Weed Infestation in Green Gram-based Cropping Systems in Central Dry Zone of Myanmar

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Abstract

The study was carried out with two objectives (1) to find out the dominant weeds and common weeds in green gram growing areas of the central dry zone, and (2) to examine weed intensity in different green gram-based cropping patterns. Dominant weed species were *Echinochloa colona*, *Paspalum distichum* and *Cyperus iria* in Tatkon lowland, *Cynodon dactylon, Cyperus iria* and *Echinochloa colona* in Tatkon upland, *Cyperus iria* and *Cyperus rotundus* in Magway upland. Common weed species were *Cyperus iria* and *Echinochloa colona* in Tatkon lowland, *Cyperus iria* and *Cynodon dactylon* in Tatkon upland and *Achyrathes aspera*, *Cyperus rotundus, Cleome viscose*, *Commelina benghalensis*, *Digitaia ciliaris*, *Dactylonctenium aegyptimum*, *Leucas lanvandulifolia*, *Phyllanthus niruri*, *Richardia brasiliensis* and *Scirpus juncoides* in Magway upland. A total of ten green gram-based cropping patterns were mainly observed in the study areas. Among these patterns, pattern 4 in Tatkon lowland, pattern 5 in Tatkon upland and pattern 10 in Magway upland could give benefits of reducing the weed density. Pattern 3 and pattern 1 could limit the chance of dominating weed species. Pattern 6 and pattern 9 could maintain diversity of weed flora without substantial increase of weed density in the dry zone area of Myanmar. Weed infestation in all patterns were varying with crops and associated with management practices and, accordingly, these factors may cause various weed species composition.

Key words: cropping patterns, green gram, weed intensity, central dry zone

Introduction

In Myanmar, wide diversity of genetic resources of legumes is available with different duration, photo and thermo sensitivities. This makes different legumes flexible to grow as pre-monsoon, monsoon, and post-monsoon crops, resulting in the application of variety of cropping patterns which are being practiced in Myanmar. Legume-based cropping patterns varied mostly according to the hydrological conditions. Although legumes are cultivated throughout the country, the area is mainly concentrated in lower and central Myanmar. Cultivation of food legumes in Myanmar largely depends on soil moisture and temperature. Legumes are primarily grown by small-holder farmers with minimal inputs.

Among the legumes, mungbean (*Vigna radiata* L.) is one of the most important pulse crops and an excellent source of high quality protein (Kumari et al. 2012). Lack of high yielding cultivars, good quality inputs and the management of biotic and abiotic stresses are the major constraints to legume production in Myanmar. Among the biotic stresses, weed is one of the most important factors responsible for low yield of mungbean. The decrease in mungbean productivity due to weed competition is 45.6% (Pandey and Mishra 2003).

The goal of weed management should be to reduce the impact of weeds on crop yield by maintaining a diverse community of controllable weed species so that any weed species that is difficult to control does not become dominant (Clements et al. 1994). The diversity of weed communities will determine the nature of weed management strategies required and changes in diversity may be indicative of potential weed management problems (Derksen et al. 1995). As agronomic practices and cropping intensities change, the weed flora will change, hence, better records of changing weed population as a result of a change in cropping systems must be

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kept (Moody 1983). Chancellor and Froud-Williame (1984) also reported that periodic weed surveys are necessary as weed population, composition and intensity of infestation changes with climatic variations and agricultural practices. However, there has been no data of weed infestation due to different cropping systems in Central Dry Zone of Myanmar. Information of weed infestation for legumes-based cropping pattern is still insufficient in Myanmar. Therefore, this study was conducted with the following objectives; (1) to find out the dominant weeds and common weeds in green gram growing areas, and (2) to examine weed intensity in different green gram-based cropping patterns.

Materials and Methods

The study was conducted in Tatkon township and Magway township which were selected based on the criteria of rain-fed condition and green gram-based cropping pattern. Weed samples were collected at one-third of crop life cycle with the use of quantitative sampling method (quadrat method) in Tatkon green gram fields during pre-monsoon, May 2015 and Magway green gram fields during post monsoon, September 2015. There were 36 plots from Tatkon and 40 plots from Magway. In each plot, 3 quadrats were randomly placed. One quadrat size was 1 m x 1 m ($1m^2$). In each pattern, the weed flora were recorded and the numbers of individual for each species within randomly distributed quadrats were counted and identified.

