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Asexual Propagation of Physic Nut (*Jatropha curcas* L.) Under Different Rooting Media and Hormones

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Abstract

One of the main problems in jatropha cultivation is the poor seed germination**.**It is an open pollinated crop with high percent of cross pollination and genetically mixing. Use of cuttings will save seeds for oil production. Vegetative propagation, on the other hand, produces exact duplicates to their parent plants.This Study was conducted at the nursery of the College of Agricultural Studies, Sudan University of Science and Technology at Shambat, Sudan, with the objectives of evaluating the impact of using different rooting media (Sand, Silt-loam and Compost) using different cutting lengths (20cm, 30cm and 40cm) treated with different (IBA)concentrations on shoot and root performance of (*Jatropha curcas L.*) during seasons of 2012 and 2013. Stem cuttings were from three years old of *Jatropha curcas* plants from Shambat Agricultural Research Center Farm. Cutting bases were dipped in (IBA) solution for one hr. Treated cuttings were planted in rooting media, arranged in RCBD. The studied shoot and root parameters were: number and length of roots/cut, number of leaves/cut, number and lengths of branchesnumber of leaves/cut. Results showed that there were significant differences between length of cuttings, hormone concentrations, and the media on all measured parameters at $P\leq_{0.05}$.The 40 cm long cuttings performed highly better for all measured parameters compared to 30 and 20 cm cuttings. Both low (313 mg/L) and high (2500 mg/L) of IBA concentrations were comparable and resulted in significantly high results for the measured parameters compared to zero control. Compost and silt-loam media are almost similar but better than sand media for rooting and establishment of Jatropha cuttings. Based on the above results it is advisable to use 40cm cuttings with low (IBA) concentration (313 mg/L water) in silt-loam rooting media for successful root formation and cuttings performance for mass propagation techniques of *Jatropha curcas* L.

Keywords: Rooting media, *Jatropha curcas*, IBA, Cutting length.

Introduction

Jatropha curcas L. is a multipurpose shrub belonging to the family Euphorbeaceae with significant economic importance since its seed oil can be converted to biodiesel. It is emerging as a renewable energy source,

alternative to petro diesel. Due to the increasing demand for energy and declining fossil fuel resources (Becker and Francis, 2003) biofuels are worldwide recognized as an alternative source of energy. Several reports have demonstrated better performance of the Jatropha biodiesel compared with the conventional petro diesel, Ghosh *et al*., (2007) and Mandpe *et al*., (2005). Physic Nut (*Jatropha curcas* L.) is a perennial shrub of the tropics and subtropics grow up to five meter and produces seeds containing approximately 30% of oil, Heller (1996), Grimm (1996) and Rockefeller Foundation (1998). It has low requirements to soil quality and can grow under low rainfall conditions. Before being able to conduct research on generation of physic nut oil using different extraction methods and on combustion properties of the oil in the stove, it is necessary to develop high yielding variety, cultivation technology and grow a sufficient amount of physic nut to obtain the desired oil.
Asexual propagation is one of the important factors in the production process of the crop. Jatropha is an open pollinated crop with high percent of cross pollination and genetically mixing Heller (1996). Use of cuttings will also save seeds for oil production. For one hectare, 2X2 meter spacing, about 5000 seeds (four kg) is required. Plantations from stem cuttings result in true to type plants to the selected mother plants.

Since the independence of Sudan energy supply was a challenge because the country imports all it is needs from fossil petrol and gas. Demand increased drastically with the increase in agricultural sector areas. South Sudan secession creates a huge energy gap that aggravated the growing energy needs. This matter enforced the government to search for suitable and renewable energy sources. Significant efforts has been made to boost bio-fuels with the expectations of positive contribution to renewable fuel that does not compete with wildlife, food crops, with limited agricultural inputs and can be grown on areas of land that are not suitable for commercial crops. *Jatropha curcas* L. proved to be an opportunistic crop in tropical areas under unfavorable environments. Producing of biodiesel in commercial quantities achieves energy security goals, and generates rural employment through increasing their income that leads finally to their settlement and lowering poverty Achten *et al*., (2007). This situation lead the government to attempt a (National Program for Biofuel in the Sudan), with concentration on the non-edible sources namely *Jatropha curcas*. In an area of (1million feddan) about (42.194 ha) covering most States, irrigated or rain fed.
The main objectives of this study were to maximize germination of cuttings and enhance root formation for the production of elite seedlings under Central Sudan environment conditions, and to compare different stem cuttings length, propagation media, and rooting hormones for best cuttings establishment.

