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A Study of Weed Populations and Their Buried Seeds in the Soil of MARDI Research Station and at Farmers' Rice Fields in Sungai Burung, Tanjung Karang, Selangor, Malaysia

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ABSTRAK

Kajian populasi rumpai dan biji yang tertanam sebelum dan selepas penuaian telah dilakukan di kawasan sawah di Stesyen Penyelidikan MARDI dan Sungai Burung, Selangor. Hasil menunjukkan bahawa rumpai berdaun lebar sangat dominan di kawasan sawah di Stesyen MARDI dan Sungai Burung. Dua spesies iaitu Cyperus difformis (rusiga) dan Najas graminae *(daun lebar), masing-masing merupakan spesies dominan di kedua-dua kawasan tersebut. Populasi biji rumpai tidak berbeza di antara kedua-dua kawasan tersebut. Bagaimanapun, biji rumpai yang dikira sebelum dan selepas penuaian menunjukkan perbezaan bilangannya. Pada umumnya bilangan biji yang tertinggi di kedua-dua kawasan sawah tersebut dikesan pada kedalaman 0-5 cm.*

ABSTRACT

A study of weed populations and their buried seeds before and after harvesting was carried out at the MARDI Research Station and at Farmers' Rice Fields, Sungai Burung in Tanjung Karang, Selangor. The results showed that the broadleaf weeds were the most dominant in the MARDI and Sungai Burung rice fields. Two species, namely Cyperus difformis *(sedge) and* Najas graminae *(broadleaf) were the most dominant species in the MARDI and Sungai Burung rice fields respectively. The weed seed populations were similar in both rice fields. However, the weed seed counts before and after harvesting were different. In general, it was also found that the highest number of weed seeds in the soil was detected in the 0-5 cm layer of soil in both rice fields.*

INTRODUCTION

Weed infestation is one of the most problematic and troublesome scenarios in rice cultivation. Factors such as cultivation practice, land preparation, soil moisture content and management strategies greatly affect the presence and abundance of weeds in rice fields (De Datta 1981). Previous studies have shown that weeds found in direct seeded rice fields were more complicated than those in transplanted rice fields (Teerawatsakul 1976; Tengku Zunaidah 1996). As reported, weed composition and dominance were affected by water management and soil preparation. Rice field soils, which are flattened and submerged in water in the early stage of land preparation coupled with proper tillage, could reduce the growth of weeds (Khalid 1988; Yamada 1965). Noda (1977) reported that weeds in transplanted and direct seeded rice fields caused rice yield losses of 16 and 62%, respectively.

Weed problems begin with weed seeds in the soil and they continuously create problems even though attempts are made to prevent them from going to seed in the field (Wilson *et al.* 1985). Thus, knowledge of the total number and type of buried seeds is very useful in predicting which species are likely to emerge in a particular field (Lawson 1988). Reports on weeds from rice fields in Tanjung Karang are very limited. Recently, it was reported that *Limnophila erecta* and *Bacopa rotundifolia* were the newly detected dominant weeds in Sekinchan (Azmi and Baki 2003). Experiments were therefore conducted to determine the weed flora composition and seed population in wet-seeded rice fields in Tanjung Karang, Selangor.

MATERIALS AND METHODS

The Study Area

The study was conducted at the Research Station of MARDI and farmers' rice fields in Sungai Burung, Tanjung Karang, Selangor. The MARDI and Sungai Burung areas have 9.6 and 2,000 ha of rice fields respectively. Farmers in MARDI practise the wet direct seeding method in the monsoon season (Jun-Oct 2000) and the transplanting method in November-March (2000/01). Almost 98% of the rice fields in Sungai Burung are wet-direct seeded and the main sources of water supply are irrigation canals and rain.

Weed Population Determination

Two plots from each study area were selected randomly and used for the weed population assessment study. The paddy plants were approximately 2 to 2 $^1/_2$ months old in both sites. Weeds from each of thirty 1-m^2 quadrats (Kim and Moody 1983) in each plot were removed and counted by species. Summed dominance ratio (SDR) of each species was determined from the sum of the relative density, relative abundance and relative frequency.

