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Survey rain-fed wheat compatibility with Kermanshah climate

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Abstract

At present human's nutritional security has been threatened by population growth and people have tended to preserve their own food security by means of modern sciences and techniques and tried to improve it better more than ever. Among the effective factors on production of agricultural products, climatic conditions are considered as the paramount variables. Lack of paying attention to climatological capabilities of various regions and traditional cultivations of farming crops may cause lower and very fluctuating efficiency and even destroying farming products during several years. In the current investigation, evaporation and transpiration potential were also estimated by means of FAO's Penman Montieth evapotranspiration estimation method and Deviation from Optimum Percentage (DOP) technique by climatic elements (min-max temperature, relative humidity, wind speed and radiation) during at least 20years statistical period regarding wheat phenological conditions in Kermanshah Province. Likewise in the following, DOP maps for cultivation of dry- farmed wheat were zoned by the aid of functions of GIS software. The acquired results from this survey indicated that the minimum water requirement has belonged to West Eslamabad substation (352.2mm) during growth season of wheat crop while the maximum rate was ascribed to Sarpolzahab and Kermanshah substations (respectively, 388.5mm and 383.3mm). It is also inferred from zoning maps this fact that most of regions in this province, particularly, Northern, Center, and Northeast regions of province are under appropriate conditions to cultivate this crop and there is no restraint for them in this regard.

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Introduction

Due to the limited rainfall and extreme heat during summer and very icy conditions in winter season in our country, climate plays special role in agricultural achievement.

The rate of producing agricultural crops is highly correlated with atmospheric precipitations and appropriate climatic conditions every year (Hundal *et al* ., 1997).

Propagation of plant's pests and diseases is function of climatic conditions and vegetation coverage in ranches and even flora in weeds in the fields are also subjected to climatic conditions (Sharma *et al*., 2004).

Thus, deep and accurate detection of climate effect on yield of farming crops may extremely contribute to optimal consuming divinely resources from atmosphere and its relevant parameters (Howden and Jones, 2001).

Any plant is exposed to critical stage or stages in relation to climatic factors such as cooling, heating, humidity, wind etc recognizing these phases may provide the ground for making appropriate decision regarding implementation of successful farming operation (Satya and Shibasaki,1999).

It is very necessary to examine and study on result of findings and history of researchers' studies in any investigation and this may prevent from doing rehashing works and encountering mistakes and wasting time rather than helping to collection of useful information (Oche,1998).

(Robertson, 1974:1) has explored wheat yield regarding atmospheric conditions in Saskatchewan during 50 years ago.

(Fischer and Maurer, 1976:2) addressed water stress within various stages of plant's germination and wheat yield.

(Zhang,1994) carried out several experiments to determine temperature variations and rainfall on growth in winter- wheat in China.The results of this study indicated that compared to rainfall, temperature has more important impact on seed yield.(Satya and Shibasaki ,1999) has employed some climatic elements and agents like height above level sea, slope, temperature, rainfall, day length, rate of evaporation, and wind speed for zoning of farming crops like sorghum, wheat, and potato in India.

(Sharma *et al*., 2006) in their studies investigated into the reaction of wheat crops in Australia and climatic change and cost and profit resulting from change in atmospheric carbon dioxide and its consequents on wheat production (Hundal *et al*., 1997).

In this survey, it was characterized that the adaptable methods are not adapted for conditions of climatic changes in semi-arid areas in Australia, the farming land for wheat cultivation will be noticeably reduced due to deceasing potential yield and this may lead to remarkable decline in economy and wheat production in this country.

With entering adaptable techniques in simulation models, they showed that despite of the needed cost for implementation of these methods, the resultant profit is reasonable and the land area under cultivation will not be reduced if yield reduction is compensated. With respect to above-said issues about agroclimatic dry- farmed wheat cultivation, this study is also purposed to evaluation and zoning of agroclimatic elements in Kermanshah province by means of Geographical Information System (GIS).

Materials and methods

Data gathering

In this study, by means of statistical data for at least 20 years and from 5 synoptic substations in Kermanshah province (including Kermanshah, Ravansar, Sarpolzahab, and Kangavar), agroclimatic elements in Kermanshah province have been evaluated and zoned (Fig. 1).

