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Effects of Climate Change on Autumnal Oilseed Cultivation in South Khorasan Province using the Model LARS-WG

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ABSTRACT: Climatic and environmental factors and their effects on crop yield one of the most effective factors of production. In this study, in order to evaluate the agricultural climate of spring canola cultivation in selected stations in South Khorasan province, the daily temperature data over a period of 10 years were used. The deviation from the optimum conditions, the degree of active days index and thermal gradient methods are applied to perform the agro-climatic calculations and analysis. The results show that late October the optimum time for planting Autumn canola regions (Ghaen and Ferdos). Thermal gradient analysis and deviation from optimal conditions at different altitudes in the study area show that for every 100 meters increase of altitude, the deviation from the optimal conditions of planting is delayed by one month. This point is important in terms of cultivating time and commercial crops production. According to the obtained agricultural calendar, the most appropriate time for Autumn planting and harvest in the area are The early October and late may, respectively. The average annual temperature change results in model LARS WG South Khorasan shows an increase of 1.12°C. That this increased temperature does not affect the cultivation autumnal canola plant. The results showed that the mean rainfall in the study area will have reduced of about 8.23 mm this reduced rainfall reduced canola yield in the region

Keywords: climate, Autumn canola, phenology, LARS-WG , South Khorasan

INTRODUCTION

Due to the trend of population increase all over the world, providing the basic food requirements for humans is an inevitable issue (Morrison and Stewart, 2002). Among the various factors affecting agricultural production, the weather condition is considered as the most important variable (Bagli *et al*, 2003) In the other word, Weather condition, is one of the determining factors of crop type which could be cultivated and developed in an area. Understanding the climate and required parameters of crops, are of the most important factors in agricultural production. The amount of sunlight, heat and rainfall and their incidence type are major factors in this determination. Lack of attention to climatic potentials of any region and traditional cultivation of crops, leads to low and fluctuating yields of crops and even full destroy of crops in some years. Several studies have been conducted on effects of climate on canola growth (Jones *et al,* 2001). Malcolm and Stewart (2002) conducted a study in Canada and concluded that the climatic factors can alter canola yield between 15 to 74 percent and among the major climatic factors, temperature and humidity are the most influential factors. Among these two factors, the temperature effect is much more important. This fact is also mentioned by who studied effects of climatic factors on this plant. Despite the fact that canola plant reacts severely against the climatic element, it is frost-resistant; so that it can tolerate cold temperatures up to -20°C (Nada, Bharyava *et al,* 1996). (Poorenbos 1997) also stated that, in cold and semi-cold areas, planting should be done at a time, so that the rosette stage happens before the first frost incidence. Canola Association of Canada in 2006, stated that the growth stage of autumn canola (from planting until the rosette), based on 5°C, is about 400 to 600 GDD. showed that the performance of autumn canola is a function of spring growth and Carbohydrates transfer from the vegetative parts, as well (Auld *et al.*, 1984). Canola is one of the most important oil crops; in terms of cultivation area, it has the second rank after soybean and in terms of oil production, has the third rank after soybean and palm oil (Adamsem and Coffelt 2005).

Like many other crops, canola plants get affected due to water deficiency stress. Studies show that the incidence of water deficit at different growth stages, particularly during reproductive growth, will affect the quality and quantity of produced oil (Muller *et al,* 2006). The aim of this study was to evaluate the climatic conditions for the cultivation of canola in South Khorasan province

MATERIALS AND METHODS

In this study, the minimum and maximum daily temperatures during the period of 2001-2011 from synoptic stations of Ghaen, Birjand, Ferdos, have been used.

A. Thermal Gradient Method

In order to study the relationship of temperature of study area with deviation from optimal condition in different altitudes or time optimal conditions, it was necessary to use the thermal gradient to obtain the temperature of altitude points where there was no station. To obtain the temperatures, the linear regression method was used.

Using linear regression, coefficients of variation of temperature with altitude, were calculated for the months of the year and the whole year. Following equation was used to calculate the curve equation: y= b +ax

In this equation, (y) the expected value (dependent variable), (x) the most important variable which predictions will be based on that (the independent variable), (a) constant coefficient known as intercept and (b) line slope or thermal gradient slope showing the thermal decrease with altitude. Following equations are used to calculate a and b:

$$A = \frac{\sum(y) \sum (X^2) - \sum(x) \sum (xy)}{N\sum X^2 - (\sum X)} \quad (1)$$

$$b= \frac{N\sum XY - (\sum X) (\sum Y)}{N\sum X^2 - (\sum X^2)} \quad (2)$$

To achieve results and calculate the above equations, first, table of correlation elements for selected stations and time intervals was formed; that will be mentioned as the monthly and annual correlation elements of selected stations.

