Quantitative Assessments and Spatial Pattern Analyses of Weed Seed Banks of Arable Peat in Selangor, Malaysia

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말레이지아 세랑고지역 부식질토양경지 매립잡초종자에 대한 정량생태분석

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ABSTRACT

Collated data from the 1995-1996 field surveys of weed seeds buried in the plough layer of peat soil in Selangor district were analysed to assess species-dominance and spatial pattern of distribution of weed seeds based on selected quantitative indices and index of dispersion. Forty five species within 14 families were recorded of which 24 were broadleaves, 12 grasses and 9 sedges. They comprised *ca.* 53.2, 31.2 and 15.6%, respectively based on total population counts. Total seed population was *ca.* 8.14×10^7 seeds/ha within the first 25cm soil depth. Wide variabilities in population counts were registered among species ranging from $<7.0\times10^4$ seeds/ha for *Amaranthus gracilis* to *ca.* 5.64×10^6 seeds/ha for *Heteropogon contortus*. Seeds of *Cleome rutidesperma* was the most abundant(*ca.* 2.347×10^7 seeds/ha). Difference in seed population counts may be attributed to inherent variation in fecundity, population fluxes, their spatial distribution patterns and the agronomic practices prevailing in the areas of survey. The profile distribution of soil seed banks was skewed within the first 0 - 10cm depth, comprising *ca.* 69% of the total seed counts. Seed counts in the 10 - 15, 15 - 20 and 20 - 25cm soil profiles were in the order of 17.9, 8.6 and 4.0% of the total populations, respectively. Weed seeds of all species displayed different degree of aggregated pattern of distribution with variance-to-mean ratios of >1 and Lloyd's mean crowding(m^*) values from 1.244 for *Cyperus iria*, *Phyllanthus debilis*, *Phyllanthus urinaria*, *Scirpus grossus* and *Urinaria lagopodiodes* to 9607.7 for *Cleome rutidosperma*. Lloyd's patch indices(*Ip*) ranging from 5.1 for *Aeschynomene indica* to 188.5 for *Bracharia reptans* were registered. Differences in the VMR, m^* and Ip values among species suggested *inter-alia* inherent variabilities in their disposal capacity from seed source and different agronomic practices prevailing in the areas surveyed.

Key words : weed seeds, spatial pattern, dispersion indices, peat soil.

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INTRODUCTION

Peat soils cover *ca.* 6.5% of the total land area of Malaysia[18] of which *ca.* 800K ha. are in Peninsular Malaysia and *ca.* 1.66 millions ha. in Sabah and Sarawak. About 40% of the peat areas have been developed for agriculture and related activities[8]. While the agronomic problems and practices associated with the cultivation of peat soils in Malaysia have been well researched[6,8,18], few studies have been made on weed seed banks of weed communities in peat. Lee[12] studied weed succession and management in pineapple plantations. Studies reported here were conducted with the objectives of assessing species dominance and spatial patterns of distribution of weed seed populations in arable peat soils in Selangor, Malaysia. Field surveys were made in Selangor and collated data were analyzed in 1996 at the Weed Science Lab. of Seoul National University, Korea.

MATERIALS AND METHODS

Field surveys of weed seed banks in arable peat were conducted in 1995 - 1996 in Kelang, Banting, Tanjung Karang, Sabak Bernam and Batang Berjuntai Selangor(Fig. 1). These areas have a mean rainfall of *ca.* 2360mm/year and mean minimum and maximum temperatures of 26 and 32℃, respectively. Thirty transects each measuring 50m were laid in the sampling areas. A total of 120 soil samples were collected along those transects using soil sampler lined with 4cm diameter and 25cm long aluminium linings. Each soil sample was divided into 5 equal sub-samples according to the depths of 0 - 5, 5 - 10, 10 - 15, 15 - 20 and 20 - 25cm. Seeds were separated from soil debris using metal sieves with pore size of 150, 250 and 750μm by passing through steady flow of water[11]. Identification of the weed seeds were made with the aid of a binocular microscope based on the nomenclature of Soerjani *et al.*[14].

These seeds were then separated into germinable, viable and dead ones[11]. Germinable ones are those which germinate readily when exposed to water and light and left at room temperature for two weeks. The non-germinable seed portions were tested for viability using the tetrazolium salt test, separating them from dead ones.

Several quantitative indices, *viz.* relative density, relative dominance and important value of each weed species were calculated using the methods of Kim and Moody[10]. The seed population data according to the soil depths were subjected to the analysis of variance and Tukeys tests[20].

In order to assess the spatial distribution pattern of weed seeds of each species several indices of dispersion were calculated based on the methods of Dessaint *et al.*[5] using the following formulae :

$$VMR = ms / m$$

$$m^* = \sum_{i=1}^{Q} X_i (X_i - 1)$$

$$Ip = m^* / m$$

Where
- Q = No. of quadrats
- X_i = No. of individual species in the i th quadrat
- m = Mean no. of each species
- ms = Mean square of each species
- m^* = Lloyd's mean crowding
- Ip = Lloyd's patchiness
- VMR = Variance-to-mean ratio

Difference in th degree of aggregation of individual species were compared using Morans autocorrelation tests on Ip values[5]

