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The Management of Soil and Water for Date Palm in Hyper-Arid Region [South Algéria]

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RESUME

La présente étude a porté sur le suivi de 13 troupeaux de moutons, qui se composent de 747 brebis et 33 La région d'El-Hadjira appartient à l'étage bioclimatique saharien. Les amplitudes thermiques sont fortes et extrêmement brutales, les précipitations sont déficientes et mal réparties. Le vent très fréquent, sa violence détermine le caractère désertique de la région. Les sols sont de faibles profondeurs et pauvres en matière organique. Cependant, ils se distinguent par une conductivité hydraulique et une salinité appréciables. Au mois de pointe, la densité du flux déficit est de 7.8 mmj-1. L'eau d'irrigation se range dans la catégorie C4-S2. La faisabilité du projet est raisonnée par une utilisation efficiente de la ressource en sol et en eau pour réduire des effets contraignants la productivité du palmier dattier et de l'inter-culture.

ABSTRACT

El-Hadjira region belongs to Saharan bioclimatic floor. The thermal amplitudes are high and extremely brutal; rainfall is deficient and badly distributed. Violence and frequency of wind determine the character of the desert region. The depths and organic matter soils are low. Against, it is distinguished by appreciated hydraulic conductivity and salinity. In peak months, the flux of deficit density was 7.8 mm day-1. The irrigation water was ranged in the C4-S2 category. The project feasibility is reasoned by an efficient use of soil and water resources to reducing the constrained effects of the date palm and intercrops productivity

1. Introduction

In bioclimatic hyper arid floor, soil and water resources valorization require an appropriated management agricultural territories. The aleatory character of rainfall is the limited factor of agricultural production. In fact, rainfall is infrequent and irregular, sometimes absent for long periods. The cumulative annual rainfall is less than 100 mm (FAO, 1995; Ozenda, 2004). Wind erosion is one of the most determinant physical phenomena of the Saharan environment. The maximum temperature observed at Touggourt is 54°C, the minimum is -10 °C. Yearly amplitudes are above 60°C, diurnal temperature variation exceeded 35°C. During the day, soil heats up more than the air; its surface temperature is 60°C (Ozenda, 2004). Soil and climatic conditions restricted agriculture development by a dry season that extends throughout the year (Chennafi, 1981). Soil constraints are added to limited climate by the erosion risk, low of depth and of caution exchange capacity, also by salinity and sodicity of soils (Calvet, 2003). The salts constitute the characteristic traits of arid landscapes of Algeria (Halitim, 1988). The choice of irrigable soils should be founded in function of soil, water and plant tolerance to salinity (Durand, 1981). However, water resources and its use remains the tool to establish a sustainable development in deserted areas. The use of salt water compromises soil sustainability by spatial and temporal contamination of soil. Nevertheless, the permeability of soil reduces the effect of saline water irrigation (Peyron, 2000). Date palm is the main crop in the Sahara and ensures export trade (Peyron, 2000). But, its potential yield decreases from 10 to 20% under soil with electrical conductivity (EC, 25°C) = 8 mm hos cm-1 (Durand, 1983; Bernstein, 1965). The feasibility of development project is judged in terms of the study of natural environment and of technical and economical realization for sustainable environmental management (Chennafi, 1984). In this aspect, the present investigation was focused.

2. Materiels and Methods

The irrigation area is located in the town of El-Hadjira, Daïra of Touggourt, Wilaya of Ouargla, in South of Algeria. Latitude and longitude are respectly 32°32'39"N and 5°35'36"NE, altitude is 117.8 m als. Physical environment has been characterized by typographic elements (map: 1/2000), soils were characterized by the Algeries hydraulic Society (SETHYAL) (1979), weather data were taken from the Oued Rhir Valley studied by the Central equipment society Territory (SCET) (1964) and also from document of Seltzer (1954).

