Advanced Studies in Biology, Vol. 15, 2023, no. 1, 15 – 27
HIKARI Ltd, www.m-hikari.com
https://doi.org/10.12988/asb.2023.91608

Impact of the Electric Field on the Distribution of Vegetation of South of Jeddah Province (Saudi Arabia)

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Abstract

In this study, Al- Shuaiba Power and desalination plant was selected as study area. It is located in the coast of Red Sea, about 120 kilometres (75 mi) south of Jeddah province. For comparison another area away from the factories was chosen as the control. One location were selected in each of them . each covering (10m× 10m) inside each area 10 small quadrates (1m × 1m) were also taken. plant species. Plant density, frequency, coverage and important value were calculated. The results showed there were 6 plant species were found. These are *Zygophyllum simplex, Prosopis vaegitata* , *Calotropis gigantea* , *Asarum hartwegii, Distichlis spicata,* and *Sphaeralcea ambigua*. The highest absolute frequency were recorded in *Distichlis spicata*, at affected and unaffected areas. *Prosopis vaegitata* showed the high absolute and relative coverage an importantance value at the affected area. *Zygophyllum simplex* disappeared from affected area while *Asarum hartwegii* diapered from unaffected atrea. Thus, the electric field at Al-Shauiba power plant and the desalination water may not have a substantial effect on the vegetation there.

Keywords: Electric field, Vegetation, Zygophyllum simplex, *Prosopis vaegitata* , *Calotropis gigantea* , *Asarum hartwegii, Distichlis spicata, Sphaeralcea ambigua,*

1. Introduction

Al-Shuaiba power and Desalination plantis located approximately 120km south of Jeddah on Saudi Arabia's Red Sea coast.. The power station has a number of turbines, heat recovery steam generators (HRSGs) and ancillary power generation equipment. In 2013, Saudi Electricity Company produced 198,900 GWH of energy (Annual report of Saudi Electricity Company, 2013). The capacity of the power grid is planned to be increased by 120 gigawatts by 2020. Electricity generated by power plants is usually sent over long distances through overhead power transmission lines. An interconnected grid of high-voltage power lines runs along tall towers and brings power from power plants to local substations.. This high transmission voltage is 380 kV may have possible effect of on the growth of plants nearby. Insufficient experiments where the effect of electric current upon the physiologic functions of plants has been investigated, the results obtained have failed to provide a satisfactory explanation for yield differences.Therefore, field studies of high voltage on natural vegetation are highly required to provide a satisfactory explanation for yield differences. Research has mainly focused on the growth of plants and the germination of their seeds in recent years. Several studies have shown that these fields promote growth and early germination of seeds (Florez et al., 2004; Dardeniz et al., 2006; Liang et al., 2009). On the other hand, the harmfull effect of electric on some vegetations have been reported (Apasheva et al., 2006; Ahmad et al., 2007). Agriculturally important plants are the focus of most studies, leaving a gap of knowledge in wild plants. Further research is needed to clarify the basics of electric fields' biological effects, including their economic and ecological impacts..

2. Materials and Methods

A study area was selected for this study at Al-Shuaiba power and desalination plant. This site is located about 120 kilometers (75 miles) south of Jeddah province to observe the effects of the electric field on the vegetation. To serve as a comparison, another area away from the factories was selected. In each of them, one location was chosen. Within each 10 m x 10 m area, 10 small quadrates (1 m x 1 m) were also taken. plant species. Plant density, frequency, coverage and important value were calculated.

Affected Area

Unaffected Area

Following are the equations for density, frequency, coverage, and Important Value.:

Absolute density (AD)=

$$\frac{\text{Total of each type of species for all quadrates}}{\text{The total number of quadrates} \times \text{area of the quadrate}} \times 100$$

Relative density (RD) =

$$\frac{\text{Absolute density of the species}}{\text{Total of the absolute density of all species.}} \times 100$$

Absolute frequency (AF)=

$$\frac{\text{Number of quadrates that were found by species}}{\text{The total number of quadrates}} \times 100$$

Relative frequency (RF) =

$$\frac{\text{Absolute frequency of the species}}{\text{Total of the absolute frequency of all species}} \times 100$$

