

## THRESHOLD DENSITY OF *ECHINOCLOA CRUSGALLI* (L) BEAUV. IN RICE WEED COMPETITION

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(Date of receipt : 19.11.85)

(Date of acceptance : 10.10.86)

**Abstract :** Experiments were conducted to determine the threshold *Echinochloa crusgalli* (L) Beauv. density in transplanted rice at the Regional Research Station, Angunukolapalessa, during the seasons Maha 1984/85 and Yala 1985. The soil of the experimental site was Ranna series of Reddish Brown Earths. The data indicated that the threshold *E. crusgalli* density at season long interspecific competition with rice was five plants per square meter. The decrease in yield at this weed density level was 8 - 17 per cent. The sensitive yield components of rice for the interspecific competition with *E. crusgalli* were the panicle number and the spikelet number per panicle. Projecting the data for broadcast rice the threshold level of *E. crusgalli* density was 6% of the total density. Weed dry weight gave highly significant negative correlation with grain yield and paddy straw weight.

### 1. Introduction

One of the major problems that reduces the rice yields world over is weed competition. Many weed species, vary from area to area and compete with rice in the field. Economics and statistics of the United States, Department of Agriculture (U.S.D.A.) reported that worldwide losses from weeds in rice was 33 m. metric tons annually valued at 12 billion dollars. Datta<sup>3</sup> reported that annual and perennial weed infestation reduced rice grain yields 20-80% depending on the method of establishment and in transplanted rice 11% reduction was observed.

In Sri Lanka, both annual and perennial weeds compete with lowland rice reducing the rice grain yields drastically. *Echinochloa crusgalli* (L) Beauv. among large number of genera in *Echinochloa* spp., is one of the most noxious weeds. *Echinochloa colonum* is second in importance.<sup>5</sup> Smith<sup>10</sup> reported that in the U.S.A. season long competition from *E. crusgalli* reduced grain yield by 25-70% and at a density of 11 plants/m<sup>2</sup> reduced grain yields inversely to rice stands. Chang<sup>2</sup> indicated that weed species at different densities vary in their competitiveness with rice and *E. crusgalli* at densities 100-200 plants/m<sup>2</sup> reduced rice yields 86-91%, respectively.

The method of land preparation and fertiliser practice also encourages the growth of weed species. Arai and Matsunaka<sup>1</sup> reported that emergence of *E. crusgalli* in transplanted rice was greatly reduced, when the field was ploughed 15 — 18 cm deep. Smith *et al.*<sup>11</sup> showed that pre-planting application of phosphorous stimulated the growth of *E. crusgalli*. Kleining and Noble<sup>6</sup> indicated at moderate levels of N (140 kg/h) grain yield of rice was inversely proportional to the density of *E. crusgalli*. In the present study, threshold density of *E. crusgalli* in lowland transplanted rice was determined with recommended rates of fertiliser application.

## 2. Materials and Methods

The experiments were conducted at the Regional Research Station, Angunukolapalessa, during the wet season (Maha) 1984/85 and dry season (Yala) 1985. Both experiments, *viz*; wet season and dry season, were conducted under rainfed conditions with supplementary irrigation, because of exceptionally high rainfall during the dry season. During experimentation, total rainfall of 251 mm and 365 mm and average sunshine hours of 6.79 and 6.85 per day were received during Maha 1984/85 and Yala 1985 seasons, respectively. In both experiments, 6m x 3m plots were used in a randomized complete block design replicated three times. The soils of the experimental site belonged to Ranna series of Reddish Brown Earths in the intermediate land class.

Three-month age group rice cultivars Bg 276—5 (Maha season) and Bg 34—8 (Yala season) were used. Seven treatments 1,3,5,10,15 and 20 *E. crusgalli* plants/m<sup>2</sup> and a control were used during the Maha season. In the Yala experiment, an additional treatment with 25 *E. crusgalli* plants/m<sup>2</sup> was used. Wet bed nurseries of both rices and *E. crusgalli* were raised and the rice was transplanted at the age of 21 days at a spacing of 20 cm x 20 cm with 3 plants/hill. The required density of *E. crusgalli* was also transplanted along with the rice and was well spaced in the plot. Fertiliser application and pest and disease control was carried out as per recommendations of the Department of Agriculture.<sup>4</sup>

Plant height and flag leaf length at harvest were measured from 10 plants selected at random. Tiller count/m<sup>2</sup> at 30 days after transplanting (DAT) and at harvest, yield components *viz*; panicle number/m<sup>2</sup> 1000 seed weight, percentage filled grain, spikelets/panicle and panicle length from 10 panicles selected at random, were measured from each treatment. Paddy was harvested and *Echinocloa* straw was separated from paddy straw before threshing and weighed. After threshing and winnowing, grain weight and paddy straw weight were recorded.

