metric ton/hectare (MT/ha) and 1.12MT/ha. Similarly, the yield from the improved seeds was 2.34 MT/ha, whereas that from the local seeds was 1.12MT/ha Due to global warming temperature of the world is increasing by 0.18 ℃ per year (Puri et al., 2020). The normal temperature regime for wheat grain filling is 15-18 ℃. Wheat production is decreased by 3-4 tons when the temperature rises by 1 ℃ (Wardlaw et al., 1989). According to(M. R. Poudel et al., 2020), under heat stress and drought conditions 29.99% and 52.98% grain yield was decreased as compared to irrigated conditions. Similarly, at late sowing condition 47.58% grain yield was decrease than timely sowing condition. The effect of high temperature during the anthesis and reproduction stage is called terminal heat stress. The grain yield of wheat is dependent upon the sowing date. In late sown conditions, there is terminal heat stress during the reproductive stage of wheat and the reproductive stage is very susceptible to high temperature. High temperature during the reproduction stage has a detrimental effect on fertilization and post-fertilization stages leading to lower grain production. The grain yield of wheat is decreased by 50% in late sown conditions (Senapati et al., 2018). Heat stress causes morphological, physiological, biochemical, and molecular alterations in wheat. Under heat stress conditions, crop duration is reduced and there is reductions in the assimilation of photosynthate thus result in lower biomass production. There is poor pollen tube development, high pollen mortality, and shrinkage of grains due to short grain filling duration (Oshino et al., 2011). Under heat stress conditions, high temperature alters the source to sink relationship that causes poor photosynthetic accumulation in grain. High temperatures cause an alternation of water relations and affect the physiological and metabolic activities of the plant. Photosynthesis is a highly affected physiological process under heat stress conditions. High temperature causes disintegration of chlorophyll content and photosynthetic activity in a crop is reduced (Qaseem et al., 2019).There is an urgent need to develop wheat varieties that are tolerant to heat stress conditions. The genotypes with short crop duration and stay green characters are less affected at late sowing conditions. Selection of wheat genotype that can give higher grain yield, good quality grain, and early maturing genotype was select under heat stress condition is predominant. So, evaluation of yield and yield attributing characters of wheat genotypes was done under normal and heat stress conditions.

**2. Material and method**

 **2.1 Plant material:**

 Twenty wheat genotypes were obtained from National Wheat Research Program (NWRP), Bhairahawa, Nepal. All the name of genotypes is listed below table 1.

**2.2 Field experimentation:**

The field experiment was conducted on the agronomy farm of the Institute of Agriculture and Animal Science (IAAS) Paklihawa, Bahirahawa, Nepal. The geographic location of the research site is 27º30ˈN and 83º27ˈ E and 79 meters altitude above the sea level. This site has a sub-humid tropical region of Nepal where winter is cold and summer is hot. This field experiment was conducted on Alpha Lattice design Fig1. In this experiment, 5 blocks with 4 plots on each block, replication twice on the Heat stress condition. Each genotype has sown on 4.5m2 (3m × 1.5m) plot size. Within the plot, 25cm and 2-3cm are rows to row and plant to plant space respectively. Infield experimental design, 0.5 m gap between two plots and 1m gap present between two replication. Similarly, the distance between two blocks is 0.5m within replication.

2.3 Weather condition:

Metrological data was shown in fig 2.

**2.4 Agronomic practice**

**2.4.1 Field preparation and sowing**

The field preparation was done by using a tractor for deep ploughing two times and manually labeling at last time. The seed has sown in line sowing method on 24th December 2020. Late sowing varieties should be faced heat stress at the flowering period due to the high temperature is present at flowering time.

**2.4.2 Nutrient management**

 Twelve soil samples were taken W shape at 20-25 cm depth from the agronomic field. These soil samples were mixed thoroughly and then air-dried, sieved through a 2mm sieve. The soil characteristics were analyzed in the soil laboratory of IAAS, Rupandehi. The soil analysis showed that the soil was clay loam having 0.39 kg/ha nitrogen, 160 kg/ha phosphorous, 130 kg/ha potash, and 4.5% organic matter. The soil was found slightly acidic with pH 6.7. Compost manure at 5 ton/ha and NPK was applied as recommended dose 100:50:30 kg/ha on each plot. All recommended doses of phosphorus, potash and half dose of nitrogen fertilizer were applied before sowing. The remaining dose of nitrogen was applied two splits at 30 days after sowing (DAS) last dose at70DAS.

**2.4.3 Irrigation**

 Under late sowing, condition irrigation was done similarly as timely sowing condition. The irrigation schedule is present in Table 2.

