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EFFECT OF DUNE POSITION AND TREE SPECIES ON BIOMASS PRODUCTION, WOOD VOLUME AND WOOD DENSITY OF SAND DUNE PLANTATIONS IN SIWA OASIS

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ABSTRACT

This study was carried out on 16-year old trees of *Acacia saligna*, *Tamarix articulata* and *Prosopis juliflora* cultivated in Siwa Oasis and used for stabilization of moving sand dunes. Measurements of biomass production, wood volume and wood density were estimated from different tree species. These species were planted in different positions over the dune surface (foot, medium and crest positions). The results showed that, the crest position was highly significant than medium and foot positions in total biomass production as 139.0, 96.01 and 59.91 t/ha respectively. *Prosopis juliflora* was highly significant in biomass production when compared with *Acacia saligna* and *Tamarix articulata* 153.7, 75.72 and 65.48 t/ha respectively. Total wood volume in the first season showed that, the crest position was highly significant than medium and foot positions in total wood volume 169.2, 112.3 and 69.22 m^3/ha respectively, and in the second season the results were 174.1, 116.2 and 71.62 m^3/ha respectively. *Prosopis juliflora* was highly significant in total wood volume when compared with *Acacia saligna* and *Tamarix articulata* 172.5, 103.9 and 74.30 m^3/ha respectively in the first season, and in the second season the results were 176.4, 107.1 and 78.35 m^3/ha respectively. Wood density of *Prosopis juliflora* was highly significant followed by *Tamarix articulata* and *Acacia saligna* was the lowest 0.84, 0.73 and 0.61 g/cm^3 respectively.

Keywords: Sand dunes, Stabilization, Biomass production, Position on dune, *Acacia saligna, Tamarix articulata, Prosopis juliflora,* Wood volume, Wood density

INTRODUCTION

The plateau areas in Egypt as well as low plains are covered by scattered accumulations of shifting sand dunes. Sand dunes covers about 160,000 km^2 (16%) of the total surface area of Egypt (Mounir, 1983). These are particularly noticeable in Siwa depression, West and East of the Nile delta, along of the costal plains, the inland high plains of Sinai Peninsula and in the New Valley. Hence, there are many tree species were successfully planted and easily developed under sand dune conditions. Afforestation of sand dunes depends on three objectives protection, recreation and production. In fact, the main objective of these plantations is the protection of erosion of sand dunes and stabilization of the mobile dunes. (Regional project, 1992)

Siwa Oasis located the Northern edge of the Great Sand Sea which is considered one of the closed inland depressions of the Western Desert (sand dunes covers about 169.000 km^2 of this desert) and the area of Siwa Oasis is about 980 km^2. It exists within the extremely arid conditions (refer to chemical analysis of agriculture drainage water presented in table 1). The average amount of rainfall is 9.6 mm/year (Meteorological data of Siwa Oasis presented in table 2). The mobile sand dunes which are present at the Southern fringes of the Oasis.

High human and livestock populations in the desert are leading to the mismanagement of the sandy terrain causing reactivation and land degradation resulting from sand dunes movement**,** and encroachment upon productive agricultural fields, human habitations, canals, roads and railway tracks. Thus, it is necessary to stabilize the moving sands to control the menace of sand drift. Many methods have been tried to control sand movement but biological control through a careful plantation of trees, shrubs and grasses was the best (Draz *et al*., 1992; Singh and Rathod, 2002). In arid areas, woodlands have been a source of existence human communities for several centuries, provided people with shade, firewood, charcoal, timber, forage and food (Villagra *et al*., 2005).

Fuel wood is the primary source of cooking energy for the majority of the world's populations (Kennedy, 1998). In Egypt, large scale of people use fuel wood to produce energy from charcoal form, as it is the cheapest and most accessible source of energy (Bradley, 1988).

