

Study on Crop Growth Rate and Relative Growth Rate of Growth Analytical Parameters in Wheat, Barley and Oat

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ABSTRACT

An experiment was 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 initial stage at 95 DAS and wheat and barley during reproductive stage at 30 DAS. Cutting at 50 DAS is proved beneficial on chlorophyll accumulation. Photosynthetic rate were 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 fodder yield without sacrificing grain yield of cereal crops.

Keywords

Wheat, Oat, Barle
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leaf area duration.

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Introduction

Wheat (*Triticum aestivum*), Oat (*Avena sativa* L.) and Barley (*Hordeum vulgare* 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 varentizle ecological adaptability barley is the second largest producing crop cereal crop of winter season in India. Oat is mainly used as fodder crop in the world with legume fodder 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 utilized 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 (Dost, 1997) in terms of world 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

rain fed conditions is 20 tons/ha, which is very low and insufficient to provide even maintenance rations for the numbers of livestock 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 been linked to increased chlorophyll content in plants. As a result, chlorophyll content is a measurement of physiological activities in plants. *Abiotic* stress is a 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.

Materials 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 Split 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 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 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

Crop growth rate (CGR)

The results showed that the Barely (0.0002667) dominated others crops for CGR. Oat registered the lowest (0.0001633)

magnitude for this trait and in sub treatments C_1 (0.00027) significant superseded others for CGR. The significant lowest magnitude was noted in C_4 (0.00018). In interactions, BC_1 (0.00031) at par with WC_1 (0.0028) had significant more CGR over rest of the interactions. The lowest value (0.00011) was recorded in OC_4 . At 40 days. The study revealed that Barely (0.00057) dominated others crops for CGR Oat registered the lowest (0.00032) magnitude for this trait at 60 days and also sub treatments, C_1 (0.00049) significant superseded others for CGR. The significant lowest magnitude was noted in C_4 (0.00039). In interactions BC_1 (0.00028) possessed the significant maximum and minimum values for this character at 60 days. At the 75 days result of the study showed that Barely (0.0015) significantly dominated others crops for CGR Oat registered the lowest (0.00091). And in sub treatments, C_1 (0.0012) and C_4 (0.0010) possessed the significant maximum values for this character and in interaction, BC_1 (0.0012) and BC_2 (0.0014) registered significant more CGR over rest of the interactions. The lowest value was noted in OC_4 (0.00085). The results revealed that at 90 days Barely crop (0.00033) dominated others crops for CGR. Oat registered the lowest (0.00020) magnitude for this trait. Among sub treatments, C_1 (0.00031) and C_4 (0.00021) possessed and C_4 (0.00021) possessed the significant maximum and minimum values for this character. In interactions, BC_1 (0.00040) at par with BC_2 (0.00036) had significant more CGR over rest of the interactions. The lowest value (0.00016) was found in OC_4 . The result revealed that Barely (0.00017) significant dominated over rest for CGR. Oat registered the lowest (0.00096). Among sub treatments C_1 (0.00016) and C_4 (0.00010) possessed the significant maximum and minimum values for this character. In interactions, BC_1 (0.00020) and maximum and minimum values for CGR at 105 days (Table 1).

CGR (pooled)

The results pertaining to the study of crop growth rate indicated significant difference among main treatments at 45, 60, 75, 90, and 105 DAS and average and interactions at 45, 60, 75 and 90 DAS and average and interactions at 45, 60, 90, and 105 DAS and average. However in remaining period the treatments and interactions did not differ significant pooled analysis and at 45 DAS the results showed that wheat (0.0003) dominated others crops for CGR. Oat registered the lowest (0.0002) magnitude for this character. Among sub treatment, C_1 (0.0067) superseded others sub treatments for the same character C_4 registered the lowest value. In interaction WC_1 (0.003) and WC_2 (0.000.) registered significant more CGR over rest of the interactions. The lowest CGR was recorded on OC_4 (0.001) and result on pooled at 60 DAS revealed that Barely crop (0.0006) possessed significant higher CGR over rest of the crops. Oat registered the lowest (0.0003). Among sub treatments, C_1 (0.0005) superseded others sub treatments for CGR. The lowest value (0.0004) was found in C_4 . In interactions, BC_1 (0.0006) had significant more CGR over rest of the interactions. Though BC_2 (0.0006) lagged behind the former but showed significant superiority over rest of the interactions except WC_1 and BC_4 . The lowest value (0.0003) was found in OC_3 and at 75 DAS the study showed that Barely crop (0.0015) significant dominated lowest (0.0009) magnitude for this character. Among sub treatments, C_1 (0.0012) and C_2 (0.0012) possessed higher CGR over others sub treatments. C_4 (0.0011) recorded the lowest value for this character though was at par with C_3 . In sub treatment, BC_1 (0.0016) and BC_2 (0.0015) registered significant more CGR over rest of the interactions. The lowest value was recorded in OC_2 (0.0009) and at 90 DAS the results exhibited that wheat (0.0003) had the highest CGR over rest of the main

