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IMPACT OF DIFFERENT DESIGNS OF SHELTERBELT ON THE CONTROL OF SHIFTING SAND AT TOSHKA, SOUTH EGYPT.

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ABSTRACT

In Toshka, south of Egypt, the extremely arid conditions reflect vast areas covered by the aeolian deposits. To control the shifting sand along El-Sheikh- Zayed canal, which convey water to the newly reclaimed land, an experimental pilot area was established . In such area, four plant species were cultivated as a shelterbelt and arranged in plots including different plant distributions of variable spacing. The results achieved show that the shelterbelt plays an important role in the control of shifting sand. The shelterbelt enhances the deposition of the aeolian sand at a reasonable distance from the irrigation canal. The reduction percentage of shifting sand down wind the different plots of shelterbelt varied from 70.9 to 90.8 %. The plot of four rows of *Acacia saligna* and one row of *Tamarix articulata* as well as the plot of four rows of *Prosopis juliflora* and one row of *Tamarix articulata* show the highest efficiency for sand encroachment control . The above mentioned two designs are recommended for large scale application.

Keywords: Control of shifting sand, efficiency of shelterbelts, *Prosopis, Tamarix, Acacia, Casuarina*, porosity, growth characteristics , Toshka, Egypt .

INTODUCTION

At present, the development and rehabilitation of the South portion of Egypt recieving a great attention to absorb the over population in the Nile Vally and Delta . In such portion, the extremly arid conditions reflect vast areas covered by the aeolian deposits (Embabi,1998 and Embabi ,2000).

The land reclamation at Toshka (216000 hectars), 300 km South of Aswan, is considering enormous terrain affected by the migration of the shifting sand, which considered one of the major constraints for the development of such area . In this concern, El-Sheikh Zayed canal, which convey 5 million cubic meters of water /day from lake Nasser to the reclaimed land is affected, in some locations, by shifting sand (Figure.1). Aiming of controlling the migration of the mobile sand dunes to insure the function of the canal and to reduce its maintenance costs, a pilot experiment was adopted by the Desert Research Center, in collaboration with the Faculty of Engineering, Cairo University and the Ministry of Water Resources and Irrigation. The experimental plot includes double shelterbelts of 1km length and 12m width for each belt. The shelterbelt contains four plant species of different arrangements and spacing. Mann (1985) reported that the reduction in wind speed through the plantation of shelterbelts is effective in the wind erosion and sand movement control. Also, the same author mentioned that the efficiency of the shelterbelt in the control of shifting sand is governed by the height, width and porosity of the shelter. Meanwhile, the shelterbelt could be effective for the alleviation of the adverse climatic conditions in the arid land (Taichi *et al.*,1994). Bolds and Maranon (2001) showed that herbaceous double row shelterbelts with larger overall density exhibit a dramatically better average wind and turbulence intensity reduction than the single row shelterbelt. Hegazi *et al.* (2001) reported that *Casuarina equestifolia* and *Eucalyptus camaldulensis* windbreaks has an effective role in the protection of Thompson seedless grapevine from wind damages compared with unprotected ones. Jensen and Hajej (2001) indicated that reforestation with species like *Prosopis juliflora* provides permanent protection of the road and was viable in both financial and socioeconomic terms. (Zhang *et al.*,2004) found that the planting of *Artemisia halodendron* was considered to be the most proper way for stabilizing moving sand dunes.