B. Method of deviation from the optimal conditions

There are four phenological stages for spring canola plant and each stage has an optimal temperature, at which the maximum growth rate occurs at this temperature. Identifying and determining the optimal point for each phenological stage and the mean daily temperature resulted from monitoring minimum and maximum daily temperatures; one can determine optimum locations in various periods of time, particularly months of a year, and actually, the location which has the least deviation from the optimal condition, would be considered as the optimum location. In this method, to obtain the optimum location, optimal points or optimal temperatures were first determined and then, considering the average of daily data, deviations from the optimal conditions were calculated for a whole year. Next, the deviations of the averages from the optimal points are calculated; consequently, the deviations from the optimal conditions are obtained for the above locations and the results are tabulated.

C. Method of thermal coefficient or total degrees of active days

Due to importance of total thermal units in study and locating of favorable regions of spring canola cultivation and determining the planting and harvest time, based on defined thresholds, calculation methods of degree-day have been implemented. These data were analyzed by functions of Microsoft EXCEL software. In this study, active method, amongst the common methods of thermal units' estimation, was used. There are two main methods of summarization of the temperature, including effective total and active total that active total method is applied in this study.

Sum of degrees of active days: Phenology is one of the topics of ecology, in which the life cycle of plant life from the germination to the onset of permanent winter sleep, are assessed. Start and end of each period, due to climate changes, particularly temperature and soil moisture varies in different years. To sum up the temperature, the values of all daily temperature (without subtracting the base temperature) and during the period of active growth, are added together. Computational equation is as follows.

$$\frac{T_{Min} + T_{max}}{2} \quad \text{If the} \quad \frac{T_{Min} + T_{Max}}{2} >= Tt \quad (3)$$

In this equation, t_{min}, t_{max} are the minimum and maximum daily temperature, respectively, and Tt is a biological temperature. In active temperatures method that has been used in this study, the total sum of positive daily temperature is used; but only for the days when the average temperature is greater than the biological threshold or biological zero point. All values more than 5°C will be considered and values less than 5°C will not.

Method of determining the duration of stages in phenological studies: To enhance the performance, the proper use of irrigation and farming operations at every stage of grapes plant growth, an individual can provide required planning for crops' growth through determining the time each phenological stage takes, based on daily temperature and determining the duration of each stage. Therefore, in order to determine the time between two phenological stages (the inter-stage time) based on the minimum temperature, the following equation is used:

$$n = \frac{A}{T-B} \qquad (4)$$

where, N is time between the two phenological stages, (A) is temperature coefficient for completion of that stage, (B) is biological threshold of crop and (T) is daily temperature.

D. Model introduction

General circulation models can provide the best information with atmosphere response to focus on increasing greenhouse gases. Now, the most valid tool is atmosphere-ocean general circulation model(AOGM) for producing climatic scenarios. These models depend on basis of physical values which are presented by mathematic relations. In order to simulate earth climate, main climatic processes (atmosphere, ocean, earth surface, crust of ice and biosphere) in separated secondary models are coupled and they form models of AOGCM. These models are performed in different centers which some of them include: CSIRO-MK2 model in CSIRO research center of Australia, HADCM3 and HADCM2 models in HCCPR research center in England, CGCM1 and CGCM2 models in CCMA center in Canada, GFDL-R15 model in GFDL center in America, IPCM4 in France, INCM3 in Russia and CCSR and NIES models in Japan are done in center with the same name (IPCC, 1996).

Important inputs of AOGCM models are amount of emission greenhouse gases in future periods. IPCC already presented different scenarios that SRES is the newest one. Each one of sub-SRES scenarios are related to one of B2, B1, A2, and A1 groups.

In A1 family, emphasis is on rapid economic growth and population growth to middle of century and then it's reducing and introducing new and efficient technologies. Family of A1scenario divides development into 3 groups for changing technology in energy system which includes fossil energy (A1F1),non-fossil energy resources (A1T) and balance in all resources(A1B).Generally, It can be said that scenarios of A family have pessimistic scenarios and scenarios of B family have optimistic scenarios and AB scenarios have middle station. In this research, we compare 3 atmosphere general circulation models (INCM3, IPCM 4 and HADCM3).

