

Interspecific Competition Between *Echinochloa colona* and Rice

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*Echinochloa colona*와 直播벼 간의 種間競爭에 관한 研究

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ABSTRACT

Interspecific competition between *E. colona* and rice was determined over four growth stages in replacement series. No competition between the two species as measured by plant height, leaf area and dry weight occurred by 30 days after seeding (DAS) at all the density combinations studied. At 45 DAS reductions in leaf area and dry weight of *E. colona* due to the competition occurred at the density combinations where number of competing *E. colona* plant was less than that of rice. However, there was a great increase in leaf area and dry weight of *E. colona* at the density combination of one *E. colona* competing with four rice plants at 60 DAS. As the number of *E. colona* plants increased, the leaf area and dry weight of *E. colona* decreased resulting from intraspecific competition between *E. colona* plants. Although rice absorbed more nitrogen than *E. colona* up to 30 DAS, the reverse was observed from 45 DAS. A relatively small amount of phosphorous was absorbed by both rice and *E. colona*, but the amount of phosphorous taken up by *E. colona* was greater than that taken up by rice. *E. colona* absorbed extremely high amount of potassium when compared to rice.

Key words : Competition, Rice, *Echinochloa colona*

INTRODUCTION

Echinochloa colona is one of the most serious weeds in several major crops in the tropics (4). Mercado and Talatala (6) determined a 76% yield reduction in direct-seeded rainfed rice caused by natural density of 280 plants/m². Dewit (1, cited in Alkamper) reported that in Venezuela untreated plots of upland rice infested with *E. colona* gave no yield. Kapoor and Ramakrishnan (5) observed that in moderately moist and loamy soil, *E. colona* suffered more from competition when associated with broadleaf weeds than when associated with grassy weeds.

Extensive reviews on nutrient uptake by weeds and crops have been made by Alkamper (1) and Moody (7). In general, weeds have a large requirement for nutrients and have higher mineral contents in comparison with crops. Alkamper (1) reported that *E. colona* increasingly profited at high fertilizer levels, whereas rice absorbed more nutrients than the weed at a low level of added fertilizer. However, patterns of nutrient uptake vary with plant species. For instance, Pons and Utomo (9) observed that *Echinochloa crus-galli* (L.) Beauv. had a higher nitrogen content than rice 4 weeks after transplanting (WAT) but the content decreased sharply in *E. crus-galli* so that by 6 WAT, it was lower than that of rice.

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This study was undertaken to investigate the competitive ability of *E. colona* against upland rice with respect to the growth and nutrient uptake pattern of the two competing species.

MATERIALS AND METHODS

The experiments were conducted in the Agronomy greenhouse at the International Rice Research Institute (IRRI), Los Banos, Philippines. The soil type was a sandy clay loam (pH 6.3, organic matter 0.46%, Total N 0.07%, and CEC 26 meq/100g). An ecotype (IRRI green) (2) of *E. colona* was collected at IRRI field and grown to maturity in the greenhouse to obtain uniform seeds. Excess seeds of *E. colona* and rice (cv. C171-136) were sown 0 and 2 cm deep, respectively, in a plastic pot (25 x 22 cm) and the seedlings were thinned down on emergence to the desired level. The density combinations of *E. colona* versus rice in a replacement series model (3,10) were 0:5, 1:4, 2:3, 3:2, 4:1, and 5:0. Fifty kg/ha of nitrogen as urea were applied 0 and 15 DAS, respectively. There were 16 replications.

At 15-day intervals, four replications were selected at random and harvested to determine plant height, leaf area, and dry weight (dried 80°C for 3 days) of the two competing species. The dry matter was analyzed for nitrogen, phosphorus, and potassium using the method described by Varley (11).

RESULTS AND DISCUSSION

The height of rice was taller than *E. colona* 15 DAS in all the density combinations but the relationship was reversed from 45 DAS (Table 1). The growth of rice at the early growth stages was much faster than that of *E. colona*, which was attributed to the heavier seed weight. Similar results were obtained by Pons (8) between rice and *E. crus-galli* and *E. colona*.

The height of rice and *E. colona* was unaffected by competition up to 45 DAS, the height of *E. colona* at 4:1 combination was taller than that in monoculture. On the other hand, the height of rice was not affected by *E. colona* competition at the all density combinations employed. This indicated that there was no interspecific competition for light between rice and *E. colona*, but there was intraspecific competition for light between *E. colona* plants.

