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Effect of Phyllochron On Leaf Emergence Stage In Barley, Wheat And Rye

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Abstract: To study determine the effect to temperature on leaf emergence rate and phyllochron in barely, wheat and rye genotypes. Experiments were conduct in field condition at different temperature. The leaf emergence rate increased with increasing temperature until an optimum temperature was reached and there after declined with further increase in temperature for most of the genotypes except to K-179 barely. These genotypic differences in sensitivity phyllochron to temperature may be in important aspect of modeling phyllochron in barley, wheat and rye was found to be liner. The relationship of phyllochron to growing degree days for all the genotypes of barley, wheat and rye has been analyzed and it was found to be linear.

Key words: Phyllochron, growing degree days (GDD), leaf emergence rates, barley, wheat and rye

INTRODUCTION

The phyllochron was defined as the interval between similar growth stages of successive leaves on the same culms (Wilhelm and Mc Master, 1995). It has been used extensively to describe and understand development of grasses. The environment and genetic factor have great impact on the relationship between leaf appearance and whole plant development. The phyllochron is a measure of rate of development of plant leaves (Frank and Beuer, 1995).Knowledge of the phyllochron of a crop species in useful in formulating simulation models and of tracking plant development to determine when to apply management practices that depend on crop development stage. Temperature and day length are two major environment factors that differ among planting dates and latitudes. The phyllochron of plants is strongly related to air temperature (Klepper *et al*., 1982; Bauer *et al*., 1984; Rickman and Klepper, 1981). Other environment factors such as day length, water, carbohydrate reserves and nutrient stress have also been shown little effect on phyllochron of grasses (Kiniry *et al*., 1991). However, severe water stress decrease the phyllochron (Cutforth *et al*., 1992) and sever N (Longanecker *et al*., 1993) stress decrease rate of leaf emergence in spring wheat. Plant genetics has a role in determining, the phyllochron, but detailed evaluation of genetic effects has not been reported. The two major components that characterize plant development are the number of leaves on the plant and the GDD needed for a leaf to fully develop. These two components are necessary for developing models to aid in making management decisions. The plant phyllochron or number of GDD between a leaf number an n and n+ 1 result from a combination of genetic and environmental factors that interest to produce plant leaves in an orderly and predicable manner. Keeping these facts in view, this study was designed to determine the effect of temperature on leaf emergence and phyllochron barley, wheat and rye.

MATERIAL AND METHODS

The true breeding induced mutant of barely along with their parental controls and wheat and rye were used in the present study. All the materials were planted in a prepared plot at the research farm of the department of Genetics and Plant Breeding, C.C.S. University at Meerut. The materials were studied at various stages starting by from seedling stage to maturity during 2010-2011.A randomized block design was used in experiment, with fifteen genotypes, including twelve genotypes of barley mutant, two genotypes of wheat and one genotype of rye per block and three replications. One replication for each genotype was one plot with four seed lines. Observations were made daily on the leaf number per culm in "Haun unit "a quantitative scale for described the growth of barely leaves in which the leaf stage is measured as the number of fully expanded leaves plus the ratio of the laminar length of the last visible growing leaf to that of the preceding leaf (Haun 1973). Data were collected on various aspect of the study as the time of appearance of successive leaves on clum.Measurement of the growth of an individual leaf and the time taken for its complete development etc.

The phyllocron was determined as per Haun (1973) which is given below-

Haun stage = [Ln /Ln-1)]+ (n-1)

Where Ln = the length of the youngest leaf blades above the collar of the

subtenty leaf.

L (n-1) = the length of the blade of the subtending leaf.

N = the total number of leaves that are bible on the culm.

Daily growing degree- days GDD were calculate as-

GDD = [(T max +T min)/2} –Tb.

Where T max and T min, are maximum and minimum temperatures and Tb minimum temperature at which growth ceases (the base temperature). Extrapolation of our data suggested a base temperature of 0.02^0C for barley, wheat and rye. This agreed closely with the suggestion of 0^0C by Gallagher (1979), Beaker *et al*., (1980) and Beaker *et al*., (1986) and we used 0^0C to calculate degree days. Growing Degree days were accumulated from seedling emergence.