Usually, the Athel wood (*Tamarix aphylla*) is used for fuel because its produces a fragrant odor when burned and it has been proposed for use in making furniture and fence posts,… etc. (Mozingo, 1987). Moreover, *Prosopis juliflora* was introduced as a multipurpose tree which provides, fuel wood, charcoal, fodder, nitrogen, huny gum, small timber, high biomass production, soil conservation, cash income, good coppicing qualities, wide adaptability, fast growth and resistance for salt and drought (Brahmi and Singh, 1997; El-Fadl, 1997).

In general, the fixed sand dunes areas are not successfully managed and used so that, large areas of afforested locations deteriorated. In such deteriorated areas the sand dunes are reactivated and affected on the development activities.

Therefore, the aim of this research study is to evaluate biomass production, wood volume and wood density under three sand dune positions using three tree species viz., *Acacia saligna*, *Tamarix articulata* and *Prosopis juliflora*.

MATERIALS AND METHODS

1. Location and duration

This investigation was carried out in Siwa Oasis (Khamesa region) during the period from October 2004 to the end of September 2006.

2. Plant material

The present study was carried out on 16-years old trees of acacia *(Acacia saligna),* tamarix *(Tamarix articulata)* and *(Prosopis juliflora)* in Siwa Oasis.

3. Data collection

3.1. Determination of biomass production

It was determined by cutting some sample trees as production – indicator for the productivity of the tree and division the cutting trees into three parts

1. The main trunk (from the earth to the branches), and weighted it.
2. The branches (all branches), and weighted it.
3. The shoots and leaves, and weighted it.

3.1.1. The fresh weight:

The fresh weight of three division of the tree was determined by cut samples of different heights of the tree and from (main trunk, branches and leaves) and weighted it in the same time of cutting.

3.1.2. The dry weight:

The dry weight was determined by drying the samples on 80 ˚C in an electric oven until constant weight, and weighted the dried samples.

3.1.3. Relative water content

The wood samples weighted freshly and dried at 80 ˚C, and then the water content was calculated from the following formula:

RWC (%) = (The sample fresh weight – The sample dry weight) / (The sample fresh weight) * 100.

3.2. Determination of wood volume

The wood volume was determined by divided each tree into three parts as according to **(Regional project, 1992)**

a- Lower part: Its volume was calculated by follow model:

$V_1 = 1.30 * (C_{1.30})^2 / (4 * PI)$ when, V_1 = volume of lower part (m^3)

$C_{1.30}$ = circumference (m) at 1.30 m height and PI = 3.1416… (22/7)

b- Intermediate part: To compute the volume by Smalian formula was suggested:

$V_i = L_i * (C0_i^2 + C1_i^2) / (8 * PI)$ where: V_i = volume (m^3) of (log) i, $C0_i^2$ = circumference (m) at the base of (log) i , $C1_i^2$ = circumference (m) at the top of (log) i , L_i = length (m) of the (log) i , and PI = 3.1416… (22/7)

The total volume (V_2) for this intermediate part was determined by the sum of all volumes from different (logs):V_2 = sum (V_i)

c- Upper part: The volume of this part was determined by:

$V_3 = L * (C_m^2) / (12 * PI)$ when: V_3 = the volume (m^3) of the upper part, L = length (m) of the upper part, C_m = the merchandable circumference (m) PI = 3.1416 (22/7)

The total tree volume (m^3) was then given by summing up the volume of the three parts of the tree as follow: $V = V_1 + V_2 + V_3$.

2.3.3. Determination of wood density:

The wood density was determined as following steps

a) Saturation of the samples by immersion in water for 4-5 days to approximate the conditions of natural saturation.

b) Determination of the volume by measuring the water (the Archimedes principle by displacement of water), (ASTM, 2002).

c) Drying the wood samples in an electric oven at 80 ˚C until constant weight, and determined the dry weight of samples.

d) Determination of the basic density (g cm^3) for each of 270 samples by computing the ratio of the dry mass of wood (g) to its respective saturated volume (cm^3).

Table (1) Chemical analysis of agriculture drainage water used for irrigation in Siwa Oasis. Khamasa region.