Weed species occurred in each pattern were identified, counted and recorded to determine the dominance for every species in term of Summed Dominance Ratio (SDR).

Summed Dominance Ratio (SDR) value was calculated as stated by Moody (1995).

Species diversity within the given community was described by two components: richness and evenness. Richness is the number of species present in an area or in a community. Evenness provides information on whether a community is dominated by one or more species or whether the species within the community are presented by approximately equal numbers (Booth et al. 2010).

Two indices are used to estimate the within-community-diversity: the Margalef's Diversity Index (D_{Mg}) and the Simpson's Dominance Index (D^{-1}) were calculated within community diversity by the following formula given by Nkoa et al. (2015).

Margalef's Diversity Index (D_{Mg})

$D_{Mg} = (S-1)/ln\ (N)$

S = species richness (total number of species)

N = total number of all species in the community

Simpson's Dominance Index (D^{-1})

$D = \Sigma\{[n_i\ (n_i-1)\ ]/[N\ (N-1)]\}$

n_i = density or number of the ith species

N = total number of all species in the community

Weed infestation in terms of weed density data was analysed with the analysis of variance (ANOVA) by using Statistix Program (Version 8.0) and means comparison were done by Least Significant Difference (LSD) at 5% level.

Results and Discussion

Different Green gram-based Cropping Patterns in the Study Areas

A total of ten main green gram-based cropping patterns were mainly observed in Tatkon lowland area, Tatkon upland area and Magway upland area

Absolute density	= The total number of plants for a given species in all quadrats
Relative density (Rd)	= { Absolute density/ Total number of plants for all species}x 100
Absolute frequency (F)	= Number of quadrats in which a given species occurred/ The total number of quadrats used
Relative frequency (Rf)	= {Absolute frequency for a species/ Total of absolute frequency for all species}x100
Average abundance	= Absolute density/ Number of quadrat in which species occur
Frequency abundance	= Absolute frequency x Average abundance
Importance Value	= Relative density + Relative frequency + Frequency abundance
Summed Dominance Ratio	= Importance Value/3

(Table 1). Sowing time of green gram was different in the two regions. Green gram was grown as pre-monsoon crop in Tatkon whereas post monsoon crop in Magway.

Weed Infestation in Different Cropping Patterns in Tatkon Lowland Area

Seventeen weed species were identified in pattern 1, nine species in pattern 2 and pattern 3, and four species in pattern 4 (Table 2). Many weed species within all patterns were broadleaf weeds. It is well known that weeds are very well adapted to the crop that they infest, because of their morphological characteristic (FAO 1997). According to SDR results, grass weeds and sedge weeds were observed as dominant weeds. They were *Echinochloa colona, Cyperus iria* and *Paspalum distichum*. In addition, *Cyperus iria* and *Echinochloa colona* were commonly found in every pattern. Therefore, these two species were not only dominant but also common weed species in Tatkon lowland ecosystem.

Weed density observed in different cropping

Table 1. Cropping patterns in the study areas during April to October 2015

	Cropping patterns	Study area
Pattern 1	Green gram - Rice	Tatkon lowland
Pattern 2	Green gram - Rice - Chickpea	Tatkon lowland
Pattern 3	Green gram - Rice - Black gram	Tatkon lowland
Pattern 4	Green gram - Rice - Vegetable	Tatkon lowland
Pattern 5	Green gram - Sesame	Tatkon upland
Pattern 6	Green gram - Lablab bean	Tatkon upland
Pattern 7	Green gram - Vegetable	Tatkon upland
Pattern 8	Green gram - Cotton	Tatkon upland
Pattern 9	Sesame - Green gram	Magway upland
Pattern 10	Peanut - Green gram	Magway upland

Table 2. Summed dominance ratio (SDR) of weed species in Tatkon lowland green gram fields

