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Comparison of Phenology and Growth Dynamics of Wheat (*Triticum aestivum* L.) Cultivars in Amritsar under Different Dates of Sowing

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ABSTRACT

Field experiments were undertaken in Amritsar to assess the phenology and growth dynamics of two wheat cultivars (HD-2967 and PBW-621) at two planting dates during the 2013-14 and 2014-15 rabi seasons. Crop phenological development phases and growth characteristics were documented on a regular basis. With a delay in seeding from November to December, crop growth was shorter and dry matter buildup was lower. Crop growth rate (CGR) was lower during the early phases of crop development and rose as the crop matured. On the other hand, relative growth rate (RGR) was higher throughout the early stages of the crop's development and declined as the crop matured. Crops seeded in November (D1) and cv. HD-2967 collected higher dry matter in general than crops sown in December (D2) and cv.PBW-621, which might be due to the extended crop growth time. CGR, RGR, specific leaf weight (SLW), and leaf weight ratio (LWR) were all higher in cv. HD-2967 and D1 crop compared to cv. PBW-621 and D2 crop, respectively, due to increased dry matter buildup.

Key words: Crop growth rate; Leaf weight ratio, Phenology; Relative growth rate, Specific leaf weight; Wheat

In northern India, wheat (Triticum aestivum L) is a key winter grain crop. It is India's most significant cereal crop, second only to rice, accounting for nearly a third of total food grain output. Prabhjyot Kaur and Hundal (2010) found that the lowest temperature in Ludhiana, Punjab, has risen steadily over the last 30 years (from 0.4 to 1.6°C). Temperature fluctuations have a direct impact on crop output. Intra-seasonal fluctuations in environmental conditions have a big impact on wheat productivity. According to Prabhjyot-Kaur and Hundal (2009), the most favourable maximum temperatures for wheat yields in January, February, and March were 16.1-18.0 oC, 21.0 oC, and 28.1-30.0 oC, respectively, while minimum temperatures were 3.1-5.0 oC, 5.1-7.0 oC, and 11.1-13.0 oC.

A crop's agronomic management and production technologies have a substantial impact on yield. The usual wheat planting season in Punjab runs from the final week of October to the third week of November, with late sowing continuing into December. Due to high temperatures during late planted wheat's lateral development stages, late planted wheat had less time to move into other phenophases such jointing, booting, and grain formation (Hussain et al., 2012). The early seeded wheat crop had greater phenothermal indices and heat usage efficiency than the late sown wheat crop (Haider et al., 2013). The current study compared phenological development, crop production, and growth dynamics of wheat cultivars under various settings in order to evaluate the performance of wheat crop in Punjab's central zone.

MATERIALS AND METHODS

Field experiments were done at the Research Farm, Khalsa College, Amritsar, over two rabi seasons (2013-14 and 2014-15). The Research Farm is located at 31o 38′ North latitude, 72o 52′ East longitudes, and at an elevation of 236 metres above mean sea level. The texture of the soil in the experimental field was loamy sand, with normal response and EC (0.3 to 0.26), low organic content (0.44 to 0.35) and available nitrogen (154 to 158) and medium available phosphorus (24.5 to 28.9) and available potassium (24.5 to 28.9). (328 to 358).   The kera technique was used to sow two wheat cultivars (HD-2967 and PBW-621) at two different times (3rd week of November and 1st week of December) with a row to row spacing of 22.6 cm and a seed rate of 35 kg/ha. Under a split-split plot design, the Experiment was duplicated three times. Nitrogen @50 kg/acre (12 at sowing and 12 spread with initial irrigation), P2O5 @25 kg/acre, and K2O @12 kg/acre were all treated to the crop.

Observing the plants from a 1m row length of each plot allowed the phenological events from emergence to physiological maturity to be recognised. Plant samples were taken every two weeks, and leaf area dry matter was measured. According to Hunt (1989), growth indices at periodic periods were calculated as follows:

Leaf area index (LAI) :

$$LAI = \frac{LA\ (m^2)}{\text{Ground area}\ (m^2)}$$

Where, LA is leaf area in m^2

Crop growth rate (CGR):

$$CGR\ (g\ m^{-2}\ d^{-1}) = \frac{W_2 - W_1}{}$$

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$$T_2 - T_1$$

Where, W_2 and W_1 are the total dry matter of crop (g/m^2) on days T_2 and T_1, respectively.

Relative growth rate (RGR):

$$\text{RGR } (g\ m^{-2}\ d^{-1}) = \frac{\text{in } W_2 - \ln W_1}{T_2 - T_1}$$

Where, InW_1 and InW_2 is natural log of total dry matter of crop (g/m^2) on days T_1 and T_2, respectively.

Leaf area ratio (LAR):

$$\text{LAR } (m^2\ g^{-1}) = \frac{LA}{W}$$

Where, LA = Leaf area (m^2)

W = Total plant dry weight (g)

Leaf weight ratio (LWR):

$$\text{LWR} = \frac{LW}{W}$$

Where, LW = Leaf weight (g)

W = Plant dry weight (g)

Specific leaf area (SLA):

$$\text{SLA } (m^2\ g^{-1}) = \frac{L\ A}{LW}$$

Where, LA = Leaf area (m^2)

LW = Leaf weight (g)

Specific leaf weight (SLW):

$$\text{SLW } (g\ m^{-2}) = \frac{LW}{LA}$$

Where, LW = Leaf weight (g)

LA = Leaf area (m^2)

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RESULTS AND DISCUSSION

Phenological stages

Phenological phases of two wheat cultivars as impacted by planting dates across two crop seasons. In all crop years, data analysis demonstrated that delayed seeding decreased the growth time of both cultivars. The results showed that, while cv. PBW-621 reached physiological maturity sooner than cv. HD-2967 in all settings, it took longer to complete its vegetative development phases than cv. HD-2967. It takes less days to complete its reproductive development phases, though.