RESULTS AND DISCUSSION

A study of phyllochron in some cultivars and mutants of barley, wheat and rye was made on three different dates following Haun, (1973) and the data are presented in table 1. Among the three dates (18^{th} of January, February and March) on which phyllochron activity was measured i.e. at 20 days after sowing DAS), 51 DAS and 79 DAS, the phyllochron activity was maximum at 79 DAS in all the materials studied Table 1. All the mutant of K-169 showed increased activity of the phyllochron over that of control at 20 DAS i.e. at the early stages of growth. However, as growth advanced the phyllochron values in the mutant decreased in comparison to control. In case of DL-281, the semi-dwarf mutant recorded increased phyllochron activity at 20 DAS and 51 DAS stages over that of control. However, at 79 DAS the reverse trend was noticed with tall mutant recording increased phyllochron and semi-dwarf mutant showing reduced phyllochron over their parental **Table** 1. Marked differences in phyllochron activity have also been noticed among the different varieties/ genotypes of barley, wheat and rye studied here. Among the various genotypes analyzed here maximum phyllochron value was recorded for K-169 control while lowest values were for PBW-343 (wheat) at 79 DAS **Table1**.

The growing degree days (GDD) per leaf determined for different genotypes of barely, wheat and rye are presented in **Table 2**. All the genotypes showed similar response for leaf emergence. The values of GDD per leaf showed a steady increase as the leaf emergence progressed from leaf through the last leaf. The GDD for the flag leaf are the maximum while that of the basal leaf (first leaf) are maximum in **Table 2**.

The response of leaf emergence rate to temperature has been analyzed for K-169 control and its dwarf mutant of barely and also for two wheat genotypes namely Kalyan sona and PBW-435. The leaf emergence rate increased with increasing temperature until an optimum temperature was reached and there after declined with further increase in temperature for the K-169 control of barley and two wheat genotypes. However, the dwarf mutant of barley exhibited a perfect linear relationship of increasing leaf emergence rate with increase in temperature. The R2 values for the leaf emergence rate to temperature foe all the genotypes analyzed were high (<0.72). The phyllochron increased with increasing temperature. The relationship of phyllochron to GDD for all the 15 different genotypes of barley, wheat and rye has been analyzed and it was found to be linear.

The rate of appearance and expansion of leaves is the basis for determining the phyllochron and has been reported to be influenced by the environment and genotype. However, Klepper *et al*., (1982) concluded that the phyllochron of winter wheat is the same in any given environment. Mc master *et al*., (1992) also did not find difference in the phyllochron among 10 cultivars of winter wheat or between maturity classes. On the other hand, several others have reported that leaf emergence rate wheat cultivars; (Syme., 1974 Baker *et al*., 1980; Kirby *et al*., 1985; Kirby and Perry, 1987; Cao and Mass, 1989; and Cutforth *et al*., 1992;) and sowing dates differed (Baker and Gallagher, 1983; Kirby and Perry, 1987; Cao and Mass, 1991). The results of the present study also support the above view with marked differences in phyllochron values among the different genotypes of barley, wheat and rye.

A steady increase in leaf emergence from first leaf through the last leaf was noticed with flag leaf exhibiting maximum value for GDD while that of the basal leaf, the minimum. A linear relationship between leaf emergence rates with increasing temperature was recorded until an optimum temperature was reached but thereafter a decline with further increase in temperature. This observation was recorded for barley cv. K-169 and two genotypes of wheat. However, the dwarf mutant of barely exhibited a perfect linear relationship of increasing leaf emergence rate with increase in temperature thereby indicating genotypes. These genotypic differences in sensitivity of phyllochron to temperature may be an important aspect of modeling phyllochron in barley and wheat. Similar observations on leaf emergence rate were also made by Tollenaar *et al*., (1979) and Warrington *et al*., (1983) in maize.

A linear relationship of phyllochron to GDD for all the 15 different genotypes of barley, wheat and rye studied reveal that our results are similar to those of Franke and Bouer, (1995).

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Table 1: Data on phyllochron in some cultivars and mutants of barley, wheat and rye on three different dates.

S.No	Genotypes	Phyllochron at three different dates		
		20 DAS*	51 DAS*	79 DAS*
		18-1-09	18-2-09	18-3-09
1.	K-169 Control (barley)	3.403	7.462	7.910
2.	K-169 Semi-dwarf mutant	3.491	7.458	7.795
3.	K-169 Dwarf mutant	3.464	7.313	7.610
4.	K-169 Semi-dwarf early maturing mutant	3.644	7.332	7.671
5.	K-169 Early maturing mutant	3.690	6.950	7.740
6.	K-169 Lax spike mutant	3.439	6.606	7.720
7.	K-169 Chlorina mutant	3.422	6.790	7.685
8.	DL-281 Control	3.547	7.042	7.550
9.	DL-281 Semi-dwarf mutant	3.667	7.201	7.224
10.	DL-281 Tall mutant	3.531	6.862	7.659
11.	EC-312424 (Barley)	3.397	6.868	7.662
12.	EC-312425(Barley)	3.345	6.842	7.679
13.	Kalyann sona (Wheat)	3.415	6.611	6.896
14.	PBW-435 (Wheat)	3.520	6.557	6.786
15.	Rye	3.643	6.472	7.673

*DAS = Days after sowing

Table-2.Growing degree-days (GDD), per leaf for Barley, Wheat and Rye genotypes.

