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EFFECT OF TREE SPACING AND STUMP HEIGHT ON COPPICING AND BIOMASS PRODUCTION OF *POPULUS NIGRA* L. GROWN IN SANDY SOIL UNDER ASWAN CONDITIONS

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ABSTRACT

Black poplar planted at 2x2 , 3x3 and 4x4 m spacing was established on April 1997 in an infertile soil at Kom-Ombo, Aswan . Selected trees were cut at 10 , 15 and 20 cm above ground level in August 2007 to start a new rotation and evaluate their products for biomass and some wood properties . On January 2009 , the plantation was coppiced to evaluate their shoots in light of the used tree spacing and cutting levels .

Results showed that wide (4x4 m) spacing increased total and merchantable height , diameter at breast height , stem and branches fresh weight as well as total biomass compared to the 2x2 or 3x3 m spacing . It appeared that tree spacing had no significant effect on physical and chemical properties of the wood . The best results for moisture, cellulose and holocellulose contents were obtained from 2x2 m spacing. Meanwhile, extractive content , specific gravity and hemicellulose content percentage in wood were increased for the wide spacing (4x4) .

For shoots that generated from coppicing (age of 17 months), cutting at 15 cm above ground with the wide (4x4 m) spacing gave the best results for branch number and diameter and branch fresh weight , while 15 cm stump height with 2x2 m

spacing resulted in the tallest branches compared to the other treatments . In relation to the studied physical and chemical properties in wood of shoots, there were no significant differences among cutting levels and tree spacing treatments . However, the 3x3 m spacing gave the best results for moisture content, specific gravity , cellulose , hemicellulose and holocellulose content in wood of shoots , while the highest value (3.33 %) of extractive content was with 2x2 m spacing .

Total stool mortality percentage over the 17 months rotation period after coppice was reduced at the 15 cm stump height and with the 3x3 m spacing , while the highest value (25.91 %) of stool mortality was with stump height of 20 cm above ground level .

Soil under black poplar plantation was improved after ten years from tree establishment . However, the best results for organic matter percentage and pH value were due to planting trees at 3x3 m spacing . Meanwhile, the best result for EC was attained with 2x2 m spacing .

INTRODUCTION

Black poplar (*Populus nigra* L.) is a species of poplar in the cottonwood (*Aegiros*) section of the genus *Populus* in the family Salicaceae , native of Europe , southwest and central Asia , and northwest Africa . It is a medium - sized to large deciduous tree , reaching 20 - 30 m , with a trunk up to 1 – 5 m diameter . The species is dioecious (male and female flowers on different plants), with flowers in catkins and pollination by wind (Rushforth , 1999) . In many areas fast-growing poplars are grown on plantations for pulpwood and manufacture of paper .It is also sold as an inexpensive hardwood timber ,used for pallets and cheap plywood and more specialized uses including matches and boxes. There is an interest in using poplar as an energy crop for biomass or biofuel , in energy forestry systems , particularly in light of its high energy out-energy in ratio , large carbon mitigation potential and fast growth .

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The use of alternative and renewable energy play a role in the efforts to reduce the carbon dioxide emission levels. Energy crops, and tree biomass crops in particular, are among the most promising renewable energy sources. Tree biomass cropping or short rotation forestry refers to woody biomass production in carefully tended plantation using fast growing hardwoods for rotations shorter than 15 years . However, an atmospheric CO_2 concentrations have risen some 35 - 40% since preindustrial times. The planting of trees proposed as one means to decrease the rate of CO_2 increase in the atmosphere as trees actively absorb CO_2 in the process of photosynthesis . Fast growth tree plantations as poplars are considered highly efficient carbon sinks because of their relatively high rates of productivity.

Coppicing , or cutting down a tree to produce new growth, has been a way of harvesting wood for hundreds of years . Far from being destructive, coppicing has been the reason why many woodlands have survived, because the woodland had an economic value. Coppicing rejuvenates the tree, so some coppice stumps or stools are hundreds of years old, and are an important genetic link back to the ancient woodlands. Moreover, in the past, the rural economy was based on coppicing, and coppice products were used for building, fencing, fuel, furniture and many uses . On the other hand, coppicing requires only simple hand tools and produces material which can be manually handled, the reason for its importance in the past and its relevance today.