Total dry matter accumulation

Statistics on dry matter buildup throughout time. The dry matter content of the crop rose in general during the growing season. The delayed seeding of the wheat crop, on the other hand, resulted in a considerable drop in total dry matter buildup. In comparison to PBW-621, HD-2967 gathered much more dry matter, which might be attributable to its extended crop growth time.

Crop growth rate

The data on CGR (Crop growth rate) for growth periods between emergence to 30 DAS and thereafter at biweekly interval are presented in Table 2. In general, the crop growth rate was lower during initial crop growth stages and increased with crop growth and development. The maximum CGR of 25.39 and 32.15 g m^{-2} day^{-1} was recorded for cv. PBW-621 sown in 3rd week of November and 1st week of December, respectively. Similarly, the maximum CGR of 30.97and 23.41 g m^{-2} day^{-1} was recorded for cv. HD-2967 sown in 3rd week of November and 1st week of December, respectively. Generally, somewhat higher CGR at most growth intervals was observed in cv. HD-2967 as compared to cv. PBW-621. This may be attributed to longer crop duration and thereby more dry matter accumulation of the cv. HD-2967 as compared to cv. PBW-621.

Relative growth rate

The data on RGR (Relative growth rate) for growth periods between emergence to 30 DAS and thereafter at biweekly interval are presented in Table 2. The relative growth rate was higher during early and vegetative growth of the crop and thereafter it decreased as the crop advanced towards maturity. Like CGR, the RGR was more in cv. HD-2967 as compared to cv. PBW-621 which may be attributed to its longer crop duration and thereby more dry matter accumulation.

Leaf area development

The data on periodic leaf area index (LAI) are presented in Table 3. As the crop growth occurred after the crop emergence stage, the LAI increased and peak LAI occurred at about 105 DAS (days after sowing) under 1st date of sowing and at 90 DAS under 2nd date of sowing during all the crop year. The maximum LAI was slightly more in cv PBW-621 as compared to cv. HD-2967 under early sown crop environments. This may be attributed to slightly prolong vegetative growth period in cv. PBW-621.

Leaf area ratio

The data on LAR (Leaf area ratio) for growth periods between emergence to 30 DAS and thereafter at biweekly interval are presented in Table 3. The value of LAR was maximum between 30-50 days of crop duration and after that it declined steadily during rest of the growth period. The perusal of the data revealed that LAR was generally more for cv. PBW-621 as compared to cv. HD-2967. This may be attributed to prolonged vegetative growth period and as a result more leaf area development in cv. PBW-621.

Specific leaf area

The data on SLA (Specific leaf area) for growth periods between emergence to 30 DAS and thereafter at biweekly interval are presented in Table 3. The perusal of the data revealed that peak SLA was obtained between 30-60 DAS. This may be due to the fact that the SLA is higher for young tender leaves and decrease with crop age as leaves become thicker. In general, the SLA was more for cv. PBW-621 as compared to HD-2967, which may be attributed to thicker leaf texture of cv. HD-2967.

Leaf dry weight

The data on periodic leaf dry weight between 30 DAS up to maturity at biweekly interval are presented in Table 4. In general, the leaf dry weight went on increasing throughout the crop growing period. Amongst the two cultivars, cv. HD-2967 accumulated more leaf dry weight as compared to cv. PBW-621. Due to this reason the LAR and SLA for cv. HD-2967 was lesser as compared to cv. PBW-621.

Specific leaf weight

The data on SLW (Specific leaf weight) between 30 DAS up to maturity at biweekly interval are presented in Table 4. The perusal of the data revealed that the SLW increased with the age of crop. This may be due to the fact that as the crop growth occurred, leaf thickness increased, thereby resulting in increase in SLW. Amongst the two cultivars, cv.HD-

2967 accumulated more leaf dry weight as compared to cv. PBW-621. Due to this reason the SLW for cv. HD-2967 was more as compared to cv. PBW-621.

Leaf weight ratio

The data on LWR (Leaf weight ratio) between 30 DAS up to maturity at biweekly interval are presented in Table 4. The perusal of the data revealed that LWR decreased with crop age as during early vegetative growth period more dry matter were partitioned towards leaves, but with the onset of reproductive phase, the partitioning of dry matter towards leaves decreased and more dry matter was partitioned towards the grain formation. Amongst the two cultivars, cv. HD-2967 accumulated more leaf dry weight as compared to cv. PBW-621. Due to this reason the LWR for cv. HD-2967 was more as compared to cv. PBW-621.

Conclusion

In conclusion, early planted wheat crop outperformed with more growth parameters like TDM, LAR, CGR and RGR. Short growing season caused penalty in late planted wheat than early planted wheat. Long durational cultivar HD-2967 had attained more growth than PBW-621.

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