Materials and Methods

Study area:

The experiment was conducted under shade house in the nursery of the Collage of Agriculture Studies, Sudan University of Science and Technology at Shambat. The area enjoys semi-arid type of climate with mean annual rainfall (200 - 600ml/yr), and means minimum and maximum temperature, February (21°C) and May (45°C). It focused only on nursery production of jatropha cuttings for three months from the planting date.

Sources of materials and preparation:

Cuttings were collected from three years old of Jatropha plants from (Shambat Agricultural

Research Center) (300 m) from nursery site, for the 1st season. And the 2nd season cuttings were from (Soba Energy Research Center) 20 km south of Khartoum. Mature stem cuttings from basal and intermediate branches with diameter of (2.5-3.5cm) were divided in to three groups (20 cm, 30 cm and 40 cm), (180pieces) each.

IBA hormone was obtained from tissue culture lab, (College of Agricultural Studies – Shambat) Tow concentrations of IBA was used. The stock solution was prepared by dissolving 78.25 and 625 mg in a little amount of Ethanol alcohol then completed with a tap water to 250 ml that will be equivalent to (313 mg/L), and (2500 mg/L) for both concentrations respectively besides 0.00 mg/L as control. The concentrations were prepared and stored at 4°C for further used.

Silt-loam was collected from the river bank, while pure sand obtained from Barren area of Khartoum East, and compost (Shomookh al-Tabya) from domestic market were used as rooting media. Black poly ethylene bags of (35×20×10cm) size have been used for cutting propagation.

Data Collection:

Primary data such as root number, root length cm, branches length cm, branch number, and number of leaves were taken throughout three months of study period in the nursery.Branches length, and root lengths was measured using a ruler or plastic tape, while root thickness was measured with a digital caliper. Data were taken on weekly bases and arranged for analysis.

Results and Discussion:

Number of roots:

There were significant differences between length of cuttings (20, 30 and 40cm), IBA hormone concentration (0.00mg, 313 and 2500mg/L) and rooting media (Silt-loam, Sand and Compost) on all parameters measured at $P \leq 0.05$. (Number of roots, root length, number of branches, length of branches and number of the leaves) (Table 1-2) and (Figures 1- 2- 3). Data from table (1) showed that highest number of roots per stem cut resulted from high IBA concentration under silt-loam media for 20 and 30 cm long cuttings. 40 cm cuttings resulted in high number of roots on low and high IBA under silt-loam media. While sand media gave results comparable to the above under high and low IBA concentration and 30, 40 cm cuttings. Similar results were recorded under compost media only with high IBA concentration for 30 and 40 cm long cuttings. In the second season, data from Table (2) showed that high number of root per stem cut resulted from low IBA concentration under silt-loam media for 30 cm long cuttings. 40 cm cutting resulted in highest number of roots on low and high IBA under silt-loam media. While sand media gave results comparable to the above only under low IBA concentration for 30 cm long cuttings. Similar results were recorded under compost media with all IBA concentrations including control only for 40 cm long cuttings.

Number of roots per cutting increased with increase of cutting length for silt-loam and compost media and overall best results are obtained from 40 cm long cuttings. The overall results from IBA concentration indicated that low concentration (313 mg/L) is economically best for rooting of *Jatrophacurcas* stem cuttings. This was supported with the results recorded by Krishnankutty (2005), Noor *et al*., (2009) Kathiravan *et al*., (2009) Maya *et al*., (2010), and Liv *et al*., (2011).

