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Types of Weed Community in Transplanted Lowland Rice and Relationship between Yield and Weed Weight in Weed Communities

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논 雜草의 群落型 種類와 群落型別 雜草發生과 水稻收量과의 關係

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ABSTRACT

Eight different weed community types growing in association with transplanted rice were identified in the experimental fields used in these studies.

The Importance Value (I.V.) of weed species growing in association with rice changed with time. The I.V. of *Echinochloa glabrescens* Munro ex Hook f. increased from 40 days after transplanting (DAT) until heading and then, decreased from heading to maturity of rice. However, the I.V. of *Monochoria vaginalis* (Burm.) Presl. and *Echinochloa crus-galli* ssp. *hispidula* (Retz.) Honda increased from 40 DAT to maturity while *Scirpus maritimus* L. decreased from 40 DAT.

There was a high negative correlation between grain yield and weed weight at rice heading in all weed communities. The competitive ability of rice against weeds varied depending upon weed species. The highest yield decrease due to weed competition was obtained from the *E. crus-galli* ssp. *hispidula-S. Maritimus* community. Forty-two percent yield reduction was caused by competition of 100g dry weight of weeds per square meter of this community type at rice heading. The yield decrease for the same amount of weeds was 10% for the *E. glabrescens* community, 15% for the *M. vaginalis* community and the *M. vaginalis-Scirpus supinus* L. community and 21% for the *M. vaginalis-E. glabrescens-Fimbristylis littoralis* Gaud.-*S. maritimus* community type.

INTRODUCTION

The weed vegetation of a particular area is determined by many interrelated factors such as climatic, edaphic, and biotic factors. In a given environment, however, the weed vegetation is most strongly affected by the biotic factor, particularly, by cultural practices such as irrigation, fertilizer, cultivar grown, tillage, herbicide, and crop rotation.

The degree and nature of competition between rice and weeds are dependent upon the weed species growing in association with rice. Therefore, for a comprehensive understanding about crop damage due to weed competition, the weed vegetation should be sampled and analyzed at the correct rice growing stage.

Information on the degree and pattern of weed damage to the rice plant, caused by competition for light, nutrients, and water, is needed to establish a feasible weed control method. Competition between rice and weeds is influenced by the season as which the crop is sown, the weed species present and their habit, and the growth rate and density of both rice and weeds.

Several authors have reported that *Echinochloa* sp. are more competitive than *M. vaginalis,* causing higher yield reductions (Lubigan and Vega, 1971; Arai and Kawashima, 1956; Naidu and Bhan, 1979; IRRI, 1967, 1968). Arai (1967) reported that the rate of decrease of rice yield was larger from competition with *M. vaginalis* than with *Echinochloa crus-galli* (L.) Beauv. The relationship between weed weight and grain yield was linear at maturity. The yield decrease due to weed competition was approximately 13% for *M. vaginalis* and 8% for *E. crus-galli* when the weed weight at maturity was 100 g/m^2.

The experiments reported here were conducted to define the weed community type in transplanted lowland rice and to determine the relationship between yield and weed weight of different weed communities.

MATERIALS AND METHODS

Eleven field experiments were conducted at the International Rice Research Institute experimental farm in 1978 and 1979. Each field in which an experiment was conducted was considered as a different vegetation complex. Weed samplings were taken 40 DAT, at rice heading, and at rice maturity.

For quantitative vegetation analysis, however, the weed weight at rice heading in the weedy check plots was used because the floristic composition of the transplanted lowland area was distinct and dry matter production of weeds reached at a maximum at this time.

Each field was plowed once and harrowed three times at 7 to 10 day intervals. The final harrowing was done 1 day before transplanting to level the field and to incorporate the basal fertillizers and insecticide. Eighty kilogram of nitrogen per heactare was applied in three equal splits; basally, at maximum tillering, and at panicle initiation while 40 kg P_2O_5/ha and 40 kg K_2O/ha were applied as basal applications.

