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GROWTH AND DEVELOPMENT PATTERN OF BARLEY VARIETIES AS INFLUENCED BY DATE OF SOWING AND NITROGEN LEVELS

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ABSTRACT

A field experiment was conducted at research farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during *rabi* season 2012-13. A set of 27 treatment combinations including three dates of sowing viz. 16th October (D_1), 15th November (D_2) and 15th December (D_3) in main plot, three varieties; PL 172, PL 426 and PL 807 in sub plot and three nitrogen levels; 75, 100 and 125 per cent of recommended dose of nitrogen (RDN 62.5 kg/ha) in sub-sub plot were evaluated. Treatments were replicated thrice as per split-split plot design. Crop sown on D_1 attained significantly higher (plant height, dry matter accumulation at harvest). Crop sown on D_3 attained significantly higher crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) at harvest. Varieties PL 807 performed better than all other varieties for growth parameters (plant height and dry matter accumulation) and growth pattern (CGR, RGR NAR). Application of 125 per cent of RDN resulted in improvement in most of the growth parameters (plant height, dry matter production and LAI) and growth pattern (CGR, RGR NAR). Crop sown on 16th October took more number of days from sowing to heading than other dates of sowing, thus it availed longest vegetative phase.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop of the world after wheat, rice and maize. Under North Indian conditions, it's recommended sowing time is from middle of October to middle of November (Anonymous, 2014). The differences in production of timely sown and late sown crops may be attributed to the unfavourable temperature prevailing at different growth stages, such as low temperature at the time of germination which may delay crop emergence. Low temperature may also slow down the growth and development of the crop, resulting in the accumulation of insufficient biomass and shortening of crop duration (Alam *et al.* 2006). Over the time, they also start behaving differently to the applied nutrients. It is hence, desirable that varieties should be evaluated for staggered sowing and variable nutrients. Different varieties have different yield potential requiring variable nitrogen dose. All the varieties may not be suitable for timely as well as the late sowing. Nitrogen is a constituent of amino acids, required for proteins synthesis and other related compounds; it plays a role in almost all plant metabolic processes. It is an integral part of chlorophyll responsible for plant food manufacturing through photosynthesis. So it induces rapid growth, increases leaf size and improves quality, promotes fruit and seed development (Yesmin *et al.,* 2014). The yield depends on reaction of different cultivars to environmental conditions such as planting date, cultivars, plant density, types of soil, fertilizer etc. (Soleymani *et al.,* 2011). Planting date and cultivar are of the agricultural factors which can be effective on enjoyment of the desirable factors and light energy absorbed by plant population and accumulation of dry matter. Growth analyses have been studied to investigate reaction of crops cultivars to environmental condition and improvement of economic performance (Dehghanzadeh *et al.,* 2007). Therefore, reaction of different barley cultivars to planting date is different based on change in crop growth rate, net assimilation rate and yield of their grain will be also different. CGR value as well as NAR increases due to increased number of leaves and large leaves and also increase of stems weight (in CGR) and then their rate will be reduced due to creation of shade on lower leaves and reduction of light abruption as well as senescence of leaves . Intensity of falling leaves and as a result, loss of weight will be different in different genotypes of barley (Sharifi *et al.,* 2011). Keeping these points in view, the present investigations were under taken.

MATERIALS AND METHODS

A field experiment was carried out at Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during *rabi* season of 2012-13 (30º54'N; 74º48'E and 247 meter above the mean sea level). A set of 27 treatment combinations including three dates of sowing *viz.* 16th October (D_1), 15th November (D_2) and 15th December (D_3) in main plot, three varieties; PL 172, PL 426 and PL 807 in sub plot and three nitrogen levels *viz.* 75, 100 and 125 per cent of recommended dose of nitrogen (RDN 62.5 kg/ha) in sub-sub plot were evaluated. Each treatment was replicated thrice in split-split plot design. Soil of the experimental field was loamy sand in texture, neutral in reaction (pH 7.8), free from salts (EC 0.29 dS/m), low in organic carbon (0.37%) & available nitrogen (130 kg/ha) but high in available phosphorus (28.7 kg/ha) and potassium (161 kg/ha). The crop was sown at 22.5 cm row spacing using 87.5 kg seed rate per hectare. Thirty kg P_2O_5 per hectare was drilled uniformly at the time of sowing. Periodic observations on plant height, LAI and dry matter accumulation were recorded at 30 days interval. Computations on the photosynthetic efficiency in terms of Crop Growth Rate (CGR), Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) during the growth periods of 0-30, 30-60, 60-90 days and 90-at harvest were made. For CGR, dry weights (W_1 and W_2) of aerial parts of plants at beginning and end of time intervals (t_1 and t_2) was calculated as per the procedure given by Radford (1967).