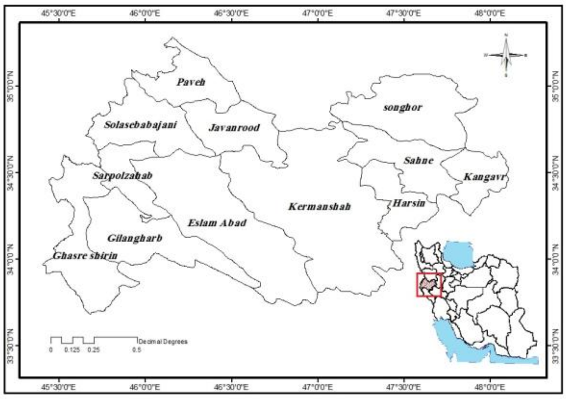

Fig. 1. Study area.

FAO- Penman- Montieth method is used as one of the most reliable techniques for ETo estimation.

FAO- Penman- Montieth equation is expressed as follows.

(Eq. 1)

$$ET_o = \frac{0.408\Delta(R_n - G) + [890/(T+273)]U_2(e_a - e_d)}{\Delta + \gamma(1 + 0.34U_2)}$$

Where:

ETo = Evaporation – Transpiration of reference plant (mm/ day)

R_n = Net radiation on flora level $(MJm^{-2}d^{-1})$

T = Mean temperature at height 2m above ground level $(^o c)$

U_2 = Wind speed at height 2m above ground level (ms^{-1})

$e_a - e_d$ = Shortage of vapor pressure at height 2m (kpa)

Δ = Vapor pressure slope $(KPa^o c^{-1})$

γ = Humidity coefficient $(KPa^o c^{-1})$

G = Heat flux into soil $(MJm^{-2}d^{-1})$

(Eq. 2)

$$u2 = u = \frac{4.87}{\ln(67.87zw - 5.42)}$$

Where U denotes the wind speed (m/s) at height 2m, U2 is wind speed at the given height (m/s), and ZW as height of anemometer, which here is 10m and equal to height of anemometer derricks in synoptic substations.

Deviation from Optimum Percentage (DOP) method

There are 7 phenological stages in wheat plant and any phase has optimum or optimal temperature where the max growth of the plant occurs at this optimum temperature. The spatial optimums may be characterized within several time intervals, especially year months through identifying and determination of these optimums for any phenological phase and mean daily temperature derived from detection of min and max daily value and in fact those points with min deviation from optimum conditions are considered as optimal location. To acquire various spatial optimums in this technique, initially optimums or optimal temperatures were determined and then by considering daily mean statistics, the values of deviation from optimum conditions were computed for total year. Then at next step, difference among the given means from optimum limit was calculated and as a result rate of deviation from optimum conditions is obtained for the above locations.

Table 1. Physiological characteristics of dry- farmed wheat crop (UN Food and Agriculture Organization FAO, 2008).

Height of plant (cm)	Root primary depth (cm)	Root maximum depth (cm)	Maximum tolerable salinity (mmhos/cm)	Yield response coefficient (ky)	Allowed discharge percentage (%)
1	70	170	6	1.7	0.55

Results and discussion

Agroclimatic elements are affected by tmeteorological and plant- related factors and administrative and environmental conditions.

The effective meteorological factors on evaporation-transpiration on plants and agro- meteorological processes are radiation, weather temperature, and wind speed.Thus, with respect to importance of the above factors, the effort has been made to estimate and analyze Evapotranspiration Potential (ETO) and to study on water requirement and the efficient rainfall in the region. As it observed in Table 2, the maxi and mini rates of evaporation and transpiration have taken place respectively in July and January.

Table 2. Evapotranspiration (ETO) with FAO- Penman- Montieth technique during several months of year in substations at Kermanshah province.

Substation	Jan	Feby	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean
Kermanshah	0.73	1.02	1.77	2.69	3.74	4.53	4.67	4.31	3.31	2.16	1.22	0.78	2.47
Kangavar	0.66	0.9	1.66	2.95	3.6	4.33	4.54	4.03	2.88	1.89	1.07	0.67	2.43
Ravansar	0.67	0.93	1.65	2.6	3.66	4.39	4.61	4.23	3.24	2.08	1.14	0.75	2.45
Eslamabad	0.69	0.97	1.69	2.68	3.69	4.38	4.58	4.28	3.23	2.09	1.16	0.74	2.46
Sarpolzahab	0.71	0.98	1.68	2.65	3.83	4.6	4.75	4.38	3.24	2.12	1.17	0.75	2.52

With respect to Table 2, the highest mean values o evaporation and transpiration belong to Sarpolzahab and Kermanshah substations with means of 2.52 and 2.47mm while the lowest rate is related to Kangavar substation with 2.43mm. Given the comparative and typical diagrams 1 and 2, it is seen that the rate of evaporation and transpiration has the highest monthly value from the middle of warm days of May (Ordibehesht month in Iranian calendar) to August (end of Shahrivar month in Iranian calendar). The numbers from 1 to 12 in horizontal axis in the following diagrams are related to Gregorian Months from January to December.