For insect control, carbofuran (2, 3-dihydro-2, 2-dimethylbenzofuran-7-ylmethylcarbamate) at 1.5kg active ingredient (a.i)/ha was applied basally and ethylan /1,1-dichloro-2,2-bis (4-ethylphenyl) ethane/ at 0.75 kg a.i./ha was applied at 2-to 3-week intervals.

The following information was used in determining the weed community type.

The I.V. of a species indicates the degree of dominance of a species over the other species in a given sample plot. Simpson's index (Cited in Whittaker, 1965), which is a measure of concentration of dominance can be used to determine the degree of diversity in a given community type. These can be determined using the following equations:

$$\text{Importance value(I.V.)} = \frac{\text{Dry weight of each species in a community}}{\text{Dry weight of all species in a community}} \times 100$$

$$\text{Simpson's index} = \Sigma\ (Y/N)^2$$

where, Y = I.V. of a given species.
N = the sum of the I.V.'s for all species in the sample.

Weed community type can be defined by a two-dimensional ordination diagram. An aggregation of sample plots in a two-dimensional ordination diagram is a conceptual grouping of a number of stands of similar morphology and biotic composition (Sajise et al., 1976; Newsome and Dix, 1968). A community type is defined by a single species or a combination of species that have a restricted range of distribution over the entire sample spectrum. The methods of ordination analysis were as follows:

The *similarity coefficients* of each community were determined by using the I.V. s. The similarity coefficient (C) which reflects the degree of similarity between the communities in terms of floristic composition was calculated using the equation,

$$C = \frac{2W}{a + b} \times 100$$

where W = sum of the lower I.V. s of species shared by two communities.
a = sum of the I.V.'s of all species in the first community.
b = sum of the I.V.'s of all species in the second community.

The community similarity coefficient was converted to a dissimilarity coefficient (D) by the equation,

$$D = 100 - C$$

where C = the similarity coefficient.

A two-dimensional ordination system was used in locating the position of each plot in the ordination diagram. The two most dissimilar stands were determined and the other stands were located with reference to them. The similarity values of each stand were totalled and the stand having the least similarity total (or the greatest dissimilarity total) was designated as stand A and assigned a value of O along the X-axis. Stand B which had the greatest dissimilarity to stand A was selected and assigned a value of 100 along the X-axis. The distance(x) of each of the remaining stands from A and B was calculated using the equation,

$$X = \frac{(L)^2 + (DA)^2 - (DB)^2}{2L}$$

where L = dissimilarity value between stand A and stand B.

DA = dissimilarity value between stand A and stand in question.

DB = dissimilarity value between stand B and the stand in question.

In selecting stand B, there were at least three similarity values of 50% or above shared by the stand under consideration with the other communities. This was to avoid using two reference communities which were totally dissimilar. The poorness of fit(e) associated with each stand was calculated using the equation,

$$e = \sqrt{DA^2 - X^2}$$

where DA = dissimilarity value between stand A and the stand in question.

X = computed distance of the stand in question with reference to stand A and stand B.

The stand having a maximum value for e or having the poorest fit was designated as A′ and assigned a value of O on the Y-axis. B′ was determined by the same method used in obtaining B′ and was assigned a value of 100 along the Y-axis. The distance(Y) of each of the remaining stands from A′ and B′ was then calculated using the equation,

$$Y = \frac{(L')^2 + (DA')^2 - (DB')^2}{2L'}$$

where L′ = dissimilarity value between stand A′ and stand B′.

DA′ = dissimilarity value between stand A′ and the stand in question.

DB′ = dissimilarity value between stand B′ and the stand in question.

To test the relationship between the direct distance (S) of the stand under consideration and its dissimilarity value (D), a correlation coefficient, r, was computed. For this purpose, 15 random pairs of communities were used. The direct distance (S) between communities in each random pair was obtained using the equation,

$$S = \sqrt{DX^2 + DY^2}$$

where DX = difference of stands in a random pair on the X-axis.

DY = difference of stands in a random pair on the Y-axis.

