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CROP GROWTH ANALYSIS AND SEED DEVELOPMENT PROFILE OF WHEAT CULTIVARS IN RELATION TO SOWING DATES AND NITROGEN FERTILIZATION

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Abstract

Growth attributes from sowing to physiological maturity and seed developmental changes from anthesis to physiological maturity were monitored in two varieties of wheat (Pirsabaq-2005 and Khyber-87) under the influence of four sowing dates (Oct. 24th, Nov. 13th, Dec. 3rd and Dec. 23rd) and four levels of nitrogen (0, 100, 130 and 160 Kg ha^{-1}) at New Developmental Farm of The University of Agriculture, Khyber Pakhtunkhawa Peshawar, Pakistan during 2008-09 and 2009-10.Analysis of the two years average data indicated that early and normal (Oct. 24th and Nov. 13th) seeded crops resulted in the highest significant values of Crop Growth Rate (CGR) and Absolute Growth Rate (AGR) at third month of sampling after sowing, fresh seed weight (wet basis) and fresh seed germination (%) at 50 DAA (days after anthesis) but fresh seed moisture content was reduced up to 30-40% at 50 DAA while all the studied characters were declined under late seeded condition. Individual effect of 130 kg N ha^{-1} was founded best for all the concern growth and seed developmental traits but further increase in nitrogen dose responded negatively to the concern study of crop and seed. All growth attributes and seed developmental profile under study revealed that interaction of early and normal sowing with 130 kg N ha^{-1} using Pirsabaq-2005 cultivar, were also recorded for significant relation. The overall findings concluded that growing wheat variety Pirsabaq-2005 on Oct.24th and Nov.13th and application of 130 kg N ha^{-1} could be more beneficial in the study area.

Introduction

Wheat (*Triticum aestivum* L.) is the major crop of food supply in the region. Its importance may be understood from the fact that it exceeds all other crops in both area and production and major commodity in the world food trade and basic foodstuff of the developing countries (Khalil & Jan 2005; Hussain *et al.,* 2012). Crop growth rate and absolute growth rate are used extensively in growth analysis of field crops and these physiological parameters are best measure of the total performance of the crop (Nataraja *et al*., 2006). These growth parameters mainly depend on climatic condition. Achieving higher growth of wheat is well governed by planting on suitable dates and applying of optimum nitrogen level.The growth attributes and vegetative characters are directly influenced by different nitrogen levels (Achakzai, 2012; Iftikhar *et al.,* 2010).The dry matter yield of wheat increased with increased nitrogen level (Khail *et al.,* 2011). The growth characteristics of wheat crop are directly affected by late seeded condition. Sattar *et al*., (2010) reported that early sowing have significant contribution in the growth parameters. Ehsanullah *et al*., (1999) also documented highest AGR at early and normal sowing. Nitrogen fertilization performed positive role in the growth analysis of wheat cultivars (Poma *et al*., 2002). Maximum CGR achieved significantly by optimum nitrogen application and further increased in nitrogen dose have non-significant effect (Asif *et al.,* 2010).

Seed development is a function of rate and duration of seed growth and mainly determined by photosynthates supply. It also affected by a number of environmental factors including sowing dates, water and nitrogen application (Babar *et al.,* 2011). Early and normal sowing may prolong the grain filling duration which ultimately produced healthy and vigorous seed due to more dry matter accumulation. Similarly the nitrogen deficiency reduces photosynthates production because of stomata closure and early senescence (Sing & Wilkens 1999).

Keeping in view these controversial statements, the present study was planned to investigate the crop growth analysis and seed developmental profile of wheat cultivars in relation with sowing dates and nitrogen fertilization.

Materials and Methods

Experimental site: Two years field experiment entitled "crop growth analysis and seed developmental profile of wheat cultivars in relation with sowing dates and nitrogen fertilization" were made on two varieties Pirsabaq-2005 and Khyber- 87 at New Developmental Farm (NDF) of The University of Agriculture, Khyber Pakhtunkhawa Peshawar, Pakistan during the two successive seasons 2008/09 and 2009/10.

Experimentation: A trial layout consisted of Randomized Complete Block Design having split plot arrangement with four replications. The experiment comprised two factors. Factor A contained four sowing dates (Oct. 24th, Nov. 13th, Dec. 3rd and Dec. 23rd) with 20 days intervals randomly kept in main plots and factor B included two varieties (Pirsabaq-2005 and Khyber-87) and four nitrogen levels (0,100,130 and 160 kg ha^{-1}) were randomized in the sub plots each measuring 5 x 0.3m.

Crop management practices: The amount of nitrogen was split into two portions. Half dose of nitrogen in the form of urea (46% N) and whole dose of phosphorus and potash in the form of triple super phosphate (46% P_2O_5)

and murate of potash (60% K_2O) respectively were applied immediately at sowing time. The remaining half dose of nitrogen was given at second irrigation. All other cultural practices including irrigation and hand weeding were standard and kept uniform for all treatments in both years as and when needed to the crops.

Soil analysis: Soil sample were collected from the soil surface of experimental area before and after the treatments (Nitrogen, P_2O_5 and K_2O) application and were analyzed for physico-chemical characteristics like pH, phosphorus (ppm) and nitrogen (%) in the soil science laboratory of Agriculture Research Insistute, Tarnab, Peshawar during both years (Table 1).

Table 1. Soil analysis of the new developmental farm of KP, Agricultural University Peshawar before and after the treatments application

Soil chemical properties	Before treatment application	After treatment application
pH	8.24	7.94
Nitrogen	0.018 %	0.034%
Phosphorus	9.84 ppm	15.43 ppm

Measurements of observation: Physiological study and seed development were measured using their standard procedures.