S.No	Genotypes	Leaf Number							
		1	2	3	4	5	6	7	8
1.	K-169 Control (barley)	10.50±0	12.50±0.00	14.45±0.67	14.52±0.67	12.70±0.12	12.95±0.45	14.60±0.60	16.30±0.46
2.	K-169 Semi-dwarf mutant	10.5±0	12.60±0.03	12.35±0.93	14.65±0.15	12.65±00.3	13.05±0.21	13.30±0.36	17.95±2.66
3.	K-169 Dwarf mutant	10.5±0	13.05±0.25	15.35±0.58	14.61±1.15	14.50±0.44	13.55±0.53	13.53±0.53	23.20±0.59
4.	K-169 Semi-dwarf early maturing mutant	10.5±0	13.30±0.13	13.85±0.38	14.40±0.50	13.05±0.36	12.95±0.20	13.30±1.45	18.50±0.82
5.	K-169 Early maturing mutant	10.5±0	12.75±0.17	14.35±0.55	13.75 ±.08	13.25±0.61	13.75±0.21	15.05±0.48	19.35±0.58
6.	K-169 Lax spike mutant	10.5±0	12.50±0.00	14.15±1.70	14.50±0.50	13.20±0.37	13.25±0.52	14.55±0.61	20.65±0.67
7.	K-169 Chlorina mutant	10.5±0	12.45±0.18	13.30±1.33	13.50.0.23	13.65±0.29	13.60±0.31	13.70±0.57	21.40±0.32
8.	DL-281 Control	10.5±0	12.55±0.08	14.30±0.32	15.45±0.60	13.60±0.21	14.25±0.64	14.63±0.40	16.50±0.00
9.	DL-281 Semi-dwarf mutant	10.5±0	12.75±0.08	13.55±0.15	13.85±0.18	14.15±0.14	14.10±0.27	17.05±0.29	16.20±0.10
10.	DL-281 Tall mutant	10.5±0	12.50±0.00	13.20±0.08	14.35±0.10	14.10±0.18	14.15±0.10	14.25±0.13	17.75±0.11
11.	EC-312424 (Barley)	10.5±0	12.70±0.10	13.25±0.08	13.0±0.10	13.15±0.27	13.95±0.21	13.95±0.21	17.85±0.07
12.	EC-312425(Barley)	10.5±0	12.70±0.10	13.45±0.13	14.20±0.50	13.45±0.50	13.45±0.20	13.95±0.17	15.85±0.79
13.	Kalyann sona (Wheat)	10.5±0	12.50±0.00	13.45±0.17	14.70±0.32	14.15±0.20	14.55±0.47	14.65±0.58	17.50±0.92
14.	PBW-435 (Wheat)	10.5±0	11.15±1.13	13.35±0.07	16.25±0.55	13.50±0.15	14.30±0.45	14.00±0.34	20.25±0.48
15.	Rye	10.5±0	12.50±0.00	12.80±0.63	12.50±0.63	13.65±1.15	12.50±0.16	13.00±0.74	14.10±3.58

Table-3. Data on emergence of different leaves in a tiller in different genotypes of Barley, Wheat and Rye.

S.No	Genotypes	Emergence of different leaves on the main stem (in no. of days after sowing)							
		1	2	3	4	5	6	7	8
1.	K-169 Control (barley)	8	15	21	27	33	38	46	56
2.	K-169 Semi-dwarf mutant	9	16	22	28	33	39	47	58
3.	K-169 Dwarf mutant	8	15	21	30	33	41	51	61
4.	K-169 Semi-dwarf early maturing mutant	9	16	23	29	34	41	47	56
5.	K-169 Early maturing mutant	7	19	22	28	33	40	46	55
6.	K-169 Lax spike mutant	9	16	21	28	34	40	46	51
7.	K-169 Chlorina mutant	8	15	23	30	36	34	50	61
8.	DL-281 Control	9	15	20	24	29	35	42	57
9.	DL-281 Semi-dwarf mutant	9	15	29	23	28	33	43	58
10.	DL-281 Tall mutant	8	15	22	28	32	38	45	60
11.	EC-312424 (Barley)	8	15	21	28	33	37	46	62
12.	EC-312425(Barley)	8	14	21	25	34	38	45	58
13.	Kalyann sona (Wheat)	8	14	18	23	30	42	52	56
14.	PBW-435 (Wheat)	7	15	22	16	32	38	54	59
15.	Rye	9	14	18	24	29	40	52	63