The correlation coefficient, r, was then calculated using the equation,

$$r = \frac{\Sigma\, x \cdot y}{\sqrt{\Sigma x^2 \cdot y^2}}$$

RESULTS AND DISCUSSION

Eleven weed species were included in the quantitative vegetation analysis. These include three Gramineae, five Cyperaceae and one Pontederiaceae, one Sphenocleaceae and one Compositae species (Table 1).

The sample plot arrangement of transplanted

Table 1. List of weed species included in the quantitative vegetation analysis.

A. Gramineae

Echinochloa glabrescens Munro ex Hook f.
E. crus-galli (L.) Beauv. ssp. hispidula(Retz.) Honda
Paspalum distichum L.

B. Cyperaceae

Cyperus difformis L.
C. iria L.
Scirpus maritimus L.
S. supinus L.
Fimbristylis littoralis Gaud.

C. Pontederiaceae

Monochoria vaginalis (Burm.) Presl.

D. Sphenocleaceae

Sphenoclea zeylanica Gaertn.

E. Compositae

Eclipta alba (L.) Hassk.

lowland rice fields based on lthe floristic composition in a two-dimensional ordination diagram is shown in Fig. 1. The correlation coefficients between dissimilarity values and distances between sample plots in the ordination diagram were highly significant (r = 0.729**). Therefore, based on these results, the community types were defined.

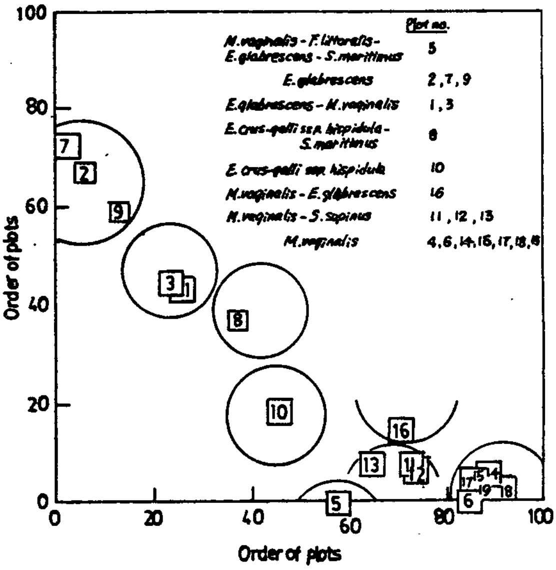

Fig. 1. Distribution of sample plots based on floristic composition using a two-dimensional ordination diagram. The dominant species in each plot is indicated by a square. The size of each square is related to its degree of dominance expressed as Importance value(I.V.) which is based on dry weight. The order of plots refers to their positions along the x-and Y-axes. Circles indicate probable boundaries of each community type on the ordination diagram. IRRI, 1978.

In his experimental fields there were eight different community types.

The floristic composition of each community was as follows:

M. vaginalis community type — An aggregate of seven sample plots constituted this community type. Based on the I.V., this community was almost exclusively dominated by *M. vaginalis* (Fig. 2).

E. glabrescens community type — Three sample plots were included under this community type. The I.V. of *E. glabrescens* in this community was approximately 70% (Fig. 3).

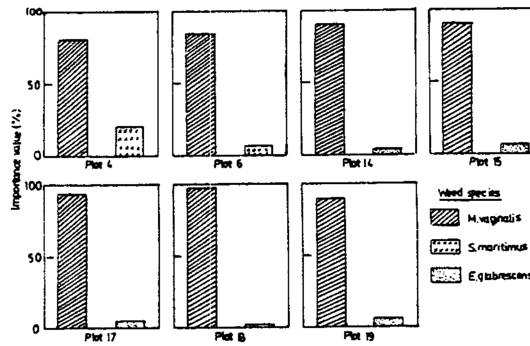

Fig. 2. Floristic composition of *M. vaginalis* community type. IRRI, 1978.

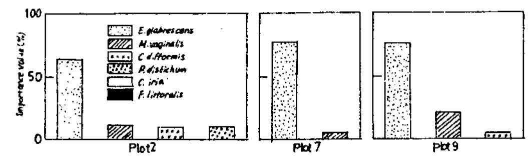

Fig. 3. Floristic composition of *E. glabrescens* community type. IRRI, 1978.

