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RESEARCH ARTICLE

Effectiveness of planting intervals on the growth, above-ground biomass and some wood properties of two Sesbania Species

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Abstract

Sesbania grandiflora and *S. sesban* at three growing spaces (1 X 0.5, 1 X 1 and 1 X 1.5 m) were conducted in a loamy sandy soil of Kom-Ombo Tropical Farm, Aswan Botanical Garden during 2013/2014 and 2014/2015 seasons. Generally, plant height, root length, stem diameter, fresh weight of plant and root as well as dry weight of plant and root significantly increased due to using 1 X 1.5 m plant spacing compared to other treatments, whatever time elapsed or species tested .Concerning, 1 X 1 m space the stem length for the two species in the mean of seasons were recorded. Also, the highest value of plant height at 90 days from planting was due to 1 X 0.5 m space in the two seasons. However, *S grandiflora* recorded significantly higher for growth and above ground biomass characters when compared to *S. sesban* in the two seasons. On the contrary, the effect of plant spacing on the moisture content and specific gravity were not significant. Meanwhile, the 1 X 0.5 m space with *S. grandiflora* gave the highest value of specific gravity while, the same space with *S. sesban* recorded the more moisture content compared to the other combinations.

INTRODUCTION

Multi-purpose legume trees that provide fodder and fuel wood have beneficial effect on environment, economy and livestock. In addition, nitrogen-fixing trees are of particular interest as fuel woods due to their ability to support nitrogen fixation as well as fix carbon. They have long been used as multi-purpose trees for shade, fodder, green manure, shifting cultivation improvement, timber, and a number of other uses (Burley, 1980). Optimizing the productivity of fuel wood plantings is only possible when the proper species are selected for local conditions. The promising species important among are *Leucaena* and *Sesbania*. The two most promising perennial species are *S. grandiflora* and S. *sesban* (Desai and Halepyati, 2007). The genus of *Sesbania* can be described as soft, semi or slightly woody, 1-8 m tall perennial nitrogen fixing trees. *S. sesban* can grow up to 8 meter and obtain a diameter of up to 12 cm. Growth is extremely rapid, on the right sites it can reach 4-5 m in just 6 months, common name of Egyptian pea or River hemp, and it is very common throughout Africa and in Asian countries such as India, Malaysia, Indonesia and the Philippines where it is commonly seen growing on the dikes between rice paddies, along roadsides and in backyard vegetable gardens. Also, *S. grandiflora* (L.) Pers. was planted in India at 90 cm intervals, yields 4.5 - 9.1 kg leaves/yr (Duke, 1983). Morover, *S. grandiflora* recorded significantly higher tree height when compared to *S. sesban* produced significantly higher number of branches than *S. grandiflora*. Increase in plant density from 10,000 to 40,000 plants/ha decreased all the growth parameters studies (Nigussie and Alemayehu, 2013). *Sesbania* as fodder is one of the green forage under marginal lands including salt-affected soils (El-Nahrawy and Soliman, 1998). Several reports have considered *Sesbania* as a good quality feed for small ruminant (Reed *et al*., 1990).

The effect of plant spacing on growth and leaf yield was investigated by King and Reynolds (1986) and Ella (1988) they reported that, for *Leucaena spp*, *Gliricidia spp*, *Calliandra spp*, and *Sesbania spp* leaf yield per unit area increased with increasing planting density. Thus, the object of this investigation was to evaluate the variations between selected *Sesbania* species (*S. sesban* and *S. grandiflora*) grown under different plant spacing and their effect on growth, above ground biomass and some of wood properties.