**2.4.4 Harvesting and post-harvesting operations**

Normal sown wheat was harvested on 7th April 2021 and late sown wheat was harvested on 21st April 2021. Harvesting was done manually by sickle from two places of the plot each of 1m2 area when wheat was fully dried and grains were hard enough that give metallic sound on biting. After harvesting, wheat was manually threshed and cleaned.

**2.5 Observation record**

Twelve different yield and yield attributing characters were recorded. Yield attributing characters were recorded from randomly selected 10 plants for each plot excluding border crops.

**2.5.1 Days to booting (DTB):**

DTB was recorded between days after sowing (DAS) to 50% of plants in the plot have swollen flag leaf sheath.

**2.5.2 Days to heading (DTH):**

DTH was recorded between DAS to 50% of plant in the plot has half ear emerged.

**2.5.3 Days to maturity (DTM):**

DTM was recorded between DAS to 75% of plants in plot show golden yellow color in flag leaf, spike, and peduncle.

**5.5.4 Chlorophyll content (CC):**

Chlorophyll value is observed by using SPAD (soil plant analysis development) after flag leaf emergence and each leaf with three readings at the top, middle, and bottom of the leaf.

**2.5.5 Plant height (PH):**

 PH has measured the height of culm from the soil surface to the tip of the spike excluding awn.

**2.5.6 Spike length (SL):**

SL was measured from attachment of the lowest spikelet to tip of the spike excluding awn.

**2.5.7 Spike weight (SW):**

 Spike used in random sampling which detached from lowest spikelet was weight and then average.

**2.5.8 Number of spikelets per spike**

It was measured from lowest spikelet means spikelet attaches to lower rachis to top of central spikelet without awn.

**2.5.9 Number of Grain per spikelet**

 Several grains were count by manually threshing of spikelet per spike.

**2.5.10 Effective tiller/m2**

The number of effective tillers was count which presents in per meter square with the help of scale.

**2.5.11 Thousand Kernel Weight (TKW):**

TKW of grain was recorded by weighting weight of 1000 grains obtained from the bulk of grain for each plot.

**2.5.12 Grain yield (GY):**

 GY were recorded by averaging the values obtained from two places each of 1 m2 area for each plot.

**2.6 Statistical Analysis**

Data entry and processing were carried out by using Microsoft Office Excel 2010. Analysis of variance of all the parameters and estimation of means was done by using R3.5.0 a software package for alpha lattice design by ADEL-R (CIMMYT, Mexico).

**3. Result**

**3.1 Days to booting (DTB)**

Under timely and late sowing, DTB shows the highly significant difference among genotypes, and also combined environment shows the significant difference among genotypes (Table 3). Under timely sowing, maximum DTB means in Gautam, NL1368, and NL1386 (81 days) and minimum DTB mean in NL1350, NL1404 (75 days). Under late sowing conditions, the maximum DTB means show NL1386 (72 days) and the minimum DTB mean was recorded in NL 1350. Mean DTB in late sowing conditions is 15.64% lower than in timely sowing conditions.

**3.2. Days to heading (DTH)**

Under timely sowing, late sowing, and combined environment show a significant difference within genotypes (Table 3). Under timely sowing, maximum DTH mean was recorded in NL1386 (85days) and minimum DTH means in NL1350 (79 days). Under late sowing, maximum DTH mean was recorded in NL1386 (75 days) and minimum DTH means in NL1350 and BL4919 (67days). Mean DTH in late sowing conditions was 14.97% lower than in timely sowing conditions.

**3.3. Days to maturity (DTM)**

There was a significant difference among genotypes in DTM under timely sowing, late sowing, and combined environment (table 3). Under time sowing maximum DTM mean was recorded in Gautam (120.7days) and the minimum in BL4919, BL4669 (119.2 days). Under late sowing, the maximum DTM mean was recorded in NL 1386 (106.3 days) and the minimum in BL 4407(100.6 days). Mean DTM in timely sowing condition was 14.16% timely than late sowing condition

**3.4. Chlorophyll content (CC)**

 Chlorophyll content was a significant difference among genotype in late sowing condition and non-significant difference in timely sowing and combined environment (Table 4). Under timely sowing conditions, the maximum CC mean was recorded in NL 1381 (43.31) and the minimum in Bhirkuti (40.6). Under late sowing, the maximum CC mean was recorded in NL 1387 (39.2) and the minimum in NL 1376 (29.6). Mean CC in late sowing was 15.99% lower than timely sowing condition.

**3.5. Plant height (PH)**

Plant height shows a significant difference in timely sowing, late sowing, and combined environment among genotypes (Table 4). Under timely sowing conditions, the maximum PH mean was recorded in NL1350 (100.9 cm) and the minimum in NL 1387 (86.1cm). Under late sowing, the maximum PH mean was recorded in NL1350 (84.3cm) and the minimum in NL1381(74.3 cm). Mean PH in late sowing condition was 8.99% lower than in timely sowing condition.

