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DIVERSITY OF WEEDS SPECIES IN GRAPES FARMS OF TAYMA (TABUK, SAUDI ARABIA): IMPLICATION FOR INVASIVE SPECIES ECOLOGY

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Abstract

The biodiversity of the agroecosystem leads to changes in the Floristic composition, diversity, and abundance of weed species in crop and orchard farms. The present study is considered the first attempt to categorize, evaluate, and document the diversity of weed populations among different grape farms in Tayma, Tabuk region, Saudi Arabia. The results of ANOVA showed that the number of weed species varied significantly across the six grape farms. During six grape farms under study, 30 weed species belonging to thirteen families and 28 genera were recorded. In total, twelve weed species belong to the Poaceae family with a rate of 40%. While the other families are represented either by one or two species with rates of 3.3% and 6.7%, respectively. Biogeographic origins analysis showed that the Tropical area represented 23.3% of total weed flora, followed by Saharo Arabian (16.7%), Mediterannean-Euro Siberian-Irano-Turanian (13.3%) and American (10.0%). Therophytes were the dominant life forms with a rate of 66.7%, followed by Hemicryptophyte (20.0%), Geophyte (6.7%), and Chamaephyte (6.7%). A total of 16 and 14 weed species belong to the annual and perennial life span, respectively. Also, the grass and herb habits represented 40% and 60% of 30 weed species, respectively. According to the abundance score, the most common weed species of those grape farms in the region study are *Cynodon dactylon*, *Desmostachya bipinnata*, and *Setaria verticillata*, they belong to the Poaceae family. Based on the presence and absence of weed species in grape farms, the Principal Component Analyses (PCA) show that the grape farms and weed species (into two groups) are distinguished mainly along the first two components. Also, positive correlations were observed among most grape farms, according to PCA. Generally, more studies on the ecological aspects and floristic composition of weed species in grape farms are also needed.

Keywords: Abundance. Agroecosystems. Floristic composition. Grape. PCA. Weed species.

1. Introduction

Although somewhat ambiguous, the idea of a biotic community as a separate ecological unit is valuable since it enables ecologists to identify the vegetation they are interested in precisely (Radosvich 1984). The biodiversity of the agroecosystem includes weeds (Sawicka et al. 2020) and other plant species

(El-Hashash and El-Absy 2019). Species richness, distribution, and production in agroecosystems are influenced by the cooperative interactions that form between weeds, crops, and the environment they all share (Radosvich 1984). When viewed as a cohesive, functional system, a weed community and its surroundings are referred to be an ecosystem (El-Sheikh 2013). In actuality, habitat conditions influence weed infestation in crops (Sawicka et al. 2020). Where, compared to other vegetation types, weed communities, which are primarily made up of annual plants, show a significantly higher level of temporal dynamics (El-Sheikh 2013). According to Shaltout and El Halawany (1992), weeds are a very productive and crucial element of the ecosystems, such as arid lands, range lands, forests, and aquatic ecosystems.

Weeds are defined as undesirable plants that are found in association with agricultural crop areas and bring about a significant reduction in yield through their competition with agricultural crops for resources (Hamadache 1995; Dangwall et al. 2010; Robin 2014). Weeds are plants that are damaging because they obstruct agricultural activities, raise costs, lower crop yields, and require more labor than necessary, according to Robbins et al. (1952). Baker (1974) reported that weeds are distinguished from other plant species by their strong seed production, which increases their population, quick germination, early growth, lengthy longevity, and life cycle. Thus, they have the potential to compete with crops for resources including water (soil moisture), soil nutrients, light, carbon dioxide, solar radiation, and space, which would harm seeds germination, production and availability of crops (Wang et al. 2007; Gomaa et al. 2014; Shah et al. 2018; Misbahullah et al. 2019). The amount of loss in crop production caused by weeds is more than the amount of loss resulting from all the pests put together (Sen et al. 1984; Adeux et al. 2019).

Weed growth and distribution in agroecosystems are strongly influenced by a variety of environmental and biological factors, including soil tillage, crop type and nature, irrigation techniques, climate conditions, humidity availability, herbicide use, and fertilizer use (Brand et al. 2007; Fried et al. 2008; Ahmad et al. 2016). Data comparing weed assemblages within single-farms fields frequently show significant field-to-field variance, demonstrating that both field history and the local environment have an impact on the prevalence of weeds (Marshall and Arnold 1994).

Saudi Arabia is the largest arid territory in the Arabian Peninsula with a total size of roughly 2,250,000 km^2, and is distinguished by a variety of habitats and a wide range of plant species (Zahran 1982). The flora of the Tabuk region revealed that Saharo-Arabian elements made up the majority of plant species, followed by Irano-Turanian and Sudanese elements, which together accounted for about 60% of all plant species (Al-Mutairi et al. 2016).

In grape farms, it’s important to do a weed survey and determine if the weed species are annual or perennial (Craig 2022). In the first few years of establishment, grapes are extremely sensitive to competition with weeds, thus every effort should be made to preserve the area inside the row, under the vines, weed-free (Craig 2022).

