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Evaluation of Moisture Deficit Index in Dry Land in Iraq

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Abstract: This investigation has been conducted to study the magnitude of water deficiency in the arid land in Iraq, the moisture deficit index (MDI) has been evaluated for 4 dry land stations (Sulaimaniya, Mousl, Baghdad and Bassra). The results in general show that the moisture index values were negative at Sulaimaniya and Mousl it ranges from -56.0 to -73.0. It was -28.0 in Jan. in Sulaimaniya. The above range -56.0 to -73.0 indicates that the available moisture is enough for sowing and subsequently for the establishment of the crop but not necessarily for optimal growth if there was full crop canopy. Crops do grow in Sulaimaniya and Mousl.However, Moisture Deficit Index range from -80.0 to -94.0 in Baghdad and Bassra. For all the crops such as Barley (*Hordeum vulgare*) and Wheat (*Triticum aestivum*), broad beans (Vici *faba*) and other winter crops must experience moisture stress and unless they receive irrigation, they may not grow and produce yields in Baghdad and Bassra. However, in Sulaimaniya and Mousl the available moisture is enough to grow crops and produce yields.

Key word: Moisture · Deficit Index. Dry land · Available water · Crop production · Iraq

INTRODUCTION

Dryland occupies 30-40% of the Earth's land surface. Dryland is divided into severe deserts, semiarid regions including savannas and dry steppes [1]. Basic understanding of the moisture deficit index in arid and semiarid regions is essential for proper land management of these lands, in which it is characterized by a severe lack of available water.This has unfavorable effect on their quality and production. An aridity index is a numerical indicator of the degree of dryness of climate at a given location. a number of aridity indices have been proposed by Blaney and Criddle [2], Thornthwaite and Mather [3], Kharrufa [4] and UNEP [5]. These indices have serve to identify, locate or delimit regions that suffer from deficit of available water a condition that can severely affect the effective use of the land for such activities as agriculture or stock-farming [6].

In Iraq, almost all the area considered as arid land (more than75%) and the rest of the land is semi-arid [7] area where crops experience moisture stress.

To determine the magnitude of water deficiency in these regions, the moisture deficit index (MDI) will be evaluated for selected stations in the country based on normal data which has been worked out. Its implications for crop production in relation to other meteorological factors will be also discussed.

MATERIALS AND METHODS

To determine the magnitude of water deficiency in these regions, the moisture deficit index (MDI) has been evaluated for 4 dry land stations in Iraq (Fig. 1). The MDI is usually determined on the basis of annual precipitation [8,9].

Moisture Deficit Index (MDI) is modified to be suitable for Iraqi condition by the author after [3] as follow:

$$MDI = \frac{R\text{-}ETP}{ETP} \times 100$$

Where; MDI is Moisture Deficit Index.
R = Precipitation (mm).
ETP = potential evapotranspiration(mm).

This does not reflect the true nature of MDI for the purpose of crop production, although it does give information regarding the degree of aridity. Since this index sometimes is used as a criterion for crop planning, it would appear more appropriate for it to be based on precipitation and ETP during the crop growth period. Both monthly and annual data for Sulaimaniya, Mousl, Baghdad and Bassrah, were obtained from the Iraq

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Fig. 1: Iraqi map shows the investigated areas

Meteorological Department. The normal monthly and annual ETP were computed using the Blaney and Criddle [2] method in 1950 as follow:

$$ETP = 1.1 (T c + 18) P$$

Where ETP is the potential evapotranspiration (mm)
Tc = The temperature (°C).
P = The day length, (%) [8]

RESULT AND DISCUSSION

It can be seen in Table 1, the monthly means of precipitation (mm), day length (%), temperature, Tc (°C), evapotranspiration, ETP (mm) and Moisture Deficit Index (MDI) of the investigated areas. In general, the most rain fall is in Dec. and Jan.However,there is no rain from June until Oct., (Table 2), but the temperature is higher than those in Dec., Jan, Feb.,Mar. And April.Accordingly the evapotranspiration, ETP (mm) and Moisture Deficit Index (MDI) are deferent. Indeed, if ETP is more than precipitation, the plants must experience moisture stress and unless they receive irrigation, they may not grow and produce yields.

Table 3 shows the monthly mean of the Moisture Deficit Index (MDI) of the investigated areas. the Moisture Deficit Index (MDI) value was -77.0, -86.0, -97.0 and -95.0 in Sulaimaniya, Mousl, Baghdad and Bassrah respectively.

Table 1: The monthly mean of Precipitation (mm),day length(hour), temperature,Tc(Cú), evapotranspiration, ETP (mm) and Moisture Deficit Index (MDI) of the investigated areas