Leaf area development of the two associated plants is shown in Table 2. *E. colona* gained an increasing advantage over rice in leaf area in the mixtures from 45 DAS to the end of the experiment. At 45 DAS leaf area of an individual *E. colona* plant either in the mixtures or in monoculture was greater than that of the rice plant. As the competition continued, *E. colona* benefited for producing greater leaf area from the competition with rice. The leaf area of an individual rice plant in the mixtures was significantly less than that in monoculture at 60 DAS,

Table 1. Plant height of dryland rice and *Echinochloa colona* as affected by interspecific competition.

Density combination (Rice vs <i>E. colona</i>)	Plant height (cm)							
	Rice				<i>E. colona</i>			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
5:0	29.9a	37.7a	57.2a	83.2a	-	-	-	-
4:1	26.5a	36.3a	57.5a	85.9a	15.7a	34.4a	71.5a	104.4a
3:2	26.8a	32.5a	62.3a	13.9a	36.2a	66.1a	66.1a	99.7ab
2:3	27.9a	34.4a	60.6a	84.8a	14.9a	31.5a	67.3a	96.5ab
1:4	24.6a	39.3a	65.5a	84.3a	14.8a	38.3a	71.0a	93.5ab
0:5	-	-	-	-	14.3a	36.2a	67.7a	92.2b

^aIn a column, means followed by a common letter are not significantly different at the 5% level by Duncan's Multiple Range Test. DAS=days after seeding.

Table 2. Leaf area of dryland rice and *Echinochloa colona* as affected by interspecific competition.

Density Combination (Rice vs <i>E. colona</i>)	Leaf area (cm ² /plant)							
	Rice				<i>E. colona</i>			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
5 : 0	8.9a	26.7a	108.5a	304.6a	-	-	-	-
4 : 1	9.1a	26.2a	112.1a	243.8b	2.0a	23.5a	211.6c	2063.7a
3 : 2	8.9a	25.1a	115.2a	251.9a	1.9a	22.5a	233.1bc	1149.3b
2 : 3	9.4a	24.3a	115.0a	230.9b	2.1a	24.9a	243.6ab	810.9c
1 : 4	9.5a	25.5a	117.7a	234.0b	1.8a	25.0a	262.4a	793.5c
0 : 5	-	-	-	-	2.0a	22.8a	252.8a	762.0c

^aIn a column, means followed by a common letter are not significantly different at the 5% level by Duncan's Multiple Range Test. DAS=days after seeding.

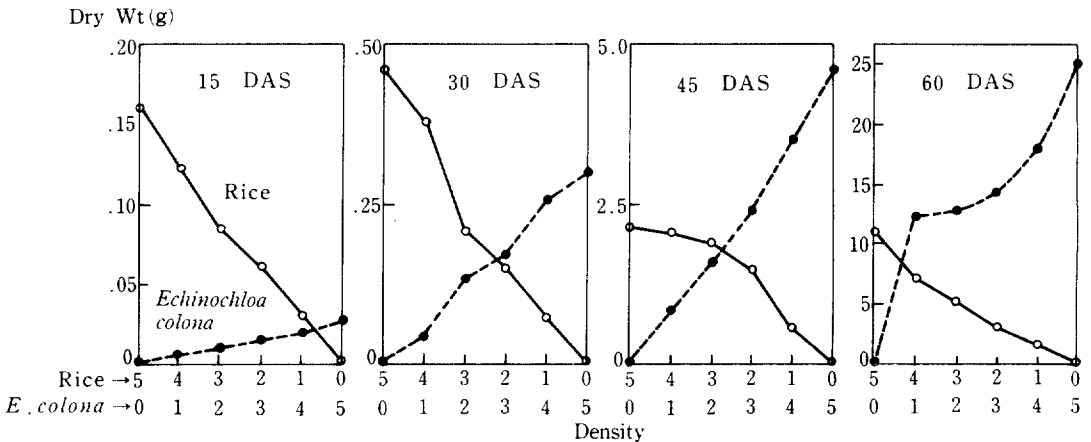


Fig. 1. Dry weight of dryland rice and *Echinochloa colona* as affected by interspecific competition. (DAS=days after seeding.)

whereas the reverse occurred for *E. colona*. In addition, increasing the density of *E. colona* plant at 60 DAS. This implied that there was a strong intraspecific competition between *E. colona* plants.