**3.6. Spike length (SL)**

There was a significant difference among genotypes in timely sowing, late sowing, and combined environment (Table 4). Under timely sowing maximum SL mean was recorded in Bhirkuti (11.5cm) and the minimum in NL1381 and NL1404 (9.8cm). Under late sowing, the maximum SL mean was recorded in NL1350 (10.8cm) and the minimum in NL1381 (9cm). Mean SL in late sowing was 7.03% lower than in timely sowing conditions.

**3.7. Number of spikelets per spike (NSPS)**

NSPS was a significant difference in timely sowing, late sowing, and combined environment (Table 5). Under timely sowing, the maximum NSPS mean was recorded in NL1381 (17.2) and the minimum in NL1376 (15.1). Under late sowing, the maximum NSPS mean was recorded in BL 4669(16.85) and the minimum in NL1376 (13). Mean NSPS in late sowing conditions was 9.21% lower than in timely sowing conditions.

**3.8. Number of grain per spike (NGPS)**

NGPS was a significant difference in timely sowing and combined environment and non-significant difference in late sowing condition among genotype (Table 5). Under timely sowing, maximum NGPS mean was found in NL 1381(49.9) and minimum in NL 1369 (39). Under late sowing, the maximum NGPS mean was recorded in NL1387 (40.4) and the minimum in NL 1420 (35.1). Mean NGPS in late sowing conditions was 10.6% lower than in timely sowing conditions.

**3.9. Spike weight (SW)**

SW was a significant difference among genotypes in timely sowing, late sowing, and combined environment (Table5). Under timely sowing, maximum SW mean was recorded in BL 4919 (20.8gm) and minimum in NL 1376 (18.3gm). Under late sowing, the maximum SW mean was recorded in NL 1387 (17.8gm) and the minimum in NL1346 (14.5gm). Mean SW in late sowing conditions was 15.32% lower than timely sowing conditions.

**3.10. Effective tiller/m2 (ET)**

ET was a significant difference in early sowing, late sowing, and combined environment among genotype (Table 6). Under time sowing, maximum mean ET was recorded in NL1368 (476.7) and minimum in NL1350 (344.1). Under late sowing, maximum mean ET was recorded in NL1420 (395.7) and minimum in NL 1350 (305.5). Mean ET in late sowing conditions was 9.92% lower than timely sowing conditions.

**3.11 Thousand kernel weight (TKW)**

TKW was a significant difference in timely sowing, late sowing, and combine environment among genotypes (Table 6). Under timely sowing, the maximum mean TKW was recorded in NL1350 (43gm) and the minimum in NL 1179 and NL1346 (31gm). Under late sowing, the maximum mean TKW was recorded in NL1350 (39gm) and the minimum in NL 1368 and NL1384 (28gm). Mean TKW in late sowing conditions was 10.3% lower than timely sowing conditions.

**3.12. Grain yield (GY)**

GY was a non-significant difference among genotype in timely sowing, late sowing, and combined environment (Table 6). Under timely sowing, the maximum mean GY was recorded in NL 1420 (4118 kg/ha) and the minimum in NL1346 (3155 kg/ha). Under late sowing, the maximum GY mean was recorded in NL1420 (3310.5 kg/ha) and the minimum in NL 1386 (2499kg/ha). Mean Grain yield in late sowing conditions is 22.50 lower than timely sowing conditions.

**4. Discussion**

**4.1. Days to booting**

Under late sowing conditions, DTB was reduced to timely sowing conditions. A similar result was reported by (P. B. Poudel et al., 2020);(Hossain et al., 2012). According to (Hossain et al., 2012);(Tarchoun et al., 2012) during late sowing conditions, high temperatures are most sensitive to reproductive phage, booting, fertilization, gametogenesis which reduced yield than timely sowing condition.

**4.2 Days to heading**

Under late sowing conditions, DTH was reduced to timely sowing conditions. A similar result was reported by (M. R. Poudel et al., 2020);(P. B. Poudel et al., 2020);(P. B. Poudel et al., 2020). Under late sowing conditions, early maturity and a long time to heading avoid terminal heat stress for enhancing grain yield(Akter & Islam, 2017);(Álvaro et al., 2008).