Weed species composition		Summed Dominance Ratio			
		Cropping Pattern 1	Cropping Pattern 2	Cropping Pattern 3	Cropping Pattern 4
Broadleaf	*Alternanthera sessilis*	1	0	0	0
	Boerhavia diffusa	1	0	0	15
	Commelina benghalensis	1	0	1	0
	Celosia argentea	4	3	0	2
	Cleome viscosa	2	1	0	0
	Convolvulus arvensis	1	0	0	0
	Cardiospermum halicacabum	0	0	1	0
	Digera arvensis	0	1	0	0
	Euphorbia hirta	1	2	0	0
	Eclipta albaba	0	0	4	0
	Luffa aegyptiaca	3	1	2	0
	Phyllanthus niruri	3	2	0	0
	Unknown 1	1	0	0	0
Grass	*Digitaia ciliaris*	2	0	0	0
	Echinochloa colona	**50**	**55**	5	9
	Cynodon dactylon	2	9	15	0
	Paspalum distichum	1	0	**25**	0
	Panicum repens	1	0	0	0
	Rottboellia cochinensis	5	0	1	0
Sedge	***Cyperus iria***	6	8	**23**	**50**
Total	20 species	17	9	9	4

patterns of Tatkon lowland were not significantly different among the patterns (Table 3). However, highest density was observed in pattern 2 and the lowest density was observed in pattern 4. Although farmers who practised pattern 2 weeded just only at early growing season of chickpea, farmers who practised pattern 4 kept weed free condition throughout vegetable growing season. Weed population may depend on not only frequency of weeding but also farmers' attention and care according to crop types. Although weed density and species composition depend to a great extent on climatic and edaphic conditions, crops and associated management practices are important (Fried et.al 2008).

The highest value of dominance index (3.42) was observed in pattern 3 followed by pattern 4, pattern 1 and 2, accordingly (Table 4). The higher the dominance index value, the more species evenness there is (Nkoa et al. 2015). It indicated that the weed species composition in pattern 3 was the most even among these four cropping patterns. Differences in species evenness in these four patterns may be probably due to the fact that population of weed species depends on agronomic practices. Buhler et al. (2001) stated that weed seed banks may reflect the status of weed population in the present and the past, and could be regarded as an indicator of the impact of soil and crop management.

Pattern 1 gave the highest diversity index (4.2) and pattern 4 gave the lowest diversity index (0.92) (Table 4). It may be probably due to the fact that species diversity may depend on agrochemicals which affect weed seed bank communities in the soil. Use of inputs in double cropping pattern 1 might be lower than the other three triple cropping patterns. Barberi et al. (1998) also reported that weed seed bank communities were more diverse in low-input and organic systems.

Weed Infestation in Different Cropping Patterns in Tatkon Upland Area

Among four patterns of Tatkon upland area, a total of eight weed species under pattern 5, twenty weed species under pattern 6, eight weed species under pattern 7, and nine weed species under pattern 8 were found respectively (Table 5). Various weed species composition in each pattern was observed and many of them were broadleaf weeds. Based on SDR values, dominant weeds were found as grass and sedge weeds. They were *Cynodon dactylon, Echinochloa colona* and *Cyperus iria*. In all patterns, *Cynodon dactylon* and *Cyperus iria* were commonly found among species. Therefore, these two species were not only dominant but also com-

Table 3. Weed density (no. of plants/m^2) in different cropping patterns of Tatkon lowland

Cropping Pattern	Density (no. of plants/m^2)
Pattern 1	45.111
Pattern 2	50.667
Pattern 3	43.889
Pattern 4	26.417
Pr > F	0.2183
CV %	49.95

Note: Common LSD values cannot be expressed as based on different standard error

Table 4. The dominance and diversity indices for weed communities in different cropping patterns of Tatkon lowland

Cropping Pattern	Indices	
	Simpson's Dominance Index (D^{-1})	Margalef's Diversity Index (D_{Mg})
Pattern 1	1.48	4.20
Pattern 2	1.38	2.04
Pattern 3	3.42	2.12
Pattern 4	1.55	0.92

Table 5. Summed dominance ratio (SDR) of weed species in Tatkon upland green gram fields