Season	EC	pH	Cations (ppm)				Anions (ppm)			
			Ca^+	Mg^+	Na^+	K^+	$CO3^=$	$HCO3^-$	Cl^-	$SO4^-$
Winter	3500	9.8	562.2	190.5	1750	90	60	134.2	3327.7	1200
Summer	6300	9.8	247.4	350.7	1800	74	_	308.6	2963.5	1550

Table (2) Meteorological data of Siwa Oasis

Month	WSknot/h	Air Temp ^0C	RH%	Total Rain mm	ET mm
Jan.	5.7	11.9	53	0.8	6.0
Feb.	6.4	13.6	46	2.0	7.9
Marc.	7.5	16.7	40	0.7	10.7
Apr.	7.7	21.0	34	0.9	14.1
May	6.9	25.4	30	1.5	16.1
Jun.	6.2	28.4	31	0.0	17.0
Jul.	6.1	29.3	34	0.0	16.8
Aug.	5.2	29.2	36	0.0	15.2
Sep	4.9	26.7	42	0.0	12.1
Oct.	4.2	23.3	45	0.3	9.6
Nov.	5.1	18.3	51	0.6	7.0
Dec.	5.0	15.3	58	2.8	5.2

4. Experimental Design and Statistical analysis

Experiments were arranged in a split-plot design with 4 replicates (every replicate consists of two trees) for each kind of the three chosen tree species. Where as, the site on dune in main plots and the tree species was in sub-main plots. Analysis of variance using LSD (0.05) was carried out according to (Snedecor and Cochran, 1989). The MSTATC Program by computer was utilized for this task

RESULTS AND DISCUSSION

1. Biomass production

1.1. Wood production of main trunk

1.1.1. Fresh weight

Data presented in table (3) show that, wood production of main trunk produced from different tree species was significantly higher over the crest of dune compared with medium and foot positions (123.6, 82.67 and 46.19 kg/tree, respectively). Whereas, data presented in this table observed that, the wood production of main trunk produced from *Prosopis juliflora* was significantly higher compared to *Tamarix articulata* and *Acacia saligna* (120.5, 68.86 and 63.11 kg/tree, respectively). In respect to the tree species grown under different positions on the dune, it was obvious that, all tree species grown over the crest of dune produced high significant mass of wood compared with obtained on the medium and foot positions. Meanwhile, *Prosopis* trees produced highest quantity of wood over the crest position (154.2 kg/tree), and *Tamarix* trees produced lowest quantity of wood in the foot position (25.42 kg/tree).

1.1.2. Dry weight

Wood production of main trunk from all three tree species was significantly higher in the crest position when compared to medium and foot positions (62.14, 43.85 and 25.45 t/ha, respectively). Whereas, data presented in table (3) observed that, the wood production of main trunk produced from *Prosopis juliflora* was significantly higher compared with *Tamarix articulata* and *Acacia saligna* (70.02, 34.01 and 27.41 t/ha, respectively). Meanwhile, *Prosopis* trees produced the highest quantity of wood over the crest position (87.32 t/ha), and *Tamarix* trees produced the lowest quantity of wood in the foot position (13.55 t/ha).

1.1..3. Moisture content

Moisture content in main trunk wood from the three tree species was significantly higher over the crest of dune when compared with medium and foot positions (41.17, 38.73 and 36.48%, respectively). Whereas, data presented in table (3) observed that, the Moisture content in main trunk wood produced from *Acacia saligna* was significantly higher compared to *Tamarix articulata* and *Prosopis juliflora* (47.31, 39.25 and 29.82%, respectively**).**

1.2. Wood production of branches

1.2.1. Fresh weight

Wood production of branches produced from all three tree species was significantly higher in the crest position compared to medium and foot positions (120.7, 82.28 and 54.89 kg/tree, respectively). Data presented in table (3) showed that, the wood of branches produced from *Prosopis juliflora* was highly significant compared to *Acacia saligna* and *Tamarix articulata* (135.1, 80.39 and 42.44 kg/tree, respectively). *Prosopis* trees produced highest quantity of wood in the crest position (166.3 kg/tree), and *Tamarix* trees produced lowest quantity of branches wood in the foot position (16.17 kg/tree).