Seed Bank Sampling

Soil samples were taken from the same locations as those used for weed population determination. Soil samples 7 cm in diameter were taken up to a depth of 15 cm from 30 quadrats in each study site. The soil depth of 15 cm was studied as reports have shown that the viability of the seed decreased at the depth of 10 cm and the buried seeds were skewed within the first 10 cm soil depth besides being well-correlated to the seedling emergence in fields (Baki *et al.* 1997; Graham and Hutchings 1988; Wilson *et al.* 1985; Zoner *et al.* 1984). The soil cores were divided into three different sections according to depth: 0-5 cm, 5-10 cm and 10-15 cm. Soil samples of the same depth for each particular site were pooled, mixed thoroughly and air-dried. The soil sampling before harvesting was conducted when the paddy plants were 2 to 2 $^1/_2$ months old whilst soil samples after harvesting were taken immediately after the crop was harvested. All sampling was done from the wet-direct seeded rice fields at both sites.

A modification of the seed separation methods described by Wilson *et al.* (1985), Sastroutomo and Yusron (1987) and Ball and Miller (1989) were used. For each soil, a 400 g soil sample was soaked in water and passed through a sieve with a screen size of 250 μm to collect weed seeds. Water was run through the screen to enhance sample movement. The contents collected in the screen were removed and air-dried. Seeds from the entire samples were sorted using a dissecting microscope and counted according to species. The total number of buried seeds found in the soil at different depths was expressed in numbers per m^2.

RESULTS

Weed Composition

A total of 17 weed species belonging to 13 families were found in these arable sites (Table 1). Among the families, Poaceae was the family with the highest number of species. Generally, broadleaf weeds were the most dominant (9 species) compared to grasses (4) and sedges (3). A species of aquatic ferns (*Marsilea crenata* Presl) from the family Marsileaceae was identified too. The number of weed species in the MARDI rice fields was slightly higher (14 species) than that in the Sungai Burung (13 species) area.

There were four species with SDR values of more than 5% in the MARDI rice fields. The most dominant weed was *Cyperus difformis* L. with a SDR value of 12.14%, followed by *Mimulus orbicularis* (Bl.), *Lemna minor* L. Griff and *Limnocharis flava* Buchenau in the respective order of 10.12, 7.78 and 5.39%. However in the Sungai Burung rice fields, the hierarchical order of the dominant weed species was *Najas graminea* (non Del.) Ridl, *L. minor*, *Sagittaria guayanensis* Kunth, *Hydrilla verticullata* (L.f) Royle and *Monochoria vaginalis* (Burm.f.) Presl with SDR values of 12.77, 8.92, 7.14, 5.42 and 5.19% respectively.

Based on the SDR value, the broadleaved weeds dominated the weed community in the MARDI and Sungai Burung rice fields accounting for *ca.* 32.48% and 39.60% respectively (*Fig. 1*).

Weed Seed Population in the Soil

Tables 2 and 3 illustrate the number of species collected from the study sites. Twenty-four species of weed seeds were recorded. The total weed seed populations in both rice fields were quite similar for both harvest times (369,720 and 526,042 seeds/m^2 in MARDI; 390,721 and 535,316 seeds/m^2 in Sungai Burung before and

TABLE 1
Summed dominance ratio values of weeds in transplanted rice fields of the Research Center MARDI and farmers' fields in Sungai Burung, Tanjung Karang, Selangor

Species	SDR (%)	
	MARDI	Sungai Burung
Alismataceae		
Sagittaria guayanensis	-	7.14
Limnocharitaceae		
Limnocharis flava	5.39	-
Cyperaceae		
Cyperus difformis	12.14	-
Cyperus iria	2.96	-
Hydrocharitaceae		
Hydrilla verticillata	1.57	5.42
Lemnaceae		
Lemna minor	7.78	8.92
Lentibulariaceae		
Utricularia aurea	0.88	1.03
Lythraceae		
Rotala indica	1.65	3.54
Marsileaceae		
Marsilea crenata	1.37	1.50
Najadaceae		
Najas graminea	3.52	12.77
Onagraceae		
Ludwigia adscendens	0.70	1.01
Poaceae		
Digitaria adscendens	-	0.56
Echinochloa colona	2.21	2.65
Echinochloa crus-galli	3.76	3.48
Leptochloa chinensis	-	1.79
Pontederiaceae		
Monochoria vaginalis	2.44	5.19
Scrophulariaceae		
Mimulus orbicularis	10.12	-

