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Weed Diversity and Abundance in Rice Growing Areas of Malinyi District, Morogoro, Tanzania

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Abstract

Weeds are globally foremost yield reducing factor in rice production. Therefore, it should be controlled before causing economic yield loss, but proper weed control is happened when they are well known. Thus a survey was conducted in 70 rice fields of 0.4ha each in Malinyi District to identify weeds associated with rice which is key information for weed management decision. Systematic quadrat sampling method in diagonal pattern was used and ten 1m² quadrat established in a field. Weeds in each quadrat were uprooted, identified and counted by species. Weed counts obtained used to calculate frequency, field uniformity, density and relative abundance for each species. Total of 35 weed species belonging to 13 families were identified. Among weed species identified 19 were annual and 16 perennial, in which 15 were grassy, 3 sedges and 17 broadleaved weeds. Out of 10 most prevalent and abundant weed species, there were six grasses, *Paspalum scrobiculatum* (36.7%), *Ischaemum regosum* (27.9%), *Echinochloa colona* (24.5%), *Oryza longistaminata* (21.8%), *Leptochloa chinensis* (13.1%), and *Leersia hexandra* (11.6%); two sedges, *Fimbristylis miliacea* (26.0%) and *Cyperus rotundus* (12%) and two broadleaved weeds, *Ageratum conyzoides* (22.5%) and *Physalis minima* (12.1%). Relative abundance indicated that, grassy weeds were more dominant than perennial. Shanon wiener index had the highest value in Makerere village (2.84) and the lowest was in Usangule village (1.95). Diversity indices shown that weed species were moderately diverse which implies weeds were not evenly distributed. The study suggested that the most abundant weed species should be controlled for increasing rice production. Sequential cropping system is proposed for reducing weed pressure in rice fields. Moreover, more surveys are needed to identify possible problematic weed and weed population shifts and more research toward new or enhanced weed control measures.

Key words: Rice; weed; Uniformity; Frequency; Density; Perennial; Annual; Diversity. Relative abundance

1 INTRODUCTION

Weeds are a significant yield-limiting problem in rice farming around the world. According to estimates, pests actually cause 40% of the yield losses, with weeds accounting for 32% of those losses (Juraimi *et al.*, 2013). Due to competition, weeds reduce rice yield by roughly 40–60%, but if they are not promptly and effectively removed, they can increase to 94–96%. (Chauhan *et al.*, 2011; Sarmah, 2019). The amount that weed competition reduces rice yield varies based on planting techniques, weed species, agricultural practices, and meteorological conditions (Jabran and Chauhan, 2015). Weeds can grow and reproduce in a variety of settings and are very aggressive (Bourgeois *et al.*, 2019). *Ischaemum rugosum* (saramollagrass), which may produce up to 4,000 seeds per plant and has the ability to flourish even in shady places, and *Echinochloa colona* (jungle rice), which primarily reproduces vegetatively but can also produce 3000 to 6000

seeds per plant, are two examples of weeds that do both. It begins to grow during the wet season or when the water level is rising and ends during the dry season.

Weed community patterns and variety are naturally dynamic and location-specific (Nichols *et al.*, 2015). A weed species' dynamics is the change in population size (number of plants per unit area) over time as a result of its biology, management, and environmental conditions (Joel and Kim, 2017). Therefore, environmental, farm management, and competition between weed species and rice crop species are the main drivers of weed species diversity (Kraehmer and Bell, 2019; Matloob *et al.*, 2015).

The amount of agricultural loss brought on by weed competition depends on the type of weed and how long it has been present in the crop. If weeds are not controlled, the crop's output is likely to decrease (Sarmah, 2019). For example, it has been found that uncontrolled *Fimbristylis miliacea* (hoorahgrass) alone lowered grain yields by 42%. (Hakim, 2013). Light, water, and nutrients are the major resources that crops and weeds compete for. Typically aggressive, weeds consume nutrients more quickly than crops (Sarmah, 2019). Weed control strategies include physical, chemical, and cultural weed control, among others. The fundamental approach for controlling weeds is to prevent their introduction and spread (Singh *et al.*, 2016). Use of weed-free seeds, upkeep of clean irrigation canals, fields, and borders, and washing of agricultural equipment are examples of preventive methods (Martin *et al.*, 2017). Except when community activities are taken to enforce rules and regulations, preventative efforts are not justifiable. One of the main reasons of weed infection, particularly in direct planting rice, is weed-contaminated rice seed.

Physical control can be exercised mechanically or manually. Rice can be mechanically weeded because different crops respond differently to disturbances, and monocotyledonous cereals are less sensitive than dicotyledons (Juraimin *et al.*, 2013). When rice is sown directly, harrowing has been found to be effective, particularly when the crop plants are larger than weeds to avoid harm (Singh *et al.*, 2016). Weeding by hand is a simple, environmentally friendly practice, but it is also time-consuming and labor-intensive. Furthermore, hand weeding is challenging when dealing with grassy weeds like *Ischaemum rugosum* and *Oryza longistaminata* because of their similar morphology to rice seedlings. Due to labor shortages and/or high labor costs, which also depend on hand weeding, this task is frequently postponed or even abandoned.

An international danger to weed control technology is the newly emerging problem of weed resistance to herbicide. Herbicide-resistant weeds currently provide a challenge to agriculture globally. According to Heap, the number of weed species that are resistant to herbicides is rising, as are the impacted nations and herbicide sites of action (2021).

Thus, boosting the ability of crops adjacent to weeds to compete is one cultural weed management strategy. Cultural approaches help to decrease weeds by giving crops a competitive edge in capturing light, moisture, nutrients, and physical space. They do not, however, completely eradicate weeds (Juraimi *et al.*, 2013). Applying proper cultural techniques on time can help with integrated weed control by lowering weed competition, density, and number of herbicide applications. It can also lessen herbicide resistance by lowering selection pressure.