$$CGR = \frac{W_2 - W_1}{t_2 - t_1}$$

For RGR log values of the data were fitted in the formula

$$RGR = \frac{Log_e W_2 - Log_e W_1}{t_2 - t_1}$$

NAR was calculated with the formula:

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{Log_e L_2 - Log_e L_1}{L_2 - L_1}$$

Where, L_1 and L_2 are the areas of foliage at the beginning and end of time intervals, t_1 and t_2, respectively.

RESULTS AND DISCUSSION

Plant height

The plant height of 30 days old crop sown on 15th November was significantly higher than crop sown on other two dates. However, at 60 DAS differences in plant height under different dates of sowing were non-significant (Table 1). Ninety days after sowing plant height under 15th November became statistically at par with 15th December and was significantly higher than 16th October. However, plant height at harvest of 16th October sown crop was the highest which was statistically at par with 15th November but significantly higher than 15th December sown crop. Variety PL 426 attained the highest plant height 30 DAS, which was statistically at par with PL 172 but significantly higher than that of PL 807. However at the time of harvest PL 807 attained the highest plant height, which was statistically at par with PL 172 and both these varieties had significantly higher plant height than PL 426. Varietal differences for plants height were also reported by Sardana and Zhang (2004). Plant height was not influenced with nitrogen levels up to 30, 60 and 90 DAS. The highest plant height was attained with the application of 125 per cent of recommended dose of nitrogen (RDN) which was statistically at par with 100 per cent of recommended dose of nitrogen but was significantly higher than 75 per cent of RDN. Similar results were reported by Meena *et al.* (2013).

Dry matter production

Thirty and 60 DAS the highest dry matter was attained by 15th November sown crop which was statistically at par with crop sown on 16th October but it was significantly higher than crop sown on 15th December. Significantly lower dry matter production was recorded from crop sown on under 15th December at 30 and 60 DAS. However, dry matter production at 90 DAS was significantly higher under 15th December sown crop than 16th October and 15th November. The date of recording the observation on 90 days old crop coincided with heading stage under first date of sowing (16th October), early grain formation in second date of sowing (15th November) and dough stage by third date of sowing (15th December), which caused the 15th December sown crop to attain more dry matter (Table 3). At harvest the highest dry matter was attained in 16th October sown crop and lowest in 15th December sown crop. The highest dry matter accumulation under 16th October sown crop might be attributed to more plant height and leaf area index which might be ascribed to congenial climatic conditions during the growth stage of the crop (Table 1). Varieties differed significantly for dry matter production at 60, 90 DAS and at harvest. The data indicates that at 60 DAS, the variety PL 426 attained the highest dry matter production. The varieties PL 426 and PL 172

Table 1: Periodic plant height, dry matter production and leaf area index of barley varieties as affected by date of sowing and nitrogen level

