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EFFECT OF TRANSPLANTING METHODS, NITROGEN AND PHOSPHORUS FERTILIZER RATES ON STEM GIRTH OF FEMALE DATE PALM OFFSHOOT, AT DUTSE, JIGAWA, NIGERIA.

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ABSTRACT
An experiment on the effect of transplanting methods and Nitrogen and Phosphorus fertilizer (NP- fertilizer) rates on stem girth of a female date palm offshoot was conducted (June, 2017 – September, 2019), at the Date Palm Research Substation/ Federal University Dutse (11°50' N, 09°25' E), in the Sudan Savanna of Nigeria to determine the effect of direct and indirect transplanting methods and (NP- fertilizer) rates on stem girth and to establish the combination of NP - fertilizer rate and transplanting method that will produce thicker stem girth. Treatments consisted of a factorial combination of two transplanting methods and five NP - fertilizer rates arranged in a Randomized Complete Block Design (RCBD); with three replications. Indirect transplanting proved more effective than direct transplanting as it produced statistically thicker girth ($p<0.05$) which is indicative of better chances of crop survival and establishment. Fertilizer applied at rate 320 g N + 160 g P_2O_5 statistically outperformed other rates ($p<0.05$) in the formation of thicker girth. However, it is instructive to note that this may not be the optimum rate since higher rates were not tested. A combination of indirect transplanting method and applied at the highest rate of 320 g N + 160 g P_2O_5 resulted in significantly thicker stem girth and thus recommended to date growers in the Sudan ecology of Nigeria.
***Keywords**: Date palm, direct and indirect transplanting, NP- fertilizer and stem girth.*

INTRODUCTION

Phoenix dactylifera L., known as date palm, is one of the oldest fruit crops grown in the arid regions of the Arabian Peninsula, North Africa and the Middle East (Chihcheng and Robert, 2007). It is a flowering plant species in the palm family, *Arecaceae*. It is a diploid, perennial, dioecious and monocotyledonous plant with a unique biological and developmental characteristics that necessitate special propagation, culture and management techniques (Chihcheng and Robert, 2007). Seed propagated plants produce 50% male seedlings and 50% female bearing fruits. And this becomes visible only when the crop starts flowering, 5 – 6 years after transplanting (FAO, 2002). Dates from seed propagated seedlings are smaller in size and of poorer quality. Propagation through offshoots produce fruits of the same quality and characteristics as the parent palm. The offshoots are true to type to the parent palm. Tissue culture seedlings are grown using the vegetative part of a plant under controlled nutritional and environmental conditions (Jessica,2020). These seedlings are true to type, and produce fruits with the same characteristics as parent palm. On the other hand, tissue culture seedlings are unavailable and when found are beyond the purchasing power of the date growers of the semi-arid tropics of Nigeria where the cultivation of this crop is concentrated. To overcome these production challenges, offshoot propagation is preferred as it produces fruits of the same character as the parent palm and guarantees reliability and profitability of production. But of a major concern is the fact that, there is lack of information and research work on direct and indirect transplanting methods as well as optimum Nitrogen and Phosphorus fertilizer combination (NP – fertilizer) which is vital for offshoot establishment and growth in the semi – arid zone of Nigeria. Without doubt research work on direct and indirect transplanting methods as well as NP – fertilizer rates will promote the cultivation and distribution of the crop, address youth unemployment and provide livelihood for date growers and families involved in the date palm value chain. Vegetative growth characteristics are good indicators of crop performance. Stem girth refers to the base diameter of the palm. Tomlinson (1990) referred to the area where the roots originated from the stem of the palm as root initiation zone (RIZ) located just beneath the girth of the palm. Anonymous (2019) established that, increased in the diameter of stem girth in date palm, is due to the activities of apical meristem and leads to the development of a good root system. Broschat (2018) linked increased in palm girth with the development of new roots within the stem, although parenchyma cell enlargement or lignin deposition can also cause the swellings of the girth. It follows therefore that any cultivation practices that exert effect on the size of the girth will improve root development, growth and yield of the crop. While information on NP –fertilizer requirements for female date palm transplant is lacking, Williams *et al*., 2005, established that date seedlings of up to 18 months require 0.3kg N/palm/annum, small palms, 0.5 – 1.0 kg N/palm/annum, medium palms, 1.5 – 2.0 kg N/palm/annum and fruiting palms 2.5 – 3.5 kg N/tree/annum. Klain and Zaid (2000) recommended the use of 262 g N and 138 g P for seedling of four years and below. Ibrahim *et al*., 2013 reported an increased number and length of leaf when 1.20 – 1.50 kg N/palm/ annum and 0.04 – 0.07 kg P was applied in a female fruiting palm.

