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EFFECT OF WATER HARVESTING METHODS, NITROGEN AND PHOSPHORUS FERTILIZER RATE ON NUMBER OF LEAVES OF DIFFERENT DATE PALM (*Phoenix d-*) VARIETIES

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ABSTRACTS
A field experiment was conducted to study the effect of water harvesting methods, NP - fertilizer rate on leaf number of some young date palm plants over a period of 32 months (May 2004-December 2006).The trial was sited at the Date palm Research Sub-station of the Nigerian Institute for Oil palm Research (NIFOR) Dutse (11°50'N, 09°25'E) in the Sudan savanna ecological zone of Nigeria. The treatments consisted of six water harvesting methods (standard 30cm radius basin, single side pit, double side pits, perimeter square basin, side square basin and double square basin). Six NP-fertilizer rates (control which is zero level fertilizer, 20g N + 10g P, 40g N + 20g P, 60g N + 30g P, 80g N + 40g P and 100g N + 50g P) and six date palm varieties (Palm 300, Tirgal, Dan Mali, Deglet Noor, Shuwarin C and Shuwarin B) arranged in a Latin square design. Two plants per experimental plot were sampled for plant leaf number, giving a total of 72 plants. Results from this study revealed that the effects due of varying water harvesting methods were not significant on leaf number. The effects due to varying NP-fertilizer rates were also not significant on leaf number. A three year experiment was not long enough to cause pronounced effects. Deglet Noor and Dan Mali significantly recorded more leaf number while Shuwarin B, Tirgal and Palm 300 recorded the lowest leaf number. Application of NP- fertilizer at rates 80- 100g N and 40- 50g P/ plant/year on a three year Deglet Noor or Dan Mali date palm variety will enhance plant leaf number and yield and may be recommended for better date palm production, within the Sudan ecological zone of Nigeria where this experiment was conducted, following further studies.

Key words: Water harvesting method, Nitrogen-Phosphorus fertilizer, Date palm variety, and leaf number

INTRODUCTION

Water harvesting can be defined as the trapping of run-off for productive use. (Anon, 1997, Pacey and Cullins, 1999). The principle of water harvesting involves diverting run-offs from uncultivated (catchments areas) to the cultivated areas where the crops are grown. The run-off is collected in the cultivated area using soil moisture conservation methods, which allow the water to infiltrate into the soil and become available to the roots of the crops. (FAO, 1991). This technology is essential in arid and semi arid regions where rainfall is accompanied by a large amount of surface runoff and high rate of moisture evaporation in the growing season. The generally sandy soils of arid and semi arid regions cannot retain the amount of water, which falls in such a short time, surface runoff can therefore be harvested which will lead to greater reliability of production even in a year of severe drought (Anonymous, 1997). Literature on the effects of water harvesting methods on date palm growth are not available, but many authorities reported an increase in crop yield in water harvesting systems compared to non- water harvesting systems in other crops. The use of water harvesting in strawberry reduced pumping of water from aquifer for irrigation by more than 50% (Zuzueta, 1986). Mulching with maize Stover increased the moisture conservation and significantly increased grain yield in wheat (Sharma, 1991). Also, maize sown in furrows, a moisture trapping measure, recorded yield increased compared to that on a flat seedbed (Sharma, 1991). Zhu qiang, (2005) reported an increased grain yield of 20.50% in maize grown under water harvesting compared with that in non water harvesting system. Leaf number is an essential growth parameter in date palm and is one of the good indicators of potential yield performance of the crop. Leaf production influences photosynthesis and crop growth. The number of leaves determined the number of axillaries bud which produced inflorescence and later date fruits (FAO, 2002). Leaf production determines potential bunch production and the rate of inflorescence initiation is the same as the rate of leaf initiation (Corley, 1977). A leaf can support the production of 1-1.5kg date fruits or an average of 8 leaves can support the production of one fruit bunch (FAO, 2002; Latifa *et al.,* 2007). The application of 1.2kg N, 600g P and 1.2 kg K to a matured female fruiting palm increased yield 2-3 times and doubled the number of leaves per tree. (Al- Bakr, 1972). Al- Dekaili and Al-Dejaili, (1989) reported that, the addition of 2.7-3.6kg N/palm/year in Deglet Noor resulted in 20% increase in dates compared to unfertilized tree through 4 year experiment.