Materials and Methods

Experimental procedure and treatments

The experiment was conducted in the Tropical Farm, Kom-Ombo, Aswan Botanical Garden, Egypt on a loamy sandy soil during 2013/2014 and 2014/2015 seasons to study the effect of different plant spacing on the growth, biomass production and some wood properties of two *Sesbania* species. The initial levels of soil pH, E.C. and organic matter were 8.4, 2.08 dSm^{-1} and 0.86 %, respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) with factorial arrangement and having three replications. The experiment comprises of three different plant spacing levels i.e; 1 X 0.5, 1 X 1 and1 X 1.5 m as well as two *Sesbania* tree species (*Sesbania sesban* and *S. grandiflora*). A constant row spacing of 1m was kept, while plant to plant distance of 0.5, 1and 1.5 m was maintained having a net plot size was 4 m in width and 7.5 m long with 5 rows in each plot. Two seeds from the two tested species were directly sown on the experimental units for 2013/2014 and 2014/2015 seasons according to plant spacing and thinned to one healthy plant per hill one week after plant emergence. However, weeding was done manually at one month interval.

Data Collection

Five plants were randomly selected from the net plot of 4 X 7.5 m for measurement of the two *Sesbania* species 90 days from establishment. The response parameters measured were plant height, root length, stem diameter, plant fresh and dry weight as well as root fresh and dry weight. Plant height was measured from the base of the plant to the top of the apical meristem using a tape measure, stem and root diameters were measured at the base of the plant stem using a veneer sliding calipers.

In order to determine aboveground biomass and some wood properties of the two species under varying plant spacing, data for range, average and standard deviation of stem diameter, stem length, stem and wings fresh and dry weights, aboveground biomass, moisture content and specific gravity were taken after one year of sowing. Specific gravity (g/cm^3) and moisture content % of wood were estimated according to American Society for Testing Materials (ASTMD, 1989). The sampled trees (a total 3 trees from each species) were harvested by harvesting machinery. The total height for each tree was measured from the stump to the tree top. All branches stem and leaves were weighted. In addition, three disks about 5 cm. in thickness at breast height, 0.25, 0.50, 0.75 m height were removed from each tree for specific gravity and moisture content. All data were tabulated and statistically analyzed according to the method by Snedecor (1956), and L.S.D mentioned by Little and Hills (1978). Data of stem diameters for all trees were pooled to compute the range, average and standard deviation of these trees.

Results

The plant heights between the two Sesbania species sowing at different spacing treatments were significant differences. The tallest seedling resulted from *S. grandiflora* in both seasons (Table 1). The tallest stem length was due to 1 X 0.5m spacing and the shortest one was at 1 X 1.5 m. The interaction between tree species and plant spacing was significant in both seasons. However, the tallest trees were obtained from *S. grandiflora* that planting at 1 X 0.5m.

The mean of root length of seedling was significantly affected by all different plant spacing and *Sesbania* species treatments as shown in Table (1). The highest value (23.05 cm) of root length for mean of both seasons was detected with *S. grandiflora*. Also, the mean of two seasons was obtained from 1 X 1.5 m spacing. Concerning the interaction between treatments and tree species, 1 X 1.5 m spacing with *S. grandiflora* proved to be the most effective treatments to produce the tallest root.

Increasing of plant spacing pronouncedly increased the stem diameter of seedlings, while using 1 X 0.5 m spacing resulted in the least one. The *S. grandiflora* species gave the highest value of stem diameter compared to *S. sesban* in both seasons. The interaction between tested plant spacing and *Sesbania* species indicated that sowing *S. grandiflora* at 1 X 1.5 m gave the highest value of mean stem diameter in both seasons (Table, 1).

S. grandiflora seedlings had significantly higher plant fresh weight than *S. sesban* in the mean of seasons (Table 2). A significant differences in plant fresh weight of plant spacing, 1 X 1.5 m spacing. The interaction between plant spacing and the tested *Sesbania* species revealed that *S. grandiflora* at 1 X 1.5 m raised the fresh weight of plant to the maximum limits compared to the rest of treatments. The interaction between spacing treatments and *Sesbania* species for plant dry weight was significant. Applying 1 X 1.5 m spacing with *S. grandiflora* for two seasons produced more dry weight in their plants than the other combination treatments.

