International Journal of Agriculture, Environment and Biotechnology
Citation: IJAEB: 9(5): 827-831, October 2016
DOI: 10.5958/2230-732X.2016.00106.6

AGRONOMY

Study on leaf area index and leaf area duration of growth analytical parameters in Wheat, Barley, and Oat

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Paper No. 509 Received: 14-3-2016 Accepted: 18-9-2016

Abstract

An experiment were conducted in *rabi* season during 2012-2013 and 2013-2014 to find out the effect of cereal crops (Wheat, Oat, Barley) and cutting schedule on forage and grain yield. The study revealed the maximum chlorophyll accumulation in Barley and wheat during the initial stage at 95 DAS and wheat and barley during the reproductive stage at 30 DAS. Cutting at 50 DAS is proved beneficial on chlorophyll accumulation. Photosynthetic rate was maximum in wheat at 90 DAS. However cutting did not affect photosynthesis rate stomatal conductance and transpiration rate. Barley gave maximum fodder yield (fresh/day). Cutting at 50 DAS was beneficial in producing maximum forage yield without sacrificing grain yield of cereal crops.

Highlight

- Barely recorded the average maximum LAI and LAD in crops whereas cutting at 50 DAS among cutting management systems found maximum LAI and LAD.

Keywords: Wheat, Oat, Barleyleaf area index and leaf area duration

Wheat (*Triticumaestivum*), Oat (*Avena sativa L.*) and Barley (*Hordeumvulgare L.*) are the cereal crops of the world in general and India in particular. India ranks second in wheat, fifth in oat, fourth in barley. Wheat is the most important staple food grain in India (70 million tons per year). Owing to versatile ecological adaptability barley is the second largest producing crop cereal crop of the winter season in India. Oat is mainly used such a fodder crop in the world as compared to food grain crop. In the recent years, it has been observed that because of severe drought in the drier of northern plains (Rajasthan, Southern Haryana, Western U.P. and Madhya Pradesh), there is an acute shortage of green fodder in the months of November to January. Barley can be utilize as a source of green fodder under such situations. The crop can be given one cut at definite time after sowing for green fodder and regeneration crop may be utilized for grain purpose. Oats (*Avena sativa* L.) rank fifth in terms of regarding wordiness production of cereals.

They are also widely used as a companion crop for under-seeding of forage legumes The average green yield of local cultivars (tall with very narrow leaves and thin stems, hence, not responsive to nitrogenous fertilizers due to lodging) under rainfed conditions is 20 tons/ha , which is very low and insufficient to provide even maintenance rations for the numbers of live stock kept. In winter farmers have only dried summer grass or dry stalks of summer cereals to supplement the small amount of forage grown and have to purchase costly fodder transported in large quantities from distant irrigated tracts.

In contrast to local landraces, improved oats grow very fast, can be cut earlier and have considerable potential to provide feed during deficit periods and low temperatures. Generally, Farmers harvest these fodders at 50 percent flowering, or at a later stage to get maximum green yield with a consequent loss in quality.

The productivity of a crop stand depends on its capacity of photosynthesis, photosynthetic area and the utilization of photosynthetic active radiation within the crop canopy. In graminaceous crops, the grain yield is a product of grain weight per ear and number of ear per unit area.

Chlorophyll is vital for photosynthesis, which allows plants to absorb energy from light. Chlorophyll content is an index of organic matter production and plant growth. The increased photosynthesis has linked to increased chlorophyll content in plants. As a result, chlorophyll content is a measurement of physiological activities in plants. *Abiotic* stress is major factor around the world in limiting plant growth and productivity. Exposure of plants to a stressful environment during various developmental stages appears to induce various physiological and developmental changes.

