Critical period of *Cyperus iria* L. competition in transplanted rice

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Summary Field studies were conducted during the summer season of 1994 and 1995 on a sandy loam soil at Punjab Agricultural University, Ludhiana, India, to determine the critical period of *Cyperus iria* competition in transplanted rice. The treatments consisted of 14 periods of weed interference laid out in a randomised block design with four replications. Infestation of *C. iria* throughout the crop growth period caused 64 per cent reduction in paddy yield. Highest paddy yield was obtained by keeping the crop weed free throughout. Weed free conditions for first 20 days after transplanting (DAT) and weedy thereafter yielded significantly less than weed free. There was no significant advantage of keeping the crop free of *C. iria* beyond 30 DAT. When the crop was weedy for the first 20 or 30 days and weed free thereafter it yielded significantly higher than weedy and on a par with weed free conditions. However, weedy conditions for the first 40 days or more had significantly less paddy yield than weed free. *C. iria* competition for the first 30 days caused less than one fourth (12.9%) of the total losses in yield while competition for 40 days resulted in more than half (43.5%) of the total losses due to the weed. Maximum reduction in paddy yield (35.2%) was observed by delaying *C. iria* removal from 30 to 40 DAT, indicating this period as the most critical period of *C. iria* competition in transplanted rice.

Keywords *Cyperus iria*, rice flat sedge, transplanted rice, competition, interference, paddy yield.

INTRODUCTION

Cyperus iria L. commonly known as rice flat sedge, is principally a weed of rice (*Oryza sativa*) through out the world. It is also a weed of sugarcane in Australia (Holm *et al.* 1977). Transplanted rice, a major summer crop in Punjab, suffers heavily due to infestation of wide variety of weeds and yield losses range from 33 to 70 per cent (Chela 1978, Singh *et al.* 1991, Brar *et al.* 1995). The major weeds invading the crop are *Echinochloa crus-galli* and *E. colonum* and the commonly used herbicides butachlor and anilofos give effective control of these weeds. However, continuous use of these herbicides over the last two decades has led to the emergence of new problem weeds like *C. iria*, *Caseulia axillaries*, *Sphenochlea zeylanica*, etc. (Kolar and Mehra 1992). Of these new weeds *C. iria* is of major concern regarding the productivity of rice in Punjab. Commonly used herbicides provide partial control of *C. iria*. Therefore to develop a comprehensive control programme for this weed, it is important to know its critical period of competition in transplanted rice.

The critical period of competition represents the time interval between two separately measured components. The first component is the time when early emerged weeds begins to reduce crop yield or when removal of weeds can no longer be delayed. The second component is the length of time a crop must be kept weed free after planting so that those weeds emerging late do not reduce yield or times when further weed removal is unnecessary to prevent loss of crop yield (Burnside *et al.* 1998). Understanding of the critical period of *C. iria* competition will allow farmers to better manage this weed and consequently increase and sustain the productivity of rice. The objective of this study was to determine the critical period of *C. iria* competition in transplanted rice through the effect of time of its removal on growth and yield of rice.

MATERIALS AND METHODS

A field experiment was conducted during summer/rainy season of 1994 and 1995 at Punjab Agricultural University, Ludhiana (30° 54' N, 70° 48' E) in India on a sandy loam soil (76.1% sand, 13.2% silt and 10.7% clay) with a pH of 8.0 and electrical conductivity of 0.2 mmhos cm^{-1}. The soil was low in organic carbon (0.33%), available nitrogen (165 kg ha^{-1}), available phosphorus (9.0 kg ha^{-1}) and high in available potassium (210 kg ha^{-1}). The site selected for the experiment had a history of *C. iria* as a major weed. Treatments consisted of weed free conditions for first 20, 30, 40, 50, 60 and 70 DAT of rice and up to harvest (120 DAT), and weedy conditions for first 20, 30, 40, 50, 60 and 70 DAT and up to harvest of rice (Table 1), replicated four times in randomised block design. The net plot size was 5.0 m × 2.0 m. After puddling the paddock, 30 days old seedlings of rice (CV PR 106) were transplanted by putting two seedling per hill, 2–3 cm deep at 20 cm × 15 cm on 18th June 1994 and 19th June 1995. The crop received 125 kg N, 30 kg P_2O_5, 30 kg K_2O and 62.5 kg zinc sulphate ha^{-1}. Water was kept ponded for the first two weeks of rice transplanting and