The trunk growth as well as leaf number was increased. The pattern of mineral uptake and distribution in plant was found to differ among varieties (Al-Whaibi, 1983). Management systems that are likely to increase soil moisture supply, improved crop nutrition and enhanced leaf production are necessary. Enhancing moisture supply and retention around the root zones of the tree and appropriate NP- levels are necessary for better crop production. Date palm research on these aspects under Nigerian conditions with Nigerian varieties has been lacking. Studies in water harvesting method which is a rudimentary form of irrigation, appropriate levels of NP which are vital for crop establishment, growth and proper moisture utilization and retention with Nigerian and improved varieties can effectively be carried out to advantage, it is with this view that this research was carried out with the objective of evaluating the effects of water harvesting methods, Nitrogen – Phosphorus levels on leaf number of improved and Nigerian date varieties in the drier Sudan ecology of Nigeria.

MATERIALS AND METHODS

A field experiment was conducted to study the effects of water harvesting methods, NP - fertilizer rate on leaf number of different date palm varieties over a period of 32 months (May 2004- December 2006).The trial was sited at the Date palm Research Sub-station of the Nigerian Institute for Oil palm Research (NIFOR) 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 600mm spread over five months and average minimum and maximum temperatures of 23 and 25^{o} C respectively. Soils of the experimental area are generally sandy loam (Table 4). The treatments consisted of six water harvesting methods (standard 30cm radius basin, single side pit, double side pits, perimeter square basin, side square basin and double square basin). Six NP-fertilizer rates (control, which is zero fertilizer level, 20g N + 10g P, 40g N + 20g P, 60g N + 30g P, 80g N + 40g P and 100g N + 50g P) and six date palm varieties (Palm 300, Tirgal, Dan Mali, Deglet Noor, Shuwarin C and Shuwarin B) arranged in a Latin square design. The seedlings were planted at 7 x 7m triangular spacing and two plants per experimental plot were sampled for plant leaf number giving a total of 72 plants. NP – fertilizer rates were derived from Urea (46%N) and Single superphosphate ($18\%P_2O_5$) fertilizers. The characteristics of the date palm varieties are as follows:

Palm 300: This is a late ripening and soft fruits date variety. It is a NIFOR sub-station locally improved material. The average fruit length and weight are 4.0cm and 50g, respectively. A mature female palm produces an average of 10 – 12 bunches and fruit yield of 80kg/plant/year.

Tirgal: This is a dry fruit variety. It is an exotic variety imported from Algeria. The average fruit length and weight are 4.0cm and 35g, respectively. A mature female palm produces an average of 8 bunches and fruit yield of 60kg/plant/year.

Dan-Mali: This is a semi - dry fruit variety. It is an exotic variety imported from Mali. It has average fruit length and weight of 4.0cm and 60g, respectively. A mature female palm produces an average of 10 bunches and fruit yield of 80 – 90kg/plant/year.

Deglet Noor: This is a semi - dry fruit, medium to late ripening date palm variety. It is an exotic variety imported from Algeria. It has average fruit length of 3.5cm and average fruit weight of 40g. A mature female palm produces an average of 12 bunches and fruit yield of 80kg/plant/year.

Shuwarin C: This is a dry fruit variety locally sourced from Shuwarin village around Dutse area. It has average fruit length and weight of 5.0cm and 55.0g, respectively. A mature female palm produces an average of 6- 8 bunches and fruit yield of 50 – 60kg/plant/year.