The most important characteristic of species that affects its suitability for particleboard manufacture is its specific gravity. As a general rule, the lower-density species - as in poplars - are preferred, the medium - density woods are used if readily available at a good price, but the highest- density woods are avoided (Maloney, 1977) . Also, density is directly related to cell wall thickness. The general rule is that the lower the density, and thus the lower the proportion of thick-walled latewood cells, the better the wood as a papermaking raw

material (Haygreen and Bowyer, 1996).

The objective of this study was to find out how the second generation biomass production is affected by tree spacing and stump height of *Populus nigra*. Also, to determine the biomass and some wood properties of ten years old of *Populus nigra* grown in sandy soil under Aswan conditions.

MATERIALS AND METHODS

Experimental design :

This study was conducted at the Tropical Farm in Kom-Ombo under directorate of Botanical Garden at Aswan . Cultured plantation of poplar (*Populus nigra* L.) was established in April 1997 in sandy soil which had the physical and chemical properties shown in Table 1. Initial planting space were 2 × 2 , 3 × 3 and 4× 4 m . A split plot design was conducted , planting space was considered the main plot and create a coppice occupide sub plot . Seventy poplar trees were planted in a randomized block design with three replicates per planting space . The first cut was made on August 2007 to create a coppice culture at three heights above ground level i.e ; 10 , 15 and 20 cm . So the treatments were three planting space and three stump height (9 treatments) . Three replicates were used for each treatment and each consisted of three poplar trees . On January 2009 , the second coppice was made at the age of 17 months for the new shoots of poplar trees .

Table 1: Experiment soil properties before planting poplar trees (1997)

Characters	1997
Coarse sand	29.80
Fine sand	47.55
Silt	7.95
Clay	14.70
EC. ds/m	0.88
pH	8.32
O.M. %	0.25

Measurements :

- Initial soil sampling was carried out on April 1997 just before the poplar trees establishment , and the final soil sampling was made on December 2006 . Soil samples were analyzed for organic matter , soil pH and electrical conductivity (E.C.) with two sub samples for each sample as following :
- Organic matter(O.M.) was determined using Walkely and Back's method (Jackson, 1973).
- The soil pH was measured in 1:1 soil - water suspension using pH meter .
- Electrical conductivity (E.C.) was estimated in 1 : 1 soil - water extracts using electrical conductivity meter.
- Measurements of shoot diameter and number were made after the first and second coppicing , as well as stool mortality after the first cutting .
- Diameter at breast height and total height of coppiced trees were recorded in the first and second coppicing . The sampled trees (a total of 3 trees from each replicate) 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 weighed . In addition, three disks about 5 cm. in thickness at breast height were removed from each tree for specific gravity, moisture content, wood extractive, cellulose, hemicellulose and holocellulose content .
- Specific gravity (g/cm^3) and moisture content of the wood were estimated according to American Society for Testing Materials (ASTMD . 1989).
- Extractive content was determined according to ASTMD - 1107 - 56 (1989).
- Cellulose was determined by treating the extractive free sawdust meal with nitric acid and sodium hydroxide : one gram of extractive free was treated with 20 ml of a solution of nitric acid 3% in flask and was boiled for 30 min. The solution was filtered in crucible G3.

The residue was treated with 25 ml of a solution of sodium hydroxide 3% and was boiled for 30 min. The residue was filtered, washed with warm water to neutral filtrate, dried and weight (Nikitin, 1960).

$$\text{Cellulose content \%} = \frac{\text{Weight of cellulose}}{\text{Oven dry weight}} \times 100$$

- Hemicellulose content was determined according to Rozmarin and Simionescu (1973).

$$\text{Hemicellulose content \%} = \frac{\text{Weight of Hemicellulose}}{\text{Oven dry weight}} \times 100$$

- Holocellulose was calculated by the addition of cellulose to hemicellulose.
- All obtained data were tabulated and statistically analyzed according to the method discribed by Snedecor (1956), and L.S.D by Little and Hills (1978) .