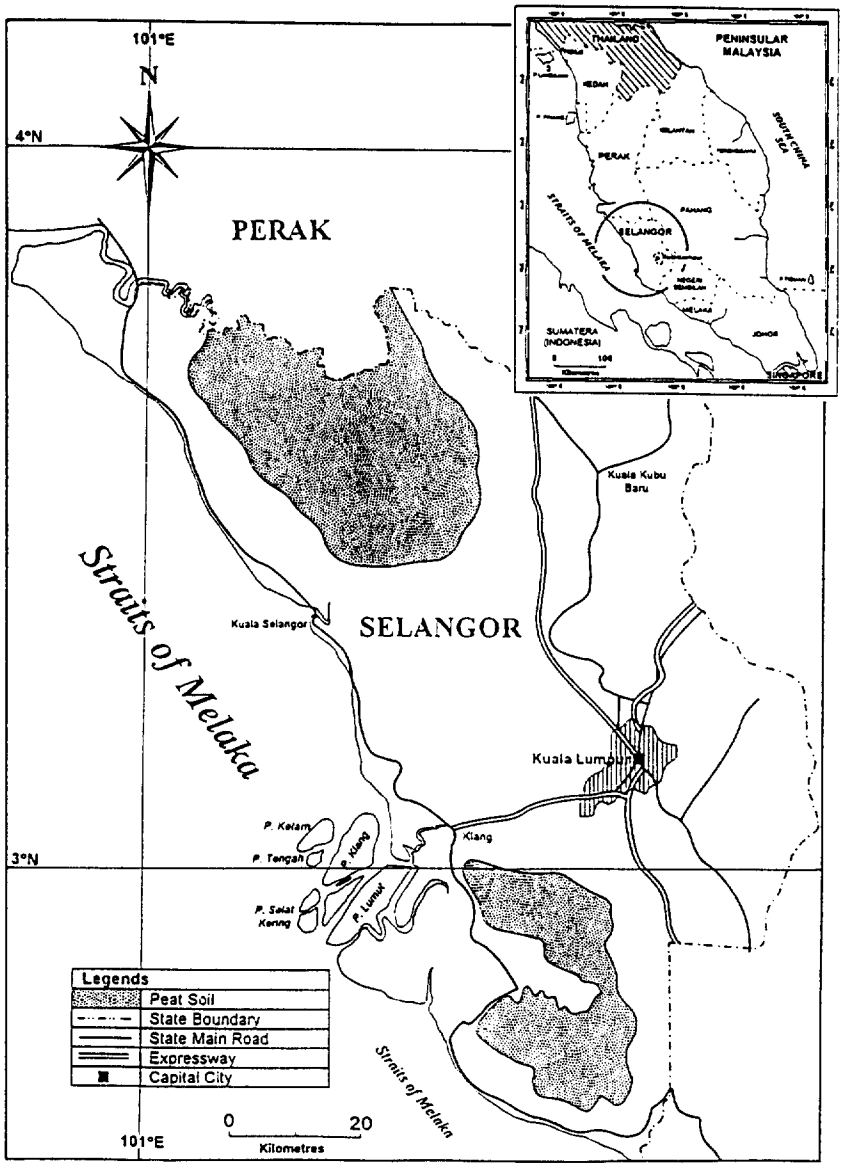

Fig. 1. Location of field survey areas in arable peat of Selangor.

RESULTS AND DISCUSSION

Quantitative assessment and species composition

Arable peat soils of Selangor were rich in weed seeds. This is exemplified by high species counts encountered during the sampling operation. A total of 45 species of weeds was recorded, of which 24 were broadleaves, 9 sedges and 12 grasses grouped under 16 families(Table 1). In the terms of species counts and affinity, weed seed bank, apparently, was not true reflections of their above-ground counterparts or *vice-versa*. Baki *et al.*[2] recorded 48 species of above-ground weeds on arable peat in Selangor comprising 31 broadleaves, 10 grasses and 9 sedges. The nota-

Table 1. Family, species and code* of weed seeds found in the arable peat in Selangor, Malaysia.

Family	No.	Species	code*
Broadleaves			
Amaranthaceae	1	*Amaranthus gracillis* Desf	AMAVI
Capparaceae	2	*Cleome rutidosperma* DC.	CLERT
Commelinaceae	3	*Commelina benghalensis* L.	COMBE
	4	*Cynotis axillaris* D.Don/Bentn./Roem & Schult Sweet	CYBAX
	5	*Murdannia nudiflora* (L.) Brenan	MUDNU
Compositae	6	*Ageratum conyzoides* L.	AGECO
	7	*Eclipta alba* (L.) Hassk.	ECLAL
Convolvulaceae	8	*Ipomoea triloba* L.	IPOTR
Euphorbiaceae	9	*Acalypha indica* L.	ACCIN
	10	*Croton hirtus* L' Herit	CVNHI
	11	*Euphorbia geniculata* Ortega	EPHNL
	12	*Euphorbia hirta* L.	EPHHI
	13	*Phyllanthus debilis* Klein ex Wild	-
	14	*Phyllanthus* uraria L.	-
Leguminosae	15	*Aeshynomena indika* L.	AESIN
	16	*Mimosa pudica* L.	MIMPU
	17	*Uraria lagopodioides* (L) Desv ex DC.	-
Melastomataceae	18	*Melastoma affine* D.Don	-
Passifloraceae	19	*Passiflora foetida* L.	PAQFO
Onagraceae	20	*Ludwigia hyssopifolia* (G.Don) Exell	LUDLI
	21	*Borreria laevis* (Lam.) Griseb.	BOILA
Rubiaceae	22	*Borreria latifolia* Schum	BOILF
Scrophulariaceae	23	*Lindernia ciliata* (Colsm.) Pennell	-
	24	*Lindernia crustacea* (L.) F.Muell	LIDCR
Grasses			
Gramineae	25	*Brachiaria mutica* (Forssk.) Stapf	PANPU
	26	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb	PANRP
	27	*Digitaria adscendwns* (H.B.K) Henr.	DIGAD
	28	*Digitaria violascens* Link	DIGVI
	29	*Echinocloa colonum* (L) Link	ECHCO
	30	*Eliusine indica* (L.) Gaertn	ELEIN
	31	*Eragrotis tenella* (L.) P.Beauv. ex Roem & Schult	ERAAM
	32	*Heteropogon contortus* (L.) P.Beauv. ex Roem & Schul	HTOCO
	33	*Ischaemum muticum* L.	ISCMU
	34	*Panicum repens* L.	PANRE
	35	*Paspalum commersonii* Lamk.	-
	36	*Paspalum conjugatum* Berg. Swartz	PASCO
Sedges			
Cyperaceae	37	*Cyperus compressus* L.	CYPCP
	38	*Cyperus iria* K.	CYPIR
	39	*Cyperus rotundus* L.	CYPRO
	40	*Fimbristylis acuminata* Vahl	FIMAC
	41	*Fimbristylis globulosa* (Retz.) Kunth	FIMGL
	42	*Fimbristylis miliacea* (L.) Vahl	FIMMI
	43	*Fimbristylis schoenoides* (Retz.) Vahl	-
	44	*Scirpus grossus* L.F	SCPGR
	45	*Scirpus juncoides* Roxb.	SCPJU

