

# Effect of Soil Type and Irrigation Pattern on Seedlings Growth (*Jatropha Curcas*)

Fatima Algunaïd Hassan\*, Muna Ibrahim Abdalla\*\*

\* Assistance Professor Field: Natural Resources, Environmental Science Faculty of Agriculture and Natural Resources, Forestry and Range Sciences Department, University of Bakht Er-Ruda Ministry of Higher Education and Scientific Research White Nile state (AD Duwem) Sudan  
\*\* Assistance Professor Department of Food Science and Technology, Faculty of Agriculture, Bakht Er-ruda University, Sudan

**Abstract-** Survival of seedlings in arid and semi arid zones plantation is strongly affected by water availability and soil type. Many tree species are able to adapt themselves in response to soil moisture content. Three soil types, sand, clay and mixture soil (according to the main classification of soil in Sudan) with different irrigation pattern (2, 4 and 7 days intervals) were used for propagation of *Jatropha Curcas* for three months. The experiment was conducted at the nursery and was laid out in a randomized complete design with three replications and the growth characteristics were measured on monthly bases. The aim of this study was to evaluate the effect of irrigation pattern and soil types in seedlings growth characteristics of *Jatropha Curcas*. Seeds used in the experiment were collected from South Kordofan. The results obtained supported earlier findings by some workers. Shoot length showed no significant difference over all treatment. The control (normal nursery practices) was the best for all seedling characteristics measurements. These results may suggest that for successfully a forestation programs, low nursery cost in raising *Jatropha* seedling recommended to irrigation that practices in the nursery, Since there are no significant differences of juvenile growth performances between the three soil type recommended that caution shouldn't done when *Jatropha* plant

the seed meal, after extraction of oil, is rich in protein, it is toxic to rats, mice and ruminants and therefore cannot be used as an animal feed but after treatment, the seeds or seed cake can be used as an animal feed (Makkar *et al.* 2001). Its nitrogen - rich seed cake is a good soil fertilizer (RF, 1998; Makkar *et al.* 2001, FACT Foundation, 2006). Traditionally the seeds are used for medical treatments and soap production (Duke 1983; Henning 2002). Several cases of *J. curcas* nut poisoning in humans after accidental eating of the seeds have been reported with symptoms of giddiness, vomiting and diarrhea and in the extreme condition even death has been recorded (Becker&Makkar, 1998)

*Jatropha* grows on well-drained soils with good aeration and is well adapted to marginal soils with low nutrient content (FACT Foundation, 2006). It grows under a wide range of rainfall regimes (200 mm to over 1500 mm per annum) It is not sensitive to day length (ICRAF,2003). In many African countries, it is grown as a live fence and can be used to recover eroded areas (Heller 1996; Joker and Jepsen 2003, FACT Foundation, 2006). *Jatropha* can reach 6 meters or more (Heller 1996; Makkar *et al.*, 2001). Its leaves and stems are toxic to animals (FACT Foundation, 2006) the plant itself is very strong and can be an excellent applicant for reclaiming eroded zones,

In Sudan, *Jatropha curcas* is widely spread. It is found in Khartoum State, Kassala State, and Kordofan States in the west. It is mentioned as a local plant in some books describing the plants of the Sudan these days the, governments is beginning to introduce the species to be planted at a large scale for bio fuel production purposes. This will need a very large amount of seedling and seeds; the adequate seedling needs to be found in order to increase seed yield and oil content and more healthy plant by reducing the usual length traditionally adopt. As Henning (2000c) has noticed that pre-cultivation of *Jatropha* seedlings in poly-ethylene bags is more suitable and helps to speed up the appropriate of a plantation by at least 3 months.

The aim of the present study on Seed germination and growth parameters of the seedling will help in distributing the plant according to the classification of soil types and amount of rainfall in the Sudan. Providing information about the different growth parameters during juvenile stage will add an important dimension to the earlier ones about the establishment and development of this important plant species.

Research objective was to analyze the effects of different re-establishment techniques through water interval and soils type on seedling growth and survivorship during the nursery stage, to investigate the growth characteristic of the plant species at the nursery stage for successful establishment and development.