**4.3 Days to maturity**

The reduction of DTM under late sowing than timely sowing condition is also reported by (M. R. Poudel et al., 2020);(P. B. Poudel et al., 2020) (Yamamoto et al., 2008). under late sowing conditions, increase 5°C temperature above 20°C which reduced grain filling duration 5-12 days(Yin et al., 2009). In wheat, night temperature is more responsive to reduced grain filling duration and grain yield than the day temperature. Reduction of Grain filling duration by 3-7days at 20°C and 23°C night temperature (Prasad et al., 2008). Recently, (Song et al., 2015)reported that day/night temperature of 32/22°C when compared with that of25/15°C which significantly reduction of grain filling period.

**4.4 Chlorophyll content**

The reduction of chlorophyll content in leaf at late sowing condition is also reported by (Cao et al., 2019) (Jespersen et al., 2016); (Balla et al., 2009). under late sown condition chlorophyll content and leaf area index were significantly decrease in heat-sensitive genotype but proline content was increased in heat-tolerant genotype (Dhyani et al., 2013). According to (Mathur et al., 2014) Photosystem II, ribulose-1,5-bisphosphate carboxylase/oxygenase oxygen-evolving complex( Rubisco) was affected under high-temperature conditions.

**4.5 Plant height**

Plant height was reduced in late sowing conditions. A similar result was reported by (Sattar et al., 2010);(Singh et al., 2011). The air temperature was increased at late sown which stops vegetative development and shortens the organ developed (Bagga & Rawson, 1997). GA-insensitive Rht1 (Rht-B1b) and Rht2 (Rht-D1b) reduced plant height and lodging in the favorable environment which enhances grain number and grain yield (Chen et al., 2018). At timely sowing conditions plant height was longer than late sowing due to longer vegetative period, better temperature, and solar radiation (Qasim et al., 2008).

**4.6 Spike length**

Reduction of spike length at late sowing than timely sowing condition. This result was similar to (P. B. Poudel et al., 2020);(Mukherjee, 2012);(Sattar et al., 2010). The date of planting and temperature was responsible for the reduction of spike length (Baloch et al., 2012).

**4.7 spike weight**

Spike weight was a reduction at late sowing than timely sowing condition. This result was similar to (P. B. Poudel et al., 2020). According to (Valluru et al., 2017) phytohormone ethylene production in spike at high-temperature stress conditions which reduced spike weight.

**4.8 Number of spikelet per spike and number of grain per spike**

NSPS and NGPS were reduced at late sown condition than timely sown condition. Similar result was reported by (Pimentel et al., 2015). Semenov report that temperatures above 20°C speed up the development of the spike initiation and anthesis which reduces the number of spikelets and grains per spike(Semenov, 2009). Floret development may cause complete sterility above 30°C based on wheat genotype(Kaur & Behl, 2010). According to (Hedhly et al., 2009) another produced structurally abnormal and nonfunctional floret under 3 days heat stress during anthesis.

**4.9 Effective tiller/m2**

ET was reduced under late sowing conditions than in timely sowing conditions. This result was similar to (P. B. Poudel et al., 2020); (M. R. Poudel et al., 2020). In wheat, tin genes are responsible for avoiding late tillering at the grain filling stage. After drought and heat stress have suppressed tillering capacity during the early growth phase. (Palta et al., 2007); (Motzo et al., 2004).

**4.10 Thousand Kernel weight**

TKW was reduced at late sowing condition. This result was similar to (Dilmurodovich et al., 2021);(Aberkane et al., 2021). Dias et al. report that shrinking of grains due to change e in structures of the aleurone layer and cell endosperm at high temperature 31/20°C during the day/night condition(Dias et al., 2008). During the reproductive stage or post-anthesis stage, high-temperature stress results in a reduction in kernel weight and also short-grain filling period of wheat (Ji et al., 2010);(Hays et al., 2007);(Plaut et al., 2004).

**4.11 Grain yield**

GY was reduced at late sowing than timely sowing condition. This result was similar to (Dilmurodovich et al., 2021);(Schittenhelm et al., 2020). In general, in late sowing conditions wheat genotype faces high-temperature stress, moistures stress and other abiotic stress which shortens the heading, grain filling duration, and maturation, ultimately reduced grain yield and grain quality(Hossain & Silva, 2012).

**5. Conclusion:**

Heat stress and moisture stress occurred at late sowing conditions which interfere with the physio- morphological and yield potential trait of wheat genotype. Drought and heat stress are the major problem in wheat production in many parts of the world including Nepal. Above that study, we can conclude that late sowing significantly affects the yield and yield attributing character of wheat genotype. Under late sowing conditions, all yield attributing character except grain yield and number of grain per spike. At late sowing condition, NL 1420 shows higher grain yield and BL1407 show early mature variety among genotypes. Under timely sowing conditions, all yield attributing characters show significant differences among genotypes except grain yield and chlorophyll content. NL 1420 and BL 1407 showed higher grain yield and early maturity at timely sown conditions. Maximum grain yield was recorded in NL1420 under combined environment.