Grape (*Vitis vinifera* L.) belongs to the genus Vitis, which of about 60 to 80 species of vining plants in the family Vitaceae (Britannica 2022). Grape is the economically most important perennial fruit crop in the world, originated in Asia (the Middle East), it is now mostly planted in Europe, America, and Asia for table grapes, wine use, dry fruits, juice and other products made thereof (Giancaspro et al. 2022). In 2020, the total Area harvested, yield, and total production of grapes are 9053 ha, 112195 hg/ha, and 101570 tonnes in Saudi Arabia, respectively (FAO 2022).

Several research investigated the weed flora to identify the main weed communities in various agroecosystems in Saudi Arabia for example Al-Yemeny (1999), Gomaa (2017), Al-Qahtani (2018 and 2019), Sher and Al-Yemeni (2020) and Al-Harbi (2021). Therefore, the objective of this study was to classify, assess and document the weed communities diversity between various grapes farms in Tayma, Tabuk region, Saudi Arabia, through identifying the dominant weed flora, floristic composition, life form, and chorotype.

2. Material and Methods

Study area and their geographic and climatic data

The Tabuk region lies in the northwest of Saudi Arabia with 117000 km^2 of total area (Al-Mutairi et al. 2016). This region is crucial for agriculture since it has a wide range of cultivated plants with high economic production, including fruits, vegetables, grabs, olives, and date palms (Al-Qahtani 2018). Some of these farms are lies in the Tayma Governorate which is approximately 255 km from the south of Tabuk city. To conduct this study of the weed flora inventory, we selected six grapes farms located in Tayma Governorate, Tabuk region (Figure 1).

Figure 1. Map of Saudi Arabia and Tayma Governorate including six grape farms (A, B, C, D, E and F) under study.

The district's average annual of temperature, rainfall, and relative humidity is 22.23 ºC, 3.16 mm and 29.44%, respectively (Figure 2). The highest and lowest mean monthly for air temperature and rainfall were observed in July, respectively. While the highest mean monthly relative humidity and rainfall, as well as the lowest mean monthly temperature, were noticed in January. While June recorded the lowest mean monthly for relative humidity.

Collecting the weeds samples

Based on extensive fieldwork in grape orchards, the current study was conducted. Collection and identification of weed infestation in six selected commercial farms were conducted so as to represent different conditions of grape plantations in Tayma province. For each farm, the current weed species were noted and their coverage was evaluated visually or arbitrarily on the surface of the ground in ten randomly sampled quadrants. Each quadrate has a surface area of 100 m^2 (10 x 10). The sampling process began in August 2022 and was completed in October 2022. The weed species were registered as data of absence or presence.

A fair level of habitat consistency and weed cover homogeneity were guaranteed when choosing each farm. Regarding the use of herbicides, farming methods, and soil type, fields were quite homogeneous. The samples of weed species were collected about 5 m from any field edge, so all samples were taken inside the field's center to avoid being impacted by field edges according to Marshall and Arnold (1995). For the purpose of verifying their identity, samples from the listed weed species were collected and processed as herbarium specimens. The next records were created: a list of the current weed species including latin name, family (Collenette 1999; Chaudhary 2000), life form (Raunkiaer 1934), chorotype (Zohary 1973), total presence, rate% and abundance. The specimens have been stored at the Biology Department, University College of Tayma, University of Tabuk, Saudi Arabia.

