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Introducing and nominating optimum locations of sugarbeet cultivation by ecological requirements and climate parameters based on GIS in Khorasan province.

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Abstract:
Today agricultural climatology has become one of the most important climatological studies in which we measure the potentials of a specific plant for adaptation in a specific region .this study tried to understand the different ecological abilities of sugarbeet cultivation and also to find out the relations between sugarbeet yield with optimum and restrictive temperatures in different phenology stages in eastern part of Iran in Khorasan province. parameters such as temperature ,freezing days, summers temperature mean ,temperature mean in late of growing season and optimal and critical temperatures was measured .In order to classify the region , de martonne expanded classification was performed.Plantation date was determind as the temperature fluctuation was above the base temperature and the minimum of temperature was above 12 degree for two weeks straight .timetable for phonology stages according to required GDD of each stage was estimated. Climatological requirements and appropriate and restrictive temperatures for different phonology stages in sugarbeet were calculated and probability in other parts of the province was calculated. finally after drawing the co-parameter maps with ArcGIS version 9.3 and combining them into one final map , the sugarbeet cultivation zones in Khorasan province was devided into 4 area which are categorized as bellow : 1-very desirable including Mashhad ,chenaran ,ghuchan ,fariman ,Neyshabur and eastern sides of sabzevar. 2-desirable regions including daregaz , kalat , Sarakhs ,Torbat e jaam ,Torbat e heydariyeh ,Torbat e Jam ,Khaaf ,Roshtkhar ,Kashmar ,Sabzevar ,jovein and joghatai. 3- Semi-desirable regions including Gonabad, Khalilabad, mahvelat, bardaskan and bajestan. 4 - Undesirable regions including western part of badjestan and south east of Khaaf.

Keywords: G.D.D, same-cilamte, de martonne, adaptation, phonology

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Introduction:

In dry and semi-arid climates, agriculture face several difficulties, also atmospheric factors have a wide range of dispersion in time and space. geography of the areas or other climate factors cause various qualities for the weather of those area which makes plants and agriculture products vulnerable, therefore having an appropriate prospect of climate and products conditions plays a significant role in domestication and revolution of plants .in fact climate is defined as a long-term function of an areas weather which is also the average of an atmospheric condition of a specific region base on meteorological statics. Generally, climate is known as an atmosphere of a specific region regardless of time (Ramzani, 1997).Climate classification is collection of rules and regulations which we can use to sort the different parts of a geographic area from different aspects. In this way, to describe these aspects, all kinds of climate classifications such as agricultural, geographical, agrological, natural potential, ecotypes development and etc. will be created (Jafarpour, 2007). Classic classification systems are usually based on one or two climate element which is temperature and precipitation but today many variables can be used to display the climate forms and on the other side progress in computer science and calculations has created new classifications which are results of these methods incorporation with classic methods. The new methods of classification actually are the continuance of the methods started from 1870, the time which classifications with mathematical base were represented. (Landsberg1958) defined the purpose of climate classification as a determination of principal parameters for meteorology including temperature and precipitation. De martonne(1873-1955) represented his drew index which for many years had a widespread use in different areas in 1926 which was based on precipitation and temperature and its available in all meteorology stations data and for this reason it became very famous and it is still one of the common classic methods for classification. (Nuttonsson 1962) had many researches on same climate regions with an agricultural prospect. He also represented the [2]G.D.D or photo thermal units as a proving method of biological character for same climate points. The basis of selecting two same climate points is their similarities in latitude and heat condition. He also estimated the different aspects of heat and precipitation and evaporation and rain ratio after estimating the same latitude and same heat conditioned points in his researches. (Goltsburg 1967) used cumulative temperatures below zero degree to determine the crop potential for several plants and specified different areas in terms of potential damages and cultivation risks. Solar radiations are the primary source of energy supply for all physiological processes on the planet and plants output is totally affiliated with their photosynthetic absorption rate[3] in every region. Davitia (1948) and Tomming (1977) used photosynthetic efficiency in crop productions to introduce different species for different areas. They also classified the crop plants based on day long. (Shashko, 1967) used cumulative temperatures above 10 degree to estimate the fully ripen date for some crop plants such as corn. He used soil moisture and temperature to classify different parts of Russians into different zones. His studies were mostly focused on wheat, grape and cotton. The benefits of using weather-crop static relations are:

- evaluate the product
-evaluate the agriculture climatology of crop productions
-evaluate the plants reaction to the weathers elements
-evaluate the effect of artificial and natural changes (human made) on crop production

Budyko (1971) determined the agricultural crops dispersal by temperature changes during a year. Jallillian (2008) showed that between 12 sugarbeet genotypes the base growing temperature is 3.4 degree Celsius and the optimum range for germination is between 12 to 27 degree Celsius. Jones studied the relations between weather variables and yield in Michigan and results showed that in monogerm sugarbeet cultivars, soybean and beans, precipitation during august and July and temperature during June and May are the most effective weather factors in those crops yield (Jones et

[2] Growing degree days
[3] P.A.R

al. 2001). The purpose of this study was to determine the potential and ecological abilities of the regions which are under sugarbeet cultivation based on temperature factor in (khorasan) province in 2009.

