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Growth Analysis of Transplanted Fine Rice Under Different Competition Durations with Barnyard Grass

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ABSTRACT

Effect of different competition periods of barnyard grass (0, 20, 40, 60 days and throughout the growth period after transplanting) on the growth behaviour of fine rice was studied under field conditions for two consecutive years (1998-1999). Growth parameters such as leaf area index, leaf area duration, dry matter accumulation and crop growth rate were, influenced significantly by all the competition durations. However, net assimilation rate was non-significantly influenced by competition duration of 20 days.

Key Words: Fine rice; Barnyard grass; Growth analysis; Competition durations

INTRODUCTION

Barnyard grass [*Echinochloa crus-galli* (L.) Beauv] locally known as "Dhiden" is commonly associated with rice crop. It is an erect and annual plant of 100-200 cm height. The stem is stout and spongy with thick root. Leaves are long (40 cm) and wide (5.15 mm). It is propagated by seed and adapted to wet soils of having 80% water holding capacity. However, its seed can germinate in standing water and tillers profusely (Auld & Kim, 1996). Barnyard grass can grow and flower in a photoperiod ranging from 8 to 16 h and is ecologically similar to rice. During the early vegetative phase, it can not be easily distinguished from the rice plants, however, ligule and aricles are absent in it. Due to its vigorous growth, it competes heavily with rice crop for essential growth factors like water, light and nutrients. The ecological relationships in weed-crop competition are complicated ones. Undoubtedly, weed and crop plants compete with one another and interfere in growth activities to a varying degree. To alleviate weed crop competition, there is need to explore the critical weed-crop competition period which seriously limits crop yields. The present study was planned to determine the growth behaviour of fine rice under different competition durations with barnyard grass, under the irrigated conditions at Faisalabad.

MATERIALS AND METHODS

The study was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 1998 and was repeated during 1999. The soil at both locations was sandy-clay loam having pH of 7.85 and 7.9 with organic matter of 0.71 and 0.70%. The treatments consisted competition durations of 0, 20, 40, 60 days and throughout the growing period. Weeds were removed by hand weeding on the expiry of each duration of rice-barnyard grass association. The experiments were laid out in a RCBD with four replications. The crop was fertilized at @ 120-60-60 kg NPK ha^{-1}. All P and K was applied at the time of transplanting the rice nursery. Nitrogen was applied in two equal splits i.e. 1/2 at transplanting and 1/2 at tillering stage. The plot size was 3 m x 2 m. Rice variety Basmati-385 was used as a test crop. The nursery was sown in the 1st week of June each year. About one-month old seedlings were transplanted at 25 cm x 25 cm hills. Seed of barnyard grass was broadcast in the experimental plots and the barnyard grass density was maintained as 25-27 plants m^{-2}. The other weed plants were eradicated manually soon after germination. The following observations were recorded to analyze the growth behaviour of rice crop.

1. Leaf area index. Six plants were randomly selected from each plot and the leaf area index (LAI) was determined through length-width method:

(Leaf area = length x width x K, where K = adjustment factor i.e. 0.75). Leaf area $hill^{-1}$ = Total leaf area of middle tiller x Total number of tillers (Yoshida *et al*., 1976). The LAI was calculated by the following formula (Watson, 1947).

$$LAI = \text{Leaf area hill}^{-1}/\text{Land area hill}^{-1}$$

2. Leaf area duration. The leaf area duration (LAD) was estimated according to Hunt (1978) in days.

$$LAD = (LAI_1 + LAI_2)/t_2 - t_1 \times 2$$

Where, LAI_1 and LAI_2 are the leaf area indices at times t_1 and t_2, respectively.

3. Dry matter accumulation. To determine dry matter (DM) accumulation, five plants from the central row were harvested starting from 30 DAT each at an interval of 20 days. DM accumulation was determined three times in a season and was calculated after oven drying at 70°C till constant weight on m^{-2} basis in grams.

4. Crop growth rate. The crop growth rate (CGR) was calculated as proposed by Hunt (1978) in gm^{-1} day^{-1}.

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

Where, W_1 and W_2 as the total dry weight harvested at time t_1 and t_2, respectively.