Table 1: Effect of cutting length (cm), IBA and rooting media on shoot and root parameters of *J. curcas* season (2012)

2012	No of roots	Length of roots cm	No of branches	Length of branches cm	No of leaves	Cutting length cm	IBA mg /L	Media
1	13.48^{fg}	36.75^{cde}	4.38^{ghi}	15.13^{abc}	24.35^{hij}		0.00	
2	13.38^{fg}	40.63^{abcde}	4.78^{fghi}	17.00^{ab}	30.75^{defghij}	20	313	
3	20.73^{abcd}	39.06^{abcde}	4.00^{ghi}	17.38^{ab}	27.80^{efghij}		2500	
4	14.56^{efg}	35.69^{de}	5.05^{efghi}	17.25^{ab}	27.30^{fghij}		0.00	
5	16.38^{cdefg}	44.44^{abc}	6.68^{abcde}	17.13^{ab}	39.42^{abcd}	30	313	Silt-loam
6	20.88^{abcd}	41.00^{abcde}	6.60^{abcde}	17.75^{ab}	42.45^{ab}		2500	
7	17.75^{bcdefg}	44.31^{abc}	6.35^{bcdef}	17.00^{ab}	39.65^{abcd}		0.00	
8	21.94^{abc}	44.69^{abc}	7.53^{ab}	17.25^{ab}	41.70^{abc}	40	313	
9	21.75^{abc}	41.25^{abcd}	8.25^{a}	17.75^{ab}	49.33^{a}		2500	
10	15.88^{defg}	33.75^{defg}	3.85^{hi}	7.75^{de}	20.73^{j}		0.00	
11	14.81^{efg}	34.94^{def}	3.73^{i}	11.38^{bcde}	23.58^{ij}	20	313	
12	14.52^{efg}	33.50^{defg}	4.30^{ghi}	7.63^{e}	25.42^{fghij}		2500	
13	17.00^{cdefg}	40.31^{abcde}	4.98^{efghi}	9.00^{cde}	27.27^{fghij}		0.00	
14	20.19^{abcde}	37.00^{bcde}	5.60^{cdefgh}	12.88^{bcde}	29,70^{defghij}	30	313	Sand
15	20.19^{abcde}	41.25 abcd	6.65^{abcde}	14.63^{abcde}	38.17^{bcde}		2500	
16	15.08^{defg}	46.26^{a}	5.53^{defgh}	14.75^{abcd}	26.42^{fghij}		0.00	
17	17.35^{cdefg}	45.06^{ab}	7.73^{ab}	13.88^{abcde}	38.80^{bcd}	40	313	
18	19.96^{abcde}	40.94^{abcde}	6.58^{abcde}	11.38^{bcde}	34.70^{bcdefgh}		2500	
19	13.25^{g}	26.69^{g}	4.68^{fghi}	16.75^{ab}	25.02^{ghij}		0.00	
20	15.18^{defg}	26.69^{g}	4.60^{fghi}	18.00^{ab}	27.73^{efghij}	20	313	
21	15.23^{defg}	26.38^{g}	4.35^{ghi}	17.88^{ab}	25.27^{fghij}		2500	
22	15.69^{defg}	32.81^{efg}	5.38^{defghi}	20.38^{a}	26.9 0^{fghij}		0.00	
23	19.44^{bcde}	35.19^{def}	5.53^{defgh}	14.63^{abcde}	32.60^{bcdefghi}	30	313	Compost
24	23.19^{ab}	27.81^{fg}	5.68^{cdefg}	17.25^{ab}	31.02^{cdefghij}		2500	
25	19.19^{bcdef}	35.81^{de}	7.05^{abcd}	18.50^{ab}	36.13^{bcdef}		0.00	
26	17.19^{cdefg}	40.06^{abcde}	7.33^{abc}	16.25^{ab}	35.80^{bcdefg}	40	313	
27	25.44^{a}	38.75^{abcde}	5.63^{cdefgh}	16.63^{ab}	26.55^{fghij}		2500	
C.V%	19.12%	12.98%	18.40%	27.92%	19.98%			
P-value	0.0163*	0.025*	0.0259*	0.0435*	0.0419*			
$Lsd_{0.05}$	4.781	6.841	0.8462	6.014	8.978			
SE±	1.698	2.43	0.3006	2/136	3.189			

