韓作誌 28(3)310~318(1983)

KJCS 28(3)310~318(1983)

Comparison of Some Methodologies for Vegetation Analysis in Transplanted Rice

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移秧畓에서 몇가지 植生分析方法들의 比較

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ABSTRACT

Four methods of vegetation analysis were compared to determine the most suitable method to use in transplanted rice.

The highest number of weed species, 14 was obtained with the list quadrat method while the least number, 8 was obtained with the line intercept method.

The clip quadrat method tended to overestimate weed species with a low moisture content such as *Sagittaria trifolia L.* and *Ludwigia prostrata* Roxb while for the list quadrat method, weed species with a high moisture content such as *Sagittaria pygmaea* Miq. and *Monochoria vaginalis* (Burm. f) Presl were overestimated. With the line intercept method, weed species having conspicuous leaf blades such as *S. trifolia* and *Potamogeton distinctus* Benn. were dominant.

Of the methods tested, the line intercept method was the least desirable because it accounted for the least number of weed species. Any of the others could be use for vegetation analysis without any significant problems arising. However, preference was given to the point quadrat method because of the ease of measurement. It was also less tedious and less time consuming than the other methods.

INTRODUCTION

The degree and nature of competition between rice and weeds are dependent upon the weed species growing in association with rice (Arai, 1967; IRRI, 1967, 1968; Kataoka and Chisaka, 1970; Lubigan and Vega, 1971; Kim et al. 1977a, b; Kim and Moody, 1980a, 1980b). A plant community is rarely homogeneous throughout as to species and their distribution and hence, the usual plant community will have some variation. Since variation is the rule, it becomes necessary to correctly analyze the vegetation and to correctly represent it in order to interpret the competitive effect between weeds and rice.

Usually all the members of a plant community in a given environment set cannot be counted or measured, and even if this was done, the information would be no more useful or significant than an adequate set of data acquired by proper sampling. Therefore, it becomes of prime importance to determine what constitutes an adequate sample in terms of the community as a whole and how to obtain such a sample with the proper sampling technique.

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Once the method of determining the area to be sampled has been decided, then the method of vegetation analysis has to be chosen. Vegetation can be analyzed by qualitative or quantitative methods. Subjective sampling methods have the tendency to overestimate conspicuous species and underestimate inconspicuous species because the rating systems used are an estimate of the occurrence of species. Quantitative sampling methods are usually used for vegetation analysis because they are more precise than subjective methods even though they are more time consuming.

In general, the density and population of weeds in rice experimental plots are commonly measured by either their weight or density or both. IRRI (1978) reported that a) weed weight by weed type, and weed density by type both correlated well with rice yields, and b) combining weed weight and weed density did not appreciably improve correlations with yield over those based on either measure. It was concluded that weed weight was more appropriate to use as the vegetation parameter for weed studies in transplanted rice because weed weight is simpler to measure than weed density.

This paper reports results of a study comparing different quantitative sampling methods to determine the most suitable method to describe the dominant weed species in a transplanted rice field in Korea.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of the Yeongnam Crop Experiment Station in 1980. The field was ploughed twice, before and after winter and harrowed once before rice transplanting to level the field and incorporate the basal dose of fertilizer. One hundred and fifty kg N/ha was applied in three equal splits, before transplanting, at maximum tillering and at panicle formation while 100kg P_2O_5/ha and 100kg K_2O/ha were applied before transplanting.

Rice cultivar (Milyang 46) was transplanted on May 27, 1980. The weeds were sampled at rice heading because the floristic composition of the field was distinct at that time. The field was not weeded prior to sampling. The moisture content of the major weeds was determined by drying them to constant weight at 80°C for 48 hours.

The importance value (I.V.) or summed dominance ratio (SDR, Numata, 1971) 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 the concentration of dominance can be used to determine the degree of diversity in a community. This can be determined using the following equation,

$$\text{Simpon's index (C)} = \Sigma\ (y/N)^2$$

where, y=I.V. or SDR of a given species

N=the sum of the I.V.'s or SDR's for all species in the sample.