5. Net assimilation rate. The net assimilation rate (NAR) was estimated in g m^{-2} day^{-1} by using the following formula:

$$NAR = \frac{W_2 - W_1}{LAD}$$

Where, W_1 and W_2 is the total dry weight measured at intervals during the growing season, and LAD is the leaf area duration calculated within this interval.

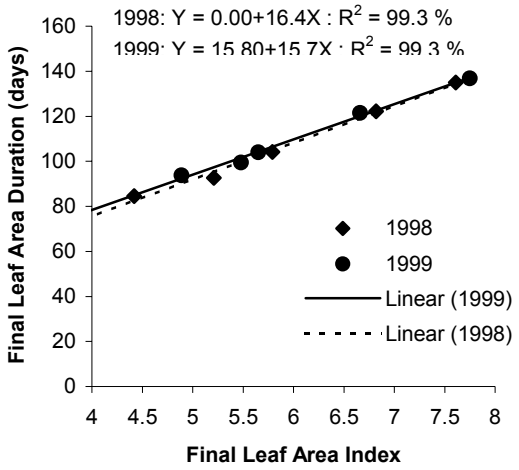
The data collected were analyzed statistically using MSTATC statistical package on computer (Anonymous, 1986). Duncan's New multiple range test was applied for treatment comparison. The data were pooled over years because of different environments and their year effect was non-significant. Only the mean data of both years were presented.

RESULTS AND DISCUSSION

1. Leaf area index. Leaf area was recorded at 30, 50 and 70 days after transplanting and then LAI for each interval was calculated (Table I). All the durations of weed competition depressed LAI significantly at 70 days after transplanting of rice. The maximum reduction occurred in plots with weed competition throughout the crop growth period (D_5). Significant decrease in LAI was observed in all the competition durations except D_5 (as the reading was taken at 50 DAT). LAI was also significantly less in the treatment having weed competition for 20 and 40 DAT, recorded at 30 DAT. The results (Table I) revealed that the LAI was significantly influenced by weed competition even for 20 DAT when the weed plants were relatively smaller than rice plants, but this indicated a serious competition effect of barnyard grass on the rice crop. Reduction in LAI due to the weed competition has also been reported by Okafor and Dedatta (1974) and also by Yamagishi *et al*. (1976).

2. Leaf area duration. Leaf area duration was significantly affected by different treatments during both years (Table I). Maximum leaf area duration (136.85 days) was achieved in plots having no weed competition after transplantation and the leaf area duration decreased as the competition increased. Minimum LAD (84.52) was noted in plots with barnyard grass competition throughout the crop growth season. All other treatments were in between these two extremes and were statistically different from one another. The leaf area duration at different intervals i.e. 30-50, 50-70 DAT was also influenced in exactly the same manner during both years of experimentation (Table I). The influence of weed competition on the leaf area durations was similar to LAI because it was derived from the LAI data. These results are in agreement with those of Tanveer (1995) who reported that weed-crop competition decreased significantly with the leaf area duration of the crop. A positive correlation was found between LAI and leaf area durations. Determination coefficient was calculated as 99.3% for the years 1998 and 1999 (Fig. 1), which showed a linear increase in the LAD with the corresponding increase in LAI.

Fig. 1. Relationship between leaf area index and leaf area duration



3. Dry matter accumulation. Year effect on DM recorded at 30 DAT was non-significant (Table II). The highest DM m^{-2} was recorded in control followed by competition of 20 days (D2) against the minimum in 60 days competition (D4), which was statistically equal to D3 and D5. DM recorded at 50 and 70 DAT showed a significant difference between years. During year 1999, the treatments D3, D4 and D5 were statistically on a par. However, the minimum DM was obtained in D5 treatment in 1998, which was statistically on a par with D4. Twenty days competition also significantly reduced the DM at 50 and 70 DAT. The data further recorded that DM increase was inversely proportional to competition duration. These results support the findings of Chavez and Moody (1988) who reported significant reduction in DM of rice with an increase in competition duration. The difference between the years might be due to variable environmental conditions. There was a positive relationship between LAI and DM accumulation (Fig. 2) with determination coefficient 99.1 and 97.2% during 1998 and 1999, respectively.