Physiological study: Crop on 50cm long row was harvested from each sub plot at one month interval during the growing season from sowing to physiological maturity. The samples were dried in oven at 72°C for 48 hours and then calculated crop growth rate (g m^{-2} day^{-1}) by using their standard formula:

$$\text{CGR (g m}^{-2}\text{ day}^{-1}) = \frac{(W_2 - W1)}{(T_2 - T_1)} \times \frac{1}{GA}$$

where
W_1 = Initial weight
W_2 = Final weight
T_1 = time at the start of period
T_2 = time at the end of period
GA = Ground area

Absolute Growth Rate (g day^{-1}) was recorded from the determined dry matter using the following formula:

$$\text{AGR (g day}^{-1}) = \frac{(W_2 - W_1)}{(T_2 - T_1)}$$

where
W_1 = Initial weight
W_2 = Final weight
T_1 = time at the start of period
T_2 = time at the end of period

Seed development: Seed development study was started after 7-10 days of anthesis and continued till physiological maturity. Seed samples were collected from five spikes of each sub plot randomly at 10 days interval and were used for seed development study like

Fresh seed weight (mg): 25 fresh were taken from the five spikes of each sub plot and recorded the fresh seed weight (mg) on wet basis by putting the fresh seed samples in container on electronic balance.

Fresh seed moisture content (%): The same samples of fresh seed weight data were used for fresh seed moisture content (%).The samples were placed in oven for drying and then calculated the moisture content (%) by formula:

$$\text{MC (\%)} = \frac{\text{(Fresh seed wt – Dry seed weight)}}{\text{Fresh seed weight}} \times 100$$

Fresh seed germination (%): 25 fresh seeds were placed in germination trays between two germination papers and were putted in germinator for 7 days at 25°C and collected the fresh seed germination (%) by formula:

$$\text{Fresh seed germination (\%)} = \frac{\text{Number of fresh seeds germinated}}{\text{Out of 25 seeds}} \times 100$$

Statistical analysis: All the data collected during 2 years were subjected to statistical analyses using Excel data sheet. Least Significant Difference Test at 5% probability was used to test the significant differences among mean values of each treatment (Steel & Torrie, 1984).

Results

Crop growth rate (CGR): Crop growth rate (CGR) calculated from the different categories of clustered columns showed significant variations for main effect of sowing dates (D), nitrogen levels (N) and sampling time periods after sowing (T). Early and normal planting exhibited highest mean CGR values (10.8 and 10.7 g m^{-2} day^{-1}) but the values of CGR become reduced (6.4 and 6.1 g m^{-2} day^{-1}) by delayed planting (Fig. 1A). Comparison of means in case of nitrogen treatment (Fig. 1B) indicated that CGR increased up to 130 kg N ha^{-1} and then decreases by further fertilization of nitrogen. Minimum CGR was recorded in case of 0 kg N ha^{-1}. When compared the means for the sampling time period after sowing (T), CGR was slower during the first two months (T1 & T2) of wheat growth and enhanced rapidly during the third month (T3) and declined again during the fourth month (T4) of wheat growth (Fig. 1C). The ANOVA constructing for interaction effect of sowing dates and sampling time period (D x T) and nitrogen and sampling time period (N x T) also detected significant responses for CGR. CGR calculated from the quadratic fitted values across the various sowing dates during different sampling time periods were increased up to a certain peak (Oct. 24th and Nov. 13th along T3 and T4) and thereafter decreased gradually and in case of delayed sowing, it declined sharply at the later stages of growth (Fig. 2G). Similarly the quadratic fitted values (Fig. 2H) showed that higher CGR trend obtained at third months after sowing (T3) across the maximum nitrogen level and then decreased gradually.