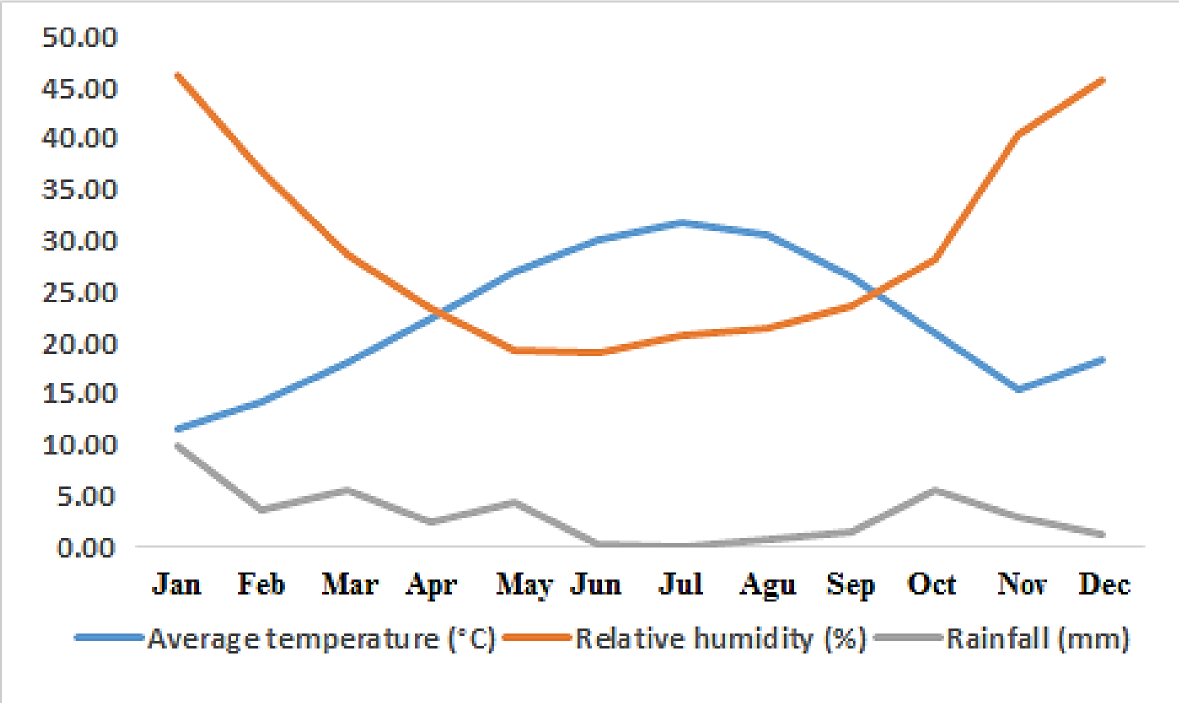

Figure 2. Average monthly temperature (°C), relative humidity (%) and rainfall (mm) for Tayma Governorate (https://tcktcktck.org/saudi-arabia/tabuk/tayma).

Statistical analysis

In this study, all data of the weed species present in the grape farms were subjected to percentage estimates. According to Gomez and Gomez (1984), the one-way ANOVA test was used to analyze differences between the six grape farms, and pairwise means comparisons were carried out using the least significant differences (LSD) test at a 0.05 probability level. Principal component analysis (PCA) was applied to assess the similarities and dissimilarities relationships among weed species during the six grape farms. All statistical analyses were done using the computer software program OriginPro 2018 version b9.5.0.193.

3. Results

Floristic composition of weed species

Latin name, family, life form, and chorotype of weed species associated with grapes in the studied farms at Tayma, Tabuk Region, Saudi Arabia are shown in Table 1. During the taxonomy of weed species in six grape farms, thirty weed species were recorded belonging to thirteen families, twenty-eight genera and thirteen chorological origins.

In relation to the distribution by botanical families in the six grape farms, thirteen families with twenty-eight genera were observed (Table 2). The largest family was Poaceae (40%), which most dominant family in the weed species of the six grape farms studied with twelve genera and species. Six families make up 40% of all weed families, including Amaranthaceae, Euphorbiaceae (one genus each), Asteraceae, Leguminosae, Resedaceae, and Zygophyllaceae (two genera each) with two weed species for each. While other families with one weed species for each account for almost 20% of the total weed families at six farms.

Table 1. Latin Name, Family, Life form and Chorotype of weed species associated with grapes in the studied farms at Tayma, Tabuk Region, Saudi Arabia.

Code	Latin Name	Family	Life Span	Life Form	Chorotype
S1	*Amaranthus viridis*	Amaranthaceae	Annual Herb	Therophyte	Tropical
S2	*Amaranthus spinosus*		Annual Herb	Therophyte	Tropical
S3	*Sonchus oleraceus*	Asteraceae	Annual Herb	Therophyte	MESIT
S4	*Pulicaria undulata*		Perennial Herb	Therophyte	SASM
S5	*Heliotropium curassavicum*	Boraginaceae	Perennial Herb	Chamaephyte	American
S6	*Sisymbrium erysimoides*	Brassicaceae	Annual Herb	Therophyte	MSA
S7	*Chenopodium murale*	Chenopodiaceae	Annual Herb	Therophyte	Paleotropic
S8	*Euphorbia granulata*	Euphorbiaceae	Perennial Herb	Therophyte	Tropical
S9	*Euphorbia peplus*		Annual Herb	Therophyte	MESIT
S10	*Alhagi graecorum*	Leguminosae	Perennial Herb	Hemicryptophyte	Saharo Arabian
S11	*Medicago sativa*		Perennial Herb	Hemicryptophyte	MESIT
S12	*Malva neglecta*	Malvaceae	Annual Herb	Therophyte	Tropical
S13	*Plantago lanceolata*	Plantaginaceae	Annual Herb	Therophyte	MESIT
S14	*Aeluropus lagopoides*	Poaceae	Perennial grass	Hemicryptophyte	Saharo Arabian
S15	*Aristida adscensionis*		Perennial grass	Therophyte	Saharo-Arabian
S16	*Cenchrus echinatus*		Annual grass	Therophyte	American
S17	*Cynodon dactylon*		Perennial grass	Geophyte	Tropical
S18	*Desmostachya bipinnata*		Perennial grass	Hemicryptophyte	SASM
S19	*Eragrostis barrelieri*		Perennial grass	Therophyte	MSA
S20	*Panicum coloratum*		Perennial grass	Chamaephyte	Tropical Africa
S21	*Phalaris minor*		Annual grass	Therophyte	MIT
S22	*Phragmites australis*		Perennial grass	Geophyte	MITSA
S23	*Setaria verticillata*		Annual grass	Therophyte	Tropical
S24	*Stipagrostis plumosa*		Perennial grass	Hemicryptophyte	SAIT
S25	*Zea mays*		Annual grass	Therophyte	American
S26	*Portulaca oleracea*	Portulacaceae	Annual Herb	Therophyte	Cosmopolitan
S27	*Oligomeris linifolia*	Resedaceae	Annual Herb	Therophyte	Chinese
S28	*Reseda decursiva*		Annual Herb	Therophyte	Saharo Arabian
S29	*Fagonia bruguieri*	Zygophyllaceae	Perennial Herb	Hemicryptophyte	Saharo Arabian
S30	*Tribulus terrestris*		Annual Herb	Therophyte	Tropical

MESIT: Mediterannean-Euro Siberian-Irano-Turanian; MITSA: Mediterranean- Irano Turanian- Saharo Arabian; SASM: Saharo Arabian-Somali Masai; MSA: Mediterranean-Saharo Arabian; MIT: Mediterranean- Irano Turanian; SAIT: Saharo Arabian-Irano Turanian.