Table 1. Grain yield and percentage yield loss of Bg 276-5, Maha 1984/85 season

Treatment	Grain yield mt/ha	% yield loss over control
Control	4.95 a	—
1 weed/m <sup>2</sup>	4.79 ab	3.23
3 weed/m <sup>2</sup>	4.35 abc	12.12
5 weed/m <sup>2</sup>	4.11 abc	16.96
10 weed/m <sup>2</sup>	3.93 bc	20.80
15 weed/m <sup>2</sup>	3.52 c	24.03
20 weed/m <sup>2</sup>	3.78 c	23.63

Any two means followed by the same letter is not significantly different at 5% probability level.

### 3. Results

Table 1 shows the results of the Maha 84/85 season experiment. In this experiment, yield component data were not taken except the panicles/m<sup>2</sup> and rice grain yields. Rice grain yield decreased with an increase in density of *Echinochloa* and was significant when it exceeds 5 plants/m<sup>2</sup>.

Results of Yala season are presented in Tables 2 and 3. The plant height and flag leaf length showed no significant differences, whereas a significant drop in tiller count was observed at *Echinochloa* density of 25 plants/m<sup>2</sup>. Among the other yield components, panicles/m<sup>2</sup> indicated a significant drop when the *Echinochloa* density exceeds 10 plants/m<sup>2</sup> (Table 2). Effect of competition on spikelet number/panicle shows that there were no significant differences among the treatments, but the treatments were significant compared to the control. Rest of the yield components do not show significant differences. Grain yield data indicate that weed density exceeding 5 plants/m<sup>2</sup> results in a significant drop (Table 3). Further, the rice straw yield also decreased with increase in *Echinochloa* density.

Correlation analysis of weed straw weight with grain yield and rice straw yield of dry season data shows a highly significant negative correlation, -0.97 and -0.91, respectively.

Table 2. Tiller count at 35 DAT, panicle number and spikelet number per panicle at harvest of Bg 34-8, Yala 1985

Treatment	Tillers/m <sup>2</sup>	Panicles/m <sup>2</sup>	Spikelets per panicles
Control	297.5 a	247.5 a	225.4 a
1 weed/m <sup>2</sup>	307.3 a	227.5 ab	196.6 b
3 weed/m <sup>2</sup>	295.0 a	237.5 ab	187.9 b
5 weed/m <sup>2</sup>	315.0 a	210.0 ab	187.5 b
10 weed/m <sup>2</sup>	292.5 a	225.0 ab	197.1 b
15 weed/m <sup>2</sup>	277.5 a	192.5 b	174.8 b
20 weed/m <sup>2</sup>	265.0 a	197.5 b	178.3 b
25 weed/m <sup>2</sup>	197.5 b	165.0 c	185.9 b

Any two means followed by the same letter is not significantly different at 5% probability level.

Table 3. Grain yield, straw and weed weight at different densities of *Echinochloa*, Yala 1985.

Treatment	Grain yield mt/ha	Straw weight mt/ha	Weed Dry weight mt/ha	% yield loss over control
Control	4.68 a	4.50 a	—	—
1 weed/m <sup>2</sup>	4.20 ab	3.84 abc	0.57 d	10.25
3 weed/m <sup>2</sup>	4.37 a	3.92 ab	1.43 c	6.62
5 weed/m <sup>2</sup>	4.29 ab	2.91 cd	1.01 d	8.33
10 weed/m <sup>2</sup>	3.41 b	2.78 d	3.18 b	27.13
15 weed/m <sup>2</sup>	3.43 b	2.85 c	2.94 c	26.70
20 weed/m <sup>2</sup>	3.04 c	2.47 d	4.24 b	35.04
25 weed/m <sup>2</sup>	1.94 d	1.51 c	5.65 a	58.54
Correlation Coefficient Weed weight	- 0.97	- 0.91	—	—

Any two means followed by the same letter is not significantly different at 5% probability level.

