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Determination of suitable date for wheat culture by data of climate: Case study Eghlid region

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ABSTRACT

Water deficit is common stress in arid and semi-arid lands, also yield of wheat reduced by another environmental stresses such as heat and cold. The main causes of these changes are due to poor distribution of rainfall, and poor agronomy calendar. According to this fact that rainfall is one of the most important factors for agronomy in dry land, we calculated time of first effective rainfall with probabilities of 50% and 75% by using meteorological data (1994 to 2011) of Synoptic station at Eghlid region, The growing degree days (GDD) of wheat growth phenological stages were obtained by using 4 ° C as physiological Zero. Based on the results, the first effective rainfall happen in the November 19th and December 8th, by probability levels of 50% and 75% also the germination of wheat seeds happen in the March12th and March31th and the ended of phenological stages happen in the August18th and August25th by probability levels of 50% and 75% respectively. We suggest this planting calendar to obtain the best wheat yield.

Introduction

Sowing and harvesting dates are the most important variables of production. The selection of the suitable sowing date is important because it effects on maturity and quality of the seeds. . Climate is an important factor in the quality and quantity of agricultural products but unfortunately, little research has been done in this field. Alsoagricultural researchers studied on exploitation of the land and farming operations (Nasiri, 2003). Drought stress reduce agricultural products but adaptation with climate changes beside of other methods could improve agronomy (Richard; 2002).

Impact of climate on rain-fed agriculture is particular importance. Wheat is one of the world's Foods and it occupied most fields of the world (Srmadnia and Kucheki, 1995). climate, soil conditions, the using of chemical fertilizers and other factors effect yield of wheat and between these parameters, climatic factors play more critical role management of planting, harvesting, disease and pests control will not succeed without sufficient knowledge of the controlling factors of the climate and atmospheric elements and in most cases insufficient harvest of crops, resulting in an inability to maintain a balance of the atmospheric conditions (Nasiri, 2003).

Norwood (2000) studied wheat crop in the Great Plains States and analyzed climatic data such as rainfall, temperature, evaporation from the soil and introduced suitable areas for rain fed wheat. Evaporation and precipitation had highest effective on wheat growth stages than other elements. Sharma and et al (2006) evaluated effect of high temperature on grain growth in wheat cultivars. Their results showed that late planting of wheat (The end of December) reduced 30 to 40 percent in compared with sowing in November, . Late planting effects on the phenologycal stage before the pollination that determined the yield. This effect has been transferred to the growth stage and grain filling growth and yield are affected. Also Azimi et al., (2013) reported that drought stress reduced yield of wheat in growth and reproductive stages.

We must place seeds in more depth in late autumn because cold could destroy the primary buds. (Khoda bande,1998). Optimum temperature has been reported between 20 to 22 degrees Celsius for germination of wheat (Kucheki, 1995). Optimum temperature for wheat tillering was reportet between 10 and 12 ° C (Karimi 1992).

Imam (2004) stated that wheat needs heat to growth. Heading and pollination steps need around 9 ° C as minimum temperature and between 27 to 32 ° C as Maximum temperatures. Also the optimum temperature for filling and ripening stages was reported between 17.7 to 22 ° C (Radmehr, 1997).Thermal requirements has been determined for wheat at different growth stages (Table 1). Therefore,This study was conducted to investigate the properties of climate in relation to rainfall wheat cultivation, in Eghlid region and determine the appropriate time for planting and crop phenological stages according to the climatic characteristics of the region and assist the regional agricultural planning in order to achieve the best performance.