Treatment	Plant height (cm)				Dry matter production (kg/ha)				Leaf Area Index (LAI)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At dough stage
Date of sowing												
October 16	23.1	39.7	66.8	95.4	315	2262	3295	11705	1.4	2.3	3.2	4.1
November 15	28.5	38.4	86.6	94.9	324	2373	4004	11410	1.5	2.6	4.3	4.7
December 15	13.0	36.6	85.2	88.7	256	2076	4611	9002	0.3	1.4	2.9	3.9
CD (P=0.05)	4.3	NS	6.5	3.2	33	202	145	249	0.06	0.18	0.23	0.14
Variety												
PL 172	21.6	37.5	80.3	93.8	297	2273	3861	10962	1.1	2.1	3.5	4.2
PL 426	23.6	39.8	79.4	90.8	291	2358	4112	9099	1.0	2.2	3.6	4.3
PL 807	19.5	37.3	78.9	94.1	306	2082	3926	12103	1.0	1.9	3.5	4.1
CD (P=0.05)	2.1	NS	NS	2.4	NS	135	151	565	NS	0.19	NS	NS
Nitrogen Level (% of recommended 62.5 kg/ha N)												
75	21.5	37.7	78.7	91.7	296	2145	3874	10160	1.0	2.0	3.4	4.1
100	21.0	38.2	79.7	93.0	291	2212	3973	10754	1.0	2.1	3.5	4.2
125	22.1	38.7	80.2	94.0	301	2354	4063	11231	1.1	2.1	3.6	4.4
CD (P=0.05)	NS	NS	NS	1.8	NS	120	118	524	NS	NS	NS	0.15

Table 2: Periodic crop growth rate, relative growth rate and net assimilation rate of barley varieties effect of dates of sowing and nitrogen levels

Treatment	Crop growth rate ($g/m^2/day$) Time intervals (days)				Relative growth rate (g/g/day)				Net assimilation rate ($g/m^2/day$)			
	0-30	30-60	60-90	90-At harvest	0-30	30-60	60-90	90-At harvest	0-30	30-60	60-90	90-At harvest
Date of sowing												
October 16	1.02	7.54	10.98	15.70	0.047	0.013	0.019	0.0088	0.063	0.015	0.10	0.080
November 15	1.10	7.91	13.35	21.68	0.051	0.014	0.020	0.0088	0.065	0.014	0.08	0.070
December 15	0.83	6.92	15.30	33.08	0.038	0.013	0.020	0.0089	0.150	0.017	0.18	0.12
CD (P=0.05)	0.13	0.69	0.49	1.17	0.006	NS	0.0001	0.00007	0.01	NS	0.03	0.021
Variety												
PL 172	0.98	7.58	12.89	23.58	0.046	0.013	0.019	0.0087	0.090	0.012	0.13	0.11
PL 426	0.99	7.86	13.73	20.54	0.045	0.013	0.020	0.0085	0.094	0.011	0.12	0.09
PL 807	0.98	6.93	13.09	26.34	0.046	0.014	0.020	0.0088	0.096	0.16	0.14	0.15
CD (P=0.05)	NS	0.43	0.50	1.09	NS	0.0003	0.0002	0.00006	NS	0.002	NS	0.013
Nitrogen Level (% of recommended 62.5 kg/ha N)												
75	0.97	7.15	12.89	22.32	0.045	0.013	0.019	0.0086	0.091	0.012	0.12	0.11
100	0.98	7.37	13.24	23.47	0.045	0.013	0.020	0.0087	0.092	0.013	0.12	0.11
125	1.00	0.85	13.54	24.67	0.046	0.014	0.021	0.0088	0.093	0.014	0.13	0.12
CD (P=0.05)	NS	0.40	0.39	1.00	NS	NS	NS	0.00005	NS	NS	NS	NS

Table 3: Days between phenophases of barley varieties as influenced by sowing dates

Date of sowing	16th October			15th November			15th December		
Variety	PL 172	PL 426	PL 807	PL 172	PL 426	PL 807	PL 172	PL 426	PL 807
Phenological stage	Days between phenophases								
Emergence to tillering	15	13	20	15	15	17	15	14	14
Tillering to jointing	22	23	20	21	20	20	28	30	30
Jointing to booting	31	26	44	23	24	31	11	10	14
Booting to heading	14	10	12	16	12	13	10	11	14
Heading to maturity	75	82	64	56	58	53	39	36	34
Vegetative phase	68	62	84	59	59	68	54	54	58
Reproductive phase	89	92	76	72	70	66	49	47	48
Total post emergence duration	157	154	160	131	129	134	103	101	106