1.2.2. Dry weight

Wood production of branches produced from tree species was significantly higher over the crest of dune compared with both of medium and foot positions (56.89, 40.89 and 27.71 t/ha, respectively). Moreover, data presented in table (3) showed that, the wood of branches produced from *Prosopis juliflora* was highly significant compared with *Acacia saligna* and *Tamarix articulata* (71.01, 34.43 and 20.05 t/ha, respectively). Meanwhile, *Prosopis* trees produced the highest production of branches in the crest position (86.17 t/ha), and *Tamarix* trees produced the lowest quantity of branches in the foot position (8.29 t/ha).

1.2.3. Moisture content

Moisture content in wood of branches from all three tree species was high significantly in the crest position when compared to medium and foot positions (44.40, 41.58 and 40.32%, respectively). Data presented in table (3) observed that, the moisture content in wood of branches produced from *Acacia saligna* was highly significant compared to *Tamarix articulata* and *Prosopis juliflora* (48.07, 41.50 and 36.73%, respectively**).**

1.3. Leaf production

1.3.1. Fresh weight

Leaf production was significantly affected by trees positions over the dune, where the crest position was the best i.e. produced more fresh weight of leaves followed by medium, and the foot positions was the lowest (62.56, 32.33 and 18.25 kg/tree, respectively).

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Acacia saligna produced the higher leaf production than both of *Prosopis juliflora* and *Tamarix articulata* (46.83, 33.25 and 33.06 kg/tree, respectively). The trees of *Acacia saligna* grown on the crest position produced the highest production of leaves (69.17 kg/tree), and the lowest leaf production produced from *Tamarix* trees grown in the foot position (11.08 kg/tree).

1.3.2. Dry weight

Leaf production of dry weight was significantly affected by positions over the dune, where the crest position was the highest followed by medium and the foot was the lowest (19.93, 11.21 and 6.746 kg/tree, respectively). *Acacia saligna* produced the highest leaf dry weight followed by *Prosopis juliflora* and *Tamarix articulata* was the lowest (13.83, 12.64 and 11.42 kg/tree, respectively). *Tamarix* trees grown over the crest position produced the highest leaf dry weight (20.48 kg/tree), and the lowest was produced from *Tamarix* trees grown in the foot position (4.28 kg/tree).

1.3.3. Moisture content

Moisture content in leaves was significantly higher over the crest of dune when compared to medium and foot positions (61.51, 57.34 and 53.57%, respectively). Whereas, moisture content in leaves produced from *Acacia saligna* was highly significant compared to *Tamarix articulata* and *Prosopis juliflora* (63.90, 56.65 and 51.87%, respectively).

1.4. Total biomass production

1.4.1. Fresh weight

Total fresh weight was differed significantly between tree positions over the dune, where the crest position was the highest in total fresh weight followed by medium and the foot position was the lowest (306.9, 197.2 and 119.3 kg/tree, respectively). *Prosopis juliflora* produced the highest total fresh weight followed by *Acacia saligna* and *Tamarix articulata* was the lowest (288.6, 190.3 and 144.6 kg/tree, respectively). *Prosopis* trees grown over the crest position produced the highest total production (376.0 kg/tree), and the lowest total production produced from *Tamarix* trees grown in the foot position (52.67 kg/tree).

1.4.2. Dry weight

As in fresh weight, total dry weight produced was differed significantly between tree positions over the dune, where the crest position was the highest followed by medium and the foot position which was the lowest (139.0, 96.01 and 59.91 t/ha, respectively). *Prosopis juliflora* produced the highest total dry weight followed by *Acacia saligna* and *Tamarix articulata* was the lowest (153.7, 75.72 and 65.48 t/ha, respectively). *Prosopis* trees grown over the crest position produced the highest total dry weight (193.2 t/ha), and the lowest total dry weight was produced from *Tamarix* trees grown in the foot position (26.12 t/ha). In this case the crest position of the dune was the highest in total biomass. This may be because of deposition of saline irrigation water in the foot and little salinity in the crest and increased of exchangeable Ca in the foot position from saline irrigation water. *Prosopis juliflora* produced the highest total in fresh and dry weight followed by *Acacia saligna* and *Tamarix articulata* was the lowest. The reason may be because of high saline water resistance by *Prosopis juliflora* and *Acacia saligna* and low resistance from *Tamarix articulata*. These results were agreement with