Absolute coverage (AC)=

$$\frac{\text{Total length of such intersections of species}}{\text{Number of sections} \times \text{Length of the section}} \times 100$$

Relative coverage (RC)=

$$\frac{\text{absolute coverage of species}}{\text{Total absolute coverage of all species.}} \times 100$$

Important value (IV)= Relative density+ Relative frequency+ Relative coverage

3. Results

3.1. Presence and Absence of Plants

Table (1) and Table (2), indicate that six plants were found in both areas. These include *Asarum hartwegii, Distichlis spicata (L.) Greene, Prosopis laevigata, Sphaeralcea ambigua*, *Calotropis gigantea, and Zygophyllum simplex*.

Table 1. The plants found in the study areas with families and description

	Species	**Family**	**Description**
	*Asarum hartwegii*	Aristolochiaceae.	is an evergreen rhizomatous perennial boasting heart-shaped, glossy green leaves, 2-4 in. wide (5-10 cm),
	Distichlis spicata (L.) Greene	Poaceae (Grass Family)	Saltgrass, Coastal Salt Grass, Inland Salt-grass
	Prosopis Laevigata	Fabaceae,	commonly known as smooth mesquite, is a species of flowering tree hat is native to Mexico, Bolivia, Peru, and north-western Argentina .
	Sphaeralcea ambigua	Malvaceae	commonly known as desert apricot. It is a perennial shrub grows well in alkaline soil, both sandy or clay.
	Calotropis gigantea	Apocynaceae	the crown flower, It is a large shrub growing to 4 m (13 ft) tall. It has clusters of waxy flowers Apocynaceae
	Zygophyllum simplex	Zygophyllaceae	annual; leaves simple, fleshy, cylindrical. A succulent annual, fragile when dry. Root perpendicular.Stems are thick

Table 2. Presence (+) and Absence (-) of the studied Plants at the two Areas

Species	Affected Area	Unaffected Area
Asarum hartwegii	+	–
Distichlis spicata	+	+
Prosopis Laevigata	+	+
Sphaeralcea ambigua	+	-
Calotropis gigantea	+	+
Zygophyllum simplex	-	+

From Table (2), it was observed that *Zygophyllum simplex* was absent in the affected area, while *Asarum hartwegii* and *Sphaeralcea ambigua* were absent in the unaffected area.

3.2. Absolute and Relative Frequency

Table (3) indicated that, *Distichlis spicata* plant recorded the highest absolute frequency in the affected area (80%), at the unaffected area *Distichlis spicata* also showed the highest absolute density together wih *Calotropis gigantea* plant (60 %) each. On the other hand, the lowest value of absplute frequency was recorded in *Prosopis Laevigata* at the affected area (10%). Similar results of the absolute frequency were reported in *Sphaeralcea ambigua* and *Calotropis gigantea* (20%). Regarding relative frequency, (Fig. 1), wide variations among plants were observed. *Prosopis Laevigata* showed the highest percent of relative frequency at the affected area (56%) followed by *Prosopis Laevigata* (44.4%). *Sphaeralcea ambigua* and *Calotropis gigantea*, again showed similar result at the affected area (11.1%). At the unaffected area however, the highest values of relatve frequency were reported in *Distichlis spicata* and *Calotropis gigantea* (31.5%) each. The lowest value at this are was in *Calotropis gigantea* (10.5%).

3.3. Absolute and Relative Density (plant/m^2) of each plant in study areas (Affected area) and (Unaffected area)

Distichlis spicata showed the highest absolute density at the affected area among other plants (2.1 plant/m^2), while *Prosopis Laevigata* showed the lowest absolute density value (0.1 plant/m^2) (Table 4). At the unaffected area, wide variations on the values of absolute density were observed. Nonetheless, *Distichlis spicata* presented the highest value (22 plant/m2), while *Prosopis Laevigata* showed the lowest value (0.2 plant/m2)..on the other hand, the highest value of relative density (Fig.2), was observed in *Distichlis spicata* at the affected (60 plant/m^2) and at the unaffected area (50 plant/m^2). The lowest value was noticed in *Prosopis Laevigata* at affected area (2.6 plant/m^2) and unaffected area (4.5 plant/m^2).