Significant differences were observed in root fresh weight of *Sesbania* species due to using different plant spacing treatments. The highest value of root fresh weight resulted from applying 1 X 1.5 m spacing while, the lowest value were observed in the 1 X 0.5 m as shown in Table (3). The highest value of root fresh weight was recorded with *S. grandiflora*. The interaction between treatments and *Sesbania* species was significant, applying 1 X 1.5 m spacing with *S. grandiflora* proved to be the most effective treatment to produce the highest value of root fresh weight.

The data in Table (3) showed the statistical analysis result from the tested *Sesbania* species that sowing at different plant spacing, showing significantly variation in the data obtained for the root dry weight from each species. Generally, *S. sesban* had the lowest value of root dry weight compared to *S. grandiflora*. On the other hand, the highest values of root dry weight of the tested species 90 days from establishment resulted from using 1 X 1.5 m spacing followed by 1 X 1 m one. The interaction between tested plant spacing and *Sesbania* species indicated that sowing *S. grandiflora* at 1 X 1.5 m gave the highest value of mean root dry weight in both seasons.

The response of *Sesbania* species to plant spacing one year after planting were also followed, the highest value of the stem diameter and its parameters i.e. range, average and standard deviation for *Sesbania* species in all spacing treatments were found in the stem of *S. grandiflora* compared to *S. sesban* species (Table 4). Application of 1 X 1.5 m spacing increased stem diameters in all tree species in the two seasons. As plant spacing increased, parameters of stem diameters for all tested trees increased. The effects of different plant spacing on the stem length one year after establishment of *Sesbania* species are shown in Table (5). Interactions effects between plant spacing and tree species during the first and second seasons were significantly different for stem length 1 year after planting. However, sowing *S. grandiflora* at 1 X 1 m gave the highest value of mean stem length in both seasons.

S. grandiflora trees (9.5 kg) had significantly higher stem fresh weight than *S. sesban* (3.4 kg) in the mean of seasons (Table 6). When there were significant differences in stem fresh weight of plant spacing, 1 X 1.5 m spacing gave more pronounced of stem fresh weight than the other plant spacing. The interaction between plant spacing and the tested *Sesbania* species reveals that *S. grandiflora* at 1 X 1.5 m raised the fresh weight to the maximum limits compared to other treatments.

Significant differences were observed of wings and leaves fresh weight between the two *Sesbania* species sowing at different spacing treatments. The highest value of wings and leaves fresh weight (4.2 kg) resulted from *S. grandiflora* in the mean of both seasons (Table 6). The interaction between tree species and plant spacing was significant in both seasons. However, the highest value of wings and leaves fresh weight was obtained from *S. grandiflora* that planting at 1 X 1.5 m.

The aboveground biomass of the tested *Sesbania* species was affected in all spacing treatments. The greatest increment in biomass production occurred in plants of the 1 X 1.5 m followed by 1 X 1 m treatment. *S. grandiflora* produced more biomass (13.7 kg) than *S. sesban* (10.3 kg) in the mean of seasons as shown in Table (6). *Sesbania* species at 1 X 1.5 m spacing plots had significantly more stem dry weight than the other spacing (Table 7). However, *S. grandiflora* species shows an apparent response to plant spacing in its stem dry weight during the two successive seasons. The interaction between spacing treatments and *Sesbania* species for stem dry weight was significant. Applying 1 X 1.5 m spacing with *S. grandiflora* produced more dry weight in their stem than the other combination treatments. Dry weight averages for wings and leaves was significantly affected by all different plant spacing and *Sesbania* species treatments as shown in Table (7).