The water requirements (ETC) of date palm were estimated by potential evapotranspiration (ETP) x kc (crop coefficient), using the corrected method of Blaney–Criddle noted by Doorenbos and Pruitt (1976) introduced in the relation:

$$ETC = 0.254\,(1.8\,t + 32) \times p \times kc \qquad (1)$$

ETC= monthly crop evapotranspiration (mm), t= mean monthly temperature (°C), p= % of day light hours (h month-1) depending on latitude, Corrected ETP by graphical method, using the model (1), with introduction of relative humidity air (RH%), relative solar (nN-1) and wind speed (v, ms-1) (Doorenbos and Pruitt, 1976).

The irrigation water requirements (IWR) were defined by the equation of Ollier and Poirée (1981):

$$IWR = ETC - (R + S) \qquad (2)$$

IWR = monthly irrigation water requirement (mm), R= Rain (mm), fjS= Available soil water (negligible)

The water requirements for leaching salts (WRL) (mm) were determined by the model developed by Bernstein and François (1973) and Rhoades et al., (1974):

$$WRL = ECi \; X \; ETC/Ei \times f\,(5\,ECs - ECi) \qquad (3)$$

ECi = Electrical conductivity (EC) of irrigation water (25°C, mmhoscm-1), ECS = EC of soil (with 10% reduction in potential yield of date palm), f = efficiency leaching, Ei = irrigation efficiency. Morphological and analytical characteristics soils were defined by 33 profiles with depths varied from 1m to 1.5 m, covering 160 ha. Crop adaptation to soils and climate conditions were proposed taking into account of its requirements.

3. Result

Climatic characteristics

Averages temperatures were 10.12°C on January and 34°C on July. The values of absolute minimum and maximum temperatures indicated 3.7°C on January and 49.1°C on june. Daily temperature of soil amounted to 70 °C. The yearly ccumulative rainfall was only 52.0 mm (Figure 1). Dominant winds were from South West to North West in wWinter, East to South in Summer, wind speed attained 2.7 ms-1 on January to 5.7 ms-1 on June. Sunshine duration wa estimed to 3600 hours per year and 10 hday-1. The average relative humidity of air was 25% in summer season to 60% on winter. The climate index (I) of De Martonne (1926), I = [P/T + 10] = 1.62 classified El-Hajj in hyperarid bioclimatic region. The ombrothermique diagram of Gaussen (1954), defined dry season by P(mm) R 2 T(°C) (P and T monthly) showed a dry period during the year (Chennafi, 1981).

Soil and hydrogeological ressources

Soils were characterized by low level organic matter, high compactness, sandy texture, high stoniness, the soil infiltration rate varied from 30 to 120,2 cmh-1 and electrical conductivity ranged from 3 to 11 mmhoscm-1.

The region benefited for four artesian water aquifers. Those of continent terminal are groundwater with 20 to 50 m, water was characterized by 4 to 10 gl-1 salinity, the second aquifer with 60-100 m of thickness and the third 100 - 200 m. The intermediate continent, Artesian Albian water is localised at 1400-2000 m, water temperature is 46 - 60 °C.

The irrigation water requirement (IWR) and leaching of soil salts (WRL)

The irrigation water requirement IWR was about 1736,08 mmyear-1. At month peak, IWR reached 240.56 mm, with a characteristic debit (qc) estimated to 0.9 ls-1ha-1 . The resource of water was of Albian aquifer, with flow water= 19 ls-1, pH= 7.5, the adsorption coefficient of sodium: SAR = Na+ /[(Mg++ + Ca++)/2]1/2 = 4.3, EC= 4.3 mmhoscm-1. The monthly variation of water requirements for soil leaching (WRL) balance varied from 56.04 mm to 265.4 mm (Table 1).