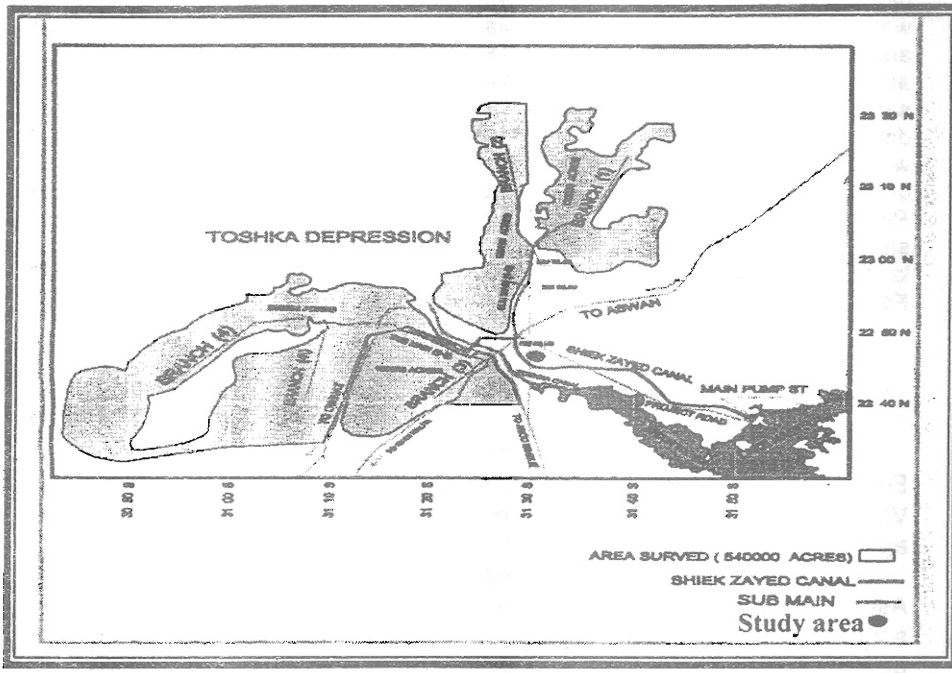

Fig (1): Location map of study area at Toshka.

In the experimental pilot area at Toshka, the shelterbelt was designed to determine the efficiency of the cultivated plants for the control of shifting sand, the proper agricultural practices and agromanagment.The results will be useful for large scale application. Therefore, the present investigation deals with monitoring and evaluation of four plant species cultivated in various arrangements within the shelterbelt for the control of shifting sand .

MATERIALS AND METHODS

The present study was carried out during the period from 2002 to 2004.The experimental pilot area was located at the El- Sheikh Zayed canal, faraway 50 km from lake Nasser .The layout of the experimental plot includes, as shown in Figure (2), 1km of green shelterbelt includes double strips established perpendicular to the dominant effective winds. The plant species were cultivated on February15 th in 2002 year.

The distance between the shelterbelt and the canal is varied between 50 -200 m and the distance between the two strips was about 200m . Each strip included four plant species, namely *Acacia saligna, Prosopis juliflora, Tamarix articulata* and *Casuarina equestifolia.*

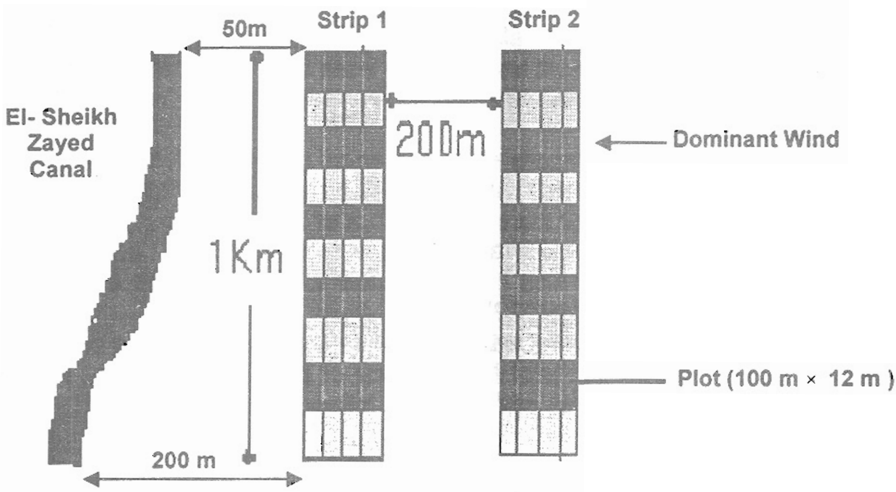

Fig. (2):Layout of the experimental pilot area at Toshka.