## I. INTRODUCTION

Few years ago there was limited attention in *Jatropha*. It is a tropical species from the family *Euphorbiaceae* which is a wild green thorny shrub that farmers in India, Africa and Central America would often plant to fence in livestock like goats or make soap. Recently wide attention has been oriented in the cultivation of the species for using its oil as a diesel fuel, primarily as it is drought resistant and can be cultivated on marginal land, without competing crop food production (Heller 1996; Grimm 1996; RF 1998). Now *Jatropha curcas* has gained much attention (Grimm 1996; Heller 1996; Henning 2000a; Pratt *et al.* 2002) of different research organizations, governments, public and international developmental agencies and industries in the tropics and subtropics; *Jatropha* is unique among renewable energy sources in terms of the number of potential benefits that can be obtained from its widespread cultivation. Its cultivation requires simple technology and relatively modest funds investment. The seeds of *Jatropha curcas* are a good source of oil; seed contains 35-40 % viscous oil known as 'curcas oil'. Petroleum based fuel, which can be used as a diesel alternative (Foid *et al.* 1996, Mandpe 2005). Although

Specific objectives include: Determination of growth parameters such as height, width, crown and root /shoot ratios, in different soil types and different irrigation patterns, and verifying the style of growth performance accordingly

## II. MATERIAL AND METHODS

The experiment was conducted at the Forestry nursery Center at AD Duwem city White Nile state during the period 26/3/2012-26/6/2012. Seeds used in the experiment were collected from South Kordfan. Three soil types (according to the main classification of soil in Sudan) were used for growing tree seeds at nursery with three irrigation patterns. The main soils are sand, clay, and sandy clay soil (50-50%). Irrigation patterns vary from 2, 4, and 7 days interval. The first irrigation started at the same time for all replications, and then followed by mentioned intervals. Polythene bags of 25cm width and 30cm length used for growing the seeds. The experiment was laid out in a randomized complete design with three replications. Seedlings were raised in the nursery for a period of three months and growth variables were measured on monthly bases including seedling height, crown height, and relation between them. Records were taken daily for estimating germination rate

### Data analysis

All results were statistically analyzed with the statistical package MSTATC program. Analysis of variance (ANOVA) and difference among treatments means were determined by Duncan, Multiple Range test at (P = 0.05) level.

## III. RESULTS

**Table (1a) Growth characteristics of 1<sup>st</sup> month *Jatropha* seedling of the three soil types**

Growth characteristic	Soil Types		
	Sand	Clay	Mixture
Growth at root color(cm)	5.5111a	5.600a	5.1778a
No .of leaves/seedling	5.4444a	5.6667a	5.2222a
Total length(cm)	32.8889a	28.9556b	30.2222ab
Shoot length(cm)	19.0667a	17.8778a	17.3111a
Root length(cm)	13.778a	10.5111a	12.322a
Crown length(cm)	8.2222a	7.6667a	6.5556a
Root/Shoot Ratio	.37a	.41a	.36a

Similar letters in the same row are not significantly different using Duncan' Multiple Range test(p=0.05)level

Result in table (1a,b) showed that most growth characteristic is not significantly different. The clay soil shows the lowest total length

**Table (1b) Growth characteristics of 1<sup>st</sup> month *Jatropha***

Growth characteristic	Irrigation interval		
	2days	4days	7days
Growth at root color(cm)	5.5111a	5.4000a	5.3778a
No .of leaves/seedling	5.3333a	5.5556	5.4444
Total length(cm)	30.3556a	30.2222a	31.08889a
Shoot length(cm)	18.0222a	17.9222a	18.3111a
Root length(cm)	11.2222a	12.5556a	12.8333a
Crown length(cm)	6.3333a	7.8889a	8.2222a
Root/Shoot Ratio	.37b	.46a	0.39ab

seedling of the three irrigation interval

**Table (2) Growth characteristics of 1<sup>st</sup> month *Jatropha* seedling of the three irrigation interval**

Growth characteristic	Irrigation interval		
	2days	4days	7days
Growth at root color(cm)	5.5111a	5.4000a	5.3778a
No .of leaves/seedling	5.3333a	5.5556a	5.4444a
Total length(cm)	30.3556a	30.2222a	31.08889a
Shoot length(cm)	18.0222a	17.9222a	18.3111a
Root length(cm)	11.2222a	12.5556a	12.8333a
Crown length(cm)	6.3333a	7.8889a	8.2222a
Root/Shoot Ratio	.37b	.46a	.39ab