Indian dairy industry is facing a lot of shortage of green forage during winter and summer seasons especially in terms of cereal forage. Hence the present experiment was conducted to find out suitable cereal crop for *rabi* season by cutting existing crop once and then crop grown for food grain production without reducing food grain productivity. Physiological traits like chlorophyll index, photosynthetic rate, stomatal conductance and transpiration rate were used as parameters to judge the suitability of cereal crops for fodder and grain production with reference to central India.

Materils and Methods

The present investigation was carried out at the experimental field of All India Co-ordinated Research Project on forage crops, Live Stock Farm, Department of Agronomy, College of Agriculture, JNKVV, Jabalpur (M.P.) during the *rabi* season 2012-13 in a Spilt Plot Design (SPD), replicated thrice.The experimental material consisted of 3 cereal crops *viz.;* (VL829), Oat (RD2552), Barley (JO1) as main plot treatments and 4 cutting dates *i.e.* no cutting wheat, single cutting at 50 days after sowing (DAS), single cutting 60 (DAS) and single cutting at 70 (DAS) respectively as sub -plot treatment. Growth parameters studied were leaf area index (LAI) at 45, 60, 75, 90 and 105 DAS), and leaf area duration at 45, 60, 75, 90 and 105 DAS), the leaf area index was determined as per specifications of Gardner *et al*. (1985)and LAD expresses the magnitude and persistence of leaf area of leafiness during the period of crop growth. It reflects the extent or seasonal integral of light interception and correlates with yield. Fischer's method of analysis of variance was applied for the analysis of the data and interperation of results as suggested by Panse and Sukhatme (1967). The level of significance used in F and t test was P=0.05 critical difference (CD) values were calculated at 5 per cent probability level, wherever F test was significant.

Results and Discussion

Leaf area index

The results that barely (0.78) had the significant maximum LAI. Main treatments oat (0.50) showed the significant minimum. Among sub treatment C_3 (0.68) significant superseded other sub treatment for the same trait C_1 had the lowest (0.56). In interaction, BC_3 (0.87) and BC_4 (0.81) registered significant more LAI over rest of the interaction. The significant lowest was recorded in OC_1 (0.42) at the 45 days and at 60 days the result showed that barely showed that barely (0.80) significantly dominated other for LAI. Oat registered the lowest (0.76) magnitude among main treatment. Among sub treatment C_1 (0.80) and C_2 (0.77) though were at par between them but significant supersede other sub treatment for LAI C_3 indicated the lowest (0.75) LAI. In interaction, BC_1 (0.83) showed significant higher LIE over rest of the interaction. WC_4 (0.71) was associated with the lowest magnitude for this character.

The result expressed at 75 days that barley (3.11) had the significant maximum LAI. Wheat (2.49) showed the significant minimum LAI among main treatments. Among sub treatment, C_1 (2.96) superseded other sub treatment for the same trait. The lowest magnitude was noted in C_2 (2.45).In interaction, BC_1 (3.18) and BC_2 (3.14) registered significant more LAI over rest of the interaction. The lowest LAI was recorded in WC_2 (2.13) andat 90 days that the oat (2.54) significant dominated

Table 1: Leaf area index of various treatments and interactions at different growth periods