4. Crop growth rate. The growth rate of rice determined at 30-50 DAT showed significant differences due to different durations of barnyard grass competition (Table II). The treatment D5 (competition throughout) exhibited the minimum crop growth rate, which was statistically equal to the treatment D4 (60 DAT) during 1998. Competition of 20 days showed less growth rate than control (D1) in both years followed by treatment D3 (40 DAT) and D5 (throughout) during 1999. Data regarding growth rate for 50-70 DAT revealed that minimum growth rate during 1999 was

recorded in plots with competition throughout the growth period (D5). Twenty days rice-weed competition showed statistically similar effect in both years. The effect of 40 days competition was higher than treatment D1 and D2 but lower than D4 and D5 while treatment D4 was equal to D3 during 1998. Significant year effect might be due to more favourable environmental condition in 1999. These results indicated that due to the prolonged competition, the availability of essential plant growth elements became limited and thus growth was negatively affected. Similar results were reported by Akhtar (1991). A positive correlation was found in LAI and crop growth rate (Fig. 3) and the regression accounted for 99.1 and 91.5% variability during 1998 and 1999, respectively.

Table I. Leaf area index and leaf area duration of fine rice as affected by different competition periods

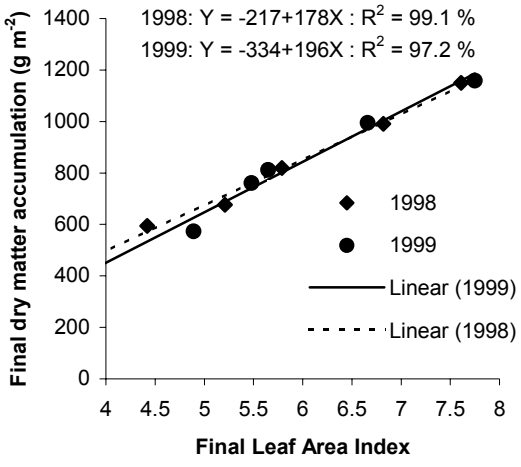
Treatments (competition after transplanting)	Leaf area index					Leaf area duration (days)		
	30 DAT		50 DAT	70 DAT		30-50 DAT	50-70 DAT	
	1998-99 (Mean)	1998	1999	1998	1999	1998-99 (Mean)	1998	1999
D_1 = 0 (days)	2.977 a[1]	5.89 a[1]	5.93 a	7.61 a[1]	7.75 a	88.86 a[1]	135.00 a[1]	136.85 a
D_2 = 20 (days)	2.683 b	5.41 b	5.47 b	6.82 b	6.66 b	81.22 b	122.27 b	121.55 b
D_3 = 40 (days)	2.259 c	4.62 cd	4.75 c	5.79 c	5.65 c	69.39 c	104.10 c	104.00 c
D_4 = 60 (days)	2.259 c	4.05 e	4.45 d	5.21 d	5.48 cd	65.04 d	92.67 e	99.40 d
D_5 = Throughout	2.248 c	4.03 e	4.50 d	4.42 f	4.89 e	65.11 d	84.52 f	93.85 e

Table II. Dry matter accumulation, crop growth rate and net assimilation rate of fine rice as affected by different competition periods

Treatments (competition after transplanting)	Dry matter accumulation (gm^{-2})					Crop growth rate (gm^{-2} day^{-1})				Net assimilation rate (gm^{-2} day^{-1})		
	30 DAT	50 DAT		70 DAT		30-50 DAT		50-70 DAT		30-50 DAT	50-70 DAT	
	1998-99 (Mean)	1998	1999	1998	1999	1998	1999	1998	1999	1998-99 (Mean)	1998	1999
D_1 = 0 (days)	81.11 a[1]	525.7 a[1]	537.6 a	1149.5 a[1]	1158.5 a	22.24 a[1]	22.81 a	30.43 a[1]	31.34 a	5.07 a[1]	5.04 a[1]	5.01 a
D_2 = 20 (days)	70.38 b	451.9 c	483.3 b	990.7 b	994.3 b	19.06 b	19.98 b	26.30 b	25.54 b	4.88 ab	4.85 ab	4.94 ab
D_3 = 40 (days)	62.04 c	377.0 e	408.5 d	819.4 c	812.3 c	15.78 d	17.29 c	22.11 c	20.24 cd	4.75 bc	4.72 bc	4.76 bc
D_4 = 60 (days)	62.01 c	327.0 f	385.7 de	676.8 e	760.6 d	13.28 e	15.99 d	17.48 e	18.73 de	4.52 c	4.10 d	4.51 c
D_5 = Throughout	62.29 c	326.0 f	390.7 de	594.2 f	573.2 f	13.24 e	16.36 cd	13.40 f	9.12 g	4.53 c	3.99 d	3.55 e