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Table 2: Effect of cutting length (cm), IBA and rooting media on shoot and root parameters of *J. curcas* season (2013)

2013	№ of roots	Length of roots cm	№ of branches	Length of branches mm	№ of leaves	Cutting length cm	IBA mg /L	Media
1	10.89^{ghi}	26.74^{efgh}	7.35^{gh}	13.69^{bcdefgh}	32.44^{efghij}		0.00	
2	11.69^{efghi}	27.75^{defgh}	6.36^{hi}	14.15^{bcdefgh}	33.44^{defghi}	20	313	
3	15.35^{bcd}	23.20^{hi}	5.75^{hij}	11.21^{efgh}	30.48^{efghij}		2500	
4	14.00^{bdefgh}	30.00^{bcdefg}	10.15^{cdefg}	17.75^{bcdef}	51.53^{bcde}		0.00	
5	16.31^{abc}	31.00^{abcdef}	11.38^{bcde}	19.38^{bcd}	57.44^{abc}	30	313	Silt-loam
6	13.06^{cdefgh}	30.31^{bcdefg}	9.81^{cdefg}	18.44^{bcd}	53.43^{bcd}		2500	
7	15.38^{bcd}	33.31^{abcde}	13.66^{ab}	26.63^{a}	70.51 ab		0.00	
8	17.19^{ab}	33.44^{abcd}	14.63^{a}	21.19^{ab}	74.01^{a}	40	313	
9	17.31^{ab}	32.06^{abcdef}	12.54^{abcd}	16.19^{bcdefg}	55.57^{a}		2500	
10	9.31^{i}	30.38^{bcdefg}	5.84^{hij}	7.63^{h}	25.77^{ghij}		0.00	
11	10.63^{hi}	28,69^{cdefgh}	5.90 hij	8.94^{gh}	24.73^{ghij}	20	313	
12	13.46^{cdefgh}	25.58^{fghi}	3.88 ij	7.04^{h}	17.18^{ij}		2500	
13	12.81^{defgh}	31.06^{abcdef}	9.60^{defg}	13.00^{cdefgh}	44.38^{cdefg}		0.00	
14	16.06^{abcd}	32.38^{abcde}	10.57^{cdef}	13.31^{bcdefgh}	44.79^{cdefg}	30	313	Sand
15	12.81^{defgh}	32.02^{abcdef}	8.33^{efgh}	11.13^{efgh}	38.10^{cdefgh}		2500	
16	14.08^{bcdefg}	31,44^{abcdef}	11.87^{abcd}	9.54^{gh}	44.60^{cdefg}		0.00	
17	14.48^{bcdef}	32.35^{abcde}	12.86 abc	11.75^{defgh}	50.60^{cdef}	40	313	
18	15.71^{bcd}	31.67^{abcdef}	9.57^{defg}	9.21^{gh}	33.24^{defghi}		2500	
19	11.21^{fghi}	26.81^{efgh}	4.05^{ij}	9.54^{gh}	18.21^{hij}		0.00	
20	11.93^{efghi}	24.56^{ghi}	3.06^{j}	11.13^{efgh}	14.47^{ij}	20	313	
21	11.48^{efghi}	20.71^{i}	2.71^{j}	10.31^{fgh}	11.96^{j}		2500	
22	13.00^{cdefgh}	28,63^{defgh}	5.73^{ijh}	15.63^{bcdefg}	28.05^{ghij}		0.00	
23	14.69^{bcde}	27.81^{defgh}	5.79^{hij}	15.81^{bcdefg}	28.41^{ghij}	30	313	Compost
24	15.81^{bcd}	31.25^{abcdef}	5.82^{hij}	16.56^{bcdefg}	31.22^{efghij}		2500	
25	16.38^{abc}	36.50^{ab}	7.51^{fgh}	19.94^{abc}	38.30^{cdefgh}		0.00	
26	17.25^{ab}	35.19^{abc}	7.58^{fgh}	18.88^{bcde}	40.74^{cdefg}	40	313	
27	19.13^{a}	37.25^{a}	8.54^{efgh}	18,06^{bcdef}	44.54^{cdefg}		2500	
C.V%	14.19%	15.95%	22.37%	32.74%	23.65%			
P-value	0,0842*	0.0582*	0.0639*	0.1536*	0.3945*			
Lsd$_{0.05}$	2.822	6.671	14.19	6.589	2.714			
SE±	1.002	2.369	5.039	2.34	0.964			