E. glabrescens-M. vaginalis community type — Two sample plots belonged to this community type. In this community, the I.V. of *E. glabrescens* was higher than that of *M. vaginalis.* The I.V. s were approximately 50 and 30%, respectively. Two other species, *Cyperus iria L.* and *Paspalum distichum L.* had I.V.'s of about 10% (Fig. 4).

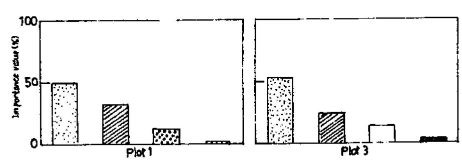

Fig. 4. Floristic composition of *E. glabrescens* — *M. vaginalis* community type. IRRI, 1978.

M. vaginalis-E. glabrescens community type — Only one sample plot constituted this community type. In this community, the dominance was shared by

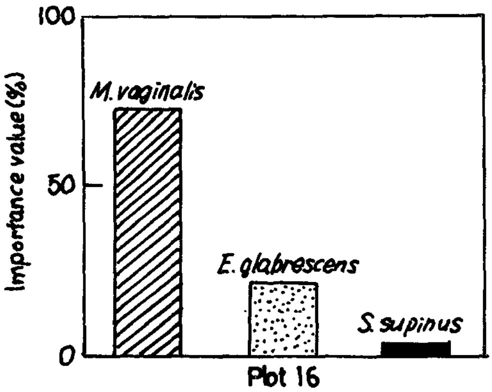

Fig. 5. Floristic composition of *M. vaginalis*—*E. glabrescens* community type. IRRI, 1978.

two species, *M. vaginalis* and *E. glabrescens*, and their I.V. s were 70 and 23%, respectively (Fig. 5).

E. crus-galli ssp. *hispidula* community type — Only one sample plot constituted this community type. The I.V. of *E. crus-galli* ssp. *hispidula* was 85% (Fig. 6).

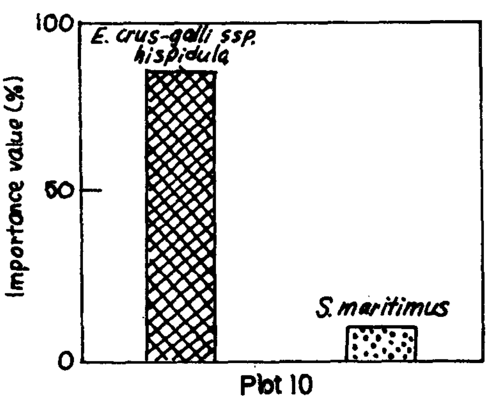

Fig. 6. Floristic composition of *E. crus*—*galli* ssp. *hispidula* community type. IRRI, 1978.

M. vaginalis-*S. supinus L.* community type — Three sample plots belonged to this community. The I.V. s for *M. vaginalis* and *S. supinus* were 55% and 30%, respectively. Another species, *E. glabrescens*, had an I.V. of about 10% (Fig. 7).

E. crus-galli ssp. *hispidula*-*S. maritimus* community type — The degree of dominance in this community was shared by four species, *E. crus-galli* ssp. *hispidula*, *S. maritimus*, *Cyperus difformis L.* and *M. vaginalis*. The I.V. s of these species were 35%, 25%, 12%, and 10%, respectively. One sample plot belonged

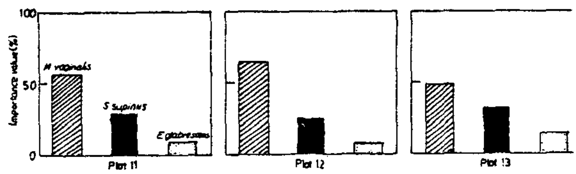

Fig. 7. Floristic composition of *M. vaginalis*—*S. supinus* community type. IRRI, 1978.