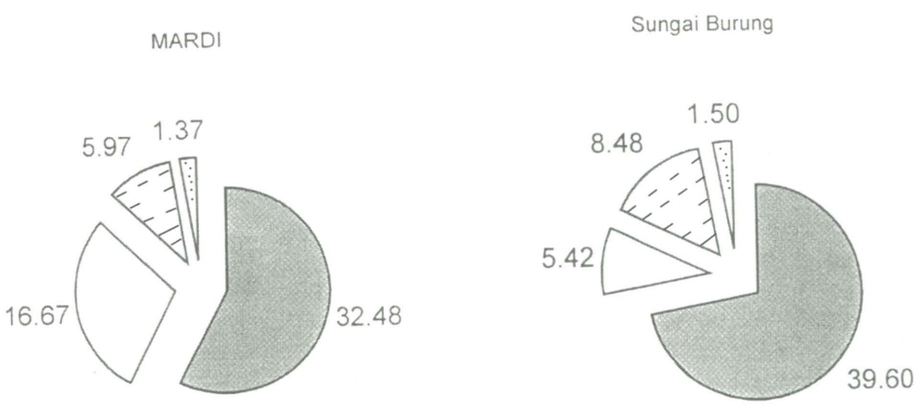

Fig. 1: SDR values of broadleaved weeds ( ), grasses( ), sedges ( ) and aquatic ferns ( ) in MARDI and Sungai Burung rice fields

TABLE 2
The distribution of weed seeds at the depth of 0-15 cm soil profile of arable rice fields in MARDI, Tanjung Karang, Selangor

Species	Soil depth (cm)				
	0-5	5-10	10-15 seeds/m^2	0-15	%
Before harvesting					
Cyperus iria	33,351	25,958	16,955	76,264	20.63
Echinochloa colona	18,332	20,580	14,265	53,177	14.38
Limnocharis flava	17,117	11,459	10,056	38,632	10.45
Scirpus juncoides	12,700	12,161	9,121	33,981	9.19
Leguminosae	11,375	9,705	9,121	30,201	8.17
Eleocharis acicularis	10,160	6,665	3,157	19,982	5.41
Monochoria vaginalis	8,835	7,600	2,806	19,241	5.20
Utricularia aurea	5,963	9,939	1,988	17,890	4.84
Najas graminea	5,301	5,847	1,754	12,902	3.49
*Oryza sativa**	7,178	3,859	468	11,505	3.11
Cyperus difformis	7,841	2,105	1,052	10,998	2.97
Echinochloa crus-galli	4,417	4,560	1,637	10,614	2.87
Sagittaria guayanensis	2,761	6,314	818	9,893	2.68
Cleome viscosa	2,761	3,508	3,274	9,543	2.58
Lemna minor	2,430	4,209	0	6,639	1.80
Echinochloa stagnina	552	2,339	0	2,891	0.78
Leptochloa chinensis	994	1,403	0	2,397	0.65
Unidentified	1,215	0	585	1,800	0.48
Fimbristylis miliacea	0	1,169	0	1,169	0.32
Total	153,283	139,380	77,057	369,720	100.00
After harvesting					
Cyperus iria	53,008	35,313	16,838	105,159	20.00
Limnocharis flava	31,597	32,039	21,047	84,683	16.10
Echinochloa colona	20,683	18,709	10,758	50,150	9.53
Utricularia aurea	12,473	18,007	11,927	42,407	8.06
*Oryza sativa**	19,644	7,016	6,197	32,857	6.25
Leguminosae	16,110	13,213	1,006	30,329	5.77
Cleome viscosa	10,393	11,108	6,197	27,698	5.27
Scirpus juncoides	11,537	9,822	5,963	27,322	5.19
Monochoria vaginalis	7,795	7,016	5,145	19,956	3.79
Cyperus difformis	9,354	3,508	4,443	17,305	3.29
Ludwigia octovalvis	5,717	8,185	2,572	16,474	3.13
Najas graminea	6,444	4,677	3,625	14,746	2.80
Eleocharis acicularis	6,236	3,859	2,339	12,434	2.36
Lemna minor	6,028	3,625	1,871	11,524	2.19
Echinochloa crus-galli	4,469	4,677	2,339	11,485	2.18
Echinochloa stagnina	1,143	4,209	1,169	6,521	1.24
Leptochloa chinensis	1,455	3,859	819	6,133	1.17
Fimbristylis miliacea	2,183	1,403	2,104	5,690	1.08
Unidentified	935	818	0	1,753	0.33
Dactyloctenium aegyptium	832	584	0	1,416	0.27
Total	228,036	191,647	106,359	526,042	100.00