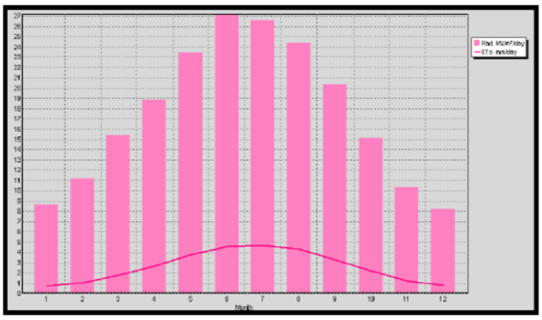

Fig. 2. Evaporation- Transpiration potential ETO and rate of annual solar radiation in Kermanshah substation by means of FAO- Penman- Montieth estimation technique.

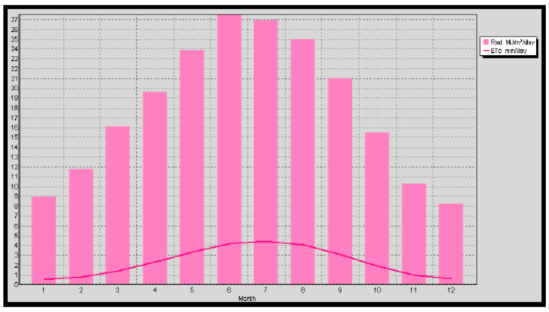

Fig. 3. Evaporation- Transpiration potential ETO and rate of annual solar radiation in Kangavar substation by means of FAO- Penman- Montieth estimation technique.

As it already mentioned, the highest rate of evaporation and transpiration has occurred within warm months during the year especially July while its lowest rate belonged to cold months of a year i.e. January. It should be noticed of course that due to low temperature, the studied region may not indicate evaporation- transpiration at high level as one of western areas in this country.

Appropriate regions for cultivation and harvest of dry-farmed wheat at Kermanshah province

At first, values of deviation from optimum conditions were calculated from any substation. These values were obtained based on sum of mini and maxi thresholds divided by two (mean of each class). Then the related values for conditions of daily temperature within various phenological periods in each of substations were subtracted from the above values and defined as values of deviation from optimum conditions. Afterward, Figs. 4-7 were dawn by means of IDW method that is shown in the following. With respect to the given results at germination and budding phases, Ravansar substation has the lowest deviation with higher optimum conditions compared to other substations. At flowering stage, Ravansar substation has the lowest deviation rate than other substations but there is no stark difference in terms of deviation from optimum conditions at this step. At maturation phase, dry- farmed wheat in Ravansar substation has the lowest deviation. After Ravansar, Eslamabad and Kangavar substations have lower deviation while Sarpolzahab and Kermanshah substations have more deviation. As a result, Ravansar substation has the lowest deviation from optimum conditions at all given phases. According to agroclimatic analyses, the best regions for cultivation of dry- farmed wheat is the lower heights at North regions (Ravansar substation) while eastern and Western regions (Kangavar and Sarpolzahab substations) are ranked after this area in this order. This means that these substations (i.e. Ravansar and Western Eslamabad) possess optimum conditions for cultivation of dry- farmed wheat crop. In general, we can say on the basis of (Fig 5) Whatever we move from the West to the East Province, due to the greater elevation of above sea level in the region to more suitable regions direction planting dryland wheat farming Research. The obtained results indicate that is the fact that between parameters studied, the the annual rainfall and Its dispersal Most importantly, because in (Fig 5), the relationship between rainfall and conducive regions planted wheat to clearly evident. Accordingly, moving from West to East provinces, regions of wheat conducive to the excellent goes.