For comparison of the variability of the degree of dominance across the methods for the dominant species the following equation was used,

$$\text{Coefficient of variability (\%)} = \frac{\text{standard deviation(s)}}{\text{mean }(\bar{x})} \times 100\ (\%)$$

The Similarity coefficient in terms of floristic composition was computed using the following equation,

$$\text{Similarity coefficient} = \frac{2(w)}{a+b} \times 100$$

where, w =sum of the lower I.V.'s or SDR's of species shared by two communities (methods).

a= sum of the I.V.'s or SDR's of all species in the first community (method).

b= sum of the I.V.'s or SDR's of all species in the second community (method).

The following methods were compared to determine which was the most suitable for describing the weed vegetation in transplanted rice.

List or census quadrat. With this method the weed species are listed and the number of individuals of each species is counted. This method is accurate, allows direct comparison of different areas and different species and is an absolute measure of the abundance of a plant. The disadvantage of the method is that it is tedious and very time consuming. The accuracy is dependent on the size of the quadrat and the number of quadrats sampled. A $1m^2$ (1m x 1m) quadrat was used. The number of individuals for each species within 10 randomly distributed quadrats were counted and the following vegetation parameters were calculated.

$$\text{Absolute density (D)} = \text{The total number of plants for a given species in all quadrats}$$

$$\text{Relative density (Rd)} = \frac{\text{Absolute density for a species (D)}}{\text{Total number of plants for all species}} \times 100\%$$

$$\text{Absolute frequency (F)} = \frac{\text{The number of quadrats in which a given species occurs}}{\text{The total number of quadrats used (10)}} \times 100\%$$

$$\text{Relative frequency (Rf)} = \frac{\text{Absolute frequency for a species (F)}}{\text{Total of the absolute frequencies for all species}} \times 100\%$$

Importance value (I.V.) = Relative density (Rd) + relative frequency (Rf) Summed dominance ratio

$$(\text{SDR}) = \frac{\text{I.V.}}{2}$$

Clip quadrat. This method is used to measure the fresh and dry weight of weeds. Fresh weight suffers from the disadvantage that it varies with the moisture content of the weed species. Weight takes into consideration both density and biomass. Therefore, dry weight is considered to be more precise in quantitative assessment of the weed vegetation than weed density. It has the following disadvantages a) destruction of plants is required b) there can be no repeatability and it is time consuming.

In this experiment, the oven dry weight of each species clipped at the soil surface was measured. The size of the quadrat used was $1m^2$ (1m x 1m) and weeds were sampled from 10 quadrats. The importance value (=Relative dry weight) was determined using the following equation:

$$\text{I.V. (or relative dry weight)} = \frac{\text{Weight of a given species}}{\text{Total weight of all species}} \times 100\%$$

Point quadrat (Point intercept) method. This method is frequently used in sampling low, dense or matted vegetation such as in pastures where it is impossible to define where one individual starts and another one ends. Vegetation parameters that can be calculated using this method are coverage and frequency. Density data cannot be obtained with this method.

A measuring tape was stretched out for 10m over the area to be sampled and divided into 10 subplots each 1m in length. In each subplot 10 sampling pins spaced 10cm apart were pushed vertically into the ground. The weed species touched by each pin were recorded. If no species was contacted, this was also noted. The following vegetation parameters were determined.

$$\text{Absolute coverage (C)} = \frac{\text{Number of hits for a given species}}{\text{The total number of points (100)}} \times 100\%$$

$$\text{Relative coverage (Rc)} = \frac{\text{Absolute coverage (C)}}{\text{The total number of hits for all species}} \times 100\%$$

$$\text{Absolute frequency (F)} = \frac{\text{The number of sample plots in which a given species occured}}{\text{The total number of sample plots (10)}} \times 100\%$$

$$\text{Relative frequency (Rf)} = \frac{\text{Absolute frequency (F)}}{\text{The total number of sample plots in which all species occured}} \times 100\%$$

Importance value (I.V.) = Relative coverage (Rc) + relative frequency (Rf)

$$\text{Summed dominance ratio (SDR)} = \frac{\text{I.V.}}{2}$$

Line intercept (Line transect) method. This method is particularly useful in dense stands of tufted plants where plant outlines are clear. It has the following advantages, a) repeatability b) relatively easy to use and c) specialized equipment is not necessary.