3.4. Absolute and Relative Coverage of each plant in study areas (Affected area) and (Unaffected area)

Table (5) demonstrated that, *Prosopis Laevigata* showed the highest value of absolute coverage at the affected area (34.3) while, *Asarum hartwegii* showed the lowest value (0.70) at the same area. At the unaffected area, *Calotropis gigantea* showed the highest value of absolute coverage (73.3), while, *Distichlis spicata* had the lowest value (0.77).

Concerning relative covrage, (Fig.3), at the affected area, the highest value was found in *Prosopis Laevigata* (58.8), while, the lowest value was recorded in *Asarum hartwegii* (1.30). at unaffected area, the highest amount was observed in *Calotropis gigantea* (66.7) and the lowest value was (0.7) in *Distichlis spicata*.

3.5. The Important Value of plant in study Areas (Affected area) and (Unaffected area)

The result in Table (6 & Fig. 4), revealed that, *Prosopis Laevigata* had the highest important value among all plants at the affected area (140.8). It is noticeable that *Distichlis spicata* and *Zygophyllum simplex* had high important values at the affected area (108.5 and 101.9) respectively. The lowest value in the affected area was observed in *Sphaeralcea ambigua* (22). At the unaffected area, the highest values was noticed in *Calotropis gigantea* (127.7), while the lowest value (37.4) was recorded in *Prosopis Laevigata.*

Table 3. Absolute and Relative Frequency (%) of each plant in study areas (Affected area) and (Unaffected area)

Species	Absolute Frequency		Relative Frequency	
	Affected	**Unaffected**	**Affected**	**Unaffected**
Asarum hartwegii	50	-	27.8	-
Distichlis spicata	80	60	44.4	31.5
Prosopis Laevigata	10	20	5.6	10.5
Sphaeralcea ambigua	20	-	11.1	-
Calotropis gigantea,	20	60	11.1	31.5
Zygophyllum simplex	-	50	-	26.3