Table 2. Number of genera and species of botanical families in the studied farms at Tayma, Tabuk Region, Saudi Arabia.

No.	Family	No. of Genera	No. of Species	Rate (%)
1	Amaranthaceae	1	2	6.7
2	Asteraceae	2	2	6.7
3	Boraginaceae	1	1	3.3
4	Brassicaceae	1	1	3.3
5	Chenopodiaceae	1	1	3.3
6	Euphorbiaceae	1	2	6.7
7	Leguminosae	2	2	6.7
8	Malvaceae	1	1	3.3
9	Plantaginaceae	1	1	3.3
10	Poaceae	12	12	40.0
11	Portulacaceae	1	1	3.3
12	Resedaceae	2	2	6.7
13	Zygophyllaceae	2	2	6.7
	Total	28	30	100

In Table 3, the spectrum of life forms showed a great variety of differences. Two Chamaephyte, two Geophyte, six Hemicryptophyte, and twenty Therophyte are found among the thirty weed species. Therophytes life forms were the most common or predominant and comprise 66.7% of the total weed species in the grape farms, followed by Hemicryptophyte with 20%. While each Chamaephyte and Geophyte were represented by 6.7% of the total weed species. The life span of thirty weed species in the grape farms studied shows that the number of annual species (16) is higher than the number of perennial species (14), which increased by 7%. Of these weed plants, 12 and 18 species are grasses and herbs, respectively. Where the herb species percentage (60%) exceeds that of the grass species percentage (40%) in the six grape farms.

Table 3. Number of species according to their life forms in the studied farms at Tayma, Tabuk Region, Saudi Arabia.

Life of species	No. of Species	Rate (%)
	Life form	
Chamaephyte	2	6.7
Geophyte	2	6.7
Hemicryptophyte	6	20.0
Therophyte	20	66.7
Total	30	100
	Life span	
Annual	16	53.3
Perennial	14	46.7
Total	30	100
	Habit	
Grasse	12	40.0
Herb	18	60.0
Total	30	100

In terms of the world's floristic regions, the thirty weed species that have been identified fall into thirteen phytogeographic zones, as shown in Table 4. The Tropical world constituted 23.3% (with seven weed species). While the Saharo Arabia, Mediterannean-Euro Siberian-Irano-Turanian and American regions were represented by five (16.7%) four (13.3%), and three (10%) weed species, respectively. Nineteen weed species of all total fell under these previous regions, which represented 63.3%. Whilst, both regions of Mediterannean-Saharo Arabian and Saharo Arabian-Somali Masai included two weed species for each (6.7%). Finally, there were only one weed species (3.3%) in each of the other zones.

Table 4. A number of weed species according to biogeographic origins in the studied farms at Tayma, Tabuk Region, Saudi Arabia.

No.	Chorological origins	No. of Species	Rate (%)
1	American	3	10.0
2	Chinese	1	3.3
3	Cosmopolitan	1	3.3
4	Mediterannean-Euro Siberian-Irano-Turanian	4	13.3
5	Mediterranean- Irano Turanian- Saharo Arabian	1	3.3
6	Mediterannean-Saharo Arabian	2	6.7
7	Mediterranean- Irano Turanian	1	6.7
8	Saharo Arabian-Irano Turanian	1	6.7
9	Paleotropic	1	3.3
10	Saharo Arabian-Somali Masai	2	6.7
11	Saharo Arabian	5	16.7
12	Tropical	7	23.3
13	Tropical Africa	1	3.3
	Total	30	100

Weed species in grape farms

Significant differences ($P < 0.05$) were observed in the number of weed species among the examined grape farms (Figure 3). As for means comparisons among grape farms, the number of weed species on A and D, B and C, B and E, as well as C and D did not differ significantly from each other. While other comparisons among grape farms showed differences significant for the number of weed species under study. The grape farm F had the significantly greatest number of weed species, followed by the first and fourth grape farms A and D. While the significantly smallest number of weed species was noticed on Farm E.