**6. Acknowledgement**

 We would like to thank Institute of Agriculture and Animal Science, Paklihawa campus, Tribhuvan University, Nepal for providing research support and facilities and also thank to National Wheat Research Program, Bhairahawa, Nepal for providing genotype for research program.

**7. Conflict of interest**

The author should be declare that there is no any conflict in personal relationship and author helps influence the work reported in this paper.

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Table 1: list of wheat genotypes used for a research program.

|  |  |  |
| --- | --- | --- |
| S.N | Genotypes  | Source  |
| 1 | Bhrikuti | NWRP, Bhairahawa  |
| 2 | BL 4407 | NWRP, Bhairahawa |
| 3 | BL 4669 | NWRP, Bhairahawa |
| 4 | BL 4919 | NWRP, Bhairahawa |
| 5 | Gautam | NWRP, Bhairahawa |
| 6 | NL 1179 | NWRP, Bhairahawa |
| 7 | NL 1346 | NWRP, Bhairahawa |
| 8 | NL 1350 | NWRP, Bhairahawa |
| 9 | NL 1368 | NWRP, Bhairahawa |
| 10 | NL1369 | NWRP, Bhairahawa |
| 11 | NL 1376 | NWRP, Bhairahawa |
| 12 | NL1381 | NWRP, Bhairahawa |
| 13 | NL 1384 | NWRP, Bhairahawa |
| 14 | NL 1386 | NWRP, Bhairahawa |
| 15 | NL 1387 | NWRP, Bhairahawa |
| 16 | NL 1404 | NWRP, Bhairahawa |
| 17 | NL 1412 | NWRP, Bhairahawa |
| 18 | NL 1413 | NWRP, Bhairahawa |
| 19 | NL 1417 | NWRP, Bhairahawa |
| 20 | NL 1420 | NWRP, Bhairahawa |

 Source: NWRP, Bhairahawa

Fig 2: Maximum and minimum temperature and the total rainfall during the crop growing period from November to April.



Fig1: Layout of a field experiment in alpha lattice design

Table 2: irrigation schedule in wheat at timely sowing and late swing condition

|  |  |
| --- | --- |
| Irrigation | Stage of plant  |
| 1st  | Crown root initiation  |
| 2nd  | Booting stage  |
| 3rd  | Heading stage  |
| 4th  | Flowering stage  |
| 5th  | Milking stage  |
| 6th  | Soft dough stage  |

Table 3: Differential response under timely and late sowing conditions among genotype on DTB, DTH, and DTM.

|  |  |  |  |
| --- | --- | --- | --- |
| Genotype  |  Days to booting  |  Day to heading  |  Days to maturity |
|  | timely sown  | late sown | Overall | timely sown  | late sown | overall | timely sown  | late sown | overall |
| Bhirkuti | 77 | 66 | 71.40 | 81 | 70 | 75.36 | 120.2 | 103.5 | 111.77 |
| BL \_4407 | 76 | 63 | 69.64 | 80 | 68 | 73.99 | 119.5 | 100.6 | 110.11 |
| BL \_4919 | 76 | 63 | 68.98 | 79 | 67 | 72.41 | 119.2 | 101.0 | 110.11 |
| BL\_4669 | 79 | 67 | 72.93 | 83 | 70 | 76.49 | 119.2 | 102.8 | 110.94 |
| Gautam | 81 | 69 | 74.69 | 84 | 73 | 78.53 | 120.7 | 104.8 | 112.66 |
| NL \_1179 | 79 | 68 | 73.15 | 83 | 70 | 76.71 | 120.3 | 103.4 | 111.82 |
| NL \_1346 | 78 | 64 | 70.96 | 82 | 68 | 74.67 | 119.7 | 101.2 | 110.49 |
| NL \_1350 | 75 | 62 | 68.54 | 79 | 67 | 72.63 | 119.0 | 101.2 | 110.16 |
| NL \_1369 | 80 | 68 | 73.81 | 83 | 70 | 76.93 | 120.2 | 102.7 | 111.47 |
| NL \_1381 | 79 | 64 | 71.40 | 82 | 68 | 75.12 | 120.2 | 101.2 | 110.80 |
| NL \_1384 | 80 | 68 | 73.81 | 84 | 71 | 77.61 | 119.3 | 103.0 | 111.18 |
| NL \_1386 | 81 | 72 | 76.45 | 85 | 75 | 80.33 | 120.6 | 106.3 | 113.34 |
| NL \_1387 | 79 | 68 | 73.59 | 83 | 72 | 77.61 | 120.6 | 104.5 | 112.51 |
| NL \_1413 | 80 | 65 | 72.28 | 84 | 71 | 77.38 | 120.2 | 102.9 | 111.59 |
| NL \_1417 | 79 | 67 | 73.15 | 83 | 70 | 76.70 | 119.9 | 102.6 | 111.26 |
| NL \_1420 | 80 | 67 | 73.37 | 83 | 71 | 76.93 | 120.5 | 102.9 | 111.76 |
| NL\_ 1368 | 81 | 68 | 74.25 | 84 | 71 | 77.61 | 120.2 | 104.8 | 112.47 |
| NL\_ 1376 | 80 | 66 | 72.93 | 83 | 69 | 76.25 | 119.9 | 101.6 | 110.80 |
| NL\_ 1404 | 75 | 64 | 69.86 | 80 | 69 | 74.43 | 119.3 | 102.7 | 111.01 |
| NL\_ 1412 | 80 | 68 | 74.03 | 84 | 72 | 78.29 | 120.2 | 103.3 | 111.76 |
| Mean | 78.75 | 66.18 | 72.46 | 82.48 | 70.13 | 76.3 | 120.0 | 103 | 111.4 |
| CV% | 1.50 | 2.77 | 1.77 | 2 | 3.14 | 1.8 | 0.67 | 2 | 1.1 |
| LSD0.05 | 2.40 | 3.83 | 1.71 | 3 | 4.99 | 1.5 | 2 | 5.21 | 1.4 |
| F-test | \*\*\* | \*\*\* | \*\*\* | \*\* | \*\* | \*\*\* | \*\* | \*\* | \* |