Shuwarin B: This is a soft fruit variety locally sourced from Shuwarin farmers around Dutse area. It has average fruit length of 4.0cm and average fruit weight of 40g. A mature female palm produces an average of 7 bunches and fruit yield of 50kg/plant/year.

The land was cleared and ploughed before field layout. The field was marked out with planting positions spaced at a 7m x 7m triangular arrangement (197 palm ha^{-1}) using surveying tools: calibrated chain, ranging poles and peg, and the planting holes were dug for transplanting. Nine month old date palm seedlings were transplanted on the 15^{th} May 2004. Furadan (Carbofuran 25%) was mixed with the soil for transplanting at the rate of 0.02kg per planting hole at the time of transplanting. The water harvesting structures were prepared on the 16^{th} and 17^{th} May each of years 2004, 2005 and 2006 according to the specifications given under treatment. Ten kilograms of farmyard manure/ plant were applied on the 14^{th} June of each year 2004, 2005 and 2006 as a uniform requirement within the WH structures. The inorganic NP fertilizers were applied in a 4 split doses in the month of August, November, February and May of each year 2004, 2005 and 2006 at the rate that varied with the treatments. The experimental field was kept free of speargrass (*Imperata cylindrica*) by manual hoeing 4 times each year during the rainy seasons of the experimental period. The incidence of Beetle (*Oryctes rhinoceros*) was observed in the year 2005 and controlled by the used of Decis (25% Deltametrin) spray at the rate of 2ml l^{-1} and by physically killing the insect with a sharp stick wherever found. Graphiola leaf spot was also observed in the year 2006 and was controlled by the use of Benlate (50% Benomyl) fungicide spray at the rate of 50g l^{-1}. Plants were largely sustained by rainfall and irrigated with 10 liters of water per plant in the first year and 10 liters morning and evening of each year 2005 and 2006 starting from December to the beginning of the rainy season.

Leaf number per plant was counted and recorded at three months interval, starting from June 2004.

Data collected was subjected to analysis of variance for a Latin square design, to test the significance of treatment effects as described by Snedecor and Cochran (1967), the treatment means were separated using Duncan's Multiple Range test (Duncan, 1965).

RESULTS AND DISCUSSION

Tables 1, 2 and 3 show the effect of water harvesting methods (WHM), Nitrogen and Phosphorus fertilizer on number of leaves of different date palm varieties in 2004, 2005 and 2006 respectively. The number of leaves per plant varied over time and treatments. The double side basin method produced a consistent higher leaf number but statistically, the differences in leaf number due to the WHM treatments were not significant. This indicate that, at the initial growth stage (1-3 years) the utilization of the harvested water by the plant was tailored towards root development and the effects of varying WHM was not significant on leaf number (Anonymous, 1997). The effect of NP-fertilizer treatments on leaf number was not significant throughout the sampling period except at the first period (June 2004) when the control (zero level fertilizer treatment) significantly produced more leaves than rates 40g N + 20g P and 80g N + 40g P but at par with rate 20g N + 10g P. This could be attributed to the heterozygous nature of the date seedlings produced by sexual propagation that were used in this experiment with the male growing faster than the female (Okolo *et al.,* 2000), or fertilizer treatments require a longer time to cause a pronounced effects and that, a three years experiment may not have been long enough to cause pronounced effects (Furr and Amstrong, (1956); Bacha and Abo- Hassan, 1983). The differences among varieties in terms of the leaf number/plant were significant between December 2004 to June 2005 and also between June to December 2006. In December 2004, Deglet Noor recorded significantly more leaf than Palm 300 and Shuwarin C but was statistically similar with Tirgal, Dan Mali and Shuwarin B. Between March and June 2005, Deglet Noor also maintained a significantly greater leaf number than Palm 300, Tirgal and Shuwarin C but was statistically at par with Dan-Mali and Shuwarin B. During the later growth stage, the variety Deglet Noor followed closely by Dan Mali, maintained a higher leaf number compared to the other varieties. This difference was significant between June to December 2006 during which period Deglet Noor recorded significantly more number of leaves than Tirgal and Shuwarin B and was statistically at par with Dan Mali, Shuwarin C and Palm 300. In December 2006, number of leaves was significantly greater in the variety Deglet Noor when compared with the other varieties except Dan Mali and Shuwarin C. Palm 300 recorded statistically similar leaf number with Dan Mali and Shuwarin C but had significantly more leaf than the varieties Tirgal and Shuwarin B. Varieties differed in leaf production with Deglet Noor, Dan Mali and Shuwarin C producing significantly greater number of leaves than Shuwarin B, Tirgal and Palm 300 (Tables 1 – 3)). This is in line with the findings of Hartley, (1988) who reported that, leaf production in Oil palm varies with variety and that; there is annual difference in leaf production between palms of similar genetic origin. The differences observed among varieties in leaf number are important since varieties with greater number of leaves will produce more inflorescences and fruit bunches, which increase the overall yield of palm (Hartley, 1988).