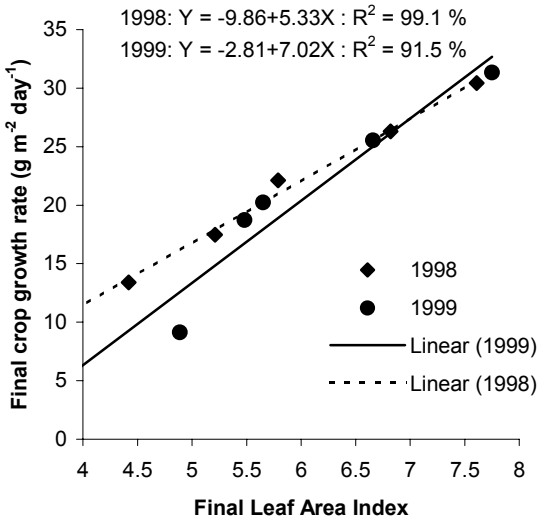
[1]Means not sharing a letter in common differ significantly at the 0.05 probability level by Duncan's Multiple Range Test; DAT= Days after transplanting

Fig. 2. Relationship between leaf area index and dry matter accumulation



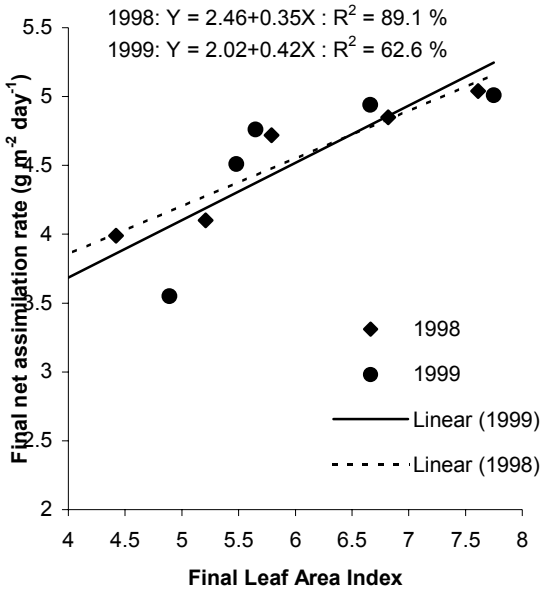
5. Net assimilation rate. The net assimilation rate was the maximum in case of no rice-grass competition (D1), which was statistically equal to 20- day competition period (D2) which on par with D3 (40 DAT) at both intervals. The minimum NAR was observed in plots with full competition throughout the growth period, which was statistically at par with 30-50 DAT and 50-70 DAT in 1998. These results showed that increase in competition period decreased the NAR probably due to less leaf area and shortage of other growth factors (nutrient, space, water etc.). Another reason

Fig. 3. Relationship between leaf area index and crop growth rate



might be the phytotoxic effect of the toxins produced by barnyard grass. Similarly, Maqsood (1998) reported that mostly cereals such as rice had NAR up to 6 gm^{-2} day^{-1} and that LAI was positively associated with NAR (Fig. 4). The variation in NAR can be explained by 89.1 and 62.6%

Fig. 4. Relationship between leaf area index and net assimilation rate



determination coefficient of the LAI during in 1998 and 1999, respectively.

CONCLUSION

It is concluded that barnyard grass is a severe competitor of rice even at early growth stage because all the growth parameters of the rice crop were significantly suppressed by the competition durations as compare to control. Therefore, it is a must that barnyard grass should be controlled as early as possible for good vegetative growth of rice crop.

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