Main Treatments	45 Das	60 Das	75 Das	90 Das	105 Das	Average
W	0.54	0.76	2.49	2.02	1.11	1.38
O	0.50	0.76	2.95	2.54	1.21	1.59
B	0.78	0.80	3.11	2.23	1.25	1.63
Sem ±	0.01	0.01	0.03	0.06	0.01	0.02
C.D.5%	0.02	0.02	0.09	0.24	0.04	0.08
Sub-treatments						
C_1	0.56	0.80	2.96	2.37	1.15	1.57
C_2	0.59	0.77	2.75	2.26	1.22	1.52
C_3	0.68	0.75	2.77	2.18	1.18	1.51
C_4	0.61	0.76	2.85	2.31	1.19	1.54
Sem ±	0.03	0.01	0.05	0.08	0.03	0.04
C.D.5%	0.06	0.04	0.19	0.10	0.06	0.09
Interactions						
WC_1	0.53	0.79	2.67	2.27	1.12	1.48
WC_2	0.56	0.79	2.13	1.90	1.13	1.30
WC_3	0.60	0.74	2.31	1.87	1.06	1.32
WC_4	0.48	0.71	2.63	2.26	1.12	1.44
OC_1	0.42	0.79	3.04	2.53	1.10	1.58
OC_2	0.48	0.73	2.98	2.60	1.28	1.61
OC_3	0.57	0.74	2.95	2.52	1.25	1.60
OC_4	0.54	0.77	2.82	2.51	1.22	1.57
BC_1	0.72	0.83	3.18	2.31	1.24	1.65
BC_2	0.74	0.79	3.14	2.29	1.27	1.65
BC_3	0.87	0.78	3.05	2.17	1.25	1.62
BC_4	0.81	0.79	3.08	2.17	1.22	1.62
Sem ±	0.02	0.01	0.05	0.07	0.03	0.04
C.D.5%	0.05	0.03	0.10	0.08	0.07	0.07

Table 2: Leaf area duration (cm^2 days) in different and interactions at successive growth intervals

Main Treatments	45 Das	60 Das	75 Das	90 Das	105 Das	Average
W	576.77	1070.35	2659.72	1967.23	737.95	1402.40
O	609.54	1118.13	2970.75	2212.38	738.66	1529.89
B	708.80	1194.97	3587.47	2370.75	813.74	1735.14
Sem ±	7.35	28.70	40.70	55.08	3.61	27.09
C.D.5%	22.71	26.06	137.77	205.60	11.67	80.76
Sub-treatments						
C_1	598.40	1159.00	3230.41	2284.14	799.92	1614.37
C_2	632.34	1142.17	2963.29	2154.03	765.75	1531.52
C_3	678.79	1087.00	2976.21	2089.85	736.34	1513.64
C_4	617.28	1123.09	3120.67	2205.81	751.78	1563.73

Sem ±	21.18	47.51	102.44	73.47	15.65	52.05
C.D.5%	48.11	53.26	233.73	124.37	36.03	99.10
			Interactions			
WC_1	571.74	1082.50	2907.88	2143.65	781.25	1497.40
WC_2	616.79	1081.84	2313.88	1788.51	771.56	1314.51
WC_3	617.61	1049.21	2486.75	1814.68	704.83	1334.61
WC_4	500.95	1067.84	2930.38	2122.10	694.15	1463.08
OC_1	567.80	1137.36	3030.38	2229.89	772.92	1547.67
OC_2	602.22	1147.24	2981.00	2263.81	722.13	1543.28
OC_3	638.69	1029.96	2979.13	2157.19	703.68	1501.73
OC_4	629.46	1157.95	2892.50	2198.64	755.93	1526.90
BC_1	655.65	1257.13	3752.99	2478.88	845.59	1798.04
BC_2	678.02	1197.44	3595.00	2409.76	803.58	1736.76
BC_3	780.08	1181.84	3462.75	2297.69	800.51	1704.57
BC_4	721.43	1143.48	3539.13	2296.69	805.28	1701.20
Sem ±	18.35	41.15	88.71	63.63	13.55	45.08
C.D.5%	40.85	NS	198.47	105.61	30.60	93.88

other for LAI. Wheat registered the lowest (2.02) magnitude among main treatments. Among sub treatment C_1 (2.37) and C_4 (2.31) through were at par between them but significant superseded other sub treatment for LAI. C_3 indicated lowest (2.18). In interaction, OC_2 (2.60) had significant more LAI over rest of the interaction. Though OC_1 (2.53) lagged behind the former but showed significant superiority over rest of the interaction except OC_3 which was at par. The lowest value (1.87) was noted in WC_3.