accumulated significantly higher dry matter than PL 807. Ninety days after sowing, PL 426 attained significantly highest dry matter than PL 172 and PL 807 (both these varieties were statistically at par with one another). However, at harvest the highest dry matter production was attained by variety PL 807 and it was statistically at par with PL 172, but PL 426 had significantly lower dry matter production than PL 807 and PL 172. These results are supported by Sardana and Zhang (2004). It was observed that dry matter production increased with increment in N level from 75 to 125 per cent of recommended dose at all growth stages except 30 DAS. Application 125 per cent of RDN significantly increased dry matter production over the lower levels 60, 90 DAS and harvest. Sixty days after sowing, dry matter production with application of 125 per cent of RDN differed significantly from other N levels. However, the dry matter production was at par in case of 75 and 100 per cent of RDN. Ninety days after sowing and at harvest, dry matter production was highest with application of 125 per cent of RDN and which was statistically at par with application of 100 per cent of RDN. These findings confirm those of Pankaj *et al.* (2015).

Leaf Area Index

Date of sowing significantly influenced the crop growth which is evident from data on LAI (Table 1). Data indicate that crop sown on 15th November attained higher LAI than 16th October and lowest in 15th December throughout the crop season. Difference in LAI due to date of sowing which were large up to 90 DAS, narrowed down at dough stage. Marginal differences in LAI of the varieties were observed with PL 426 maintaining the highest LAI at all stages of observation. Differences turned out to be significant at 90 DAS only. Similar result was found by Jena *et al.* (2014).

Crop growth rate

Crop growth rate increased up to harvest under all dates of sowing (Table 2). A comparison of crop growth rate under various date of sowing indicate that higher in 15th November sown crop over the other date of sowing at 0-30 and 30-60 DAS. However, crop growth rate at 60-90 DAS and 90-at harvest of 16th October sown crop was the highest as compare to other date of sowing. Similar results were reported by Singh (2005). Among the varieties, PL 426 had obtained the higher values of crop growth rate up to 60-90 DAS and thereafter the other variety PL 807 exhibited the higher crop growth rate. These findings are close conformity with the results of Singh (2005). The highest crop growth rate was obtained with the application of 125 per cent of recommended dose of nitrogen (RDN) as compare to lower levels. Increase crop growth rate with increase of N levels. Similar result was found by Jena *et al.* (2014)

Relative growth rate

Relative growth rate followed the decreasing trend throughout the crop growth under all the treatments (Table 2). Relative growth rate did not follow any consistent pattern during the entire crop season under the influence of date of sowing. Similar results were reported by Singh (2005). Varieties followed a similar trend for relative growth rate as for crop growth rate up to 60 days of crop growth. Variety PL 807 obtained the higher relative growth rate up to at harvest as compare to other varieties. These findings are close conformity with the results of Singh (2005). The highest relative growth rate was obtained with the application of 125 per cent of RDN as compare to lower doses. Increase relative growth rate with increase of N levels.

Net assimilation rate

Net assimilation rate under various date of sowing indicate that higher in 15th December sown crop over the other date of sowing at all stages (Table 2). Among the varieties, PL 807 had obtained the higher values of net assimilation rate at all growth stages. The highest net assimilation rate was obtained with the application of 125 per cent of RDN as compare to lower levels. Increase net assimilation rate with increase of N levels. Similar result was found by Jena *et al.* (2014).

Crop development

Days between phenophases presented in Table 3 reveals that 16th October sown, variety PL 807 took maximum number of days (44) between jointing and boot stage whereas, PL 426 took minimum 26 days. Duration between jointing to booting stage was reduced in all the varieties with delay in sowing. The effect was more pronounced on the crop sown in 15th December. The interval between heading stage to maturity stage was from 64 and 82 days for variety PL 807 and PL 426 days, respectively in October sown crop which was reduced to 53 and 58 days for these varieties in November sown crop and 34 and 39 days in December sown crop, which clearly indicates that delayed sowing caused relatively more reduction in the reproductive phase. Similar result was noted by Sardana and Zhang (2004).

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