In each strip, one year old seedlings of each plant species were planted and arranged in ten plots. Each plot was 100m length and 12m width. The plots were cultivated follows the following scheme :

Plot no.1 : Five rows of *Tamarix articulata.*
Plot no.2 : Five rows of *Casuarina equestifolia.*
Plot no.3 : Two rows of *Tamarix articulata.*
Plot no.4 : Three rows of *Casuarina equestifolia.*
Plot no.5 : One central row of *Tamarix articulata* and four rows of *Prosopis juliflora* (two rows at each side of the central row).
Plot no.6 : One central row of *Tamarix articulata* and four rows of *Acacia saligna* (two rows at each side of the central row) .
Plot no.7 : Three central rows of *Casuarina equestifolia* and two rows of *Tamarix articulata* (one at each side of the central rows)
Plot no.8: Five rows of *Prosopis juliflora.*
Plot no.9 : One central row of *Prosopis juliflora* and four rows of *Acacia saligna* (two at each side of the central row) .
Plot no.10 : five rows of *Acacia saligna* .

With the exception of the plots no. 3 and 4, the cultivated plant species were planted in spaces of 3 m between plants and 3 m between rows. For the plots no. 3 and 4, the spaces between plants are 3 m and the spaces between rows were 12m for the former and 6m for the later plot , respectively .The cultivated plants were irrigated by the brackish ground water (1980 ppm) using drip irrigation system .The climatological records of Abo Sembel Meteorological Station, the nearest to the study area, during the growth period is shown in (Table 1).Toshka is located within the extremely arid zone of North Africa. Accordingly,im the study area, the average monthly temperature vary between 16.6° in January and 17.7° in December. The rain fall is almost nil and the relative humidity vary from 21 and 44%.The effective wind (>5m/sec) represent values vary from 36.8% in December to 52.9% in March of the total wind speeds. The prevailing wind directions is generally North/South.

In order to compare the efficiency of each plot of the shelterbelt concerning the control of shifting sand, five individuals of each species in the plot were chosen for the determination of the following :

1- **Growth parameters**: Plant height, a crown cover (CC) and crown volume (CV).Crown cover and crown volume were calculated according to the formula of Thalen (1979).

2- **Porosity of the shelterbelt** for each plot was calculated on the basis of the percentage of total crown cover of the cultivated plant as related to the total surface area of the plot as follows:

Porosity (%) =

$$100 - \left[\frac{\text{TotalC.C of plants/plot x Total number of plants /plot x 100}}{\text{Total area of the plot (m}^2\text{)}} \right]$$

Table (1): Means of the climatic normal of Abo Sembel Station during the period from 2000-2004.

Months	Air temperature(c°)			Relative humidity (%)	Rain fall (mm)	Evaporation (mm/month)	Effective wind (%) (5m/sec)	Wind direction
	Max	Min	Aver					
January	22.0	11.1	16.6	43	-	12.0	39.2	N
February	23.4	12.4	17.9	36	-	13.1	47.6	N
March	28.2	16.3	22.3	30	-	16.1	52.9	N.w
April	34.2	21.6	27.9	25	-	19.3	50.5	N
May	37.6	26.2	31.9	21	-	23.9	48.1	N
June	37.9	27.0	32.4	21	-	25.1	45.5	N
July	39.9	28.1	34.0	22	-	24.3	42.8	N
August	39.9	28.6	34.3	23	-	22.7	51.5	N
September	37.9	26.7	32.3	26	-	23.7	50.2	N
October	34.4	23.9	29.2	30	-	19.8	48.5	N
November	28.6	17.5	23.1	38	-	13.4	40.6	N
December	23.5	11.9	17.7	44	-	10.7	36.8	N

3- **The quantities of the blown sand** derived from the prevailing direction was determined using of the sand collectors that previously designed by Bagnold (1941).

For the determination of the efficiency of each plot of the two strips of shelterbelt, twenty two units of Bagnold sand collectors were fixed and oriented to the prevailing wind direction (North).The distribution of the sand collectors was as follows:

- Two units were fixed at the wind- ward side at a distance of 30 m from the shelterbelt .
- Twenty units were fixed at the down wind of each plot of both strips of the shelterbelt. The distance between sand collectors and the cultivated plants were 20 m .

The efficiency of plants of each plot as regard the control of shifting sand was determined on the basis of the reduction percentage of the accumulated sand in each sand collector unit located at leeward side compared to the accumulated sand in the collectors located at the wind-ward side of the shelterbelt .

