SOIL MOISTURE CONTENT OF DATE PALM VARIETIES (PHOENIX DACTYLIFERA L) AS AFFECTED BY WATER HARVESTING METHODS AND NP-FERTILIZER RATES

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Abstract-A field study was conducted at the Date palm Research Substation of the Nigerian Institute for Oil palm Research (NIFOR), Dutse(11°50'N, 09°25'E) to studysoil moisture content of date palm varieties as affected by water harvesting methods and NP-fertilizer rates. Six water harvesting methods (WHM), Six NP-fertilizer rates (F) and six date palm varieties (V) were arranged in a Latin square design.The location has mean annual rainfall of about 600mm spread over five months and average minimum and maximum temperatures of 23 and 25° C respectively. Soils of the experimental area are generally sandy loam. Results of our findings revealed that perimeter square basin retained highest soil moisture but comparable with double side pits. NP- fertilizer rate 40 g N + 20 g P conserved more soil moisture comparable with rate 60 g N + 30 g P in the sandy loam where this experiment was conducted. Soil moisture retention due to variety effect also differs significantly. Tirgal exploit more soil moisture as it retained less soil moisture compared to other varieties. A combination of perimeter square basin or double side pits with 40 g N + 20 g P or 60 g N + 30 g P and variety Tirgal will optimize soil moisture content and utilization within the Sudan ecological zone of Nigeria where this experiment was conducted.

Key words: date palm, water harvesting method, variety and soil moisture content.

I.INTRODUCTION

Date palm (*Phoenix dactylifera L.*) is one of the oldest cultivated plants. It is a dioecious plant, with the male and female flower on a separate plants, that produces the economically popular fruits called 'dates' that are eaten as desert. Date palm belongs to the family Palmaceae (Arecacea) which contains several other cultivated palms such as coconut palm (*CocusnuciferaL.*)and oil palm (*Elaeisguineesis*Jacq). (FAO, 2002).Today, date palms are distributed widely throughout the world, from the Middle and Far East to Europe and the America as well as African continents. But the crop production is concentrated in countries of the near and Middle East, and North Africa (Michelle *et al.*, 2006). Date palm was introduced to Nigeria from North Africa during the Trans-Saharan trade by pilgrims and traders from the Middle East. The crop thrives well in the semi-arid ecology of the northern parts of the country. Because date palm tolerates a wide variety of soils, it may be found in the lower latitudes within the derived savannah areas of Plateau, Nassarawa, Niger, Kwara and Benue States. The area under date palm cultivation in Nigeria was estimated over 1,466.80 ha and a production output of over 19,958 tons per annum (Omamor*et al.,* 2000). Production in Nigeria falls short of demand and date fruits are imported form Niger Republic, Libya and Algeria. The fruits have significantly provided income and improved livelihood to growers and marketers. An average fruiting female palm can produce 40 – 60kg fruits/year which translates to N2, 500 – N3, 750/palm/year and 500, 000 – 750,000/ha using a plant population of 200 palms/ha. (Omamor*et al.,* 2000). Date fruits are nutritious, being high in carbohydrates, fiber, potassium, certain vitamins and minerals but low in fat and virtually free from cholesterol and sodium (Ahmed *et al.,* 2007). Fructose and glucose are the major sugar components of dates which make it an important source of sugar to persons who cannot tolerate sucrose (Ahmed *et al.,* 1995., Myhara*et al.,* 1999). The flesh of the fruit contains 60 – 65% sugar, 2.5% fiber, 2% protein and less than 20% fat, minerals and pectin substances.The date palm is well adapted to hot and dry climates and tolerates a wide range of temperature (18-50^{0}C). Optimum temperature for vegetative growth is 32 – 38^{0}C, above which growth tends to start decreasing (FAO, 2002). High temperatures of about 56^{0}C are endured for several days under irrigation conditions while vegetative growth stops at temperature below 7^{0}C (FAO, 2002).Inadequate and erratic supply of soil moisture has adverse effects on growth. Heavy rains during flowering may wash off most of the pollen and also reduce the receptivity of flowers when it contacted with water (FAO, 2002). Date palm is classified as a more than average consumer of water with an estimated water requirement of 250m^3/palm/year (FAO, 1993). The maximum average annual use of water occurs within the soil profile between 0.30 – 1.50 m depth, depending on the variety (FAO, 2002). The amount of rainfall is less important than the conditions under which it occurs. A light shower accompanied by prolonged periods of cloudy weather and high humidity has negative effect on fruit ripening and post-harvest qualities than heavy rain which followed by clear and