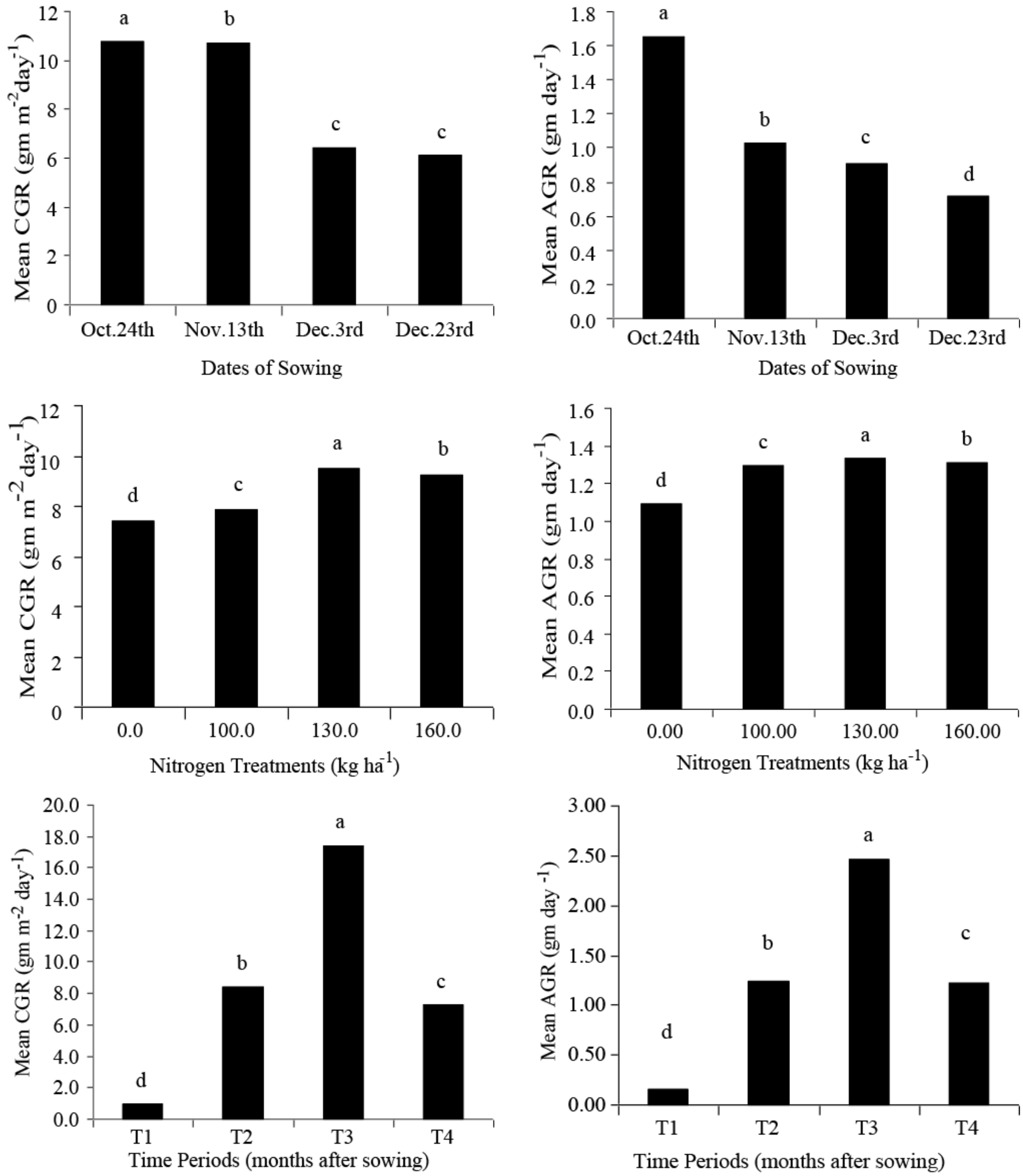

Fig. 1. Mean CGR and AGR of wheat of the four sowing dates (A,D), four different doses of nitrogen (B,E) and during four time periods after sowing (C,F) respectively at the Agriculture Research Farm of Agricultural University Peshawar during the years 2008-09 and 2009-10.

Absolute growth rate (AGR): The Absolute growth rate (AGR) determined by different categories of clustered columns indicate significant variations for the main effect of sowing dates (D), nitrogen levels (N) and sampling time periods after sowing (T). Maximum mean AGR values at early and normal sowing were calculated and lowest value was obtained under late planting (Fig. 1D). Highest AGR of wheat was obtained from plots fertilized with 130kg N ha^{-1} than that recorded in plots having 0 kg N ha^{-1} (Fig. 1E). The means of the sampling time period after sowing (T) for AGR showed (Fig. 1F) that AGR become slower during the first 2 months (T1 & T2) of wheat growth and enhanced rapidly during the third month (T3) and declined again during the fourth month (T4) of wheat growth (Muhammad Arif *et al*., 2010). The interaction effect of sowing dates and sampling time period (D x T) and nitrogen and sampling time period (N x T) also detected significant responses for AGR. AGR calculated from the quadratic fitted values (Fig. 2I) across the various sowing dates during the different sampling time period increased up to a certain peak (Oct. 24th and Nov. 13th along T3 and T4) and thereafter decreased gradually and in case of delayed sowing, the AGR declined sharply at the later stages of growth. Similarly the quadratic fitted values (Fig. 2J) showed that AGR trend first slowly increased with nitrogen application ,then reached to the maximum level at third month after sowing (T3) across the maximum nitrogen level and then decreased gradually.

