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Original article

Composition and Distribution of Aquatic Weeds in some Minor Canals, Gezira Scheme, Sudan (2018)

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Abstract

Excessive growth of aquatic weeds in irrigation systems is a worldwide problem. In Sudan, many irrigation schemes have been greatly affected by aquatic weeds such as Gezira scheme. The objective of the study was to evaluate the community composition and distribution of aquatic weeds in some minor canals in the Gezira scheme in 2018. The study area covered six minor canals at Centre Group at Gezira Scheme. Each minor canal was divided into three sections; head, middle and tail (18 sampling sites). The sites were surveyed once in every month for a period of three months during summer and winter seasons. The community composition of aquatic weeds was detected by visual observation, whereas the distribution of aquatic weeds was determined by calculation of percentage of relative frequency. Data were subjected to descriptive analysis and to analysis of variance. The results indicated that the community composition in the six minor canals consists of four groups of aquatic weeds as follows; floating, emergent, submergent and bank aquatic weeds and consisted of 12 species belonging to nine families. Results showed considerable differences in distribution throughout the year. The most dominant species within the groups were; *Vossia cuspidata* (33% - 41%) within the group of floating weeds, *Cyperus alopecuroides* (87% - 55%) within the group of emergent weeds and *Cynodon dactylon* (75% - 83%) within the group of bank aquatic weeds during both summer and winter seasons. Submergent weeds present only in winter season in one species *Najas pectinata*. Also, results of relative frequency within all aquatic species showed that *Vossia cuspidata* and *Cynodon dactylon* were the most dominant species. These finding gives many insights about the problems of aquatic weeds in minor canals and would be useful in the management and control of aquatic weeds.

Keywords: Aquatic weeds; Composition; Distribution; Gezira Scheme; Minor canals.

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INTRODUCTION

Water is one of the most important natural resource and the basis of all life forms (Lancar and Krake, 2002). Aquatic weeds may be defined as troublesome or unsightly plants growing in abundance in aquatic situations where they are not wanted (Aloo, 2013). Aquatic weed problems have increased in the last two centuries, in line with increases in industrialization, travel and communications, agricultural productivity, human population growth and changes in consumption patterns. Increased travel led to more chances for transmission of aquatic plants from their home ranges to new environments (Davis and Hirji, 2005). The presence of excessive aquatic vegetation in water influences the management of natural waterways, irrigation canals and reservoirs around the world. Also, aquatic weeds causing serious global problems for agriculture, aquaculture, natural areas, people and economic security (Ryan and John, 2009).

Aquatic weeds are famous by including some of the most intractable of weed problems, while at least one species *Eichhornia crassipes* (water hyacinth) is listed as one of the top ten world's worst weeds and several aquatic weed species can also be found in the Global Invasive Species Database, and are listed by the International Union for Conservation of Nature (IUCN) and Invasive Species Specialist Group (ISSG). Other species occur in individual countries' noxious weed lists (Ryan and John, 2009). Aquatic plants are more widely distributed throughout the world than terrestrial plants (Njuguna, 1992). The major aquatic weeds of the world are *Eichhornia crassipes*, *Typha* spp., *Ipomea carnea*, *Hydrilla verticillata*, *Salvinia* spp., *Alternenthera pheloxeroides*, *Monochoria vaginallis*, *Sagittaria* spp., *Potamogeton* spp. and *Pistia stratiotes* (Lancar and Krake, 2002). Five aquatic weeds are especially problematic in Africa; *Eichhornia crassipes*, *Azolla filiculoides*, *Myriophyllum aquaticum*, *Pistia stratiotes* and *Salvinia molesta* (Cilliers *et al*., 2003).

Sudan has many irrigated schemes; Gazira scheme, New halfa, El Suki, Gash Delta and El Rahad schemes. Aquatic weeds are considered as a major problem in the Sudan. The Gezira Scheme was established in 1925 and enlarged to its present capacity of 882.000 ha of the irrigable area in the early 1960s. The scheme occupies the area between the Blue and the White Niles, between latitudes 13˚ 30 N and 15˚ 30 N, and longitudes 32˚ 15 E and 33˚ 45 E. The Gezira comprises about 42 % of the established irrigation area of the Sudan and uses about 35 % of the Nile waters allocated to the Sudan in the Nile Water Agreement with Egypt (Eldaw, 2004). The largest gravity flow irrigation system in the Sudan is composed of the Gezira scheme and the Managil extension scheme, which comprises more than 89000 km of canals (Coates and Redding-Coates, 1981). The scheme obtains water directly from the Blue Nile. The minor canals were designed to store water overnight for daytime irrigation provides ideal conditions for the growth of both emergent and submerged plants. To function properly, they require continuous action to keep them free of weeds and to reduce the deposits of silt (Eldaw, 2004).