thereafter water was applied one day after the ponded water had infiltrated into the soil. The plots were kept free from other weeds by frequent weeding. The crop was protected adequately against insect, pests and diseases. Observations on crop growth parameters like plant height, tillers m^{-2} and dry matter accumulation were taken on 30, 60, 90 DAT and at harvest, only the final observations are being presented here along with the yield attributes and paddy yield. Data on dry matter accumulation of *C. iria* was recorded from two randomly selected spots of 50 cm × 50 cm in each plot at the time of weed removal (hand weeded) as per the treatment and also at the time of harvest during 1994 and at 90 DAT during 1995. *C. iria* dry matter accumulation data was subjected to $\sqrt{X+0.5}$ transformation. All the data was subjected to analysis of variance. Treatments were analysed over years as the treatment by year interaction was non significant except *C. iria* dry weight. *C. iria* dry weight data was not pooled as the timing of its removal was different in 'weedy up to harvest' treatment.

RESULTS AND DISCUSSION

Effect on *C. iria* Keeping the crop free from the weed for the first 20 days only accumulated significantly more dry matter than weed free situation for first 30 days. The crop kept free from the weed for initial 40 to 70 DAT resulted in smothering of late emerged *C. iria* and thus had no dry matter (Table 1).

There was a progressive increase in dry weight of *C. iria* with every delay in its removal from initial 20 to 70 DAT. Increase in dry weight with the delay in the weed removal from 20 to 30, 30 to 40, 40 to 50, 50 to 60 and 60 to 70 days were 70.5, 164.4, 37.8, 23.5 and 5.1 per cent respectively. On an average more than half of the maximum dry matter accumulation occurred when *C. iria* was allowed to grow in the crop for initial 40 days. In general *C. iria* accumulated more dry matter in 1995 than 1994 but in particular its dry weight was 8 times more in 'weedy up to harvest' treatment in 1995 as it taken at crop harvest during 1994 and by that time most of its leaves, seeds etc., had shed (Table 1).

Effect on rice Increasing the duration of *C. iria* interference beyond 30 DAT decreased the plant height, tillers m^{-2}, crop dry weight, panicle length, number of grains per panicle and grain weight as compared to weed free (Table 1). This might be due to the fact that *C. iria* completed its flowering by 36 DAT, grew taller than crop, covered the crop canopy and might have competed with crop for light, space and nutrients. Competition for light might have reduced the photosynthesis by the crop and the weed also caused the crop to lodge.

Paddy yield increased with increase in initial weed free period from 20 to 70 DAT. Maximum paddy yield was obtained by keeping the crop weed free throughout (Table 1). Weed free conditions for first 20 days and weedy thereafter yielded significantly less than weed free. This could be due to the fact that *C. iria* emerged later on accumulated meaningful dry matter (500 kg ha^{-1}), provided severe competition and reduced the plant height, tillers m^{-2}, dry matter accumulation by crop and yield attributes (Table 1). The crop kept weed free for initial 30 to 70 DAT and weedy thereafter yielded at par with weed free. The advantage of keeping the crop free of the weed up to 30 DAT or beyond could be because by this time most of the weed seedling had emerged and were weeded out. Singh (1997) reported that *C. iria* seedlings emergence was maximum at 22 DAT of rice and 56.8 % of that emerged with in one week of transplanting of rice. Weeds that emerged late in the season did not provide meaningful competition to the crop and was evident from significantly less dry weight of *C. iria* (Table 1). These conditions helped the crop to grow better and was evident from increased plant height, tillers m^{-2}, dry weight by crop, panicle length, number of grains per panicle and thousand grain weight and ultimately resulted in higher yield (Table 1). Similarly, Singh *et al.* (1991) and Brar *et al.* (1995) observed that weed free conditions for first 40 days were required to get paddy yield at par with weed free situation.

C. iria infestation in transplanted rice throughout the season affected 64 per cent reduction in paddy yield as compared to weed free situation (Table 1, Figure 1). *C. iria* competition for the initial 20 or 30 days only, did not reduce the yield significantly as compared to weed free. This could be due to the removal of weeds after 20 and 30 days of transplanting creating better crop growth environment. Increased availability of space, better penetration of light in the crop canopy helped the crop to grow better in terms of plant height, tiller number, dry matter accumulation, yield attributes and the crop yielded at par with weed free (Table 1) *C. iria* interference for the first 40 or more days in rice resulted in significantly less yield than weed free conditions. Its competition for initial 30 days caused less than one forth (12.9%) of the total losses in paddy yield and competition for first 40 days resulted in more than half (43.2%) of the total losses of 64.0 per cent due to the weed. Maximum reduction (35.2%) in yield observed by delaying *C. iria* removal from 30 to 40 DAT (Table 1, Figure 1), indicated that this period is the most critical period of *C. iria* competition in transplanted rice (Figure 1) The significant reduction in paddy yield by delaying the weed removal from 30 to 40 DAT was mainly due

Table 1. Effect of crop-weed competition on weed dry weight, crop growth parameters, yield attributes and paddy yield of rice (average data of two years for rice).

