Practical Classification of Herbicide by Two-dimensional Ordination Analysis in Transplanted Lowland Rice Field

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Two-dimensional Ordination 分析法에 의한 除草劑 殺草 Spectrum 分類에 관한 硏究

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ABSTRACT

Herbicides were classified by two-dimensional ordination analysis based on the weed flora which was not controlled by application of a particular herbicide.

The number of herbicide group was varied depending upon the weed community type and the experiment site. The technique of the two-dimensional ordination analysis gave more comprehensive informations about selecting of herbicides for increasing the herbicidal efficacy, for increasing the weed spectrum and for reducing the herbicide cost by mixing of herbicides.

The two-dimensional ordination analysis could be used not only herbicide classification and selecting effective herbicide or herbicide combination but also can be used for the evaluation of systematic application of herbicides.

Key words: Herbicide classification, combination, weed community type, rice field.

INTRODUCTION

Active search for phytotoxic compounds during the past 40 years has resulted in a great increase in the number of available weed killers. There are now quite a number of chemicals which have shown herbicidal activity, over 150 of which are commercially available around the world and the rest are still in the experimental or developmental stage.

Many chemicals of varied properties have found their way into the field of chemical weed control. Frequently herbicides of the same chemical group have common physiological characteristics that allow one to predict how a new herbicide of the group may be used. Minor differences, in chemical structure, however, often lead to significant differences in selectivity. For example, two closely related chemicals may also behave quite differently because physical factors such as the adsorption to plant components, volatility, acid or base dissociation differ and these factors may to varying degrees, change the apparent activity of the chemicals in a plant.

Indeed integration to enable the user or the re-

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searcher to embrace the subject as a whole, is not possible. Our knowledge of the biochemistry of herbicides is incomplete and it cannot yet be made the basis of a rigorous classification. Moreover, there is no simple relation between the chemical structure of a herbicide and its biochemical behavior and little of fundamental value is obtained from a classification based purely on chemical formulae. Nevertheless, in our present state of knowledge, formulae provide the only comprehensive basis on which to group the extensive variety of herbicides, but the limitations involved are clear.

At present, herbicides may be classified in several ways. One popular method is the classification of herbicide by alphabetically by common name or trade name. A second method is the chemical classification that are divided broadly into inorganic and organic. The onganic chemicals are then subdivided into familes such as aliphatic and aromatic acids and nitriles, amides, ureas and triazines where a chemical group is common to a number of herbicides. A third classification is based on how they are produce optimum results. The physiological characteristics of each herbicide determines how it is used. Categories using for this classifications are selectivity, translocatability, time of application, methods of application and mode of action (Ashton and Crafts, 1981; Audus, 1976; Fryer and Makepeace, 1977; Klingman and Ashton, 1975; King, 1966; Mercado, 1979: Moreland, 1967; Overbeek, 1964). In recent, more comprehensive classification of herbicides based on mode of action and morphological phytotoxic symptom was attempted by Matsunaka (1982) and by Ichijen (1982).

To induce the desired response, a herbicide must be able to gain entry into the plants and once inside, in concentrations great enough. Obstacles to the entry and movement of herbicides in plants are generally classified by leaf and soil obstacles, translocation obstacles and biochemical obstacles, and these obstacles are also strongly influenced by plant species and by environmental factors such as light, temperature, rainfall and relative humidity. And hence, in most instances, results obtained from laboratory or greenhouse vary from those of field experiment.

Authors attempted to classify herbicides from the field experiment using the two-dimensional ordination analysis to obtain practical informations for selecting effective herbicides to particular weed community type or to choose effective herbicide combinations for increasing herbicidal efficacy or reducing the chemical cost.

MATERIALS AND METHODS

The experiment was conducted at the Yeongnam Crop Experiment Station from 1980 to 1981. The general cultural practices used on the experiment station. This was as follow;

The fields were plowed twice before and after winter and harrowed twice at 5 to 7 day intervals. The final harrowing was done 1 day before transplanting to level field and to incorporate the basal fertilizer application. Sixty percent of the nitrogen was applied and incorporated prior to transplanting, 20% was applied at maximum tillering and 20% at panicle initiation. All the P_2O_5 and K_2O were applied and incorporated prior to transplanting. The total amount of fertilizer applied was 150 kg N/ha, 100 kg P_2O_5/ha, and 100 kg K_2O/ha.

Thirty five-day-old Cheongcheongbyeo seedlings (Tongil type cultivar) were transplanted by machine transplanter with spacing of 30cm x 14cm. Weeds were randomly harvested from each plot using 0.5m x 0.6m quadrat about 40 days after transplanting (DAT). Each plot was considered as a different vegetation complex. Three samples in each plot were bulked and cleaned, classified by species, counted and the weight(fresh and dry) of each species was recorded.