In cropping systems, weed surveys are frequently used to demonstrate weed populations (Hakim, 2013). To address the present weed issues in rice fields, a thorough survey is essential for weed control programs. It is also crucial for developing objective and targeted research programs (Westwood *et al.*, 2018) Planning weed management programs and formulating suggestions for effective weed control strategies require detailed, in-depth understanding of the nature and extent of weed flora infestation in Malinyi District. Malinyi District's weed floristic makeup is not yet fully understood. For weed management decisions, the most recent information on the presence, composition, abundance, importance, and ranking of weed species is required (Saravanane, 2020). This study's goals included locating and cataloging the prevalent weed species in the rice fields in the Malinyi District and formulating a plan for lessening weed pressure.

2 MATERIALS AND METHODS

2.1 EXPLANATION OF THE RESEARCH AREA

A survey was carried out in the Malinyi district, which is located in Tanzania's southern Morogoro at 8° 56' 0" south, 36° 8' 0" east, and has an elevation of 275 meters above sea level (Fig. 1). The annual average rainfall is between 800 and 1600 mm, while the average temperature is between 15.2° C and 34.3° C. On March 2021, during the long rainy season while the crop was in the field, 70 rice growers' fields in 10 Villages were physically surveyed (Fig. 1).

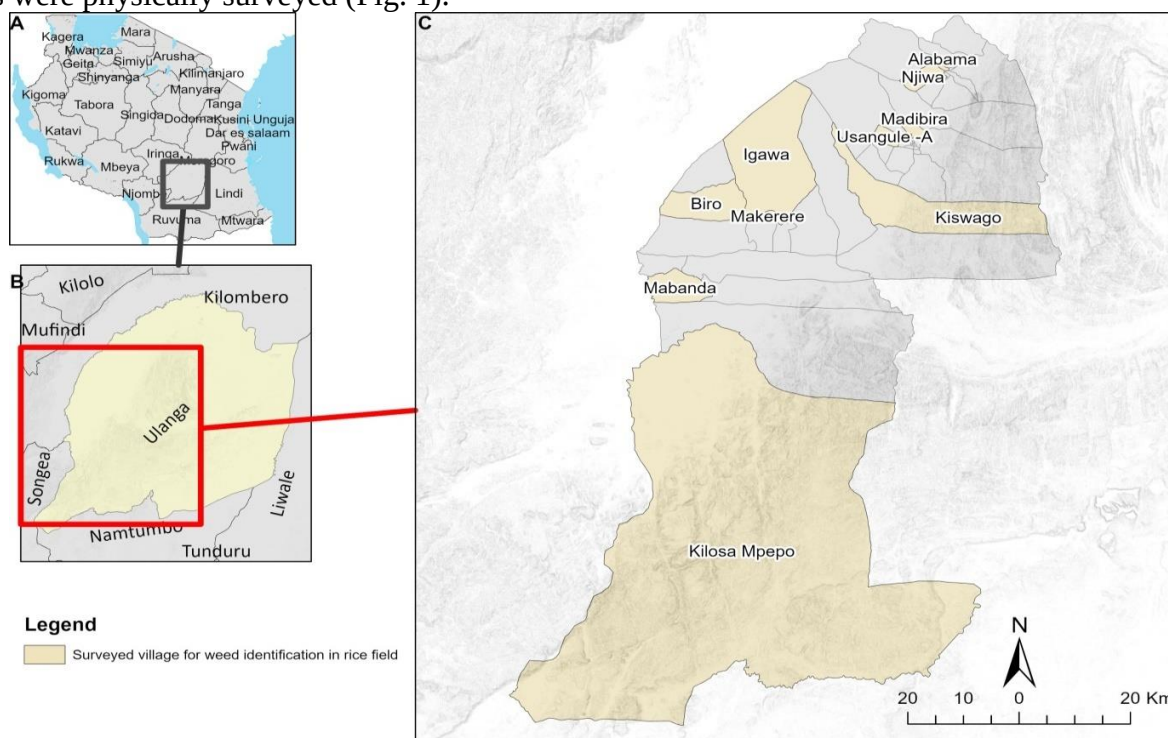


Figure 1: Map showing surveyed villages in Malinyi District, Morogoro.

2.2 FIELD SURVEY

In ten villages of Malinyi district, farmer's fields were surveyed for weeds using field sampling and quadrat techniques as the primary data gathering strategy (Hakim *et al.*, 2013; Nkoa *et al.*, 2015). Seven fields of 0.4 hectares each were purposefully chosen in each of the ten Villages that were examined. In each field, ten (10) 1 m² quadrats were laid out in a diagonal pattern for a total of 70 quadrats per village (Hubert *et al.*, 2016; Kothari, 2019). To reduce edge impact, a 5 m space was left between quadrats, and 15 m were left at each end of the diagonal line (Ruwanza, 2018). The weeds inside quadrat were pulled up, their species determined, and their numbers recorded. Several of the reference books were used to identify the observed weed species (Caton *et al.*, 2010; Naidu, 2012).

2.3 DATA ANALYSIS

According to the methods outlined by Nkoa *et al.* (2015) and explained in Appendix 1, weed density (number/m²), uniformity (%), frequency distribution (%), and abundance (%) were computed from the weed count records. Diversity indices (Shannon-Wieners and Simpson indices) were computed according to procedures described by Nkoa *et al.* (2015), as shown in Appendix 2. In order to compare weed species between villages based on their presence or absence, Sorensen's coefficient (S) was utilized. Each village was paired with every other village and the data acquired were reported as percentages. The formula shown below was employed (Slathia *et al.*, 2018).

$$\text{Sorensen}(S) = \left[\frac{2c}{a+b} \right] * 100 \dots\dots\dots (\text{Eq.i})$$

Note: (S)= the index of similarity, c = number of weed species in both sites and 'a' = number of weed species in site A and 'b'=number of weed species in site B.