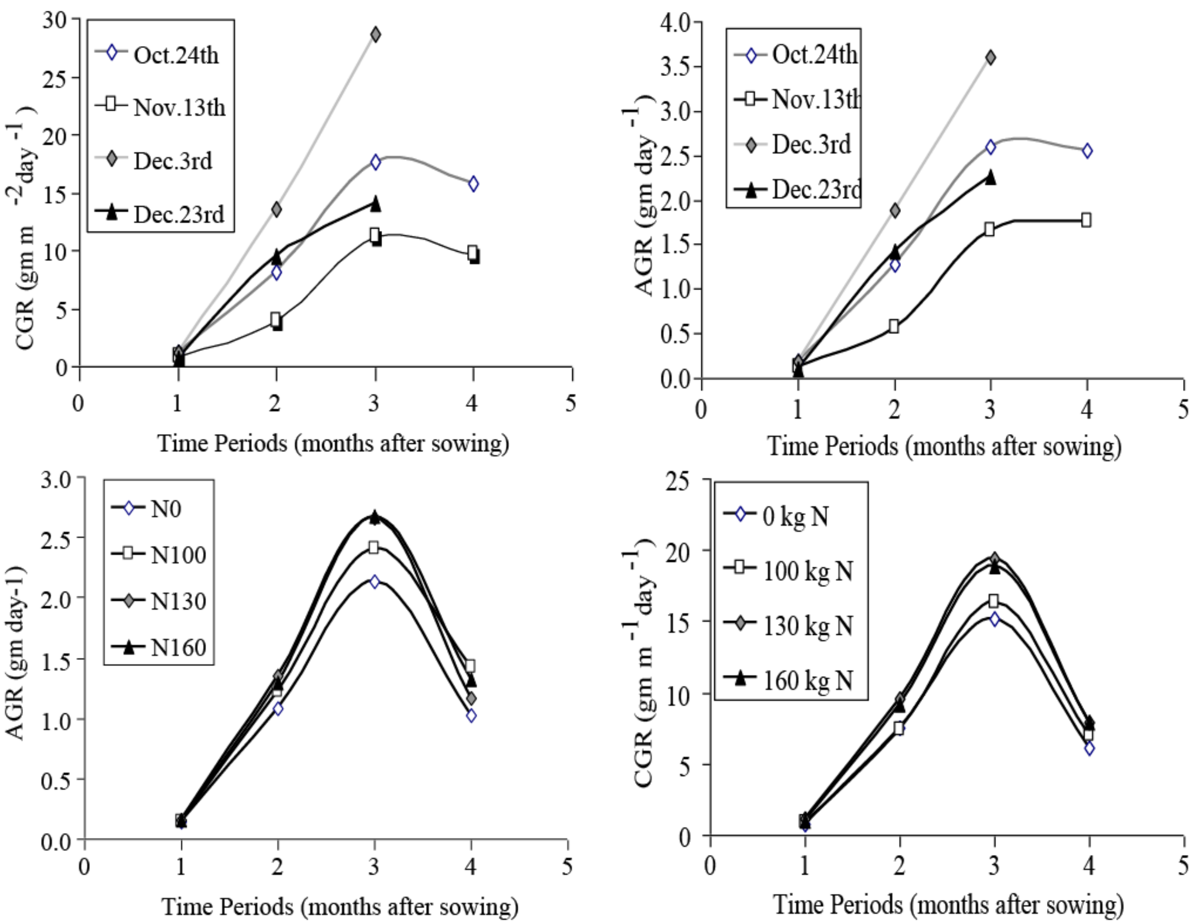

Fig. 2. Trends of CGR and AGR of wheat during interaction of four time periods with four sowing dates (G,I) and four different doses of nitrogen (H,J) respectively at the Agriculture Research Farm of Agricultural University Peshawar during the years 2008-09 and 2009-10.

Fresh seed weight: Sampling periods and their response to varieties, planting dates and nitrogen fertilization significantly alter the fresh seed weight collected after anthesis and continued up to physiological maturity as depicted in Tables 2 & 3. The seed weight (wet basis) gradually increases individually at each interval (time period), reach to maximum value (1997.0mg) at final seed sample and also responded positively towards interaction with cultivars (V x T). Khyber-87 noted best in term of higher fresh seed weight (1154.3mg) at the end of developmental period (Table 2). The fresh seed weight recorded under early sowing at 100kg N ha^{-1} was higher (1526.1mg) and similarly at final interval (T-5) during early sowing (Oct. 24th) having 100kg N ha^{-1} (D x N x T) was also achieved maximum seed weight (2349.9mg) at wet basis as compared to other interaction (Table 3). An increasing trend of time intervals across different sowing dates (D x T), nitrogen levels (N x T), and across varieties and nitrogen levels (V x N x T) and varieties and sowing dates (V x D x T) was significantly observed for fresh seed weight as shown in Fig. 3. The decreasing trend observed in late planting date at different sampling period from anthesis to physiological maturity for fresh seed weight (Fig. 3K). The mean value calculated for fresh seed weight showed increasing trend line under 100kg N ha^{-1} and after that the trend becomes decreases at higher doses of nitrogen (Fig. 3L). The difference in trend lines of both varieties at various intervals across nitrogen levels (V x N x T) and different sowing dates (V x D x T) also observed for significant relationship (Figs. 3M and 3N).

Fresh seed moisture content: The data on fresh seed moisture content contributing in seed development are listed in Tables 2 and 3. The mean values of fresh seed moisture content showed that water content gradually decreases at each sampling period and reach to 32.9% at later stages of seed development as indicated in the interaction of V x T (Table 2). The seed samples of both varieties observed similar for moisture content throughout the seed development period. The highest dose of nitrogen application at early sowing reduces the moisture content of fresh seed across the different seed samples at various intervals as listed in Table 3. The trend lines in Figs. 4U (D x T) shows that moisture content of developing seeds decreased gradually with increasing of dry matter accumulation in the endosperm under the influence of various planting dates and reached to its minimum range (30-35%) at final seed samples during physiological maturity. The significant trend fitted in Fig. 4V across the calculated values of N x T interaction presented that water content of fresh seed decreases slowly from the maximum peak at early stages under 0 and 130kg N ha^{-1} and then showed declining trend for moisture content at later stages of seed development at higher doses of nitrogen fertilization. The significant interaction of N x V x T were fitted by trend lines in Fig. 4W & X describe that both varieties showing overlap curve for moisture content under different doses of nitrogen but declined at various seed sampling periods. The changes in water content of both varieties under the effect of various planting and sampling intervals (D x V x T) were observed for significant relation as shown in Fig. 4Y & Z.

