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Weed Vegetation of Direct Seeded Ricefields in Muda Rice Granary Areas of Peninsular Malaysia

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Abstract: A survey was carried out at heading stage of direct seeded rice to determine the major weed flora in Muda area, Kedah, Peninsular Malaysia. Thirty five weed species belonging to 17 families were identified in this area. Of these, 15 species were broadleaves, 10 sedges, 6 grasses and 4 aquatics. According to % field infestation and infestation rating score the six most widespread and abundant species were *Oryza sativa* complex (weedy rice), *Leptochloa chinensis*, *Echinochloa crus-galli*, *Ischaemum rugosum*, *Fimbristylis miliacea* and *Ludwigia hyssopifolia*. The hierarchy of weed type according to % field infested ratio was in the order of grasses (G)> broadleaved weeds (BL)> sedges (SG)> aquatics.

Key words: Weed vegetation, direct seeded rice, Muda rice granary, Malaysia

INTRODUCTION

In Malaysia, rice double cropping covers an area of about 209,300 ha, which is principally found in eight granary areas in Peninsular Malaysia. Among these, the largest granary of Muda in Kedah covers 98,860 ha. Weeds represent a major constraint with yield losses of between 5 to 72% depending on season, weed species, weed density, rice cultivars, growth rate and density of weed and rice[1,2]. Azmi[3] estimated that the yield loss by grasses mainly *E. crus-galli*, broadleaved weeds and sedges was 41, 28 and 10%, respectively.

In any field, the weed flora was, in part, a result of the agronomic management practices i.e. time and type of tillage, crop establishment technique, irrigation and fertilizer used, and type, rate and effectiveness of herbicides used by the farmer. Direct wet seeding (broadcasting of pre-germinated seeds on puddle soil) results in greater weed growth than transplanting[4,5]. As a result, yield reduction due to weed competition is greater in direct-seeded rice than in transplanted rice[6,7]. Several authors[4,7,8] have reported that more broadleaf weeds grow in association with transplanted rice and more grassy weeds with wet-seeded rice.

In Peninsular Malaysia, due to shortage of labour and higher cost of rice transplanting, the method of rice establishment had been shifted to direct seeding since 1980s. All rice farmers, who practiced direct seeding, adopted chemical weed control. The changes in cultural practices and use of agrochemicals led to a shift in weed species in the rice granaries of Malaysia. Monitoring these changes is important to formulate appropriate weed management strategies in the crop.

In recent years there has been an increasing need for more information on the occurrence of individual weed species so that research focus can be directed towards the most important weeds. Therefore, the present study was undertaken to investigate the distribution and severity of weed flora prevailing in the Muda area.

MATERIALS AND METHODS

The survey was conducted at heading stage of direct seeded rice crop in Muda at Kedah from 5 to 20 July 2003. Ricefields surveyed covered 27 farm blocks comprising of 579 fields. Before starting the survey a route was planned to provide adequate coverage of the whole area. All fields along to the route were assessed irrespective of size. Visual assessments on the occurrence and density of individual weed species were made by two persons while walking along one side and again when returning along the opposite side of each field. A mean score for each weed was then determined[9]. This method was adapted both to reduce the time taken to survey a field and to prevent possible damage to the crop.

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The percentage weed cover was assessed on a whole field basis. Care was taken over the identification of weed species. As most grasses were in the flowering stage assessments could be made quite readily. Where several grasses occurred together, particular care was also taken in assessing their relative proportions. Weeds that could not be identified were tagged, pressed and submitted for positive identification.

All weed species present were recorded and scored for distribution and frequency. A rating scale of 1 to 10 was used to denote weed cover, where represents the lowest score of 1 represents 1-10% weed cover, while the maximum score of 10 represents 91-100% weed cover. Species with a few scattered plants were coded as Tr. (Trace amounts)[10].