Statistical analysis

Correlation coefficient and Confidence limits was estimated according to (Harvey, 1987).

RESULTS AND DISCUSSION

1- Growth characteristics of the cultivated plants.

The results of the growth parameters are shown in (Table 2):

1-1- *Tamarix articulata*.

In both strips of the shelterbelt, *Tamarix* stands showed variable differences as regard the growth parameters at the initial stage of cultivation (Summer 2002). Plant height, crown cover and crown volume varied between 79 and 153cm, 0.34 and 2.10cm^2 and 0.26 and 2.14m^3, respectively.The above mentioned growth parameters showed increasing trend during the study period (from Summer 2002 to Winter 2004).The ultimate records of various growth parameters values increased from 168.3 to 290.0 cm, from 1.15 to 4.67m^2 and from 1.60 to 9.02 m^3 for plant height, crown cower and crown volume, respectively .

On the basis of crown volume records, the growth of *Tamarix* plants at the end of study period was about 2.5 folds when compared with their growth at the initial stage .

1-2- *Casuarina equestifolia*.

In Summer 2002, the initial records of plant height, crown cover and crown volume varied between 81 and 123cm , 0.23 and 0.81 m^2 and 0.12 and 0.59 m^3,respectively. Such growth parameters increased during the study period .

In Winter 2004 ,the records of the above mentioned growth parameters increased from 230.0 to 326.6 cm for plant height ,from 1.63 to 3.84m^2 for crown cover and from 3.35to 8.35 m^3 for crown volume. On the basis of records of the crown volume, the growth of stands at the end of study period is 16 folds as compared to the growth at the initial stage .

Table (2):Growth parameters of the plant species cultivated in different plots.(February,2002)

Growth parameters / Plant species		Six months after cultivation			Twelve months after cultivation			Eighteen months after cultivation			Twenty four months after cultivation		
		Plant height (cm)	Crown cover (m^2)	Crown volume (m^3)	Plant height (cm)	Crown cover (m^2)	Crown volume (m^3)	Plant height (cm)	Crown cover (m^2)	Crown volume (m^3)	Plant height (cm)	Crown cover (m^2)	Crown volume (m^3)
Strip 1													
Plot 1-1	5 rows *Tamarix*	119	0.34	0.26	129	0.68	0.58	153	1.16	1.18	168.3	1.73	1.94
Plot 1-2	5 rows *Casuarina*	122	0.33	0.27	192	1.04	1.33	251	2.15	3.59	309.0	1.63	3.35
Plot 1-3	2 rows *Tamarix*	123	1.10	0.90	159	1.14	1.20	218	2.47	3.60	216.7	2.45	3.54
Plot 1-4	3 rows *Casuarina*	81	0.23	0.12	209	0.70	0.94	246	1.88	3.10	293.4	2.98	5.85
Plot 1-5	4 rows *Prosopis* (bs)	150	2.58	2.50	207	3.39	4.87	218	7.62	6.14	290.0	4.69	9.06
	1 row *Tamarix* (cent.)	107	0.83	0.59	150	0.88	0.87	167	1.89	2.10	206.7	1.16	1.60
Plot 1-6	4 rows *Acacia* (bs)	218	3.18	4.61	262	3.60	6.28	265	5.79	10.23	273.3	6.64	12.1
	1 row *Tamarix* (cent.)	132	1.10	1.36	170	1.38	1.56	193	1.77	2.27	215.0	1.15	1.34
Plot 1-7	2 rows *Tamarix* (bs)	144	1.24	0.90	169	1.35	1.52	190	2.02	3.90	206.7	2.98	4.10
	3rows *Casuarina* (cent.)	110	0.81	0.59	197	1.23	1.61	213	1.53	2.50	230.0	2.45	3.75
Plot 1-8	5 rows *Prosopis*	130	1.21	1.63	150	1.83	1.82	215	4.60	6.60	203.3	3.26	4.41
Plot 1-9	4rows *Acacia* (bs)	147	3.03	2.96	232	3.14	4.85	245	3.86	6.39	286.7	6.15	11.74
	1 row *Prosopis* (cent)	118	1.85	1.14	167	2.08	3.42	273	4.77	8.68	286.6	3.63	6.93
Plot1-10	5 rows *Acacia*	157	3.27	3.42	204	3.60	3.53	252	4.16	6.98	268.3	3.71	5.64
Strip 2													
Plot 2-1	5 rows *Tamarix*	115	1.10	0.85	124	1.69	1.39	140	1.70	1.58	201.7	1.84	2.47
Plot 2-2	5 rows *Casuarina*	86	0.40	0.22	195	1.24	1.61	285	2.34	4.45	326.6	3.84	8.35
Plot 2-3	2 rows *Tamarix*	132	1.89	1.66	162	1.97	2.12	211	3.14	4.41	246.6	3.83	6.29
Plot 2-4	3 rows *Casuarina*	86	0.33	0.18	225	1.03	1.54	275	1.71	3.14	311.7	2.95	6.12
Plot 2-5	4 rows *Prosopis* (bs)	213	3.03	4.29	257	3.12	5.34	323	6.94	14.92	376.7	6.61	16.59
	1 row *Tamarix* (cent.)	153	2.10	2.14	170	2.22	2.51	228	2.70	4.10	290.0	4.67	9.02
Plot 2-6	4 rows *Acacia* (bs)	215	2.73	3.91	272	3.12	5.65	273	5.78	10.51	283.3	5.59	10.55
	1 row *Tamarix* (cent.)	136	1.44	1.30	143	1.47	1.40	190	1.64	2.09	170.0	2.03	2.30
Plot 2-7	2 rows *Tamarix* (bs)	79	1.14	0.60	263	1.20	2.10	295	3.16	6.21	166.7	2.88	3.20
	3rows *Casuarina* (cent.)	123	0.65	0.53	173	1.30	2.27	207	2.38	3.29	283.3	2.73	5.15
Plot 2-8	5 rows *Prosopis*	139	2.53	2.34	142	3.11	2.94	277	4.67	8.02	291.7	4.89	9.56
Plot 2-9	4rows *Acacia* (bs)	135	3.30	2.95	212	3.99	5.65	275	4.63	8.48	291.7	4.73	9.19
	1 row *Prosopis* (cent)	154	3.00	3.05	177	3.14	3.40	300	3.22	6.43	264.7	3.10	5.09
Plot2-10	5 rows *Acacia*	218	3.03	4.40	229	3.97	6.10	264	4.51	8.13	288.4	4.16	7.99