MATERIAL AND METHODS

The climate variables required in this study were consist of 30year statistical period from1977 till 2006 and also 16 meteorology stations in Khorasan that are ordered by longitude and latitude as Bojnord ($_{lng}$57.19 ,$_{lat}$37.38), Boshrouyeh (57.26 , 33.53), Birjand (59.12 , 33.52), Torbat e Jam (60.35 ,35.15), Torbat e Heydarieh (59.13 , 36.13),Sabzevar (57.40 , 36.13) ,Sarakhs(61.10 , 36.32) , ferdos (58.10 ,34.01) ,qaen (58.10 ,33.34) Ghuchan(58.30 ,37.10), Kashmar (58.28 , 37.38), Golmakan (59.17 , 37.38), Gonabad(58.14 , 37.38), Mashhad (59.38 , 36.16), Nehbandan (60.02 ,31.32), and Neyshabur (58.48 , 36.12) .The basis of selecting these meteorology stations was that they must have a complete and long term statistic records. Completing the missing data and prolonging the data was done by a method called as difference method .to control the randomization of the statics correlation, statistic tests were applied .in differences method, the nearest station which had a complete and reliable data was used as a base station and then the average of mutual static for every month and their difference were calculated. Afterward, lack of static data was estimated by correcting the difference number into the stations statics (kamali 1997).there are several statistic classification methods that each of them are reliable for a specific region and all of them have their own disadvantages and benefits and in this study we used de martonne extended climatology classification method (Dr. khalilie's method) because of better adaptation with Iran's climate conditions (Mozafari and Ghomi 2001).

Sugarbeet research parameters:

Main temperatures: Minimum, maximum and optimum temperatures of sugarbeet phonology stages were extracted from several sources (table 1). Base temperature for sugarbeet is 5 degree Celsius and optimum temperature is 20-24 and minimum and maximum are respectively 1 and 35 degree Celsius.

1-Growing season duration: this parameter depending on elevation and type of the climate and terrain can be variable. Sugarbeet needs 2400 G.D.D to complete its growing cycle therefore in colder areas, growing season usually starts late and takes longer and also in warmer lands with longer summers that plants receive more radiation in longer period of time, growing season is shorter .

In table 1 phonology stages, minimum, maximum and optimum temperatures for each stage , days with temperature above zero degree, above 5 degree and average time of each phase are shown.

Table 1- : time and temperatures of sugarbeet phonology stages

PLANTSGROWING STAGES	TEMPERATURE IN CELISIUS			G.D.D	TIME
	MIN	AVERAGE	MAX		
GERMINATION	8	5	3	120-125	10-12
16 LEAF	12	15	20	800-1400	140-170
TO 40 LEAF	20	25	35	2400-2800	200-210

2-Planting date: for calculating the planting date the procedure was applied in each of the stations as follow: **A-** planting date for each station based on long-term available statics and the date of passing optimum temperature in germination phase was extracted for all of the crop years individually .then, average of all planting dates for each area were considered as the planting date and compared with agriculture department data and finally each date received a weighted number based on march as basis.

B- Weighted numbers were sorted in ascending order and then the proper date was calculated with weibull formula based on 75% probability:

$$p = m/n+1 = 100 \quad (1)$$

to be noted that the best planting date for sugarbeet considering 5 degree Celsius as the base temperature is the time in which temperature does not drop below 12 degree at least for 14 days (kamali1997). In this equation:

P: planting date with75% probability

M: row number

N: number of data

3-Calculating growing degree day

For each station the required time from plantation till full canopy coverage (800 degree days) was calculated individually. (In this article all thermal units are Celsius)

The amount of G.D.D was calculated from this formula:

$$G.D.D=\sum \left(\frac{t\min + t\,max}{2} \right) + Tb \qquad (2)$$

Tmax= maximum of daily temperature.

Tmin= minimum of daily temperature.

Tb: = base temperature.

In the formula minimum temperature was 0, maximum 35 and base temperature was 35 (Nasiri mahallati. 2001).

If Tmax>35 then Tmax =35

If Tmin< 0 then T min = 0

G.D.D calculation was began according to planting date. For determining the proper date for other phonology stages, cumulative threshold temperatures were applied. The required time sugarbeet needs to reach the cumulative temperature for each phonology stage was calculated. Each of these phonology stages is important and unique but some of them are more sensitive to climate changes which can be different in various cultivars. Alpatinov (1955) used essential thermal units to select the accommodative zones for sugarbeets cultivation according to serotinous and prematurity of the cultivars. He estimated 3000 G.D.D for serotinous cultivars and 2650 G.D.D for rath cultivars. In sugarbeet, time between planting and gaining 800 G.D.D is very essential in growing phase. This period is called (V_1) and in this study we focused on analyzing thermal processes of sugarbeet during this period. These stages including germination, canopy coverage and ripening (40 leaves) were studied according to their G.D.D requirements (table 3).