The effect of different plant spacing for *S. grandiflora* and *S. sesban* wood on specific gravity (g/cm^3) and moisture content % is presented in Table (8), a significantly differences was detected between the moisture content of wood due to the tested species while, the differences were no significant for the plant spacing. The interaction between spacing treatments and *Sesbania* species for moisture content was significant, applying 1 X 0.5 m spacing with *S. sesban* proved to be the most effective treatment to produce the highest value of this character. However, there were no significant differences for the specific gravity due to the tested species and plant spacing during the two seasons. Meanwhile, the interaction between tree species and plant spacing for specific gravity was significant in both seasons. However, the highest value of specific gravity was obtained from *S. grandiflora* that planting at 1 X 0.5 m.

Table (1): Effect of plant spacing on the plant height (cm), root length (cm) and stem diameter (cm) 90 days from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Plant height (cm)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	106.27	102.50	100.63	103.13	104.07	101.53	98.27	101.29
S.sesbsn	101.93	97.27	95.47	98.22	99.13	96.67	94.57	96.79
Mean	104.10	99.88	98.05		101.60	99.10	96.42	
LSD 5%	Species : 1.22 Spacing: 0.99 Species X Spacing: 1.72				Species :2.38 Spacing 1.94 Species X Spacing :3.37			
Root length (cm)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	26.29	21.50	24.18	23.99	23.79	21.65	23.70	23.05
S.sesbsn	19.94	20.57	21.47	20.66	19.65	20.33	22.14	20.71
Mean	23.12	21.04	22.83		21.72	20.99	22.92	
LSD 5%	Species: 2.89 Spacing: 2.36 Species X spacing: 4.08				Species: 1.14 Spacing: 0.93 Species X Spacing :1.61			
Stem diameter (cm)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	0.48	0.51	0.56	0.52	0.50	0.52	0.58	0.53
S.sesbsn	0.44	0.47	0.53	0.48	0.46	0.47	0.54	0.49
Mean	0.46	0.49	0.55		0.48	0. 50	0.56	
LSD 5%	Species: 0.01 Spacing: 0.13 Species X Spacing: 0.02				Species: 0.03 Spacing: 0.02 Species X Spacing: 0.04			

Table (2): Effect of plant spacing on the plant fresh and dry weight (g) 90 days from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Plant fresh weight (g)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	24.97	30.08	30.08	27.73	25.14	28.27	31.06	28.16
S.sesbsn	24.47	25.63	28.26	26.12	24.30	25.97	29.79	26.26
Mean	24.72	26.89	29.17		24.72	27.12	29.79	
LSD 5%	Species: 1.73 Spacing: 1.41 Species X Spacing: 2.45				Species: 1.33 Spacing: 1.09 Species X Spacing: 1.88			
Plant dry weight (g)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	5.73	6.15	6.72	6.20	5.82	6.36	6.77	6.32
S.sesbsn	4.67	5.71	5.04	5.47	4.42	5.72	6.26	5.47
Mean	5.20	5.93	6.38		5.12	6.04	6.52	
LSD 5%	Species: 0.24 Spacing:0.19 Species X Spacing :0.34				Species: 0.18 Spacing: 0.15 Species X Spacing: 0.25			

Table (3): Effect of plant spacing on the root fresh and dry weight (g) 90 days from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Root fresh weight (g)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	2.31	2.50	2.63	2.48	2.42	2.55	2.65	2.54
S.sesbsn	2.12	2.33	2.47	2.30	2.17	2.26	2.51	2.31
Mean	2.21	2.41	2.55		2.30	2.41	2.59	
LSD 5%	Species: 0.42 Spacing: 0.03 Species X Spacing: 0.06				Species: 0.07 Spacing: 0.05 Species X Spacing: 0.09			

Root dry weight (g)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	0.63	0.73	0.84	0.73	0.63	0.76	0.82	0.74
S.sesbsn	0.40	0.51	0.63	0.51	0.45	0.56	0.66	0.56
Mean	0.52	0.62	0.74		0.54	0.66	0.74	
LSD 5%	Species: 0.06 Spacing: 0.05 Species X Spacing : :0.09				Species: 0.06 Spacing: 0.04 Species X Spacing : 0.08			