In this method, a measuring tape was stretched out for 10m over the area to be sampled and divided into 10 subplots each 1m in length. The ground surface occupied by a weed species was determined by the length of the transect line that touched, lay over or lay under a particular species was recorded.

For each species, the total number of individuals, the total intercept length and the number of transect intervals in which the species occured were determined. The length of transect segments overlaying base ground was also noted. From these values, various vegetational measurements were calculated using the following equations:

$$\text{Relative density (Rd)} = \frac{\text{Total number of individuals for a given species}}{\text{Total number of individuals for all species}} \times 100\%$$

$$\text{Relative coverage (Rc)} = \frac{\text{Total of intercept lengths for a species}}{\text{Total of intercept lengths for all species}} \times 100\%$$

$$\text{Frequency (F)} = \frac{\text{Number of intervals in which a species occured}}{\text{Total number of transect intervals (10)}} \times 100\%$$

$$\text{Relative frequency (Rf)} = \frac{\text{Frequency (F)}}{\text{Total of the frequency values for all species}} \times 100\%$$

$$\text{Importance value (I.V.)} = \text{Relative density (Rd)} + \text{Relative coverage (Rc)} + \text{Relative frequency (Rf)}$$

$$\text{Summed dominance ratio (SDR)} = \frac{\text{I.V.}}{3}$$

RESULTS AND DISCUSSION

Using the list quadrat method, the greatest number of weed species were recorded; 14 species belonging to 8 families were observed (Table 1). The dominant weed species with summed dominance, ratios (SDR'S) greater than 10 were, in decreasing order of dominance *Sagittaria pygmaea* Miq., *Monochoria vaginalis* Presl., *Scirpus hotarui* Ohwi. and *Sagittaria trifolia* L. Simpson's index was only 0.10 indicating that this community was very diverse and was not dominated by one or two weed species.

In contrast to the list quadrat method, for the clip quadrat method, only 12 weed species belonging to 7 families were harvested (Table 2). In this method, based on importance values (I.V. 'S), *Lugwigia prostrata* Roxb. was the most important weed. Other species with I.V.'s greater than 10 were, in decreasing order of importance, *Scirpus hotarui, Sagittaria trifolia, Eleocharis kuroguwai* Ohwi and *Cyperus serotinus* Rottb. The concentration of dominance in this community was 0.15.

With the point quadrat method 12 weed species belong to 8 families were recorded (Table 3). The concentration of dominance of this community was again low (0.13) indicating the diversity of the community. The major weeds (SDR > 10) were in decreasing order of importance, *S. trifolia, S. hotarui, E. kuroguwai, M. vaginalis* and *L. prostrata.*

For the line intercept method, the least number of weed species were sampled (eight species belonging to five families) (Table 4) while the highest value of Simpson's index was obtained (0.16) but the flora was still very diverse. With this method, *S. trifolia* was the most important species with a SDR value of 27.1 Other weed species with SDR's greater than 10 were, in decreasing order of dominance, *Potamogeton distinctus* Benn., *S. hotarui, M. vaginalis* and *C. serotinus.*

The most important weed species in the field differed depending on the method of vegetation analysis selected. The two most important weed

Table 1. Various vegetation parameters and the summed dominance ratio of different weed species using the list quadrat method. YCES, 1980.