	Month							
Station	Jan.	Feb.	Mar.	Apr.	May	Oct.	Nov.	Dec.
Sulaimaniya-								
R	142	118	126	78	34	11	81	113
P	7.05	6.89	8.36	8.83	9.52	7.88	7.97	6.85
Tc	7.5	10.1	15.3	20.5	28.0	27.9	18.4	10.9
ETP	197.8	213.0	306.2	374.0	481.7	397.9	319.1	217.8
MDI	28.0 -	-45.0	-59.0	-79.0	-90.0	97 -	-75.0	-48.0
Mousl-								
R	84	67	52	51	19	11	67	67
P	6.99	6.86	8.35	8.85	9.31	7.85	6.92	6.9
Tc	12.8	15.3	19.0	25.4	32.9	31.2	22.1	15.0
ETP	236.8	131.0	339.8	422.5	521.3	424.8	305.2	250.5
MDI	-65.0	-49.0	-85.0	-88.0	-88.0	-97.0	-78.0	-73.0
Baghdad-								
R	25	23	24	11	4	3	20	24
P	7.2	6.97	8.37	8.72	9.63	7.93	7.11	7.05
Tc	16.0	18.7	22.7	28.7	35.8	33.4	24.6	17.6
ETP	269.3	281.4	374.7	447.9	569.9	448.4	333.2	276.1
MDI	-91.0	-92.0	-94.0	-98.0	-99.0	-99.0	-94.0	-91.0
Bassra –								
R	38	31	29	30	5	1	31	33
P	7.3	7.03	8.38	8.72	9.53	7.99	7.19	7.14
Tc	18.6	21.0	25.3	30.8	36.1	35.0	26.9	20.0
ETP	293.9	301.1	399.1	468.6	567.1	465.8	355.1	298.5
MDI	-87.0	-80.0	-93.0	-94.0	-87.0	-99.0	-91.0	-89.0

Table 2: The monthly mean of Precipitation (mm), day length (hour), temperature,Tc(Cú), evapotranspiration, ETP (mm) and Moisture Deficit Index (MDI) for dry months of the investigated areas

	Month			
Station	June	July	Aug.	Sep.
Sulaimaniya-				
R	0.00	0.00	0.00	0.00
P	9.77	9.94	9.37	8.36
Tc	34.70	38.40	38.60	34.40
ETP	566.40	616.70	583.40	481.90
MDI	-100.00	-100.00	-100.00	-100.00
Mousl-				
R	0.00	0.00	0.00	0.00
P	9.83	9.99	9.40	8.36
Tc	39.60	43.40	43.00	38.70
ETP	589.90	674.70	630.70	521.40
MDI	-100.00	-100.00	-100.00	-100.00
Baghdad-				
R	0.00	0.00	0.00	0.00
P	9.60	9.77	9.28	8.34
Tc	41.00	43.40	43.30	39.80
ETP	443.50	659.90	625.80	530.30
MDI	-100.00	-100.00	-100.00	-100.00
Bassra –				
R	0.00	0.00	0.00	0.00
P	9.48	9.67	9.22	8.34
Tc	38.80	40.50	41.50	39.40
ETP	592.30	622.30	603.40	526.60
MDI	-100.00	-100.00	-100.00	-100.00

Table 3: The monthly mean of the Moisture Deficit Index (MDI) of the investigated areas

	Stations Mositure index (MDI) (%)			
Month	Sulaimaniya	Mousl	Baghdad	Bassra
Jan.	-28.00	-65.00	-91.00	-87.00
Feb.	-45.00	-49.00	-92.00	-80.00
Mar.	-59.00	-85.00	-94.00	-93.00
Apr.	-79.00	-88.00	-98.00	-94.00
May	-90.00	-96.00	-99.00	-99.00
June	-100.00	-100.00	-100.00	-100.00
July	-100.00	-100.00	-100.00	-100.00
Aug.	-100.00	-100.00	-100.00	-100.00
Sep.	-100.00	-100.00	-100.00	-100.00
Oct.	-97.00	-97.00	-99.00	-99.00
Nov.	-75.00	-78.00	-94.00	-91.00
Dec.	-48.00	-73.00	-91.00	-89.00
Mean	-77.00	-86.00	-97.00	-95.00

Table 4: The monthly mean of the Moisture Deficit Index (MDI) of the rainy month in the investigated areas

	Stations Mositure index (MDI) (%)			
Month	Sulaimaniya	Mousl	Baghdad	Bassra
Jan.	-28.00	-65.00	-91.00	-87.00
Feb.	-45.00	-49.00	-92.00	-80.00
Mar.	-59.00	-85.00	-94.00	-93.00
Apr.	-79.00	-88.00	-98.00	-94.00
Nov.	-75.00	-78.00	-94.00	-91.00
Dec.	-48.00	-73.00	-91.00	-89.00
Mean	-56.00	-73.00	-93.00	-90.00

Table 4 shows the monthly means of the Moisture Deficit Index (MDI) of the rainy month in the investigated areas were -56.0, -73.0, -91.0 and -93.0 for the investigated area respectively. The moisture index was negative at Sulaimaniya and Mousl ranged from -56.0 to -73.0. It was -28.0 in Jan. in Sulaimaniya. This the range-56.0 to-73.0 indicats that the available moisture may be enough for sowing and subsequently for the establishment of the crop but not necessarily for optimal growth if there was full crop canopy.Crops do grow in Sulaimaniya and Mousl.However, in Baghdad and Bassrah Moisture Deficit Index range from -80.0 to -94.0.Therefore, the plants must experience moisture stress and unless they receive irrigation, they may not grow and produce yields.

In Iraq, the winter crops (rainy season crops) are sown immediately after the arrival of rains (in November) in the dry regions. Therefore, the period from the first showers to harvest time (in May) constitutes the growth and maturity period of the crop. For all the crops such as Barley (*Hordeum vulgare*) and Wheat (*Triticum aestivum*), broad beans (*Vici faba*) and other winter crops.This period ranges from 100 days to 150 days. It is clear that in most of the country, sowing occurs in the last week of November or the first week of Dec. The crops usually are harvested in may. A study of MDI during this period would be important in classifying the different regions.

CONCLUSION

From the above results. It can be concluded that the moisture index was negative at Sulaimaniya and Mousl indicats so the available moisture is enough for sowing and subsequently for the establishment of Winter crops. However, in Baghdad and Bassrah the Moisture Deficit Index values show that the plants must experience moisture stress, unless they receive irrigation.

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