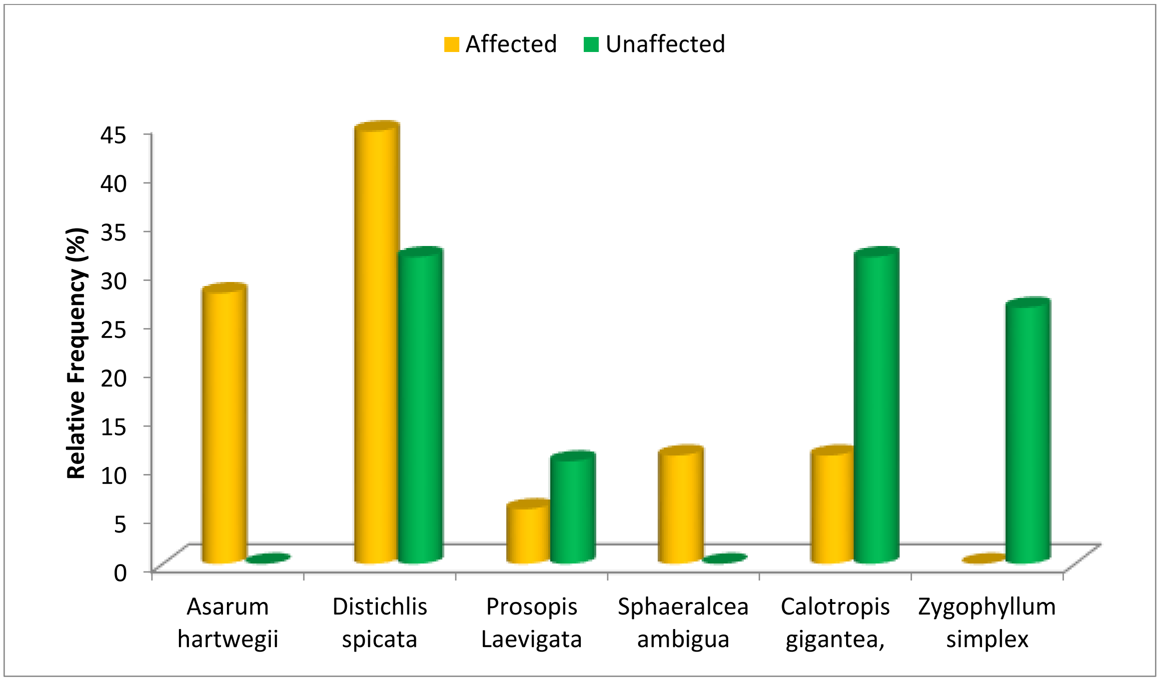

Fig. 1. Relative Frequency (%) of plants at the Two Areas

Table 4. Absolute and Relative Density (plant/m^2) of each plant in study areas (Affected area) and (Unaffected area)

Species	Absolute Density		Relative Density	
	Affected	**Unaffected**	**Affected**	**Unaffected**
Asarum hartwegii	0.8	-	22.9	-
Distichlis spicata	2.1	2.2	60	50
Prosopis Laevigata	0.1	0.2	2.6	4.5
Sphaeralcea ambigua	0.3	-	8.6	-
Calotropis gigantea,	0.2	1.3	5.7	29.5
Zygophyllum simplex	-	0.7	-	15.9

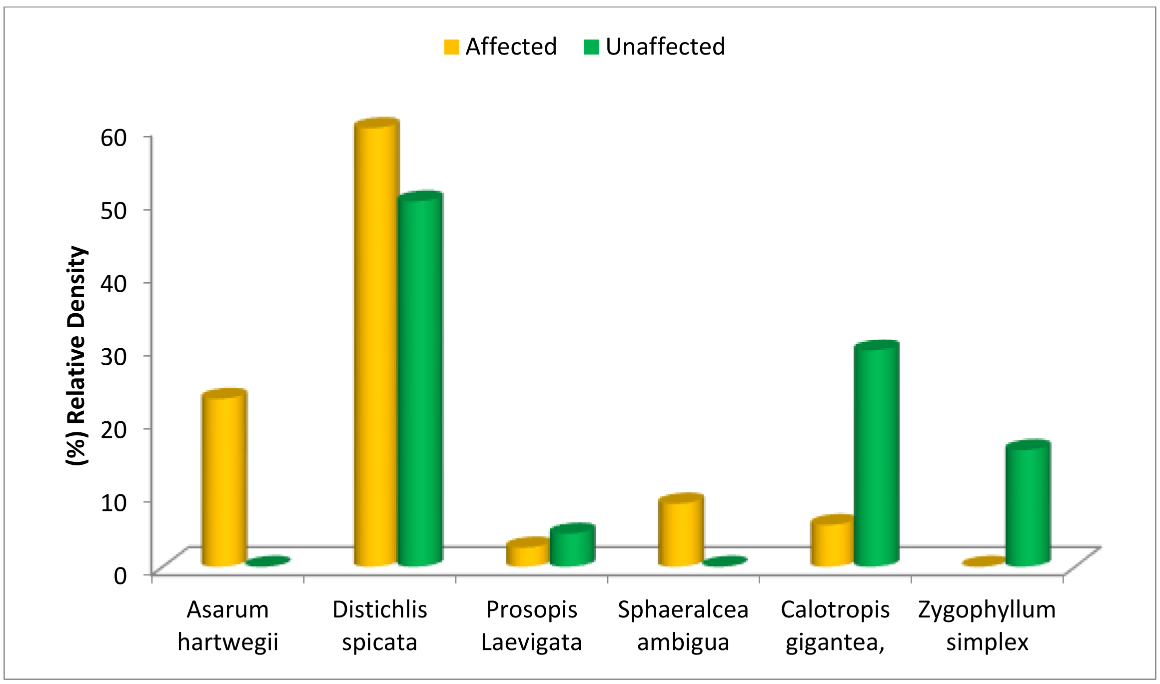

Fig. 2. Relative Density (%) of Plants at the Two Areas

Table 5. Absolute and Relative Coverage (%) of each plant in study areas (Affected area) and (Unaffected area)