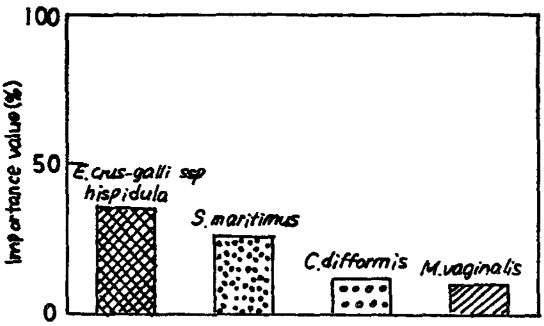

Fig. 8. Floristic composition of *E. crus*—*galli* ssp. *hispidula*—*S. maritimus* community type. IRRI, 1978.

to this community type (Fig. 8).

M. vaginalis-*F. littoralis*-*E. glabrescens*-*S. maritimus* community type. — The community was dominated by *M. vaginalis*, *F. littoralis*, *E. glabrescens*, and *S. maritimus*. The I.V. s of these species were 48%, 22%, 19%, and 12%, respectively. One sample plot belonged to this community type (Fig. 9).

A possible reason why there were different weed community types even though the cultural practices were exactly the same for all the plots was the effect of previous cultural practices used in the fields concerned. For example, the field which belong-

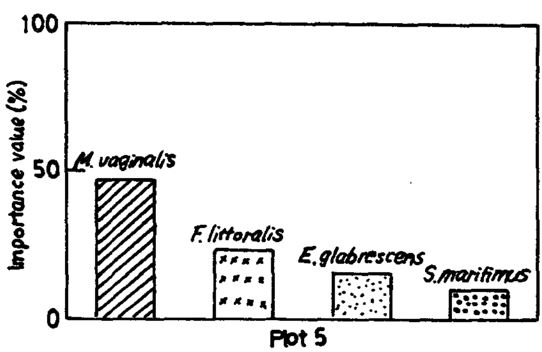

Fig. 9. Floristic composition of *M. vaginalis*—*F. littoralis*—*E. glabrescens*—*S. maritimus* community type. IRRI, 1978.

ed to the *E. crus-galli* ssp. *hispidula* community type always suffered from lack of water during the wet season and a lowland rice-upland crop rotation was practiced in these fields. Thus, to understand the weed flora in a particular field fully and the different weed community between fields, it is necessary to keep a complete record of the previous cultural practices in that field.

The I.V. of weed species growing in association with rice changed with time (Fig. 10). The I.V. of *E. glabrescens* increased from 10 DAT until heading and then, decreased form heading to maturity of rice. However, the I.V. of *M. vaginalis* and *E. crus-galli* ssp. *hispidula* increased from 40 DAT to maturity while *S. maritimus* decreased from 40 DAT. Thus, for a comprehensive understanding about competition between rice and weeds, weeds should be sampled at the correct stage. These results imply that weeds should be sampled at rice heading for *E. glabrescens*, at rice maturity for *M. Vaginalis* and *E. crus-galli* ssp. *hispidula*, and at 40 DAT for *S. maritimus*. In a mixed weed vegetation, however, if weeds are to be sampled only once, they should be sampled at rice heading to obtain the miximum floristic information.

Sampling weeds at the wrong time will give incorrect information about competition between rice and weeds. For the most diverse community type, *M. vaginalis-F. littoralis-E. glabrescens-S. maritimus* community, for example, information in terms of the floristic composition and probably competition will be different between heading and maturity even though total dry weights were similar. At maturity, the information about *S. maritimus* competition will be lost.

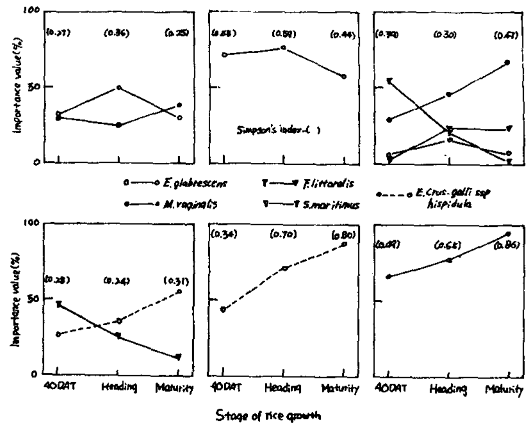

Fig. 10. Effect of time of sampling on change in Importance value based on dry weight in each community type. IRRI, 1978.