Herbicides used and how they were applied in both years were listed in Table 1. Most of these herbicides were applied as the recommendation of the handbook of agrochemical (1982).

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

The importance value (I.V.) or summed domin-

Table 1. Herbicides used and method of application during experimental years.

1980				1981			
No.	Herbicide (ingredient, %)	Dosage (kg. l ai/ha)	Time of application	No.	Herbicide (ingredient, %)	Dosage (kg. l, ai/ha)	Time of application
1	ACN/MCPB/nitrofen (5/5/0.6G)	3.18	5 DAT	1	ACN (9G)	2.7	15 DAT
2	bentazon (40 E.C)	1.6	25 DAT	2	ACN/MCPB/nitrofen (5/5/0.6G)	3.18	5 DAT
3	butachlor (6G)	1.8	5 DAT	3	bentazon (40EC)	1.6	25 DAT
4	butachlor/SW751 (3/6G)	2.7	5 DAT	4	bifenox (7G)	2.1	5 DAT
5	butachlor/chlormethoxynil (3/6G)	2.7	5 DAT	5	butachlor (6G)	1.8	5 DAT
6	butachlor/SK 223 (3/5G)	2.4	5 DAT	6	butachlor (6G)	1.8	2 DBT
7	butachlor/bifenox (6/7G)	3.9	5 DAT	7	butachoor/SW751 (3/6G)	2.7	5 DAT
8	CG 113 (7G)	2.1	5 DAT	8	butachlor/chlormethoxynil (3/6G)	2.7	5 DAT
9	oxadiazon (12EC)	0.6	2 DBT	9	butachlor/SK 223 (3/5G)	2.4	5 DAT
10	perfluidone (5G)	1.0	5 DAT	10	butachlor/MT101 (3/6G)	2.7	5 DAT
11	perfluidone/molinate (2/5G)	2.1	5 DAT	11	butachlor/thiobencarb (6/7G)	3.9	5 DAT
12	piperophos/dimethametryne (4.4/1.1G)	1.1	5 DAT	12	chlormethoxynil (7G)	2.1	5 DAT
13	pretilachlor (2G)	0.6	5 DAT	13	MCP (2G)	0.6	5 DAT
14	SW 751 (10G)	3.0	5 DAT	14	MO (9G)	2.7	5 DAT
15	2.4-D (40 EC)	0.28	25 DAT	15	nitrofen (7G)	2.1	5 DAT
16	thiobencarb (7G)	2.8	5 DAT	16	oxadiazon (12EC)	0.48	2 DBT
				17	pendimethalin (18EC)	0.9	2 DBT
				18	perfluidone (5G)	1.0	5 DAT
				19	perfluidone/molinate (2/5 G)	2.1	5 DAT
				20	piperophos/dimethametryne (4.4/1.1G)	1.1	5 DAT
				21	pretilachlor (2G)	0.6	5 DAT
				22	RH 8254 (2G)	0.6	2 DBT
				23	RH 8254 (2G)	0.6	5 DAT
				24	SW 751 (10G)	3.0	5 DAT
				25	2.4-DIPE (2G)	0.6	5 DAT
				26	thiobencarb (7G)	2.1	2 DBT
				27	thiobencarb (7G)	2.1	5 DAT
				28	thiobencarb/simethryne (7/1.5G)	1.7	10 DAT

* DBT = day before transplanting.
DAT = day after transplanting.
G = granule.
EC = emulsifiable concentrate.

ance ratio (SDR; Numata, 1971) indicates the degree of dominance of a species over the other species in a given sample plot. To avoid over or under-estimation in terms of degree of dominance species, two-factor SDR (density and weight) was used for these experiments. This can be determined using the following equations;

$$\text{SDR} = \frac{\text{Relative Density} + \text{Relative Dry weight}}{2}$$

$$\text{where Relative density} = \frac{\text{Absolute density of a given species}}{\text{Total absolute density of all species}} \times 100$$

$$\text{Relative dry weight} = \frac{\text{Dry weight of a given species}}{\text{Total dry weight of all species}} \times 100$$

Weed community type (herbicide group) can be defined by a two-dimensional ordination diagram. An aggregation of sample plots (herbicides) 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 (herbicide group) is defined by a singe 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 follow;

The similarity coefficient of each herbicide was determined by using the SDRs. The similarity coefficient (C) which reflects the degree of similarity between the herbicides in terms of floristic composition was calculated using the equation,

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

where w = sum of the lower SDRs of species shared by two herbicides.

a = sum of the SDR's of all species in the first herbicide.

b = sum of the SDR's of all species in the second herbicide.

The similarity coefficient of herbicides 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 herbicides (stands) were determined and the other herbicides (stands) were located with reference to them. The similarity values of each herbicide were totalled and the stand having the least similarity total (or the greatest dissimilarity total) was designated as herbicide A (stand A) and assigned a value of O along the X-axis. Herbicide B (stand B) which had the greatest dissimilarity to herbicide A was selected and assigned a value of 100 along the X-axis. The distance (X) of each of the remaining herbicides from A and B was calculated using the equation,

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

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

DA = dissimilarity value between herbicide A and the herbicide in question.