(Singh and Rathod, 2002; Hussain *et al*., 1994; Deans *et al*., 2003) and disagreement with (Tomar *et al*., 2003).

2. Wood volume

2.1. Lower part

Wood volume (in table 4) of lower part was significantly different between dune positions, where the crest position was the highest followed by medium and foot position was the lowest (17.99, 8.131 and 5.341 m^3/ha in the first season, and were 18.68, 8.572 and 5.699 m^3/ha in the second season respectively). *Prosopis juliflora* produced the highest wood volume of lower part followed by *Tamarix articulata* and *Acacia saligna* (12.70, 9.610 and 9.152 m^3/ha in the first season, and 13.34, 10.08 and 9.533 m^3/ha in the second season respectively). *Prosopis* trees grown over the crest position produced the highest wood volume of the lower part (22.70 m^3/ha in the first season and 23.59 m^3/ha in the second season), and the lowest wood volume of the lower part produced from *Tamarix* trees grown in the foot position (4.157 m^3/ha in the first season and 4.493 m^3/ha in the second season).

2.2. Intermediate part

The wood volume of the intermediate part showed significant differences, where the crest position was the highest followed by medium and foot position was the lowest (150.1, 103.5 and 60.10 m^3/ha in the first season, and 154.2, 106.8 and 65.40 m^3/ha in the second season respectively). *Prosopis juliflora* produced the highest wood volume of intermediate part followed by *Acacia saligna* and *Tamarix articulata* which was the lowest (158.8, 90.94 and 64.00 m^3/ha in the first season, and 161.9, 97.03 and 67.46 m^3/ha in the second season respectively). *Prosopis* trees grown over the crest position produced the highest wood volume of the intermediate part (207.5 m^3/ha in the first season and 211.3 m^3/ha in the second season), and the lowest wood volume of the intermediate part was produced from *Tamarix* trees grown in the foot position (23.39 m^3/ha in the first season and 25.52 m^3/ha in the second season).

2.3. Upper part

Wood volume of the upper part followed the same trend of results, where the crest position was the highest followed by medium and foot position was the lowest (1.008, 0.6744 and 0.4411 m^3/ha in the first season, and were 1.242, 0.7867 and 0.5233 m^3/ha in the second season respectively). *Prosopis juliflora* produced the highest wood volume of upper part followed by *Tamarix articulata* and *Acacia saligna* was the lowest (1.009, 0.6911 and 0.5033 m^3/ha in the first season, and 1.164, 0.8022 and 0.5856 m^3/ha in the second season respectively). *Prosopis* trees grown over the crest position produced the highest wood volume of the upper part (1.43 m^3/ha in the first season and 1.63 m^3/ha in the second season), and the lowest wood volume of the upper part produced from *Acacia* trees grown in the foot position (0.2933 m^3/ha in the first season and 0.35 m^3/ha in the second season).

