Indian Journal of Weed Science **44**(1): 43–45, 2012

Impact of varying densities of jungle rice on rice productivity

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Received: 21 December 2011; Revised: 18 March 2012

ABSTRACT

In order to assess the impact of varying densities of *jungle rice* (*Echinochloa colona*) on rice, a field experiment was conducted at Directorate of Weed Science Research, Jabalpur farm in *Kharif* 2005 and 2006. With increasing population density of *E. colona* from 50 to 400 plants/m^2, there was a significant reduction in LAI, biomass production as well as grain yield of rice due to competition from weed plants for growth factors like light, nutrients and space *etc.* The reduction in dry matter was to the tune of 32% with a *E. colona* density of 400 plants/m^2 as compared to pure rice crop. Though the chlorophyll content of rice decreased with increasing density of *E. colona* but it maintained a higher chlorophyll content than *E. colona*. The increasing densities of *E. colona* significantly decreased various yield attributes of rice with the effect being more drastic on effective tillers/m^2. The reduction in grain yield varied from 48 to 86% as the density of *E. colona* increased from 50 to 400 plants/m^2.

Key words: Crop-weed competition, *Echinochloa colona,* Grain yield, Rice

Rice (*Oryza sativa* L.) is the staple food crop of India, providing 30% of caloric requirement for more than 70% of the population. Jungle rice (*Echinochloa colona*) and Barnyard grass (*Echinochloa crusgalli*) are the two main weeds growing in association with other annual grasses, sedges and broad leaf weeds in rice. The extent of yield reduction due to weeds is around 20-25% in transplanted rice, 30-35% in direct seeded puddled rice and over 50% in direct seeded upland rainfed rice (Mukherjee *et al.* 2009). Higher rice yields can be realized if these major weeds are controlled. Keeping this in view the present study was conducted to assess the impact of varying densities of *Echinochloa colona* on rice.

MATERIALS AND METHODS

Field experiment was conducted at Directorate of Weed Science Research, Jabalpur located at 23.90° North Latitude, 79.58° East Longitude and at an altitude of 411.78 m above mean sea level, during *Kharif* 2005 and 2006 with seven treatments consisting of sole crop, sole weed (*Echinochloa colona*), and increasing densities of weed (50, 100, 200, 300 and 400 plants/m^2) in a randomized block design with three replications. Observations on leaf area index, biomass, chlorophyll content, yield and yield attributes were also recorded. The experimental soil was sandy clay loam in texture with low available nitrogen, medium phosphorus and high potassium and a pH of 6.85 and EC of 0.372 dS/m. Rice crop (*cv. Kranti*) was sown with a seed drill, with a row spacing of 22.5 cm. The required quantity of weed seed was evenly spread in the plots and mixed well with the soil to maintain the desired plant population. After germination the weeds arising in the plots were thinned to the desired density as per the treatment. Thinning of weeds was carried out up to a period of one month after sowing. The recommended dose of $N:P_2O_5:K_2O$ (120:60:40 kg/ha) was applied uniformly to all the plots through prilled urea, single super phosphate and muriate of potash. Entire P and K fertilizers were added as basal while N was applied in three equal splits at sowing, 30 and 60 days after seeding. Plant samples were taken periodically throughout the crop growth season for biomass accumulation. The samples were oven dried at 70^{0}C till a constant weight was reached and weighed for dry matter. Observations on leaf area were made on a leaf area meter equipped with colour image analysis system of Make: Delta T Devices and model W-C230-PCM.

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RESULTS AND DISCUSSION

Effect on leaf area index

Leaf Area Index (LAI) of rice decreased with increasing density of *E. colona* (Table 1). The LAI increased from 20 DAS to 80 DAS, beyond which it decreased due to the drying up of leaves. LAI of *E. colona* showed an increasing trend with its increasing density. However, it was maximum in sole weed (T_{max}).

Maximum LAI for pure rice crop was observed between 60 DAS (3.4) and 80 DAS (3.7) which show that this period coincides with the maximum vegetative growth period of the crop (Table 1). As the crop was approaching maturity, the LAI decreased considerably. These findings are in agreement with those of Chang *et al.* (2005).

Table 1. Periodic leaf area index (LAI) of rice and weed under different densities of *E. colona* (mean of two seasons)

Density of *E. colona* (plants/m^2)	Leaf area index (DAS)								
	20		40		60		80		100
	Rice	Weed	Rice	Weed	Rice	Weed	Rice	Weed	Rice
Sole rice (T_0)	0.69	0.00	1.8	0.00	3.4	0.00	3.7	0.00	3.1
50 (T_{50})	0.61	0.86	1.6	2.33	2.1	2.47	2.2	2.17	2.0
100 (T_{100})	0.68	1.13	1.5	2.83	1.9	3.03	2.0	2.60	1.8
200 (T_{200})	0.77	1.50	1.4	3.13	1.5	3.33	1.7	2.43	1.6
300 (T_{300})	0.65	1.73	1.0	4.07	1.1	4.17	1.0	2.80	0.8
400 (T_{400})	0.54	2.07	0.8	4.23	1.0	4.13	0.8	2.70	0.6
Sole *E. colona* (T_{Max})	0.00	1.53	0.0	4.00	0.0	4.20	0.0	3.10	0.0
LSD (P=0.05)	0.08	0.09	0.1	0.13	0.17	0.12	0.16	0.17	0.15

Table 2. Dry biomass accumulation (t/ha) of rice under different densities of *E. colona* (mean of two seasons)