RESULTS AND DISCUSSION

Species composition: The occurrence of 35 weed species belonging to 17 families were recorded in Muda rice granary, of which, 15 were broadleaves, 10 sedges, 6 grasses, and 4 aquatics (Table 1). Cyperaceae was the family, with the highest number of species (10) followed by Gramineae (6), Scrophulariaceae (3), Onagraceae (2) and Pontederiaceae (2). Another 12 families were represented by one species each (Table 1). In general, broadleaf weeds were the highest in number including two ferns, namely *Marsilea crenata* Presl and *Ceratopteris thalictroides* (L.) Brongn; although grasses were the most wide spread species with more than 40% of the fields infested, namely by *Oryza sativa* (weedy rice), *Echinochloa crus-galli*, *Leptochloa chinensis* and *Ischaemum rugosum*. *Ludwigia hyssopifolia* and *Fimbristylis miliacea* were the most widely distributed broad-leaf and sedge weeds, respectively. By far the 10 most frequent species in terms of percent fields infested were *Oryza sativa* (weedy rice, 98.96%), *Echinochloa crus-galli* (87.56%), *Leptochloa chinensis* (87.39%), *Ludwigia hyssopifolia* (68.39%), *Fimbristylis miliacea* (48.88%), *Ischaemum rugosum* (45.94%), *Scirpus grossus* (35.92%), *Cyperus iria* (27.29%), *Sphenoclea zeylanica* (20.21%) and *Echinochloa colona* (10.02%). The remaining species were present in less than 10% of fields (Table 1). Azmi *et al.*[11] observed almost similar results, except for a weedy rice and *Ischaemum rugosum* in their survey conducted at Muda in direct seeded rice in 1989-1990. They recorded a total of 40 species belonging to 18 families, of which, the highest number of weeds were

Table 1: Occurrence of weed species based on family affiliation, weed type and percent-infested fields out of 579 fields surveyed in Muda rice granary

Family	Weed species	Weed type*	% Infested fields	Total No. of infested fields
Gramineae	*Oryza sativa* L. (weedy rice)	G	98.96	573
Gramineae	*Echinochloa crus-galli* (L.) Beauv.	G	87.56	507
Gramineae	*Leptochloa chinensis* (L.) Nees	G	87.39	506
Onagraceae	*Ludwigia hyssopifolia* (G. Don) Exell	BL	68.39	396
Cyperaceae	*Fimbristylis miliacea* (L.) Vahl	S	48.88	283
Gramineae	*Ischaemum rugosum* Salisb.	G	45.94	266
Cyperaceae	*Scirpus grossus* L.f	SG	35.92	208
Cyperaceae	*Cyperus iria* L.	SG	27.29	158
Spenocleaceaa	*Sphenoclea zeylanica* Gaertn	BL	20.21	117
Gramineae	*Echinochloa colona* (L.) Link	G	10.02	58
Scrophulariaceae	*Bacopa rotundifolia* (Michx.)Wettst.	BL	9.84	57
Cyperaceae	*Cyperus babakensis*	SG	9.33	54
Butomaceae	*Limnocharis flava* (L.) Buchenau	BL	8.29	48
Lentibularaceae	*Utricularia aurea* Lour	AQ	7.60	44
Pontederiaceae	*Monochoria vaginalis* (Burm.f.)	BL	7.43	43
Alismataceae	*Sagittaria guyanensis* H.B.K.	BL	6.74	39
Cyperaceae	*Cyperus difformis* L.	SG	6.39	37
Marsileaceae	*Marsilea crenata* Presl	BL	5.18	30
Najadaceae	*Najas graminea* Del	AQ	4.84	28
Scrophulariaceae	*Limnophila erecta* Benth.	BL	3.80	22
Lemnaceae	*Lemna perpusilla* Torr.	BL	2.94	17
Parkeriaceae	*Ceratopteris thalictroides* (L.) Brongn	BL	2.42	14
Rubiaceae	*Hedyotis corymbosa* (L.) Lamk	BL	2.25	13
Onagraceae	*Ludwigia adscendens* (L.) Hara	BL	2.07	12
Gramineae	*Paspalum vaginalis* Sw	G	1.73	10
Cyperaceae	*Scirpus lateriflorus* Gmel	SG	1.38	8
Cyperaceae	*Cyperus haspan*	SG	1.38	8
Gentiaceae	*Nymphoides indica* (L.) O.k	AQ	1.38	8
Cyperaceae	*Scirpus juncoides* Roxb	SG	0.86	5
Cyperaceae	*Fuirena umbellata* Rottb.	SG	0.86	5
Hydrocharitaceae	*Blyxa malayana* Ridl	AQ	0.69	4
Pontederiaceae	*Monochoria hastata* (L.) Solms	BL	0.69	4
Scrophulariaceae	*Lindernia pusilla* Boldingh	BL	0.52	3
Cyperaceae	*Eleocharis variegata* (nec kunth) Boeck	SG	0.17	1
Salviniaceae	*Salvinia cucullata* Roxb. ex Bory	BL	0.17	1