Sugarbeet cultivation potential mapping: to find the same-climate locations for sugarbeet cultivation we used climate parameters to draw the same-value maps and after overlapping these maps with Arc-GIS software, the map of optimum locations for sugarbeet cultivation was created. the final map was the result of these maps overlap :

Same-Probable map of cultivations optimum temperatures occurrence.

Same-Probable map of germinations appropriate temperature occurrence.

Same-Probable map of receiving 800 G.D.D

Same-Probable map of daily mean temperature after receiving 800 degree day until the end of summer.

Same-Probable map of day-night temperature difference in last three month of growing season.

Same-Probable map of freezing probability in beginning and end of the season

Conclusion

Research area's climate classification by using de Martonne's method:

Zoning climate in researched area for those stations with long term reliable statics was done by de martonne method. accordingly a big area of the province was categorized as dry and semi-arid, thus in the northern part of the area because of high mountains the climate is mild to cold semi-arid ,central part because of its extensive mountains is cold-hot dry and deserted and south and south west parts because of the deserts of the area are super dry and mild to hot climate (bakhtiari 2004).

Evaluate the relation between sugarbeet yield correlation with probability of optimum and critical growing temperatures occurrence.

Study on a factor individually cannot be intended, therefore, discussed conditions and parameters incorporation defines the optimum areas for sugarbeet cultivation. To plot the same-potential maps for sugarbeet cultivation it is necessary to estimate the thermal requirements of important stages of growth. According to appropriate temperatures probability and critical temperatures in first stages of growth, chart of relation between correlations of these factors with yield statics in each region was created.

Table 3- shows the time of receiving critical temperatures of sensitive phonology stages.

Column	Station	Planting date	Date to germination	Time to receive 110 G.D.D	Time to receive 800 G.D.D	Probability	Time to receive 1400 G.D.D	Probability	Time to receive 1400 G.D.D
1	Torbat ejaam	3/26	11	4/6	6/3	87.1	8/22	89.1	9/4
2	Torbat eheydariye	4/6	12	4/18	6/5	87.6	7/30	97.2	9/19
3	Sabzevar	3/28	10	4/17	5/23	68.9	9/9	87.1	10/20
4	Sarakhs	3/22	10	4/1	5/20	83	9/1	89.5	10/7
5	Ghuchan	4/14	17	5/1	7/29	94.8	7/30	97.9	10/2
6	Kashmar	3/22	11	4/2	5/30	79.7	9/25	91.8	10/1
7	Golmakan	4/11	14	4/24	6/24	91.1	7/28	96.4	9/28
8	Gonabad	3/23	10	4/2	5/20	84.9	9/8	93.7	10/24
9	Mashhad	3/31	10	4/10	6/3	84.8	/8/6	93.6	10/1
10	Neyshabur	4/9	13	4/22	5/20	91.2	7/29	87.4	10/4

Daily received heat factor (G.D.D) was considered as an effective common element of yield. During the planting season all regions are able to provide the required G.D.D therefore, delay in cultivation will not affect the yield, because loss or deficiency of required heat will be compensated during the season. In fact received G.D.D in beginning of the season is much more important and lack of this energy in early season will bring negative effects in plant growth. Sarakhs county has the minimum days required for germination and it has the first planting date among the others and has an appropriate temperature condition for sugarbeet crop. The required day for germination in Ghuchan is utmost and it is because Ghuchan has the latest planting date (April 15th).The optimum temperature of germination for sugarbeet includes a range between 13 to 26 degree Celsius (Jalilian, et al .2008) and as much as temperature rise after planting date, germination will increase respectively.

Growing season long

One of the achievements in agricultural data analyzing systems is to have a specified time tables to determine the beginning and the end of certain phases in controlled areas (cultivation time pattern). (Sinistina et al, 1971) used the dates of last spring freezing and first autumn freezing and estimated the severity of the cold in different areas. They calculated the freezing and cold weather damage for different crops and draw the microclimate map of growing season's long (Samandari and kuchaki 1987). Data of growing season long and characteristic of these areas are shown in table 4.

Table 4 – growing season long in different parts of the area

Zone	Towns of each zone	Growing Season long	Description
A	Dargaz,kalat,Mashhad,neyshabur,ghuchan,fariman and Torbat e heydariyeh	205 to 225 days	With mild summer and colder weather
B	Sarakhs,Torbat jam,Khaaf,bajestan,bardeskan,joghatay	225 to 245 days	With mild and dry summer and warm weather
C	Gonabad,sabzevar,Kashmar and khalilabaad	245 to 265 days	With hot and dry summer and very hot weather
D	Kashmar, sabzevar, koohsorkh and gonabaad	265 to 285 days	This criteria has the longest growing season

As regards sugarbeets growing season is between 6 and 7 month. In terms of growing season long almost all the province areas were suitable for this production and do not consist of any limitation in this matter.