Species	Absolute Coverage		Relative Coverage	
	Affected	Unaffected	Affected	Unaffected
Asarum hartwegii	0.70	-	1.30	-
Distichlis spicata	2.40	0.77	4.10	0.70
Prosopis Laevigata	34.3	24.6	58.8	22.4
Sphaeralcea ambigua	1.20	-	2.10	-
Calotropis gigantea,	19.7	73.3	33.8	66.7
Zygophyllum simplex	-	11.3	-	10.3

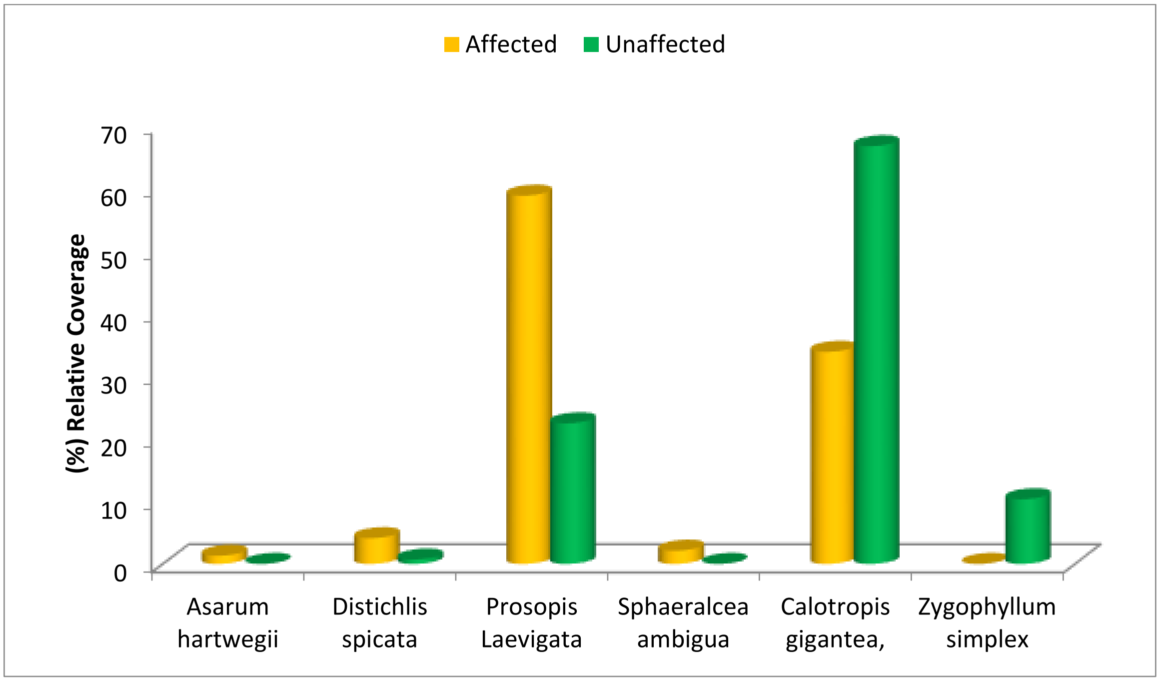

Fig. 3. Relative Coverage of Plants at the Two Areas

Species	Important Value	
	Affected	Unaffected
Asarum hartwegii	52	-
Distichlis spicata	108.5	82.2
Prosopis Laevigata	140.8	37.4
Sphaeralcea ambigua	22	-
Calotropis gigantea,	101.9	127.7
Zygophyllum simplex	-	52.5

Table 6. The Important Value of each plant in study Areas (Affected area) and (Unaffected area)