CV: coefficient of variation, LSD0.05: Least significant difference, \* significant at 0.05 level of significance, \*\*significant at 0.01 level of significance, \*\*\* significance at 0.001 level of significance.

Table 4: Differential response under timely and late sowing conditions among genotype on CC, PH, SL.

|  |  |  |  |
| --- | --- | --- | --- |
| Genotype  |  Chlorophyll content  |  Plant height  |  Spike length |
|  | timely sown  | late sown | overall | timely sown  | late sown | Overall | timely sown  | late sown | Overall |
| Bhirkuti | 40.6 | 35.9 | 38.05 | 94.5 | 87.1 | 89.89 | 11.5 | 10.4 | 11.0 |
| BL \_4407 | 42.5 | 36.3 | 39.17 | 86.4 | 81.5 | 84.23 | 10.1 | 9.9 | 10.0 |
| BL \_4919 | 41.8 | 30.4 | 37.50 | 94.9 | 80.7 | 87.46 | 10.5 | 9.1 | 9.8 |
| BL\_4669 | 42.5 | 35.9 | 39.07 | 86.4 | 82.3 | 84.55 | 10.1 | 9.9 | 10.0 |
| Gautam | 42.4 | 38.8 | 39.63 | 87.8 | 83.5 | 85.60 | 10.1 | 9.1 | 9.6 |
| NL \_1179 | 42.9 | 35.1 | 39.07 | 84.3 | 76.7 | 81.40 | 10.1 | 9.1 | 9.6 |
| NL \_1346 | 42.2 | 31.7 | 37.96 | 85.5 | 79.9 | 83.18 | 10.5 | 9.9 | 10.2 |
| NL \_1350 | 40.7 | 33.0 | 37.50 | 100.9 | 84.3 | 91.43 | 11.2 | 10.8 | 11.0 |
| NL \_1369 | 42.4 | 37.6 | 39.35 | 87.3 | 81.5 | 84.55 | 10.8 | 9.6 | 10.2 |
| NL \_1381 | 43.3 | 33.8 | 38.98 | 87.7 | 74.3 | 81.81 | 9.8 | 9 | 9.4 |
| NL \_1384 | 41.8 | 33.4 | 38.15 | 87.7 | 80.7 | 84.36 | 10.1 | 9.5 | 9.8 |
| NL \_1386 | 42.9 | 37.2 | 41.76 | 89.2 | 81.5 | 85.33 | 10.1 | 10.0 | 10.0 |
| NL \_1387 | 42.9 | 39.2 | 40.00 | 86.1 | 80.7 | 83.71 | 10.5 | 10.0 | 10.2 |
| NL \_1413 | 41.1 | 36.3 | 38.42 | 87.9 | 82.7 | 85.25 | 10.5 | 9.9 | 10.2 |
| NL \_1417 | 43.1 | 34.6 | 39.07 | 89.1 | 81.9 | 85.42 | 10.8 | 9.9 | 10.4 |
| NL \_1420 | 42.0 | 30.4 | 37.59 | 87.9 | 83.5 | 85.58 | 10.5 | 9.1 | 9.8 |
| NL\_ 1368 | 41.3 | 38.8 | 39.07 | 87.7 | 79.1 | 83.75 | 10.1 | 9.6 | 9.8 |
| NL\_ 1376 | 41.5 | 29.6 | 37.13 | 90.7 | 83.9 | 86.98 | 10.1 | 9.1 | 9.6 |
| NL\_ 1404 | 41.5 | 33.4 | 37.96 | 90.4 | 81.1 | 85.65 | 9.8 | 9.1 | 9.4 |
| NL\_ 1412 | 41.0 | 35.1 | 38.05 | 91.0 | 83.5 | 86.87 | 10.5 | 9.9 | 10.2 |
| Mean | 42.02 | 35.3 | 38.67 | 89.17 | 81.52 | 85.3 | 10.38 | 9.65 | 10 |
| CV% | 6.07 | 8.39 | 6.84 | 4.78 | 3 | 3.5 | 4.68 | 3.21 | 4 |
| LSD0.05 | 5.32 | 6.2 | 2.95 | 8.9 | 4.5 | 3.8 | 0.61 | 0.65 | 0.46 |
| F-test | NS | \*\* | NS | \*\* | \*\* | \* | \* | \*\*\* | \*\*\* |