cent=central row bs=both sides of the central rows

1-3 -*Prosopis juliflora.*

The development of different growth parameters of *prosopis* plants shown in Table (2) elucidates that from Summer 2002 to Winter 2004, the plant height increased from 118 and 213 cm to 203.3 and 376.7cm . Meanwhile, the crown cover and crown volume developed from 1.21 and 3.03 m^2 to 3.10 and 6.61m^2 and from 1.14 and 4.29 m^3 to 4.41 and 16.59 m^3, respectively .

On the basis of the records of the crown volume, the growth of *prosopis juliflora* at the end of the study period is about 3.8 folds as compared to the growth at the initial stage.

1-4- *Acacia saligna*

Plant height show an increasing trend from 135 to 218 cm at the initial stage of growth during Summer 2002 to 268.3 and 291.7 cm at the end of the study period (Winter 2004) .Concerning the crown cover in Summer 2002, the recorded values varied from 2.73 to 3.18 m^2 while it reached 3.71and 6.64 m^2 in winter 2004.Crown volume at the initial stage of growth varied from 2.96 and 4.61 m^3 and reached to 5.64 and 12.1m^3 at the end of the of the study period (Winter 2004) .

On the basis of crown volume records ,the growth of the *Acacia* stands at the end of study period was about 2.5 folds as compared to the initial stage.

The results obtained, so far, elucidates that the study has been mentioned that plant species gave superiors growth behavior in hyper arid conditions of the study area. For this reason, such plant species are commonly used for the establishment of shelterbelts and windbreaks in arid and semi arid regions (Kaul,1985 and Draz and El-Maghraby, 1997) .

2- Porosity of the cultivated shelterbelts.

The porosity of cultivated plots is controlled by the growth characteristics of different plant species and spacing between the plants in each plot.