Weed species composition		Summed Dominance Ratio			
		Cropping Pattern 5	Cropping Pattern 6	Cropping Pattern 7	Cropping Pattern 8
Broadleaf	*Amaranthus spinosus*	0.0	0.7	3.3	0.0
	Achyranthes aspera	0.0	1.3	0.0	0.0
	Boerhavia erecta	0.0	0.6	0.0	0.0
	Boerhavia diffusa	0.0	0.0	0.0	1.4
	Commelina benghalensis	4.8	0.6	0.0	3.2
	Cassia tora	0.0	0.0	0.0	2.9
	Cardiospermum halicacabum	0.0	3.5	0.0	0.0
	Celosia argentea	1.3	0.0	0.0	0.0
	Cleome viscose	0.0	1.9	1.8	1.4
	Chromolaena odorta	0.0	0.6	0.0	0.0
	Corchorus acutangulus	0.0	0.6	0.0	1.5
	Euphorbia hirta	0.0	0.6	0.0	0.0
	Phyllanthus niruri	0.0	0.6	0.0	0.0
	Portulaca oleracea	0.0	2.0	3.0	0.0
	Physalis angulata	0.0	3.6	0.0	0.0
	Richardia brasiliensis	0.0	2.4	1.7	0.0
	Tridax procumbens	1.3	0.0	0.0	0.0
	Unknown 1	1.3	0.0	0.0	0.0
	Unknown 2	0.0	0.6	4.5	0.0
Grass	***Cynodon dactylon***	**27.6**	**15.7**	**24.2**	9.6
	Isachne globosa	0.0	1.8	0.0	0.0
	Paspalum distichum	0.0	0.8	0.0	6.8
	Panicum repens	0.0	1.6	0.0	0.0
	Digitaria ciliaris	6.7	0.0	0.0	0.0
	Echinochloa colona	0.0	11.2	6.7	**33.7**
	Rottboellia cochinensis	8.2	0.0	0.0	0.0
Sedge	***Cyperus iria***	**21.5**	**24.9**	**30.9**	**28.0**
Total	27 species	8	20	8	9

Note: Bold refers to dominant weed species

mon weed species in Tatkon upland ecosystem.

The highest density was found in pattern 8 and the other three patterns were not significantly different (Table 6). This may be due to the presence of cotton crop in pattern 8, resulting greater weed density in this pattern. Cotton crop is very susceptible to weed competition and it is one of the factors which favours for higher weed infestation. Higher weed infestation, higher built up bank of weed seed and reproductive parts in this field. This may increase weed population in the season of next crops in pattern 8.

It was found that the dominance index (4.24) and diversity index (5.72) in pattern 6. These indices were the highest and followed by pattern-5 (Table 7), reflecting the more species evenness and species richness in pattern 6 compared with the others. It was probably due to the fact that weed species including in pattern 6 may compete each other. The evenness component was more sensitive to biotic interactions; specifically, changes in competi-

Table 6. Weed density (no. of plants/m²) in different cropping patterns of Tatkon upland

Cropping Pattern	Density (no. of plants/m²)
Pattern 5	18.5 b
Pattern 6	27.667 b
Pattern 7	28.444 b
Pattern 8	65.778 a
Pr > F	0.001
CV %	35.51

Note: Common LSD values cannot be expressed as based on different standard error

tion intensity (Wilsey and Stirling 2007). In addition, the greatest species richness in pattern-6 may be probably due to lablab bean crop included in this pattern. This crop is highly susceptible to early weed competition and also crop foliage loss during reproductive stage favours for late emerging weeds. Weed species may differ in early stage and later stage of crop. This fact may lead to more diverse weed species in next season. Koocheki et.al (2009) discussed that management practices of various consecutive crops could affect weed flora.

Weed Infestation in Different Cropping Patterns in Magway Upland Area

Twenty three weed species were observed in pattern 9 and ten weed species in pattern 10 (Table 8). Although many of weed species within two cropping patterns were broadleaf weeds, grass and sedge weeds were observed as dominant weeds. They were *Cyperus iria*, *Cyperus rotundus* and *Digitaia ciliaris*. However, grass weeds, sedge weeds and broadleaf weeds were commonly found in both patterns of Magway. They were *Digitaia ciliaris*, *Dactyloctenium aegyptimum*, *Cyperus rotundus, Scirpus juncoides*, *Commelina benghalensis, Lecuas lavandulifolia, Richardia brasiliensis, Phyllanthus niruri, Achyranthes aspera, Cleome viscose*. Among the dominant species, *Cyperus rotundus* was also found as the most common weed species in Magway upland ecosystem.

Weed density in pattern 10 was lower than in pattern 9 (Table 9). It may be due to the nature of previous crops. The previous crop was sesame in pattern 9 and peanut in pattern 10. Leaf canopy of peanut is well spread over the ground unlike sesame, thus reduces weed population due to smothering effect of peanut. A vigorous and highly competitive crop canopy may have resulted in more effective weed suppression and lowered weed density (Norris et.al 2001).

