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Original article

Yield and Composition of Natural Pastures from the Plains and Semi-mountainous Regions of Central Northern Bulgaria

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Abstract

One of the main problems in modern agricultural production is the inefficient use and management of natural resources. The aim of the present study is to analyze the productivity and assess the species composition of natural pastures (Np) used for grazing by sheep in farms in the region of Central Northern Bulgaria. The observations were carried out in the period mid-April - mid-June 2018-2019, at intervals of 14 days on eight natural grasslands located in the region of Central Northern Bulgaria. They are selected to cover the most typical and used natural pastures in the plains and semi-mountains of the region. The comparative assessment of the 8 plant populations of pasture type, subject of the present study, under the ecological conditions of Central Northern Bulgaria showed the highest yield of dry mass observed in the natural meadows in the plains - Np 4 (780.67 kg ha-1) , followed by Np 6 (760.09 kg ha-1) and Np 8 (740.24 kg ha-1), an average of 760.33 kg ha-1.

The grasslands from semi-mountains of the region (Np 1, 2 and 3), show a different reaction to the growing environment, but all of them are characterized by significantly lower productivity of green and dry biomass (respectively 1310.77 kg ha-1 and 380.90 kg ha-1) compared to the grasslands of the plains (2430.72 kg ha-1 and 740.66 kg ha-1 respectively).

The green biomass yield from the natural pastures, object of study, ranges from 920.38 kg ha-1 (Np 2) to 3000.13 kg ha-1.

The dry mass yield is from 290.02 kg ha-1 (Np2) to 780.67 kg ha-1 (Np 4).

Keywords: Natural pastures, yield, botanical composition, grass, legume.

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INTRODUCTION

One of the main problems in modern agricultural production is the inefficient use and management of natural resources (Korzun and Brujlo, 2011). In this respect, natural grasslands are a resource that is greatly underestimated and irrationally used. The last 100 years in Europe have seen a trend of drastic decline in natural grasslands, with efforts to assess their objective condition, maintain and improve (Poschlod and Bonn, 1998; Eriksson *et al.,* 2002).

According to statistics, meadows and pastures in Bulgaria (as of 2016) occupy about 13 million decares (Eurostat Statistics, 2018). They are especially important in mountainous and semi-mountainous areas, where they provide the main part of the hay and pasture for sheep and cattle. The potential of meadows and pastures is not yet fully exploited. One of the reasons is the low productivity (2000 kg ha^{-1}) (Ali, 2006), determined by not very favorable species composition, natural-climatic and anthropogenic factors (Stoeva and Vateva, 2013). The most valuable quality of these ecosystems according to some authors (Pavlov, 2007) is the great diversity of their constituent species and the fact that the products obtained from them are ecologically clean.

Biomass yield, the phase of vegetation during the different months of growth in combination with the plant species composition of the pasture is a key component for milk productivity during the grazing period (Stoycheva, 2015). The composition and nutritional value of grasses changes during the growing season (Naydenova and Pavlov, 2005; Stoycheva *et al.*, 2016).

Suitable for lactating sheep are pastures with a high proportion of legumes, combined with perennial grass species. The rations based on such grass mixtures ensure high milk productivity (Stoycheva, 2015).

By analyzing the quality of pastures used for grazing by dairy sheep, it will be possible to anticipate the changes and to adjust the composition of the rations in a timely manner. Could be controlled by proper feeding of cereals, to balance the ration and to meet the needs of lactating sheep and increase their milk productivity.

The aim of the present study is to analyze the productivity and assess the species composition of natural pastures (Np) used for grazing by sheep in farms in the region of Central Northern Bulgaria.