* Bayer code(Bayer 1992)

ble absentees were seeds of *Asystasia gangetica, Borreria repens, Drymaria villosa, Eclipta prostata, Emilia sorchifolia, Hedyotis corymbosa, Ludwigia perennis, Mikania micrantha, Physalis angulata, Solanum nigrum, Vernonia cinerea, Imperata cylindrica, Cyperus flaviduss, Cyperus sphacelatus, Fimbristylis dichotoma* and *Fimbristylis schoenoides*. While no concrete reasoning can be forwarded to elucidate this dicrepancy and absence of certain species of weed seeds in the arable peat, it is assumed that this may be attributed to differences in fecundity, seed viability and life span as well as seed predation among speciess. Cohen[4], Sagar & Mortimer[13], Harper[7] and Simpson *et al.*[15], *inter-alia*, provided theoretical considerations to explain the intricate relationships between weed seed banks and vegetation dynamics. Some of those considerations, *viz.* fecundity, seed predation, loss of viability, disturbance, etc. are particularly relevant to explain the nature of weed seed populations of arable peat in Selangor.

Broadleaved weeds dominated the weed seed bank populations of peat accounting for *ca.* 53.24% of the total species counts. Grasses and sedges contributed the respective 31.22 and 15.54% of the seed species populations(Fig. 2a). This contention of the dominance of broadleaves among the seed bank populations based on species affinity is further fortified by the high Importance Value(IV) ; index of broadleaved weeds (56.0%) recorded *vis-a-vis* 31.33% for grasses and 12.67% for sedges(Fig. 2b).

Fig. 3 illustrated the IV indices of individual weed species. *Cleome rutidosperma* registered the highest IV index of 47.8% and relative abundance(RA) value of 17.3%. Other species displaying relatively high IV values include *B. latifolia*(18.2%) and *H. contortus*(18.9%). Both *Phyllanthus debilis* and *P. urinaria* exhibited very low quantum of IV of 0.74%. The RA values varied considerably among species ranging from 0.36 for *P. debilis*, *P. urinaria* and *Scirpus grossus* to 17.3 for *C. rutidosperma*. Invariably, these results signify, in part, the fecundity status of the latter species producing vast numbers of seeds, thereby ensuring persistent populations *vis-a'-vis* other species in sympatry with each other.

Wide variabilities in population counts were registered among species ranging from $< 1.00 \times 10^6$ to 5.60×10^6 seeds/ha within the first 25cm soil depth(Fig. 4). *Cleome rutidosperma* was the most dominant species with 2.347×10^7 seed/ha within the first 25cm soil depth. Other dominant species with include : *Ageratum conyzoides*(1.92×10^6 seeds/ha) ; *Amaranthus gracilis*(3.60×10^6 seeds/ha) ; *Bracharia mutica*(1.68×10^6 seeds/ha) ; *B. reptans*(3.30×10^6 seeds/ha) ; *Digitaria violascens*(1.44×10^6 seeds/ha) ; *Eleusine indica*(2.32×10^6 seeds/ha) ; *F. miliacea*(2.64×10^6 seeds/ha) ; *Heteropogon contortus*(5.64×10^6 seeds/ha) ; *Lindernia crustacea*(1.84×10^6 seeds/ha) ; *L. ciliata* (1.04×10^6 seeds/ha) ; *Murdannia nudiflora*(2.08×10^6 seeds/ha) ; *Mimosa pudica*(1.92×10^6 seeds/ha) ; *Paspalum commersonii*(4.64×10^6 seeds/ha) ; *P. conjugatum*(1.44×10^6 seeds/ha). Each of the

Fig. 2. (a) Percentage occurrence of individual species within each weed group, and (b) summed Importance Value of each weed group of arable peat of Selangor, Malaysis.