Family and species	Absolute Density	Relative Density	Absolute Frequency	Relative Frequency	SDR
Alismataceae					
Sagittaria *pygmaea* Miq.	248	19.1	100	10.5	14.8
Sagittaria trifolia L.	158	12.2	100	10.5	11.4
Commelinaceae					
Aneilema japonica Kunth.	31	2.4	80	8.4	5.4
Cyperaceae					
Cyperus difformis L.	10	0.7	20	2.2	1.4
Cyperus brevifolius Hassk.	1	0.1	10	1.1	0.6
Čyperus serotinus Rottb.	132	10.2	60	6.3	8.3
Eleocharis kuroguwai Ohwi	98	7.6	90	9.5	8.6
Scirpus hotarui Ohwi	175	13.5	100	10.5	12.0
Scirpus triqueter L.	1	0.1	10	1.1	0.6
Lythraceae					
Rotala indica Koehne.	18	1.4	20	2.1	1.7
Onagraceae					
Ludwigia prostrata Roxb.	86	6.6	100	10.5	8.6
Polygonaceae					
Polygonum hydropiper Spach.	77	5.9	80	8.4	7.1
Pontederiaceae					
Monochoria vaginalis (Burm. f) Presl.	214	16.5	100	10.5	13.5
Potamogetonaceae					
Potamogeton distinctus Benn.	48	3.7	80	8.4	6.0
Total	1,297	100	950	100	100

Table 2. Dry weights and Importance values of weed species as determined by the clip quadrat method. YCES, 1980.

Family	Species	Dry Weight (g/m^2)	Importance value (%)
Alismataceae	*Sagittaria pygmaea*	32.4	2.4
	Sagittaria trifolia	208.6	15.4
Commelinaceae	*Aneilema japonica*	21.6	1.6
Cyperaceae	*Cyperus difformis*	15.2	1.1
	Cyperus serotinus	139.1	10.3
	Eleocharis kuroguwai	142.0	10.5
	Scirpus hotarui	241.9	17.9
	Scipus triqueter	2.7	0.2
Onagraceae	*Ludwigia prostrata*	325.9	24.1
Poaceae	*Leersia hexandra* Sw.	31.1	2.3
Pontederiaceae	*Monochoria vaginalis*	112.7	8.3
Potamogetonaceae	*Potamogeton distinctus*	79.0	5.8
	Total	1,352.2	99.9

Table 3. Various vegetation parameters and the summed dominance ratio of different weed species using the point quadrat method. YCES, 1980.

Family and Species	Absolute Coverage	Relative Coverage	Absolute Frequency	Relative Frequency	SDR
Alismataceae					
Sagittaria pygmaea	4	2.5	20	3.6	3.0
Sagittaria trifolia	33	10.4	100	18.2	19.2
Commelinaceae					
Aneilema japonica	4	2.5	20	3.6	3.0
Cyperaceae					
Cyperus serotinus	13	8.0	30	5.5	6.8
Eleocharis kuroguwai	21	13.0	70	12.7	12.9
Scirpus hotarui	31	19.1	100	18.2	18.7
Scirpus triqueter	1	0.6	10	1.8	1.2
Onagraceae					
Ludwigia prostrata	17	10.5	60	10.9	10.7
Poaceae					
Echinochloa crus-galli (L) Beauv	2	1.2	10	1.8	1.5
Polygonaceae					
Polygonum hydropiper	11	6.8	50	9.2	8.0
Pontederiaceae					
Monochoria vaginalis	17	10.5	70	12.7	11.6
Potamogetonaceae					
Potamogeton distinctus	8	4.9	10	1.8	3.4
Total	162	100	550	100	100

Table 4. Various vegetation parameters and the summed dominance ratio of different weed species using the line intercept method. YCES, 1980.