DB = dissimilarity value between herbicide B and herbicide in question.

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

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

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

X = computed distance of the herbicide in question with reference to herbicide A and herbicide 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 Y-axis. The distance (Y) of each of the remaining herbicides from A and B was then calculated using the question,

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

where L′ = dissimilarity value between herbicide A′ and herbicide B′

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

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

To test the relationship between the direct distance (S) of the herbicide under consideration and its dissimilarity value (D), a correlation coefficient, r, was computed. For these purposes, 30 random pairs of herbicides were used. The direct distance (S) between herbicides in each randompair was obtained using the equation.

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

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

DY= difference of herbicides 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

In 1980, 18 herbicides were treated at the weed community type of *Cyperus serotinus* Rottb. – *Scirpus hotarui* Ohwi. – *Monochoria vaginalis* Presl. – *Echinochloa crus-galli* Beauv. – *Aneilema japonica* Kunth. and importance values (or summed dominance ratio, SDR) of these weeds were 37%, 19%, 14%, 7% and 6%, respectively. From this weed community type the dissimilarity coefficient for every possible pair within herbicides and weed suppression ratio of each herbicide were calculated as shown in Table 2. Based on these dissimilarity coefficients, herbicides were analyzed by the two-dimensional ordination analysis (Fig. 1). As implied these method aggregation of herbicides in a two-dimensional ordination diagram is a conceptual grouping of a number of herbicides having similar morphology and biotic composition of weed species. Therefore, the size of herbicide group (represented by circle in two-dimensional diagram) depends on the degree of dominance of weed species which represents that weed community type. In other

Table 2. The dissimilarity coefficient for every possible pair within herbicides.

Herbicide	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Dissimilarity coefficient																	
* 1. butachlor	(63)	43	43	22	30	44	49	36	34	40	41	34	50	22	24	31	37	39
2. perfluidone		(67)	30	46	60	54	51	28	44	50	39	30	71	41	35	33	27	57
3. perfluidone/molinate			(69)	46	54	54	65	34	32	52	38	41	63	40	39	34	31	63
4. pretilachlor				(78)	30	48	58	40	36	39	43	34	60	12	33	39	38	55
5. CG 113					(56)	47	57	56	43	36	57	40	48	25	43	40	53	45
6. oxadiazon (2DBT)						(48)	65	60	54	56	65	37	40	44	51	44	51	66
7. SW751							(66)	40	62	52	69	63	70	58	55	59	49	25
8. butachlor / SW 751								(73)	44	62	49	37	70	36	45	42	33	42
9. butachlor / chlormethoxynil									(51)	50	36	42	57	33	28	35	44	48
10. butachlor / SK 223										(70)	60	50	50	46	39	39	47	42
11. butachlor / bifenox											(58)	39	70	39	35	39	45	60
12. piperophos/dimethametryne												(69)	61	28	28	29	33	53
13. ACN/MCPB/nitrofen													(68)	61	46	58	69	60
14. thiobencarb														(55)	32	39	34	55
15. bentazon															(67)	33	46	48
16. butachlor fb 2.4-D																(34)	28	55
17. piperophos/dimethametryne fb 2.4-D																	(69)	56
18. piperophos/dimethametryne fb bentazon																		(38)

* ( ) = Weed suppression ratio (%).