Length of roots:

Significantly long roots were recorded for both low and high IBA for 20 and 30 cm long cuttings under silt-loam while the 40 cm cuttings gave similar results even without IBA. Under sand media similar results came from 30 cm cuttings without IBA and high IBA concentration while 40 cm cuttings resulted in comparable long roots even without rooting hormone. Under compost similar results were recorded for only 40 cm long cuttings treated with low and high IBA (Table 1). Season two data showed significantly long roots under only low IBA concentration for 30 cm long cuttings under silt-loam media, while the 40 cm cutting gave similar results even without IBA under silt-loam media. Under sand media similar results came from 30 cm and 40 cm long cuttings even without rooting hormone. Under compost high comparable results were recorded for only 40 cm long cuttings, even without rooting hormone (Table 2). Again results obtained from season two supports the findings of season one that the stored nutrients in longer 30 and 40 cm cuttings may be the main decisive factor for root length. Hormonal treatments in low or high concentrations for long stem cuttings encouraged the initiation and root elongation in all of root media used, thus, when length of roots was main goal it is economical to use silt-loam for *J. curcas* propagation. Supporting our results was reported by Noor *et al*., (2009).

Number of branches:

Highest numbers of branches were obtained from only 30 and 40 cm with low and high IBA under silt-loam media. Sand media resulted in high number of branches with 30 cm and high IBA and both low and high IBA with 40 cm long cuttings. For compost media, comparable results came only from 40 cm long cuttings with low and high IBA (Table 1). Season two showed that, the highest number of branches was obtained from only 40 cm long cuttings even without rooting hormone under silt-loam media. Sand media resulted in high number of branches only with 40 cm long cutting and zero and low IBA concentration, compost media gave highest values under zero and low IBA (Table 2). Number of branches is highly influenced by cutting length rather than by IBA concentrations or rooting media for propagation of *J. curcas*. Similar results were reported by Maya *et al*., (2010).

Figure 1: Effects of IBA concentration, 0.00 mg/L, 313 mg/L and 2500 mg/L water from (left to right) on number and length of roots of *J. curcas*

Length of branches:

Significantly long branches were recorded for long stem cuttings lengths and all IBA concentrations under silt-loam and compost media. For the sand media 30 cm long with high IBA and 40 cm long cuttings with zero and high IBA gave similar results for rooting media. Season two showed that significant long branches were recorded for 40 cm long cuttings with zero and low IBA under silt-loam media. Compost media gave similar results only with zero IBA for 40 cm long cuttings. No significantly high results were recorded under sand rooting media. (Table 2).This ensure that long stem cuttings were most preferable when planted under suitable rooting media (silt-loam or compost) as reported by Plaster, (1997) while the silt-loam and sand rooting media were economically cheaper, even when no rooting hormone is used.

Number of leaves:

Markedly high number of leaves was reported from silt-loam media using 30 cm cuttings with low and high IBA or 40 cm cuttings with or without IBA. The other two media were not comparable and resulted in small number of leaves (Table 1). Similarly season two showed that significant number of leaves was reported only from silt-loam media with 30 cm cuttings under low IBA concentration, or by 40 cm with or without IBA. The other two media were not comparable and resulted in small number of leaves similar to 1st season (Table 2). The number of leaves was linked with long mature stem cuttings and under silt-loam media. Findings of Noor *et al*., (2009), Maya *et al*., (2010) and Liv *et al*., (2011) supported our results.