dry winds (FAO, 2002). Date palm is not very demanding on soil fertility, and will grow on almost any type of soil, from sandy to heavy alluvial soils, provided the basic needs of anchorage to the palm, supply of minerals, water and drainage are satisfied. Deep sandy loams are more suitable for date palm cultivation.Adequate moisture and nutrition are essential to crop growth. The major zone of date palm production in Nigeria falls within the semi-arid zones which receive less than 1000mm of rainfall/year (Agboola, 1978) which falls short of the crop water requirement of $250m^3$/palm/year. The growth, gestation period, yields and fruit quality of the crop is enhanced by adequate supply of soil moisture and nutrition that are not usually satisfied. These among others account for production constraints and reasons for low yield. In order to satisfy the crop water requirement under a relatively arid climate, management systems that are likely to enhance soil moisture supply and improved plant nutrition are necessary. Also, the possibilities that differences among genotypes may influence crop responses to moisture conservation treatments do exist. Enhancing moisture supply and retention around the root zones of the palm and appropriate nutrition level are approaches that need to be developed. Studies in water harvesting, which is a rudimentary form of irrigation as well as studies on appropriate levels of NP which are vital for crop establishment, growth and proper moisture utilization and retention were effectively been carried out to advantage. This experiment was conducted with a view to assess soil moisture content as affected by water harvesting methods, date palm varieties and NP-fertilizer rates.

II. MATERIALS AND METHODS

A field experiment was conducted to studysoil moisture content of date palm varieties as affected by water harvesting methods and NP-fertilizer rates 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, ($11^o50'$N, $09^o25'$E) in the Sudan Savanna ecological zone of Nigeria. The location has 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 (Isyaku, 2010).

Treatment and Experimental Design

The treatment consisted of six water- harvesting methods (WHM), six NP fertilizer rates (F) and six date- palm varieties (V) arranged in Latin square design.

(a) Water harvesting methods (WHM)

Control (WH_1):- This is the usual standard circular basin of 30cm radius and 30cm deep around the base of the plant.

Single side pit (WH_2):- This is a circular pit of 0.50m radius and 0.50m deep placed at 30cm away from the plant base.

Double side pits (WH_3):- These are two circular pits of dimensions similar to WH_2 placed on opposite sides of the plant.

Perimeter square basin (WH_4):- This is a square shaped basin of 1.00m width and 0.50m deep cut 30cm around the plant base.

Side square basin (WH_5):- This is a square shaped catchment area with 1.00m dimensions and 0.50m deep placed 30cm away from the plant.

Double square basin (WH_6):- These are two square shaped basins with 1.00m dimensions and 0.50m deep placed 30cm placed opposite sides of the plant.

(b) NP – fertilizer rates

F_1 = Control = No N + P.
F_2 =20g N + 10g P/plant/year.
F_3 = 40g N + 20g P/plant/ year.
F_4 = 60g N + 30g P/plant/year.
F_5 = 80g N + 40g P/plant/year.
F_6 = 100g N + 50g P/plant/year

(c) Brief description of the six date palm varieties

V1= Palm 300
This is a variety that is late ripening and produces soft but very sweet fruits. It has an average fruit length of 4.0cm, average fruit weight of 50g and average number of 8 bunches per palm.
V2 = Tirgal
This is a dry fruit variety. Its average fruit length and weight are 4.0cm and 35g respectively.
V3 = Dan-Mali.
This is a semi dry fruit variety. It has average fruit length of 4.0cm and average fruit weight of 40g.
V4 = Deglet Noor.
This is a semi dry fruit, medium to late ripening date. It has average fruit length of 3.5cm and average fruit weight of 40g.
V5 = Shuwarin C
This is a dry fruit variety. It has average fruit length and weight of 5.0cm and 55.0g respectively.
V6 = Shuwarin B
This is a soft fruit variety. It has average fruit length of 4.0cm and average fruit weight of 40g.
The plants were planted at the spacing of 7m x 7m in a trapezoidal arrangement with a population of about 197 palm ha^{-1}.
All cultural practices were observed as at when due. Data related to soil were taken and analyzed.
i.Physio – chemical properties: - Soils of the experimental site were taken at random sports to the depth of 0 – 15cm and 15 – 30cm using soil auger, one sample per plant was taken in the month of December of 2004, 20005 and 2006. The soil samples were bulked and the composite samples used for physical and chemical analysis using standard procedure as recommended by AOAC (1980).

ii.Soil moisture content: Soil samples were taken from within the 100cm-perimeter of ground around individual plants with auger to the depth of 0-30cm.The moisture content of these soils were determined as described by Michael, (1999).The sampling was done on 15th December each year.Soil samples were weighed fresh and then oven- dried to obtain the total moisture content.

