FUTO Journal Series (FUTOJNLS), 2015, VOL. 1, Issue 2
p-ISSN: 2467-8325; e-ISSN: 2476-8456

Evaluation of Age Effect and Seedling Management Practices on the Vegetative Growth and Field Establishment of *Jathropha Curcas L* in Southeastern Nigeria

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Abstract

Seedlings are young trees generated from seed must be transplanted with great care to increase their chances of survival. *Jatrophacurcas L*. is a multipurpose crop with significant economic interest. This study assessed the effect of various seedling management practices and age of transplant on field establishment of *J. curcas*. The field experiment was carried out in Plant Genetic Resource Centre of the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Nigeria. Seedlings of *J. curcas* were subjected to the following management practices: 4 seedling management practices (half leaf lamina removed (HLR), whole plant (WP) as control, prune all leaves (PAL), and half prune roots (HPR)) and 3 ages of transplant (4, 6 and 8 weeks after planting (WAP) in the nursery. The seedlings were planted in 30 cm x 30 cm holes of 20 cm deep with spacing of 3 m x 3 m apart in 0.2 ha of land. A poultry dropping of about 1.0 kg was applied at 2 weeks after transplanting (WAT). The experiment comprised of 12 treatments, (3 x 4) factorial laid out in randomized complete block design and replicated 4 times. Establishment percentage and vegetative growth of the plants were monitored. The following data were collected: plant height, leaf area, number of leaves, stem girth and percentage (%) field establishment, at 0, 4, 8 and 12 weeks after transplanting (WAT), respectively. All data collected were subjected to analysis of variance (ANOVA) and descriptive statistical analysis. Results showed that all ages of transplant and seedling practices improved vegetative growth of *J. curcas* in the field and had 75-100 % field establishment. Half leaf lamina removed (HLR) at age 4 is the best.

Keywords: Age effect, seedling management, *Jathropha curcas,* field establishment, vegetative growth.

1.0 Introduction

Jatropha curcas Linn is a perennial shrub belonging to the Euphorbiaceae family. It is a native of South America and was established in Thailand about 200 years ago by Portuguese who produced soap from its oil (Achten, 2008). *Jatropha* plant grows well in tropical and subtropical regions with cultivation limit of 30^0 N and 35^0 S, altitude of 0 – 50 m above sea level (Heller, 1996). There are many species of *Jatropha* found in different parts of the world, one hundred and sixty five to one hundred and ninety five species are known from the genus *Jatropha* (Heller, 1996). Fourteen wild and cultivated species in India but most common species found in Nigeria is *Jatropha curcas* (Heller, 1996). The species have been identified as a suitable plant for biofuel production as its seeds produce oil of high quality for biodiesel and biojet fuel production, meeting European and American quality standards (*Lu et al*, 2009; Openshaw, 2000). Jathropha curcasserves as valuable multipurpose crop to alleviate soil degradation, desertification and deforestation. Also, the plant is used for soap making, as well as for organic fertilizerproduction and livestock feed formulation,therefore requires specific attention (Olumakunde, 2014).

The age of transplanting has marked effect on establishment of crops in different parts of the world (Opeke, 1992). Experiment has shown that polybag seedling transplanted at older age gave significantly higher yields in the first 3 bearing years than seedling transplanted at younger ages (Hew & Tan, 1971). The right age of transplanting is determined by a number of factors-young seedling cost less to transplant and do not show so much check on growth but they will be more uneven owing to their susceptibility to pest and disease attack because they have been subjected to less culling and would take longer to come into bearing.

Different management practices account for establishment of seedling in the field. Most years,

people have been limited to ball of earth and bare root methods which also have their effect (Hartley, 1979). Nursery seedlings cannot be transplanted to the field with bare root unless they have been given special treatments and even when such treatments are given, results are variable and establishment is comparatively slow (Hartley, 1996). When seedlings are planted with naked root, many of the longer primaries decay and establishment depends on the growth of the shorter primary roots and development of secondaries (Hartely, 1996).The pertinent question is this, "Are there no other effective means of transplanting to get required production". The aim of this study is to evaluate age effect and seedling management practices on percentage field establishment and vegetative growth of *Jathropha curcus* in Southeastern Nigeria.