MATERIAL and METHODS

The observations were carried out in the period of mid-April - mid-June (2018-2019), at intervals of 14 days on eight natural grasslands located in the region of Central Northern Bulgaria (CNB). They are selected to cover the most typical and used natural pastures in the plains and semi-mountains of the region. The selected locations of natural pastures (Np) for observations and analysis are as follows: Kirchevo (Np 1; altitude-600m; GPS: 43.019224, 24.370827), Slavshtitsa (Np 2; altitude-590m; GPS:

43.049157, 24.352830), Lesidren (Np 3; altitude-580m; GPS: 43.003403, 24.421298), Hlevene (Np 4; altitude-283m; GPS: 43.092820, 24.717013), Lukovit (Np 5; altitude-171m; GPS: 43.202685, 24.149462), Katerica (Np 6; altitude-110m GPS: 43.314595, 24.922452), Odarne (Np 7; altitude-122m GPS: 43.333684, 24.931418), Pleven (Np 8; altitude-220m; GPS: 43.386296, 24.580932). The first three are located in the semi-mountains, and the rest - in the plains. From the samples taken, the dry matter determined at 105°C to constant weight, after which the productivity of green and dry mass (kg ha-1) calculated. The botanical composition determined on two samples, by dividing them into grasses, legumes and other grasses (weeds). The individual components weighed and their share in the grass sample calculated.

RESULTS and DISCUSSION

Table 1 presents the productivity results of natural pastures in the region of Central Northern Bulgaria from eight locations during the two-year survey period. The table shows that the yield of green biomass from natural pastures, object of study, ranges from 920.38 kg ha^{-1} (Np 2) to 3000.13 kg ha^{-1} (Np 8). The dry mass yield is from 290.02 kg ha^{-1} (Np 2) to 780.67 kg ha^{-1} (Np 4).

The grasslands from the semi-mountains of the region, with locations Np1, Np 2 and Np 3, show a different reaction to the growing environment, but all of them are characterized by significantly lower productivity of green and dry mass (respectively 1310.77 kg ha^{-1} and 380, 90 kg/ ha^{-1}) compared to the grasslands of the plains (2430.72 kg ha^{-1} and 740.66 kg ha^{-1} respectively). The yield of dry mass in the semi-mountains pastures is 47.86 % lower, and that of green biomass by 45.94 %, compared to the grasslands in the plains.

For the experimental conditions, the highest yield of dry mass observed in the natural meadows of Np 4 (780.67 kg ha^{-1}), followed by Np 6 (760.09 kg ha^{-1}) and Np 8 (740.24 kg ha^{-1}) - on average 760.33 kg ha-^{1}.

Next in productivity are grasslands Np 5 and Np 7, respectively, whose yields are close and with an average value of 720,178 kg ha^{-1}. The pasture in Np 2 (290.02 kg ha^{-1}) is the lowest average dry biomass yield.

The lowest are two of the pastures located in semi-mountains region (Np 2 and Np 3). They form biomass in the range of 290.02 and 340.53 kg ha^{-1}, which is on average 18.52 % lower than the same group average.

The specific climatographic conditions in the individual locations have an indisputable influence on the productivity of the studied grass associations, which is interesting to establish mathematically in the long run, as well as their species composition.

The average content of dry matter ranges from 25.03 % (Np 8) to 32.54 % (Np 5).

Table 1. Yield of natural pastures in the area of CNB kg / ha^{-1}

Region	**Np 1**	**Np 2**	**Np 3**	**Np 4**	**Np 5**	**Np 6**	**Np 7**	**Np 8**	**Average**
Green biomass	1810.25	920.38	1210.69	2550.31	2150.86	2330.19	2140.13	3000.13	2010.74
DM, %*	28.59	29.99	27.75	30.01	32.54	28.89	31.70	25.03	29.31
Dry biomass	530.16	290.02	340.53	780.67	740.05	760.09	700.29	740.24	610.26

*DM- dry matter content

During the two-year survey period, the participation of legume species is lower (8.00 %) and of grasses is higher (67.40 %), in the absence of significant differences in the average values for grasslands of the two types (semi-mountains and plains). According to Lynch (2014), in the grassland of good meadows and pastures, grasses occupy 50-80 % (as in our experiment - between 56.34 and 78.56 %), which is due to their greater longevity and adaptability to adverse climatic and soil conditions, as well as to their better competitiveness, compared to species from other botanical families.