The formula-derived weed data were subjected to IBM SPSS statistical analysis to analyze several variables using one sample t-test and one way ANOVA to test the significance of differences between groups of weed species, diversity, and similarity indices on various response variables at significance level of 0.05.

3 RESULTS

3.1 FORISTIC COMPOSITION

There were 35 weed species found in this survey, divided into 34 genera and 13 families (Tables 1). 19 of them were annual weeds, while 16 of them were perennial. In the perennial category, there were 10 grassy, 3 sedge, and 3 broad-leaves weed species; in the annual category, there were 5 grassy and 14 broad-leaf species (Tables 1). Out of the 13 families that were seen, the Poaceae family had 15 species, Asteraceae family had 5, Cyperaceae family had 3, Fabaceae family and Malvaceae family had 2 each. These five families accounted for 68.57% of the observed weed species, while the other families had one species each (Fig. 2). All 35 weeds were recognized down to the species level, and the various life cycle types, behaviors, and kinds were recorded.

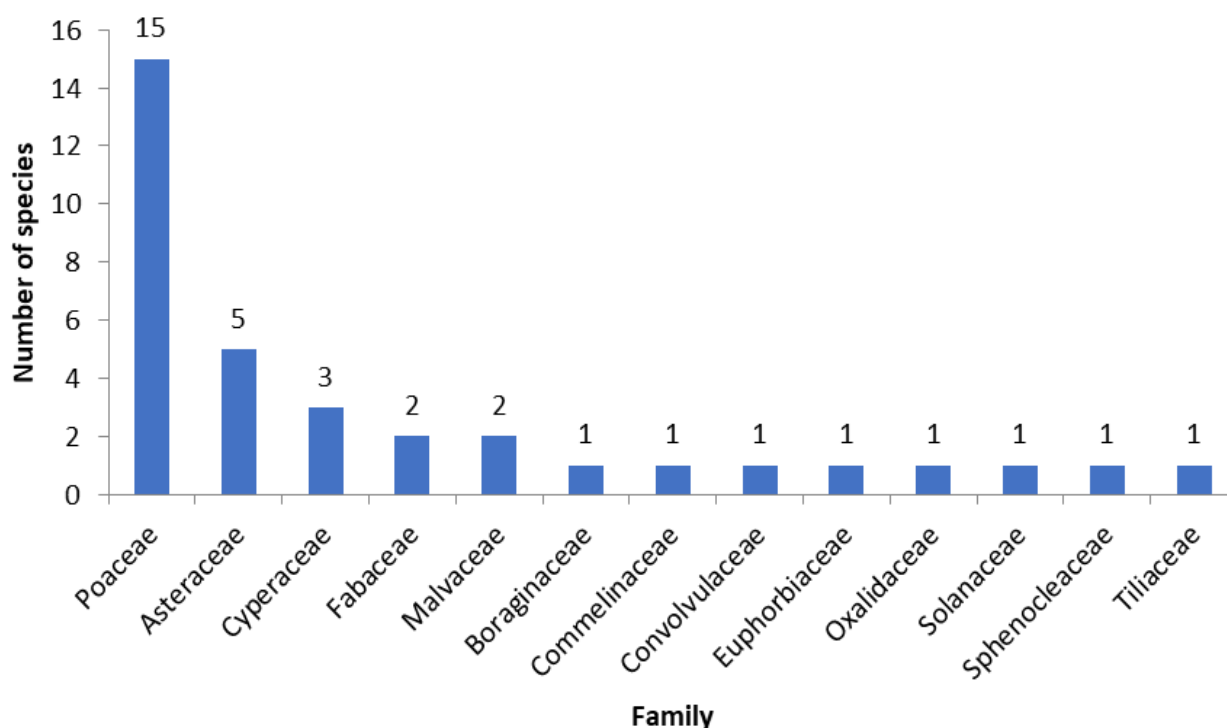


Figure 2: Weed species distribution by family

3.2 FREQUENCY, UNIFORMITY, DENSITY AND RELATIVE ABUNDANCE

The average frequency of weeds in the district ranged from 4.3%, to 75.7%, the lowest was recorded in *Cassia tora* and the highest being for *Paspalum scrobiculatum* while relative frequency ranged from 0.3% to 8.5%, the lowest being for *Cassia tora* and the highest record for *Paspalum scrobiculatum*. The weed density (weed count/m²) of weed species ranged from 0.7% to 35%, the lowest being *Lactuca serriola* and *Cassia tora* and the highest record being for *Paspalum scrobiculatum* while relative density ranged from 0.1%, being for *Lactuca serriola* and *Cassia tora* to 17% being the highest for *Paspalum scrobiculatum* (Table 1).

Uniformity ranged from 1.4%, to 50.9%, the lowest being for *Cassia tora* and highest being for *Paspalum scrobiculatum*, respectively while relative uniformity the lowest record of 0.3 being for *Cassia tora* and highest record of 11.1%, being for *Paspalum scrobiculatum*, respectively (Table 1). Relative abundance ranged from 0.7 % to 36.7%, with lowest value being for *Cassia tora* and the highest being for *Paspalum*

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scrobiculatum, respectively (Table 1). *Paspalum scrobiculatum* followed by *Eschaemaum rogusum* occurred in most of the villages and were among the most abundant weed species (Plate 1 and Table 2a and 2b). The ten (10) most abundant weed species in Malinyi district with values higher than 10% are represented in Fig. 3.