Biomass production by cuttings seems to depend strongly on the "starting mass" of the cuttings. It can be assumed that the reason for this is the difference in assimilates that are stored in the cuttings. Similar to that results were recorded by Maya *et al*., (2010), Noor *et al*., (2009), Liv *et al*., (2011),and Kathiravan *et al*., (2009)

Conclusion:

On the basis of results obtained from this study, it is concluded that propagation of *J. Curcas* through hard wood cuttings could be with the use of rooting hormones, however, the results showed good response of silt-loam medium in increase root length, plant height and other aerial parameters.

Furthermore, stem cuttings with high number of roots have the advantage of enhancing good crop establishment.

Recommendations:

1- Mature stem cutting of 30 to 40 cm long are best for propagation of *J. curcas.*
2- Silt-loam rooting medium should be used based on it is results and being economical.
3- Low concentration of rooting hormone IBA (313 mg/L) is more efficient and determined in *J. curcas* propagation.
4- Combination of 30 to 40 cm long stem cuttings on silt-loam media using 313mg/L IBA is recommended for mass propagation of *J. curcas* under nursery conditions of Sudan.

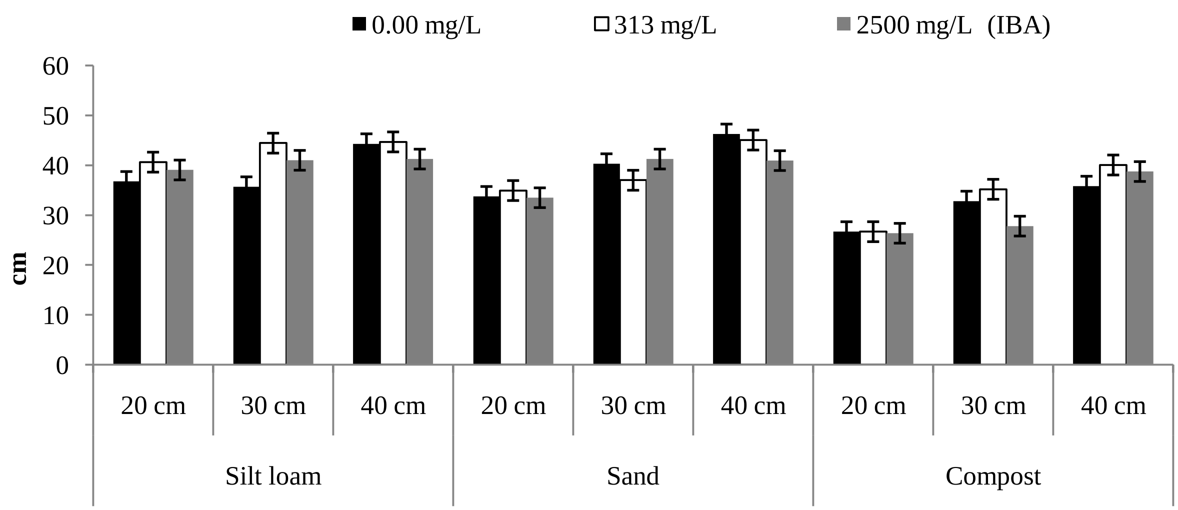

Fig. (2): Mean length of roots from different cutting lengths under three rooting media season 2012