treatments. Oat noted the significant lowest (0.0002) among sub treatments, C₁ (0.0003) superseded others sub treatments for the same character. The lowest magnitude was noted in C₄ (0.0002). In interactions, BC₁ (0.0004) at par with BC₂ (0.0004) had significant more CGR over rest of the interactions. The lowest value (0.0002) was found in OC₂ and at 105 DAS the results revealed that Barely (0.0002) significant other crop for CGR. Oat registered the lowest value (0.0001). Among sub treatments, C₁ (0.0002) significantly superseded other sub treatment for the same trait. C₄ had the lowest (0.0001). In interactions, (0.0006) and OC₃ (0.0003) maximum and minimum values for this character (Table 1).

Relative growth rate (g/g/day)

The results pertaining to the study RGR indicated significant differences among main and Sub treatments. Interaction, during 90-105 DAS for both the years were not significant. The results showed that Oat (0.0320) significantly dominated over others for RGR. Wheat registered the lowest (.0083) magnitude. Among sub treatments C₃ (0.0325) among main treatments superseded other sub treatments for RGR. The significant lowest magnitude was noted in C₄ (0.009). In interactions of WC₄ (.0038) and OC₃ (0.0038) registered significant more RGR over rest of the interactions. The lowest RGR was recorded in WC₃ (0.0038) at 45 DAS and at 60 DAS investigations revealed showed (Table 2) that crop Wheat indicated significant highest (0.0116) and Oat significant lowest (0.0032) RGR among main treatments. Among sub treatments C₁ (0.0088) significantly superseded other sub treatments for RGR. C₄ had the significant lowest (0.0026) RGR. In interactions WC₃ (0.0186) and WC₁ (0.0161) had significant more RGR over rest of the interactions. The

lowest value (0.0024) was found in OC₄ and at 75 DAS the results showed (Table 2) that Barley crop (0.0334) significantly dominated other crops for RGR. Wheat registered the significant lowest (0.0233) magnitude for this character. In sub treatments C₁ (0.0324) significantly superseded other sub treatments for RGR. C₃ had the lowest (0.028) RGR. Interactions of BC₄ (0.0367) and OC₁ (0.0352) registered significant more RGR over rest of the interactions. The lowest RGR was recorded in WC₄ (0.0186) and at 90 DAS Investigations revealed showed (Table 2) that crop wheat indicated significant highest (0.0233) and Oat significant lowest (0.013) RGR among crops treated as main treats. In sub treatments C₄ (0.0250) and C₃ (0.0233) possessed the maximum and minimum values for RGR. In interactions WC₂ (0.0328) and WC₁ (0.0314) had registered significant more RGR over rest of the interactions. The lowest value (0.0117) was found in OC₄.

At 105 DAS the results indicated (Table 2) that among treatments and interactions wheat (0.009) and Oat (0.003) in main treatments C₁ (0.007) and C₂ (0.006) in sub treatments and WC₁ (0.013) and BC₄ (0.001) in interactions recorded the maximum values for this parameter, respectively and relative growth in year 2013-14 at 45 DAS Investigations indicated that Wheat indicated highest (0.0042) and Oat registered significant lowest (0.003) RGR among main treatments (Table 2). Among sub treatments C₁ (0.0053) superseded other sub treatments for RGR. The significant lowest magnitude was noted in C₄ (0.0036). In interactions WC₁ (0.0075) and WC₃ (0.0070) had significant more RGR over rest of the interactions. The lowest value (0.0032) was found in OC₄. At 60 DAS the results showed (Table 2) that Barley crop (0.0051) significantly dominates other crop for CGR. Oat registered the lowest (0.0037) RGR among main treatments.