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Table 1: Summarized indices of weed species in rice fields in Malinyi district

S/N	Weed Species	Type	Family	Lifespan	Frequency (%)	Uniformity (%)	Density (plants/m ²)	Relative Frequency (%)	Relative Uniformity (%)	Relative Density (%)	Relative Abundance
1	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	75.7	50.9	35.0	8.5	11.1	17.1	36.7
2	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	67.1	39.7	26.0	7.6	8.8	11.5	27.9
3	<i>Fimbristylis miliacea</i> L.	Sedge	Cyperaceae	Perennial	67.1	34.0	21.6	7.9	7.8	10.3	26.0
4	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	67.1	35.9	21.0	4.7	8.0	8.9	24.5
5	<i>Ageratum conyzoides</i> L.	Broadleaf	Asteraceae	Annual	65.7	36.6	14.8	7.5	8.2	6.8	22.5
6	<i>Oryza longistaminata</i> L.	Grass	Poaceae	Perennial	61.4	33.9	19.4	6.7	7.3	7.8	21.8
7	<i>Laptochloa chinensis</i> L.	Grass	poaceae	Perennial	38.6	20.7	16.9	4.3	4.6	4.2	13.1
8	<i>Cyperus rotundus</i> L.	Sedge	Cyperaceae	Perennial	45.7	21.0	9.7	5.2	4.7	2.6	12.5
9	<i>Physalis minima</i> L.	Broadleaf	Solanaceae	Annual	42.9	20.1	6.2	4.7	4.5	2.9	12.1
10	<i>Leersia hexandra</i> Sw.	Grass	poaceae	Perennial	37.1	18.4	13.1	4.0	3.8	3.8	11.6
11	<i>Alopecurus myosuroides</i> L.	Grass	Poaceae	Annual	30.0	15.0	11.1	4.7	3.3	2.8	9.4
12	<i>Rottboellia cochinchinensis</i> Lour.	Grass	Poaceae	Annual	32.9	14.0	9.2	4.7	2.5	2.5	9.2
13	<i>Stenotaphrum secundatum</i> (Walter) Kuntze	Grass	Poaceae	Perennial	25.7	12.3	10.5	4.7	3.0	2.9	9.0
14	<i>Commelina benghalensis</i> L.	Broadleaf	Commelinaceae	Annual	22.9	10.1	6.8	2.3	2.0	1.6	5.9
15	<i>Ipomoea aquatica</i> Forsk.	Broadleaf	Convolvulaceae	Annual	21.4	12.1	3.9	4.7	2.4	0.8	5.4
16	<i>Eleusine indica</i> L.	Grass	Poaceae	Annual	21.4	8.1	6.3	4.7	1.4	1.4	4.8
17	<i>Galinsoga parviflora</i> Cav.	Broadleaf	Asteraceae	Annual	14.3	6.7	11.7	4.7	1.6	1.6	4.8
18	<i>Sphenoclea zeylanica</i> Gaertn.	Broadleaf	Sphenocleaceae	Annual	17.1	7.7	4.2	4.7	1.6	0.7	4.0
19	<i>Corchorus aestuans</i> L.	Broadleaf	Tiliaceae	Annual	15.7	7.3	4.5	4.7	1.6	0.7	4.0
20	<i>Hackelechloa granularis</i> L.	Grass	Poaceae	Annual	12.9	5.6	2.4	4.7	1.2	1.2	3.3
21	<i>Mimosa pudica</i> L.	Broadleaf	Fabaceae	Perennial	11.4	5.7	1.1	4.7	1.1	0.8	3.0
22	<i>Cynodon dactylon</i> L.	Grass	Poaceae	Perennial	11.4	4.6	5.9	4.7	1.0	0.8	3.0
23	<i>Oxalis latifolia</i> Sorrel.	Broadleaf	Oxalidaceae	Perennial	5.7	4.0	3.6	4.7	0.9	1.3	2.9
24	<i>Paspalum dilatatum</i> Poir.	Grass	Poaceae	Perennial	7.1	3.4	1.5	4.7	0.9	0.9	2.9
25	<i>Phyllanthus niruri</i> L.	Broadleaf	Euphorbiaceae	Annual	10.0	4.1	4.1	4.7	0.9	0.8	2.8
26	<i>Hibiscus trionum</i> L.	Broadleaf	Malvaceae	Perennial	11.4	4.1	2.7	4.7	0.9	0.3	2.4
27	<i>Melochia corchorifolia</i> L.	Broadleaf	Malvaceae	Annual	11.4	3.6	2.2	4.7	0.7	0.4	2.4
28	<i>Brachiaria erusiformis</i> (Sm.) Griseb.	Grass	Poaceae	Annual	8.6	3.1	6.5	4.7	0.6	0.7	2.2
29	<i>Bidens pilosa</i> L.	Broadleaf	Asteraceae	Annual	10.0	3.0	5.2	4.7	0.6	0.5	2.1
30	<i>Tridax procumbens</i> L.	Broadleaf	Asteraceae	Annual	11.4	3.3	3.3	4.7	0.6	0.4	2.1
31	<i>Carex stipata</i> Muhl.	Sedge	Cyperaceae	Perennial	8.6	3.6	1.7	4.7	0.7	0.3	1.8
32	<i>Trichodesma zeylanicum</i> R.br	Broadleaf	Boraginaceae	Annual	5.7	1.7	1.4	4.7	0.4	0.4	1.6
33	<i>Sorghum leiocladum</i> Hack.	Grass	Poaceae	Perennial	4.3	1.9	2.0	4.7	0.4	0.2	1.0
34	<i>Lactuca serriola</i> L.	Broadleaf	Asteraceae	Annual	4.3	2.2	0.7	4.7	0.4	0.1	0.8
35	<i>Cassia tora</i> L.	Broadleaf	Fabaceae	Annual	4.3	1.4	1.2	4.7	0.3	0.1	0.7