Geographical distribution of appropriate planting temperatures probability.

For all case study stations, map of sugarbeets desirable cultivation areas based on optimum temperatures was draw. To make the geographic distribution map, optimum planting temperatures probabilities in each station was determined and then this data was used to draw the map of first available planting date possibility in researched area (table 5).

As regards the purpose of the research was to determine the optimum locations of sugarbeet cultivation by ecological requirements and climate parameters. To be noticed that favorable and appropriate conditions will increase the faster germinations possibility.

Table 5 – Planting dates of each zone

Zone	Towns of each zone	Planting date	Probability
A	Part of Kashmar, goonabad and Sarakhs	3/21 – 3/30	91 – 99 %
B	Vast Parts of area including sabzevar, bardeskan, Khaaf, bajestan, mahvelat, Torbat e Jam and Torbat e Jam	3/20 – 4/9	81 -90 %
C	Joghatay, fariman, Mashhad, kalat, Torbat e heydariye, Dargaz and Roshtkhar	4/9 – 4/14	50 – 70 %
D	Small stripin the north of case study area including Golmakan, Neyshabour and ghuchan	4/14 – 4/19	Less than 50%

Dates and temperatures required for germination

Germination is one of the important and susceptible phases of the crops life cycle. In fact plants growth begins from the moment seedling emerges out of the seed. In this research to make the sugarbeet same-climate cultivation map, G.D.D for each growing stage was calculated. Required temperatures of these phonology stages were calculated and also planting dates for each station was measured. The beginning date for each phonology phase due to the planting date and effective degree day also calculated.

Necessary time to obtain 800G.D.D since planting

One of the important periods in sugarbeets growth is from planting to full coverage of the canopy. Reaching canopy full coverage requires receiving 800 G.D.D by the plants leaves. Beck (1984) stated that in optimum weather condition and proper planting date in sugarbeet cultivation, the number of leaves in canopy full covered phase would be between 14 and 16 and producing one single leaf needs daily cumulative temperature above 12 degree (17-30 degree per each leaf) and generally needs 760 to 840 G.D.D.

This area has for zoning:

1- Area where receiving 800 G.D.D occurs between May 14 till June 4. Many parts of the province which includes towns such as Kashmar, Gonabad, Sarakhs,sabzevar, bardeskan, Khaaf, bajestan, mahvelaat, taybaad, Torbat e Jam, Mashhad, khalilabaad, koohsorkh and Roshtkhar are in this category.

2- Area where receiving 800 G.D.D occurs between June 4 till June 25. Some part of area including Joghatay, Fariman, kalat, northern half of Torbat e heydariyeh, Golmakan and Neyshabour are in this category.

3- Area where receiving 800 G.D.D occurs between June 4 till July 15. This area contains dargaz and parts of Ghuchan.

4- Area where receiving 800 G.D.D occurs between June 4 and august 5.this are contains a small part in north of researched area including some parts of Ghuchan and crop lands in its heights which the date of receiving 800 G.D.D for this region is July 25. In almost all central and southern parts of the province, summer is warmer and longer. Weather warming happens faster and the radiation is higher therefore plants will receive intransitive temperature for full canopy coverage in shorter time (800G.D.D.) so they can absorb more summers heat to complete their growth. In such lands growing happens faster and growing season is shorter. In cooler regions (lighter green regions in northern parts of provinces map) according to prolonging of the plant establishment and canopy full coverage, duration of growing season is longer and possibilities for late season freezing temperature is higher.

Yield correlation with number of days to receive 800 G.D.D

Correlation between receiving 800 G.D.D and yield according to fig.1 is positive and shows a high correlation. In areas where receives 800G.D.D faster the yield is also higher. In highlands and higher latitudes due to the radiations decrease and lower temperature of the days, receiving the temperature requires spending more days. Of course in all cold regions, only more days is not always a reliable parameter for receiving full growing required G.D.D. In drawing the chart for yield correlation with receiving 800 G.D.D we used climatology and agriculture department's data to create fig.1 .This graph with equations

$$y = -179.9x + 45043 \quad (3)$$

$$R^2 = 0.718 \quad (4)$$

Shows the yield correlation with receiving 800G.D.D during the growing season. Sugarbeet yield relations with time to receive 800 G.D.D was significant, thus as much as air gets warmer the time to receive 800 G.D.D will be shorter and radiation level will be higher and this condition will have a

positive effect on yield. also in cooler areas 800 degree will be received in longer period of time and because of lower temperatures in final growing stages the crops yield will be less.