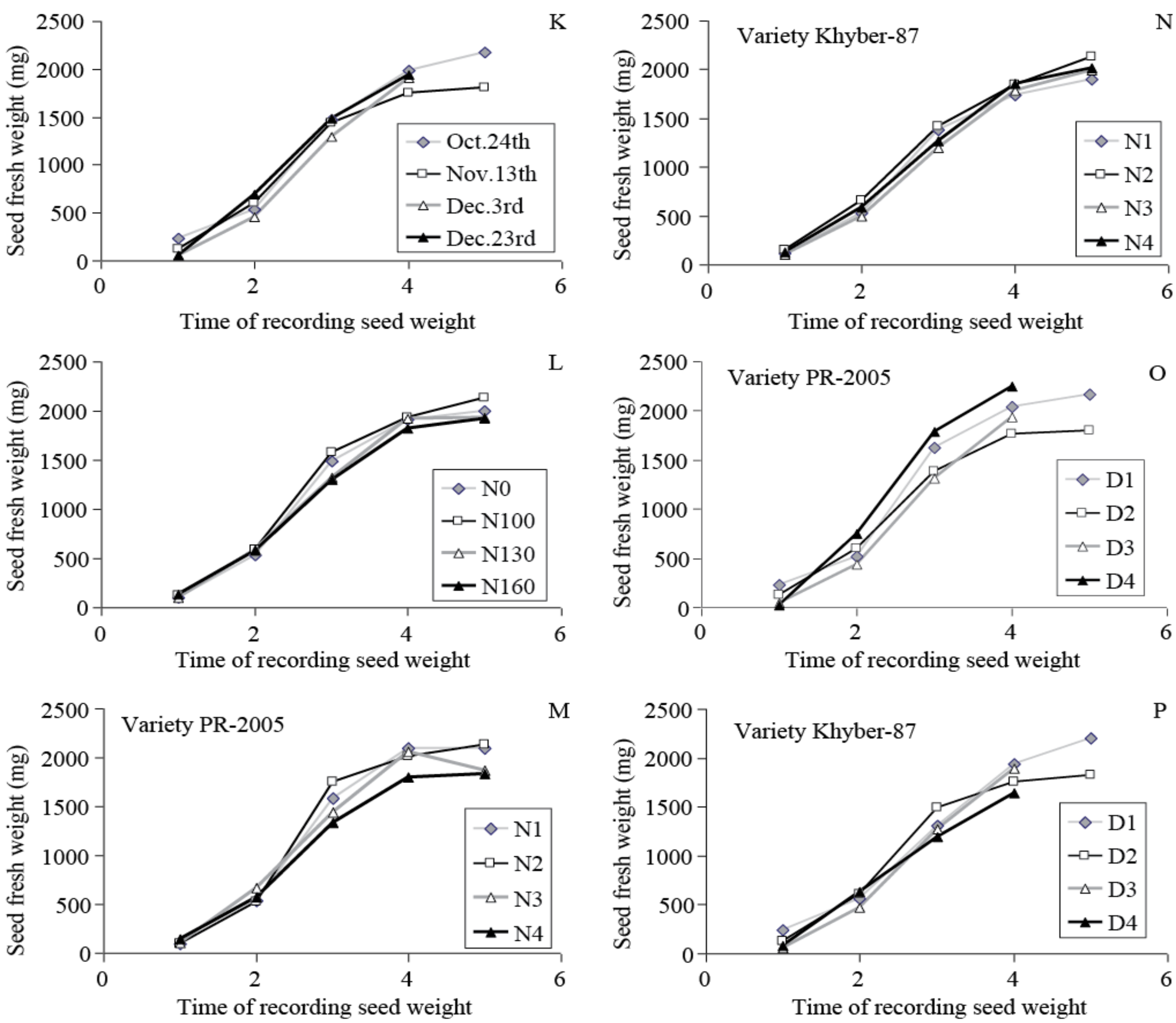

Fig. 3. Trends of seed fresh weight of wheat at different time intervals in interaction with four sowing dates (K), four different doses of nitrogen (L), four different doses of nitrogen and two varieties (M,N) and four sowing dates and two varieties (O,P) at the Agriculture Research Farm of Agricultural University Peshawar during the year 2008-09 and 2009-10.

Table 2. Mean table for fresh seed weight, fresh seed moisture content and fresh seed germination of wheat as affected by interaction of V x T.

Sampling intervals	Fresh seed wt. (mg) varieties PS-2005			Fresh seed moisture content (%) varieties			Fresh seed germination (%) varieties		
	PS-2005	**Khy-87**	**Mean**	**PS-2005**	**Khy-87**	**Mean**	**PS-2005**	**Khy-87**	**Mean**
	107.5	125.8	116.7	76.8	77.0	76.9	0.0	0.0	0.0
Time-1	575.0	567.1	571.1	55.1	54.9	55.0	0.0	0.0	0.0
Time-2	1527.7	1315.6	1421.7	43.9	43.6	43.7	24.5	27.9	26.2
Time-3	1993.0	1804.8	1898.9	36.2	35.7	35.9	52.6	56.1	54.3
Time-4	1982.5	2011.5	1997.0	32.7	33.1	32.9	67.8	76.2	72.0
Time-5	1154.3	1070.9		50.8	50.6		24.7	27.1	
Mean									
LSD values	146.25			1.21			2.42		
T	206.83			1.71			3.42		
V x T									

T = Time intervals, V = Varieties, PS = Pirsabaq, Khy = Khyber, LSD = Least significant differences