Table (4): Effect of plant spacing on the range, average and standard deviation of stem diameters (cm) of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Range, average and standard deviation of stem diameters (cm)

Treatments	2013/2014			2014/2015		
	Range	**Average**	**S.D**	**Range**	**Average**	**S.D**
S. grandiflora						
1X0.5 m	3.21 – 8.74	5.79	± 2.18	3.17 – 8.54	5.21	± 1.47
1X1.0 m	3.05 – 8.85	6.39	± 2.13	3.73 – 8.60	6.00	± 1.36
1X1.5 m	5.52 – 12.48	8.94	± 2.30	5.95 – 11.21	8.48	± 1.99
S. sesbsn						
1X0.5 m	3.69 – 7.48	5.16	± 1.47	3.03 – 6.69	4.34	± 1.06
1X1.0 m	3.22 – 7.05	5.18	± 1.16	3.82 – 7.64	5.34	± 0.93
1X1.5 m	5.59 – 8.51	6.48	± 1.25	4.50 – 8.64	6.63	± 1.23

Table (5): Effect of plant spacing on the range, average and standard deviation of stem diameters (cm), stem length (m) and stem diameter (cm) one year from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Stem length (m)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	8.17	8.10	7.34	7.87	7.72	8.82	8.59	8.38
S.sesbsn	5.94	5.12	5.84	5.63	5.27	6.24	6.08	5.86
Mean	7.05	6.61	6.59		6.50	7.53	7.33	
LSD 5%	Species: 0.44 Spaces: 0.42 Species X Spaces: 0.60				Species: 0.47 Spaces: 0.44 Species X Spaces: N.S			

Stem diameter (cm)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	6.65	7.37	8.30	7.44	6.51	7.08	7.80	7.13
S.sesbsn	5.13	5.31	6.10	5.52	4.93	5.15	6.04	5.37
Mean	5.89	6.34	7.20		5.72	6.12	6.92	
LSD 5%	Species: 1.3 Spaces: 0.82 Species X Spaces: N.S				Species: 1.26 Spaces: 0.79 Species X Spaces: N.S			

Table (6): Effect of plant spacing on the stem fresh weight, wings and leaves fresh weight and the aboveground biomass (kg) one year from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Stem fresh weight (kg)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	7.77	9.98	11.10	9.62	7.38	9.68	10.87	9.31
S.sesbsn	2.85	3.26	4.07	3.40	2.74	3.20	4.03	3.32
Mean	5.31	6.62	7.59		5.06	6.44	7.45	
LSD 5%	Species: 5.31 Spaces: 6.62 Species X Spaces: 0.98				Species: 0.76 Spaces: 0.65 Species X Spaces: 0.93			

Wings and leaves fresh weight (kg)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	3.04	4.52	5.29	4.28	2.89	4.38	5.18	4.15
S.sesbsn	1.8	2.09	2.11	1.99	1.72	2.04	2.09	1.95
Mean	2.41	3.30	3.70		2.30	3.21	3.64	
LSD 5%	Species: 0.42 Spaces: 0.39 Species X Spaces:0.55				Species: 0.40 Spaces: 0.37 Species X Spaces: 0.53			

Aboveground biomass (kg)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	10.81	14.50	16.39	13.90	10.28	14.1	16.10	13.49
S.sesbsn	4.63	5.35	6.18	5.39	4.46	5.24	6.12	5.27
Mean	7.72	9.92	11.29		7.37	9.67	11.11	
LSD 5%	Species: 1.18 Spaces: 0.92 Species X Spaces: 1.30				Species: 1.13 Spaces: 0.90 Species X Spaces: 1.27			