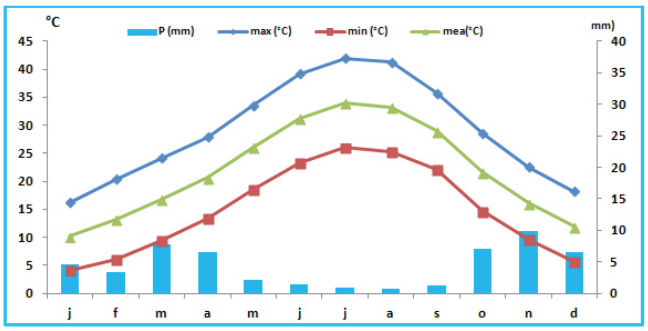

Fig.1. Monthly minimals (min), maximals (max), mean temperatures and rainfall (P). Region of El-Hadjira, Daira of Touggourt (South of Algeria)

Table 1. Potential and crop evapotranspiration's (ETP, ETC, mm), density of flux déficit (DFD, mm j-1) and water requirements for soil leaching salt (WRL, mm). Region of El-Hadjira (Algéria)

Months	J	F	M	A	M	J	J	A	S	O	N	D
ETP	65	98	155	195	241,8	285	300,7	279	222	170,5	96	62
ETC	52	78,4	124	156	193,4	228	240,6	223,2	177,6	136,4	76,8	49,6
DFD	1,7	2,8	4	5,2	6,2	7,6	7,8	7,2	5,9	4,4	2,6	1,6
WRI	56,0	85,2	135,2	171,4	213,0	251,4	265,4	2461,1	195,4	149,6	83,4	53,2

4. Discussion

The maximum of temperature in Touggourt reached 55 °C (Ozenda, 2004). The high maximum of temperatures and its large variations are explained by the atmosphere purity of which clouds and humidity air are lows, associated to continental aspect (Ozenda, 2004). The low humidity of air is considered as the fundamental character of hyperarid regions. Ccumulative rainfall in the year was deficient with 52.0 mm. The process of wind erosion in hyper arid region is favored by plane extent of loose and uncovered soil. In fact, soils were calcareous, unstructured, characterized by low level organic matter, sandy texture. According to Poirée and Ollier (1981) soil infiltration rate with 30 to 120,2 cmh-1 indicated that soils were very permeable.

At this, water and soil must be managed with more attention for its use in a durable context of preservation with improvement of production and soil property. Level of electrical conductivity indicated that soil was salt according to scale of Richard (1954) quoted by Durand (1983). Nevertheless, the date palm adapted to fine-textured soils can supports 32 mmhoscm-1 (Ayers and Westcot, 1976). However, the application of water requirements for soil leaching (WRL) was sustained by drainage.

The values of irrigation water requirement IWR estimated to 1736,08 mmyear-1 are similar to those mentioned by FAO (2008), Peyron (200) and Liebenberg and Zaid (2002). In Algerian conditions, water use efficiency(WUE) of date palm ranged from 1.4 to 6.7 kgmm-1ha-1 remained lows. However, water management efficient improves WUE for producing more dates. At month peak, IWR reached 240.56 mm obtained a characteristic debit (qc)= 0.9 ls-1ha-1 and flux deficit density= 7.76 mmj-1. Related results are reported (Peyron, 2000; Alazba, 2004; FAO 2008). The salinity of water aquifer Albian and its temperature 60 °C must be applied with more advices by the choice of tolerant crop to salinity and the use of cool water technic. The debit of 19 ls-1 , the high pressure and salinity of albian water made its exploitation very expensive. The gravity irrigation system was chosen for salinity level of soil and water. The values of SAR EC classed the irrigation water in C4-S2 cathegory, water with high salinity and alkalinity. In this area, water is scarce, WRL is recommended outside water peak period.

5. Conclusion

Soil and water salinity require proper management, regulated by an adequate irrigation and drainage to ensure potential productivity of date palm and intercrops. The natural context of this region is very fragile under constraints of energy factors climate and anthropic actions that interfere date palm, and cause irreversible damage. Spatial-temporal governance based on sustainable management of soil and water resources was advised.

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