Similar letters in the same row are not significantly different using Duncan' Multiple Range test

Result in table (2) show that the growth characteristic is not significantly different

**Table (3) Growth characteristics of 2nd month *Jatropha* seedling of the three soil types**

Growth characteristic	Soil Types		
	Sand	Clay	Mixture
Growth at root color(cm)	11.2111a	10.8778.a	11.0778a
No .of leaves/seedling	11.222a	10.8889a	11.333a
Total length(cm)	48.5556b	48.1556.b	52.6889a
Shoot length(cm)	18.6446a	18.4889a	18.778a
Root length(cm)	30.5111ab	29.1778b	33.5556a
Crown length(cm)	13.1111a	13.0000a	12.7444a
Root/Shoot Ratio	.69a	.69a	.67a

Similar letters in the same raw are not significantly different using Duncan' Multiple Range test

Result in table (3) show that the most growth characteristic are not significantly different. The clay soil shows the lowest root length and the mixture soil shows the highest total length

**Table (4)Growth characteristics of 2nd month *gatropha* seedling of the three Irrigation interval**

Growth characteristic	Irrigation interval		
	2days	4days	7days
Growth at root color(cm)	11.778a	11.3444a	11.5000a
No .of leaves/seedling	11.0000a	11.1111a	11.3333a
Total length(cm)	48.5333b	49.4889ab	51.3778a
Shoot length(cm)	18.6444a.	18.5111a	18.7556a
Root length(cm)	29.6667a	31.5556a	32.0222a
Crown length(cm)	13.4111a	12.8889a	12.5556a
Root/Shoot Ratio	.71a	.67a	.67a

Similar letters in the same raw are not significantly different using Duncan' Multiple Range test

Result in table (4) show that the most growth characteristic is not significantly different however 2days irrigation interval has the lowest total length

**Table (5) Growth characteristics of 3rd month old *Jatropha* cuscas seedling s of the three soil types**

Growth characteristic	Soil Types		
	Sand	Clay	Mixture
Growth at root color(cm)	13.58a	13.49a	12.91a
No .of leaves/seedling	12.56a	11.56a	12.56a
Total length(cm)	65.96a	67.56a	67.38a
Shoot length(cm)	19.73a	20.06a	19.93a
Root length(cm)	17.28ab	15.28b	19.00a
Crown length(cm)	46.22a	47.49a	47.49a
Root/Shoot Ratio	.85a	.85b	.93a

Similar letters in the same raw are not significantly different using Duncan' Multiple Range test

Result in table (5) show that the most growth characteristic is not significantly different. The clay soil shows the lowest root length

**Table (6)Growth characteristics of 3rd month *Jatropha* seedling of the three Irrigation intervals**

Growth characteristic	Irrigation interval		
	2days	4days	7days
Growth at root color(cm)	13.42a	12.74a	13.81a
No .of leaves/seedling	12.56a	11.56a	12.56a
Total length(cm)	64.78b	63.69b	72.42a
Shoot length(cm)	19.72a	19.91a	20.09a
Root length(cm)	17.17a	17.17a	17.22a
Crown length(cm)	45.04b	43.78b	52.38a
Root/Shoot Ratio	.95a	.95a	.87a

Similar letters in the same raw are not significantly different using Duncan' Multiple Range test

Result in table (6) show that the most oh growth characteristic are not significantly different however 7days irrigation has the highest total length, and crown length