The objective of this research therefore, is:

i. to evaluate the effect of direct and indirect transplanting methods and NP fertilizer rates on stem girth of female date palm offshoot and to:
ii. establish a suitable combination of NP fertilizer rate and transplanting method that

will produce thicker stem girth for good offshoot establishment.

MATERIALS AND METHODS

An experiment was conducted to study the effect of transplanting methods and NP - fertilizer rates on stem girth of female date palm offshoot over a period of 28 months (June 2017 – September 2019) at the Date Palm Research Substation/ Federal University Dutse ($11^{o}50'$ N, $09^{o}25'$ E), in the Sudan Savanna ecological zone of Nigeria. The location has a mean annual rainfall of about 600 mm, spread over five months and with average minimum and maximum temperatures of 23 and 25^{o} C respectively. Soils of the experimental area are sandy loam.

The treatments consisted of a factorial combination of two transplanting methods: (Direct: detachment of offshoot from the parent palm and directly transplanting into the field, and Indirect: detachment of offshoot from the parent palm and keeping in the nursery for 3 months before transplanting into the field) and five NP- fertilizer rates: Control; (0 g N + 0 g P_2O_5), 80 g N + 40 g P_2O_5, 160 g N + 80 g P_2O_5, 240 g N +120 g P_2O_5 and 320 g N + 160 g P_2O_5) arranged in a randomized complete block design with three replications. Two plants per experimental plot were sampled for stem girth measurements given a total of 60 offshoots. NP – fertilizer rates were derived from Urea (46% N) and Single superphosphate (18% P_2O_5) fertilizers as sources for N and P respectively. The equivalent amount of these fertilizers were determined and bulked.

Thirty offshoots situated at the base of the parent palms of between three to four years old, weighing about 10 kg each of the Deglet Noor variety were carefully detached in March 2017 with the help of chisel, shovel, hoe, cutlass and knife and kept in the nursery. In June 2017, another thirty offshoots were also detached using the same procedure. The field was cleared, ploughed and marked out with planting positions spaced at a 7 m X 7 m triangular arrangement (197 palm ha^{1}) using surveying tools: calibrated chain, ranging poles and pegs; and transplanting holes were dug for transplanting. Carbofuran was mixed with the soil at a rate of 0.02 kg per hole. The sixty offshoots were transplanted into the field in June 10^{th} 2017, according to the experimental design and treatments. Five kilograms of farmyard manure/plant were applied at transplanting and at the beginning of every raining season as a uniform requirement during the period of the study. The application of NP – fertilizers rates at three split doses and in the palm basins and manual hoeing were done on the 15^{th} of June, July, and August each year during the period of the study. No incidence of pest and diseases was observed and plants were mainly sustained by rainfall and irrigated with 10 liters of water every day for 5 days in a week during the dry seasons starting from 15^{th} December to 30th May each year during the period of the experiment.

Data on date palm stem girth, which is the thickness of the base of the palm at ground level, was measured and recorded at three months' interval starting from June, 2017 to September 2019.

Data collected was subjected to analysis of variance (ANOVA) for randomized complete block design, to test the significance of treatment effects using Genstat 17^{th} edition. The treatment means were separated using Duncans Multiple Range test - DMRT (Duncan, 1965).