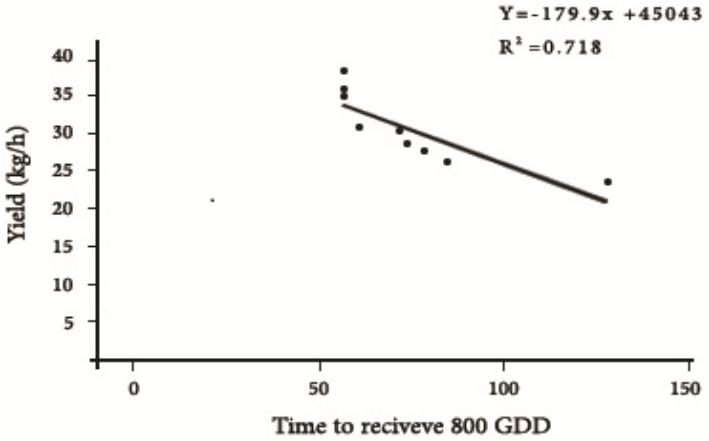

Fig 1. shows the yield correlation with receiving 800G.D.D during the growing season.

Geographical distribution of daily temperature mean after receiving 800G.D.D until last of summer.

In the late of spring until middle of summer sugarbeet has the highest level of CGR and also canopy cover so it can store the highest volume of sugar in its root. Hence, Temperature mean is important because by changing the plants respiration to photosynthesis ratio, CO_2 absorption rate and evapotranspiration, it will play a very important role in physiological processes involved in growth. Jones (1983) developed a study on relation between yield and weather variables in Michigan. He noticed that in monojerm sugarbeet and beans the most two important factors on yield are precipitation in July and August and temperature in May and June (Jalillian 2008). One of the case study factors was temperature mean after receiving 800 degree day. This factor affects the yield because of determining the radiation level and temperature of the day.

This area has five zoning:

1- Areas where the average of daily temperature is between 20 to 22 degree. (Base on the climatology department data) this area contains the central parts of Ghuchan.

2- Areas where the average of daily temperature is between 22 to 24 degree. This area contains a small part of the case study area which includes Ghuchan, Dargaz, Golmakan.

3-areas where he average of daily temperature is between 24 to 26 degree. This area contains parts of Fariman, kalat, Torbat e heydariyeh, Neyshabour , Mashhad, Torbat e Jam, tayebaad, Khaaf and Roshtkhar.

4- Areas where the average of daily temperature is between 26 to 28 degree. This area contains Gonabad, bajestan, khalilabaad, koohsorkh, Bardeskan, Mahvelat, Jovein and joghatay.

5- Areas where average of daily temperature is between 28 to 30 degree. This area contains parts of sabzevar, Kashmar and Sarakhs. In many parts of the province especially in central and southern parts, summer is quite warmer therefore after sugarbeet receives 800 G.D.D due to absorbing radiation and higher temperatures; the trend of plants growing has a acceptably high rate. In northern parts because the climate is more moderate and cooler, this procedure is slower.

4- Relation between yield and temperature mean in summer

In summer and after the plant established fully in the ground, increase in temperature and radiation will cause several different reactions in the plants which increasing in evapotranspiration, stigma closing and photosynthetic reduction, leaf area reduction and respiration increase are some of these phenomenon which result in yield reduction (fig 2). This chart with equation

$y = -1339x + 65361$ (5)

$R^2 = 0.760$ (6)

Was significant according to relation of sugarbeets yield with temperature, therefore we can use this equation in yield anticipation.

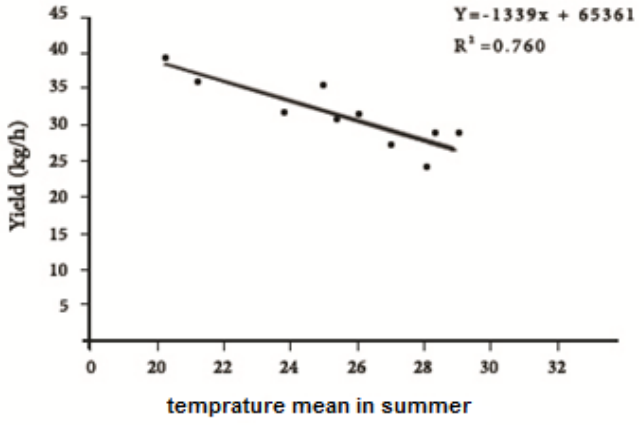

Fig 2. Correlation between yield and temperature mean in summer

Geographical distribution of day–night difference in the last three month of growing season

In many parts of the province with beginning of the summer, plant has already received the required G.D.D for establishment and full canopy coverage (800 G.D.D), so after this point difference between day–night temperature especially in last three months of the growing season is very determinative in sugars level. Cold nights reduce the plants respiration and on the other hand warm days and proper radiation with photosynthesis enhancement result in sugar aggregation in roots and therefore increase the sugar content.

This area has 4 zones:

1- Areas which the average of temperature is between 14 to 15 degree and contains central parts of cities Mashhad and Neyshabour.

2- Areas which the average of temperature is between 15 to 16 degree and contains towns ghuchan, dargaz, kalat, Sarakhs, Fariman, Torbat e heydariyeh,, Torbat e Jam, taybaad, Roshtkhar and other parts of Mashhad.