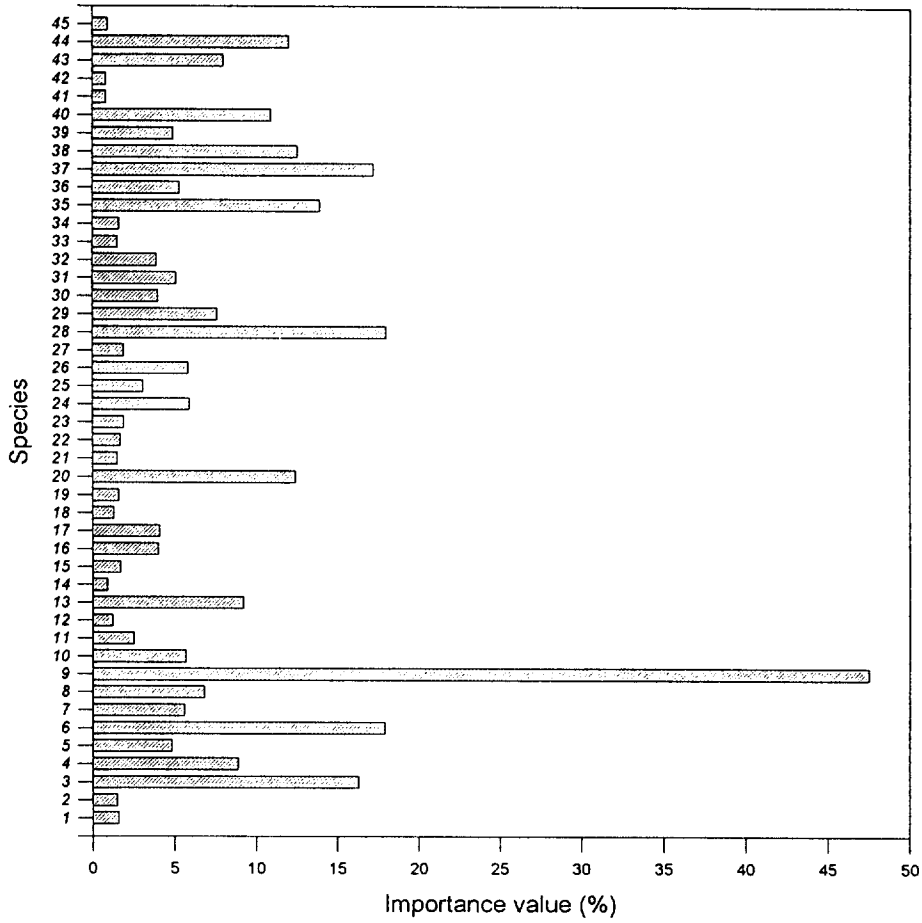

Fig. 3. Importance value (%) of individual weed species of arable peat of Selangor, Malaysia.
1. A. indica, 2. A. inica, 3. A. conyzoides, 4. A. gracilis, 5. B. laevis, 6. B. latifolia, 7. B. mutica, 8. B. reptans, 9. C. rutidosperma, 10. C. benghalensis, 11. C. hirtus, 12. C. axillaris, 13. C. compressus, 14. C. iria, 15. C. rotundus, 16. D. adscendens, 17. D. violascens, 18. E. colonum, 19. E. alba, 20. E. indica, 21. E. tenella, 22. E. geniculata, 23. E. hirta, 24. F. acuminata, 25. F. globilosa, 27. F. schoenoides, 28. H. contortus, 29. I. triloba, 30. I. muticum, 31. L. crustacea, 32. L. ciliata, 33. L. hyssopifolia, 34. M. affine, 35. M. pudica, 36. M. nudiflora, 37. P. repens, 38. P. commersonii, 39. P. conjugatum, 40. P. foetida, 41. P. debilis, 42. P. urinaria, 43. S. grossus, 44. S. juncoides, 45. U. lagopodiodes

remaining species registered $< 9.0 \times 10^5$ seeds/ha. The population seed counts of each species in a hectare within the 0 - 25cm soil depth is shown in Fig. 4. A total of 8.14×10^7 seeds/ha were sampled in arable peat of Selangor.

Sago[15] reported in a review that weed seeds in the arable soil range from 1K to 200K weeds/ m^2 showing wide variations depending on the use of herbicides, cultivated crop, cropping patterns, etc.. Kwon and Chung[11] found the weed seeds buried in the plough layer soil(0 - 16cm depth) for different cropping systems in the order of paddy rice monoculture, soybean-barley, wheat-fallow-barley-fallow, sweet potato-maize-fallow, peanut-sesame, strawberry monoculture and Chinease chive monoculture, 297K, 616K, 648K, 690K, 481K, 493K and 462K seeds per square meter, respectively. Magnitude of the weed seed