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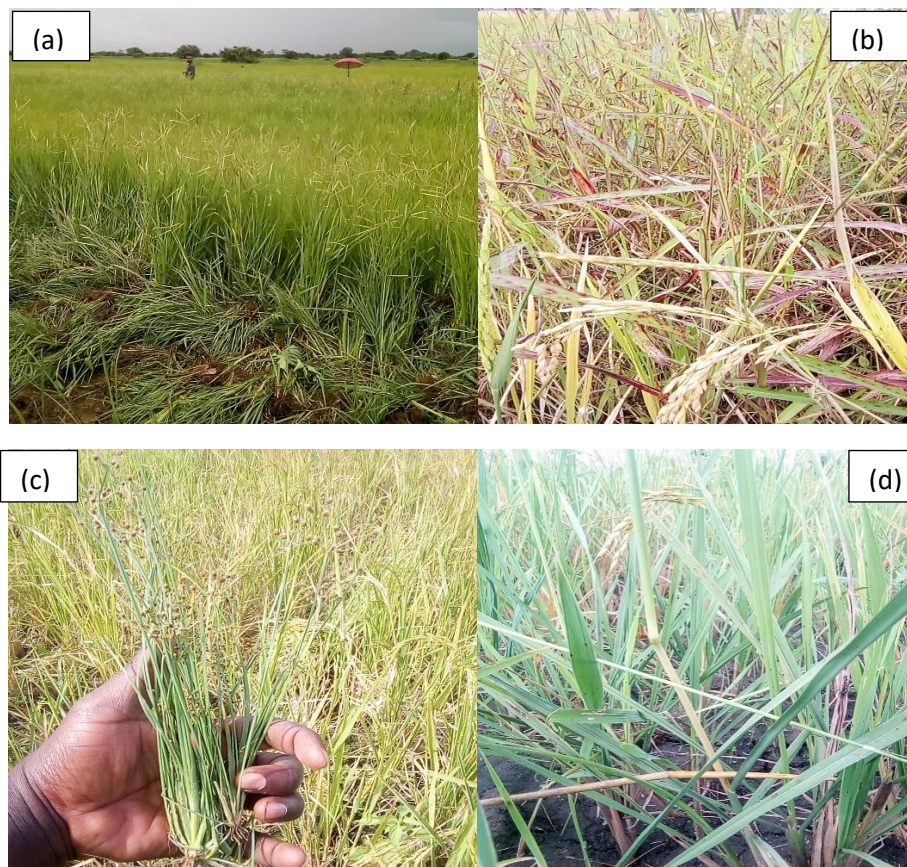
Table 2a: Five most dominant weed species in rice for each surveyed village

	SN	Weed species	Type	Family	Lifecycle	Frequency (%)	Uniformity (%)	Density (plnts/m2)	Relative frequency (%)	Relative uniformity (%)	Relative density (%)	Relative abundance
Village												
Alabama	1	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	85.7	54.3	22.6	10.7	11.7	12.6	35
	2	<i>Fimbristylis miliacea</i> L.	Sedge	Cyperaceae	Perennial	71.4	44.3	27.1	8.9	9.5	12.6	31
	3	<i>Oxalis latifolia</i> Sorrel	Broadleaf	Oxalidaceae	Perennial	57.1	40	36.1	7.1	8.6	13.5	29.2
	4	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	71.4	45.7	20.7	8.9	9.8	9.7	28.4
	5	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	71.4	42.9	21.8	8.9	9.2	10.1	28.3
Njiwa	1	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	100	70	55.1	11.9	15.1	24.9	51.9
	2	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	100	61.4	38.9	11.9	13.3	17.5	42.7
	3	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	71.4	40	27.9	8.5	8.6	9	26.1
	4	<i>Stenotaphrum secundatum</i> (Walter) Kuntze	Grass	Poaceae	Perennial	71.4	34.3	19.9	8.5	7.4	6.4	22.3
	5	<i>Ageratum conyzoides</i> L.	Broadleaf	Asteraceae	Annual	57.1	40	17.7	6.8	8.6	4.6	20
Madibila	1	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	100	67.1	46.1	9.1	12.4	22.8	44.2
	2	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	85.7	48.6	36	7.8	8.9	15.3	32
	3	<i>Oryza longistaminata</i> L.	Grass	Poaceae	Perennial	85.7	51.4	22.9	7.8	9.5	9.7	27
	4	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	57.1	32.9	9.4	11.7	6.1	6	23.7
	5	<i>Alopecurus myosuroides</i> L.	Grass	Poaceae	Annual	71.4	41.4	13.4	6.5	7.6	4.7	18.9
Usangule A	1	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	100	71.4	61.4	13.5	19.6	34.3	67.4
	2	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	100	62.9	46.6	13.5	17.3	26	56.7
	3	<i>Fimbristylis miliacea</i> L.	Sedge	Cyperaceae	Perennial	85.7	41.4	24	11.5	11.4	11.5	34.4
	4	<i>Cyperus rotundus</i> L.	Sedge	Cyperaceae	Perennial	57.1	27.1	6.2	15.4	7.5	4	26.8
	5	<i>Ageratum conyzoides</i> L.	Broadleaf	Asteraceae	Annual	71.4	34.3	14.8	9.6	9.4	5.9	24.9
Kiswago	1	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	100	72.9	57.6	7.4	12.3	28.9	48.6
	2	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	71.4	42.9	25.4	5.3	7.2	9.1	21.7
	3	<i>Laptochloa chinensis</i> L.	Grass	poaceae	Perennial	71.4	40	20.7	5.3	6.8	7.4	19.5
	4	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	57.1	38.6	26.2	4.3	6.5	7.5	18.3
	5	<i>Eleusine indica</i> L.	Grass	Poaceae	Annual	85.7	27.1	10.5	6.4	4.6	4.5	15.5