However, data in (Table 3) indicate that the porosity of different plots of various arrangements of the trees species showed obvious variable differences.

After six months of cultivation the porosity varied from 52.4 to 83.0% and from 56.2 to 77.1% for the first and second strips, respectively. The plot of five rows of *Casuarina equestifolia* and the plot of 2 rows of *Tamarix articulata* in both sectors of the shelterbelt, showed the higher values of porosity. The lower values were detected for both strips in the plots of the 4rows of *Acacia saligna* and 1row of *Tamarix articulata* and the plot of 4 rows of *Prosopis juliflora* and 1row of *Tamarix articulata*.

The recorded values for both plots varied from 52.4 to 58.1% and from 56.2 to 58.3%, respectively. The values of porosity in the different plots of both strips steadily decreased during study period. The ultimate recorded values showed that the higher porosity were detected in the plot of 2 rows of *Tamarix articulata* and the plot of 4rows of *Acacia saligna* and 1 row of *Prosopis juliflora*. The recorded values 56.8 and 46.0% for the first strip and 49.8 and 41.2% for the second one .

Table (3):Accumulation of shifting sand as affected by different combinations of tree species cultivated as shelterbelt for sand encroachment control.

Plant species \ Porosity (%)		Six months from cultivation		Twelve months from cultivation		Eighteen months from cultivation		Twenty four months from cultivation	
		Porosity (%)	Sand accumulation (g/cm width)	Porosity (%)	Sand accumulation (g/cm width)	Porosity (%)	Sand accumulation (g/cm width)	Porosity (%)	Sand accumulation (g/cm width)
Strip 1									
Wind open side of the 1st belt		-	620.5	-	278	-	448	-	306.0
Plot 1-1	5 rows *Tamarix*	76.0	264	74.6	109	50.2	199	37.9	129.0
Plot 1-2	5 rows *Casuarina*	81.6	270	73.6	52	49.8	78	38.2	74
Plot 1-3	2 rows *Tamarix*	83.0	352	82.9	42	67.0	83	56.8	102
Plot 1-4	3 rows *Casuarina*	67.0	244	65.0	39	45.5	64	34.2	56
Plot 1-5	4 rows *Prosopis* (bs) 1 row *Tamarix* (cent.)	58.1	189	58.0	37	44.1	58	33.0	45
Plot 1-6	4 rows *Acacia* (bs) 1 row *Tamarix* (cent.)	52.4	153	52.1	28	39	48	28.1	44
Plot 1-7	2 rows *Tamarix* (bs) 3 rows *Casuarina* (cent.)	74.6	257	73.9	39	48.8	77	37.1	53
Plot 1-8	5 rows *Prosopis*	62.2	226	61.0	41	41.0	61	30.2	51
Plot 1-9	4rows *Acacia* (bs) 1 row *Prosopis* (cent)	67.6	254	65.6	45	47.1	70	46.0	55
Plot 1-10	5 rows *Acacia*	68.0	242	60.2	45	46.2	65	35.2	46
Strip 2									
Plot 2-1	5 rows *Tamarix*	75.9	384	75	140	46.9	192	35.9	89
Plot 2-2	5 rows *Casuarina*	76.0	339	73.9	47	48.3	77	37.0	42
Plot 2-3	2 rows *Tamarix*	77.1	391	75.9	98	60.1	79	49.8	61
Plot 2-4	3 rows *Casuarina*	59.2	294	59.1	81	41.9	66	30.1	39
Plot 2-5	4 rows *Prosopis* (bs) 1 row *Tamarix* (cent.)	58.3	227	57.3	33	39.1	44	28.9	31
Plot 2-6	4 rows *Acacia* (bs) 1 row *Tamarix* (cent.)	56.2	148	55.8	32	37.8	42	26.1	28
Plot 2-7	2 rows *Tamarix* (bs) 3 rows *Casuarina* (cent.)	64.0	331	63.6	51	44.8	57	33.6	40
Plot 2-8	5 rows *Prosopis*	58.8	232	56.2	47	40.6	54	29.9	38
Plot 2-9	4rows *Acacia* (bs) 1 row *Prosopis* (cent)	67.1	247	65.9	46	43.1	58	41.2	40
Plot 2-10	5 rows *Acacia*	59.3	239	58.3	42	42.6	53	31.6	42

Cent=central row bs=both sides of the central rows

The lower values fluctuated between 28.1 and 30.2% and between 28.9 and 29.9% for the plots of 4 rows of *Acacia saligna* and 1 row of *Tamarix articulata* and 5 rows of *Prosopis juliflora*, respectively.