3- Areas which the average of temperature is between 16 to 17 degree and contains parts of the area including some parts of Neyshabour , Golmakan, sabzevar, Kashmar, Bardaskan, khalilabad and Khaaf,

4- Areas which the average of temperature is between 17 to 18 degree and contains Gonabad and Bajestan remained parts. Areas including Sabzevar, Gonabad, Neyshabour , Golmakan, Kashmar and Bardeskan, because of having longer summers and higher temperatures during days and on the other

hand having semi-deserted weather which has cool nights are more idealistic conditions for the end of the season. In some areas like Ghuchan, Sarakhs, Torbat e Jam, and Kalat, having cold weather and adjacency with areas highlands and mountains force the warm season in these areas to end up faster and also in comparison with western parts of the province, lower temperatures at nights and lack of enough radiation during days will result in lower sugar content in roots. In final months of sugarbeets growing, the plant becomes sensitive to temperature increases during days and temperature drop during nights. This process promotes the quality of sugar (sugar content) by controlling the plants activities during the day (fig.3). Temperature and total precipitation during growing season, is effective in yield and sugar content of sugarbeet. Climate can bring significant affects especially on sugar content during the critical times of yield components formation, after several leaves emerging stage and during sugar concentration. With soil moisture increasing, content of sugar will scale-up. In colder air this content is even more (Nasiri Mahallati. 2001).

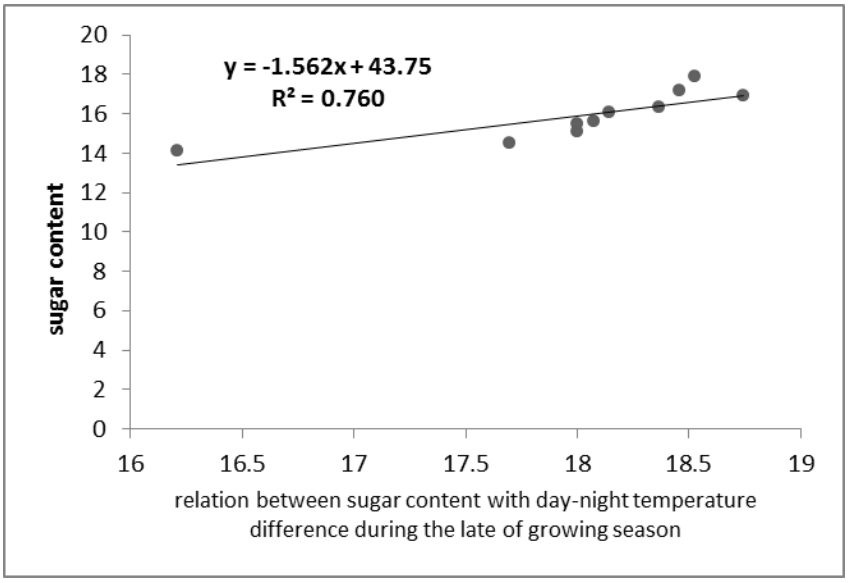

Fig 3. Relation between sugar content and temperature

This graph with equation

$y = -1.526x + 43.75$ (7)

$R^2 = 0.760$ (8)

Shows that relation between yield and day-night temperature during summer is significant therefore we can use this equation to anticipate the yield.

Probability of freezing occurrence during end of growing season

To achieve geographical distribution map of freezing occurrence probability during end of growing season, freezing probability for each region was determined individually. After determining the required time to gain the 800 G.D.D in each area and by considering the date of first freezing in each area, probability of freezing occurrence during end of growing season was estimate (table 6).

Table 6. Dates and Probability of freezing occurrence during end of growing season

Zone	Towns of each zone	Date of first freezing	probability
A	Torbat e heydariyeh	10/26 to 11/5	92-94 %
B	Ghuchan, dargaz, Torbat jam, fariman, Mashhad, golmakan, Torbat e Jam, Neyshabour , Torbat e Jam and roshtkhaar	11/5 to 11/15	82-94 %
C	Khaaf, Sarakhs, joghatay and mahvelat	11/15 to 11/25	90-92 %
D	Kashmar	12/5 to 12/15	90 %

(Sinistina et al, 1973) used freezing dates in the late of spring and beginning of autumn to determine the freezing damage in different areas. They also estimated the freezing damages to different crops and so created the microclimate maps of freezing. One of the important items in harvesting sugarbeets is to anticipate the time of freezing in any region. Those groups of freezing which often happens during the end of the growing season when the weather becomes colder are very important. The main criterion in sugarbeets yield is to achieve 2400 to 2650 G.D.D and complete the phonology processes of the plant. To be aware of freezing probabilities help us to check the growth condition of the plant in terms of time and to apply necessary policies to achieve the maximum yield.

The final map of sugarbeet crop same-climate

After providing the geographic distribution map for optimum and critical temperatures of sugarbeets growing season, we used Arc GIS software to overlap the maps for building the final map of same-potential lands for sugarbeet cultivation in Khorasan province (Table 7).