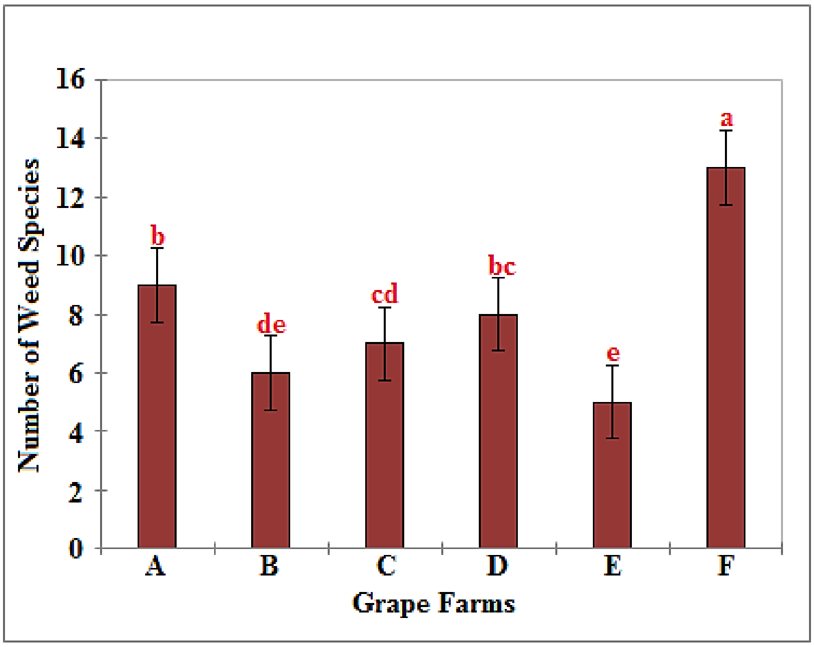

Figure 3. Weed species in grape farms at Tayma, Tabuk Region, Saudi Arabia. Different lowercase letters in the same column indicate statistically significant differences at $p \leq 0.05$ according to the LSD test.

According to the data in Table 5, grape farm E was least affected by weed species, where just five weed species were registered with the smallest percentage with a value of 10.4% of all the farms investigated. On the other hand, Farm F included the most frequent weed species at 27.1% of all grape farms making it the high damaged farm overall by weed species, followed by Farms A and D at 18.8% and 16.7%, respectively. Additionally, six (12.5%) and seven (14.6%) weed species were documented at grape Farms B and C, making it medium-damaged overall by weed species compared with other grape farms.

The qualitative abundance score for each weed species and each farm was categorized as absent (0), present but rare (from 1% to 5%), frequent (from 6% to 20%), abundant (from 21% to 40%), common (from 41% to 80%) and very common from 81% to 100%). The percentage of abundance weed species with different distributions varied from 16.7% to 100% in the six grape farms under study, as shown in Table 5. A high presence of *Cynodon dactylon* (*C. dactylon*) type was recorded in the six grape farms, in which the abundance scale is 100%, thus this weed is very common (Table 5). *Desmostachya bipinnata* (*D. bipinnata*) type dominated all weed types on Farms B, C, E, and F (66.7%), making it a common weed. On farms A, B and D, the dominating species were *Amaranthus viridis* and *Setaria verticillata* (*S. verticillata)*, with 50% in all weeds each, thus this weed is common. Also, the abundance *Alhagi graecorum* is 50% in Farms A, C and D. The two species *Oligomeris linifolia* and *Zea mays* in Farms E and F, *Sonchus oleraceus* type in Farms B and F, and *Cenchrus echinatus* type in Farms D and E represented 33.3%, therefore their weeds are abundant. According to abundance scale of 16.7%, the other weed species are frequent weeds, and are only found in one grape farm.

Principal Component Analyses (PCA)

In order to understand the relationship between weed species and the six grape farms based on the presence and absence of weed species in these farms, PCA was performed. According to the weed species data, Table 6 shows the variance% of various PCAs and the accompanying loadings for grape farms. The three principal component analyses (PCA1, PCA2, and PCA3) revealed eigenvalues greater than one (1.81, 1.47, and 1.02, respectively), and their combined value of 71.6% represented the majority of the cumulative variance. On the other hand, the eigenvalues for the remaining PCAs were less than one (<1).

The first two PCAs had percentages of variance with values of 30.19% and 24.47% of the total variability of all studied variables, respectively. In the first two PCAs, positive loadings were seen for the majority of grape farms. The highest positive correlations were noticed for PCA1 with Farms A (0.55) and D (0.51), and for PC2 with Farms E (0.68) and B (0.55). As a result, a biplot was created using PCA1 and PCA2 (Figure 4). As shown in Figure 4, positive correlations were observed among grape Farms B, C, D and E. Farm A was positively correlated with Farms B and D. While Farm F had a positive association with Farms B and E. Opposite, other relationships among grape farms showed negative correlations.

Table 5. Distribution of weed species associated with grapes in the studied farms at Tayma, Tabuk Region, Saudi Arabia.