The reduction of porosity by time is a reflection of the changes of trees shape,width,height and density during the growth period (Mann, 1985).

In the current investigation , the type of correlation between the porosity and sand accumulation was calculated. The results indicate that, such correlation is not significant. The (r) values for both strips were 0.53 and 0.50,respectively. Such results indicate that the relationship between the porosity and sand accumulation is not linear.

"The highest efficiency of the shelterbelt is attained as the porosity reached (40-50%). The highest or lowest porosity decreases the efficiency of shelterbelts" (Nageli,1946).

3- The efficiency of various arrangements of plant species on the control of shifting sand.

The efficiency of each plot of the two strips was expressed by the reduction percentage of periodical cumulative amounts of the collected sand by Bagnold sand collectors at the leeward side compared to that of the wind-ward side. The reduction of percentage of each plot of the second strip was considered the efficiency of each plot of the shelterbelt (first and second strip).

After six months of cultivation, the efficiency of the plots of the first and second strips increased from 43.3 to 75.3% and from 37.0 to 76.1%, respectively (Table 4). The highest efficiency was attained in the plots cultivated with 4 rows of *Acacia saligna* and 1 row of *Tamarix articulata* followed in descending order by the plot cultivated with 4 rows of *Prosopis juliflora* and 1 row of *Tamarix articulata*. The reduction percentage of the collected sand at the leeward side of both plots of the two strips of shelterbelt were 45.1 and 76.1% for the former and 64.5 and 63.4 for the later plot . The lowest efficiency plots of both strips were those cultivated with 2 rows of *Tamarix articulata*, 5 rows of *Casuarina equestifola* and 5 row of *Tamarix articulata.*

The efficiency of the plots to control the shifting sand are recorded during the study periods . After twenty four months of cultivation, data in Table(4) show that the reduction percentage of the collected sand at the lee side of first and second strips increased as compared with the initial period. The values obtained increased from 57.8 to 85.6 % and from 70.9 to 90.8%, respectively .

The confidence limits show that the plot of 4 rows of *Acacia saligna* and 1 row of *Tamarix articulata* and the plot of 4 rows of *Prosopis juliflora* and 1 row of *Tamarix articulata* were a superior quality as regard the efficiency for sand encroachment control. For both plots, reduction percentage of the collected sand at leeward side in the first and second strips of the shelterbelt varied from 85.6 to 90.8% and from 85.3 to 89.9%, respectively.

The lowest efficiency was attained in the plots cultivated with 5 rows of *Tamarix articulata* and 2 rows of *Tamarix articulata*. This results may be attributed to the low growth rate of the *Tamarix articulate* as well as the high porosity during study period. Hagen and Skidmore (1971)reported that the porosity of shelterbelt is one of the main factors that determine the efficiency of shelterbelts and windbreaks.

On the other hand, it could be mentioned that the combination of more than one species in the shelterbelt is more effective in the control of shifting sand compared to the single species. Brandle (1995) indicated that the species composition is among the factors that control the efficiency of shelterbelts in reducing wind speed and altering microclimate.

Table (4): Reduction percentage of the shifting sand as affected by the shelterbelt of various plant arrangements .