RESULTS

Growth and biomass production :

Table 2 represents the effect of tree spacing of black poplar at 2x2 , 3 x3 and 4x4 m on total and merchantable height, diameter at breast height, total biomass and stem and branches fresh weight of ten years old black poplar trees. The data showed that planting black poplar at 2x2 m spacing significantly decreased total and merchantable height as well as diameter at breast height . Meanwhile, the most increment in total and merchantable height and diameter at breast height was attained with of 4x4 m distance.

Table 2 also shows that stem and branches fresh weight, as well as, total biomass of black poplar were gradually increased with the increase in tree spacing . The lightest stem and branches fresh weight were recorded with the 2x2 m spacing . It is clear from Table 2 that all

studied parameters of biomass were significantly affected under plant spacing treatments

Table 2 : Effect of tree spacing on growth and biomass production of ten years old black poplar grown in sandy soil under Aswan conditions.

Tree spacing (m)	Total height (m)	Merchantable height (m)	Diameter at breast height (cm)	Stem fresh weight (kg)	Branches fresh weight (kg)	Total Biomass (kg)
2x2	11.36	8.07	23.81	225.89	90.80	316.69
3x3	11.94	8.98	27.80	255.31	173.68	428.99
4x4	12.71	9.92	34.48	359.33	265.92	625.26
L.S.D.at 5%	0.89	1.01	3.20	50.06	23.77	64.14

Physical and chemical properties of the wood :

Data in Table 3 represent the effect of tree spacing of black poplar at 2x2 , 3x3 and 4x4 m on some physical and chemical properties of the wood at 10 years age. The used spacing treatments did not significantly affect all studied properties . However, the highest value (83.77 %) of moisture content was obtained with 3x3 m spacing. Meanwhile the wider (4x4 m) spacing of poplar resulted in the highest values of specific gravity and extractive contents. In addition, the most increment in cellulose and holocellulose contents were recorded with planting black poplar at 2x2 m spacing, while the wide (4x4 m) spacing gave the highest value (26.16 %) of hemicellulose in wood compared to the other two treatments.

Effect of spacing and stump height on :

a- Number and length of branches :

Data in Table 4 indicate that tree spacing had statistical significant effect on number and length of branches after the 17 months rotation period . Cutting level at 15 cm resulted in the highest values of number and length of branches, while the lowest values were produced by trees

that coppiced at 20 cm aboveground level .

Regarding the influence of tree spacing on number and length of branches results showed that black poplar with 4x4 m spacing give the highest value of branches number . Branches length tended to be taller when the planting space decreased . Also, the shortest branches of black poplar (3.27 m)were observed with planting at the wider spacing (Table 4) .

Table 3 : Effect of tree spacing on some physical and chemical properties of the wood of ten years old black poplar grown in sandy soil under Aswan conditions.

Tree spacing (m)	Moisture content at fresh condition %	Specific gravity (g/cm^3)	Extractive content %	Cellulose content %	Hemicellulose content %	Holocellulose content %
2x2	82.96	0.41	3.98	39.56	26.11	65.67
3x3	83.77	0.42	3.95	39.11	25.99	65.10
4x4	83.21	0.43	4.05	39.22	26.16	65.38
L.S.D.at 5%	N.S	N.S	N.S	N.S	N.S	N.S

The interaction between planting space and cutting levels was significant for number and length of branches as shown in Table (4). The greatest branches number were observed when black poplar was planted at 4x4 m spacing and cut at 15 cm aboveground level . Moreover, length of poplar branches was increased more when coppiced at 15 cm with the 2x2 m spacing.

Table 4 : Number and length of branches of black poplar (at age of 17 months old) as affected by cutting and spacing levels .