Code	Latin Name	Family	Grape Farms						Total	Rate	Abundance
			A	B	C	D	E	F	Presence	%	
S1	*Amaranthus viridis*	Amaranthaceae	+	+	-	+	-	-	3	50.0	IV
S2	*Amaranthus spinosus*		-	-	+	-	-	-	1	16.7	II
S3	*Sonchus oleraceus*	Asteraceae	-	+	-	-	-	+	2	33.3	III
S4	*Pulicaria undulata*		-	-	-	-	-	+	1	16.7	II
S5	*Heliotropium curassavicum*	Boraginaceae	+	-	-	-	-	-	1	16.7	II
S6	*Sisymbrium erysimoides*	Brassicaceae	-	-	-	-	-	+	1	16.7	II
S7	*Chenopodium murale*	Chenopodiaceae	-	-	-	+	-	-	1	16.7	II
S8	*Euphorbia granulata*	Euphorbiaceae	+	-	-	-	-	-	1	16.7	II
S9	*Euphorbia peplus*		-	-	-	-	-	+	1	16.7	II
S10	*Alhagi graecorum*	Leguminosae	+	-	+	+	-	-	3	50.0	IV
S11	*Medicago sativa*		+	-	-	-	-	-	1	16.7	II
S12	*Malva neglecta*	Malvaceae	-	-	-	-	-	+	1	16.7	II
S13	*Plantago lanceolata*	Plantaginaceae	-	-	-	+	-	-	1	16.7	II
S14	*Aeluropus lagopoides*	Poaceae	+	-	-	-	-	-	1	16.7	II
S15	*Aristida adscensionis*		-	-	+	-	-	-	1	16.7	II
S16	*Cenchrus echinatus*		-	-	-	+	+	-	2	33.3	III
S17	*Cynodon dactylon*		+	+	+	+	+	+	6	100	V
S18	*Desmostachya bipinnata*		-	+	+	-	+	+	4	66.7	IV
S19	*Eragrostis barrelieri*		-	-	-	-	-	+	1	16.7	II
S20	*Panicum coloratum*		-	-	-	-	-	+	1	16.7	II
S21	*Phalaris minor*		-	-	-	+	-	-	1	16.7	II
S22	*Phragmites australis*		-	-	+	-	-	-	1	16.7	II
S23	*Setaria verticillata*		+	+	-	+	-	-	3	50.0	IV
S24	*Stipagrostis plumosa*		-	-	-	-	-	+	1	16.7	II
S25	*Zea mays*		-	-	-	-	+	+	2	33.3	III
S26	*Portulaca oleracea*	Portulacaceae	-	+	-	-	-	-	1	16.7	II
S27	*Oligomeris linifolia*	Resedaceae	-	-	-	-	+	+	2	33.3	III
S28	*Reseda decursiva*		+	-	-	-	-	-	1	16.7	II
S29	*Fagonia bruguieri*	Zygophyllaceae	-	-	-	-	-	+	1	16.7	II
S30	*Tribulus terrestris*		-	-	+	-	-	-	1	16.7	II
	Total Presence		9	6	7	8	5	13	48		
	Rate %		18.8	12.5	14.6	16.7	10.4	27.1	100		
	Abundance		II	II	II	II	II	III			

(- and +): Presence and absence of weed species, respectively; I (if present but rare; 1-5%); II (if frequent; 6-20%); III (if abundant; 21-40%); IV (if common; 41-80%); V (if the species was very common; 81-100%).

Table 6. Data of principal component analysis (PCAs) in the first six PCAs for the weed species found in the grape farms under study.

Grape Farms	PCA1	PCA2	PCA3	PCA4	PCA5	PCA6
Farm A	0.55	-0.06	0.21	0.41	0.63	0.30
Farm B	0.25	0.55	0.27	0.51	-0.48	-0.25
Farm C	0.13	0.29	-0.88	0.19	-0.05	0.29
Farm D	0.51	0.23	0.17	-0.64	-0.27	0.41
Farm E	-0.12	0.68	-0.01	-0.32	0.55	-0.36
Farm F	-0.58	0.32	0.28	0.15	0.02	0.68
Eigenvalue	1.81	1.47	1.02	0.77	0.62	0.31
variance %	30.19	24.47	16.94	12.84	10.34	5.22
Cumulative%	30.19	54.66	71.60	84.44	94.78	100.00

In comparison to the PCA1, the PCA2 had more weed species (18 species). PC1 correlated positively with weed species including S4, S6, S9, S12, S19, S20, S24, S29, S3, S18, S25 and S27, whilst other weed species had negative correlations. On the other hand, PCA2 had negatively correlated to weed species including S1, S3, S16, S17, S18, S23, S25, S26, and S27, while it showed a positive association with the other weed species evaluated. The two first PCAs primarily dispersed and distinguished the weed species into two groups based on their presence and absence. The first group (G1) includes the most common weed species in grape farms, which are located in the third and fourth second quarters. These weed species are S17 (100%), S18 (66.7%), S1, S10 and S23 (50%), S3, S16, S25 and S27 (33.3%). These results indicate these species' threats to grape crops and agricultural crops and emphasize the need to identify ways to get rid of them in the study area before a problem occurs. While the second group (G2) occurred in the first and second quarters and comprised the other weed species evaluated, which were less common in the grape farms investigated.

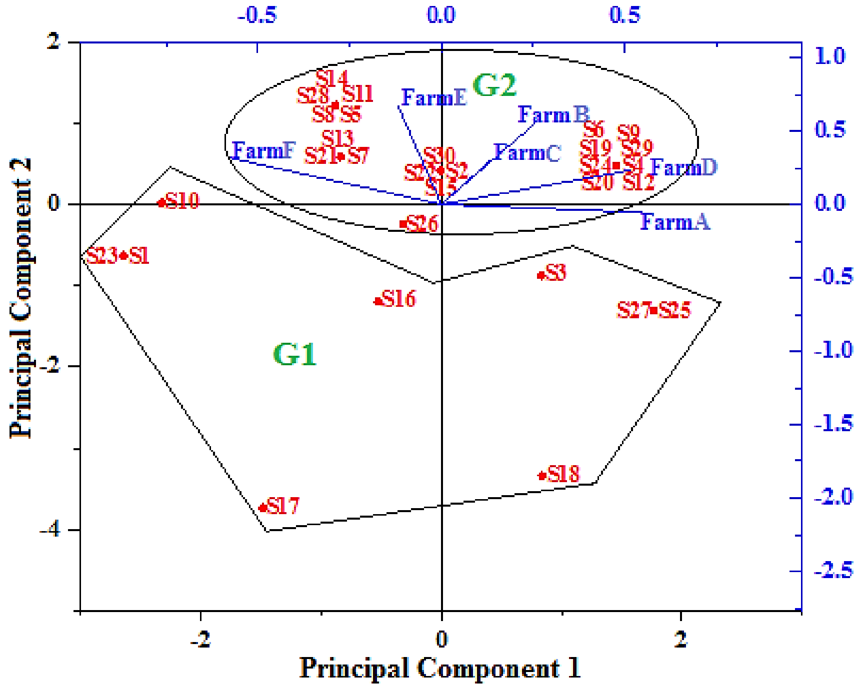

Figure 4. Biplot diagram based on the first two PCAs shows the distribution and prevalence of weed species in the grape farms. The weed species key names can be found in Table 5.