** Weed community type : *C. serotinus* (37%) - *S. hotarui* (19%) - *M. vaginalis* (14%)

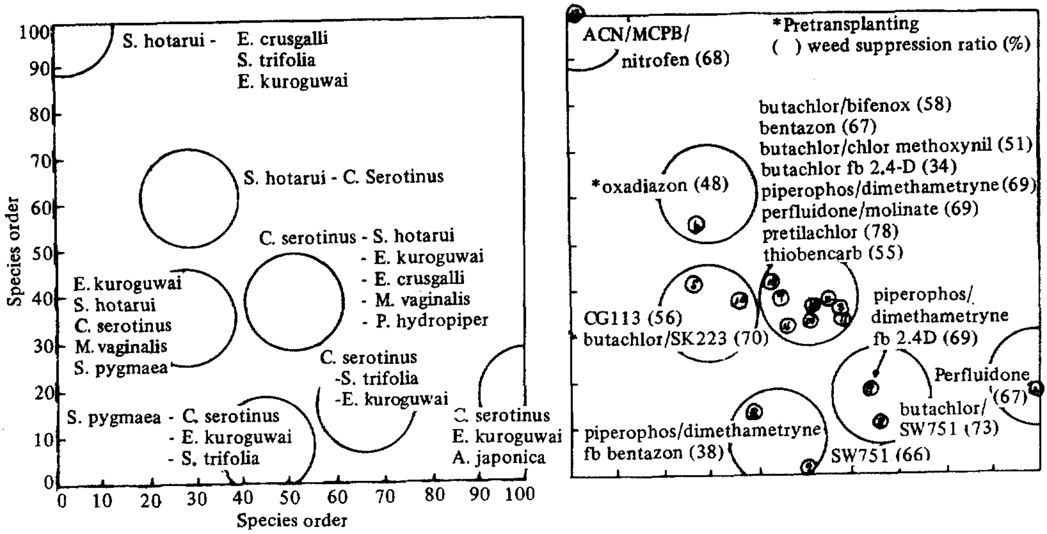

Fig. 1. Classification of herbicides by the two-dimensional ordination analysis in *C. serotinus -S. hotarui -M. vaginalis* community type.

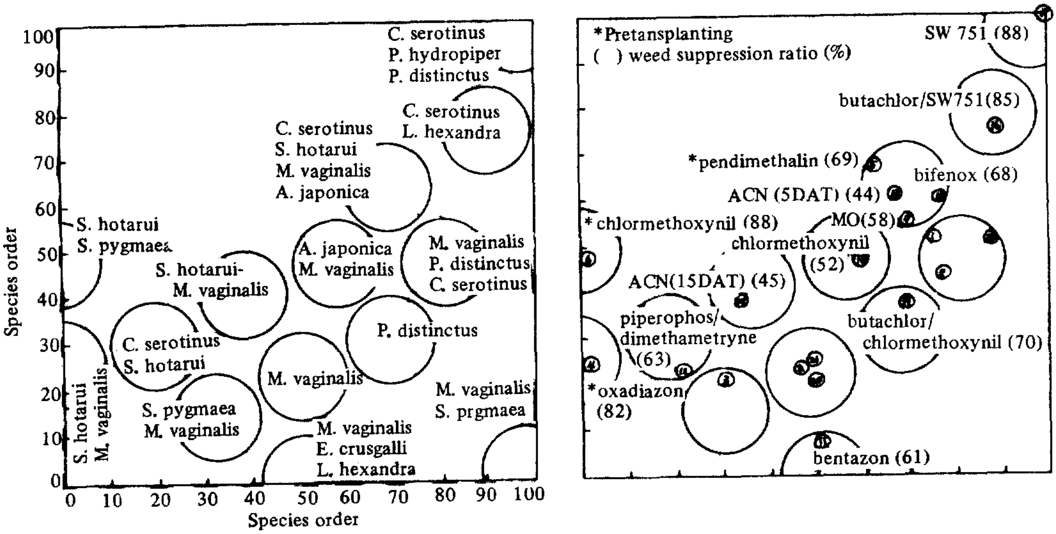

Fig. 2. Classification of herbicides by the two-dimensional ordination analysis in *M. vaginalis -L. prostrata -C. serotinus -s. hotarui* community type.

word, the higher degree of dominance of representing weed species, the smaller the herbicide group (size of circle). In this paper, aggregation of herbicides was defined by 80% or above in terms of the degree of dominance by the representing weed species. This meant that representing weed species showed at least 80% importance value in that community type (or herbicide group). And also community type or herbicide group was defined ~~by~~ a single weed species or a combination of weed species. From the results, 7 weed community types or 7 herbicide groups were classified (Fig. 1).

Due to the results of field experiment, most herbicides showed poor weed suppression ratio ranging 34% – 88%. For 1981, 19 herbicides were evaluated at the weed community type of *M. vaginalis* –

Ludwigia prostrata Roxb. – *C. serotinus* – *S. hotarui* having their importance values of 40%, 27%, 17% and 12%, respectively. From this experiment, 14 weed community types or 14 herbicide groups were obtained (Fig. 2). Also, the dissimilarity coefficient for every possible pair within herbicides and weed suppression ratio of each herbicide were calculated in Table 3. Compared to 1980, the weed community types within the experiment plot were more diversified in 1981. In the same year, 26 herbicides were evaluated at the two weed community types from the pot experiment. These two