Stump height (cm)	Branches number				Branches length (m.)			
	Tree spacing (m)(A)				Tree spacing (m)			
	2x2	3x3	4x4	Mean	2x2	3x3	4x4	Mean
10 cm.	47	64	76	62	3.75	3.47	3.22	3.48
15 cm.	52	73	85	70	4.65	3.85	3.66	4.06
20 cm.	35	60	58	51	3.28	3.35	2.93	3.19
Mean	44	66	73		3.90	3.56	3.27	
L.S.D.at 5%	A: 6	B: 5	AB: N.S.		A: 0.13	B: 0.17	AB: 0.29	

b - Diameter and fresh weight of branches :

Table 5 shows diameter and fresh weight of branches after 17 months from coppicing as affected by distance of planting and cutting height . Data revealed that the most effective treatment of stump height was 15 cm , which gave 4.7 cm and 56.5 kg for branch diameter and branch fresh weight , respectively. Cutting at 10 cm aboveground level significantly improved of branches diameter and fresh weight compared to 20 cm cutting height .

Concerning the effect of tree spacing on branches diameter and fresh weight , it was clearly noticed that planting at wide (4x4 m) spacing recorded the highest values of branch diameter and fresh weight compared to the other spacing treatments .

The interaction between the used different spacing treatments and cutting levels indicated that the thickest branch (5.6 cm) and the heaviest one (75.6 kg) were obtained at the 15 cm cutting with 4x4 m spacing treatments . Whereas, coppicing at 20 cm with 2x2 m spacing for black poplar gave the least value (3.0 cm) of branch diameter . On the other hand , using the 10 cm cutting level with 2x2 m spacing gave the least value (25.0 kg) of branch fresh weight .

Table 5 : Diameter and fresh weight of branches of black poplar (at age of 17 months old) as affected by spacing levels and cutting high .

Stump height (cm)	Branches diameter (cm)				Branches fresh weight (kg)			
	Tree spacing (m)				Tree spacing (m)			
	2x2	3x3	4x4	Mean	2x2	3x3	4x4	Mean
10 cm.	3.6	3.9	4.1	3.8	25.0	49.3	63.3	45.9
15 cm.	3.7	4.8	5.6	4.7	40.7	53.1	75.6	56.5
20 cm.	3.0	3.3	3.6	3.3	37.7	27.8	47.3	37.6
Mean	3.4	4.0	4.4		34.5	43.4	62.1	
L.S.D.at 5%	A: 0.7 B: 0.4 AB: 0.6				A: 4.1 B: 3.7 AB: 6.4			

c – Physical wood properties :

The effect of tree spacing and stump height on moisture content and specific gravity of poplar shoots are shown in Table 6. No significant differences were observed between means of either moisture percentage and specific gravity as a result of using the cutting levels . However, 20 cm cutting level decreased both moisture content and specific gravity in shoots. It is also clear that 2x2 m spacing increased moisture percentage (84.89 %) , while, 3x3 m spacing gave the greatest value (0.36 g/cm^3) of specific gravity in the produced shoots .

The interaction between tree spacing and stump height on the physical properties of shoots, was not significant . However, the lowest value of moisture percentage (84.00 %) at the fresh condition was recorded by using the third level of cutting with the 2x2 m spacing . The highest value (0.37 g/cm^3) of specific gravity of poplar shoots was obtained at 15 cm cutting level with spacing of 3x3 m .

Table 6 : Physical properties of black poplar wood (at age of 17 months old) as affected by cutting and spacing levels .

Stump height (cm)	Moisture content at fresh condition %				Specific gravity			
	Tree spacing (m)				Tree spacing (m)			
	2x2	3x3	4x4	Mean	2x2	3x3	4x4	Mean
10 cm.	85.33	84.67	85.00	85.00	0.34	0.35	0.35	0.35
15 cm.	85.33	85.00	84.33	84.89	0.35	0.37	0.35	0.35
20 cm.	84.00	84.33	85.00	84.44	0.35	0.35	0.32	0.34
Mean	84.89	84.67	84.78		0.35	0.36	0.34	
L.S.D.at 5%	A: N.S	B: N.S	AB: N.S		A: N.S	B: N.S	AB: N.S	

d– Chemical properties :

Planting black poplar at 3x3 m spacing resulted in the highest value (36.67 %) of cellulose content in the wood . On the other hand, the least content of cellulose (34.22 %) was recorded with the wider (4x4 m) spacing . The interaction between stump height and tree spacing in relation to extractive and cellulose contents of poplar wood

was statistically not significant. However, the highest value (3.33 %) wood extracts of poplar were obtained at 10 cm cutting level and planting at 2x2 m spacing. Meanwhile , the highest value (36.67 %) of cellulose content resulted from 20 cm stump height with 3x3 m spacing.