2.4. Total volume

Total wood volume showed significant differences between tree positions over the dune, where the crest position was the best i.e. highest in total wood volume followed by medium and the foot position which was the lowest 169.2, 112.3 and 69.22 m^3/ha in the first season, and 174.1, 116.2 and 71.62 m^3/ha in the second season, in a respective manner. *Prosopis juliflora* produced the highest total wood volume followed by *Acacia saligna* and *Tamarix articulata* was the lowest (172.5, 103.9 and 74.30 m^3/ha in the first season, and 176.4, 107.1 and 78.35 m^3/ha in the second season respectively). *Prosopis* trees grown over the crest position produced the highest total wood volume (231.6 m^3/ha in the first season and 236.5 m^3/ha in the second season), and the lowest total wood volume produced from *Tamarix* trees grown in the foot position (27.96 m^3/ha in the first season and 30.49 m^3/ha in the second season). As an explanation, as pointed out before may be because of deposition of saline irrigation water in the foot and little salinity in the crest and increased of exchangeable Ca in the foot position from saline irrigation water. *Prosopis juliflora* produced the highest total wood volume followed by *Acacia saligna* and *Tamarix articulata* was the lowest, the reason may be because of high saline water resistance by *Prosopis juliflora* and *Acacia saligna* and low resistance by *Tamarix articulata*. These results were agreement with (Singh and Rathod, 2002; Hussain *et al*., 1994) and disagreement with (Tomar *et al*., 2003).

3. Wood density

Wood density was significantly higher between the dune positions (Table 4), where the crest position was the highest followed by both of medium and foot positions (0.7278, 0.7233 and 0.7233 g/cm^3, respectively). *Prosopis juliflora* was highest wood density followed by *Tamarix articulata* and *Acacia saligna* was the lowest (0.8389, 0.7278 and 0.6078 g/cm^3, respectively).

CONCLUSION

Dune positions showed significant differences in biomass production, wood volume and wood density. The crest position was the best i.e. highest in biomass production, total wood volume and wood density followed by medium and foot positions. *Prosopis juliflora* showed a significantly higher in biomass production and total wood volume under saline irrigation water when compared to *Acacia saligna* and *Tamarix articulata* trees. In wood density *Prosopis juliflora* was the highest followed by *Tamarix articulata*, and *Acacia saligna* showed the lowest wood density.

REFERENCES

ASTM (2002). Standard Test Methods for Specific Gravity of Wood and Wood-Based Materials. Designation: D239502. ASTM International, West Conshohocken, PA, USA, 8pp.

Bradley P.N. (1988). Survey of woody biomass on farms in Kenya. Ambiomass, 17: 40-48.

Brahmi M.K. and H.P. Singh (1997). *Prosopis juliflora* an excellent multi-purpose tree species for the development of degraded lands of India. Advance in Forestry Research in India, 17: 95-109

Deans J.D., O. Diagne, J. Nizinski, D.K. Lindley, M. Seck, K. Ingleby and R.C. Munro (2003). Comparative growth, biomass production, nutrient use and soil amelioration by nitrogen-fixing tree species in semi-arid Senegal. Forest Ecology and Management, (176): 253-264.

Draz M.Y., A.M. Ahmed and M.Y. Afify (1992). Studies on sand encroachment in Siwa Oasis, Western desert, Egypt. II Feasibility of sand dune fixation measures. Journal of Engineering and Applied Science, 39, (4): 723-735.

El-Fadl M.A. (1997). Management of *Prosopis juliflora* for use in agroforestry system in the Sudan. Tropical Forestry Reports, Department of Forest Ecology, University of Helsinki, (16): 107.

Hussain G., M. Sadiq, Y.A. Nabulsi and O.J. Helweg (1994). Effect of saline water on establishment of windbreak trees. Agricultural Water Management, (25): 35–43.

Kennedy A. D. (1998). Coppicing of *Tarchonanthus camphorates* (Compositae) as a source of sustainable fuel wood production an example from Laikipia Plateau, Kenya. African Journal of Ecology, (36): 148-158.

Mounir M.M. (1983). Sand dunes in Egypt. Academy of Science Research and Technology, Cairo, Egypt., 55 – 78.

Mozingo H.N. (1987). Shrubs of great basin: A natural history. University of Nevada Press, Reno, NV, 342 pp.

Regional Project RAB /89 /034 (1992). Approach and methodology for management of stabilized dunes plantations. Sand Dunes Stabilization and Afforestation, 21-26.

Singh S. and T.R. Rathod (2002). Plant growth, biomass production and soil water dynamics in a shifting dune of Indian desert. Forest Ecology and Management, (171): 309 – 320.