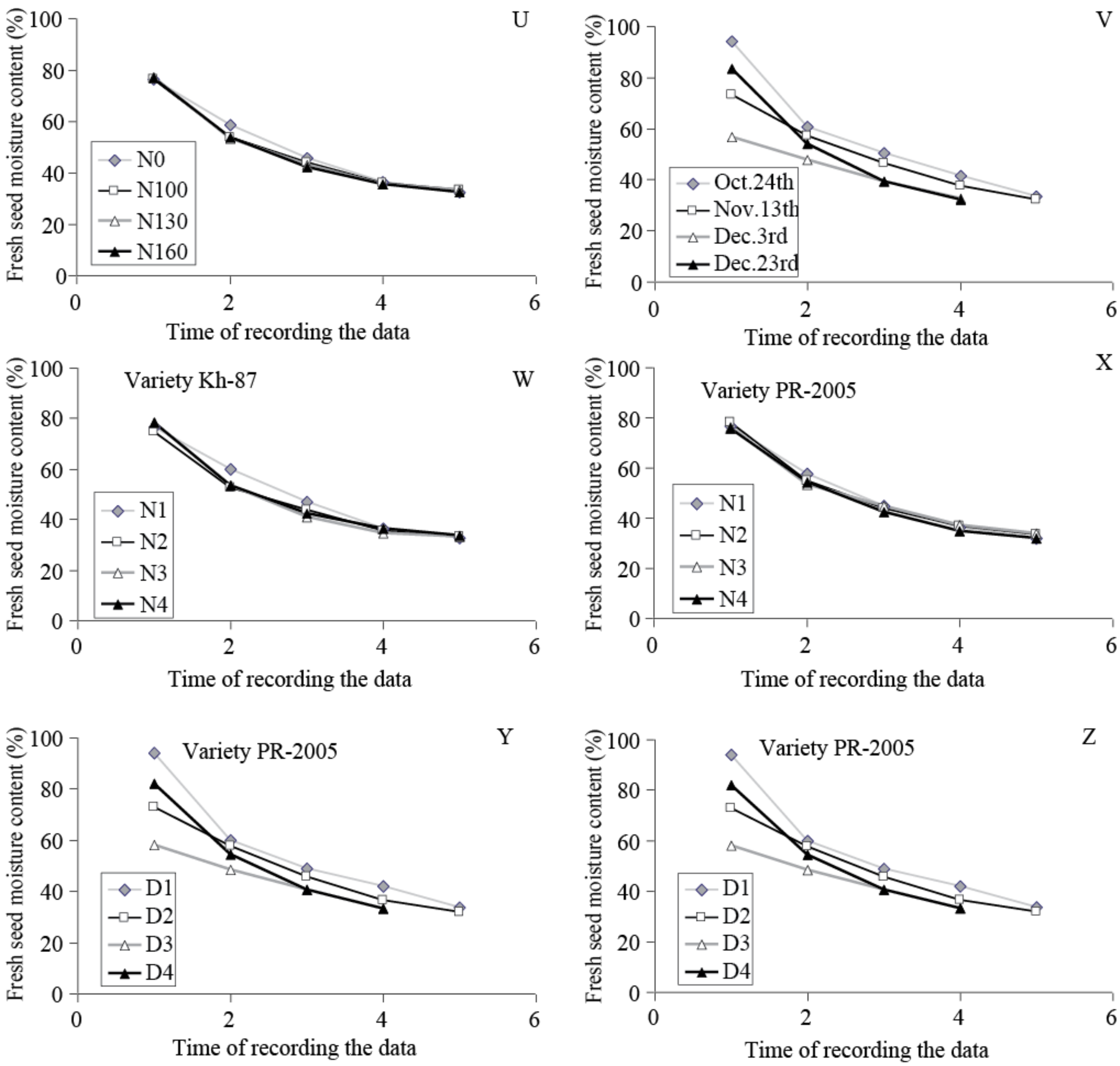

Fig. 4. Trends of fresh seed moisture content of wheat at different time intervals in interaction with four sowing dates (U), four different doses of nitrogen (V), four different doses of nitrogen and two varieties (W,X) and four sowing dates and two varieties (Y,Z) at the Agriculture Research Farm of Agricultural University Peshawar during the year 2008-09 and 2009-10.

Table 3. Mean table for fresh seed weight, fresh seed moisture content and fresh seed germination of wheat as affected by interaction of D x N and D x N x T.

SD	Nitrogen (kg ha^{-1})	Fresh seed weight (mg)						Fresh seed moisture content (%)						Fresh seed germination (%)					
		T-1	T-2	T-3	T-4	T-5	Mean	T-1	T-2	T-3	T-4	T-5	Mean	T-1	T-2	T-3	T-4	T-5	Mean
D1	N0	228.1	383.1	1630.0	1948.1	2203.1	1278.5	95.9	76.4	57.2	41.9	33.0	60.9	0.0	0.0	21.8	74.4	81.2	35.5
	N100	283.1	631.3	2175.6	2190.6	2349.9	1526.1	96.4	58.1	48.9	41.5	34.4	55.9	0.0	0.0	22.1	59.3	74.6	31.2
	N130	173.8	498.8	1095.0	2068.8	2152.4	1197.7	91.1	56.1	49.6	41.9	34.5	54.6	0.0	0.0	28.5	75.9	83.5	37.6
	N160	260.6	647.5	980.0	1735.0	2019.4	1128.5	94.1	53.1	45.8	40.1	32.8	53.2	0.0	0.0	10.1	38.5	53.3	20.4
D2	N0	120.6	540.6	1435.0	1703.8	1790.6	1118.1	70.8	56.3	45.6	37.4	31.8	48.4	0.0	0.0	16.8	45.5	62.4	24.9
	N100	95.2	535.6	1414.4	1807.5	1908.8	1152.3	73.8	58.0	46.0	37.4	31.8	49.4	0.0	0.0	21.4	62.9	76.6	32.2
	N130	148.8	668.1	1485.0	1803.8	1718.1	1164.8	73.3	56.9	45.4	37.0	32.5	49.0	0.0	0.0	14.4	54.1	76.6	29.0
	N160	133.1	653.8	1426.3	1706.3	1833.5	1150.6	74.2	58.2	47.9	38.7	32.5	50.3	0.0	0.0	17.0	50.1	67.8	27.0
D3	N0	32.3	553.3	1234.4	1890.0		927.5	58.0	47.9	40.1	33.3		44.8	0.0	0.0	13.8	46.6		15.1
	N100	67.3	452.2	1295.6	1901.3		929.1	56.0	48.0	38.0	32.2		43.6	0.0	0.0	21.7	44.3		16.5
	N130	35.6	474.4	1238.8	1879.4		907.0	57.1	46.6	40.5	33.2		44.3	0.0	0.0	24.8	41.2		16.5
	N160	81.6	340.5	1388.1	1974.4		946.2	55.6	48.5	38.0	31.9		43.5	0.0	0.0	13.9	41.8		13.9
D4	N0	30.4	651.9	1640.0	2119.4		1110.4	81.4	54.8	40.4	32.7		52.3	0.0	0.0	53.5	63.0		29.1
	N100	51.6	745.0	1443.8	1824.7		1016.3	84.9	52.6	41.8	32.7		53.0	0.0	0.0	53.7	64.4		29.5
	N130	59.1	703.8	1457.5	1935.0		1038.8	82.9	52.6	37.0	31.4		51.0	0.0	0.0	43.5	53.4		24.2
	N160	65.6	657.5	1407.5	1895.0		1006.4	84.3	55.6	37.9	31.8		52.4	0.0	0.0	42.4	54.0		24.1

LSD values	Fresh seed weight (mg)	Fresh seed moisture content (%)	Fresh seed germination (%)
D x N	121.40	1.45	3.14
D x N x T	292.50	1.21	4.84