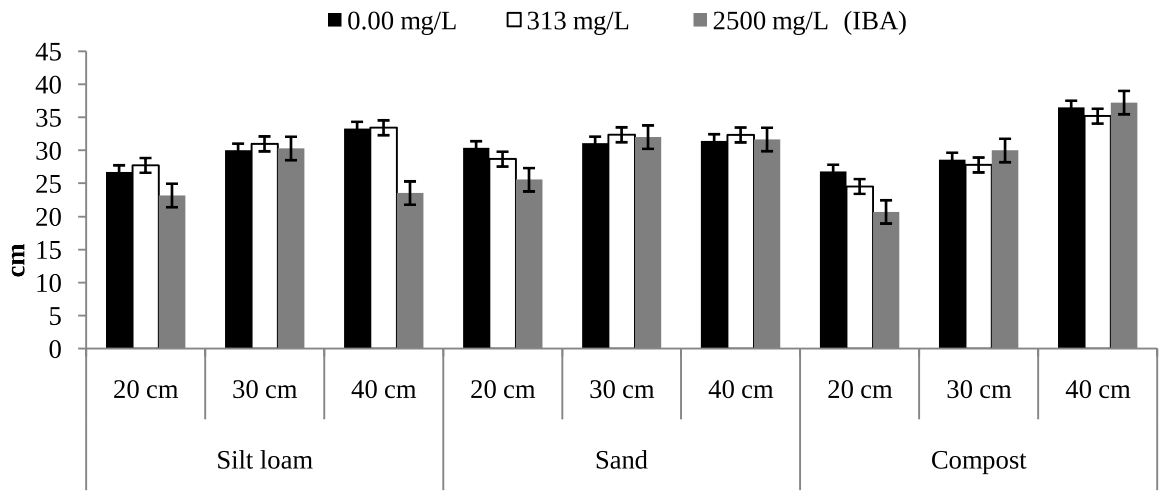

Fig. (3): Mean length of roots from different cutting lengths under three rooting media season 2013

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التكاثر اللاجنسي لنبات الجاتروفا باستخدام هرمون و أوساط تجذير مختلفة

ابراهيم محمد مهدي حماد و سيف الدين محمد الأمين
كلية الدراسات الزراعية – جامعة السودان للعلوم والتكنولوجيا

المستخلص:

أحد أهم المشاكل التي تواجه زراعة الجاتروفا،هي ضعف إنبات البذور.فارتفاع نسبة التلقيح الخلطي لأزهارها يجعلها عرضة للخلط الوراثي وفي المقابل فان استعمال العقل في اكثارها يساعد في توفير البذور لأجل إنتاج الزيت من جهة وإنتاج نباتات تتطابق وصفات الأبوين الوراثية من جهة أخري. لأجل ذلك وغيرها أجريت هذه التجربة في مشتل كلية الدراسات الزراعية – شمبات – جامعة السودان للعلوم والتكنولوجيا – السودان. لدراسة أثر إستعمال أوساط تجذير مختلفة وهي (الرمال، الطمي و الكمبوست) لتجذير عقل ذات أطوال (20 ، 30 و 40 سنتيمتر) معاملة بتركيزات مختلفة من هرمون التجذير (IBA) وذلك لقياس آداء النمو الخضري والجذري لنباتات الجاتروفا خلال موسمي 2012 و 2013. تم تجهيز العقل من مزرعة جاتروفا عمر نباتاتها ثلاث سنوات تابعة لمركز البحوث الزراعية – شمبات، غمست قواعد العقل في محلول الهرمون لمدة ساعة.ثم غرست العقل المعاملة في أوساط التجذير مرتبة في قطاعات عشوائية كاملة.
قياسات النمو الخضري والجذري المدروسة هي: عدد وأطوال الجذور، عدد وأطوال الأفرع وعدد الأوراق لكل عقلة. أظهرت النتائج عن وجود إختلافات معنوية في ما بين أطوال العقل، تركيز الهرمون وأوساط التجذير المستخدمة وذلك علي كافة القياسات التي أجريت تحت مستوي معنوية 5%. فالعقل ذوات ال (40 سنتيمترا) فائقة الآداء في جميع القياسات التي أجريت مقارنة للعقل ذوات الأطوال 30 و20 سنتيمترا. كلا التركيزان المنخفض (313 ملجم/لتر) و المرتفع (2500 ملجم/لتر) (IBA) متماثلتين وأسفرتا عن نتائج معنوية عالية للقياسات التي أجريت مقارنة بالشاهد(الصفر). وسطي التجذير الكمبوست والطمي متشابهتان تقريبا لكنهما أفضل من الرمال كوسط تجذير لتجذير وتأسيس عقل الجاتروفا. بناءا علي النتائج السابقة ينصح بإستخدام عقل بأطوال 40 سنتيمترا مع التركيز المنخفض (313 ملجم/لترماء) (IBA) في الطمي كوسط تجذير لأجل الحصول علي أفضل تكوين جذري وكفاءة للعقل لتقنية إكثار كميات هائلة للجاتروفا.