Table 7. Euation of Correlation between sugarbeets mean yield with critical and optimum temperatures in khorasan

Row	Reed temperatures probabilities in different phases	Correlation equation	R^2
1	Planting dates	Y = -20.071x + 1640.8	0.0681
2	Growing season long	Y = -7.779x + 2788	0.0857
3	Receiving 800 G.D.D	Y = -179.9x + 45043	0.718
4	Average of temperature in summer	Y = -1339x = 65361	0.760
5	Relation between sugar content with average of temperature in last 3 month of crop season	Y = -1.562 x + 43.75	0.761

The map contains 4 areas:

1-Very desirable areas (level 1)

A-very desirable areas are located in north and center of the case study region and have a cold to mountainous mild weather with long winter and mild summers. In these areas:

1-sugarbeet will receive 800 G.D.D mostly until June 25th to rich the highest canopy leaf cover.

2-In summer time, average of the temperature after receiving 800 G.D.D is between 22 to 26 degree Celsius.

3-average of day-night difference is between 15 and 16 degree Celsius.

4-the length of the growing season is between 210 days minimum and 265 days maximum.

5-in this area probability of freezing in critical stages during growth according to the climatology department data is less than 30%. This area contains of cities Mashhad, chenaran, ghuchan, fariman and Neyshabour which in crop years between 1990 till 2000 average of yield was about 30800 kg/h. Because of having appropriate climate, faster planting possibility, warmer summers and mild weather at the end of the season these regions have a high potential for sugarbeet cultivation.

2-desirable regions (level 2)

Desire regions (2ed degree) are located in central, eastern and western half of the province and mostly have deserted, hot and warm climate with hot and long summers and shorter, dryer and colder winters and covers a big part of the province. In these areas:

1-sugarbeet will receive 800 G.D.D mostly until June 4th to rich the highest canopy leaf cover.

2-In summer time, average of the temperature after receiving 800 G.D.D is between 24 to 28 degree.

3-average of day-night difference is between 16 and 18 degree Celsius.

4-the length of the growing season is between 260 days minimum and 275 days maximum.

5-in this area probability of freezing according to the climatology department data is between 30% to 50%. Desirable area (2nd degree) is located in central, eastern and western half of the province and mostly have a desert, dry and hot weather with long hot summers and also with cold, dry and shorter winters and in terms of scale, it covers the most part of the area. This area contains dargaz, kalat, Sarakhs, Torbat e Jam, Torbat e Jam, Khaaf, Roshtkhar, Kashmar, sabzevar, jovein and joghatay which in crop years between 1991 to 2009 the average of yield in this area was 31140 kg/h. Despite that these areas are less important than first degree areas (less desirable), but in yield and under cultivation area does not show a big difference. yield parameters and environmental-climate factors impacts on each other and appearing of these impacts in phonology stages of the plants and influence the products are items that classify the areas of Khorasan province therefore in areas which there is minor difference, practically result of these factors interactions will categorize the different parts of the regions. In the referred area (desirable), one of the reasons for yield decrease can be adjacent to desert and dry lands located in south of the province which strongly influence their climate with very dry and very hot summers and cold winters with long freezing times. Therefore their condition is less qualified in comparing with northern parts.

3-semi desirable areas (level 3)

This area (semi-desirable) because of having special environment and climate features which are:

A- Being located inside or across the southern deserts of the province

B- Dry summers and very high level of radiation

C- Low and unfavorable temperatures at nights at the end of growing season in late summer and, therefore these areas are placed in the third level in compare with two above. In these areas:

1-sugarbeet will receive 800 G.D.D maximum until middle of June to rich the highest canopy leaf cover.

2-in summer, average of temperature after receiving 800 G.D.D is between 26 to 28 degree.

3-average of day–night temperature difference in this area is between 16 to 17 degree Celsius.
4-growing season long in this area is between 250 and 270 days.
5-freezing probability in late of growing season according to freezing data from climatology department is between 30% to 50%. According to this study, because of the discussed conditions, areas under cultivation of sugarbeet and sugarbeet yield are almost the same. this area is including Gonabad, Mahwelat, Khalil abad, Bardeskan and Bajestan which in years between 1991 till 2009 average of yield was between 27185 kg/h. In fact these areas do not have a significant outcome but because of the research statics, they stand in the semi-desired level but as a matter of fact they have a small share in province's sugarbeet production.

4-Undesired area (level 4)

This area has relatively undesirable conditions comparing with areas above and sugarbeet crop in this area has a climate limitation and is not profitable and has these characteristics:
1- Sugarbeet will receive 800 G.D.D mostly until May 15 to rich the highest canopy leaf cover.
2- In the summer, average of temperature after receiving 800 G.D.D is between 26 to 28 degree.
3- Average of day–night temperature difference in this area is between 17 to 18 degree Celsius.
4- Growing season long in this area is minimum 250 and maximum 260 days.
5- Freezing probability in late of growing season according to the climatology department data is between 70% and 85%. Undesirable areas (level 4) are located in a narrow strip in western and eastern boarders of south of area and because of being adjacent with central deserts of Iran they have a hot and dry climate and according to area surface percentage it belongs to the grade 4th. These areas are containing southern parts of Bardeskan and western parts of Bajestan and south of Khaaf which in crop years between 1991 and 2009 average of sugarbeets yield was less than 22000 kg/h.