2.0 Materials and Methods

2.1 Location

The field experiment was carried out in Plant Genetic Resource Centre of the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Imo state Nigeria. The coordinates of the site (latitude 05 ^{0}C 22.863' N, longitude 006 ^{0}C 59.456' E and 161.7 m elevation) was geo-referenced using hand-held Geographical Position System (GPS) receiver (Garmin Ltd, Kansas USA). The area is of the humid tropics with bimodally-distributed annual rainfall of about 2,500 mm. The soil is a sandy loam, and earlier classified as an ultisol (Orajaka, 1975) with humidity of 88-89 % and temperature of between 24.5 ^{0}C-34.9 ^{0}C respectively.

2.2 Field establishment

A 0.2 ha of land was cleared, packed and marked for field establishment of the vigorous seedlings from the nursery to the Plant Genetic Resource Centre, School of Agriculture and Agricultural Technology, Federal University of Technology Owerri. The field was cleared and marked at a standard planting distance of 3 m x 3 m (1,111plants/ha) (Heller, 1996) according to the experimental design.

2.3 Experimental design

This experiment consisted of three transplant ages (4, 6, and 8 weeks of planting) and 4 seedling management practices (half leaf lamina removed and retain all roots (HLR),whole planting as control (WP), prunning all leaves and retain all roots (PAL), half prune roots and retain all leaves (HPR). A total of 12 treatment combinations, (3 x 4) factorial experiment were laid out in randomized complete block design (RCBD). Each treatment was replicated 4 times. Seedlings were transplanted using naked root system of transplanting in 30 cm x 30 cm holes in a depth of 20 cm each. Poultry droppings were applied in the field at standard rate of 1.0 kg per seedling. This was applied 2 weeks after transplanting to boost soil fertility. Slashing was also done at 3 weeks intervals to reduce weed competition.

2.4 Data collection

Data were collected on the following parameters: percentage establishment at 2 weeks after transplanting, others were on: plant height, number of leaves, leaf area, stem girth at 0, 4, 8 and 12 weeks after transplanting.

2.5 Data analysis

Data collected was subjected descriptive statistical analysis and analysis of variance (ANOVA) according to the procedure by Wahua, (1999); Steel & Torie, (1980). Test of significant difference amongst treatment means was performed using Fishers Least Significant Difference and Obi, (2002) at 5 % level of probability.

3.0 Result and Discussion

3.1 Effect of age of transplant and seedling practices on the plant height of Jatropha curcas L. at 0, 4, 8 and 12 weeks after transplanting (WAT)

At 0 (initial), age of transplant and seedling practices did not significantly ($P < 0.05$) affect plant height of *Jatropha curcas* but significant differences ($P < 0.05$) were recorded in age of transplant and seedling practices interactions (Table 1). Plant height of *J. curcas* seedlings of half leaf lamina removed (HLR) + transplant age of 8 interactions were significantly ($P < 0.05$) shorter than those of half leaf lamina removed (HLR) + ages 4 and 6 interactions respectively. Plant height of whole plant (WP) + age 8, prune all leaves (PAL) + age 8, and half prune roots (HPR) + age 8 interactions, respectively were significantly taller than those of other interactions. At 4 week after transplanting (WAT), age of transplant and seedling practices significantly ($P < 0.05$) affected plant height of *J. curcas* plants in the field. Plants of age 4 were significantly ($P < 0.05$) tall compared to those of ages 6 and 8, respectively. Plants of whole plants (WP) were significantly taller than plants of other

seedling management practices. There were no significant difference (P < 0.05) in the interactions. At 8 weeks after transplanting (WAT), age of transplant, seedling practices and interactions did not show any significant (P < 0.05) differences on plant height of *J. curcas L* in the field. At 12 weeks after transplanting (WAT), age of transplant had high significant (P < 0.05) effect on plant height. Age 4 was significantly (P < 0.5) tall compared to plants of ages 6 and 8, respectively. The seedling management practices and interactions between age effect and seedling management practices recorded no significant (P < 0.05) differences on plant height of *J. curcas* in the field.

Table 1. Age effect and seedling practices on the plant height of *Jatrophacurcasl.* at 0, 4, 8 and 12 weeks after transplanting.