*G=Grass; BL=Broadleaves; SG=Sedge; AQ=Aquatic Weed (Submerged)

Table 2: Number of rice fields infested by each species at each of six levels of occurrence (Total field surveyed = 579)

Weed species	Score of occurrence*						Total infested fields
	Tr	1	2	3	4	5	
Oryza sativa complex (weedy rice)	183	163	124	68	23	12	573
Echinochloa crus-galli	311	119	62	13	1	1	507
Leptochloa chinensis	278	159	51	12	5	1	506
Ludwigia hyssopifolia	355	38	3	-	-	-	396
Fimbristylis miliacea	244	29	9	1	-	-	283
Ischaemum rugosum	153	77	25	7	3	1	266
Scirpus grossus	162	37	9	-	-	-	208
Cyperus iria	142	16	-	-	-	-	158
Sphenoclea zeylanica	79	34	4	-	-	-	117
Echinochloa colona	58	-	-	-	-	-	58
Bacopa rotundifolia	54	3	-	-	-	-	57
Cyperus babakensis	53	1	-	-	-	-	53
Limnocharis flava	46	2	-	-	-	-	48
Utricularia aurea	38	6	-	-	-	-	44
Monochoria vaginalis	41	2	-	-	-	-	43
Sagittaria guyanensis	38	1	-	-	-	-	39
Cyperus difformis	28	3	6	-	-	-	37
Marsilea crenata	29	1	-	-	-	-	30
Najas graminea	23	5	-	-	-	-	28
Limnophila erecta	20	2	-	-	-	-	22
Lemna perpusilla	13	3	1	-	-	-	17
Ceratopteris thalictroides	14	-	-	-	-	-	14
Hedyotis corymbosa	10	3	-	-	-	-	13
Ludwigia adscendens	10	2	-	-	-	-	12
Paspalum vaginalis	9	1	-	-	-	-	10
Scirpus lateriflorus	5	2	1	-	-	-	8
Cyperus haspan	8	-	-	-	-	-	8
Nymphoides indica	8	-	-	-	-	-	8
Scirpus juncoides	4	1	-	-	-	-	5
Fuirena umbellata	3	2	-	-	-	-	5
Blyxa malayana	3	1	-	-	-	-	4
Monochoria hastata	4	-	-	-	-	-	4
Lindernia pusilla	3	-	-	-	-	-	3
Eleocharis variegata	1	-	-	-	-	-	1
Salvinia cucullata	1	-	-	-	-	-	1