Dry weight of the two competing species was not affected by the interspecific competition up to 30 DAS (Fig. 1). In monoculture, the dry weight of *E. colona* did not exceed that of the rice and the dry weight of the two species in the mixtures linearly increased as the number of plants increased. A great increase in dry weight of *E. colona* was observed from 45 DAS to 60 DAS.

The competitive ability of rice and *E. colona* could be determined by the replacement diagram. In a replacement series model, the growth of a species which is more competitive over the other competing species shows a convex curve, while the less competitive species depicts a concave

curve (3). There was no clear interspecific competition by 30 DAS. At 45 DAS a convex curve of the dry weight was obtained by the density combination of two rice plants with three *E. colona* plants. This suggested that at the density combinations rice was more competitive than *E. colona*. However, this trend did not continue when one rice plant was competing with four *E. colona* plants, indicating that the competitive ability of rice decreased with decreasing number of rice plants associated. Thereafter the competitive ability of *E. colona* was greatly increased. At all the density combinations employed, the dry weight of rice plants showed a concave curve at 60 DAS, whereas *E. colona* gave a convex curve at the density combination of four rice plants with one *E. colona* plant and a concave curve from the density combination that more than two *E. colona* plants

were competing. This implied that *E. colona* became more competitive than rice and there was an intraspecific competition between *E. colona* plants.

E. colona was a strong competitor against rice for nutrients such as nitrogen, phosphorus, and potassium. Rice absorbed more nitrogen than *E. colona* in all the density combinations at 15 and 30 DAS. However, at 45 and 60 DAS, the amount of nitrogen taken up by *E. colona* was invariably higher than that taken up by rice (Fig. 2). Although at the early growth stage the total amount of nitrogen absorbed was greater in rice than in *E. colona*, the nitrogen concentration in

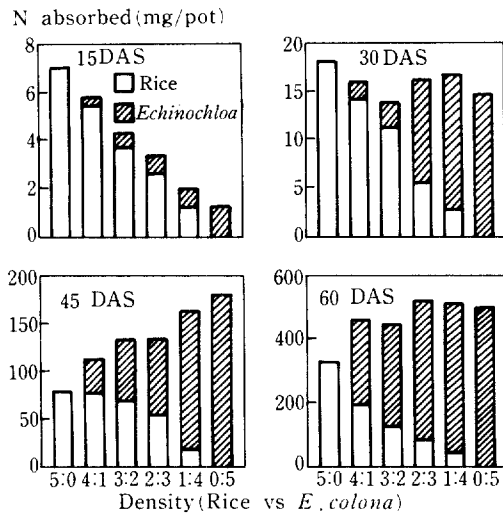


Fig. 2. Nitrogen uptake of dryland rice and *Echinochloa colona* as affected by interspecific competition. (DAS=days after seeding.)

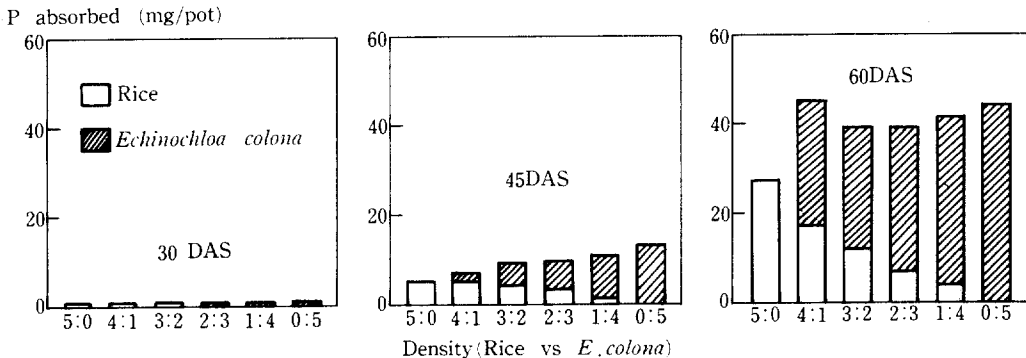


Fig. 3. Phosphorus uptake of dryland rice and *Echinochloa colona* as affected by interspecific competition. (DAS=days after seeding.)

terms of percentage (data not presented) was higher in *E. colona* than in rice. The average nitrogen levels of all the density combinations were 4.34 and 5.01% at 15 DAS and 3.72 and 4.79% at 30 DAS for rice and *E. colona*, respectively. The relationship continued up to 45 DAS (3.64% N in rice and 4.13% N in *E. colona*). However, at 60 DAS the nitrogen level of *E. colona* decreased sharply to 2.62% which was lower than that of rice (2.75% N).