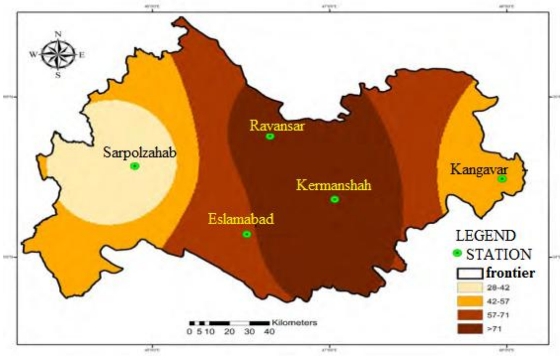

Fig. 4. Deviation from the optimal conditions at wheat plant germination stage.

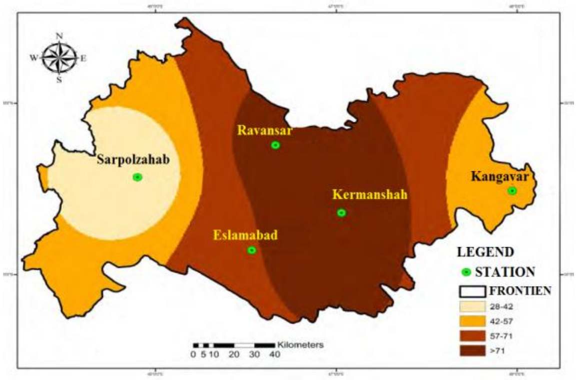

Fig. 5. Deviation from the optimal conditions at wheat heading completed flowering.

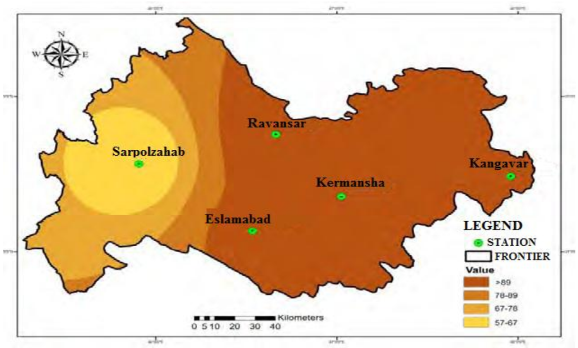

Fig. 6. Deviation from the optimal conditions at wheat mature and harvest-ready.

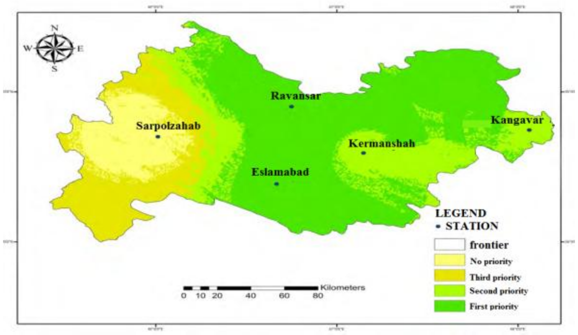

Fig. 7. The final map of suitable regions for wheat cultivation.

Conclusion

After conducting investigations and review on effective parameters on cultivation of dryland wheat farming, it was characterized that in terms of evapotranspiration estimation by FAO method the rates of evaporation and transpiration were identified as the mini value (2.43) in Kangavar substation and the maxi values respectively in Sarpolzahab and Kermanshah substations. Thus, it may be found that annual rainfall in most of the studied substations can the water requirement for cultivation of dryland wheat farming crop and based on rate of evaporation and transpiration and water need (plant's consuming water) an appropriate relationship may be observed among annual precipitations and cultivation of dryland wheat farming in terms of location between studied substations. With respect to the derived results from Deviation from Optimum Percentage (DOP) technique at germination and budding phases, Ravansar substation has the lowest deviation with more optimal conditions compared to other substations.At flowering phase, Ravansar substation has the less deviation from optimum criterion than other substations but there is no stark difference in terms of DOP at this stage.

At maturation stage, dry-farmed wheat in Ravansar substation has less deviation in this regard. After Ravansar, West Eslamabad and Kangavar substations have the lower deviation while there is more deviation in Kermanshah and Sarpolzahab substations.

As a result, Ravansar substation has the lowest deviation from optimum conditions at all steps. Based on agroclimatic analyses, the best region for cultivation of dry-farmed wheat is lower at North region (Ravansar substation) while North east and central areas (Kermanshah and Kangavar substations) are ranked after this substation in this order.

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