*Tr = a few scattered plant, c1 = 1-10% weed cover; 2 = 11-20% weed cover; 3 = 21-30% weed cover; 4 = 31-40% weed cover; 5 = 41-50% weed cover

broadleaves (17) followed by grasses (10), sedges (10) and aquatics (3). Among them the most frequent species were three grasses (*Echinochloa crus-galli*, *Leptochloa chinensis* and *Echinochloa colona*); six sedges (*Fimbristylis miliacea*, *Scirpus grossus*, *Cyperus iria*, *Cyperus difformis*, *Cyperus babakensis* and *Fuirena umbellata*); eight broadleaf weeds (*Monochoria vaginalis*, *Sphenoclea zeylanica*, *Marsilea crenata*, *Ludwigia hyssopifolia*, *Lemna minor*, *Limnocharis flava*, *Limnophila aromatica* and *Sagittaria guyanensis*) and two aquatic weeds (*Najas graminea* and *Utricularia aurea*. Similar species were also recorded by Pane[12] in an intensive survey with 20 sampling sites in the Muda area during the 1994 first crop season, but recorded only 13 species, comprising of four grasses (*Echinochloa crus-galli*, *Leptochloa chinensis*, *Ischaemum rugosum* and *Paspalum distichum*) four sedges (*Fimbristylis miliacea*, *Cyperus iria*, *Cyperus difformis*, *Scirpus juncoides*) and five broadleaf weeds (*Limnocharis flava*, *Sphenoclea zeylanica*, *Ludwigia octovalvis*, *Sugittaria guyanensis* and *Marsilea crenata*). A major exception observed in this survey compared to previous surveys was infestation by *Oryza sativa* complex (weedy rice) in almost 100% of fields.

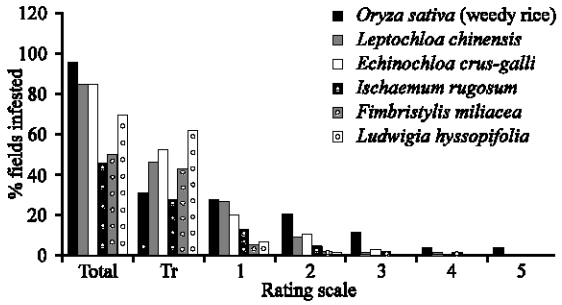

Fig. 1: Severity of infestation of dominant weed species in the Muda rice granary area

Severity of weed infestation: Severe infestations of grassy weed species *Oryza sativa* (weedy rice), *Leptochloa chinensis*, *Echinochloa crus-galli* and *Ischaemum rugosum* were distinctly noticeable with high scores of 4 and 5 (Table 2). Species of intermediate severity, namely *Ludwigia hyssopifolia, Fimbristylis miliacea, Scirpus grossus, Sphenoclea zeylanica, Cyperus difformis, Lemna perpusilla* and *Scirpus lateriflorus* recorded scores of up to 2, while *Fimbristylis miliacea* occurred as a serious infestation in one field with a score of 3. Rest of the species occurred infestation levels of between trace to a score of 1. The low levels of infestation recorded for most weeds reflect both the competitive ability of the crop and also the excellent level of weed control achieved, in particular of that species.

The hierarchy order of the six most widespread and abundant species with relative scores of 2-5 was *Oryza sativa* > *Leptochloa chinensis* > *Echinochloa crus-galli* > *Ischaemum rugosum* > *Fimbristylis miliacea* > *Ludwigia hyssopifolia* (Fig. 1). Azmi *et al.*[11], Azmi[13], Ho and Zuki[14] and Pane[12] reported that the predominant position of grasses such as *Echinochloa crus-galli*, *E. colona*, *Leptochloa chinensis* and *Ischaemum* as key species in Muda area were due to the shift in cultural practice from transplanting to direct seeding. In addition the ecological shift of weed species from broad-leaved weeds and sedges in transplanted rice culture to competitive grassy weeds in direct seeded rice has been related to continuous use of herbicides in weed control operation[15,16]. The build up of certain weed species after continuous use of particular herbicides might be due to inherent resistance to that herbicide or gradual development of herbicide resistance. Sometimes