Treatment (DAT)	Weed dry weight (kg ha^{-1})			Plant height (cm)	Tillers (m^{-2})	Dry weight (kg ha^{-1})	Panicle length (cm)	Grains panicle^{-1}	1000 Grain weight (g)	Paddy yield (kg ha^{-1})	Yield loss (%)
	1994	1995	Av.								
Weed free for the first											
20	110 (10.5)	890 (29.8)	500	72.5	254	8420	24.0	130	19.9	3331	40.0
30	70 (8.4)	360 (19.0)	215	82.5	330	12626	24.9	153	20.7	4966	10.6
40	0 (0.7)	0 (0.7)	0	83.4	337	12825	24.9	154	21.2	5031	9.4
50	0 (0.7)	0 (0.7)	0	83.0	343	12880	25.2	155	21.2	5106	8.0
60	0 (0.7)	0 (0.7)	0	83.4	338	12991	24.8	157	21.2	5206	6.2
70	0 (0.7)	0 (0.7)	0	84.6	334	13073	25.1	158	21.3	5438	2.1
up to harvest	0 (0.7)	0 (0.7)	0	85.1	349	13163	25.4	159	21.4	5553	0.0
Weedy for the first											
20	200 (14.1)	410 (20.3)	305	82.1	328	12651	25.1	157	21.0	5004	9.9
30	320 (17.9)	720 (26.8)	520	81.5	296	12510	24.7	154	20.6	4839	12.9
40	760 (27.6)	1990 (44.6)	1375	71.3	255	7898	23.7	127	19.8	3136	43.5
50	1230 (35.1)	2560 (50.6)	1895	67.4	228	7669	23.6	125	19.8	2858	48.5
60	1460 (38.2)	3220 (56.7)	2340	63.3	233	7114	23.6	122	19.6	2460	55.7
70	1520 (39)	3410 (58.4)	2465	65.0	227	6563	23.7	117	19.5	2200	60.4
up to harvest	440** (20.9)	3590* (59.9)		62.7	215	6121	23.5	116	19.4	1996	64.1
LSD (P=0.05)	(2.1)	(5.9)		5.8	32	1054	0.8	9	0.9	732	

*Removed at 90 DAT.
** Removed at harvest of the crop. Figures in parentheses are transformed √X+0.5 values.

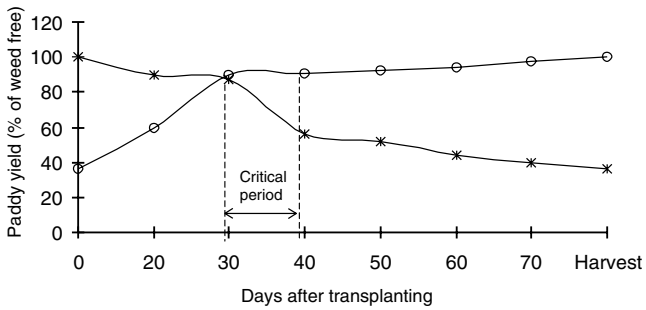

Figure 1. Paddy yield averaged over 1994 and 1995 for rice kept weed free (o) or weed infested (*) for different length of time after transplanting.

to tremendous increase in dry weight (2.6 folds) by *C. iria* during this period (Table 1). The presence of the weed in the crop during initial 40 days or beyond exerted severe competition and adversely affected the crop growth in terms of plant height, tillers m^{-2}, dry matter accumulation, panicle length, number of grains per panicle and thousand grain weight and ultimately reduced the paddy yield (Table 1). These results are in

line with Gill and Kolar (1980) and Bhan and Singh (1993) who reported that the critical period of rice weed competition was between 30 to 45 DAT.

It may be concluded that critical period of *C. iria* competition with transplanted rice is between 30 and 40 DAT. If growers use pre-emergence herbicides 2–3 DAT of rice for its control, they should use herbicides with residual activity until 40 DAT. Use of post emergence herbicides should be designed to give its control from 30 to 40 DAT.

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