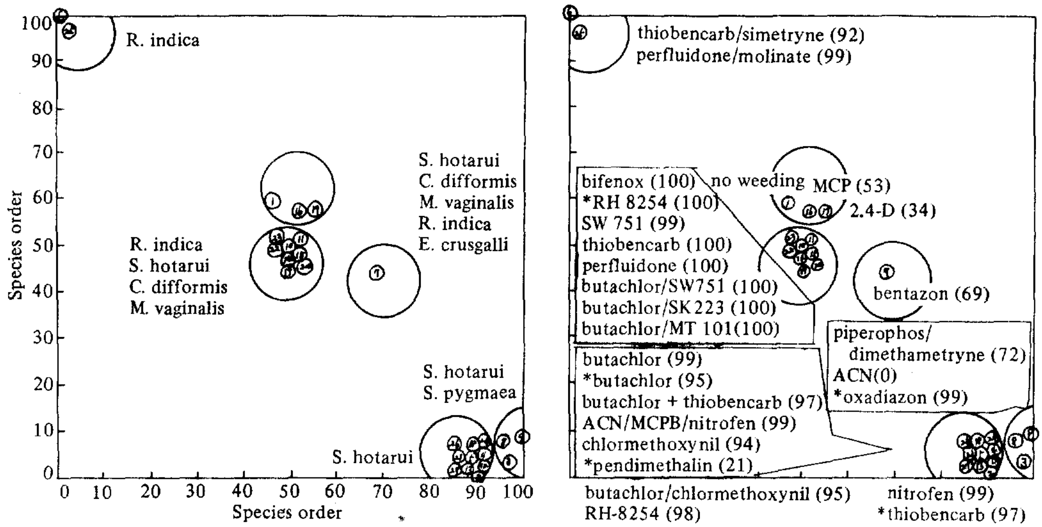

Fig. 3. Classification of herbicides by the two-dimensional ordination analysis in *R. indica -S. hotarui -C. difformis* community type.

Table 3. The dissimilarity coefficient for every possible pair within berbicides.

	Herbicide	Dissimilarity coefficient 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	no weeding	(0)*	37	41	88	58	88	59	43	60	35	56	69	46	31	43	41	56	83	62	46	37
2.	hand weeding		(47)	48	87	65	87	73	50	55	54	42	68	52	38	55	41	91	91	62	15	31
3.	butachlor			(46)	63	67	55	53	36	38	54	57	70	58	44	49	42	84	84	60	59	49
4.	oxadiazon (2DBT)				(82)	74	11	86	92	70	85	91	65	83	59	87	97	100	93	98	92	89
5.	pendimethalin (2DBT)					(69)	74	45	38	83	64	85	58	30	45	41	54	57	54	81	77	67
6.	chlormethoxynil (2DBT)						(88)	86	92	97	85	98	65	83	59	97	97	100	100	97	92	89
7.	MO							(58)	35	68	38	79	67	46	63	37	52	60	60	82	75	51
8.	pretilachlor								(75)	46	58	55	69	38	48	32	29	58	51	60	47	51
9.	perfluidone/molinate									(95)	70	34	68	77	64	64	55	100	87	60	55	55
10.	chlormethoxynil										(52)	69	64	55	48	45	60	74	89	71	59	32
11.	bentazon											(61)	79	54	58	69	51	98	77	60	45	40
12.	piperophos/dimethametryne												(63)	64	53	68	79	100	94	79	73	70
13	ACN (5 DAT)													(44)	41	35	45	61	61	77	67	46
14	ACN (15 DAT)														(45)	45	45	81	85	64	50	41
15	bifenox															(68)	23	46	53	53	59	56
16	nitrofen + piperophos/dimethametryne																(53)	50	62	42	48	43
17	SW 751																	(88)	50	78	93	92
18.	butachlor/SW751																		(85)	92	98	92
19.	butachlor/chlormethoxynil																			(70)	62	62
20.	butachlor/SK 223																				(68)	44
21	butachlor/MT 101																					(58)

* ( ) = Weed suppression ratio (%).

** Weed community type: *M. vaginalis* (40%) - *L. prostrata* (27%) - *C. serotinus* (17%) - *S. hotarui* (12%)

Table 4. The dissimilarity coefficient for every possible pair within herbicides.