Seedling practices	(0) Initial WAT				4 WAT				8 WAT				12 WAT			
	Age 4	**Age 6**	**Age 8**	**Means**	**Age 4**	**Age 6**	**Age 8**	**Mean**	**Age 4**	**Age 6**	**Age 8**	**Means**	**Age 4**	**Age 6**	**Age 8**	**Means**
HLR	25.33	25.33	22.00	24.22	24.17	16.67	15.00	18.61	32.50	32.33	26.67	30.50	47.67	46.33	42.67	45.56
WP	23.33	24.33	25.33	24.33	24.17	20.17	21.83	22.08	32.57	27.33	31.67	30.52	52.00	33.33	36.67	40.67
PAL	22.33	22.00	26.67	23.67	18.90	19.50	18.67	19.02	28.33	22.00	30.33	26.89	53.67	26.00	41.00	40.22
HPR	25.00	22.00	26.67	24.56	22.50	16.67	17.7	18.96	30.50	28.33	27.00	28.61	45.00	28.00	36.67	36.56
Means	23.99	23.42	25.17		24.44	18.25	18.30		30.98	27.49	28.92		49.59	33.42	39.55	
$LSD_{(0.05)}$Age	1.44^{ns}				2.28*				1.52^{ns}				6.39**			
$LSD_{(0.05)}$ SMP	4.77^{ns}				2.64*				1.13^{ns}				2.15^{ns}			
$LSD_{(0.05)}$Age x SMP	0.83*				1.83^{ns}				1.19^{ns}				1.78^{ns}			

HLR = Half leaf lamina removed, WP = Whole plant (control) PAL = prune all leaves, HPR = Half Prune Roots, LSD = Least significant difference, * = Significant, ns = non significant.

3.2 Age effect and seedling practices on the leaf area of *Jatropha curcas l.* at 0, 4, 8 and 12 weeks after transplanting.

Ages of transplant had high significant (P < 0.05) effect on leaf area of J. curcas. at the initial stage. Leaf area of the plants of age 4 were significantly broader than those of ages 6 and 8, respectively. The seedling management practices and interactions between age effect and seedling management practices were not significantly (P < 0.05) different. At 4 and 8 weeks after transplanting (WAT), respectively, age effect, seedling management practices and interactions between age effect and seedling management practices showed no significant (P < 0.05) differences. At 12 weeks after transplanting (WAT), age effect had high significant (P < 0.05) effect on leaf area of *J.curcas.*. Age 4 had broader leaves than those of ages 6 and 8, respectively. Seedling management practices and interactions had no significant (P < 0.05) effect on leaf area of J. curcas (Table 2).

Table 2: Effect of age and seedling practices on leaf area of *JatrophacurcasL.* at time of transplanting (initial), 4 WAT, 8 WAT and 12 WAT

Seedling practices	Initial				4 WAT				8 WAT				12 WAT			
	Age 4	**Age6**	**Age 8**	**Means**	**Age 4**	**Age 6**	**Age8**	**Mean**	**Age 4**	**Age 6**	**Age 8**	**Means**	**Age 4**	**Age 6**	**Age 8**	**Means**
HLR	40.33	46.33	31.67	39.44	80.69	79.65	56.42	72.25	188.07	178.36	149.89	172.10	107.92	192.16	202.89	187.66
WP	45.33	29.33	31.67	35.44	85.95	75.99	58.53	73.49	160.8	149.15	169.73	159.89	167.98	143.16	192.58	167.91
PAL	58.67	48.67	38.67	48.67	70.06	65.90	61.52	65.83	164.78	114.67	179.42	152.96	204.77	105.95	162.00	159.57
HPR	56.67	56.67	54.00	49.11	61.58	98.2	73.38	71.05	154.68	152.50	189.72	165.63	196.05	135.35	159.25	163.55
Means	50.25	42.25	34.01		74.57	74.94	62.46		167.08	148.67	172.19		184.18	144.16	179.23	
$LSD_{(0.05)}$AGE	10.07**				1.06^{ns}				0.95^{ns}				27.27**			
$LSD_{(0.05)}$SMP	1.79^{ns}				0.71^{ns}				0.31^{ns}				1.47^{ns}			
$LSD_{(0.05)}$ Age XSMP	0.38^{ns}				0.45^{ns}				0.76^{ns}				2.34^{ns}			

SMP = Seedling management practices, HLR = Half leaf lamina removed, WP = Whole plant (control) PAL = prune all leaves, HPR = Half Prune Roots, LSD = Least significant difference, * = Significant, ns = non significant. **= High significant difference.