By using B1, A2 and A1B emission scenarios are considered future climate of region to determine the best atmosphere-general circulation model and emission scenario for region.

Data of this research include daily data of min temperature, max temperature, rainfall and radiation of studied station from establishing time to 2012.

RESULTS

A. Thermal Gradient

In order to evaluate the deviation from optimal conditions at different altitudes, or the optimal spatial position based on the altitude, first, using the linear regression, coefficients for changes in daily temperature as a function of altitude are calculated for months and whole year. Four phenological stages have been considered in spring canola plant which are significant in terms of agro-climatic matters; including: germination stage, flowering stage, rosette stage, flowering stage and ripening stage. Each stage has an optimum temperature, in which, the maximum growth rate occurs. In order to study the grapes plant species, phenologically, according to this study, mid-mature plant varieties which are more common in the region, are considered as the basis. Table 1 shows the deviation from the optimal conditions for each phenological stage of canola plant based on the average daily temperature at selected stations.

Table 1: Determining the deviation from optimal conditions of phenological stages of Autumnal Canola in selected stations.

Total Deviations	Ripening		Flowering		Rosette		Germination		Growth Stages
	Deviation	Optimal	Deviation	Optimal	Deviation	Optimal	Deviation	Optimal	Station
-30.28	-7.21	20-22	7.41	11-13	-10.77	6-8	-4.89	15-20	Ghaen
-34.36	-8.52	20-22	-6.81	11-13	-13.34	6-8	-5.69	15-20	Birjand
-39.02	-8.83	20-22	-8.32	11-13	-14.10	6-8	-7.77	15-20	Ferdos

According to the results flowering and ripening stages, Ghaen station has lower deviation and more optimal conditions than the other stations; which is followed by Birjand and Ferdos stations; consequently, Ghaen stations has the least deviation from optimal conditions than other stations; which means that this station has the optimum condition for cultivation of Autumnal canola (Table 1).

B. Optimal time, based on active days degree method

Another method to determine the optimal time for agricultural climate, based on the latest incidence of minimum thresholds at each phenological stage of spring Canola plant, is active temperatures' method that it is used in this study. The total daily temperatures with positive values are used, but only for the days when the temperature is greater than the average of biological thresholds or zero point of activity. In this study, the basis for calculating the thermal coefficients is as follows. Based on minimum thresholds of Autumnal Canola plants at each stage, and the other is zero degrees Celsius. Since plant species are highly dependent on temperature, the monitored daily minimum temperature is used for phenology of the Autumnal Canola plant. By specifying thresholds of phenological stages of Canola plant and accurate daily temperatures, completion date of each stage is calculated. For all stations, incidence date of minimum threshold of Canola plant activation at greater than 5C° is considered. In order to obtain the completion date of phenological stages of spring Canola plant in germination stage 150, the rosette stage 613, the flowering stage 935 and fully ripening stage of Canola plant, 1450 thermal units, more than 0 degrees Celsius, are necessary. According to Table 4, the date of germination, rosette, flowering and ripening of spring Canola plant occurs earlier in Ghaen, Birjand and Ferdos stations than other stations. The completion date of phenological stages of Autumnal Canola plant in selected stations are shown in Table 2.

Table 2: Completion date of phenological stages of Autumnal Canola.

Ripening	Flowering	Rosette	Germination	Station
10 June	5 may	16 April	4 October	Ghaen
12 June	8 may	17 April	13 October	Birjand
16 June	18 may	11 April	15 October	Ferdos

C. Areas suitable for cultivation of spring Canola

Based on the agro-climatic analysis, most favorable areas for a spring Canola cultivation are in Northern lowlands (Ghaen stations) and central and eastern regions (Birjand station), while West regions (Ferdos stations) are next in this rank (Fig. 1).