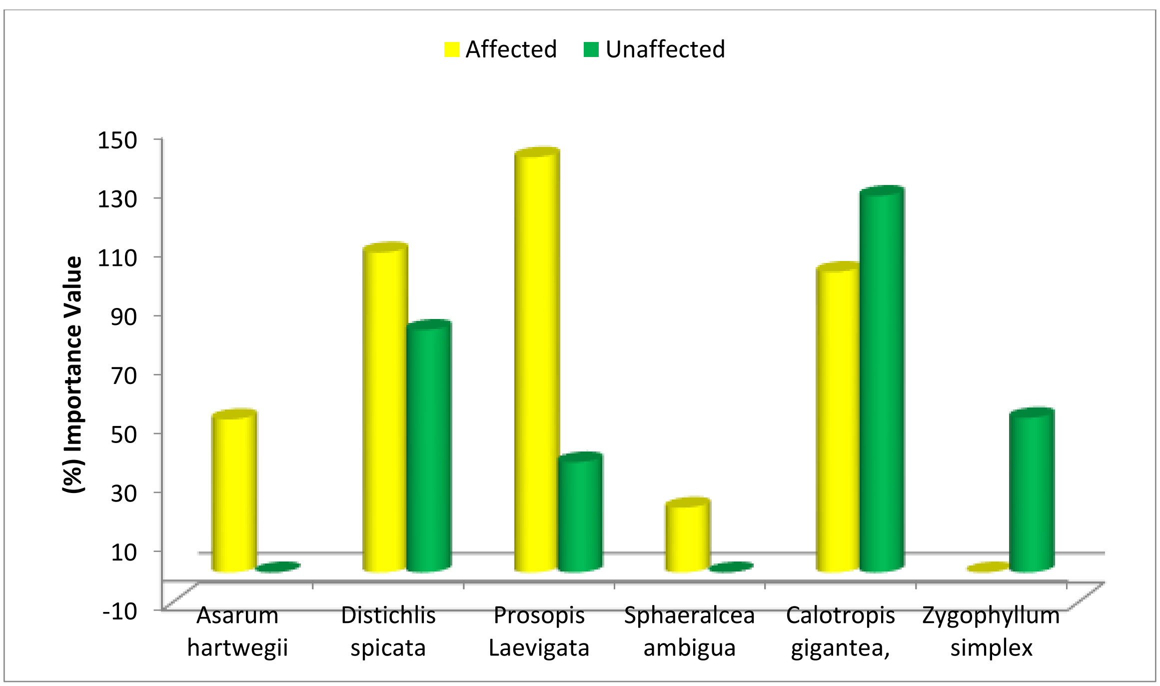

Fig. 4. Importance Value (%) of the plant at The Two Areas

4. Discussion

In general, the vegetation in the study area is somewhat dispersed and only a few species that can familiarize to the severe environment of the coastal plain. ((Al-Nafee, 2004). In addition, the soils of these areas are poor in organic matter because of scarcity of plants and animals as was reported by (Zoukah, 2000).
The relationship between electric field and plant responses is becoming increasingly important as new evidence emerges. Plants are able to respond quickly to varying electric fields by altering their gene expression and phenotype (Trebacz, et al., 2006)..
Distichlis spicata (Saltgrass, Coastal Salt Grass) and *Asarum hartwegii* (is an evergreen rhizomatous perennial) had high absolute frequency at ithe affected area. This may be due to their adaptive power. Both plants are halophytess, which enabled them to withstand abiotic stresses like the electric field.. Plants are able to adapt to salinity stress at molecular, cellular, metabolic, and physiological levels (Bhaskar and Bingru, 2014).
Prosopis Laevigata showed high absolute and relative cover at the affected area. This mainly due to large crown of this plant. This plant also achieved a high important value. In a stand, the plant is well represented with a large number of individuals compared with other species in the position..This is in consistant with the study of ((Al-Nafee, 2004). who reported that Coastal plain vegetation is scattered and limited to plant species with large roots that can adapt to the harsh desert environment, except for some annual vegetation that grows after rainfall.
In the affected area, some plants have completely disappeared, including *Zygophullum simplex* (an annual succulent), which may indicate the effects of an electric field. Nonetheless, others were absent at the unaffected area like *Asarum hartwegii*. Although the two plants are halophytes. This is surprising, some authors found high adaptation of *Zygophullum simplex* to abiotic stresses (Varsha and Kishan, 2014).

5. Conclusion

It appears that the effects of electric fields on plants may be species-specific and/or influenced by the characteristics of the plant and its ability to overcome electric stress based on the inconsistent and contradictory results of the studies.. Hence, the electric field at Al-shauiba power plant and desalination water may have no pronounce effect on the vegetation there. However, more research needs to be conducted on the effects of electric fields, including physiological and biochemical studies.

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Received: January 15, 2023; Published: February 4, 2023