Obtained data in Table 7 also show that extractive percentage and cellulose percentage of shoots wood were not significantly affected by different stump height levels . Coppiced trees at 10 cm above ground level resulted in increasing extractive percentage (3.12 %) and cellulose content (34.89 %) compared to the cutting at the highest level from ground surface . Data in Table 7 clearly indicate the effectiveness of the 2x2 m spacing in augmenting content of extractives (3.21 %) shoots wood compared to the wider spacing .

Table 7 : Chemical properties of black poplar wood (at age of 17 months old) as affected by spacing levels and cutting

Stump height (cm)	Extractive content (%)				Cellulose content (%)			
	Tree spacing (m)				Tree spacing (m)			
	2x2	3x3	4x4	Mean	2x2	3x3	4x4	Mean
10 cm.	3.33	3.07	2.97	3.12	34.00	36.33	34.33	34.89
15 cm.	3.13	3.09	3.11	3.11	35.67	34.00	35.00	34.89
20 cm.	3.18	3.04	3.09	3.11	34.33	36.67	33.33	34.78
Mean	3.21	3.07	3.06		34.67	35.67	34.22	
L.S.D.at 5%	A: N.S	B: N.S	AB: N.S		A: N.S	B: N.S	AB: N.S	

Data recorded in Table 8 indicate that stump height levels ,i.e. 10 , 15 and 20 cm did not significantly affected either hemicellulose or holocellulose content in poplar wood. Generally, cutting trees at 10 cm above ground level increased hemicellulose and holocellulose contents in wood compared to the cutting at the highest level. Both hemi – and holocellulose contents were decreased in case of planting poplar trees at the wider (4x4 m) spacing. However, the highest values of hemi – and holocellulose were obtained with planting at the medium (3x3 m) spacing.

The interaction between stump height and tree spacing was not significant in concern their effects on hemi – and holocellulose in poplar wood. However, the highest value (62.00 %)of holocellulose content was obtained from the 10 cm stump height with planting at 3x3 m spacing.

e - Stool mortality % :

Data in Table 9 represent the effect of tree spacing and stump height on stool mortality percentage after the first coppicing of black poplar. Stool mortality percentage was decreased with using the medium (15 cm) cutting level. The 20 cm cutting level had the highest stool mortality (25.91 %) compared with the other levels of cutting. Table 9 also shows that medium spacing (3x3 m) resulted in the lowest value (7.43 %) of stool mortality compared with the other spaces . The effect of interaction between stump height and tree spacing on stool mortality percentage , show that 20 cm stump height with 2x2 m spacing resulted in the highest value (33.20 %) of stool mortality percentage.

Table 8 : Some chemical properties of black poplar wood (at age of 17 months old) as affected by cutting and spacing levels .

Stump height (cm)	Hemicellulose content %				Holocellulose content %			
	Tree spacing (m)				Tree spacing (m)			
	2x2	3x3	4x4	Mean	2x2	3x3	4x4	Mean
10 cm.	24.67	25.33	25.33	25.11	58.67	62.00	59.67	60.11
15 cm.	25.33	25.33	24.33	25.00	61.00	59.33	59.33	59.89
20 cm.	23.67	23.67	23.67	23.67	58.00	60.33	57.00	58.44
Mean	24.56	24.78	24.44		59.22	60.56	58.67	
L.S.D.at 5%	A: N.S	B: N.S	AB: N.S		A: N.S	B: N.S	AB: N.S	

Table 9 : Stool mortality percentage of black poplar trees after the first coppicing as affected by tree spacing and cutting levels .

Stump height (cm)	Stool mortality %			
	Tree spacing (m)			
	2x2	3x3	4x4	M
10	0.00	0.00	22.20	7.40
15	0.00	0.00	11.10	3.70
20	33.20	22.30	22.23	25.91
M	11.06	7.43	18.51	

f – Soil properties :

Data in Table 10 show the effect of tree spacing ,i.e. 2x2 , 3x3 and 4x4 m on some soil properties under black poplar planting . Planting poplar at the medium (3x3 m) spacing resulted in the highest value (3.53 %) of organic matter compared to the other tree spacing. The least value (7.66) of PH was obtained planting trees at 3x3 m spacing, while the least value (0.29) of E.C. was obtained from planting trees in the wider (4x4 m) spacing.