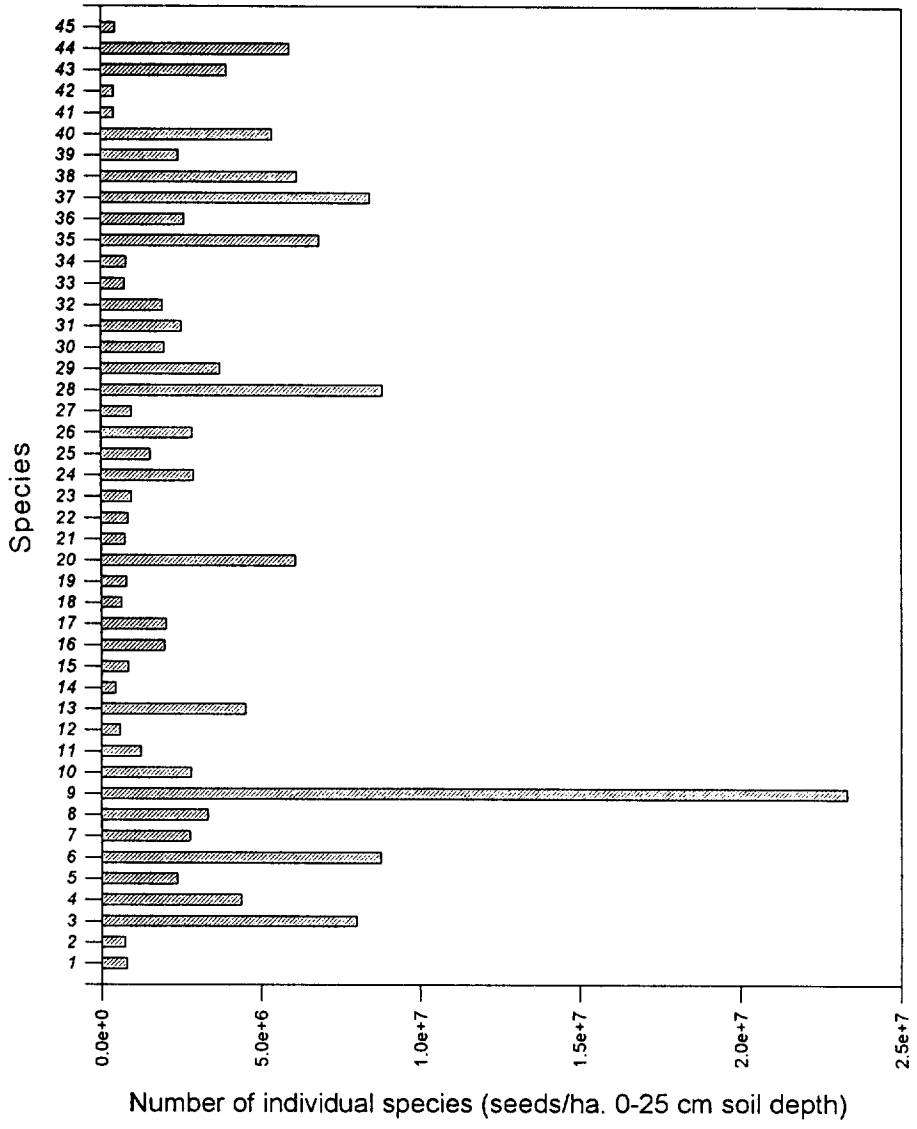

Fig. 4. Number of individual species/ha of arable peat of Selangor, Malaysia.

1. A. indica, 2. A. inica, 3. A. conyzoides, 4. A. gracilis, 5. B. laevis, 6. B. latifolia, 7. B. mutica, 8. B. reptans, 9. C. rutidosperma, 10. C. benghalensis, 11. C. hirtus, 12. C. axillaris, 13. C. compressus, 14. C. iria, 15. C. rotundus, 16. D. adscendens, 17. D. violascens, 18. E. colonum, 19. E. alba, 20. E. indica, 21. E. tenella, 22. E. geniculata, 23. E. hirta, 24. F. acuminata, 25. F. globilosa, 27. F. schoenoides, 28. H. contortus, 29. I. triloba, 30. I. muticum, 31. L. crustacea, 32. L. ciliata, 33. L. hyssopifolia, 34. M. affine, 35. M. pudica, 36. M. nudiflora, 37. P. repens, 38. P. commersonii, 39. P. conjugatum, 40. P. foetida, 41. P. debilis, 42. P. urinaria, 43. S. grossus, 44. S. juncoides, 45. U. lagopodiodes

bank of the arable peat soil of Selangor is comparatively quite small.

Spatial distribution pattern

Weed seeds of arable peat displayed aggregated pattern of distribution registering variance-to-mean ratio values(VMR) of < 1. The Lloyd's mean crowding(m^*) values ranged from 1.24 for *Cyperus iria, P. debilis, P. urinaria, Scirpus grossus*

Table 2. Mean density(m), variance(v), variance-to-mean ratio(VMR), Lloyd's mean crowding(m^*) and Lloyd's patchiness indices(Ip) of weed seeds found in the arable peat in Selangor, Malaysia.