The studies on the composition and distribution of aquatic weeds in minor canals of Gezira scheme and other irrigation systems have been reported in the literature, but, the information on the current status of the aquatic weeds in the minor canals in Gezira Scheme is scarce. So that, this information is useful in aquatic weeds management and conservation of the agro-ecosystem. Therefore. this study was carried to evaluate the composition and distribution of aquatic weeds in six minor canals in Center Group at Gezira Scheme, Sudan (2018).

MATERIALS and METHODS

Study Area

The study was carried out in the Centre Group at Gezira Scheme. The study area lies between latitudes 14° 15 N and 14° 20 N, and longitudes 33° 20 E and 33° 30 E (Map 1). The climate of the region is semi-desert with a mean annual precipitation of 100-250 mm/year, with the rainy season from June to October and the dry season from March to June. The mean annual evapotranspiration is 2400 mm/year. The mean annual minimum and maximum temperatures are 12 °C in January and 42°C in May, respectively. The soil of the area is characterized by heavy soil (clay 60%), with pH 8-8.5, low organic matter and nitrogen, adequate potassium and low available phosphorous (Elbasher, 2016).

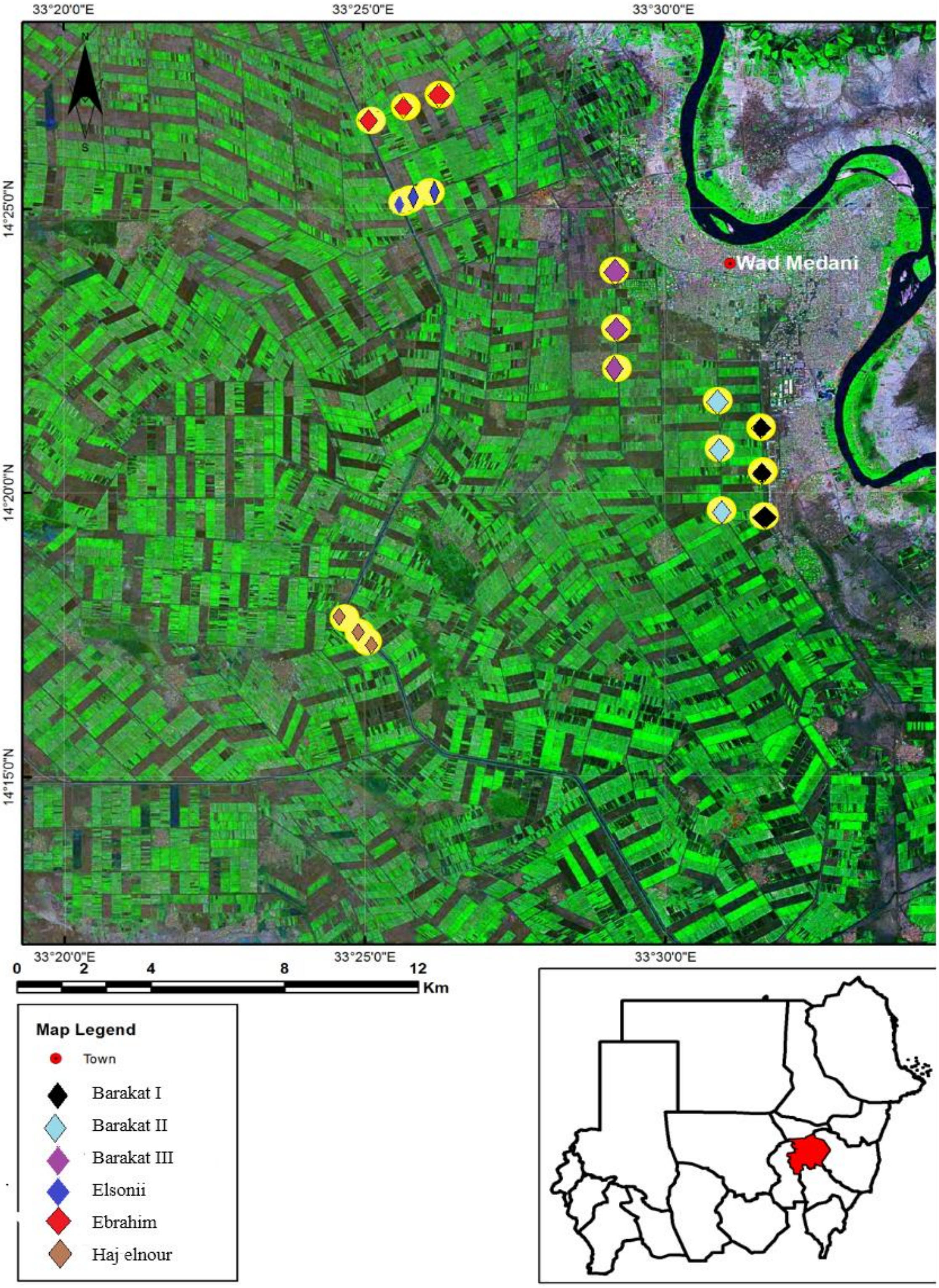
The experiment

General

Six minor canals at Centre Group at Gezira Scheme were selected randomly for the purpose of the study. The selected minor canals were *Barakat* I, *Barakat* II, *Barakat* III, *El sonni*, *El ebrahimi* and *Haj elnour*. Each minor canal was divided into three sections; head, middle and tail. So, the study area consists of 18 sites (6 minor canals x 3 sections). The community structure (composition and distribution of aquatic weeds) of each site was determined during summer and winter seasons. The study included all aquatic species which grow in canals and their banks. The study was conducted during the winter season (January, February and March) and summer season (August, September and October) in 2018/2019. The sites were surveyed once in every month for a period of three months in each season.

Composition of aquatic weeds

The community composition of aquatic weeds in each site was detected by visual observation (Yousif, 2019). The composition of the aquatic weeds included identification of the families, genera and species as well as a life form of aquatic weeds.