Table 2. Botanical composition (grass:legume:other) of natural pastures in CNB , %

Region	**Np 1**	**Np 2**	**Np 3**	**Np 4**	**Np 5**	**Np 6**	**Np 7**	**Np 8**	**Average**
Grass	64.09	70.48	56.34	63.56	70.50	69.13	78.56	66.50	67.40
Legume	12.06	0.90	16.86	10.12	5.63	1.25	1.63	15.62	8.00
Other	23.85	28.62	26.80	26.31	23.87	29.62	19.81	17.88	24.60

Legumes are species with a higher nutritional value, but their share in natural grasslands is usually 5-10 % (rarely up to 20-30 %), with values for specific study conditions between 0.90 and 16.86 %. The percentage of weeds varies from 17.88 to 29.62 %, average 24.60 %.

Conclusions

The comparative assessment of the 8 plant populations of pasture type, subject of the present study, under the ecological conditions of Central Northern Bulgaria showed the highest yield of dry mass observed in the natural meadows in the plains - Np 4 (780.67 kg / ha^{-1}) , followed by Np 6 (760.09 kg / ha^{-1}) and Np 8 (740.24 kg / ha^{-1}), an average of 760.33 kg/ ha^{-1}.

The grasslands from semi-mountains of the region (Np 1, 2 and 3), show a different reaction to the growing environment, but all of them are characterized by significantly lower productivity of green and dry biomass (respectively 1310.77 kg ha^{-1} and 380.90 kg ha^{-1}) compared to the grasslands of the plains (2430.72 kg ha^{-1} and 740.66 kg ha^{-1} respectively).

The green bio mass yield from the natural pastures, object of study, ranges from 920.38 kg / ha^{-1} (Np 2) to 3000.13 kg ha^{-1}.

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Yield of green biomass from natural pastures ranges from 1210.69 kg ha^{-1} (Np 3) to 3000.13 kg ha^{-1} (Np 8).

The dry mass yield is from 290.02 kg ha^{-1} (Np 2) to 780.67 kg ha^{-1} (Np 4).

The relative share of grasses in natural pastures is higher and varies between 56.34 and 78.56 %.

In region of CNB participation of species is lower (8.00 %) and of grasses is higher (67.40 %), in the absence of differences in the average values for grasslands of the two types (semi-mountains and plains).

REFERENCES

Ali, H.S., 2006. Use of mountain pastures for production of cattle products from farms with different volume in the region of Central Stara Planina. PhD These, Troyan.

Eriksson, O., S.A.O Cousins, H.H. Bruun, 2002. Land-use history and fragmentation of traditionally managed grasslands in Scandinavia. *Journal of Vegetation Science* 13: 743-748.

Eurostat Statistics, 2018. http://ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics/bg

Korzun, O.S., Brujlo A.S., 2011. Adaptive features of breeding and seed production of agricultural plants. Grodno, GGAU, 140.

Naydenova, Y., D. Pavlov, 2005. Near Infrared Reflectance Spectroscopy calibration models for feeding value prediction of forage perennial grasses and legumes. *Journal of Animal Science* 42 (4): 24-29.

Pavlov, D., 2007. Increasing the usability of natural resources and natural grass associations for rural development. *Journal of Mountain Agriculture on the Balkans* 10 (1): 37-64.

Poschlod, P., S. Bonn, 1998. Changing dispersal processes in the central European landscape since the last ice age: an explanation for the actual decrease of plant species richness in different habitats. *Acta Botanica Neerlandica* 47: 27-44.

Stoeva, K., V. Vateva, 2013. State of natural pasture swards in the Strandzha Mountain in different locations. II. Productivity. *Soil Science, Agrochemistry and Ecology*, XLVII (3): 68-73.