Shelterbelts efficiency (%)		Reduction percentage of the shifting sand			
Plant species		Six months from cultivation	Twelve months from cultivation	Eighteen months from cultivation	Twenty four months from cultivation
		Strip (1)			
Plot 1-1	5 rows *Tamarix*	57.4	60.8	55.6	57.8 -
Plot 1-2	5 rows *Casuarina*	56.5	81.3	82.6	75.8 -
Plot 1-3	2 rows *Tamarix*	43.3	84.9	81.5	66.6 -
Plot 1-4	3 rows *Casuarina*	60.7	86.0	85.7	85.0 +
Plot 1-5	4 rows *Prosopis* (bs) 1 row *Tamarix* (cent.)	69.5	86.7	87.1	85.3+
Plot 1-6	4 rows *Acacia* (bs) 1 row *Tamarix* (cent.)	75.3	90.0	89.3	85.6+
Plot 1-7	2 rows *Tamarix* (bs) 3 rows *Casuarina* (cent.)	58.6	86.0	82.8	82.7+
Plot 1-8	5 rows *Prosopis*	63.6	85.3	86.4	83.3+
Plot 1-9	4rows *Acacia* (bs) 1 row *Prosopis* (cent)	59.1	83.8	84.4	82.0+
Plot 1-10	5 rows *Acacia*	61	83.8	85.5	85.0+
Confidence limits		-	-	-	78.9±3
		Strip (2)			
Plot 2-1	5 rows *Tamarix*	38.1	49.6	57.1	70.9 -
Plot 2-2	5 rows *Casuarina*	45.1	83.1	82.8	86.3+
Plot 2-3	2 rows *Tamarix*	37.0	64.7	82.4	80.1 -
Plot 2-4	3 rows *Casuarina*	52.6	70.9	85.3	87.2+
Plot 2-5	4 rows *Prosopis* (bs) 1 row *Tamarix* (cent.)	63.4	88.1	90.2	89.9+
Plot 2-6	4 rows *Acacia* (bs) 1 row *Tamarix* (cent.)	76.1	88.4	90.6	90.8+
Plot 2-7	2 rows *Tamarix* (bs) 3 rows *Casuarina* (cent.)	46.4	81.6	87.3	86.9+
Plot 2-8	5 rows *Prosopis*	62.6	83.1	87.9	87.6+
Plot 2-9	4rows *Acacia* (bs) 1 row *Prosopis* (cent)	60.2	83.4	87.1	86.9+
Plot 2-10	5 rows *Acacia*	61.5	85.0	88.1	86.3+
Confidence limits		-	-	-	85.3±2.7

CONCLUSION AND RCOMMENDATION

In view of the results given, the shelterbelts could play an important role in the control of shifting sand at EL-Sheikh Zayed canal. The shelterbelt enhance the deposition of the aeolian sand at a reasonable distance from the irrigation canal . The reduction percentage of shifting sand down wind the different plots of shelterbelt varied from 70.9 to 90.8 % . The plot of four rows of *Acacia saligna* and one row of *Tamarix articulata* as well as the plot of four rows of *Prosopis juliflora* and one row of *Tamarix articulata* show the highest efficiency for sand encroachment control . The above mentioned two designs are recommended for large scale application.

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تأثير التصميمات المختلفة للحزام الأخضر علي مقاومة زحف الرمال بتوشكي ، جنوب مصر

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تمثل التكوينات الرملية احد مظاهر السطح الرئيسية في منطقة توشكي بجنوب مصر . وتؤثر حركة الرمال علي قناة الشيخ زايد التي تنقل مياه الري إلي مناطق الاستصلاح الجديدة في هذه المنطقة . ولحماية القناة من حركة الرمال ، فقد تم إنشاء منطقة رائدة تشمل حزام أخضر بطول ١ كم ، ويشمل هذا الحزام أربعة أنواع نباتية منزرعة في قطاعات ذات تراكيب نباتية ومسافات مختلفة .

وتشير النتائج إلي فعالية الحزام الأخضر في حجز وترسيب الرمال الزاحفة باتجاه القناة ، حيث تراوحت نسبة الانخفاض في حركة الرمال خلف الحزام بقيم تتراوح بين ٧٠,٩ و ٩٠,٨ % مقارنة بالمناطق غير المحمية .

كذلك تشير النتائج إلي تفوق القطاع الذي يضم أربعة صفوف من الأكاسيا وصف واحد من الأثل وكذلك القطاع الذي يضم أربعة صفوف من البروسوبس وصف واحد من التاماركس وذلك من حيث قدرتها علي التحكم في حركة الرمال مقارنة بالنباتات المنزرعة في القطاعات الأخرى . وتوصي الدراسة بالتوسع في زراعة الأحزمة الخضراء وفق النتائج السابق الإشارة إليها.