RESULTS

Table 1 shows effect of transplanting methods and NP-fertilizer rates on stem girth of female date palm offshoot between September 2017 and September 2019. The effect of transplanting methods on stem girth was statistically significant throughout the sampling periods except in December, 2017. Indirect transplanting method recorded significantly thicker girth. NP-fertilizer rate 320 g N + 160 g P_2O_5 produced statistically thicker girth than direct transplanting throughout the period, except in December, 2017, when the stem girth was statistically the same. Fertilizer rates had a significant effect on date palm stem girth throughout the period. NP – fertilizer applied at 320 g N + 160 g P_2O_5 per plot produced significantly thicker stem girth than all other treatments throughout the sampling periods except in March, 2018 when they produced statistically similar stem girth when plots were applied with 240 g N +120 g P_2O_5. The lowest stem girth width was recorded on control plots with no fertilizer application. The interaction between transplanting methods and NP-fertilizer rates on stem girth was highly significant throughout the sampling periods.

Table 1. Effect of transplanting methods and NP - fertilizer rates on stem girth of female date palm offshoot between June 2017 to September 2019; at Dutse, Jigawa, Nigeria.

	2017			2018				2019		
Treatments	June	Sept	Dec	March	June	Sept	Dec	March	June	Sept
Transplanting methods										
Direct transplanting	0.03b	0.05b	0.13	0.16b	0.20b	0.27b	0.29b	0.30b	0.34b	0.40b
Indirect transplanting	0.05a	0.10a	0.13	0.18a	0.23a	0.34a	0.38a	0.41a	0.47a	0.54a
SE±	0.001	0.002	0.001	0.002	0.006	0.003	0.005	0.004	0.004	0.004
Fertilizer rates (g/plant/year)										
0g N + 0g P_2O_5	0.01e	0.02e	0.11d	0.16d	0.20e	0.22e	0.23e	0.25e	0.26e	0.28e
80g N +40g P_2O	0.01e	0.03d	0.12c	0.16d	0.23d	0.26d	0.27d	0.29d	0.31d	0.34d
160g N +80g P_2O	0.02c	0.06c	0.13b	0.17c	0.26c	0.27c	0.31c	0.33c	0.35c	0.41c
240g N +120g P_2O	0.04b	0.11b	0.14a	0.18b	0.31b	0.36b	0.38b	0.41b	0.48b	0.56b
320g N +160g P_2O	0.09a	0.17a	0.14a	0.19a	0.37a	0.43a	0.48a	0.50a	0.63a	0.77a
SE±	0.001	0.002	0.010	0.003	0.002	0.004	0.007	0.006	0.006	0.006
PM × F	**	**	**	**	**	**	**	**	**	**

Means followed by the same letter(s) are not statistically different at 5% level of significant using DMRT

Table 2 shows the interaction between direct transplanting showed that, stem girth width generally increased with increasing rate of fertilizer application up to the highest rate of 320 g N + 160 g P_2O_5 which was statistically the same with fertilizer applied at rate 160 g N + 80 g P_2O_5. Also, stem girth recorded from the control plots 0 g N + 0 g P_2O_5 were statistically the same with those applied with fertilizer at rate 80 g N + 40 g P_2O_5. Similarly, the stem girth of date palms applied with fertilizer rate 80 g N + 40 g P_2O_5 was statistically the same with that applied with fertilizer rate 160 g N + 80 g P_2O_5. The stem girth produced under the direct transplanting method and with the fertilizer rate 320 g N + 160 g P_2O_5 were significantly higher than all other treatment combinations. The thinnest stem girths were recorded with both (direct and indirect) methods of transplanting and the control (0 g N + 0 g P_2O_5).

Table 2. Transplanting methods and NP- fertilizer rates interactions on stem girth of female date palm offshoot March, 2018; Dutse, Jigawa, Nigeria.