Although a relatively small amount of phosphorus was absorbed by both rice and *E. colona*, the uptake patterns depicted the competition for phosphorus (Fig. 3). In monoculture, the total amount of phosphorus absorbed by rice at 60 DAS was 27.8 mg/pot, whereas 44.4 mg/pot was taken up by *E. colona*. On the other hand, one *E. colona* at a 4:1 density absorbed 27.3 mg P/plant which was greater than the amount of phosphorus taken up by four rice plants (17.7 mg P), and more than half of the total amount of phosphorus absorbed by five *E. colona* in monoculture. This was due to the strong interspecific competition for phosphorus.

During the competition period, the patterns of phosphorus uptake by rice and *E. colona* differed considerably. The phosphorus levels in rice remained at about 0.25% throughout the period. In contrast, the levels in *E. colona* declined from 0.37% at 30 DAS to 0.21% at 60 DAS.

The pattern of potassium uptake was similar to that of nitrogen (Fig. 4), but extremely high

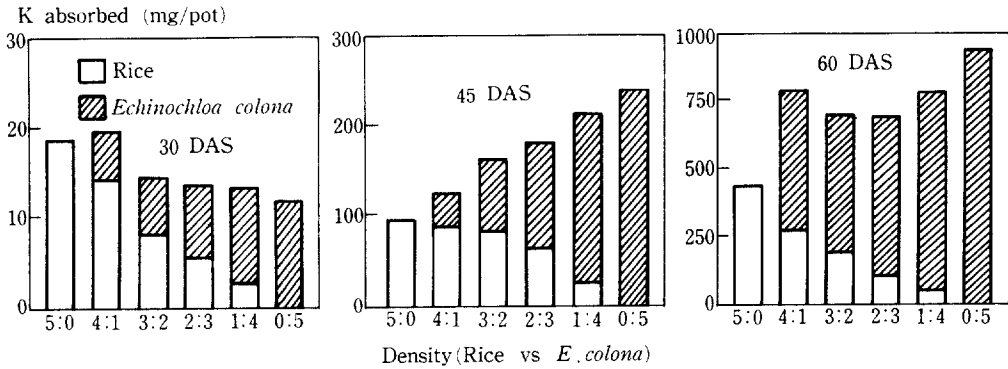


Fig. 4. Potassium uptake of dryland rice and *Echinochloa colona* as affected by interspecific competition. (DAS=days after seeding.)

contents of potassium were obtained in *E. colona* when compared with those of nitrogen and phosphorus. At 60 DAS, the total amount of potassium taken up by *E. colona* in monoculture. High uptake of potassium by *E. colona* was also noticed by Alkamper (1). The levels of potassium in *E. colona* (5.09 and 4.04% at 30 and 60 DAS, respectively) were higher than that of rice (4.21 and 3.66% at 30 and 60 DAS, respectively) throughout the competition period.

摘 要

Echinochloa colona (L.) Link와 直播벼 간의 種間競合을 生育時期에 따라 調査하였다. 두 草種間 草長, 葉面積 및 乾物重에 대한 競合은 播種後 30日까지는 全競合密度 條件에서 일어나지 않았다. 競合에 의한 *E. colona*의 葉面積 및 乾物重의 減少는 播種後 45日에 *E. colona*의 密度가 벼보다 적은 競合密度 條件에서 나타났다. 그러나 播種後 60日에 한 本의 *E. colona*가 4本の 벼와 競合하는 密度 條件에서 *E. colona* 密度의 增加와 함께 *E. colona*의 葉面積 및 乾物重은 種內 競合 때문에 減少되었다. 播種後 30일 까지 벼는 *E. colona* 보다 많은 窒素를 吸收하였으나, 播種後 45日부터는 反對 現狀을 나타내었다. 벼와 *E. colona* 모두 比較的 적은 量의 磷을 吸收하였으나, *E. colona*의 吸收量이 벼의 것보다 많은 傾向이었다. *E. colona*는 벼의 比하여 극히 많은 量의 加里를 吸收하였다.

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