Table (7): Effect of plant spacing on the stem, wings and leaves dry weight (kg) 1 year from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Stem dry weight (kg)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	4.05	4.21	5.79	4.68	3.93	4.12	5.73	4.59
S.sesbsn	1.38	1.59	1.98	1.65	1.35	1.57	1.98	1.64
Mean	2.72	2.90	3.89		2.64	2.85	3.86	
LSD 5%	Species: 0.32 Spaces: 0.97 Species X Spaces: N.S				Species: 0.46 Spaces: 0.48 Species X Spaces: 0.68			

Wings and leaves dry weight (kg)

Treatments	2013/2014				2014/2015			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	1.40	2.08	2.44	1.97	1.36	2.04	2.41	1.94
S.sesbsn	0.84	0.98	0.99	0.94	0.82	0.97	0.99	0.93
Mean	1.12	1.53	1.72		1.09	1.51	1.71	
LSD 5%	Species: 0.19 Spaces: 0.18 Species X Spaces: 0.25				Species: 0.18 Spaces: 0.17 Species X Spaces: 0.24			

Table (8): Effect of plant spacing on the moisture content (%) and specific gravity of wood (g/cm^3) 1 year from establishment of *Sesbania* species during 2013/2014 and 2014/2015 seasons.

Moisture content (%)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	33.14	39.96	34.09	35.73	33.47	41.56	34.77	36.60
S.sesbsn	46.64	39.29	39.67	41.87	49.44	40.47	41.66	43.86
Mean	39.89	39.63	36.88		41.45	41.02	38.22	
LSD 5%	Species: 5.78 Spaces: N.S Species X Spaces: 4.21				Species: 6.05 Spaces: N.S Species X Spaces: 4.33			

Specific gravity (g/cm^3)								
Treatments	**2013/2014**				**2014/2015**			
	1X0.5 m	**1X1.0 m**	**1X1.5 m**	**Mean**	**1X0.5 m**	**1X1.0 m**	**1X1.5 m**	**Mean**
S.grandiflora	0.59	0.51	0.56	0.55	0.57	0.48	0.54	0.53
S.sesbsn	0.45	0.53	0.48	0.49	0.43	0.50	0.47	0.47
Mean	0.52	0.52	0.52		0.50	0.49	0.51	
LSD 5%	Species: N.S Spaces: N.S Species X Spaces: 0.01				Species: N.S Spaces: N.S Species X Spaces: 0.08			

Discussion

The effect of different plant spacing on the growth, biomass production and some wood properties of two *Sesbania* species were conducted on two successive seasons. Increase in plant spacing from 1 X 0.5 m up to 1 X 1.5 m significantly increased all the growth parameters in both the species under tested. The highest value of growth and biomass production were obtained with *S. grandiflora*. However, significant influence of the growing space on growth and biomass characters were observed at 90 days and one year from establishment in *S. grandiflora* and *S. sesban*. In this respect, individual plant performance was superior at low plant density as compared to high plant density (Desai and Halepyati, 2007). Also, Beldt *et al.*, (1982) also observed decrease in DBH and tree height with increase in density from 5,000 to 40,000 plants per ha in *Leucaena* and attributed it to interplant competition. Moisture content and specific gravity of wood are an important determinant of wood quality and dry weight yields per volume of woody material. Density of wood decreases as moisture content decreases, but below the fiber saturation point the specific gravity of a sample increases as the moisture content decreases (USFPL, 1987). Moreover, by increasing growth rate, wide spacing of some woody trees tends to maximize its density (Haygreen and Bowyer, 1996).

In conclusion, the *Sesbania* production not only benefited for the wood and other uses but also high yield of the following agricultural crop. However, the growth and yield of *Sesbania* plantations in Egypt can be further improved through the use of good planting materials, application and management techniques during the establishment and maintenance of plantation. Results of the present study may be useful in the choice of species for growing as alley cropping with the different crops at the newly reclaimed soil and establishing of artificial forests in Egypt.

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