5-Sugarbeets yield anticipation base on optimal and limitative temperatures of phonology stages

In this part after determining limitative, critical and optimal temperatures in sugarbeets growth and estimating their relations with agricultural departments yield statics and drawing correlation charts, the final conclusion is showed in (fig 4).
1- Most of the areas have a high potential for sugarbeet cultivation.
2- Because of having a favorable and moderate climate in North and North West of the province, these areas are very desirable for sugarbeet cultivation.
3- In the central parts and eastern and western borders of the area, although they have no climate condition superiority on central parts of the region but because of area under cultivation surface and climate potential for sugarbeet cultivation, they belong to desirable area.
4- Southern parts and south west borders of the area because of being neighbor with deserts of the region classified in semi-desirable areas for sugarbeet cultivation.
5- There is a narrow strip in east and south west of the province which because of the heat period long and environmental stresses, sugarbeet cultivation does not have an economic justification in such areas and classified as undesirable cultivation areas.
6- Regarding to average of yield in these areas, first place in the chart according to crop yield belongs to desirable region (area class 2) with a slight difference with very-desirable region. This indicates that desirable area has a very high potential for sugarbeet production and the reason for their differences in final map could be of having various geographical differences and also difference between case study data and factors used in Arc-GIS application.

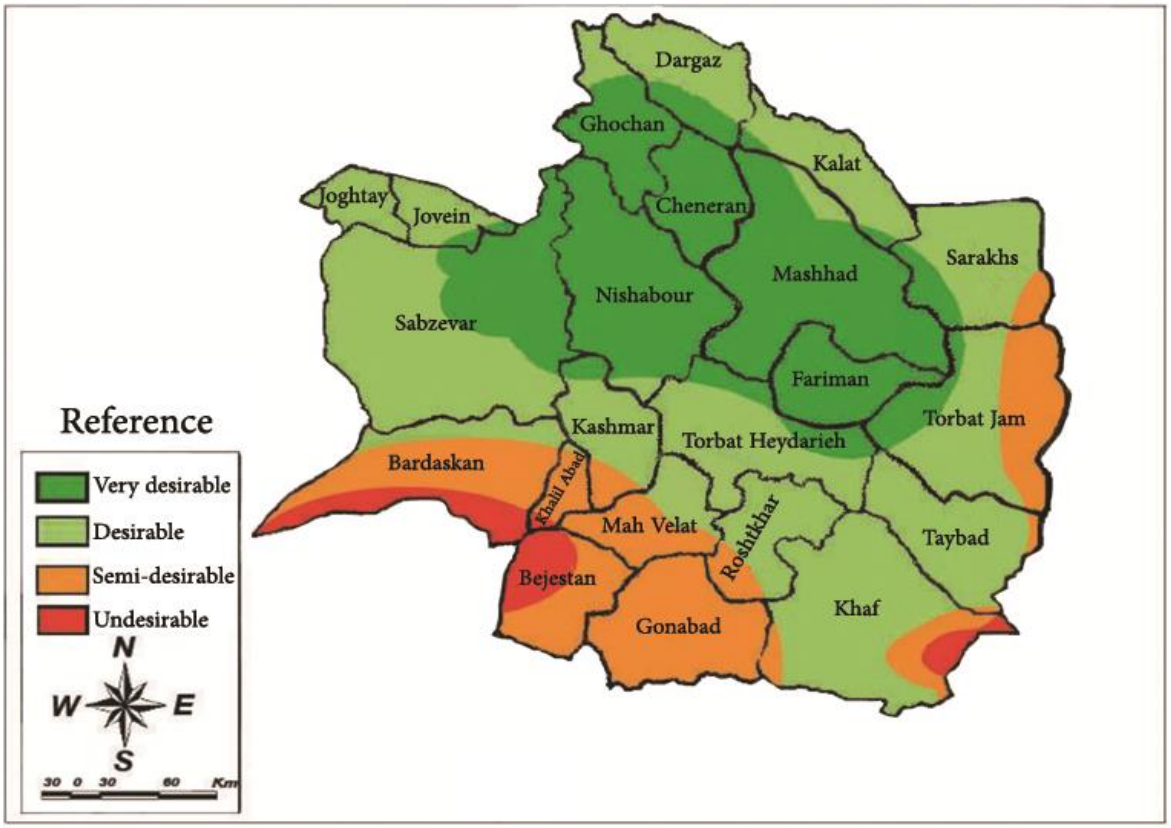

Fig 4. final map for same-potential lands for sugarbeet cultivation in Khorasan province

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