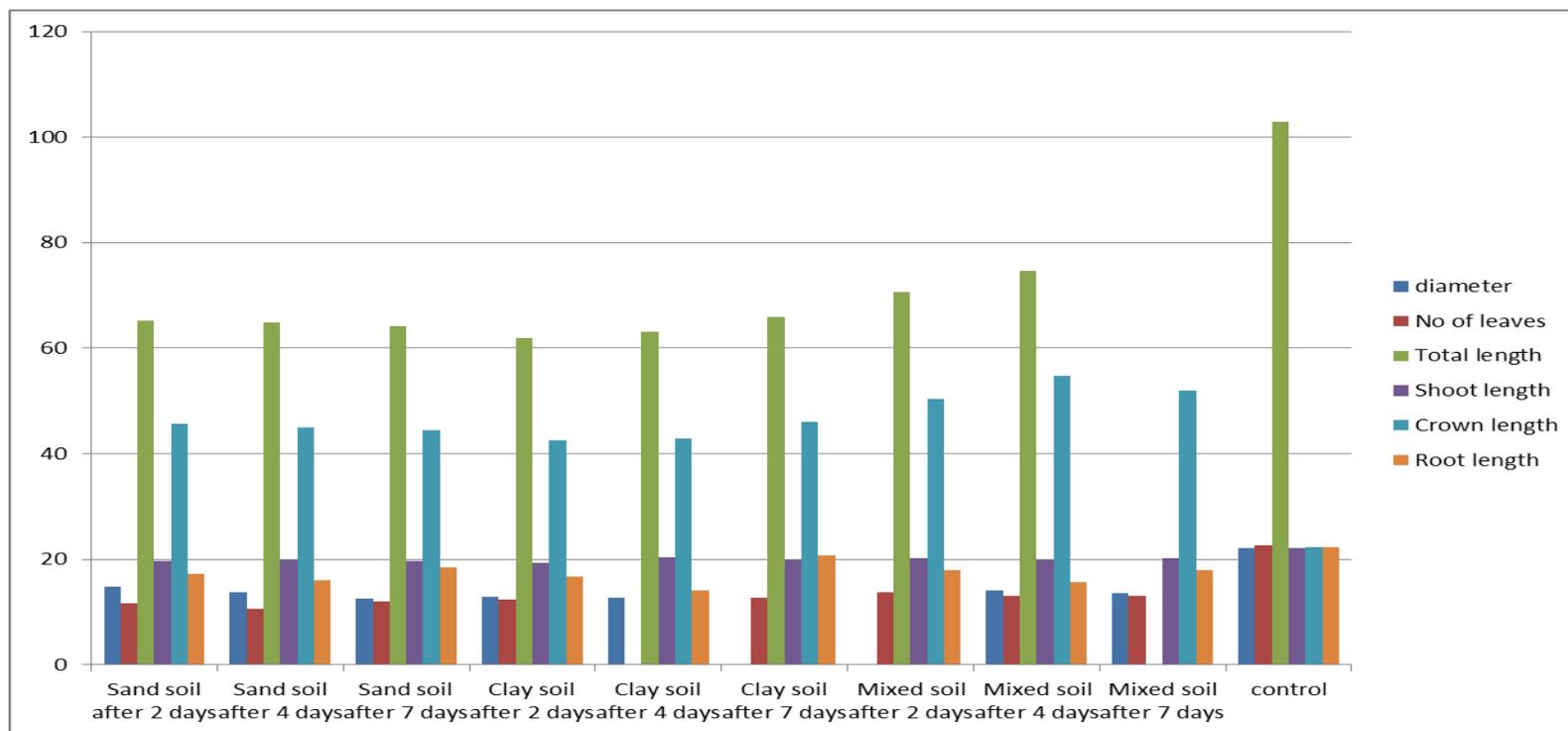
**Table (7) Growth characteristics of 3<sup>rd</sup> month *Jatropha* seedling of the three Irrigation intervals interact with three soil type**