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Table 2b: Five most dominant weed species in rice for each surveyed village

	SN	Weed species	Type	Family	Lifecycle	Frequency (%)	Uniformity (%)	Density (plnts/m2)	Relative frequency (%)	Relative uniformity (%)	Relative density (%)	Relative abundance
Village												
Igawa	1	<i>Oryza longistaminata</i> L.	Grass	Poaceae	Perennial	100	58.6	17.5	10	11.3	11.8	33.1
	2	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	85.7	55.7	23.7	8.6	10.7	13.7	33
	3	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	85.7	50	19.4	8.6	9.6	11.2	29.4
	4	<i>Leersia hexandra</i> Sw.	Grass	poaceae	Perennial	85.7	44.3	15	8.6	8.5	8.7	25.8
	5	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	71.4	42.9	21.7	7.1	8.2	10.4	25.8
Makerere	1	<i>Ageratum conyzoides</i> L.	Broadleaf	Asteraceae	Annual	100	60	13.7	8.9	11.3	9.8	29.9
	2	<i>Oryza longistaminata</i> L.	Grass	Poaceae	Perennial	100	51.4	15.6	8.9	9.7	11.1	29.6
	3	<i>Mimosa pudica</i> L.	Broadleaf	Fabaceae	Perennial	100	55.7	10.9	8.9	10.5	7.8	27.1
	4	<i>Fimbristylis miliacea</i> L.	Sedge	Cyperaceae	Perennial	85.7	40	19	7.6	7.5	11.7	26.8
	5	<i>Cyperus rotundus</i> L.	Sedge	Cyperaceae	Perennial	85.7	45.7	9.6	7.6	8.6	5.9	22.1
Biro	1	<i>Ageratum conyzoides</i> L.	Broadleaf	Asteraceae	Annual	100	55.7	16.1	14	15.3	15.9	45.2
	2	<i>Physalis</i> sp	Broadleaf	Solanaceae	Annual	85.7	51.4	10.7	12	14.1	9	35.2
	3	<i>Laptochloa chinensis</i> L.	Grass	poaceae	Perennial	57.1	32.9	13.4	8	9	7.6	24.6
	4	<i>Oryza longistaminata</i> L.	Grass	Poaceae	Perennial	57.1	27.1	14.5	8	7.5	8.2	23.6
	5	<i>Rottboellia cochinchinensis</i> Lour.	Grass	Poaceae	Annual	57.1	24.3	10.9	8	6.7	6.2	20.8
Mabanda	1	<i>Fimbristylis miliacea</i> L.	Sedge	Cyperaceae	Perennial	85.7	48.6	27.1	12.5	13	19.9	45.5
	2	<i>Echinochloa colona</i> L.	Grass	Poaceae	Perennial	85.7	52.9	22.6	12.5	14.2	16.6	43.3
	3	<i>Alopecurus myosuroides</i> L.	Grass	Poaceae	Annual	85.7	47.1	17.5	12.5	12.6	12.9	38
	4	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	57.1	40	20.9	8.3	10.7	10.2	29.3
	5	<i>Paspalum dilatatum</i> Poir.	Grass	Poaceae	Perennial	71.4	34.3	14.5	10.4	9.2	8.9	28.5
Kilosa mpepo	1	<i>Fimbristylis miliacea</i> L.	Sedge	Cyperaceae	Perennial	71.4	40	21.3	9.8	10.9	14.8	35.5
	2	<i>Stenotaphrum secundatum</i> (Walter) Kuntze	Grass	Poaceae	Perennial	71.4	40	13.8	9.8	10.9	9.6	30.3
	3	<i>Ischaemum rugosum</i> Salsb.	Grass	poaceae	Perennial	57.1	34.3	20.6	7.8	9.3	11.5	28.7
	4	<i>Ageratum conyzoides</i> L.	Broadleaf	Asteraceae	Annual	71.4	37.1	12.4	9.8	10.1	8.6	28.6
	5	<i>Paspalum scrobiculatum</i> L.	Grass	Poaceae	Perennial	42.9	31.4	25.3	5.9	8.6	10.6	25



(a) = *Paspalum scrobiculatum* (b)= *Eschaema rugosum* (c) = *Fimbristylis miliacea*(d) = *Oryza longistaminata*