3.3 Age effect and seedling management practices on number of leaves of Jatropha curcas l. at 0, 4, 8 and 12 weeks after transplanting in the field

Age of transplant and seedling management practices showed significant ($P < 0.05$) differences in the number of leaves of Jatropha curcas in the field. Interactions between age of transplant and seedling management practices had no significant ($P < 0.05$) differences. At the initial stage of transplanting (0), age of transplant, seedling management practices and interactions between age of transplant and seedling management practices showed no significant ($P < 0.05$) differences. At 4 weeks after planting, age 4 produced high number of leaves significantly ($P < 0.05$ %) compared to those in ages 6 and 8, respectively. Half leaf lamina removed (HLR) had greater number of leaves than those in whole plant (WP), prune all leaves (PAL) and half prune roots (HPR), respectively. Transplant ages and seedling practices interactions did not affect number of leaves significantly ($P < 0.05$). At 8 weeks after transplanting, age of transplant, seedling management practices and interactions did not show any significant ($P < 0.05$) differences on the number of leaves of J. curcas. At 12 weeks after transplanting, age of transplant had significant ($P < 0.05$) effect on the number of leaves of J. curcas. Age 4 produced greater number of leaves significantly than those of ages 6 and 8, respectively. Seedling management practices and interactions had no significant ($P < 0.05$) effect on number of leaves (Table 3).

Table 3: Effect of age and seedling practices on leaf number of *Jatrophacurcas* L. at time of transplanting

	Initial				4 WAT				8 WAT				12 WAT			
Seedling practices	Age 4	Age 6	Age 8	Means	Age 4	Age 6	Age 8	Mean	Age 4	Age 6	Age 8	Means	Age 4	Age 6	Age 8	Means
HLR	3.67	4.33	3.67	3.89	10.33	7.00	5.67	7.67	16.67	23.33	11.67	21.00	21.00	24.00	13.33	19.44
WP	3.67	4.33	4.00	4.00	9.67	6.67	5.33	7.22	19.67	12.67	13.33	15.22	28.67	14.33	16.67	19.89
PAL	4.67	3.67	4.67	4.34	7.00	7.33	4.67	6.33	18.67	8.67	15.00	14.11	30.67	7.00	18.67	18.78
HPR	4.33	5.00	4.67	4.67	7.33	6.00	4.67	6.00	15.33	11.67	14.00	13.67	24.33	12.67	12.00	16.33
MEANS	4.085	4.333	4.253		8.583	6.75	5.085		17.585	14.085	13.50		26.17	14.5	15.17	
$LSD_{(0.05)}$ AGE	0.15^{ns}				1.36^{*}				1.45^{ns}				8.41^{*}			
$LSD_{(0.05)}$SMP	0.88^{ns}				1.58^{*}				0.56^{ns}				0.22^{ns}			
$LSD_{(0.05)}$AGE X SMP	0.50^{ns}				1.25^{ns}				1.46^{ns}				1.07^{ns}			

SMP = Seedling management practices, HLR = Half leaf lamina removed, WP = Whole plant (control) PAL = prune all leaves, HPR = Half Prune Roots, LSD = Least significant difference, * = Significant, ns = non significant. **= High significant difference.

(initial), 4 WAT, 8 WAT and 12 WAT

3.4 Age of transplant and seedling management practices on stem girth of jatropha curcas l. at 0, 4, 8, and 12 weeks after planting (WAT) respectively