Snedecor G. W. and W.G. Cochran (1989). Two – ways classification: Analysis of Variance in Statistical Methods (8^{th} Edition), Iowa State Press, Ames, Iowa, U.S.A., Chapter 14: 254 – 272.

Tomar O.S., P.S. Minhas, V.K. Sharma, Y.P. Singh and Raj K. Gupta (2003). Performance of 31 tree species and soil conditions in a plantation established with saline irrigation. Forest Ecology and Management, (177): 333-346.

Villagra P.E., J.A. Boninsegna, J.A. Alvarez, M. Cony, E. Cesca and R. Villalba (2005). Dendroecology of *Prosopis flexuosa* woodlands in the Monte desert: Implications for their management. Dendrochronologia, (22): 209-213.

تأثير الموقع غلى الكثيب و أنواع الاشجار على الانتاج ، حجم الخشب و كثافة الخشب فى زراعات الكثبان الرملية بواحة سيوة

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**** قسم الكثبان الرملية – شعبة البيئة و زراعات المناطق الجافة – مركز بحوث الصحراء ، المطرية ، القاهرة**

زرعت بعض أنواع الاشجار بهدف تثبيت الكثبان الرملية فى واحة سيوة على أماكن مختلفة من الكثيب (قدم- وسط –قمة الكثيب). و أجريت بعض القياسات عليها لتقييمها و معرفة أفضلها فى الانتاج فى كل مكان من أماكن الزراعة و أحسن تلك الانواع فى الانتاج. و أظهرت النتائج تفوق قمة الكثيب فى كل من (الانتاج الكلى – حجم الخشب – كثافة الخشب). كما أوضحت النتائج أن أشجار البروسوبس كانت الأفضل فى جميع أنواع الانتاج فيما عدا الانتاج من الأوراق و جاءت بعدها أشجار الأكاسيا ، بينما كانت أشجار العبل (الأتل) هى الأقل فى الانتاج الكلى و فى الحجم الكلى للخشب. أما فى انتاج الأوراق سواء كوزن طازج أو كوزن جاف كانت أشجار الأكاسيا هى الأعلى انتاجا و جاءت بعدها أشجار البروسوبس ، بينما كانت أشجار العبل (الأتل) هى الأقل فى انتاج الأوراق. أما بالنسبة لكثافة الخشب فكان الخشب الناتج من أشجار البروسوبس هو الأعلى كثافة ثم تلاه الخشب المنتج من أشجار العبل (الأتل)، بينما كان خشب الأكاسيا هو الأقل كثافة.

Table (3): Effect of dune position and tree species on total biomass production in Siwa Oasis