treatment Parameters/	2days			4days			7days		
	sand	clay	mixture	sand	clay	mixture	sand	Clay	mixture
diameter	14.87a	13.73ab	12.47d	12.87acd	12.75cd	12.63cd	13.80abc	14.00ab	13.63abc
No of leaves	11.67bcd	10.67d	12.00bcd	12.33abc	11.00cd	12.67ab	13.67a	13.00ab	13.00ab
Total length	65.27c	64.87c	64.20cd	61.93d	63.2cd	65.93c	70.67b	74.60a	72.a0b
Shoot length	19.60a	19.83a	19.73a	19.40a	20.40a	19.93a	20.20a	19.93a	20.13a
Crown length	45.67c	45.00cd	44.47cd	42.53d	42.8d	46.00c	50.47b	54.67a	52.00b
Root length	17.17bc	16.00bcd	18.44ab	16.67bc	14.17d	20.67a	18.00bc	15.67cd	18.00bc
Germination	62.00a	56.33b	41.67c	35.33d	52.00b	54.00b	52.33b	54.67b	43.33c
Root/shootratio	.87b	.80c	.93b	.85b	.69f	1.03a	.89b	.78d	.89b

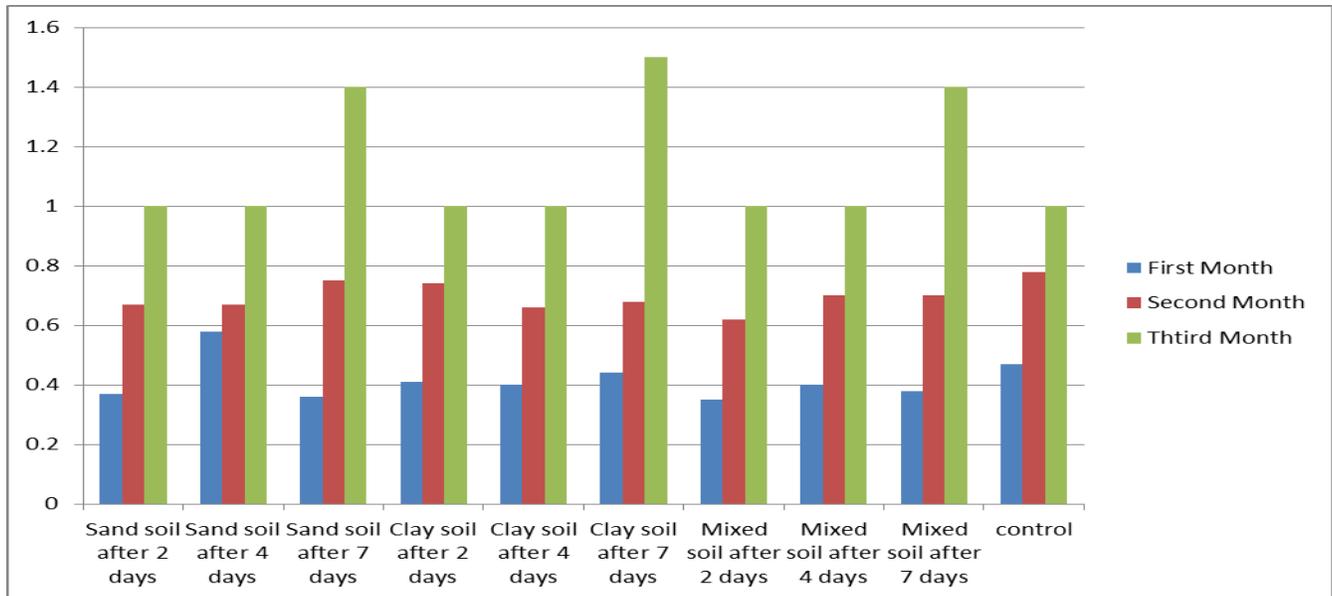
Similar letters in the same row is not significantly different using Duncan Multiple Range test

Result in table (7) show that the most of growth characteristic different the 2days irrigation interval with sand soil has the highest germination mean, and the