At 0 time of transplanting (initial) age of transplant, seedling management practices and interactions had no significant ($P < 0.05$) effect on stem girth of J.curcas (Table 4). At 4 weeks after transplanting, age of transplant recorded high significant ($P < 0.05$) differences in stem girth of J. curcas. Stem girth of age 8 plants were significantly ($P < 0.05$) bigger than those of ages 4 and 6, respectively. Half leaf lamina removed (HLR) and half prune roots had significantly ($P < 0.05$) bigger stem girth than those of prune all leaves (PAL) only. The interactions in age of transplant and seedling practices did not affect stem girths significantly ($P < 0.05$). At 8 weeks after transplanting, age of transplant had significant ($P < 0.05$) effect on stem girth. Age 4 had bigger stem girth than those of ages 6 and 8, respectively. The seedling management practices and interactions between age and seedling management practices did not affect stem girths significantly ($P < 0.05$). At 12 weeks after transplanting, age of transplant had high significant effect ($P < 0.05$) on stem girth. Stem girths of plants of age 4 were significantly bigger than those of ages 6 and 8, respectively. Seedling management practices and interactions between age of transplant and seedling management practices did not show any significant ($P < 0.05$) differences.

Table 4: Effect of age and seedling practices on stem girth of *Jatrophacurcus* L. at time of transplanting (initial), 4 WAT, 8 WAT and 12 WAT.

Seedling practices	Initial (0)				4 WAT				8 WAT				12 WAT			
	Age4	Age 6	Age8	Means	Age 4	Age6	Age 8	Means	Age4	Age 6	Age8	Means	Age 4	Age6	Age8	Means
HLR	1.83	1.67	1.87	1.79	2.17	2.27	2.87	2.44	3.83	4.53	4.00	4.12	6.57	7.07	5.77	6.47
WP	1.77	1.87	1.67	1.75	2.10	2.10	2.57	2.26	5.07	3.90	4.30	4.42	6.87	7.13	6.33	6.78
PAL	1.77	1.87	2.00	1.88	1.63	2.13	2.57	2.12	4.07	3.07	4.03	3.72	6.77	4.50	6.00	5.73
HPR	1.83	1.60	1.93	1.77	2.33	2.43	2.50	2.42	5.17	3.40	4.10	4.22	7.37	5.33	6.17	6.29
MEANS	1.783	1.753	1.868		2.058	2.243	2.628		4.535	3.725	4.108		6.875	6.008	6.068	
$LSD_{(0.05)AGE}$	1.14^{ns}				0.19^{**}				0.55^{*}				0.78^{**}			
$LSD_{(0.05)SMP}$	0.65^{ns}				0.23^{*}				1.78^{ns}				1.14^{ns}			
$LSD_{(0.05)AGEXSMP}$	1.42^{ns}				1.91^{ns}				2.16^{ns}				1.83^{ns}			

SMP = Seedling management practices, HLR = Half leaf lamina removed, WP = Whole plant (control) PAL = prune all leaves, HPR = Half Prune Roots, LSD = Least significant difference, * = Significant, ns = non significant. **= high significant difference.

3.5 Percentage (%) establishment

Effect of transplant age and seedling management practices on the percentage (%) field establishment of *J.curcas* at 4, 8 and 12 weeks after transplanting, respectively (Fig.1). At 4 weeks after transplanting, half leaf lamina removed (HLR) had highest field establishment (100 %) in transplant ages 4, 6 and 8 respectively followed by half prune roots (HPR) compared to whole plant (WP) and prune all leaves (PAL) (75 %), respectively. At 8 weeks after transplanting, half leaf lamina removed (HLR) had 100 % field establishment in all transplant ages. Ages 6 and 8 of transplant had 100 % establishment in all the seedling management practices compared to age 4 that had 75 % establishment. At 12 weeks after transplanting, half leaf lamina removed (HLR) and half prune all roots (HPR) had highest establishment percent of 100 in all transplant ages compared to 75 % for whole plant (WP) and prune all leaves (PAL) respectively. Ages 6 and 8 of transplant, respectively had 100 % establishment more than age 4 which had 75 % establishment.