Family	No.	Species	m	v	VMR	M^*	IP
Broadleaves							
Amaranthaceae	1	*Amaranthus gracilis* Desf	1.60	1691.27	155.03	1281.96	117.51
Capparaceae	2	*Cleome rutidosperma* DC.	10.43	8156.17	121.63	9607.69	143.28
Commelinaceae	3	*Commelina benghalensis* L.	0.21	47.01	34.27	35.91	26.18
	4	*Cynotis axillaris* D.Don/Bentn./Roem & Schult Sweet	0.07	3.55	7.76	2.49	5.45
	5	*Murdannia nudiflora* (L.) Brenan	0.92	385.29	64.83	313.96	52.83
Compositae	6	*Ageratum conyzoides* L.	0.85	137.09	23.56	118.04	20.29
	7	*Eclipta alba* (L.) Hassk.	0.07	3.55	7.76	2.49	5.45
Convolvulaceae	8	*Ipomoea triloba* L.	0.32	20.11	9.78	16.89	8.21
Euphorbiaceae	9	*Acalypha indica* L.	0.07	3.76	7.75	2.49	5.14
	10	*Croton hirtus* L' Herit	0.18	45.71	40.00	34.67	30.34
	11	*Euphorbia geniculata* Ortega	0.11	5.16	7.53	3.73	5.44
	12	*Euphorbia hirt* L.	0.21	13.12	9.57	10.31	7.52
	13	*Phylanthus debilis* Klein ex wild	0.04	1.83	8.00	1.24	5.43
	14	*Phylanthus uraria* L.	0.04	1.83	8.00	1.24	5.43
Leguminosae	15	*Aeshynomena indica* L.	0.07	7.76	16.00	5.33	10.99
	16	*Mimosa pudica* L.	0.85	134.67	24.55	120.89	22.04
	17	*Uraria lagopodioides* (L) Desv ex DC.	0.04	1.83	8.00	1.24	5.43
Melastomataceae	18	*Melastoma affine* D.Don	0.14	6.67	7.29	4.98	5.45
Passifloraceae	19	*Passiflora foetida* L.	0.32	16.35	7.95	14.04	6.83
Onagraceae	20	*Ludwigia hyssopifolia* (G.Don) Exell	0.07	3.55	7.76	2.49	5.45
	21	*Borreria laevis* (Lam.) Griseb.	0.57	141.53	38.70	114.49	31.31
Rubiaceae	22	*Borreria latifolia* Schum	0.32	27.64	13.44	22.58	10.98
Scrophulariaceae	23	*Lindernia ciliata* (Colsm.) Pennell	0.46	41.73	14.05	36.09	12.15
	24	*Lindernia crustacea* (L.) F.Muell	0.82	274.61	52.24	224.89	42.78
Grasses							
Gramineae	25	*Brachiaria mutica* (Forssk). Stapf	0.75	181.46	37.80	151.29	31.52
	26	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb	1.47	2270.02	240.76	1776.93	188.46
	27	*Digitaria adscendens* (H.B.K) Henr.	0.32	23.88	11.61	19.73	9.59
	28	*Digitaria violascens* Link	0.64	72.93	17.73	65.07	15.82
	29	*Echinocloa colonum* (L) Link	0.11	16.46	24.00	12.27	17.89
	30	*Eleusine indica* (L.) Gaertn	1.03	84.65	12.77	92.98	14.03
	31	*Eragrostis tenella* (L.) P.Beauv. ex Roem & Schult	0.14	10.43	11.41	7.82	8.55
	32	*Heteropogon contortus* (L.) P.Beauv. ex Roem & Schult	2.51	557.63	34.60	610.76	37.90
	33	*Ischaemum muticum* L.	0.28	19.15	10.47	15.64	8.55
	34	*Panicum repens* L.	1.21	148.65	19.13	153.24	19.72
	35	*Paspalum commersonii* Lamk	2.06	587.08	44.28	569.96	42.99
	36	*Paspalum conjugatum* Berg./Swartz	0.64	72.93	17.73	65.07	15.82
Sedges							
Cyperaceae	37	*Cyperus compresus* L.	1.49	232.66	24.24	240.00	25.00
	38	*Cyperus iria* L.	0.04	1.83	8.00	1.24	5.43
	39	*Cyperus rotundus* L.	0.11	8.93	13.02	6.58	9.60
	40	*Fimbristylis acuminata* Vahl	0.71	211.90	46.35	172.80	37.80
	41	*Fimbristylis globulosa* (Retz.) Kunth	0.73	283.74	60.19	228.00	48.36
	42	*Fimbristylis miliacea* (L.) Vahl	1.17	1430.37	189.63	1119.11	148.37
	43	*Fimbristylis schoenoides* (Retz.) Vahl	0.21	31.95	23.29	24.53	17.89
	44	*Scirpus grossus* L.F	0.04	1.83	8.00	1.24	5.43
	45	*Scirpus juncoides* Roxb.	0.83	77.23	14.46	76.40	14.30

and *Uraria lagopodiodes* to 9607.69 for *Cleome rutidosperma* while Lloyd's patch indices(*Ip*) registered values ranging from 5.14 for *Aeschynomene indica* to 188.46 for *Bracharia reptans* (Table 2). These different may be attributed, inter-alia, to different dispersal ability of different weed species from the seed source and possibly different agronomic practices prevailing in the area. the different degree of aggregation of species distribution pattern is illustrated by the variable relationship between Lloyd's mean crowding (m^*) and mean density values(m), hence their variable relative positions, albeit consistently below, the Iwao line[9](Fig. 5) signifying further aggregated distribution pattern. Invariably, seeds of broadleaved weeds exhibited greater degree of aggregation compared with grasses and sedges. The former have bigger seed sizes, thereby hindering long-distant dispersal *vis-a'-vis* the seeds of the latter two weed groups. Zaharuddin[19] in his study on weed seed banks of the rice granary of Tanjung Karang, Selangor cited similar explanations to illustrate the limited dispersal of broadleaved weed seeds.

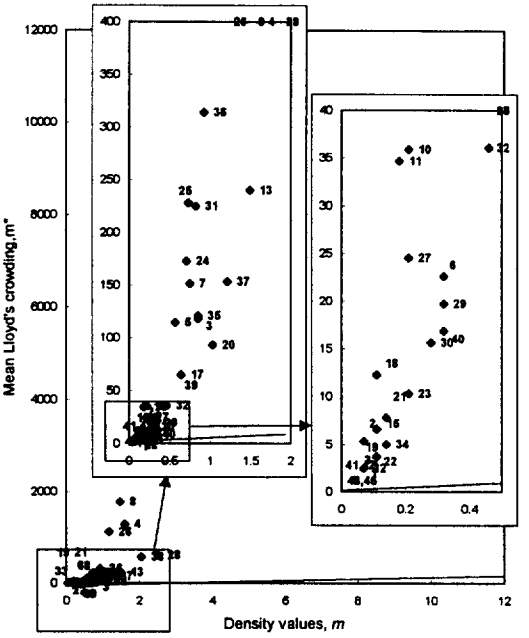

Fig. 5. Mean Lloyd's crowding(m*) versus density values(m) for each individual species of arable peat of Selangor, Malaysia. X=Iwao lines, (1968)