Herbicide	Dissimilarity coefficient in community type I.																										
Dissimilarity cofficient in Community type II	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	(0) (07)	65	57	65	65	49	36	55	53	100	100	65	65	99	100	8	9	65	100	100	65	100	100	65	52	65	65
2	98	(99) (99)	29	34	30	100	72	34	42	100	100	34	34	100	100	63	66	34	100	100	34	100	100	34	100	34	34
3	98	44	(99) (98)	24	20	100	50	7	23	100	100	24	24	100	100	49	51	24	100	100	24	100	100	24	100	24	24
4	98	0	44	(21) (93)	4	100	72	20	42	100	100	0	17	100	100	63	66	0	100	100	0	100	100	0	100	0	0
5	100	100	100	100	(94) (100)	100	72	20	42	100	100	4	17	100	100	63	66	4	100	100	4	100	100	4	100	4	4
6	89	87	87	87	100	(92) (95)	79	98	99	100	100	100	100	100	100	51	54	100	100	100	100	100	100	100	6	100	100
7	38	95	95	95	100	86	(69) (72)	53	48	100	100	72	72	99	100	36	32	72	100	100	72	100	100	72	82	72	72
8	53	94	94	94	100	85	21	(72) (90)	24	100	100	20	20	100	100	47	49	42	100	100	20	100	100	20	100	20	20
9	47	90	90	90	100	81	46	43	(0) (71)	100	100	42	42	1001	100	47	48	42	100	100	42	100	100	42	100	42	42
10	100	100	100	100	100	100	100	100	100	(100) (100)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
11	100	100	100	100	100	100	100	100	100	100	(93) (100)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
12	64	70	70	70	100	87	53	24	38	100	100	(98) (91)	17	100	100	63	66	0	100	100	0	100	100	0	100	0	0
13	86	12	44	12	100	87	83	82	78	100	100	58	(99) (98)	100	100	63	66	17	100	100	17	100	100	17	100	17	17
14	100	100	100	100	100	100	100	100	100	100	100	100	100	(99) (100)	100	100	100	100	100	100	100	100	100	100	100	100	100
15	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(100) (100)	100	100	100	100	100	100	100	100	100	100	100	100
16	19	98	98	98	100	98	53	61	51	100	100	46	86	100	100	(53) (63)	6	63	100	100	63	100	100	63	100	63	63
17	22	93	93	93	100	84	73	80	51	100	100	79	81	100	100	37	(34) (46)	66	100	100	66	100	100	66	100	66	66
18	57	57	57	57	1001	87	95	94	90	100	100	42	57	100	100	83	93	(99) (91)	100	100	0	100	100	0	100	0	0
19	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(100) (100)	100	100	100	100	100	100	100	100
20	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(100) (100)	100	100	100	100	100	100	100
21	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(95) (100)	100	100	0	100	0	0
22	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(100) (100)	100	100	100	100	100
23	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(100) (100)	100	100	100	100
24	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(97) (100)	100	0	0
25	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(99) (100)	100	100
26	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	(95) (100)	100
27	98	0	44	0	100	87	95	94	90	100	100	70	12	100	100	98	93	57	100	100	100	100	100	100	100	100	(97) (98)

* 1. no weeding
2. butachlor
3. oxadiazon (2DBT)
4. pendimethalin (2DBT)
5. chlormethoxynil
6. thiobencarb/simetryne
7. bentazon
8. Piperophos/dimethametryne
9. ACN
10. bifenox
11. RH8254 (2DBT)
12. RH 8254
13. nitrofen
14. SW751
15. thiobencarb
16. MCP
17. 2,4-DIPE
18. ACN/MCPB/nitrofen
19. perfluidone
20. butachlor/SW751
21. butachlor/chlormethoxynil
22. butachlor/ SK223
23. butachlor/MT101
24. butachlor+thiobencarb (2DBT)
25. perfluidene/molinate
26. butachlor (2DBT)
27. thiobencarb (2DBT)

**Weed community type I: *R. indica* (48%)- *S. hotarui* (35%)-*C.* difformis (8%).

Weed community type II: *R. indica*(45%)- *M. vaginalis*(34%)-*F. miliacea*(9%).

***( ) = Weed suppression ratio (%).

weed community types were *Rotala indica* Koehne – *S. hotarui* – *Cyperus difformis* L. (I.V.S. = 48%, 35%, 8%) (community type I) and *R. indica* – *M. vaginalis* – *Fimbristylis miliacea* Vahl. (I.V.S. = 45%, 34%, 9%) (community type II). The dissimilarity coefficient for every possible pair within herbicides and weed suppression ratio of each herbicide were computed in Table 4. Six herbicide groups were classified from the weed community type I (Fig. 3) while 10 herbicide groups were obtained from the weed community type II (Fig. 4). In these experiments, most of herbicides exhibited excellent performance in terms of weed suppression ratio. This was due to the difference in the site of experiment (i.e., generally, better performance is exhibited by the pot experiment compared to the field experiment although the degree of difference varied among herbicides). As shown the above results, herbicide group was varied depending upon the weed community type. Therefore, it is necessary to conduct the experiment at the desired weed community type to obtain the appropriate informa-