Material and methods

This research had a descriptive-analytical method and was applied in order to understand the capabilities and limitations of Climatology Eghlid region for rainfall wheat cultivation. Daily temperature and precipitation data were obtained for this region (Table 2) from the Meteorological Agency (synoptic stations). The data imported in Excel and SPSS software and performed descriptive analysis such as sum, average, standard deviation, coefficient of variation, minimum and maximum, the first effective rainfall (at least 5 mm), average monthly and annual precipitation and temperature (daily minimum and maximum) and adjusted monthly and yearly analysis . , We cited September 1th as start point to determine day number after first of

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precipitation.. Frequency of occurrence of the first effective rainfall (5 mm) was determined based on Weibull formula (P = m / n +1) by using of probability distribution. In this formula, P = occurrence probability, m = number of rows (number of years of data) and n = number of data Statistical data of meteorological stations was used to determine the total amount of temperature or thermal energy for different stages of phenology. This scale is called growing degree days - which was shown in the GDD (Saeedfar, 2000).

$GDD = \sum \lceil (Tmax + Tmin/2) - Tbase \rfloor$

Tmax = the maximum temperature

Tmin = the minimum temperature

Tbase = Base temperature (4 ° C for wheat crop in this study were considered)

Results

Minimum temperature: The minimum temperature taken 3 degrees below zero in the region (Table 3) that the temperature is happening in January therefore according to 50% probability, germination of wheat will be postponed to February. The reason for this phenomenon could be due to the high altitude (2300) and proximity to higher latitudes.

Maximum temperature: The maximum temperature occurs in June and its value is 15.8 ° C (Table 3) and therefore is the warmest month of the year, the highest of GDD will be provided at this month. Evaluation of 18 years data on annual rainfall shows that the most rainfall occurred in the 2003 year (616.1 mm) and minimum rainfall with 153 mm in 1999 and coefficient of variation and standard deviation are 0.37 and 121.3 respectively (Table 4), this difference in rainfall may be due to drought in 70 decade.

Monthly precipitation: November, December and January have highest rainfall with 59.8, ,58.6, and 56.6 mm respectively the lowest rainfall occur in the August with a 0.2 mm (Table 5). Result shows that rains began in the second half of October and continue until late May (Figure 1). Therefore it was resulted that Eghlid region is suitable for rainfall wheat cultivation.

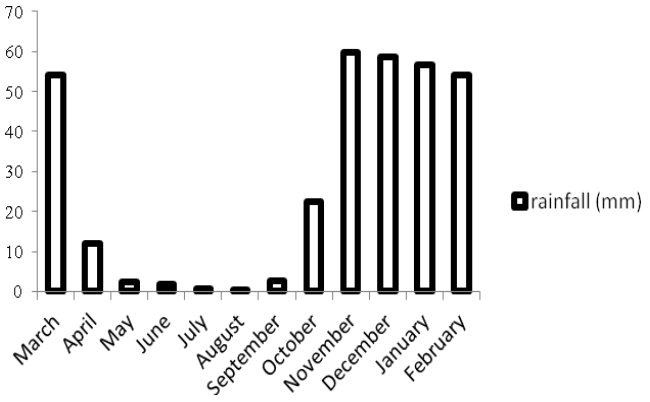

Fig1. Monthly rainfall of Synoptic stations, Eghlid region

This study confirms that the winter season had highest seasonal rainfall (56.23 %) and autumn and spring had 26 and 21% respectively (Table 6). This fact can be associated with enter of Mediterranean climate systems (Lashkari, 1996).

Start Rainfall: Rainfall is one of the most important parameters in determining the start date of agricultural in a region. This is important in rainfall farm because in dry farming water requirements of crop are provided by rainfall also seed germination,and biological activity are depended to date of first rainfall. Thus, the occurrence of the first rainfall with 5 mm was determined and the cumulative frequency was calculated for 18 years period. Symbol x represents the rainfall value (Table 7).

Rain fed wheat cultivation based on the start date:

In this study, rain starting date was determined based on the second definition of Stern (1982) and consider the possibility of 50 and 75% (Table 8). According to dates and for rainfall efficiency, it proposed to cultivation performed 10 days before the mentioned date. Value of rainfall was calculated based on probability of occurrence (Weibull formula) in Synoptic stations of the Eghlid (table 9).