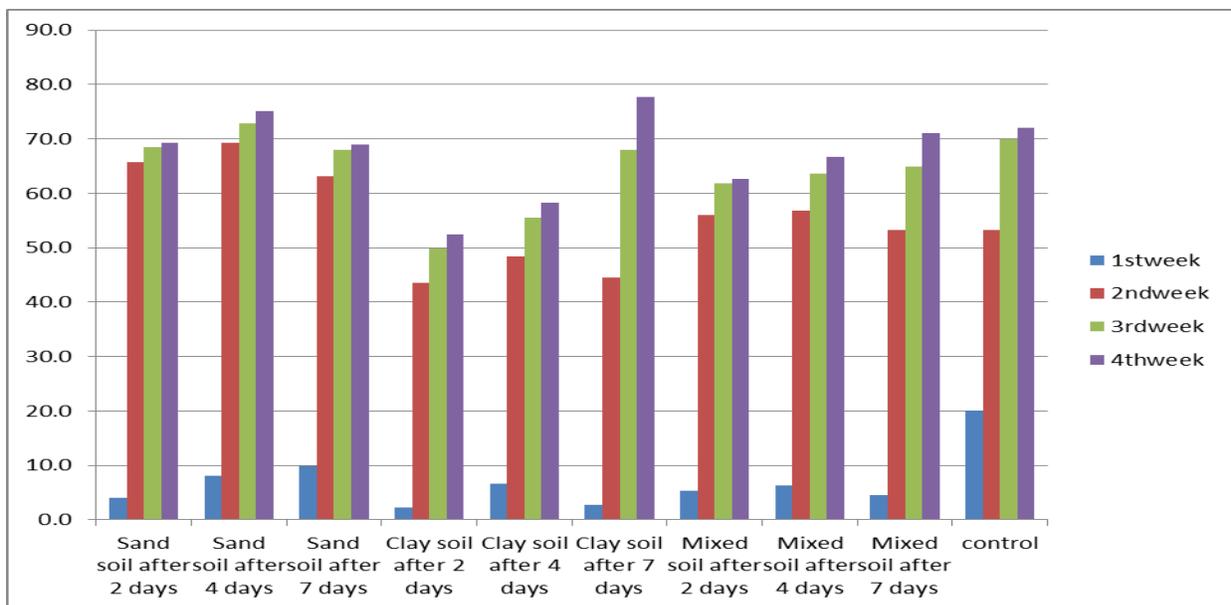
biggest diameter at root color, shoot length show not significantly different over all treatment However 4days irrigation with clay soil has the lowest root and length, crown length and 7days irrigation with sand has highest number of leaves. The result also indicate that 7day irrigation clay soil has the highest crown length



**Figure (1) Growth parameter for of three soil type via three irrigation interval with the control of 3<sup>rd</sup> month growth**



**Figure (2) Figure Ratio of Root length/Shoot length for three month of three soil type via three irrigation interval with the control**



**Figure(3)germination percentage for 3rdmonth of three soil type via three irrigation interval with the control**

Growth parameter show the best record of all parameter for control as shown in figure (1)but 4days irrigation with mixture soil show the best root/shoot ration and germination percentage for 2<sup>nd</sup>,3<sup>rd</sup>.and4<sup>th</sup> month as show in figure (2)and(3) respectively

#### IV. DISCUSSION

Table (7) shows mean seedling characteristic by water interval interact with soil type for Jatropha in third month of growth .Seedling growth was evaluated in term of measurement of 8 growth parameters. The result showed significant differences for all growth characteristic of the nine treatment .From the result obtained it is clear that shoot in all treatment grow in the same habits The lowest root length attained by 4days/clay This may be explained in the light of findings obtained by Ahmed (in Ibrahim 1988)for Acacia subspecies that root length is critical importance at early stage as deeper primary root system provide contact to more reliable source of water in short time than available to shallow root system . From figure(2) the ratio of root length/shoot length increase by month this is important under difficult condition particularly low soil moisture the ratio of root length to shoot length is considered as an important factor in survival of plants. The ratio is believed to be large for species grow in dry region this some as quoted by Abbatt (1984). Ahmed (1982) claimed that seedling of arid land tree species are characterized by that their roots grow taller than shoots even if they are watered. And 2day irrigation interval for sand soil Have highest diameter at root color and germination mean. Highest number of leaves record by 7days irrigation with sand the produced relatively higher number of leaves per seedling .This is an indication of adaptation species to drier condition compared to the other species Algunaid (2004)