4. Discussion

Our study findings directly demonstrate that there were thirty weed species were recorded in six grape farms at Tayma Governorate, Tabuk Region, Saudi Arabia. These weed species belong to thirteen families, twenty-eight genera and thirteen chorological origins. Similar results were reported in the farms cultivating grapes, Arabian coffee, orange, and other citrus fruits, and vegetables by El-Sheikh (2013). Higher species richness and lesser species turnover define the communities of cultivated farms (Shaltout and El Halawany 1992). The more diverse weed ecosystems on cultivated farms are indicated by the higher species richness that distinguishes these farms (Pielou 1975). The floristic composition of weed species has been studied in orchards crops at Tayma by Al-Qahtani (2018 and 2019) and in many Regions of Saudi Arabia by Gomaa (2012 and 2017), Al-Harbi (2017), Alhaithloul (2019) and Al-Harbi (2021). A taxonomic study to identify, and enumerate the weed species of agricultural farms, and highlight the extent of their diversity is the first step in the management and control strategies of these weed species, therefore timely implementation of special control programs and management initiatives is necessary to prevent their spread (Ghazali and Al-Soqeer 2013).

The Poaceae family dominated the weed species in the six grape farms under study. The same finding was published by Al Yemeny (1999), El-Ghazali and Alsoqeer (2013), Gomaa (2017), Alhaithloul (2019) and Sher and Al-Yemeni (2020), who reported weed species of the Poaceae family were the most common and predominance in orchards crops at different Regions of Saudi Arabia. The metabolic benefits of C4 plants, which are well adapted to hot and dry clime conditions, explain why the Poaceae family is predominant, according to Stenchly et al. (2017). The chemical characteristics of each plant family may be to blame for the effects of the families, as the roots of plants release chemicals into the soil (Alsherif 2020), which have an impact on weed species either negatively or positively (Rice 1974).

High therophytes contributions lead to an adjustment of the flora to water balance (Al-Gifri et al. 2019). Our results indicated that the Therophytes life form and annual herb made a considerable contribution to the weed vegetation of the six grape farms studied. A similar trend has been reported in orchards farms by several researchers, for example, Shaltout and El-Halawany (1992), Al-Harbi (2017), Al-Hawshabi et al. (2017), Ibrahim et al., (2018) and Al-Harbi (2021). Therophytes are more prevalent in cultivated farms, which may be explained by their brief life cycles, which allow them to survive in unstable agroecosystem habitats (El-Sheikh 2013). They also devote a large portion of their resources to reproductive structures (Harper 1977), create flowers early in their life cycle to ensure some of their seed (Sans and Masalles, 1995), and produce seeds without the assistance of a traveling pollinator (Baker 1974). In another trend, the hot, dry temperature, topographic variation, and intervention from humans and animals are all thought to contribute to therophytes supremacy over other types of life forms (Al-Gifri 2006).

Saudi Arabia vegetation is a composite of six biogeographic origins, including the Palaearctic (Europe and Asia), Afrotropical (Africa south of the Sahara), Indo-Malayan terrestrial realm, and smaller versions of the Saharo-Sindian, Somali-Masur, and Afro-Montane (Alyemeni and Sher 2010). Compared to the other floristic regions, the tropical is represented by a large number of weed species under study, followed by Saharo-Arabian and Mediterannean-Euro Siberian-Irano-Turanian. In other studies, Saharo–Sindian phytochoria and Saharo–Sindian–Irano–Turanian floristic regions (Al-Harbi 2021) and Saharo-Arabian floristic region (Al-Gifri et al. 2019) were dominated than other biogeographic origins. Due to migration to the north, the percentages of Saharo-Arabian chorotypes decreased and were replaced by Mediterranean and Irano-Turanian region (Abd El-Ghani and Amer 2003).

There were significant variations in the number of weed species between the six grape farms under study. In the study by Al-Qahtani (2018 and 2019) and Sawicka et al. (2020), the number of weed species varies significantly ($P < 0.05$) among the farms studied. Species richness indicated that the differences among vegetation groups (Gomaa 2012) and studied districts (Al Harbi 2017) were significant ($P < 0.05$). Both soil compaction and high levels of disturbance had an impact on the grape crops (El-Sheikh 2013). Farm F was the highest affected and damaged farm overall by weed species compared with other grape farms, followed by Farms A and D, the opposite is true for Farm E. This could be a result of the fact that these farms exhibit the least amount of disturbance from the time the grape crop is growing until the annual harvest (El-Sheikh 2013). According to Shaltout and El-Halawany (1992), cultivated farms have higher values for species richness and total cover, and this higher species richness denotes that the weed communities on these farms are more diverse (Pielou 1975).