Table 10 : Effect of tree spacing of black poplar after ten years from Planting on some soil properties .

Tree spacing (m)	Organic matter %	pH values	E.C. values
2x2	3.22	7.82	0.34
3x3	3.53	7.66	0.33
4x4	3.43	7.68	0.29

DISCUSSION

The results of this experiment show that planting black poplar at the wider (4x4 m) spacing increased growth and biomass production at age of ten years old of trees . Similar results were reported for Balsam Spire poplar (Proe *et. al.* 2002) . Planting at wider spacing increased root : shoot ratios and leaf weight ratios in poplar trees and reduced the

seasonal interception of photosynthetically active radiation (PAR) . In addition, the amount of space in which a tree grows is an extremely important determinant of growth rate and thus of wood properties (Haygreen and Bowyer 1996) .

Planting black poplar at the wider spacing (4x4 m) resulted in the highest values of specific gravity and extractive contents . These results are similar to that reported by Clark *et. al.* (1994) on loblolly pine and found that wider spacing of trees can result in higher properties of juvenile wood and greater stem taper than that which develops with closer spacing. Also, increasing growth rate and spacing of young ring-porous hardwoods tended to maximise density and thus strength of these trees (Haygreen and Bowyer 1996) .

Spacing levels had no significant effect on wood contents of cellulose, hemi- and holocellulose . Evidence of higher cellulose and holocellulose contents in wood poplar at 4x4 m spacing than of those planted in 2x2 or 3x3 m spacing . These findings are in agreement with the results of Clark *et. al.* (1994) .

The trend towards a higher yield of biomass when black poplar was grown at 4x4 m spacing . Moreover, the produced shoots after coppicing trees tended to increase with planting at the wider spacing as well as cutting at 15 cm above ground level. Similar observation was also reported by Proe *et. al.* (2002) . If cutting was made several centimeters higher the stools does not dry sufficiently far down to affect the buds around the base of the stool (Matthews 1989) .

In relation to the effect of stump height and tree spacing on the physical and chemical properties of the wood of shoots, it was not significant. In fact, the wood properties required for energy should have high specific gravity and low moisture content (Matthews 1989). Generally , planting black poplar at 3x3 m with coppicing at 10 cm from ground level was useful in this respect. The main application of intensive cutture appears to be for production of wood for reconstituted products such paper and flakeboard or for energy generation (Haygreen

and Bowyer 1996). Planting black poplar at 3x3 m spacing decreased the percentage of stool mortality when coppiced at 15 cm from ground level. In this respect, Casella *it. al.* (2001) found that reducing the original planting density of poplar c.v. Clone Gaver resulted in decreasing shoot and stool mortality.

Soil under black poplar trees contained a higher concentration of organic matter especially at 3x3 m spacing and had a better pH and E.C than before planting. The primary process held responsible for the formation of high fertility soils around trees related to enhanced biological processes with the seasonal and long-term return of nutrients accumulated in trees to the soil through litter fall , root decay and exudation and their mineralization , as well as leaching of nutrients stored in canopies (Boffa 1999). The study of Ebeid (2006) further confirmed the benefits of trees to the soil fertility. In conclusions , there is an interest in using poplar as an energy crop for biomass or biofuel , in energy forestry systems , particularly in light of coppicing and resprouting ability. Poplar coppicing is worked on a shorter rotation than most high forest crops. Thus coppice is particularly suitable for small private properties in places when is demand for the produce yielded by it.