SD = Sowing dates, N = Nitrogen levels, T = Time intervals, D1 = Oct. 24th sowing, D2 = Nov. 13th sowing, D3 = Dec. 3rd sowing, D4 = Dec. 23rd sowing, LSD = Least significant differences

Fresh seed germination: From the mean values in Table 2, we can say that fresh seed germination was significantly affected by time interval and their interaction with varieties. Highest germination achieved at final seed sample (T5) which was collected at physiological maturity stage of crop while at early stages of seed development after 14-21 days of anthesis, the germination was 0%. The germination noted in the developing seed of Khyber-87 at final stages of crop was higher while the performance of PS-2005 in term of germination was not appreciable in comparison with Khyber-87 variety. The interaction of sowing dates and nitrogen levels were reflect significant relation for fresh seed germination as listed in Table 3. Early sowing along with 130kg N ha^{-1} accelerates germination while effect of delay sowing on germination was not compensated even at higher application of nitrogen. Similarly the same Table represent that early sowing combined with 130kg N ha^{-1} at final seed sample produced highest germination (83.5%). Data on fresh seed germination were fitted to an appropriate trend line among sowing dates and seed sampling intervals (Fig. 5I). The trend line slowly and gradually increased from 0% and reach to peak value of germination (70-75%) at final seed sample during early and normal sowing but the germination recorded at final interval during delayed sowing was minimum (40-50%). The germination percentage calculated from the trend fitted values (Fig. 5II) across the various levels of nitrogen during different seed sampling period increases up to a certain peak (130kg N ha^{-1} along T5). The fresh seed germination determined by different trend lines among the interaction of nitrogen, varieties and seed sampling intervals (N x V x T) indicates significant variation (Figs. 5III & IV). Maximum values obtained for the concerning data at final seed sample in both varieties using 130kg N ha^{-1}. Similarly the quadratic fitted values (Figs. 5V & VI) showed that higher germination trend obtained at fifth sampling period across early and normal sowing in both varieties.

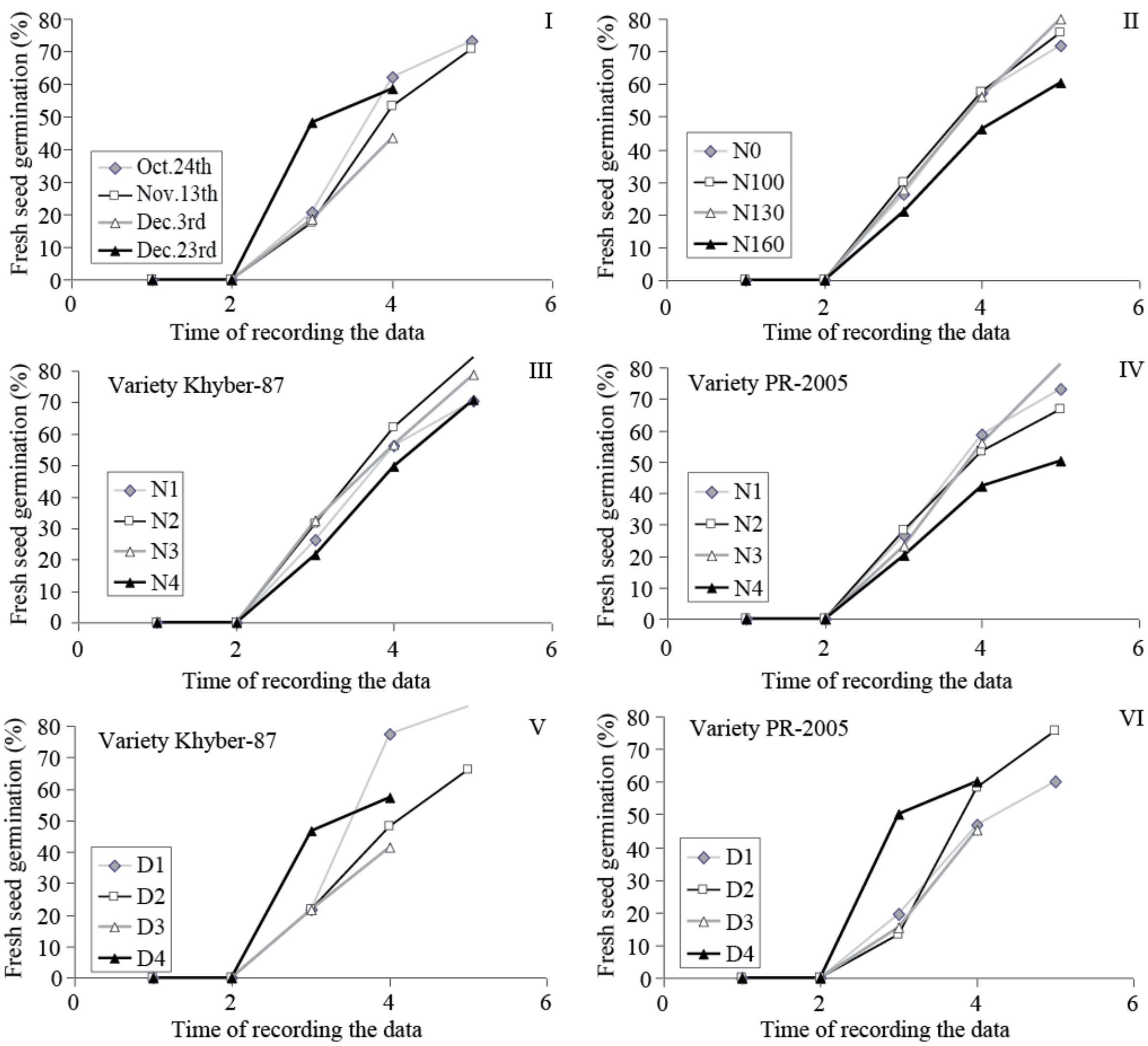

Fig. 5. Trends of fresh seed germination of wheat at different time intervals in interaction with four sowing dates (I), four different doses of nitrogen (II), four different doses of nitrogen and two varieties (III, IV) and four sowing dates and two varieties (V, VI) at the Agriculture Research Farm of Agricultural University Peshawar during the year 2008-09 and 2009-10.