#### 4. Discussion and Conclusions

Plant height at harvest in both seasons and flag leaf length during dry season showed no significant differences among treatments even though there were slight differences in height with increased *Echinochloa* density.

Tillers/m<sup>2</sup> at 35 DAT indicated that there appears to be no effect (Table 2) on increase in density of *Echinochloa* upto 20 plants/m<sup>2</sup>. However equal number of hills planted to rice and *E. crusgalli* (25 plants/m<sup>2</sup>) indicated a 33% drop in tiller number which was significant. On the other hand, panicle number at harvest, which is also the effective tiller number, showed significant differences among treatments and a decreasing trend with the increase in *E. crusgalli* density/m<sup>2</sup>. This also indicates that increased interspecific competition with increased weed density rendered a greater number of tillers ineffective, thus bringing about significant differences in panicle number among treatments. Noda<sup>9</sup> also indicated that *E. crusgalli* competition during maximum tillering reduces the panicle number, while during early ripening reduces grain yield and quality. Data further indicated that the spikelet number/panicle was highly sensitive to interspecific competition rendered by *E. crusgalli* and gave a significant drop even at a density of 1 weed/m<sup>2</sup>. Further significant decrease in spikelet number, was not observed even if the *E. crusgalli* density increased to 25 plants/m<sup>2</sup>. The percentage filled grain and 1000 seed weight did not show significant differences among treatments.

Grain yield in both seasons with season long interspecific weed competition decreased with the increase in *E. crusgalli* density and was significant when it exceeds 5 plants/m<sup>2</sup>. At this threshold level, the decrease in grain yield over the zero weed density was 8.33% and 16.9% during Yala and Maha seasons respectively. Datta<sup>3</sup> also indicated season long competition by mixed annual and perennial weeds reduced grain yield by 11% in transplanted rice. The threshold level as a percentage of total density (75 rice plants and 5 *E. crusgalli* plants) was 6.2%. Thus if we were to project this data for broadcast sown rice, we can safely conclude that a significant drop in grain yield could be expected if the *E. crusgalli* density exceeds 6%. Further, increasing the *E. crusgalli* density to 25 plants/m<sup>2</sup>, a 58.5% drop in grain yield was observed and at this density all the planting hills were shared by 3 rice plants and a single weed. Smith<sup>10</sup> indicated similar results where season long competition at density levels, 3 rice and 25 *E. crusgalli* plants/ft<sup>2</sup> and 31 rice and 25 *E. crusgalli* plants/ft<sup>2</sup> resulted in 79% and 95% rice yield reduction, respectively. Noda<sup>9</sup> also indicated that competition at early ripening stage reduced rice grain yield and quality. Lubigan and Vega<sup>7</sup> showed that *E. crusgalli* density of 20 plants/m<sup>2</sup> reduced grain yield by 20%.

These data indicate that *E. crusgalli* at very low densities renders a very high competition to rice. The highly competitive nature of this weed could be attributed to its physiological superiority, being a plant following  $C_4$  photosynthetic pathway.  $C_4$  plants normally have a very high growth rate and a high dry matter production, as reflected in these experiments. At the highest weed density level (25 plants/m<sup>2</sup>), while competing with 3 rice plants at the same hill, gave 5.65 mt/ha dry matter production whereas the control treatment (25 hills/m<sup>2</sup>, with 3 rice plants per hill) with only intra-specific competition rice plants gave 4.50 mt/ha (Table 3).

Correlation analysis showed a very high significant negative correlation between weed dry weight and grain yield. Significant negative correlation between weed dry weight and rice straw indicate an increase in weed dry matter with the increase in weed density and a corresponding decrease in rice straw weight due to increasing intensity of inter-specific competition (Table 3). Matsunaka<sup>8</sup> indicated that a linear relationship existed between weed density and yield loss, at *E. crusgalli* densities normally encountered in the field. At threshold population level decrease in rice straw weight due to interspecific competition was 35.3% even though the decrease in grain yield was 8.33%.

In conclusion, the threshold *E. crusgalli* density with season long inter-specific competition was 5 plants/m<sup>2</sup> and the decrease in yield was 8.33 – 16.9%. The major contributory yield components decreasing grain yield with the increase in weed population were panicles/m<sup>2</sup> and the spikelet number/panicle. Significant negative correlation between weed dry weight with grain yield and rice straw weight was also observed.

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