• Paddy

TABLE 3
The distribution of weed seeds at the depth of 0-15 cm soil profile of farmers' arable rice fields in Sungai Burung, Tanjung Karang, Selangor

Species	Soil depth (cm)				
	0-5	5-10	10-15 seeds/m^2	0-15	%
Before harvesting					
Najas graminea	35,693	23,839	10,513	70,045	17.93
Sagittaria guayanensis	27,332	16,768	7,104	51,204	13.11
Scirpus juncoides	26,368	11,718	8,808	46,894	12.00
Monochoria vaginalis	16,507	15,657	12,786	44,950	11.50
Echinochloa colona	10,290	13,435	7,388	31,113	7.96
Utricularia aurea	12,970	6,364	5,115	24,449	6.26
Cleome viscosa	10,611	7,374	2,178	20,163	5.16
Eleocharis acicularis	7,396	8,990	1,988	18,374	4.70
*Oryza sativa**	11,898	4,445	1,705	18,048	4.62
Limnocharis flava	6,002	7,778	2,178	15,958	4.08
Cyperus iria	7,074	3,232	1,515	11,821	3.03
Cyperus difformis	2,358	6,465	947	9,770	2.50
Echinochloa crus-galli	4,716	2,121	852	7,689	1.97
Lemna minor	5,788	1,313	378	7,479	1.91
Unidentified	1,179	2,929	2,272	6,380	1.64
Leptochloa chinensis	2,359	1,212	0	3,571	0.91
Ludwigia octovalvis	1,822	707	284	2,813	0.72
Total	190,363	134,347	66,011	390,721	100.00
After harvesting					
Najas graminea	76,472	47,552	14,096	138,120	25.80
Scirpus juncoides	48,058	30,012	8,299	86,369	16.13
Echinochloa colona	27,245	20,138	11,141	58,524	10.93
Sagittaria guayanensis	12,979	27,414	9,436	49,829	9.31
Utricularia aurea	29,934	12,732	6,253	48,919	9.14
Monochoria vaginalis	11,225	15,980	1,819	29,024	5.42
*Oryza sativa**	15,084	8,055	3,638	26,777	5.00
Eleocharis acicularis	10,290	8,185	2,501	20,976	3.92
Echinochloa crus-galli	9,822	4,807	2,387	17,016	3.18
Cleome viscosa	7,133	2,728	1,250	11,111	2.08
Limnocharis flava	2,456	4,417	3,410	10,283	1.92
Cyperus difformis	5,145	2,339	2,046	9,530	1.78
Cyperus iria	2,339	3,248	1,592	7,179	1.34
Ludwigia octovalvis	1,637	3,248	455	5,340	1.00
Leguminosae	1,169	3,378	796	5,343	1.00
Cyperus compressus	2,339	1,560	0	3,899	0.73
Leptochloa chinensis	1,052	1,560	568	3,180	0.59
Unidentified	819	1,819	341	2,979	0.56
Lemna minor	350	0	568	918	0.17
Total	265,548	199,172	70,596	535,316	100.00

* paddy

TABLE 4
Estimation of weed seeds found in the arable soil at the Research Station MARDI and in farmers' fields Sungai Burung, Tanjung Karang, Selangor[a]

Soil depth (cm)	Estimated mean number of seed (seeds/m^2)	
	Before harvesting	After harvesting
MARDI		
0-5	153,283 a	228,036 a
5-10	139,380 a	191,647 a
10-15	77,057 b	106,359 b
Total*	369,720	526,042
Sungai Burung		
0-5	190,363 a	265,548 a
5-10	134,347 b	199,172 b
10-15	66,011 c	70,596 c
Total*	390,721	535,316

a Means in a column followed by the same letters are not significantly different (P>0.05) according to the Tukey test.
* The total seed count between before and after harvesting is significantly different at the 5% level as determined by Tukey test.

after harvesting, respectively). Nevertheless, the estimated number of weed seeds after harvesting was higher than the number before harvesting (Table 4). Nineteen and twenty species of weed seeds were recorded in the MARDI rice fields before and after harvesting, respectively. Meanwhile, the corresponding number was 18 and 17 species in the Sungai Burung rice fields. The seeds of *Cyperus iria* L. were the most abundant in the MARDI rice fields while *N. graminea* had the highest percentage of total seeds found in the Sungai Burung rice fields irrespective of the harvest time. Most of the weed seeds were found in the top 5 cm of the soil at both sites. In general there was a significant difference in the seed count at the different depths of the Sungai Burung soil. The total number of weed seeds declined with increasing depth, i.e. they were lower at 10-15 cm than at 0-5 cm.