Table.1 Crop growth rate (g/cm²/day) in different and interactions at successive growth intervals

Main treatments	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	AVERAGE
W	0.0003	0.0004	0.0010	0.0003	0.0001	0.0004
O	0.0002	0.0003	0.0009	0.0002	0.0001	0.0003
B	0.0003	0.0006	0.0015	0.0003	0.0002	0.0006
Sem ±	5.7720	0.8300	3.5550	2.4050	3.1000	3.1324
C.D.5%	5.6600	6.5415	3.2500	0.9400	4.7000	4.2183
Sub treatments						
C ₁	0.0003	0.0005	0.0012	0.0003	0.0002	0.0005
C ₂	0.0003	0.0005	0.0012	0.0003	0.0001	0.0005
C ₃	0.0002	0.0004	0.0011	0.0003	0.0001	0.0004
C ₄	0.0002	0.0004	0.0011	0.0002	0.0001	0.0004
Sem ±	5.3445	5.8615	2.6000	2.1350	5.7450	4.3372
C.D.5%	0.0000	0.8150	0.0000	0.0000	0.0000	0.1630
Interactions						
WC ₁	0.0003	0.0005	0.0012	0.0003	0.0002	0.0005
WC ₂	0.0003	0.0004	0.0011	0.0003	0.0001	0.0004
WC ₃	0.0002	0.0004	0.0010	0.0003	0.0001	0.0004
WC ₄	0.0002	0.0004	0.0009	0.0003	0.0001	0.0004
OC ₁	0.0002	0.0004	0.0010	0.0002	0.0001	0.0004
OC ₂	0.0002	0.0003	0.0009	0.0002	0.0001	0.0004
OC ₃	0.0001	0.0003	0.0009	0.0002	0.0001	0.0003
OC ₄	0.0001	0.0003	0.0009	0.0002	0.0001	0.0003
BC ₁	0.0003	0.0006	0.0016	0.0004	0.0002	0.0006
BC ₂	0.0003	0.0006	0.0015	0.0004	0.0002	0.0006
BC ₃	0.0003	0.0006	0.0015	0.0003	0.0002	0.0006
BC ₄	0.0002	0.0005	0.0014	0.0003	0.0001	0.0005
Sem ±	4.6304	2.3570	2.2568	1.8500	5.0030	3.2194
C.D.5%	0.0000	0.6850	0.0012	0.0000	NS	0.1716

Table.2 Relative growth rate (g/g/day) in treatments and interactions at successive life span (pooled)

Main treatments	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	AVERAGE
W	0.0062	0.0084	0.0183	0.0135	0.0061	0.011
O	0.0178	0.0177	0.0177	0.0080	0.0047	0.013
B	0.0104	0.0056	0.0189	0.0157	0.0032	0.011
Sem ±	0.0015	0.0025	0.0004	0.0026	0.0024	0.002
C.D.5%	0.0060	0.0031	0.0015	0.0048	0.0016	0.003
Sub treatments						
C ₁	0.0083	0.0067	0.0189	0.0146	0.0042	0.011
C ₂	0.0128	0.0065	0.0169	0.0142	0.0042	0.011
C ₃	0.0183	0.0045	0.0164	0.0118	0.0032	0.011
C ₄	0.0064	0.0016	0.0160	0.0128	0.0037	0.008
Sem ±	0.0024	0.0005	0.0006	0.0011	0.0007	0.001
C.D.5%	0.0070	0.0019	0.0016	0.0005	0.0005	0.002
Interactions						
WC ₁	0.0041	0.0108	0.0173	0.0175	0.0096	0.012
WC ₂	0.0046	0.0072	0.0158	0.0183	0.0071	0.011
WC ₃	0.0039	0.0117	0.0136	0.0175	0.0028	0.010
WC ₄	0.0034	0.0039	0.0112	0.0158	0.0050	0.008
OC ₁	0.0035	0.0044	0.0198	0.0075	0.0043	0.008
OC ₂	0.0037	0.0029	0.0170	0.0071	0.0035	0.007
OC ₃	0.0038	0.0033	0.0174	0.0074	0.0055	0.007
OC ₄	0.0038	0.0031	0.0167	0.0100	0.0056	0.008
BC ₁	0.0040	0.0056	0.0195	0.0172	0.0024	0.010
BC ₂	0.0042	0.0082	0.0177	0.0152	0.0030	0.010
BC ₃	0.0042	0.0052	0.0180	0.0152	0.0033	0.009
BC ₄	0.0039	0.0038	0.0203	0.0182	0.0018	0.010
Sem ±	0.0021	0.0004	0.0006	0.0009	0.0006	0.001
C.D.5%	0.0059	0.0016	0.0014	0.0004	0.0004	0.002