Regarding dominance and diversity indices for weed communities, pattern 9 possessed higher dominance index value (8.05) and higher diversity index value (5.92) than pattern 10 did, reflecting more diverse weed species in pattern 9 (Table 10). It may probably due to high weed density at present and also lower fertilizer application in previous crop (sesame) which may reflect on more weed diversity. **Ņečajeva** et.al (2015) recognized that weed diversity was positively related to weed density. Andersson and Milberg (1998) described that fertilizing has a greater effect on the composition of weed flora.

Table 7. The dominance and diversity indices for weed communities in different cropping patterns of Tatkon upland

Cropping Pattern	Indices	
	Simpson's Dominance Index (D^{-1})	Margalef's Diversity Index (D_{Mg})
Pattern 5	3.42	2.41
Pattern 6	4.24	5.72
Pattern 7	2.61	2.09
Pattern 8	2.73	1.91

Table 8. Summed dominance ratio (SDR) of weed species in Magway upland green gram fields

Weed species composition		Summed Dominance Ratio	
		Cropping Pattern 9	Cropping Pattern 10
Broadleaf	*Achyranthes aspera*	1.8	0.6
	Amaranthus spinosus	0.3	0.0
	Celosia argentea	3.0	0.0
	Cleome viscose	3.7	0.6
	Cassia tora	0.1	0.0
	Cardiospermum halicacabum	0.2	0.0
	Commelina benghalensis	1.5	4.3
	Digera arvensis	0.5	0.0
	Euphorbia hirta	0.1	0.0
	Ipomoea pes-tigridis L.	1.3	0.0
	Leucas lavandulifolia	1.9	1.3
	Phyllanthus niruri	0.6	0.7
	Portulaca oleracea	0.1	0.0
	Richardia brasiliensis	6.1	1.3
	Unknown 3	6.5	0.0
	Unknown 4	0.7	0.0
Grass	*Cynodon dactylon*	4.0	0.0
	Digitaria ciliaris	**11.8**	16.9
	Dactylonctenium aegyptium	1.2	4.1
	Panicum repens	5.0	0.0
Sedge	***Cyperus iria***	**16.3**	0.0
	Cyperus rotundus	**12.5**	**42.8**
	Scirpus juncoides	1.1	0.6
Total	23 species	23	10

Note: Bold refers to dominant weed species

Table 9 . Weed density (no. of plants/m²) in different cropping patterns of Magway upland

Cropping Pattern	Density (no. of plants/m²)
Pattern 9	41.01
Pattern 10	20.08
Pr > F	0.069
CV %	55.52

Note: Common LSD values cannot be expressed as based on different standard error

Table 10. The dominance and diversity indices for weed communities in different cropping patterns of Magway upland

Cropping Pattern	Indices	
	Simpson's Dominance Index (D^{-1})	Margalef's Diversity Index (D_{Mg})
Pattern 9	8.05	5.92
Pattern 10	1.73	3.00

Conclusion

A total of ten main green gram-based cropping patterns were mainly observed in the study areas. Although many broadleaf weeds were observed within all patterns, dominant weeds were grasses and sedges. Dominant weed species were observed as *Cyperus iria* in Tatkon and Magway, *Echinochloa colona* in Tatkon, *Cynodon dactylon* in Tatkon lowland, *Paspalum distichum* in Tatkon upland and *Cyperus rotundus* and *Digitaia ciliaris* in Magway upland. One sedge weeds (*Cyperus iria*) was commonly found in all patterns of Tatkon lowland and upland ecosystem. *Echinochloa colona* was found as common grass weeds in Tatkon lowland and *Cynodon dactylon* in Tatkon upland. Two grass weeds, two sedge weeds and six broadleaf weeds were commonly found in Magway upland. They were *Digitaia ciliaris*, *Dactyloctenium aegyptimum*, *Cyperus rotundus, Scirpus juncoides*, *Commelina benghalensis, Lecuas lavandulifolia, Richardia brasiliensis, Phyllanthus niruri, Achyranthes aspera, Cleome viscose*.

Green gram-rice-vegetable (pattern 4) in Tatkon lowland, green gram-sesame (pattern 5) in Tatkon upland and green gram-peanut (pattern 10) in Magway upland could give benefits of reducing the weed density. Green gram-rice-black gram (pattern 3) and green gram-rice (pattern 1) could limit the chance of dominating weed species. Green gram-lablab bean (pattern 6) and sesame-green gram (pattern 9) could provide maintaining diversity of weed flora without substantial increase of weed density.

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