DISCUSSION

According to the findings of Saharan (1977), the most common broadleaved weeds found in rice fields were *M. vaginalis, L. flava, S. guayanensis* and *Jussiaea repens.* All these species except *J. repens* were found in this study. The abundance of broadleaf weeds in both study sites indicates that flooding has a major suppressive effect on the stand establishment and growth of grasses and sedges. Anon (1982) and Moody (1977) reported that almost all weeds cannot survive in water at the depth of more than 10 cm, except certain broadleaved weeds.

Seventeen out of the 55 weed species recorded by Itoh (1991) were identified in the MARDI and Sungai Burung rice fields. Only two species were in the group of common weeds, *viz. L. minor* and *Scirpus juncoides* meanwhile two other species (*H. verticullata* and *Rotala indica*) were rare species. Drost and Moody (1982) reported that moisture or saturated soil conditions after planting was the major factor affecting the composition of the weed flora and the dominance patterns of the major weed groups in particular populations. Water supplied to rice fields after seeding hinders the establishment of sedges and grasses. The SDR values reflect this, as the value for broadleaves is more than double those obtained for sedges and grasses. Thus, flooding favoured the growth of broadleaved weeds over sedges and grasses (Ho and Itoh 1991).

The total numbers of buried seeds (including viable and non-viable seeds) in the two sites were similar. This was due to the geographical factor. Both study sites were close to each other (5 km apart) and irrigated by canals from the same point. Kelly and Bruns (1975) have proven that water played a significant role in the process of weed dissemination. The same source of irrigation might contribute to the similarity of weed seed counts at both sites.

On the other hand, seed counts before and after harvesting were significantly different in both areas. In most cases, the life cycle of weeds in rice fields is shorter compared to that of the rice plant. Within 3 months, weed seeds will ripen and fall, thus contributing to the seed reservoir in the soil. For instance, *E. crus-galli* has a growth duration of 90 days, which is shorter than the maturation period of the paddy plant (via. 120 days) (Azmi 1990). Thus, the weed seed population in the soil is higher after the harvest period. It is also reasonable to suggest that the species found possess characteristically efficient and strong vegetative growth coupled with the ability to produce a vast number of seeds.

Weed seeds of both rice fields were skewed mostly to the first 0-5 cm soil depth accounting for *ca.* 41.5 to 43.3% and 48.7 to 49.6% of the total seed counts in the MARDI and Sungai Burung rice fields, respectively. The large number of seeds may appear to be those seeds buried during previous years and the continuous seed shedding by the existing weeds onto the soil surface. Baki *et al.* (1997) have also proven that the total seed counts are high in the first 0-5 cm soil depth in arable peat of Selangor, Malaysia.

The depth from which soil samples are taken is an important factor to estimate the seedbank in the soil (Zhang *et al.* 1998). Studies have shown that burial depth significantly affects seed germination and seedling emergence in a variety of plant species under both greenhouse and field conditions (Fenner 1985; Maun and Lapierre 1986). In our study, soil samples were taken up to a depth of 15 cm to determine the density of the soil seedbank. This is because taking soil samples to ploughing depth may increase the chances of sampling the seeds of weed species in an area and thus enhance the degree of accuracy in the estimation of the existing soil seedbank.

Seedbanks can make eradication of weeds very difficult. It is possible to locate and destroy growing plants, but dormant viable seeds may remain undetected in the soil for many years and later on give rise to a new population of plants. Therefore, control of weed seed population in the soil is necessary for better weed management (Ismail and Kalithasan 1994) and may be more practicable if the seeds in the active soil seedbank are used (Zhang *et al.* 1998). Further studies on the viability of the weed seeds are required to achieve this goal.

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