Plate 1: Most abundant weed species in rice fields

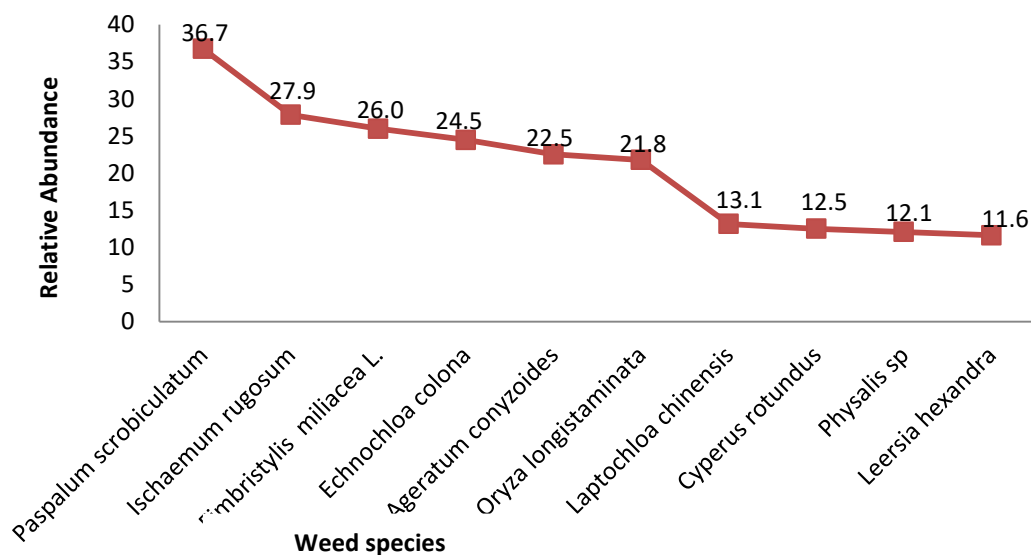


Figure 3: Ten (10) important weed species in rice fields in Malinyi District

The frequency, uniformity, density, relative frequency, relative uniformity, and relative abundance of weed species varied statistically significantly. As a result, the distribution of weed species in the Malinyi district differed.

3.3 DIVERSITY INDICES

Each village's weed species count ranged from 15 to 29 species. Usangule Village recorded the lowest while Kiswago Village recorded the highest number of species; also see Appendix 3 for details. The Simpson distribution index had the highest values in Makerere Village and the lowest in Usangule A Village (Table 3). The Shannon-Wiener index, the highest value was recorded in Makerere village and the lowest value was recorded in Usangule village (Table 3).

Table 3: Diversity indices of weed in rice fields for 10 Villages in Malinyi District

SN	Village	Shannon Wiener Index (H')	Simpson Index (1 - D)	Number of Species
1	Alabama	2.62	0.91	21
2	Njiwa	2.47	0.88	25
3	Madibila	2.61	0.89	23
4	Usangule A	1.95	0.79	15
5	Kiswago	2.72	0.88	29
6	Igawa	2.61	0.91	20
7	Makerere	2.84	0.93	25
8	Biro	2.68	0.92	18
9	Mabanda	2.34	0.88	17
10	Kilosa mpepo	2.60	0.91	19

Note: the classes range of species diversity according to Haris *et al.* (2019), H 'value > 3: high species diversity, $1 \leq H \leq 3$ value: moderate species diversity and H '<1 value: low or small species diversity.

There was statistical significant difference for weed diversity among villages. This result assures that the surveyed villages had variations.

3.4 SIMILARITY INDEX (SORENSEN (S) SIMILARITY INDEX)

Table 4 shows the weed species similarity index across pairs of villages; the results varied from 50 to 89.4%. The values between Mabanda and Usangule Village were the lowest, while those between Biro and Kilosa Mpepo Village were the highest.

Table 4: Similarity index of weed species (%) between pairs of rice growing Villages in Malinyi District

Village/ Location	Alabama	Njiwa	Madibila	Usangule	Kiswago	Igawa	Makerere	Biro	Mabanda	Kilosa Mpepo
Alabama	100	75.5	68.1	72.2	76.6	73	73.9	56.4	57.8	68.2
Njiwa	75.5	100	81.6	76.9	83.6	77.2	81.6	66.6	73.1	77.2
Madibila	68.1	81.6	100	68.4	61.5	74.4	75	73.1	70	74.4
Usangule	72.2	76.9	68.4	100	63.6	74.2	65	78.7	50	80
Kiswago	76.6	83.6	61.5	63.6	100	73.4	81.5	76.5	65.2	81.6
Igawa	73	77.2	74.4	74.2	73.4	100	84.4	78.9	59.4	80
Makerere	73.9	81.6	75	65	81.5	84.4	100	69.7	66.6	75.5
Biro	56.4	66.6	73.1	78.7	76.5	78.9	69.7	100	57.1	89.4
Mabanda	57.8	73.1	70	50	65.2	59.4	66.6	57.1	100	59.4
Kilosa Mpepo	68.2	77.2	74.4	80	81.6	80	75.5	89.4	59.4	100

Note: Site is not similar in weed species if < 65% sites are similar in weed species

There was a statistically significant difference in the similarity of weed species between linked villages. As a result, the weed species varied amongst the villages.

2.4 DISCUSSION

2.4.1 FLORISTIC COMPOSITION

According to Haris *et al.* (2019) the dominance among families in the weed species community have been divided into three groups which are dominant (>20% of all individual species), co - dominant (10% - 20%) and not dominant if <10%. Under this study Poaceae family with 15 out of 35 weed species which is equivalent to 43% of all individual weed species (Fig. 2.2), therefore this family was dominant. In terms of types/groups weed species identified in this study was different to findings by Golmohammadi *et al.* (2018),

where cyperaceae had the highest weed species among 29 families observed; annual weeds had higher number than perennial and broadleaved weeds were the highest.

The results from this study showed an opposite tendency, with a higher number of species in the poaceae family with 15 species. This may be because of their excellent adaptation and effective dispersal system in the environmental conditions that supported their prodigious populations. Weed distribution has been shown to be influenced by variables including dissemination mode, structure, period of germination, viability of seeds, and soil seeds bank (HE *et al.*, 2019). The presence of weeds in a particular location is consequently influenced by edaphic conditions (pH, nutrients, and moisture), weed management methods, and the history of the fields where the weeds were located (Travlos *et al.*, 2020).

2.4.2 FREQUENCY, UNIFORMITY AND DENSITY

The frequency of weed species has been divided into classes A to E in intervals of 20%, reported by Haile *et al.* (2021) and Duary *et al.* (2015), but the number of species tends to decline as the percentage rises. This phenomenon has been demonstrated under this study in which 20 species are class A (1 – 20%), 7 species in class B (21 – 40%), 2 species in class C (41 – 60%) and 6 species in class D (61 – 80%) were, there was no species in class E (81 – 100%). High frequency weed species are highly adapted to the environments in which they are found and demonstrate the dispersion of weed species. This study found that some species, such as *Paspalum scrobiculatum*, had a high incidence of this condition, followed by *Ischaemum rugosum*, *Fimbristylis miliacea*, and *Echinochloa colona*. All other weed species with low frequency values indicated that they were either less competitive, successfully managed by weed control techniques applied in the study area, or the environment was unfavorable at that time of year.