Dune position (A)	Tree species (B)	Trunk wood			Branches wood			Shoot and leaves			Total production	
		Fr.we. kg/tree	Dr.we. t/ha	% moisture	Fr.we. kg/tree	Dr.we. t/ha	% moisture	Fr.we. kg/tree	Dr.we. t/ha	% moisture	Fr.we. kg/tree	Dr.we. t/ha
Foot	Acacia	35.00	15.87	45.52	48.17	21.49	46.40	29.50	9.610	60.91	112.7	46.98
	Tamarix	25.42	13.55	35.99	16.17	8.290	38.38	11.08	4.280	53.64	52.67	26.12
	Prosopis	78.17	46.92	27.93	100.3	53.34	36.18	14.17	6.347	46.15	192.7	106.6
	Mean	46.19	25.45	36.48	54.89	27.71	40.32	18.25	6.746	53.57	119.3	59.91
Medium	Acacia	65.50	28.96	46.92	73.33	31.84	47.93	41.83	12.27	64.77	180.7	73.25
	Tamarix	53.33	26.76	39.74	35.00	17.31	40.61	25.50	9.503	55.22	113.8	53.58
	Prosopis	129.2	75.82	29.52	138.5	73.53	36.21	29.67	11.85	52.04	297.2	161.2
	Mean	82.67	43.85	38.73	82.28	40.89	41.58	32.33	11.21	57.34	197.2	96.01
Crest	Acacia	88.83	37.39	49.47	119.7	49.96	49.87	69.17	19.59	66.01	277.7	106.3
	Tamarix	127.8	61.72	42.04	76.17	34.55	45.51	63.17	20.48	61.08	267.2	116.8
	Prosopis	154.2	87.32	32.00	166.3	86.17	37.81	55.33	19.71	57.42	376.0	193.2
	Mean	123.6	62.14	41.17	120.7	56.89	44.40	62.56	19.93	61.51	306.9	139.0
$LSD_{0.05}$		A = 5.101	A=2.86	A=0.865	A = 6.491	A=2.06	A=1.633	A = 5.342	A=1.97	A=0.7764	A = 14.04	A=5.79
		AB=6.937	AB=4.87	AB=0.825	AB=4.255	AB=2.31	AB=1.42	AB=3.352	AB=1.08	AB=1.212	AB=10.63	AB=6.32
	Acacia	63.11	27.41	47.31	80.39	34.43	48.07	46.83	13.83	63.90	190.3	75.72
	Tamarix	68.86	34.01	39.25	42.44	20.05	41.50	33.25	11.42	56.65	144.6	65.48
	Prosopis	120.5	70.02	29.82	135.1	71.01	36.73	33.06	12.64	51.87	288.6	153.7
$LSD_{0.05}$		4.005	2.811	0.4762	2.457	1.335	0.8204	1.935	0.6214	0.6996	6.136	3.651

Table (4) Effect of dune position and tree species on wood volume and wood density in Siwa Oasis

Dune position (A)	Tree species (B)	Lower part (m^3/ha)		Intermed. part (m^3/ha)		Upper part (m^3/ha)		Total volume (m^3/ha)		Wood density (g/cm^3)
		2005	2006	2005	2006	2005	2006	2005	2006	
Foot	Acacia	5.883	6.157	48.14	59.89	0.2933	0.3500	64.31	66.39	0.6000
	Tamarix	4.157	4.493	23.39	25.52	0.4067	0.4833	27.96	30.49	0.7267
	Prosopis	5.983	6.447	108.8	110.8	0.6233	0.7376	115.4	118.0	0.8433
	Mean	5.341	5.699	60.10	65.40	0.4411	0.5233	69.22	71.62	0.7233
Medium	Acacia	9.373	9.750	92.75	95.62	0.4267	0.5033	102.5	105.9	0.6100
	Tamarix	5.607	5.993	57.73	61.29	0.6233	0.7300	63.96	68.01	0.7267
	Prosopis	9.413	9.973	160.1	163.6	0.9733	1.1270	170.5	174.7	0.8333
	Mean	8.131	8.572	103.5	106.8	0.6744	0.7867	112.3	116.2	0.7233
Crest	Acacia	12.20	12.69	131.9	135.6	0.7900	0.9033	145.0	149.2	0.6133
	Tamarix	19.07	19.77	110.9	115.6	1.0430	1.1930	131.0	136.5	0.7300
	Prosopis	22.70	23.59	207.5	211.3	1.4300	1.6300	231.6	236.5	0.8400
	Mean	17.99	18.68	150.1	154.2	1.0080	1.2420	169.2	174.1	0.7278
$LSD_{0.05}$		A=2.309 AB = 3.596	A=2.348 AB=3.673	A=8.478 AB=14.86	A=6.294 AB = 9.931	A = 0.1672 AB = 0.1125	A = 0.186 AB = 0.1125	A=6.36 AB=10.47	A=6.467 AB=10.52	A=0.00115 AB=0.0018
	Acacia	9.152	9.533	90.94	97.03	0.5033	0.5856	103.9	107.1	0.6078
	Tamarix	9.610	10.08	64.00	67.46	0.6911	0.8022	74.30	78.35	0.7278
	Prosopis	12.70	13.34	158.8	161.9	1.0090	1.1640	172.5	176.4	0.8389
$LSD_{0.05}$		2.076	2.120	8.581	5.734	0.065	0.065	6.042	6.077	0.001027