Map 1. Study area

Distribution of aquatic weeds

The distribution of aquatic weeds was determined by calculation of percentage of relative frequency in the heads, middles and tails of minor canals as follows:

Relative frequency of aquatic weeds

$$RF(\%) = \frac{X}{y} \times 100$$

Where:

RF (%) = Relative frequency of aquatic weeds

X = Frequency of a species

Y = Sum frequency of all species

Statistical analysis

Data were subjected to descriptive analysis and to analysis of variance (ANOVA) at P ≤ 0.5. Significant means were separated using Duncan's Multiple Range Test (DMRT). Microsoft Excel, statistical packages for social sciences (SPSS), Statistics 8 and MSTATC were used to analyze the data.

RESULTS

Composition of the aquatic weeds

The results showed that the composition of aquatic weeds in the six minor canals (*Barakat* I, *Barakat* II, *Barakat* III, *El sonni*, *El ebrahim* and *Haj elnour*) consists of four groups of aquatic weeds; floating weeds (free floating and rooted floating), emergent weeds, submergent weeds (free submergent) and bank aquatic weeds. In addition to the presence of some algae (Table 1-4).

All Aquatic weeds in the six minor canals consist of 12 species belonging to nine families. Floating weeds consist of five species belonging to five families in both summer and winter seasons with the absence of *Azolla* sp. and presence of *Echinochloa stagnina* in summer season (Table 1).

Table 1. Composition of floating weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer seasons, 2018.

Species	Family	Growth form	Winter season	Summer season
Azolla sp.	Salvinaceae	ff	Present	Absent
Echinochloa stagnina	Poaceae	rf	Absent	Present
Ipomoea aquatica	Convolvulaceae	rf	Present	Present
Ludwigia palustris	Onagraceae	rf	Present	Present
Pistia stratiotes	Araceae	ff	Present	Present
Vossia cuspidata	Poaceae	rf	Present	Present

* ff ≡ free floating rf ≡ rooted with floating leaves

Table 2. Composition of emergent weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer seasons, 2018

Species	Family	Growth form	Winter	Summer
Cyperus alopecuroides	Cyperaceae	em	Present	Present
Polygonum glabrum	Polygonaceae	em	Present	Present
Typha latifolia	Typhaceae	em	Present	Present