Family and Species	Total individual	Relative density	Coverage (cm) (Intercept length)	Relative coverage	Frequency	Relative frequency	SDR
Alismataceae							
Sagittaria pygmaea	6	3.7	61.0	3.5	30	5.8	4.3
Sagittaria trifolia	28	17.4	768.5	44.6	100	19.3	27.1
Cyperaceae							
Cyperus serotinus	33	20.5	68.4	4.0	40	7.7	10.7
Eleocharis kuroguwai	6	3.7	7.0	0.4	50	9.6	4.6
Scirpus hotarui	29	18.0	70.4	4.1	100	19.2	13.8
Onagraceae							
Ludwigia prostrata	12	7.5	184.5	10.7	60	11.5	9.9
Pontederiaceae							
Monochoria vaginalis	12	7.5	252.0	14.6	60	11.5	11.2
Potamogetonaceae							
Potamogeton distinctus	35	21.7	311.0	18.1	80	15.4	18.4
Total	161	100	1,722.8	100	520	100	100

Table 5. Comparisons of summed dominance ratios or importance values between the various methods of vegetation analysis for different weed species. YCES, 1980

Family and Species	List Quadrat	Clip Quadrat	Point Quadrat	Line Intercept	Average	Coefficient of Variability (%)
Alismataceae						
Sagittaria trifolia	11.4	15.4	19.2	27.1	18.3	36.5
S. pygmaea	14.8	2.4	3.0	4.3	6.1	95.3
Commelinaceae						
Aneilema japonica	5.4	1.6	3.0	–	2.5	–
Cyperaceae						
Cyperus brevifolius	0.6	–	–	–	0.2	–
C. difformis	1.4	1.1	–	–	0.6	–
C. serotinus	8.3	10.3	6.8	10.7	9.0	20.1
Eleocharis kuroguwai	8.6	10.5	12.9	4.6	9.2	38.3
Scirpus hotarui	12.0	17.9	18.7	13.8	15.6	20.6
S. triqueter	0.6	0.2	1.2	–	0.5	–
Lythraceae						
Rotala indica	1.7	–	–	–	0.4	–
Onagraceae						
Ludwigia prostrata	8.6	24.1	10.7	9.9	13.3	87.1
Poaceae						
Echinochloa crus-galli	–	–	1.5	–	0.4	–
Leersia hexandra	–	2.4	–	–	0.6	–
Polygonaceae						
Polygonum hydropiper	7.1	–	8.0	–	3.8	–
Pontederiaceae						
Monochoria vaginalis	13.5	8.3	11.6	11.2	11.2	19.3
Potamogetonaceae						
Potamogeton distinctus	6.0	5.8	3.4	18.4	8.4	80.6
Simpson's index	0.10	0.15	0.13	0.16	0.12	19.6

species were, in decreasing order of dominance, *S. pygmaea* and *M. vaginalis* for the list quadrat method *L. prostrata* and *S. hotarui* for the clip quadrat method *S. trifolia* and *S. hotarui* for the point quadrat method and *S. trifolia* and *P. distinctus* for the line intercept method.

When all methods were taken into consideration, 16 weed species were recorded. The degree of dominance for each species varied depending on the method used (Table 5). The variability also differed depending upon weed species. The greatest variability was observed with *S. pygmaea*, *L. prostrata* and *P. distinctus* while the weed species which had a relatively stable degree of dominance were *M. vaginalis*, *Cyperus serotinus* Rottb. and *Scirpus hotarui* Ohwi. (Table 5). This could partially be explained by the differences in the moisture content of weeds (Table 6) and differential conspicuousness of the weed species as affected by

Table 6. Moisture contents of major weed species found in the experimental fields. YCES, 1980.

Species	Moisture content (%)
Sagittaria trifolia	91.0
Scirpus hotarui	89.0
Eleocharis kuroguwai	89.1
Monochoria vaginalis	93.0
Ludwigia prostrata	90.9
Polygonum hydropiper	87.0
Cyperus serotinus	90.7
Potamogeton distinctus	88.7
Sagittaria pygmaea	93.4
Echinochloa crus-galli	89.6
Aneilema japonica	92.9

plant height, plant type and leaf characteristics.