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مسافات الزراعة وارتفاع الأرومة وتأثيراتهما على إنتاج الأفرع والكتلة الحيوية لأشجار الحور الأسود النامى فى تربة رملية تحت ظروف أسوان

أحمد فخرى على عبيد - رمضان محمد محمد سيد - أماتى عبد الرحيم أحمد

قسم بحوث الأشجار الخشبية والغابات

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تمت زراعة عقل الحور الأسود فى أرض رملية منخفضة الخصوبة بمنطقة كوم أمبو –محافظة أسوان فى شهر أبريل من عام 1997على مسافات 2 x 2، 3 x 3، 4 x 4م ، وأتبع فى الرى طريقة الرى بالغمر . وفى أغسطس من عام 2007تم قطع بعض الأشجار بالطريقة الجمية على أرتفاع 10، 15، 20سم من سطح التربة ، فكانت هناك 9معاملات وكل معاملة أحتوت على ثلاث مكررات وتم تقدير الكتلة الحيوية وكذلك بعض خصائص الخشب الطبيعية والكيماوية للأشجار التى قطعت . وفى يناير 2009تم قطع الأفرع الناتجة لتقييمها عند عمر 17شهر من حيث خصائص الكتلة الحيوية وبعض صفات الخشب الطبيعية والكيماوية .

وكانت أهم النتائج المتحصل عليها مايلى :

١ - أعطت أشجار الحور الأسود المنزرعة على مسافة 4 x 4م أعلى القياسات الخاصة بأرتفاع الأشجار الكلى والطول التجارى والقطر عند مستوى الصدر والوزن الطازج للساق الرئيسى وللأفرع وأيضا إجمالى الكتلة الحيوية مقارنة بالأشجار المنزرعة على باقى المسافات . وكانت النتائج الخاصة بالصفات الطبيعية مثل محتوى الرطوبة والثقل النوعى للخشب غير معنوية ، وأيضا بالنسبة للصفات الكيماوية موضع الدراسة مثل محتوى المستخلصات الخشبية ، محتوى السليولوز ، الهيميسليولوز والهولوسليولوز كانت غير معنوية . وكانت أفضل النتائج بالنسبة لمحتوى الرطوبة والسليولوز والهولوسليولوز نتيجة لزراعة أشجار الحور الأسود على مسافة 2 x 2م . بينما أعطت الزراعة على مسافة 4 x 4م أفضل النتائج بخصوص محتوى الخشب من المستخلصات الخشبية والثقل النوعى ومحتوى الهيميسليولوز .

٢ - بالنسبة للأفرع الناتجة عن القطع بالطريقة الجمية)عمر 17شهر (، كانت أفضل النتائج بخصوص عدد وقطر ووزن الأفرع الطازج نتيجة لقطع الأشجار المنزرعة على مسافة 4 x 4م مع القطع على أرتفاع 15سم فوق سطح التربة . بينما أعطت الزراعة على مسافة 2 x 2م مع القطع على أرتفاع 15سم فوق سطح التربة أكثر القياسات بالنسبة لطول الأفرع الناتجة . وبالنسبة للخصائص الطبيعية والكيماوية موضع الدراسة فى خشب الأفرع الحديثة الناتجة ، ليس هناك فروق معنوية بين المعاملات المستخدمة ، مع أن الزراعة على مسافة 3 x 3م أعطت أفضل النتائج بخصوص محتوى الرطوبة والثقل النوعى ومحتوى السليولوز ، الهيميسليولوز والهولوسليولوز. بينما المحتوى العالى من المستخلصات الخشبية (3.33 %)كان نتيجة للزراعة على مسافة 2 x 2م .

Populus nigra L. in sandy soil

٣ – إنخفضت النسبة المئوية للأرومات الميتة عند الزراعة على مسافة 3 x 3م ومع القطع على إرتفاع 15سم فوق سطح التربة ،بينما كانت أعلى قيمة (25.91 %) للأرومات الميتة بعد القطع على المستوى الأعلى 20سم .

٤ – زادت خصائص التربة الجيدة بعد عشر سنوات من زراعة أشجار الحور الأسود فى التربة الرملية. وكانت أفضل القياسات بخصوص النسبة المئوية للمادة العضوية والرقم الهيدروجينى pHفى التربة نتيجة لزراعة الأشجار على مسافة 3 x 3م ، بينما زادت خصائص التوصيل الكهربى E.Cعند زراعة الأشجار على مسافة 2 x 2م .