The abundance percentage of weed species was various in the six grape farms under study. The abundance of genera and species in this ecosystem shows that these farms are highly heterogeneous (El-Sheikh 2013). The abundance and diversity of weed species in agroecosystems are mostly a result of agricultural practices (Rauber et al. 2018) and water availability (Saeed and Alsubai 2001). While in agroecosystems, excessive herbicides use affects both the abundance and diversity of weed species (Sher and Al-Yemeni 2020). After adjusting for geographic location, the abundance had a substantial impact on weed species communities (Amin and Behary 2018), indicating that it has an impact independent of and in addition to the overall effect of geography (Houngbédji et al. 2016). The kind of *C. dactylon* was typically the most prevalent weed species in those grape farms at Tayma Governorate, followed by *D. bipinnata*, and *S. verticillata* species. These three species belong to the Poaceae family. El-Sheikh (2013) reported similar outcomes in the fields growing grapes, Arabian coffee, oranges and other citrus fruits, as well as vegetables. There are many studies supporting the dominance of *C. dactylon* type in orchards and crops farms in many regions of Saudi Arabia, such as Chaudhary et al. (1981), Gazer (2011), Gomaa (2012), El-Ghazali and Alsoqeer (2013), Al Harbi (2017) and Al-Qahtani (2018). According to Hâkansson (1982) and Holm et al. (1977), *C. dactylon* is one of the worst weeds in the world and invades the majority of subtropical and temperate agroecosystems. They added it grows on almost all soil types, can be a serious weed, quickly encroaches on cultivated land, and is challenging to eradicate. Andersson and Milberg (1998), Fried et al. (2008) and Alsherif (2020), the Poaceae family has shown strong effects as a factor impacting weed composition. The degree and condition of weed species in fields are determined by a variety of factors, and the abundance of weed species is one of them (Sawicka et al. 2020). Because *C. dactylon* belongs to Geophytes that may regenerate from underground perennating organs following the demise of their above-ground vegetative shoots brought on by weed management techniques, they are ideally adapted to agricultural systems (Gomaa et al. 2017). According to Drinkwater et al. (2000) and Doucet et al. (1999), the variation in the cover crop is what caused the observable variance in weed species, when the fields investigated were uniformly chosen in terms of management practices and soil properties.

According to PCA, the eigenvalues for the first three PCAs were higher than one. Our results are in line with the results by Scavo et al. (2022), for eigenvalues and the variance for weeds species, while the eigenvalues obtained here are in not line with Chipomho et al. (2021) who reported the eigenvalues were lower than one. The high eigenvalue and variance percentage for PCA1 and PCA2 indicate that it explains the large variability in weed species composition of the vegetation groups in the grape farms evaluated. The first two PCAs accounted for 79.8%, 73.3%, 60.0%, 39.9% of the total variability in weed species composition (Loureiro et al. 2019; Chipomho et al. 2021; Scavo et al. 2022; Yousaf et al. 2022, respectively). Angles between variable vectors less than 90º (sharp angles) and more than 90º (obtuse angles) denote a positive and negative association among the studied variables, respectively (El-Hashash et al. 2022). The majority of grape farms showed positive connections depending on the presence and absence of weed species, but the strength and consistency of these relationships varied. The PCA biplot shows that the crop farms discriminated mainly along the first component for the weed species evaluated (Scavo et al. 2022). The results of the multivariate analysis demonstrated that the composition of weed species in the study area was influenced by the different agronomic practices (e.g. mowing, irrigation, plowing and other tillage practices) used in grape farms and other crops (El-Sheikh 2013). The new findings were consistent with Yousaf et al. (2022), which also revealed that most weed species exhibited a favorable association with one another, where weed species contributed strongly to the PCA1 and PCA2. Based on the presence and absence of weed species, the weeds species were divided into two groups by PCA. The association among weed species abundance was investigated by the PCA model (Loureiro et al. 2019). According to the PCA biplot, the size of the changes in the weed species community is different between these weeds, therefore suggesting a little harmony between weed communities (Scavo et al. 2022). According to edaphic parameters, the PCA analysis reveals the precise composition and distribution patterns of the evaluated weed species (Yousaf et al. 2022). In our study, the PCA was effective in classifying both low and widespread weed species, and the findings from Table 5 and the PCA analysis were strikingly similar.

Generally, the findings of our study and the results of Amin and Behary (2018) support the need to remove weeds early and frequently, even after a long time, in order to decrease weed infestations and enhance crop growth. According to Callaway (1992), crops with traits including quick germination, rapid root development, early aboveground growth and vigor, the quick establishment of leaf area and canopy, development and leaf area, and larger height have been demonstrated to be the most effective at competing with weed species.

5. Conclusions

Thirty weed species were recorded in six grape farms at Tayma Governorate, Tabuk Region, Saudi Arabia. Dominant weed species in these farms were *C. dactylon, D. bipinnata*, and *S. verticillata*, which belong to the Poaceae family. The PCA enables the clustering of weed species based on their presence and absence in the six grape farms at the studied area. Generally, studies on the ecological aspects and floristic composition of weed species in grape and orchard farms are also needed, as well as the search for ways to eliminate them through a national project in Tayma Governorate.

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