Stoycheva I., A. Kirilov, Y. Naydenova and A. Katova, 2016. Yield and composition changes of temporary and natural pasture. In: Grassland Science in Europe, vol. 21.Eds. M. Höglind, A.K. Bakken, K.A. Hovstad, E. Kallioniemi, H. Riley, H. Steinshamn and L. Østrem., 3017-3019.

Stoycheva, I., 2015. Influence of grazing and preserved forage on milk production of sheep. PhD These, Pleven, 2015, 148 pp.

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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).

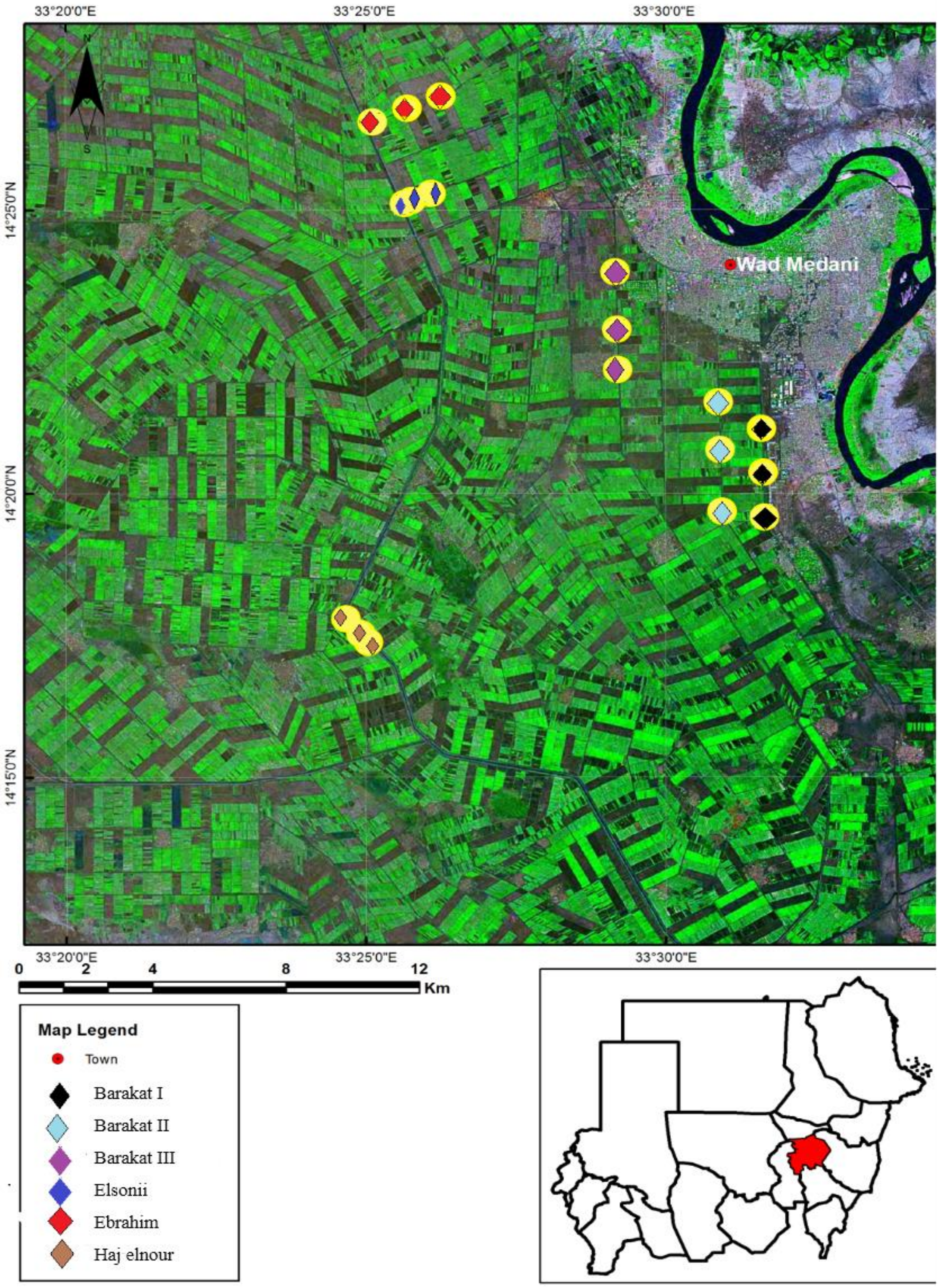
The experiment

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 ≤ 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.