***** em ≡ emergent

Table 3. Composition of submergent weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter, 2018

Species	Family	Growth form	Winter	Summer
Najas pectinata	Najadaceae	fs	Present	Absent

* fs ≡ free submergent

Table 4. Composition of bank aquatic weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer, 2018

Species	Family	Growth form	Winter	Summer
Cynodon dactylon	Poaceae	b	Present	Present
Ipomoea hildebrandtii	Convolvulaceae	b	Present	Present

* b ≡ bank aquatic weeds

Emergent weeds include three species involving in three families in both summer and winter seasons (Table 2). While, submergent weeds found in winter season only in one species and one family (Table 3). Bank weeds cover two species comprise to two families during both summer and winter seasons (Table 4).

Distribution of aquatic weeds

Relative frequency of aquatic weeds

The results of relative frequency of floating weeds in winter season indicated that *Vossia cuspidata* was the higher relative frequency (33%) within floating species, followed by *Ipomoea aquatica* (22%), *Ludwigia palustris* (17%), *Pistia stratiotes* (15%) and finally *Azolla* sp. (13%) (Table 5). Relative frequency of floating weeds in summer season also showed that *Vossia cuspidata* was the higher (41%) among other floating species followed by *Ipomoea Aquatica* (26%), *Ludwigia palustris* (18%), *Pistia stratiotes* (9%) and *Echinocloa stagnina* (7%) (Table 5). Emergent weeds showed that the relative frequency of *Cyperus alopecuroides* was higher (87%) than *Polygonum glabrum* (7%) and *Typha latifolia* (7%) in the winter season (Table 6). In summer season, *Cyperus alopecuroides* gave (55%) followed by *Polygonum glabrum* (38%) and *Typha latifolia* (7%) (Table 6). Submerged weed *Najas pectinata* appeared only in winter season with a relative frequency of (100%) (Table 7) and bank aquatic weeds gave the higher relative frequency for *Cynodon dactylon* (75%) compared with *Ipomoea* *hildebranditi* (25%) in the winter season and (83%) for *Cynodon dactylon* compared with (17%) for *Ipomoea hildebranditi* in summer season (Table 8). The results also, showed that there were significant differences ($P \leq 0.05$) in the relative frequency between aquatic weeds.

The relative frequency of all aquatic species in the six minor canals showed that *Vossia cuspidata* and *Cynodon dactylon* were highest among other aquatic weed species (6.6% – 7.5%) in both summer and winter seasons (Table 9).

DISCUSSIONS

Many researchers in different studies reported that aquatic vegetation in irrigation canals are a major impediment to irrigated agriculture (Abou El Ella and El Samman 2016; Brinkhoff *et al*, 2018). The results of this study showed that the composition of aquatic weeds in irrigation water of the six minor canals consists of different families and genera belonging to four groups of aquatic weeds that might cause many problems in irrigation system of Gezira Scheme.

Ghavzan *et al.* (2006) mentioned that relative frequency is important to know the distribution of aquatic species. The results of this study showed that *Vossia cuspidata* and *Cynodon dactylon* exceed all other species in relative frequency. This result indicated that the relative frequency of aquatic species is important in the distribution and community structure of aquatic weeds.

Table 5. Relative frequency of floating weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer, 2018

	Relative frequency (%)			**Mean ±SD**
Species	**Head**	**Middle**	**Tail**	
Winter season				
Azolla sp.	11.8	12.5	15.4	13.2 b ± 0.02
Ipomoea aquatica	23.5	18.8	23.1	0.0321.8 ab ±
Ludwigia palustris	17.6	25.0	7.7	16.8 ab ± 0.09
Pistia stratiotes	17.6	12.5	15.4	15.1 b ± 0.03
Vossia cuspidata	29.4	31.3	38.5	33.1 a ± 0.05
Total	100	100	100	100 ± 0.00
SE±				4.4
CV%				26.84%
Summer season				
Echinochloa stagnina	5.6	6.7	8.3	6.9 b ± 0.01
Ipomoea aquatica	33.3	26.7	16 .7	25.6 ab ±0.08
Ludwigia palustris	16.7	20	16.7	17.8 b ± 0.02
Pistia stratiotes	11.1	6.7	8.3	8.7 b ± 0.02
Vossia cuspidata	33.3	40	50	41.1 a ± 0.08
Total	100	100	100	100± 0.00
SE±				5.0
CV%				30.70

*Means followed by the same letter(s) are not significantly different (P ≤ 0.05) accordingly Duncan's Multiple Range Test.