1. A. indica, 2. A. inica, 3. A. conyzoides, 4. A. gracilis, 5. B. laevis, 6. B. latifolia, 7. B. mutica, 8. B. reptans, 9. C. rutidosperma, 10. C. benghalensis, 11. C. hirtus, 12. C. axillaris, 13. C. compressus, 14. C. iria, 15. C. rotundus, 16. D. adscendens, 17. D. violascens, 18. E. colonum, 19. E. alba, 20. E. indica, 21. E. tenella, 22. E. geniculata, 23. E. hirta, 24. F. acuminata, 25. F. globilosa, 27. F. schoenoides, 28. H. contortus, 29. I. triloba, 30. I. muticum, 31. L. crustacea, 32. L. ciliata, 33. L. hyssopifolia, 34. M. affine, 35. M. pudica, 36. M. nudiflora, 37. P. repens, 38. P. commersonii, 39. P. conjugatum, 40. P. foetida, 41. P. debilis, 42. P. urinaria, 43. S. grossus, 44. S. juncoides, 45. U. lagopodiodes

Weed seed of arable peat, apparently, was preferentially skewed mostly in the first 0 - 5cm soil depth(Fig. 6) accounting for *ca.* 37.1% of the total seed counts. The distribution of weed seeds in the 5 - 10, 10 - 15, 15 - 20 and 20 - 25cm profiles were in the respective order of 31.9, 18.7, 8.7 and 4.0% of the total seed counts. The preferential skewness of distribution pattern of weed seeds within the first 10cm soil depth indicates their apparent limited movements in soils. Robert[12] observed that in the non-disturbed situations, *ca.* 37% of the total seed banks are found in the first 0 - 7.6cm. Despite differences in crops and cropping pattern and nature of disturbance

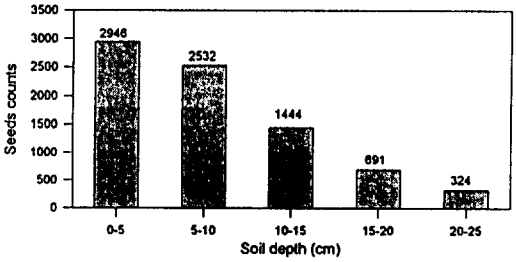

Fig. 6. The distribution of weed seeds in the depth of 0-25cm soil profiles of arable peat in Selangor.

Table 3. Quantitative indices of weed seeds found in the arable peat in Selangor, Malaysia.

Family	No.	Species	RD*	RDo	RF	RA	I.V.
Broadleaves							
Amaranthaceae	1	*Amaranthus gracilis* Desf	4.54	1.96	1.86	3.20	8.36
Capparaceae	2	*Cleome rutidosperma* DC.	29.57	13.30	4.97	17.27	47.84
Commelinaceae	3	*Commelina benghalensis* L.	0.60	4.25	1.24	0.92	6.10
	4	*Cynotis axillaris* D.Don/Bentn./Roem & Schult Sweet	0.20	0.12	0.62	0.41	0.94
	5	*Murdannia nudiflora* (L.) Brenan	2.62	1.01	2.48	2.55	6.12
Compositae	6	*Ageratum conyzoides* L.	2.42	10.25	3.73	3.07	16.40
	7	*Eclipta alba* (L.) Hassk.	0.20	0.33	1.24	0.72	1.77
Convolvulaceae	8	*Ipomoea triloba* L.	0.91	4.34	2.48	1.70	7.73
Euphorbiaceae	9	*Acalypha indica* L.	0.20	0.18	1.24	0.72	1.62
	10	*Croton hirtus* L' Herit	0.50	1.29	0.62	0.56	2.42
	11	*Euphorbia geniculata* Ortega	0.30	0.43	1.24	0.77	1.97
	12	*Euphorbia hirt* L.	0.60	0.01	1.86	1.23	2.48
	13	*Phylanthus debilis* Klein ex Wild	0.10	0.01	0.62	0.36	0.74
	14	*Phylanthus uraria* L.	0.10	0.01	0.62	0.36	0.74
Leguminosae	15	*Aeshynomena indika* L.	0.20	0.71	0.62	0.41	1.53
	16	*Mimosa pudica* L.	2.42	7.17	4.35	3.38	13.94
	17	*Uraria lagopodioides* (L) Desv ex DC.	0.10	0.17	0.62	0.36	0.89
Melastomataceae	18	*Melastoma affine* D.Don	0.40	0.01	1.24	0.82	1.66
Passifloraceae	19	*Passiflora foetida* L.	0.91	6.37	3.73	2.32	11.01
Onagraceae	20	*Ludwigia hyssopifolia* (G.Don) Exell	0.20	0.01	1.24	0.72	1.46
	21	*Borreria laevis* (Lam.) Griseb.	1.61	1.33	1.86	1.74	4.81
Rubiaceae	22	*Borreria latifolia* Schum	0.91	14.83	2.48	1.70	16.22
Scrophulariaceae	23	*Lindernia ciliata* (Colsm.) Pennell	1.31	0.01	2.48	1.90	3.80
	24	*Lindernia crustacea* (L.) F.Muell	2.32	0.02	3.11	2.71	5.44
Grasses							
Gramineae	25	*Brachiaria mutica* (Forssk). Stapf	2.12	1.27	2.48	2.30	5.87
	26	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb	4.16	0.57	2.48	3.32	7.22
	27	*Digitaria adscendens* (H.B.K) Henr.	0.91	0.66	2.48	1.70	4.05
	28	*Digitaria violascens* Link	1.81	0.55	1.86	1.84	4.22
	29	*Echinocloa colonum* (L) Link	0.30	0.29	0.62	0.46	1.21
	30	*Eleusine indica* (L.) Gaertn	2.92	5.01	4.35	3.64	12.28
	31	*Eragrostis tenella* (L.) P.Beauv. ex Roem & Schult	0.40	0.01	1.24	0.82	1.65
	32	*Heteropogon contortus* (L.) P.Beauv. ex Roem & Schult	7.11	6.24	5.59	6.35	18.94
	33	*Ischaemum muticum* L.	0.81	0.42	3.11	1.96	4.33
	34	*Panicum repens* L.	3.43	10.16	3.73	3.58	17.31
	35	*Paspalum commersonii* Lamk	5.85	2.17	4.35	5.10	12.36
	36	*Paspalum conjugatum* Berg./Swartz	1.81	0.25	2.48	2.15	4.55
Sedges							
Cyperaceae	37	*Cyperus compresus* L.	4.23	1.17	3.73	3.98	9.13
	38	*Cyperus iria* L.	0.10	0.03	0.62	0.36	0.75
	39	*Cyperus rotundus* L.	0.30	0.19	1.24	0.77	1.73
	40	*Fimbristylis acuminata* Vahl	2.02	0.91	3.11	2.56	6.03
	41	*Fimbristylis globulosa* (Retz.) Kunth	2.08	0.11	1.24	1.66	3.43
	42	*Fimbristylis miliacea* (L.) Vahl	3.33	0.09	2.48	2.91	5.90
	43	*Fimbristylis schoenoides* (Retz.) Vahl	0.60	0.22	1.24	0.92	2.06
	44	*Scirpus grossus* L.F	0.10	0.06	0.62	0.36	0.78
	45	*Scirpus juncoides* Roxb.	2.36	1.51	4.35	3.35	8.21