The result revealed that the barely (1.25) possessed the higher LAI over rest of the main treatment. Wheat registered the lowest (1.11). Among sub treatment C_2 (1.22) supersede other sub treatment for the same trait. The lowest magnitude was noted in C_1 (1.15). In interaction, OC_2 (1.28) had significant more LAI over rest of the interactions. Though BC_2 (1.27) lagged behind the former but showed significant supersede over rest of the interactions except OC_3 and BC_3 which were at par, WC_3 had the lowest (1.06) at the 105 days.

Leaf area duration

The result exhibited that the barely (708.80) and wheat 576.77 possessed the maximum and minimum values for LAD. Among sub treatments C_3 (678.79) and C_2 (632.34) possessed higher LAD over other sub treatment. C_1 (598.40) recorded the lowest value for this character though was at par with C_2. In interaction, BC_3 (780.08) and BC_4 (721.43) registered significant more biological yield over rest of interactions. The lowest value was recorded in WC_4 (500.95) at 45 days and the result indicated at 60 days that the barely (1194.97) wheat (1070.35) had significant maximum and minimum values for LAD. Among sub treatment C_1 (1159.00) supersede other sub treatment for the same character. The lowest magnitude was noted in C_3 (1087.00). In interaction BC_1 (1257.13) and OC_1 (1029.96) possessed the maximum and minimum values for LAD.

At 75 DAS result showed that the barely crop (3587.47) significant supersede others for LAD wheat registered the lowest (2659.72). Among sub treatment C_1 (3230.41) and C_4 (3120.67) though were at par between them but significant supersede other sub treatment for LAD. C_2 indicated the lowest (2963.29) LAD. In interaction, BC_1 (3752.99) had significant more LAI over rest of the interaction. The lowest value (2313.88) was noted in WC_2 and at 90, days result revealed that barely (2370.75) possessed the higher LAD over rest of the main treatment. Wheat registered the significant lowest (1967.23) magnitude. Among sub treatment, C_1 (2284.14) and C_4 (2205.81) indicated highest LAD through they were at par between them C_3 (2689.85) indicated

the lowest. In interaction BC_1 (2478.88) at par with BC_2 (2409.76) had significant more LAD other rest of the interaction. The value was found in WC (1788.51) and at 105 days result showed that the barely (813.74) dominated others for LAD. Wheat registered the lowest (737.95) magnitude among main treatments. Among sub-treatment, C_1 (799.92) superseded other sub-treatment for the same trait. The lowest magnitude was noted in WC_4 (964.15). In interaction, BC_1 (845.59) registered significant more LAD over rest of the interactions. The lowest value (694.15) was recorded in WC_4.

The present study showed that the LAD was found to increase in magnitudes in all treatments and interactions with the attainment of age till 75 DAS, afterwards it reduced in subsequent growth period which was due to reduction in the magnitude of LAI as a result of drying and senescence of leaf foliage and transport of food material from the source to the utilization sinks. Among main treatments Barley recorded an average higher (1735.14) LAD followed by oat (1529.89). On the other hand C_1 (1614.37) in sub treatments and treatment combinations of barley with all sub treatments recorded the highest magnitudes for this trait.

Conclusion

The leaf area index (LAI) had an increasing trend with the advancement of crop age till 75 DAS in all treatment and interactions, after that, it declined during the successive growth period. Barely recorded the average maximum (0.63) LAI in crops whereas C_1 (1.57) among cutting management systems and OC_3 (1.60), BC_1 and BC_2 (1.65) in interactions recorded an average higher performance for LAI, respectively.

LAD in treatments and interactions was found to be enhanced with the progressive increase in life span of crop, attaining the peak at 75 DAS, afterwards it decreased in remaining phase of growth. Barley recorded an average higher (1735.14 cm^2 days) LAD followed by Oat (1529.89 cm^2 days). On the other hand C_1 (1614.37 cm^2 days) in sub treatments and combinations of Barely with all sub-treatments recorded the higher magnitudes for this character.

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