#### V. VARIATION IN GROWTH

From table (1,2,5,6)Sand soil showed good growth for three month while clay showed better growth in the first month and showed lowest growth for the root in the 3rd months. For the root growth among the three soil it was found not significant during initial 1st month while these insignificant were evened down for three soil by the 3rd months. Variation in growth in the three soil of special interest to the tree breeder as it makes selection among soil available as the three soil investigated in the study not differ significantly from each other this is when using shoot height as only criteria for evaluating growth performance and productivity this is mainly due to the important of early height growth in determining the success of seedling establishment .Seedling that will grow rapidly could have practical advantages, damage from animal for instance , would be lessened because the terminal part of the tree would sooner be unreachable to browsing . Fast growing seedling can compete better with other vegetation Demster (1972) argued that outstanding seedling can maintain superior growth and rates for considerable periods.

#### VI. CONCLUSION

The conclusions drawn from this study may be summarized as follows:

- The results support earlier findings obtained by some workers.
- Findings from interaction between irrigation interval and soil type pre-germination 2days irrigation interval with sand soil has the highest germination mean, and the biggest diameter at root color,
- Shoot length show no significantly different over all treatment
- The control (normal nursery practices) the best for all seedling parameter measurement
- 4days irrigation with clay soil has the lowest root and crown length and 7days irrigation with sand has highest number of leaves. On the other hand 7day irrigation clay soil has the highest crown length

#### VII. RECOMMENDATION

1. Since there are no significant difference of juvenile growth performances between the three soil type(according to the main classification of soil in Sudan) recommended that caution shouldn't be done when Jatropha plant
2. For successfully a forestation programs, less nursery cost in raising Jatropha seedling recommended to irrigation that practices in the nursery
3. The result of this study is important for utilization successful and establishment of the species in the nursery and later in the field.
4. Further studies on seed from different provenances of the country

#### ACKNOWLEDGEMENT

We are greatly thankful to all those who have supported and assisted in completion of this work. Most of all we would like to express National Forests corporation of the White Nile state and the staff of AD Duwem forestry circle. Our grateful thanks also to Dean of Deanship of Graduate Studies &Scientific Researches professor Khalafalla Ahmed Mhomamed Arabi and Dean of Faculty of Agriculture and Natural Resources, University of Bakht Elruda Dr. Mutaz bellah bakri ahmed sidahmed

#### REFERENCES

- [1] **Ahmed, E.A.** (1982) The Autrecology of Acacia tortilis (Forsk) Hayne Ph .D. Thesis University of Khartoum – Sudan
- [2] **Algunaid,F.**(2004) Comparative study on Seed Polymorphism, Dormancy breaking mechanisms and early Juvenile Growth of khaya senegelensis ( Desr) A.juss at provenance level M.SC thesis Department of Forestry and Range Science Faculty of Agriculture and Natural Resources University of Bakht-er- Ruda.
- [3] **bbott , 1** (1984) Emergence early survival and growth of seedling of six tree species in Mediterranean forest of
- [4] **Becker, K., & Makkar, H. P. S.** (1998). Effects of phorbolsters in carp(Cyprinus carpio L.). Veterinary Human Toxicology, 40, 82–86. Carbonaro, M., Cappelloni, M., Nicoli, S., Lucarini, M., & Carvonale, E.