SUMMARY AND CONCLUSION

The results from this study revealed that the effects of varying water harvesting methods were not significant on leaf number. The effects due to varying NP-fertilizer rates were also not significant on leaf number. A there year experiment was not long enough to cause pronounced effects (Furr and Amstrong,(1956); Bacha and Abo Hassan, 1983). Deglet Noor and Dan Mali significantly recorded more leaf number, while Shuwarin B, Tirgal and Palm 300 recorded the lowest leaf number. Application of NP- fertilizer at rates 80- 100g N and 40- 50g P/ plant/year on a three year Deglet Noor or Dan Mali variety will enhance plant leaf number and yield may be recommended for better date palm production within the Sudan ecological zone of Nigeria where this experiment was conducted, following further studies.

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Table 1: Effect of Water harvesting methods, Nitrogen and Phosphorus fertilizer on Number of Leaves of Different Date palm (*Phoenix d*-) varieties between June – December 2004, at NIFOR Date palm Research Sub – station, Dutse

Treatments	Period in Month		
	June	September	December
Water Harvesting Methods			
Control	3.167	6.500	8.000
Single side pit	3.167	5.000	6.500
Double side pits	3.000	5.333	6.833
Perimeter square basin	3.167	5.883	7.000
Side square basin	3.333	6.000	8.000
Double square basin	3.500	6.333	8.000
SE+	0.1639	0.6075	0.7372
NP-fertilizer rates (g/plant/year)			
Control	3.667a	6.167	7.667
20g N + 10g P	3.333ab	5.333	6.667
40g N + 20g P	3.000c	6.000	7.333
60g N + 30g P	3.167b	5.167	6.667
80g N + 40g P	3.000c	6.050	7.833
100g N + 50g P	3.167b	6.333	8.167
SE+	0.1639	0.6075	0.7372
Varieties			
Palm 300	3.167	5.333	6.500b
Tirgal	3.167	5.833	7.500ab
Dan-Mali	3.167	6.000	7.3333ab
Deglet Noor	3.333	6.333	9.000a
Shuwarin C	3.167	5.500	6.667b
Shuwarin B	3.333	6.050	7.333ab
SE+	0.1639	0.6075	0.7372

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

Table 2: Effect of Water harvesting methods, Nitrogen and Phosphorus fertilizer on Number of Leaves of Different Date palm (*Phoenix d*-) varieties between March – December 2005, at NIFOR Date palm Research Sub – station, Dutse