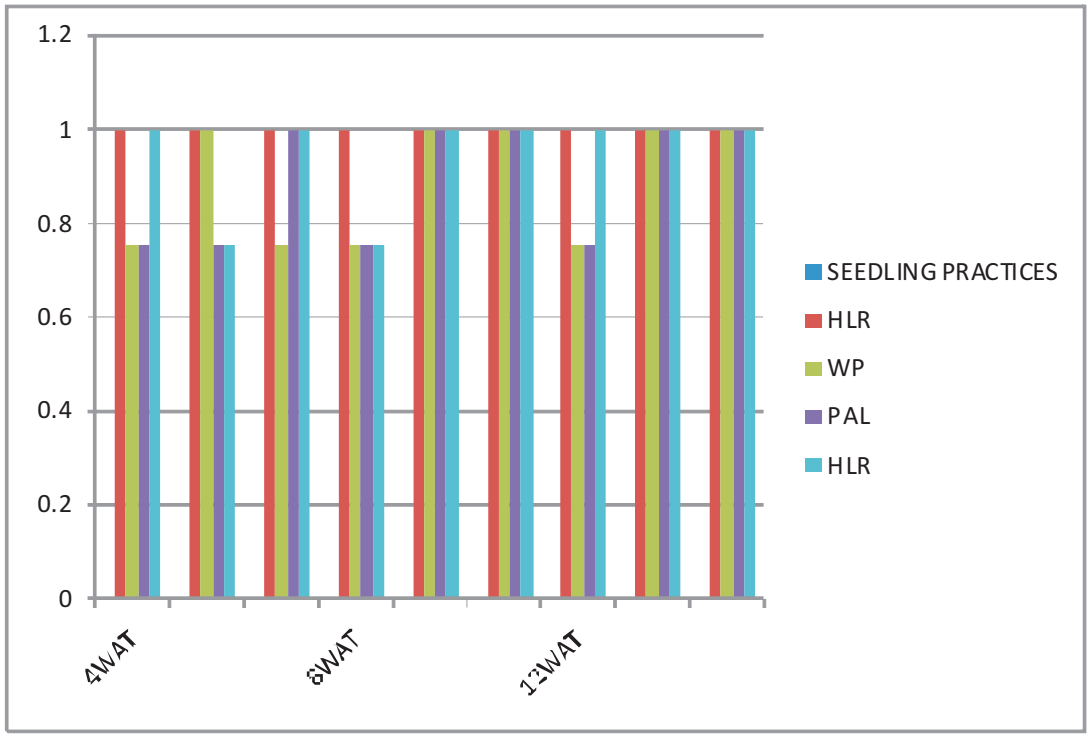

Fig. 1. Percent (%) establishment of *J.curcas* at 4WAT, 8WAT and 12WAT.

Seedlings are young trees generated from seeds; hence, seedlings must be transplanted with great care to increase their chances of survival (Williams, 1985). Seedlings transplanted at age 4 had tall plants followed by age 8 transplants. This agrees with Opeke, (1992) who stated that older seedlings may look impressive in the nursery but suffer great set back when transplanted. Highest leaf area and number of leaves were obtained in transplant age 4 at 12 weeks after transplanting. This study agrees with Acikgoz, (1987) who reported that young seedling produces higher leaf yield. Also, Simons, (1997) reported that quality of a plant is measured by the fullness of the foliage.

The seedling practices had significant influence on the vegetative growth of *J.curcas*. Half leaf lamina removed (HLR) recorded largest stem girth followed by half prune roots (HPR). This agrees with South, (1998) who stated that proper pruning in the nursery increases the root weight ratio and therefore increases the chances of survival when the site environment is less than optimum.

All ages of transplant and seedling management practices evaluated in the *J.curcas* field establishment recorded 75 -100% survival rate. This is in line with the finding of Tchoundjeu *etal*, (2006) who reported that seedling survival rates of 75-100% are considered to be normal for seedlings properly transplanted but disagrees with Opeke, (1992) who reported that transplanting varieties from the nursery to the field at less than 9 months from potting usually leads to early death but the most rapid establishment is obtained with seedlings of 18 months or more.

4.0 Conclusion

Good performance of plant is a combination of height, leaf area, leaf number, girth etc. Together, these characteristics determine how well the plant will establish itself in the field and they affect the rate of survival. One parameter alone is not a good predictor of how well a plant will perform in the field. All the transplant ages and seedling management practices performed well in the field. All ages of transplant and seedling management practices evaluated in the *J.curcas* field establishment recorded 75 -100% survival rate. From the research, results proved that all transplant ages and seedling

management practices were very effective for establishment of *Jatrophacurcas* and are therefore recommended for adoption by farmers.

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