Among sub treatments C_2 (0.0045) superseded others sub treatments for RGR the significant lowest magnitude was noted in C_4 (0.0036). In interactions WC_2 had significant more RGR over rest of the interactions. Though BC_3 (0.0046) lagged behind the former but showed significant superiority over rest of the interaction except WC_1 , BC_2 and BC_1 . The lowest value was found in WC_4 (0.0030) and at 75 DAS Investigations revealed showed that crop Barley indicated highest (0.0043) and Wheat (0.0029) though they were at par between them Oat indicated lowest (0.0020) RGR among main treatments. Among sub treatments C_2 (0.0025) significantly superseded other sub treatments for RGR. C_3 had the lowest (0.0002) RGR thought was at par with C_3 (0.0002) in interactions WC_1 (0.0066) and WC_2 (0.0044) had significant more RGR over rest of the interactions. The lowest value (0.0001) was found in WC_4 and at 90 DAS the results showed (Table 2) that Wheat crop (0.0037) significantly dominated other crops for RGR.

Oat registered the significant lowest (0.0026) magnitude for RGR. Among sub treatments C_2 (0.0049) and C_1 (0.0044) possessed higher CGR over rest over others sub treatments C_3 (0.002) recorded the lowest value for this character though was at par with C_1 . In interactions BC_1 (0.0051), BC_4 (0.0051), BC_2 (0.0047) and BC_3 (0.0047) recorded significant higher CGR over rest of the treatments OC_1 (0.0016) was associated with the minimum magnitude for this trait and at 45 DAS the results showed (Table 2) that Wheat crop (0.0029) significantly dominate other crop for RGR. Oat registered the significant lowest (0.0020) magnitude for RGR. In sub treatments C_2 (0.0054) and C_3 (0.0002) possessed the maximum and minimum values for RGR. In interactions of crop cuttings indicated that treatment combinations BC_1 (0.0060) and WC_1 (0.0055) registered significant more RGR over rest of

the interactions. The lowest RGR was recorded in OC_2 (0.0034).

RGR (g/g/day), pooled

The result exhibited (Table 2) that the oat (0.0178) maximum and minimum value for RGR. Among sub treatment, C_3 (0.0183) superseded other sub treatment for the same traits. The lowest value (0.0064) was found in C_4 at 45 DAS and at 60 DAS the results indicated (Table 2) that oat crop (0.0177) significant superseded others for RGR and barely registered the lowest value (0.0056). Among sub treatment C_1 (0.0067) supersede other sub treatments for the same character. C_4 (0.0016) the registered the lowest value. In interaction WC_3 (0.0117) at par with WC_1 (0.0108) had significant more RGR over rest of the interaction. The lowest value (0.0029) was found in OC_2 and at 75 DAS the result showed (Table 2) that barely crop (0.0189) dominated other crops for RGR. Oat registered the lowest (0.177) magnitude for this trait. Among sub treatments C_1 (0.0189) superseded other sub treatment for the same character. The lowest magnitude was noted in C_4 (0.0160). In interaction, BC_4 (0.0203) registered significant more RGR over rest of the interactions. The lowest value (0.0112) was recorded in WC_4 and at 90 DAS the result revealed (Table 2) that barely (0.0157) possessed the higher RGR over rest of the main treatment oat registered the significant lowest (0.0080) magnitude among main treatments. Among sub treatments C_1 (0.0146) superseded other sub treatment for the same trait C_2 had the lowest value (0.0118) in interactions, WC_2 (0.0183) at par with BC_4 (0.0182) had significant more RGR over rest of the interaction. The lowest value (0.0071) was found in OC_3 and at 105 DAS the result showed (Table 2) that wheat (0.0061) had the highest RGR over rest of the main treatment barley noted the significant lowest (0.0032). Among sub treatments, C_1

(0.0042) significant superseded other sub treatment for RGR. C₃ had the lowest (0.0032). In interactions, WC₁ (0.0096) and BC₁ (0.0018) possessed the significant maximum and minimum values for this character.

Thus the study revealed (T, F) that the CGR in treatments and interactions increased with the age, attaining the peak at 75 DAS, therefore it decline in sub sequent growth period. Among main treatments, barely recorded the average maximum CGR (0.0006), followed by wheat (0.0004). In sub treatments C₁ and C₂ (0.0005) recorded the higher magnitude. On the others hand in interactions BC₁, BC₂ and BC₃ (.0006) were found to be associated with the higher magnitudes for this character.

The study showed that the RGR starts increasing magnitudes from early growth phase onwards, recording the peak between 75 and 90 DAS, followed by a subsequent decline in rest of the growth period. Oat recoded an average higher RGR (0.013) in main treatments. In sub treatments except C₄ all others possessed the same magnitude (0.011). In interactions WC₁ (0.012) and WC₂ (0.011) were found to be associated with the maximum values for this character.

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