	Fertilizer rates				
Transplanting methods	1	2	3	4	5
Direct transplanting	0.17f	0.17f	0.22cd	0.20de	0.24bc
Indirect transplanting	0.17f	0.21cd	0.20de	0.25b	0.29a
SE±			**0.014**		

Means followed by the same letter(s) are not statistically different at 5% level of significant using DMRT

Key: 1 = Fertilizer rate control (0 g N + 0 g P_2O_5)
2 = Fertilizer rate 80 g N + 40 g P_2O_5
3 = Fertilizer rate 160 g N + 80 g P_2O_5
4 = Fertilizer rate 240 g N +120 g P_2O_5
5 = Fertilizer rate 320 g N + 160 g P_2O_5

Table3 shows the interaction between transplanting methods and NP – fertilizer rates on stem girth in June, 2018. Under both the direct and indirect transplanting methods, stem girth increased with increasing fertilizer rate application. Date palms grown under the indirect transplanting method and applied fertilizer at 320 g N + 160 g P_2O_5 produced significantly thicker stem girths than all other treatment combinations. The thinnest stem girth was recorded under direct transplanting method and with the control plots 0 g N + 0 g P_2O_5 – no fertilizer application. The interaction between indirect transplanting method and rate 320 g N + 160 g P_2O_5 produced statistically thicker girth (0.50 a) followed by indirect transplanting method with rate 240 g N +120 g P_2O_5 (0.40 b). A combination of direct transplanting method with the control produced statistically thinner girth (0.20 h).

Table 3. Transplanting methods and NP- fertilizer rates interactions on stem girth of female date palm offshoot June, 2018; Dutse, Jigawa, Nigeria.

	Fertilizer rates				
Transplanting methods	1	2	3	4	5
Direct transplanting	0.20h	0.23g	0.25f	0.31d	0.36c
Indirect transplanting	0.23g	0.29e	0.30de	0.40b	0.50a
SE±			**0.007**		

Means followed by the same letter(s) are not statistically different at 5% level of significant using DMRT

Table 4 shows the interaction between transplanting methods and NP – fertilizer rates on stem girth in September, 2018. Under both (direct and indirect) transplanting methods, stem girths increased with increasing rate of fertilizer application. Stem girths produced under the indirect transplanting method and with the fertilizer rate 320 g N + 160 g P_2O_5 application produced significantly thicker stem girths than all other treatment combinations. The thinnest stem girth was recorded under the direct transplanting method and the control plots 0 g N + 0 g P_2O_5 – no fertilizer application

Table 4. Transplanting methods and NP- fertilizer rates interactions on stem girth of female date palm offshoot September, 2018; Dutse, Jigawa, Nigeria.

	Fertilizer rates				
Transplanting methods	1	2	3	4	5
Direct transplanting	0.22h	0.24g	0.27f	0.33e	0.39c
Indirect transplanting	0.25fg	0.30e	0.34d	0.43b	0.56a
SE±			**0.010**		

Means followed by the same letter(s) are not statistically different at 5% level of significant using DMRT

Table 5 shows the interaction between transplanting methods and NP – fertilizer rates on stem girth in December, 2018. In both direct and indirect transplanting methods, stem girths increased with increasing rate of fertilizer application. Stem girths produced under the indirect transplanting method and with the fertilizer rate 320 g N + 160 g P_2O_5 application significantly produced thicker stem girths than all other treatment combinations. On the other hand, thinnest stem girth was produced under the direct transplanting method and the control plots 0 g N + 0 g P_2O_5 – no fertilizer application

Table 5. Transplanting methods and NP- fertilizer rates interactions on stem girth of female date palm offshoot December, 2018; Dutse, Jigawa, Nigeria.