NS: statistically non –significance

Table 5: Differential response under timely and late sowing condition among genotypes on

NSPS, NGPS, SW.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Genotype  |  No. of spikelet per spike  |  No of grain per spike  |  Spike weight  |  |
|  | Timely sown  | Late sown | Overall | Timely sown  | Late sown | Overall | Timely sown  | Late sown | Overall |
| Bhirkuti | 16.7 | 15.7 | 16.28 | 42.3 | 37.8 | 40.12 | 20.4 | 17.0 | 19.11 |
| BL \_4407 | 16.2 | 14.5 | 15.34 | 38.7 | 37.2 | 37.65 | 18.6 | 15.9 | 17.01 |
| BL \_4919 | 16.7 | 14.1 | 15.53 | 45.3 | 38.1 | 42.01 | 20.8 | 16.1 | 18.96 |
| BL\_4669 | 17.0 | 16.5 | 16.85 | 42.6 | 39.8 | 41.64 | 19.0 | 16.4 | 17.61 |
| Gautam | 15.4 | 14.6 | 14.78 | 40.0 | 36.6 | 38.03 | 18.6 | 17.0 | 17.61 |
| NL \_1179 | 16.7 | 15.0 | 15.91 | 42.6 | 38.4 | 40.69 | 19.3 | 16.1 | 17.76 |
| NL \_1346 | 17.0 | 14.2 | 15.72 | 44.3 | 37.2 | 40.88 | 18.8 | 14.5 | 16.41 |
| NL \_1350 | 15.9 | 13.8 | 14.78 | 40.0 | 35.4 | 37.27 | 20.0 | 17.5 | 19.11 |
| NL \_1369 | 16.2 | 15.4 | 15.72 | 39.0 | 36.0 | 37.08 | 19.0 | 16.7 | 17.76 |
| NL \_1381 | 17.2 | 15.4 | 16.47 | 49.9 | 39.2 | 45.43 | 19.3 | 16.1 | 17.76 |
| NL \_1384 | 16.2 | 15.0 | 15.53 | 43.0 | 37.8 | 40.50 | 19.2 | 15.6 | 17.31 |
| NL \_1386 | 16.2 | 14.6 | 15.34 | 40.0 | 35.4 | 37.27 | 19.5 | 17.2 | 18.51 |
| NL \_1387 | 16.4 | 15.4 | 15.91 | 44.0 | 40.4 | 42.77 | 19.7 | 17.8 | 18.96 |
| NL \_1413 | 16.2 | 15.3 | 15.72 | 43.3 | 38.7 | 41.26 | 19.3 | 16.7 | 18.06 |
| NL \_1417 | 16.7 | 15.3 | 16.09 | 43.0 | 37.8 | 40.50 | 20.6 | 16.1 | 18.81 |
| NL \_1420 | 15.7 | 14.5 | 14.97 | 39.4 | 35.1 | 36.70 | 18.5 | 15.0 | 16.41 |
| NL\_ 1368 | 16.4 | 14.6 | 15.53 | 41.7 | 38.1 | 39.93 | 18.5 | 15.6 | 16.71 |
| NL\_ 1376 | 15.1 | 13.0 | 13.84 | 40.0 | 36.0 | 37.65 | 18.3 | 15.9 | 16.71 |
| NL\_ 1404 | 16.7 | 15.0 | 15.91 | 40.0 | 37.2 | 38.41 | 18.5 | 15.6 | 16.71 |
| NL\_ 1412 | 17.0 | 15.3 | 16.28 | 40.0 | 36.9 | 38.22 | 19.2 | 17.2 | 18.21 |
| Mean | 16.38 | 14.87 | 15.6 | 41.95 | 37.5 | 39.7 | 19.25 | 16.3 | 17.8 |
| CV% | 6.31 | 4.38 | 5.5 | 8.05 | 6 | 7.2 | 12.24 | 8.78 | 10.9 |
| LSD0.05 | 1.11 | 1.35 | 0.8 | 4.10 | 4.6 | 2.8 | 2.10 | 2.98 | 1.6 |
| F-test | \* | \*\* | \*\* | \* | NS | \*\* | \* | \* | \* |