REFERENCES

Abdel Gadir, H. (1987). Annual Report of the Gezira Research Station. Season 1986/87. Ministry of Agriculture. Agricultural research corporation.

Abou El Ella, S.M. and T.A. El Samman (2016). Review: Egyptian Experience in Controlling Aquatic Weeds. Journal of American Science, 12(9), 104-115.

Aloo, P., W. Ojwang, R. Omondi, J.M. Njiru, and D. Oyugi (2013). A review of the impacts of invasive aquatic weeds on the biodiversity of some tropical water bodies with special reference to Lake Victoria (Kenya). Biodiversity Journal, 4 (4), 471 – 482.

Brinkhoff, J., Hornbuckle, J. and Barton, J.L. (2018). Assessment of Aquatic Weed in Irrigation Channels Using UAV and Satellite Imagery. Water, 10, 1-20. doi:10.3390/w10111497.

Cilliers, C.J., Hill, M.P., Ogwang, J.A. and Ajuonu, O. (2003). Aquatic weeds in Africa and their control. *In*: Neuenschwander, P., Borgemeister, C., Langewold, J. eds. Biological Control in IPM Systems in Africa. Wallingford, UK: CAB International, 161- 178.

Coates, D. and T.A. Redding-Coates (1981). Ecological problems associated with irrigation canals in the Sudan with particular reference to the spread of Bilharziasis, Malaria, and aquatic weeds and the ameliorative role of fishes. International Journal of Environmental studies, 16, 207-212.

Davis, R., and Hirji, R. (2005). Management of aquatic plants water resources and environment technical notes G.4. The International Bank for Reconstruction and Development /the World Bank 1818 H street, N.W., Washington, D.C. 20433, U.S.A.

Elbasher, O.A. (2016). Vermination of climate changes using rainfall and temperature as indicators and its impacts on agricultural production in the arid zone of Sudan (1981-210). Ph.D. Thesis, University of Gezira, Sudan.

Eldaw, A.M. (2004). The Gezira Scheme: Perspectives for Sustainable Development. University of Gezira. German Development Institute. die@die-gdi.de www.die-gdi.de ISBN 3-88985-262-9.

Ghavzan, N.J., R.V. Gunale, D.M. Mahajan, and D.R. Shirke (2006). Effects of environmental factors on ecology and distribution of aquatic machrophytes. Asian journal of plant sciences, 5(5), 871 – 880.

Lancar, L. and Krake, K. (2002). Aquatic Weeds and Their Management. ICID.CIID International Commission on Irrigation and Drainage. (Available at: http://www.icid.org/ weed_report.pdf.

Njuguna, S.G. (1992). Floating aquatic weeds in Kenya. *In*: Crafter, S.A., Njuguna, S.G. and Howard, G.W. (eds).Wetlands of Kenya. Proceedings of the KWWG Seminar on Wetlands of Kenya, National Museums of Kenya, Nairobi, Kenya, 3-5 July 1991. 183 pp.

Ryan, M.W. and John, D.M. (2009). A review of the global status of aquatic plants, Aquatic Plants Their Uses and Risks. International Plant Protection Convention (IPPC). Pp 94.

Yousif, M. Y. H. (2019). Composition, Abundance and Distribution of Aquatic Weeds in Minor and AbuXX Canals, Rahad Scheme, Sudan (2017-2018). M Sc. Thesis, University of Gezira, Sudan. Pp .35.