Growing degree days (GDD):

After determination of date for first effective rainfall, GDD was calculated and result shown in Table 3 (the base temperature was considered for grain growth at 4 ° C),... Also, GDD calculated for different stages of growth and development and probability level was used 50% (Table 10).

Different development stages of Dry land wheat:

Different development stages of wheat needs various climatic requirements In this study, according to optimum temperature and best GDD for different stages, approximate time of occurrence was calculated for phenological stages of wheat in the studied area based on the first occurrence of precipitation (Table 11).

Conclusions

Yield of crops can be improved by understanding about climatic parameters and their effects on yield. This is particularly important in Dry land agriculture. According to the supply of moisture and thermal requirements of wheat, It can be generally concluded that if dry land farmers cultivate winter wheat a week to 10 days before start date of rainfall (50% chance of precipitation) resulted high yield with high quality and also to supply the moisture needed for seed germination conditions.

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Table 1. Thermal requirements of wheat at different growth stages [1]

References	GDD			GDD required	Definition	Period
	maximum	Optimum	Minimum			
Mahajer milani (1997)	25-30	14-20	3-4	150 Quanta (1977)	Availability of water and oxygen grain swell And therefore it is the seed pod shells Shkafnd roots and seeds are removed from the bottom buds early. Karimi (1992)	Germination
Radmehr (1997)	25	12-22	4			
Mahajer milani (1997)	25-30	12-15	3-4			
Seyadat (1998)	27	12-15	4			
Radmehr (1997)	22-25	8-14	5	500 Quanta (1977)	After a short time the plant stops growing pod elongation near the soil surface node bifurcation appears that paw paws say. Seyadat (1998)	Tillering
Mahajer milani (1997)	12-18	8-14	4-8			
Mahajer milani (1997)	20	10-16	4	550 Quanta (1977)	Since the elongation of wheat stem elongation say. Karimi (1992)	Stem Extension
Radmehr (1997)	22	10-16	4-6			
Meteorological Organization, Report of Quanta (1977)	35	20-23	9	300 Quanta (1977)	In a short time after conception (first pod) inflorescences flag off Pod and clusters appear after 3 to 5 days and subsequent flowering, inoculation Grdafshany action takes place. (1997)Mahajer milani	Heading
Seyadat (1998)	32	18-24	10			
Radmehr (1997)	27-32	18-23	9			
Radmeh (1997)	25	18-22	9	800 Quanta (1977)	Grains formed after fertilization and this stage of growth and the amount of protein and Carbohydrate The seeds are stored inThis process is called grain filling and ripening. Karimi (1992)	Boot stage
Meteorological Organization, Report of Quanta (1977)	18-22	9-18	9			

1. Source table (Nasiri, 2003)

Table 2. Specifications of Synoptic stations, Eghlid region

Type of station	The main synoptic - Automatic
Station ID	40828 - FASE
Year of establishment	1993
Altitude Sea level	2300 m
Longitude	52^0 and $38^{//}$ east
Latitude	30^0 and $54^{//}$ north
Address	Eghlid - Boulevard beginning of Imam Reza
Phone and Fax	4221777-4228777 - 0752-0091

Table 3. The average daily, minimum and maximum temperature of Eghlid region

	Temperature			GDD
Month	Average min	Average max	Average daily	
March	4.4	16.4	10.4	192
April	9.0	22.5	15.7	351
May	12.2	27.9	20	480
June	15.8	31.2	23.5	585
July	14.7	30.4	22.6	558
August	12.4	28.2	20.3	489
September	7.9	23.0	15.5	345
October	3.5	16.2	9.9	177
November	-0.9	10.3	4.7	21
December	-0.3	7.8	2.4	0
January	-2.8	7.9	2.5	0
February	0.6	12.1	6.4	72
Sum total	73.9	233.9	153.9	3270
Average	6.2	19.5	12.8	272.5
S.deviation	6.8	8.8	7.8	223.22
C.V	1.1	0.4	.6	0.82
MAX	15.8	31.2	23.5	585
MIN	-0.3	7.8	2.4	0