There was a high negative correlation between grain yield and weed weights at rice heading in all weed communities. Based on this relationship, the expected yield reduction due to weed competition was computed (Table 2). The competitive ability of rice against weeds varied depending upon weed species. The highest yield decrease due to weed competition was obtained from the *E. crus-galli* ssp. *hispidula-S. maritimus* community. Forty-two percent yield reduction was caused by competition of 100 g dry weight of weeds per square meter of

Table 2. The relationship between yield reduction and weed weight for different weed community types. IRRI 1978-79.

Weed community type	Yield reduction (%) Weed weight (g/m^2) 100	200	300	400	500	Weed weight required for 50% yield reduction (g/m^2)
Echinochloa crus-galli ssp. *hispidula-Scirpus maritimus*	42	80	100	–	–	123
Monochoria vaginalis-Fimbristylis littoralis-Echinochloa glabrescens-Scirpus maritimus	21	42	63	84	95	239
Monochoria vaginalis-Scirpus supinus	15	31	46	62	77	333
Monochoria vaginalis	15	31	46	61	75	366
Echinochloa glabrescens	10	20	30	40	51	497

this community type at rice heading. The yield decrease for the same amount of weeds was 10% for the *E. glabrescens* community, 15% for the *M. vaginalis* community and the *M. vaginalis-S. supinus* community and 21% for the *M. vaginalis-littoralis-E. glabrescens-F. maritimus* community type. The yield decrease due to competition from *E. glabrescens* and *M. vaginalis* was similar to that reported by Arai (1967) and Kataoka et al. (1970).

Noda (1968) found a curvilinear relationship between yield loss and weed weight for *Echinochloa* sp. A point was reached beyond which additional *Echinochloa* sp. caused no further yield loss. However, Kataoka and Chisaka (1970) and Arai (1967) found a linear relationship between weed weight and yield loss. In our studies, there was always a linear relationship between grain yield and weed weights in all community types. The possible reason why a different relationship was obtained between our studies and that of Noda (1968) is that in Noda's study the weed weight reached a maximum of over 1000 g/m^2 whereas in our studies, the maximum weed weights obtained were less than 600 g/m^2 for all experiments.

摘 要

移秧畓에 分布되여 있는 雜草群落型 種類와 雜草群落型別, 雜草發生과 水稻收量과의 關係를 究明하고자 1978 ~ 1979 년에 걸쳐 필리핀 所在 國際米作硏究所(IRRI)試驗圃場에서 圃場試驗을 實施한 結果는 다음과 같다.

1. 國際米作硏究所實驗圃場에 分布되어 있는 雜草群落型은 8個로 分類되었으며, 이들 群落型은 1) 물달개비, 2) 피, 3) 물달개비－피, 4) 피－물달개비, 5) 물달개비－올챙이고랭이, 6) 강피－매자기, 7) 강피, 8) 물달개비－피－바람하늘직이－매자기 群落型이었다.

2. 移秧畓에 發生되는 雜草의 優占度는 벼의 生育이 進展됨에 따라 變化되었다. 즉, 피의 優占度는 벼 出穗期까지 增加하다가 以後부터는 減少되었으며, 물달개비와 강피의 境遇 벼成熟期까지 계속 增加되었다. 한편 매자기의 優占度는 移秧後 40日頃에 最大値를 나타내었으며 그 以後부터는 減少되었다.

3. 雜草群落型別 雜草發生과 벼收量과는 負의 相關關係가 있었는데, 雜草와의 競爭力은 雜草群落型에 따라 差異가 있었다. 즉, 雜草發生量이 1㎡當 100 g 일 때, 벼收量減少는 강피－매자기群落型에서 42%, 피群落型에서 10%, 물달개비, 물달개비－올챙이고랭이群落型에서 各各 15%, 물달개비－피－바람하늘직이－매자기群落型에서 21%였다.

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