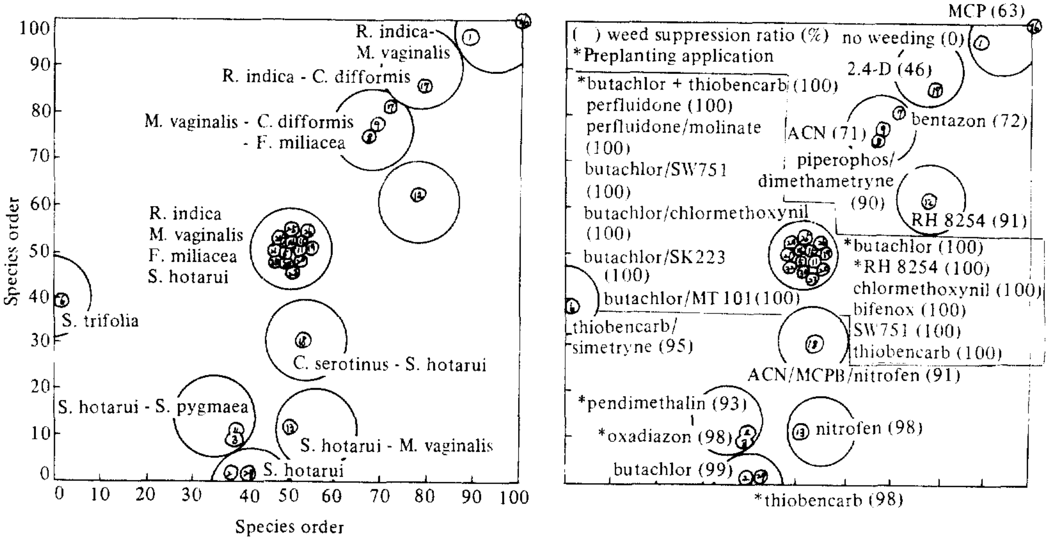

Fig. 4. Classification of herbicides by the two-dimensional ordination analysis in *R. indica - M. vaginalis-F. miliacea* community type.

tion about weed suppression ratio and weed control spectrum.

There are several advantages of the two-dimensional diagram over the simple dissimilarity coefficient.

The dissimilarity coefficient can give us the information only about the degree of floristic composition between two herbicides (i.e. how much differ between two herbicides in terms of weed control spectrum). But this does not give us any information about the kinds of weed flora that remained and controlled by application of particular herbicide. However, for the two-dimensional diagram, each herbicide can be easily determined by the degree of weed suppression and weed spectrum that can be controlled or cannot be controlled by a particular herbicide and hence, several basic informations about systematic treatment or mixing of herbicides for increasing the herbicidal efficacy and the spectrum of weeds to be controlled and for reducing the cost of herbicide can be obtained. For increasing the herbicidal efficacy by mixing two herbicides, for example, two herbicides having great distance between them on the two-dimensional

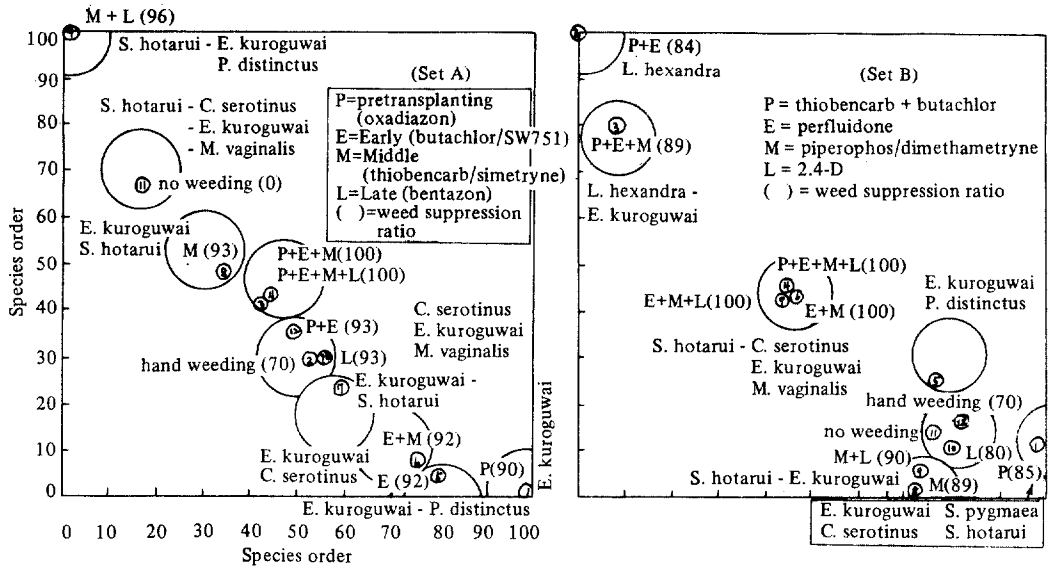

Fig. 5. Classification of vegetation by the two-dimensional ordination analysis as affected by herbicide application.

Table 5. The dissimilarity coefficient for every possible pair within time of applications.