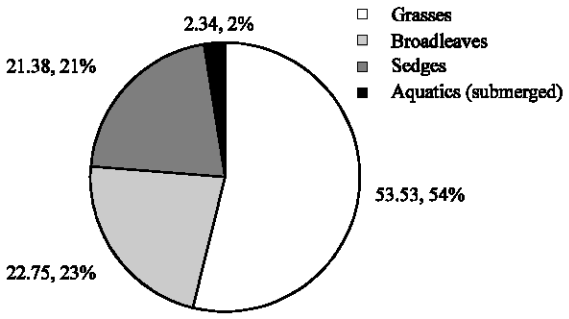

Fig. 2: Weed community in the Muda rice granary area

elimination of the competitors of a particular weed favours the abundance and predominance of that particular weed.

Pane[12] observed that *Leptochloa chinensis* was the dominant species instead of *Echinochloa crus-galli* which was once a dominant species in Muda area[11,13,17]. Perhaps the widespread use of herbicides (molinate) by local farmers, specifically to suppress the massive populations of *Echinochloa crus-galli* had resulted in the gradual increase of *Leptochloa chinensis* and *Ischaemum rugosum*. The weed population could have shifted as a consequence of herbicide usage. Normally, control methods are selected based on the most competitive weed in the previous season and this could result in a shift in. dominance of the weed species in the following season. Thus, the ranking of weed species dominance may have been influenced by the pressure and intensity applied by farmers to control the weeds.

The present study shows that *Oryza sativa* complex (weedy rice) is still the more dominant grass species, infesting almost 100% of rice fields with high levels of occurrence. In Malaysia, a weedy form of rice was first reported in Project Barat Laut Selangor (PBLS) in 1988 and then found to occur sporadically in the southern part of Muda area in 1990. The infestations became serious in 1993 and by 1994, the affected area increased to 300 ha[18]. Vaughan *et al.*[19] opined that the wide spread occurrence of weedy rice in Malaysian rice culture were favoured by (I) the practices of direct seeding and volunteer seedling rice culture, (ii) the use of easy shattering varieties and (iii) the use of combine harvesters, which moved from one rice growing area to another.

The high incidence of *Fimbristylis miliacea* may be attributed to the development of resistance to 2-4 D compounds, which were widely used in the Muda area[20]. Moreover, dominance of *Fimbristylis miliacea* and *Ludwigia hyssopifolia* could remain unchanged for an extended period because of the tremendous size of the accumulated seed bank of these weeds[21].

The overall pooled indices of % field infestation ratios for the grasses, broad-leaf weeds, sedges and aquatic weeds for Muda area are shown in Fig. 2. The hierarchy was in the order of grasses (G) > broad-leaved weeds (BL) > sedges (SG) > aquatics (AQ). This trend in order of prevalence of these weeds communities in the Muda area was also supported by Azmi *et al.*[11]. They noted that farmers in the Muda area used high level of inputs of agro chemicals. However, the grassy weeds may have escaped herbicide damage as several of the species were not adequately controlled by a number of herbicides in current use. The relatively high incidence of specific species recorded in this survey emphasizes the inadequacy of farmers weed management practices.

Weeds are dynamic and change in abundance and dominance in response to changes in the rice ecosystem. The major change in Malaysian rice culture from transplanting to direct seeding has led to an increase in weed infestations of especially grassy weed species. Weeds *Oryza sativa* complex (weedy rice), *Leptochloa chinensis*, *Echinochloa crus-galli* and *Ischaemum rugosum* were the four most widespread and abundant grassy weed species. Other dominant but equally important weed species were *Fimbristylis miliacea* and *Ludwigia hyssopifolia*. *Oryza sativa* (weedy rice) was not designated as a noxious weed in the past, but is increasingly becoming widespread in direct seeded rice. The management of these weeds required a well coordinated system of continuous monitoring in order to devise sustainable weed control options that can be readily and easily adapted by small farmers. Greater awareness of farmers on the importance, significance and causes of weed seed banks and the need to be vigilant of weed shifts to management practices would be beneficial in the long term.

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