occurring in immature palms, rubber, fruit orchards and vegetable plots(one would tend to rightly assume that more disturbance due to trampling, tillage, etc. occuring in vegetable plots than in immature oil palm or rubber plantations) no apparent difference was observed in the seed distribution pattern as a function of soil depth in the sampling areas.

Several broad conclusions can be derived from this study. Firstly, weed management practices on arable peat did not apparently annihilate the soil seed banks. Secondly, the prevailing agronomic protocols among different crops did not bring about differences in species composition in peat although different degree of aggregation in the spatial distribution pattern between species, arguably, in part, was attributed to such practices. Finally, future weed management programme on arable peat has to take into account the prevailing multi-species scenario of weeds, thereby requiring non-selective herbicides with wide window application options while keeping the crops intact.

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摘 要

말레이지아 Selangor地域의 부식질 耕地土壤의 土深 0 - 25cm에 埋立되어있는 雜草種子들의 種類와 分布特性을 調査分析하였으며, 이를 地上에 자라고 있는 雜草植生調査結果와 관련시켜 고찰한 결과는 다음과 같이 要約된다.

1. 耕地土壤에 埋立되어 있는 雜草種子는 14科에 속하는 45種의 雜草가 식별되었으며, 그 중 24種이 廣葉雜草이었고, 禾本科 12種, 莎草科 9種으로 地上에 자라고 있던 19科 31種과는 다소 달랐다.
2. 埋立種子數는 8.14×10^7/ha · 土深25cm 수준이었으며, 草種別로 埋立種子數에 큰 差異를 보였는데 埋立種子數에서 廣葉雜草 53.2%, 禾本科雜草 31.2%, 莎草科雜草 15.6%로 構成되어 있었다.
3. 埋立種子數(種子數/ha · 토심25cm)가 많은 10順位 草種은 *Cleome rutidesperma*(2.347×10^7), *Heteropogon contortus*(5.64×10^6), *Paspalum commersonii*(4.64×10^6), *Amaranthus gracilis* (3.60×10^6), *Bracharia reptans*(3.30×10^6), *Fimbrystylis miliacea*(2.64×10^6), *Eleusine indica* (2.32×10^6), *Murdannia nudiflora*(2.08×10^6), *Ageratum conyzoides*(1.92×10^6), 및 *Mimosa pudica*(1.92×10^6)이었다.
4. 埋立種子數의 土深別 分布는 表土 0 - 10cm에 69%, 10 - 15cm에 17.9%, 15 - 20cm에 8.6%, 20 - 25cm에 4.0%로서 表層에 현저히 많이 分布하였다.
5. 土中 埋立種子數面에서의 優點種은 地面生育中의 優點度와 달라서 埋立種子數가 제일 많은 *C. rutidesperma*는 地上에서 優點度 6順位이었고 地上에서 優點度 2, 4順位이었던 *M. nudiflora*와 *A. conyzoides*가 埋立種子數에서 각각 8, 9順位이었으며 그 밖에는 優點度 10順位內에서 서로 관련되지 않았다.
6. 埋立種子들의 地理的 位置分布에 관하여 分散/平均比, Lloyd의 平均群集度, Lloyd의 集中性 分析을 한 결과 平均群集度가 *Cyperus iria* 등 5草種은 1.244수준인데 대하여 *Cleome rutidosperma*는 9,607.7이었고, 優點度는 *Aeschynomene indica*의 5.1에서 *Bracharia reptans*의 188.5까지 草種別로 다양한 差異를 보였다.

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