When the density was used as the vegetation parameter as in the list quadrat method, weed species of high moisture content like *S. pygmaea* and *M. vaginalis* were dominant. However, when the dry weight was used as in the clip quadrat method, weed species of low moisture content such as *S. trifolia* and *L. prostrata* had a tendency to be dominant. For the line intercept method weed species having conspicuous leaf blades such as *S. trifolia* and *P. distinctus* were dominant.

The floristic composition did not differ greatly among methods. The similarity coefficients between methods were always higher than 65% (Table 7). In addition, the importance values or summed dominance ratios by weed group varied by less than 15% between methods (Table 8). Of the four methods tested, however, the point quadrat method minimized the tendency of under or over-estimation of a particular weed species in the weed community (Table 5). And had the greatest similarity to the average of all the methods in terms of order of dominance of species. In addition, the similarity coefficients between methods of vegetation analysis were always highest between the point quadrat method and the other methods compared to the other comparisons tested (Table 7). These results imply that the point quadrat method could overcome to some extent the problems arising from the other methods.

Table 7. Similarity coefficients between methods of vegetation analysis. YCES, 1980.

Methodology	Clip quadrat	Point quadrat	Line intercept
List quadrat	68.3	76.1	66.4
Clip quadrat	—	77.2	70.5
Point quadrat		—	71.9

Table 8. Importance values or summed dominance ratios of different weed groups as affected by method of vegetation analysis. YCES, 1980.

Weed group	List quadrat	Clip quadrat	Point quadrat	Line intercept
Broadleaf weeds	68.5	57.6	58.9	70.9
Grasses	0	2.4	1.5	0
Sedges	31.5	40.0	39.6	29.1

Of the methods tested in this experiment the line intercept method was the least desirable because it accounted for only eight weed species. Any of the others could be use for the vegatation analysis without any significant problems arising because of the high similarity coefficients between them in terms of floristic composition and weed type. Preference, however, is given to the point quadrat method because of the ease of measurement and it was less tedious and less time consuming than the other methods.

Further studies are needed using different weed community types to confirm the results found in this experiment.

摘 要

本 試驗은 植生分析法(vegetation analysis)에 많이 利用되는 4가지 分析方法 즉, List quadrat 方法, Clip quadrat方法, Point quadrat方法, Line intercept方法을 比較 分析하였다.

1. 分析 方法別로 얻어지는 草種數에 있어서는 List quadrat方法이 14種으로 가장 많았고, Line intercept方法이 8種으로 가장 적었다. 한편 Clip quadrat方法과 Point quadrat方法은 다같이 12種씩 記錄되었다.

2. Clip quadrat方法은 여뀌바늘(Ludwigia prostrata Roxb), 벗풀(Sagittaria trifolia L.)等과 같이 水分含量이 比較的 적은 草種에 對해서는 지나치게 높은 優占度(Importance value)를 보이는 傾向이

며 反面 올미(Sagittaria pygmaea Miq.) 또는 물달개비〔Monochoria vaginalis(Burm. f)〕와 같은 水分含量이 높은 草種에 對해서는 지나치게 낮은 優占度를 나타내는 傾向이었다. 한편 Line intercept方法은 벗풀(S. trifolia)와 가래(Potamogeton distinctus Benn.) 等과 같이 넓은 잎을 가진 草種에 對해 높은 優占度를 나타내는 傾向이었다.

3. 本 試驗에 使用된 4가지 方法中에서 어느 方法을 選擇하드라도 別다른 큰 問題點을 惹起시키지는 않았으나 作業過程中의 勞力節減, 時間節約 또는 優占草種의 草種數 및 優占順位 等을 綜合的으로 볼 때 Point quadrat方法이 가장 바람직하였고, Line intercept方法이 가장 바람직하지 못하였다.

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