Density of *E. colona* plants/m^2	60 DAS		80 DAS		100 DAS	At harvest
	Rice	Weed	Rice	Weed	(Rice)	(Rice)
Sole rice (T_0)	6.71	0.00	9.77	0.00	10.51	10.00
50 (T_{50})	4.40	5.10	5.70	4.79	6.71	6.35
100 (T_{100})	3.73	6.46	4.72	5.96	5.36	5.17
200 (T_{200})	3.08	7.00	3.77	6.62	4.63	4.42
300 (T_{300})	2.35	7.78	3.46	7.54	4.32	3.95
400 (T_{400})	1.90	8.16	3.02	7.83	3.33	3.16
Sole *E. colona* (T_{Max})	0.00	10.12	0.00	9.69	0.00	0.00
LSD (P=0.05)	1.54	0.56	1.74	0.73	1.58	0.93

LAI of *E. colona* showed an increasing trend with its increasing density. However, it was maximum in T_{max}. The LAI in all the treatments increased from 20 DAS to 60 DAS beyond which it decreased as the plants started to dry. This higher LAI of weed with its increasing density caused an increasing light extinction which reduced the tillering of rice. These results are in agreement with the findings of Graf *et al.* (1990).

Effect on biomass accumulation

The biomass accumulation of rice was affected significantly by *E. colona* density at all stages of observation (Table 2). The biomass accumulation depends upon the amount of radiation received, the area of intercepting surface, the efficiency with which the intercepted radiation is utilized in the production of dry matter and loss of dry matter due to physiological, pathological and weed competition factors. Biomass accumulation by the crop decreased with increase in weed population, with the maximum accumulation by the crop being at 100 DAS, which coincided with the grand growth phase of the crop. The reduction in biomass accumulation of rice is due to the severe competition posed by *E. colona*. These findings are also supported by those of Graf and Hill (1992) who reported that even at a density of 100 rice plants/m^2, 10 plants of *E. crusgalli*/m^2 cause a yield loss of about 50 per cent.

The biomass accumulation of *E. colona* was highest in Tmax and least in T_{50}. The biomass accumulation increased significantly as the density of *E. colona* increased from 50 to 400 plants/m^2, up to 60 DAS beyond which it decreased mainly due to seed shedding.

The chlorophyll content of rice and *E. colona* decreased with increasing density of *E. colona* (Table 3). It was higher at 60 DAS in all the treatments as compared to those at 40 DAS. However, rice maintained a higher chlorophyll content than *E. colona*.

Effect on yield contributing characters

The increasing densities of *E. colona* from 0 to 400 plants/m^2 significantly decreased various yield attributes of rice (Table 4). These findings were also supported by those of Dhaliwal *et al.* (1997). The effect was more drastic in case of effective tillers/m^2 resulting in reduced grain yield with increasing density of the weed.

Table 3. Chlorophyll content (mg/g fresh weight) of rice and *E. colona* under different densities of *E. colona* (mean of two seasons)

Treatment (Density of *E. colona* plants)	40 DAS		60 DAS	
	Rice	*E.colona*	Rice	*E. colona*
Sole rice (T_0)	2.26	-	3.64	-
50 (T_{50})	2.13	1.96	3.03	2.93
100 (T_{100})	2.03	2.00	2.78	2.84
200 (T_{200})	1.79	1.90	2.60	2.61
300 (T_{300})	1.74	1.66	2.31	2.41
400 (T_{400})	1.71	1.53	1.99	2.23
Sole *E. colona* (T_{Max})	-	1.43	-	2.14
LSD (P=0.05)	0.06	0.04	0.15	0.05

Table 4. Yield attributes of rice crop under different densities of *Echinochloa colona* (mean of two seasons)

Treatment (Density of *E. colona* plants)	Effective tillers/m^2	Panicle length (cm)	No. of grains/panicle	Test weight (g)
Sole rice (T_0)	340	18.4	84.0	24.1
50 (T_{50})	242	17.9	53.0	23.7
100 (T_{100})	195	16.1	42.7	23.5
200 (T_{200})	167	13.9	37.8	23.3
300 (T_{300})	115	13.5	31.7	22.8
400 (T_{400})	90	12.5	24.7	22.1
Sole *E. colona* (T_{Max})	0	0	0	0
LSD (P=0.05)	15	0.6	2.3	0.2

Effect on grain yield

The decrease in panicle length, number of grains per panicle and 1000 grain weight contributed to reduction in yield with increasing population density of *E. colona* from 0 to 400 plants/m^2. The reduction in grain yield increased from 48% at T_{50} to 86% at T_{400}. Maximum grain yield was recorded in weed free treatment (T_0) where there is no competition for growth factors between the rice plant and weeds (Fig. 1). These findings are also supported by the findings of Walia and Singh (2005).

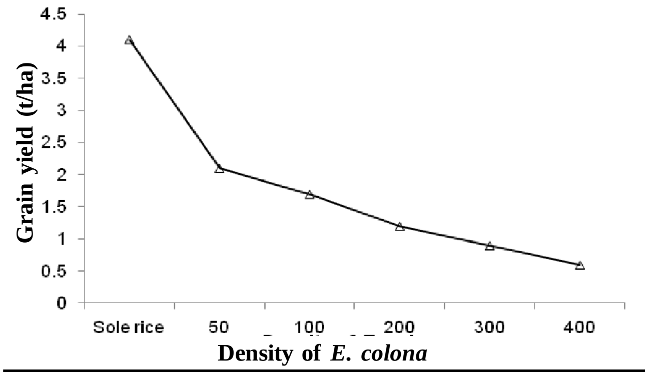

Fig. 1. Impact of increasing density of *E. colona* on grain yield of rice

The study conclusively showed that the productivity of rice decreases drastically as the density of *E. colona* increased from 50 to 400 plants/m^2.

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