Thus,S.M.C (% by weight)

$$\frac{\text{Weight of moist sample - weight of oven dried sample}}{\text{Weight of oven dried sample.}} \times 100$$

III. DATA ANALYSIS

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

IV. RESULTS

Soil moisture content (%) during 2004, 2005 and 2006 seasons.Table 1 presents mean percentage of soil moisture content of date palm varieties as affected by water harvesting method and NP-fertilizer rate during 2004, 2005 and 2006. The effect due to water harvesting on soil moisture was significant in all the years except in 2004. In 2005, perimeter square basin and double side pits statistically retained more moisture than side square basin, control and double square basin but statistically at par with single side pit. In 2006, perimeter square basin statistically retained the highest moisture which was at par with double side pits. Single side pit was statistically similar with double side pits and statistically retained more moisture than other water harvesting method treatments. Varying NP- fertilizer rate statistically resulted in different moisture level only in 2005. In 2005, rate 40g N + 20g P statistically retained the highest moisture which was statistically similar with the rate 60g N+ 30g P. Rate 60g N + 30g P statistically retained similar moisture with the other rates. The effect of variety on soil moisture was significant in all the three years. In 2004, Palm 300 statistically retained the highest moisture which was at par with all other varieties except Tirgal. In 2005, all the varieties recorded similar moisture except Tirgal which recorded the lowest moisture level. In 2006, Deglet Noor, Palm 300 and Shuwarin B statistically recorded the highest moisture and were statistically similar with Shuwarin C and Dan- Mali. Tirgal recorded the lowest moisture.

Table 1: Soil moisture (%) (0-30cmdepth) of date palm varieties as affected by water harvesting methods and NP-fertilizer rates during 2004, 2005 and 2006.

Treatments	2004	2005	2006
Water harvesting methods			
No water harvesting method	7.88	9.71b	9.13c
Single side pit	10.62	11.91ab	11.40bc
Double side pits	13.49	13.33a	13.03ab
Perimeter square basin	14.29	14.41a	13.73a
Side square basin	9.68	9.74b	10.39c
Double square basin	16.82	9.47b	9.85c
SE±	3.925	1.114	0.868
NP-fertilizer rates (g/plant/year)			
No N + P	11.12	10.83b	10.81
20g N + 10g P	18.60	10.73b	11.14
40g N + 20g P	10.70	14.06a	10.98
60g N + 30g P	11.64	11.92ab	12.09
80g N + 40g P	10.89	10.70b	11.57
100g N + 50g P	9.83	10.34b	10.95
SE±	3.925	1.114	0.868
Varieties			
Palm 300	19.55a	11.65a	11.98a
Tirgal	8.16b	8.41b	9.22b
Dan-Mali	10.96ab	12.92a	10.88ab
Deglet – Noor	11.45ab	11.51a	12.36a
Shuwarin C	11.70ab	12.00a	11.34ab
Shuwarin B	10.94ab	12.09a	11.73a
SE±	3.925	1.114	0.868

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

V. DISCUSSION

Table 1 presents the effects of water harvesting method, NP-fertilizer and variety on soil moisture. In 2005 and 2006 perimeter square basin recorded highest moisture level although comparable with double side pits. This is expected because, perimeter square basin have bigger basin to retain and conserve soil moisture. The influence of NP- fertilizer on soil moisture was only significant in 2005. Rate 40 g N + 20 g P recorded higher moisture although comparable with rate 60 g N + 30g P. This indicates that, rate 40 g N + 20 g P is the optimum rate in terms of soil moisture conservation in the sandy loam where this experiment was conducted.

Varieties also differ in their ability to exploit soil moisture. Palm 300 recorded statistically higher soil moisture than only Tirgal and statistically similar with Dan Mali, Deglet Noor, Shuarin C and Shuarin B in all the sampling periods. This indicates that, Tirgal has higher moisture requirement than all other varieties as it exploit more soil moisture than others. This is in line with the findings of (Aref and Sam, 2005) that, water requirements differ among to varieties.

Perimeter square basin retained highest soil moisture but comparable with double side pits. NP- fertilizer rate 40 g N + 20 g P conserved more soil moisture comparable with rate 60 g N + 30 g P in the sandy loam where this experiment was conducted. Soil moisture retention due to variety effect also differs significantly. Tirgal exploit more soil moisture as it retained less soil moisture compared to other varieties.

CONCLUSIONS

Field trials to study Soil moisture content of date palm varieties as affected by water harvesting methods and NP-fertilizer rates has been conducted. Results of our findings revealed thatperimeter square basin retained highest soil moisture but comparable with double side pits. NP- fertilizer rate 40 g N + 20 g P conserved more soil moisture comparable with rate 60 g N + 30 g P in the sandy loam where this experiment was conducted. Soil moisture retention due to variety effect also differs significantly. Tirgal exploit more soil moisture as it retained less soil moisture compared to other varieties. A combination of perimeter square basin or double side pits with 40 g N + 20 g P or 60 g N + 30 g P and variety Tirgal will optimize soil moisture content and utilization within the Sudan ecological zone of Nigeria where this experiment was conducted.

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