Table 6. Relative frequency of emergent weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer, 2018

Species	Relative frequency (%)			Mean ± SD
	Head	**Middle**	**Tail**	
Winter season				
Cyperus alopecuroides	100	100	60	86.7 a ±0.3
Polygonum glabrum	0	0	20	6.7 b ± 0.1
Typha latifolia	0	0	20	6.7 b ± 0.1
Total	**100**	**100**	**100**	**100 ± 0.00**
SE±				11.3
CV%				58.2
Summer season				
Cyperus alopecuroides	74.6	49.8	40.2	54.84 a ± 0.2
Polygonum glabrum	24.9	49.8	40.2	38.26 a ± 0.1
Typha latifolia	0	0	20.1	6.69 a ± 0.1
Total	**99.5**	**99.5**	**100.5**	**99.8 ± 0.01**
SE±				10.06
CV%				52.35

*Means followed by the same letter(s) are not significantly different (P ≤ 0.05) accordingly Duncan's Multiple Range Test.

Table 7. Frequency of submergent weeds in some minor canals in Centre Group at Gezira Scheme, Sudan in winter, 2018

Species	Frequency (%)			Mean ± SD
	Head	**Middle**	**Tail**	
Winter season				
Najas pectinatus.	0	20	20	13 ± 11.55
Total	0	20	20	40
Mean	0	20	20	13

Table 8. Relative frequency of bank weed in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer, 2018

Species	**Relative frequency (%)**			**Mean ± SD**
	Head	**Middle**	**Tail**	
Winter season				
Cynodon dactylon	83.3	71 .4	71.4	75.37 a ± 0.1
Ipomoea hildebrandtii	16.7	28.6	28.6	24.63 b ± 0.1
Total	100	100	100	100±0.2
SE±				5.66
CV%				19.62
Summer season				
Cynodon dactylon	75.2	100	75.2	83.47 a ± 0.1
Ipomoea hildebrandtii	25.1	0	25.1	16.73 a ± 0.1
Total	100.3	100	100.3	100.2 ± 0.2
SE±				11.76
CV%				40.66

*Means followed by the same letter(s) are not significantly different ($P \leq 0.05$) accordingly Duncan's Multiple Range Test.

Relative frequency of floating and bank aquatic weeds were the highest among other groups of aquatic weeds. This is probably due to the modification of the bottom of canals due to siltation and sometimes accumulations of submersed weeds, thus creating a suitable habitat for a species such as Vossia cuspidata, Cynodon dactylon, and Ipomoea aquatica. In addition to some bank aquatic weed species such as Ischaemum afrum and Xanthium stramarium were the commonest in the banks of canals. Most of the canals were free of submerged weeds, possibly because of their hydrological characteristics of minor canals such as the depth with fast current and also mechanical clearance. This also reported by Abdel Gadir (1987).

Table 9. Relative frequency of all aquatic weed species in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer seasons, 2018

	(%) Relative frequency	
Species	**Winter season**	**Summer season**
Azolla sp.	4	—
Ipomoea aquatica	4.4	5
Ludwigia palustris	3.5	3.3
Pistia stratiotes	1.8	1.7
Vossia cuspidata	6.6	7.5
Echinochloa stagnina	—	1.3
Cyperus alopecuroides	2.6	2.9
Polygonum glabrum	0.5	2.1
Typha latifolia	0.5	0.3
Najas pectinata	0.9	—
Cynodon dactylon	6.6	7.5
Ipomoea hildebrandtii	2.2	1.7

* (——) ≡ not found

The results showed that the percentage of relative frequency of different species in the canals was higher in the winter season than summer season, this also reported previously by Abdel Gadir (1987) and was attributed mainly to the turbidity of the water in summer season compared with the clearest water in winter season.

Conclusion

The community composition of aquatic weeds in minor canals of Gezira scheme consists of four groups of aquatic weeds with considerable differences in distribution during both summer and winter seasons, this may explain the importance of studying the community composition and distribution of aquatic weeds in irrigated schemes which enable farmers to control it in optimum time throughout the year. However, many surveys should be done in irrigated schemes to evaluate the community structure of aquatic weeds in irrigation systems for complete management.

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