	Time of application	Herbicide A: 2 DBT	2 DBT 5 DAT	2 DBT 5 DAT 15 DAT	2 DBT 5 DAT 15 DAT 25 DAT	5 DAT	5 DAT 15 DAT	5 DAT 15 DAT 25 DAT	15DAT	15 DAT 25 DAT	25 DAT	no weeding	hand weeding
Herbicide B	2 DBT		71	100	100	27	35	27	49	83	69	82	51
	2DBT, 5DAT	49		100	100	71	52	71	71	83	71	60	60
	2DBT,5,15DAT	49	5		100	100	100	100	100	100	100	100	100
	2DBT,5,15,25DAT	100	100	100		100	100	100	100	100	100	100	100
	5DAT	49	47	47	100		35	27	49	83	69	80	60
	5,15 DAT	100	100	100	100	100		35	49	83	69	63	60
	5,15,25DAT	100	100	100	100	100	100		26	60	69	59	37
	15 DAT	68	77	77	100	77	100	100		34	69	51	37
	15, 25 DAT	53	64	64	100	64	100	100	34		83	50	60
	25 DAT	44	55	55	100	55	100	100	46	22		70	51
	no weeding	49	72	72	100	82	100	100	49	41	44		47
	hand weeding	40	60	60	100	60	100	100	45	33	26	35	

* Herbicides	A	B
2 DBT	oxadiazon	thiobencarb + butachlor
5 DAT	butachlor/SW751	perfluidone
15 DAT	thiobencarb/simetryne	piperophos/dimethametryne
25 DAT	bentazon	2.4-D

** ( ) = Weed suppression ratio (%).

*** Weed community type: *S. hotarui* (31%) -*C. serotinus* (22%) -*E. kuroguwai* (18%) -*M. vaginalis* (12%).

diagram and having good weed suppression ratio should be selected. On the other hand, for simply reducing the herbicide cost by mixing two herbicides, some portion of the herbicide dose can be replaced by another herbicide within herbicide group by selecting herbicide having low cost and high weed suppression ratio.

The method of two-dimensional ordination analysis can be used not only herbicide classification in terms of weed spectrum but also it can be used for the evaluation of systematic treatment of herbicide. For the transplanted lowland rice field, there are four general times for herbicide applications, before transplanting (2DBT), early application (5DAT), middle application (15DAT) and late application (25DAT). Two sets of experiment were conducted at the weed community type of *S. hotarui* – *C. serotinus* – *Eleocharis kuroguwai* Ohwi – *M. vaginalis* having their importance values of 31%, 22%, 18% and 12%, respectively. The herbicides used for these experiments were oxadiazon (pretransplanting), butachlor/sw751 (early application), thiobencarb/simetryne (middle application) and bentazon (late application) for set A and thiobencarb + butachlor (pretransplanting), perfluidone (early application), piperophos/dimenthametryne (middle application) and 2.4-D (late application) for set B. Twelve combinations were evaluated and the results were given in Fig. 5. The dissimilarity coefficient for every possible pair within time of applications was also computed in Table 5. From these experiments 9 weed community types were obtained from set A while those were 7 weed community types in set B. From these two-dimensional diagrams it could be determined which combination is the most promising and what particular weed species are troublesome by a particular combination treatment.

Based on the above results it was concluded that the technique of two-dimensional ordination analysis can be used for herbicide classification to obtain more informations about selecting of herbicides for increasing the herbicidal efficacy, for increasing the weed spectrum and for decreasing the herbicide cost by mixing two herbicides.

摘　　要

植物 生態學에서 植生分析에 利用되는 two-dimensional ordination 分析法을 使用하여 雜草群落型殺草 spectrum을 分類하여 效果的인 除草制選拔, 體系處理 및 藥劑價格節減을 爲한 基礎資料를 얻고자 2個年(1980, 1981)에 걸쳐 圃場試驗 및 pot試驗으로 實施하였던 結果를 要約하면 다음과 같다.

1. 26種의 水稻用 除草劑를 pot試驗으로 處理하여 除草劑群을 分類한 結果 마디꽃(48%)－올챙고랭이(35%)－알방동산이(8%) 雜草群落型에서는 6個群, 마디꽃(45%)－물달개비(35%)－바람하늘지이(9%) 雜草群落型에서는 10個群으로 分類되었다.

2. 圃場 試驗結果에 있어 18種의 除草劑를 너도방동산이(37%)－올챙고랭이(19%)－물달개비(14%)－피(7%)－사마귀풀(6%) 雜草群落型에서 處理하였던 結果 7個 除草劑群으로 分類되었고, 물달개비(40%)－여뀌바늘(27%)－너도 방동산이(17%)－올챙고랭이(12%) 雜草群落型에서 19種의 除草劑를 處理하였던 結果는 14個 除草劑群으로 分類되었다.

3. two-dimensional ordination 分析法은 除草劑殺草 spectrum 分類 뿐만 아니라 除草劑處理方法에 따른 問題雜草를 究明하는데도 利用이 可能하였다.

4. 本 試驗結果를 미루어 보아 效果的인 除草劑使用을 爲해서는 單純히 除草劑 相互間의 類似性係數(Similarity coefficient)를 利用하는것 보다 two-dimensional ordination 分析法을 利用하므로서 效果的인 除草劑選拔, 殺草spectrum 增大를 爲한 混合處理 또는 體系處理 및 藥劑價格을 節減하기 爲한 混合處理等에 關한 情報를 比較的 쉽게 얻을 수 있었다.

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