Table 6: Differential response under timely and late sowing conditions among genotype on ET, TKW, and GY.

|  |  |  |  |
| --- | --- | --- | --- |
| Genotype |  Effective tiller/m2 |  Thousand kernel weight  |  Grain yield  |
|  | timely sown  | late sown | overall | timely sown  | late sown | overall | timely sown  | late sown | Overall |
| Bhirkuti | 370.1 | 355.4 | 362.29 | 37 | 30 | 33.56 | 3810 | 2803.5 | 3307 |
| BL \_4407 | 362.7 | 351.6 | 356.28 | 36 | 31 | 33.33 | 3479 | 2752 | 3115 |
| BL \_4919 | 376.7 | 353.7 | 364.57 | 32 | 29 | 30.27 | 3577 | 2930.5 | 3254 |
| BL\_4669 | 385.0 | 365.7 | 375.97 | 29 | 26 | 27.44 | 3492 | 2803 | 3147 |
| Gautam | 429.6 | 386.1 | 410.59 | 32 | 29 | 30.49 | 3797 | 3053 | 3425 |
| NL \_1179 | 411.0 | 384.0 | 400.02 | 31 | 28 | 29.55 | 3628 | 3071 | 3349 |
| NL \_1346 | 435.8 | 395.3 | 419.30 | 31 | 27 | 28.61 | 3155 | 2628 | 2891 |
| NL \_1350 | 344.1 | 305.5 | 319.18 | 43 | 39 | 40.85 | 3954 | 2657 | 3306 |
| NL \_1369 | 375.1 | 323.8 | 345.71 | 32 | 31 | 31.70 | 3596 | 2806.5 | 3201 |
| NL \_1381 | 389.6 | 370.2 | 380.95 | 29 | 26 | 27.23 | 3517 | 2732.5 | 3125 |
| NL \_1384 | 459.0 | 384.3 | 424.27 | 28 | 26 | 26.98 | 3765 | 3058.5 | 3412 |
| NL \_1386 | 385.4 | 345.8 | 364.16 | 32 | 30 | 30.99 | 3640 | 2499 | 3070 |
| NL \_1387 | 383.8 | 348.9 | 365.19 | 34 | 30 | 32.16 | 3466 | 2869 | 3167 |
| NL \_1413 | 428.8 | 378.8 | 405.82 | 30 | 27 | 28.38 | 4027 | 2962.5 | 3495 |
| NL \_1417 | 378.4 | 337.5 | 355.66 | 36 | 29 | 32.38 | 3485 | 2809.5 | 3147 |
| NL \_1420 | 438.3 | 395.7 | 420.75 | 32 | 29 | 30.74 | 4118 | 3310.5 | 3714 |
| NL\_ 1368 | 476.7 | 358.9 | 417.85 | 28 | 23 | 25.35 | 3769 | 2759 | 3264 |
| NL\_ 1376 | 374.3 | 363.7 | 369.34 | 32 | 29 | 30.06 | 3548 | 2718 | 3133 |
| NL\_ 1404 | 418.1 | 359.9 | 389.03 | 29 | 28 | 28.40 | 3739 | 2886.5 | 3313 |
| NL\_ 1412 | 363.5 | 328.6 | 342.81 | 36 | 32 | 33.80 | 3632 | 2609 | 3121 |
| Mean | 399.3 | 359.68 | 379.5 | 32.4 | 28.83 | 30.61 | 3659.68 | 2835.9 | 3247.80 |
| CV% | 6.4 | 7.53 | 6.8 | 3.9 | 5.23 | 4.19 | 9.30 | 11 | 10.33 |
| LSD | 34.6 | 56.5 | 28.6 | 1.8 | 3.14 | 1.82 | 391.78 | 671 | 531.61 |
| F-test | \*\*\* | \* | \*\*\* | \*\*\* | \*\*\* | \*\*\* | NS | NS | NS |