Treatments	Period in Month			
	March	June	September	December
Water Harvesting Methods				
Control	8.833	9.833	14.333	15.667
Single side pit	7.500	8.500	12.500	13.333
Double side pits	7.833	9.000	12.333	13.667
Perimeter square basin	8.000	9.500	14.333	15.500
Side square basin	9.167	10.333	11.000	15.333
Double square basin	9.833	11.000	14.833	16.500
SE+	0.8176	0.9319	1.2266	1.2748
NP-fertilizer rates (g/plant/year)				
Control	8.667	9.500	14.500	15.667
20g N + 10g P	7.667	8.833	12.000	13.167
40g N + 20g P	8.667	9.667	14.000	15.833
60g N + 30g P	7.667	8.833	12.667	14.167
80g N + 40g P	9.333	10.833	14.833	15.833
100g N + 50g P	9.167	10.500	14.333	15.333
SE+	0.8176	0.9319	1.2266	1.2748
Varieties				
Palm 300	7.500b	8.333b	14.167	15.333
Tirgal	7.833b	8.833b	12.333	14.000
Dan-Mali	8.667ab	9.833ab	14.167	16.000
Deglet Noor	10.833a	12.167a	15.000	16.667
Shuwarin C	8.000b	9.167b	14.333	15.000
Shuwarin B	8.333ab	9.833ab	12.333	13.000
SE+	0.8176	0.9319	1.2266	1.2748

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

Table 3: Effect of Water harvesting methods, Nitrogen and Phosphorus fertilizer on Number of Leaves of Different Date palm (*Phoenix d-*) varieties between March – December 2006, at NIFOR Date palm Research Sub – station, Dutse

Treatments	Period in Month			
	March	June	September	December
Water Harvesting Methods				
Control	17.500	19.500	22.167	25.333
Single side pit	16.000	17.000	20.000	22.833
Double side pits	15.333	17.500	20.833	24.333
Perimeter square basin	16.167	18.333	21.000	24.167
Side square basin	16.833	18.667	21.333	24.500
Double square basin	18.000	19.667	22.667	25.667
SE+	3.8118	1.3911	1.4888	1.3003
NP-fertilizer rates (g/plant/year)				
Control	16.667	18.500	21.333	24.667
20g N + 10g P	15.000	17.167	19.333	22.333
40g N + 20g P	17.500	19.167	21.833	24.333
60g N + 30g P	15.667	18.000	21.000	24.167
80g N + 40g P	18.000	19.333	23.167	26.000
100g N + 50g P	16.667	18.500	21.333	25.333
SE+	3.8118	1.3911	1.4888	1.3003
Varieties				
Palm 300	16.667	18.667ab	21.333a-c	23.667b-d
Tirgal	14.000	16.000b	18.833c	21.833d
Dan-Mali	18.167	20.000ab	23.500ab	26.833ab
Deglet Noor	19.000	21.000a	23.833a	27.833a
Shuwarin C	16.667	18.833ab	22.000a-c	25.833a-c
Shuwarin B	14.333	16.167b	18.500c	20.833d
SE+	3.8118	1.3911	1.4888	1.3003

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

Table 4: Physical and chemical properties of soils (0 – 15 and 15 – 30cm) December 2004, 2005 and 2006 at NIFOR, Dutse.

	December 2004		December 2005		December 2006	
	0-15	15-30	0-15	15-30	0-15	15-30
Particle Size (%)						
Clay	14.00	19.00	14.00	17.00	15.00	16.00
Silt	16.00	13.00	16.00	13.00	16.00	15.00
Sand	71.00	68.00	71.00	68.00	71.00	68.00
Soil Textural Class	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Chemical Properties						
pH in Water	6.60	6.50	6.60	7.20	6.30	7.00
Organic Carbon (%)	0.16	0.13	0.15	0.11	0.16	0.13
Total Nitrogen (%)	0.01	0.01	0.01	0.01	0.01	0.01
Available P (ppm)	18.00	21.00	16.00	18.00	18.00	21.00
Exchangeable bases (meq/100g)						
Mg+Ca	1.55	2.10	1.55	1.35	1.55	2.10
K	0.45	0.40	0.45	0.40	0.45	0.40
Na	0.50	0.50	0.50	0.50	0.50	0.50
$H+Al^+$	1.10	1.35	1.10	1.35	1.10	1.35
CEC	2.75	2.65	2.75	2.65	2.15	2.00

Analysed by: Jigawa Research Institute's Laboratory, Kazaure.