	Fertilizer rates				
Transplanting methods	1	2	3	4	5
Direct transplanting	0.23h	0.25g	0.28f	0.35e	0.41c
Indirect transplanting	0.26g	0.33e	0.37d	0.46b	0.59a
SE±			**0.008**		

Means followed by the same letter(s) are not statistically different at 5% level of significant using DMRT

Table 6 shows the interaction between transplanting methods and NP – fertilizer rates on stem girth in March, 2019. For both direct and indirect transplanting methods, stem girths increased with increasing rate of fertilizer application. Stem girths produced under the direct transplanting method and with rate 320 g N + 160 g P_2O_5 application, produced significantly thicker stem girths than all other treatment combinations. On the other hand, the thinnest stem girth was recorded under the direct transplanting method and the control plots 0 g N + 0 g P_2O_5 – no fertilizer application

Table 6. Transplanting methods and NP- fertilizer rates interactions on stem girth of female date palm offshoot March, 2019.

	Fertilizer rates				
Transplanting methods	1	2	3	4	5
Direct transplanting	0.24i	0.26h	0.30g	0.42d	0.49c
Indirect transplanting	0.28h	0.35f	0.39e	0.54b	0.77a
SE±			**0.008**		

Means followed by the same letter(s) are not statistically different at 5% level of significant using DMRT

DISCUSSION

The pronounced effect of indirect transplanting method in producing thicker stem girth in the female date palm transplant, pointed the importance of nursery treatment preparatory to a successful offshoot establishment in the field. The three months' nursery care given to the offshoots in the indirect method most have caused a faster regeneration of new roots and consequently thicker girth over the offshoots transplanted directly into the field. Broschat and Donselman (1990a) maintained that, offshoots possessing more roots when they were initially removed from the mother palm have a greater ability to regenerate a new root system. In other words, offshoots prepared three months in the nursery will have more roots primordia at the time of transplanting than those that did not pass through the nursery treatment. The increased in stem girth is also connected to the development of RIZ and the regeneration of palm root system (Broschat and Donselman, 1990b). The indirect transplanting method has demonstrated a significant capacity for increase in stem girth over direct method. This significant increase in stem girth of the offshoot is related to the formation of longer leaves and wider canopy in addition to the improved root system. Hodel and Pittenger (2003) maintained that successful establishment of date palm offshoot is dependent on the regeneration of new root system and leaf growth, while Isyaku *et al*., (2020a) and Isyaku *et al*., (2020b) reported an increase in leaf length and wider canopy in the indirect transplanting method over the direct transplanting method in dates offshoot. The significant increase in the stem girth in the indirect transplanting method over the direct transplanting method that resulted in enhanced root system and formation of longer leaves and wider canopy provides an indication of the more likely survival of dates offshoot that passed through the nursery over those that were transplanted directly into the field. Information on optimum NP – fertilizer rate for transplant dates offshoot is lacking. In this study, the highest rate tested 320 g N + 160 g P_2O_5 was found to record statistically thicker girth than other tested rates. However, this may not be the optimum rate since higher rates were not tested. The interactions further showed that indirect transplanting method and fertilizer applied at highest rate of 320 g N + 160 g P_2O_5 significantly enhanced the production of thicker stem girths.

CONCLUSION AND RECOMMENDATION

This study on the effect of transplanting methods and NP – fertilizer rates on stem girth of a female date palm offshoot was conducted over a period of 28 months (June, 2017 – September 2019 at the Date Palm Research Substation/ Federal University Dutse ($11^o50'$ N, $09^o25'$ E) in the Sudan Savanna zone of Nigeria. The indirect transplanting of date palm through nursery treatment proved more effective than direct transplanting; as it produced significantly thicker stem girth; which is an indication of better chances of crop survival and establishment. The highest fertilizer rate of (320 g N + 160 g P_2O_5) significantly outperformed other rates in the formation of thicker stem girth may not be the optimum fertilizer rate, since higher rates were not tested. A combination of indirect transplanting method and the highest rate 320 g N + 160 g P_2O_5 of applied fertilizer that resulted in thicker stem girth is preferable as offshoots with thicker stem girth have more stored carbohydrates for root growth, higher levels of root-promoting substances, and lower levels of root-inhibiting substances than offshoots with thinner stem girths (AL-Mana et al. 1996). This combination is therefore, recommended to date growers in the Sudan ecology of Nigeria. But, further works need to be done to validate these findings.

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