Discussion

Crop growth analysis, one of the basic approachs to the analysis of yield influencing factors and plant development as net photosynthate accumulation is naturally integrated over time. Growth analysis is frequently used by plant physiologist and agronomists. Achieving higher growth attributes such as crop growth rate (CGR) and absolute growth rate (AGR) is well governed by planting on suitable dates, density, balance use of N-fertilizer and favorable climatic condition. Sowing dates had remarkable effect on most growth analysis of wheat. Crop growth rate (CGR), the gain in weight of a community of plants on a unit of land in a unit time, is used extensively in growth analysis of field crops like wheat, maize and soybean. It is regarded as the most common representative of growth function because it represents the net results of photosynthesis, respiration and canopy area interaction. The superiority of early and normal planting of wheat with respect to crop growth rate might be due to suitable weather conditions i.e. temperature, day length and light intensity which held rapid growth and formation of good canopy and resulted efficient photosynthesis as compared to delay seeded condition. Rauf & Sadaqat (2007) also observed that differential growth rates were achieved due to differential production of plant growth regulator such as cytokinins. Therefore, earlier sowing may have induced higher production of cytokinins than late sowing dates. Sattar *et al*., (2010) also concluded that sowing dates has significant effect on CGR. Absolute growth rate (AGR), the dry matter production palnt^{-1} day^{-1} is a major contributor to plant growth like CGR. AGR mainly depend upon plant response to various factors such as planting dates. Early and normal seeded condition significantly enhanced the AGR values while late sowing decline the concern character of growth attributes. Another possible justification could be increase in CGR values which directly related with an increase in AGR values. Our results are in conformity with those of Ehsanullah *et al*., (1999) who also reported highest AGR at early and normal sowing. Judicious use of N- fertilizer is a key factor in the cereal based system of sustainable agriculture and may affect overall growth attributes and productivity. CGR of wheat crop has a significant relation with nitrogen fertilization because most plants were healthy and vigorous which may help the plants to absorb water and light more efficiently that may have resulted higher CGR. Similar observation was obtained by Alam & Haider (2006), Asif *et al*., (2010). Similarly AGR is significantly affected by an adequate supply of nitrogen which in turn influences photosynthetic activity and crop productivity .These findings are in line with Amanullah *et al*., (2010) who obtained that nitrogen application affects the AGR of maize and Nataraja *et al*., (2006) also confirmed the same results. Sampling intervals (T) play main role in the growth attributes including CGR and AGR. The crop may have minimum number of leaves per plant and tillers m^{-2} during early sampling intervals which produced low CGR as compared to later sampling intervals (Baghestani *et al*., 2006) .The crop become fully developed and in full bloom stage during the third month of sampling due to which higher AGR value were achieved. Temperature fluctuations during various growing may be the possible cause for changing CGR which turned higher AGR values in different sampling periods. The same findings were also recorded by Arif *et al*., (2010) in soybean. Significant relation among sowing dates and sampling periods (D x T) interaction were observed for CGR as well as AGR values. Temperature fluctuations during various sowing dates may be the possible cause for changing CGR and AGR values in different sampling periods. Interaction of nitrogen and sampling intervals (N x T) have significant association with the growth analysis because sufficient nutrients availability causes higher leaf area which resulted higher photosynthesis and dry matter accumulation at later period of growth which ultimately produce maximum CGR and AGR.

Seed development describes as a function of rate and duration of seed growth. It promotes remobilization of dry matter and restrained current photosynthesis (Ercoli *et al*., 2010). It is influenced by many environmental factors including sowing dates, water nitrogen application, light and temperature. More duration of grain filling during early sowing could increase fresh seed weight and short period of very high temperature severely affect the grain filling and yield (Reynolds *et al*., 2001). Reduce in fresh seed weight during late sowing may be in part attributable to low protein content due to greater metabolic activity (Finnie *et al*., 2002).This particular data thus fits well regarding Dokuyucu *et al*., (2004) who stated that sowing dates had significantly affect the grain filling and seed weight. High temperature stress at later growth stages primarily affects the grain size, development and composition (Dupont & Altenbach 2003). Increase in dry matter accumulation in the starchy endosperm of developing seed with passage of time decreases the moisture content (wet basis) of developing seeds and at this lowest moisture, the seed filling period is ended. A doughy consistency appeared in seed when its moisture content drops to about 30-35 %. Early sowing produces vigorous seeds having lower water content which strengthen the germination as it is cleared that the seed moisture content have an inverse relation with dry matter accumulation. Reduce growth rate of crop and dry matter accumulation in fresh seed under late sowing condition decline the fresh seed germination percentage. Similarly optimum temperature and photoperiod during seed development and maturation increases the fresh seed germination (Collinson *et al*., 1992). The literature proved that nitrogen playing main role in dry matter accumulation in the endosperm of seed by increasing grain filling duration. Singh & Wilkens (1999) studied that nitrogen stress shortens duration of grain filling. Similarly nitrogen application during early sowing substantially increased grain filling period which in turn more dry matter accumulation (Yang *et al*., 2000), while slower growth rate and forced maturity by increasing temperature might be the possible attributes noted under late seeded condition.

Conclusion

To summarize the overall results of this study it is generally concluded that early (Oct. 24th) and normal (Nov. 13th) seeding dates in combination with 130kg N ha^{-1} accelerated the growth attributes as well as seed developmental profile of Khyber-87 whereas late seeded condition declined the growth and seed developmental parameters even using maximum dose of nitrogen.

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