- (1997). Solubility–digestibility relationship of legume proteins. *Journal of Agriculture and Food Chemistry*, 45, 3387–3394
- [5] **Dempster, W.R.**(1972)The Influence of the Environment During seed development and germination and the growth of pinus Sylvetrisl.
- [6] **Duke, J. A. (1983.)** *Handbook of Energy Crops*. Purdue University. Center for New Crops and Plants Products.
- [7] **FACT Foundation:**(2006) Handbook on *Jatropha Curcas* First draft March 2006 www.factfuels. Org Western Australia Forest Ecology and management 9:51-66
- [8] **Foidl, G. Foidl, M. Sanchez, M. Mittelbach**(1996), S. Hackel, *Jatropha curcas* L. as a source for the production of biofuel in Nicaragua, *Bioresources Technol.* 58:7782.
- [9] **Grimm, C. (1996).** *The Jatropha project in Nicaragua*. Bagani Tulu (Mali) 1: 10-
- [10] **Heller, J. (1996).** *Physic nut (Jatropha curcas L.)*. Promoting the conservation and use of underutilised and neglected crops. I. *Gatersleben: Institute of Plant Genetics and Crop Plant Research/Rome: International Plant Genetic Resources Institute*
- [11] **Henning, R. (2002).** Using the Indigenous Knowledge of *Jatropha* – The use of *Jatropha*
- [12] **Henning, R. (2000a).** *The Jatropha Booklet*. A Guide to the *Jatropha* System and its Dissemination in Zambia. GTZ-ASIP Support Project Southern Province. Bagani GbR. *Jatropha* Plant in Zambia.
- [13] **Henning, R. (2000c.)** Use of *Jatropha curcas* oil as raw material and fuel: an integrated
- [14] **Ibrahim, A.M (1988).** Juvenile development of some important arid land tree species with particular reference to salt tolerance M.Sc .Thesis, Department of Forestry, Faculty of Agriculture University of Khartoum . *approach to create income and supply energy for rural development*. Experiences of the
- [15] **Jatropha** Project in Mali, West Africa. Presentation at the International Meeting “Renewable Energy - A Vehicle for Local Development - II”. Folkecenter for Renewable Energy,
- [16] **ICRAF, (2003).** *Jatropha curcas*. Agroforestry Database. <http://www.worldagroforestrycentre.org/Sites/TreeDBS/AFT/SpeciesInfo.cfm?SpID=1013>.
- [17] **Jøker, D and J. Jepsen (2003).** *Jatropha curcas* L. Seed leaflet No. 83 August 2003. Danida Forest Seed Centre. Denmark.
- [18] **Makkar, H.P.S, Becker, K and B. Schmook (2001).** Edible provenances of *Jatropha curcas* from Quintana Roo state of Mexico and effect of roasting on antinutrient and toxic factors in seeds. Institute for Animal Production in the Tropics and Subtropics (480), University of Hohenheim, D-70593 Stuttgart, Germany.
- [19] **Mandpe, S., Kadlaskar, W. Degen, S. Keppeler,**(2005) On road testing of advanced common rail diesel vehicles with biodiesel from the *Jatropha curcas* plants, Paper presented at International Mobility Engineering Congress and Expo (Paper Chennai organised by SAE India).
- [20] **Pratt, J.H.; Henry, E.M.T.; Mbeza, H.F.; Mlaka, E. and L.B. Satali (2002).** *Malawi Agroforestry Extension Project Marketing & Enterprise Program Main Report*. Publication No. 47. Malawi Agroforestry. 2002
- [21] **RF (1998).** The Potential of *Jatropha curcas* in Rural Development and Environment Protection – An Exploration. Concept paper. Rockefeller Foundation and Scientific & Industrial Research & Development Centre, Harare, Zimbabwe 1998 *curcas oil as raw material and fuel*. IK Notes. No.47. August.
- [22] **World Bank.** (Prom Underused Crops) 1:1–66. Denmark, August 2000. No. 2005-26, 356), 23–25 October 2005, Chennai Trade Centre, Nandambakkam,

Sudan Cell phone 0024991163343, E-mail: fhassan50@yahoo.com

**Second Author** – Muna Ibrahim Abdalla, Assistance Professor Department of Food Science and Technology, Faculty of Agriculture, Bakht Er-Ruda University, Sudan E-mail: muaiibrahim@gmail.com

#### AUTHORS

**First Author** – Fatima Algunaïd Hassan, Assistance Professor Field: Natural Resources, Environmental Science Faculty of Agriculture and Natural Resources, Forestry and Range Sciences Department, University of Bakht Er-Ruda Ministry of Higher Education and Scientific Research White Nile state (AD Duwem)