Table 4. Annual rainfall of Synoptic stations, Eghlid region

Rainfall	Year
442	1994
337.1	1995
171.7	1996
450.9	1997
273.4	1998
153	1999
221.3	2000
458.5	2001
339.4	2002
616.1	2003
466.1	2004
258.2	2005
319.4	2006
259	1386
182.9	2007
312.5	2008
311.1	2009
280.7	2010
5853.3	Sum total
325.2	Average
121.3	S.deviation
616.1	C.V
153	MAX
0.37	MIN

Table 5. Monthly rainfall of Synoptic stations, Eghlid region

Rainfall	**Month**
54.2	March
12.1	April
2.3	May
1.7	June
0.6	July
0.2	August
2.6	September
22.5	October
59.8	November
58.6	December
56.6	January
54.0	February
325.2	Sum total
27.1	Average
25.7	S. deviation
59.8	C.V
0.2	MAX
0.9	MIN

Table 6. Seasonal Rainfall regimes percent of Synoptic stations, Eghlid region

Winter		Fall		Summer		Spring	
(%)	rainfall (mm)	(%)	rainfall (mm)	(%)	rainfall (mm)	(%)	rainfall (mm)
52.23	169.2	26	84.9	0.77	2.5	21	68.6

Table 7. Cumulative probability distribution of frequency of occurrence of the first effective rainfall of Synoptic stations, Eghlid region

M	X	P=m/n+1
1	13	0.053
2	30	0.105
3	47	0.158
4	39	0.211
5	40	0.263
6	42	0.316
7	45	0.368
8	49	0.421
9	50	0.474
10	55	0.526
11	63	0.579
12	66	0.632
13	71	0.684
14	75	0.737
15	82	0.789
16	85	0.842
17	91	0.895
18	110	0.947
Sum total	1043	9
Average	57.94	0.5
S. deviation	24.45	0.28

Table 8. Descriptive statistics of effective the first day of rainfall wheat the first day of September

C.V	S. deviation	probability		Synoptic station Eghlid town
		75%	50%	
0.4	24.45	December 8	November 19	

Table 9. Cumulative probability distribution of rainfall frequency of Synoptic stations, Eghlid town

M	X	P=m/n+1
1	616.1	0.053
2	466.1	0.105
3	458.5	0.158
4	450.9	0.211
5	442	0.263
6	339.4	0.316
7	337.1	0.368
8	319.4	0.421
9	312.5	0.474
10	311.1	0.526
11	280.7	0.579
12	273.4	0.632
13	259	0.684
14	258.2	0.737
15	221.3	0.789
16	182.9	0.842
17	171.7	0.895
18	153	0.947
Sum total	5853.3	9
Average	325.18	0.5
S. deviation	121.32	0.28
Symbol x in the second column shows the rainfall figures values.		

Table 10. Average date of first effective rainfall and number - a day in the Synoptic stations, Eghlid region

Rainfall		
number - a day	Rainfall initial	Year
47	November 8	1994
30	October 22	1995
85	December 15	1996
66	November 27	1997
110	Junuary 10	1998
50	November 11	1999
13	October 4	2000
71	December 2	2001
45	November 6	2002
75	December 6	2003
63	November 23	2004
55	November 16	2005
49	November 10	2006
91	December 23	1386
39	October 30	2007
42	November 13	2008
82	December 13	2009
40	November 1	2010
1053		Sum total
58.5	November 19	Average
24.05		S. deviation
0.41		C.V

Table 11. Possible dates completion of dry land wheat phenological in Eghlid region

Boot stage	Heading	Stem Extension	(Tillering)	Germination	Rain start		
August 18	July 5	June 19	May 14	March 11	November 19	50	probabilities
August 23	July 11	June 26	May 22	March 30	December 7	75	