Usually high **weed density** is a threat to rice growth because of competition. Less weeds cause low yield loss and weed biomass have negative relationship to rice yield that is increased weed biomass lower the rice yield (Naziret *et al.*, 2022). Different weed species compete with rice differently because some germinate in large densities, requiring more resources (Gharde *et al.*, 2018). In this study revealed that *Paspalum scrobiculatum* having high density, followed by *Ischaemum rugosum* and *Fimbristylis miliacea* which means these weeds had greater contributions in reducing rice yield. If the seeds are viable and the environment is favorable, massive seed banks may be the cause of the high density of weed species (HE *et al.*, 2019). Due to the considerable capacity of species with high seed output to live, disperse, and establish themselves, the big seed bank may ensure their dense population (Osca *et al.*, 2021).

Weed species uniformity measures the evenness of the weeds in a given area. It shows how the species spread in a given location. High uniformity values denotes wide spread while low values indicates that it is localized. The most abundant weed species observed in this study had higher values of uniformity. The results of this study is supported by Hakim *et al.* (2013), found that *Echinochloa crusgalli* recorded highest frequency, uniformity and density followed by other species like revealed in this study for *Paspalum scrobiculatum*, *Ischaemum rugosum*, *Fimbristylis miliacea*, *Echinochloa colona*, *Ageratum conyzoides* and *Oryza longistaminata*.

2.4.3 RELATIVE ABUNDANCE

It combines the frequency, uniformity, and density of a specific weed species compared to all other detected species to calculate the predominance of that species in a given area. The larger relative abundance value indicates the higher relative uniformity (FU), frequency, and density values, respectively (Golmohammadi *et al.*, 2018). It serves as a warning about the overall weed problem that a species has brought about.

The outstanding differences in the abundance of weed species in Malinyi district showed that the rice fields had weeds species which are most dominant and abundant. A gently steep slope in the relative abundance (Fig.2.3) indicates slightly differences to most weeds species except few which had high values. High-ranking species were few but abundant (large number of individuals and widely distributed) than the low ranking species were greater in number of members with few individuals (Hakim *et al.*, 2013). In this study

revealed that *Paspalum scrobiculatum* had the highest relative abundance over all other weed species, therefore is dominant weed followed by *Ischaemum rugosum* (Fig.2.3). Similar observations had also been reported by Golmohammadi *et al.* (2018). The reasons of being dominant and abundant may be due to suitable environment and availability of dissemination agent for a specific weed species. These weeds supposed to be managed to a level that cannot cause economic yield loss by employing integrated weed management and abandon mono cropping (Andreset *et al.*, 2021; Jiyaet *et al.*, 2019).

2.4.4 WEED DIVERSITY

The Simpson distribution index prioritizes weed species that are more prevalent. The relative abundance of dominant weed species is higher (Nkoa *et al.*, 2015). A high score suggests a diverse population, whereas a low score implies a homogeneous population. The diversity score rises with the expansion of weed species and evenness. Makerere Village had the highest index scores in this survey, while Usangule A Villages had the lowest (Table 2.3). As a result, the weed species in the research area were diversified, as indicated by the results that there were variances between villages.

The Shannon-Wiener index places more emphasis on the abundant and evenness of the species present. Diversity can be promoted by having many different species. Additionally, increasing the consistency of individual distribution within and between species will boost diversity. The diversity index is highest when each individual is from a different species. The highest value was recorded in Makerere village and the lowest value was recorded in Usangule village (Table 2.3). These values fall under the same category (Moderate) according to Haris *et al.* (2019) which may be due to fields found in similar ecology.

2.4.5 WEED SIMILARITY

According to Khan *et al.* (2018) the values obtained by paired test are greater or equal to 65%, then communities is similar, but when less than 65%, the communities become not similar. The similarity test used in this study found that only seven sets of two villages had different weed species compositions. Haile *et al.*, (2021) acknowledged that two sites have separate weed communities if the similarity index value is less than 65%, which supports the conclusion. A larger value of the similarity index reveals more or less uniform environmental circumstances, whereas a smaller value reveals noticeable heterogeneity. The low similarity index may be caused by varied environmental conditions at the analyzed areas (Singh, 2012). The findings of this study (Table 2.4) indicated that most of the paired village had similarity index above 65%, meant they had similar community, and few had similarity index below 65%, which meant the weed species in the paired villages were not similar. It implied that similar weed management techniques may be used by the slight variance in weed communities found among the rice fields.

2.5 CONCLUSIONS

The results of the survey provide a quantitative comparison of the weed species in rice fields of Malinyi District. Regarding relative abundance, the most prevalent and abundant weed species were grasses followed by sedge and broadleaved. Based on relative abundance indicates that, annual weeds were more dominant than perennial. Shannon wiener index had the highest value in Makerere village and the lowest value in Usangule village. Simpson index values, highest values in Biro Village and the lowest in Usangule A Villages.

This indicates that the weed species in Malinyi district are diverse. *Paspalum scrobiculatum* and *Ischaemum rugosum* weed species were the most abundant and dominant in Malinyi district, therefore they should be controlled. Sequential cropping system (type of crop rotation) is proposed to be practiced by rice farmers in order to minimize weed pressure. Moreover, further survey work is recommended to identify possible problematic weeds and weed population shifts. Also more research towards new or enhanced weed control measures is suggested.

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