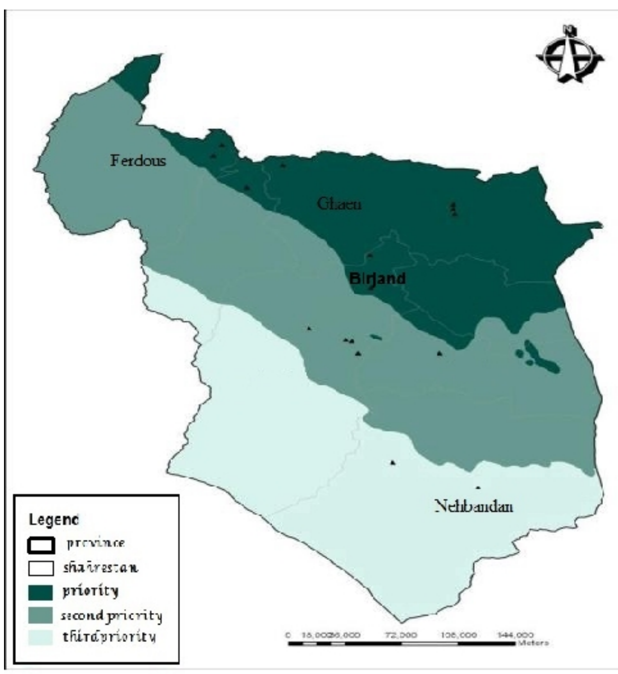

Fig. 1. The total deviation from optimal conditions for Autumnal Canola plant.

D. GTM model

GTM model can provide the best information with atmosphere response to increasing greenhouse gases' focus. In this research, by using exit of GCM models under emission. Scenario of B1, A2 and A1B of province climate evaluated. As seen in shapes 1 to 6, rainfall and observed temperature of stations are compared with rainfall and produced temperature by LARSE-WG under GCM models (3 models of HADCM3, INCM3, and IPCM4) and different scenarios of emission. For better conclusion, weight of each model is determined and finally mean of all models are determined with each weight Interference (Ensemble). In present research, mean of all models is used by noticing at their weight for producing climatic elements by surveying different climatic models and different scenarios and determining weight of each model that results of temperature increasing are obtained 1/12 centigrade. Rate of daily rainfall of surveyed stations is computed in period of 2011-2039 by using LARSE-WG model and GCM models. It has more weight among different models and scenarios of HADCM3 model with B1 emission scenario in South Khorasan stations and HADCM3 with A2 scenario. So it is more suitable for producing future rainfall. this model has better coincidence for models' mean. Results of these models South Khorasan, annual rainfall rate in 2011-2039 periods in comparison with statistical period (1988-2010) that has decreased to 8/23 centigrade.

CONCLUSION

Climatic conditions play a major role in all aspects of life especially plant life. The appearance of genera, varieties and other plant ecotypes can be affected by environmental factors particularly climatic ones. Although all mankind focused their attention on the awareness of the relationship between the environment and plant life from the beginning of agricultural evolution, but this subject has currently been taken into proper consideration by the appearance of new indexes relating to meteorology entitled 'Agro-climatology' or 'Crop-ecology'. Among different factors influencing agricultural production, weather conditions is the most variables in natural environment that human is not able to control them, except in small scale with high cost. Lack of attention to capabilities of climate and traditional cultivation of agricultural Products has been resulted to low changing yield and even the destruction of crops in some years. Agro climatology assesses interaction relationship between climatic and hydrologic factors with agriculture. The results show that late October the optimum time for planting Autumn canola regions (Ghaen and Ferdos). Thermal gradient analysis and deviation from optimal conditions at different altitudes in the study area show that for every 100 meters increase of altitude, the deviation from the optimal conditions of planting is delayed by one month. This point is important in terms of cultivating time and commercial crops production. According to the obtained agricultural calendar, the most appropriate time for Autumn planting and harvest in the area are The early October and late may, respectively. . The average annual temperature change results in model LARS WG South Khorasan shows an increase of 1.12C°. That this increased temperature does not affect the cultivation autumnal canola plant. The results showed that the mean rainfall in the study area will have reduced of about 8.23 mm this reduced rainfall reduced canola yield in the region.

REFERENCES

Auld D, Bettis L and MJ Dail. (1984). Planting date and cultivar effect on winter rape production. *Agronomy Journal* **76**: 197-200.

Adamsem FJ and T Coffelt. 2005. Planting date effects on flowering, seed yield and oil content of rape and crambe cultivars. *Industrial Crops and Products*, **21**(3): 293-307.

Bagli S, Terres, JM Gallego, J Annoni, A and Dallemand J. 2003, Agro-Pedoclimatological Zoning of Italy, Definition of Homogeneous Pedo-climatic Zoning for Agriculture, Application to Maize, Durum Wheat, Soft Wheat, Spring Barley, Sugar Beet, Rapeseed, Sunflower, Soybean, Tomato, EUR 20550/EN, p 82.

Jones JW, Keating BA, and Porter CH. 2001. Approaches to modular model development. *Agric. Sys.* **70**: 421 - 443.

Malcolm JM, and Stewart DW. 2002. Crop physiology and metabolism heat stress during flowering in summer Brassica. *Crop Sci.* **42**: 797-803.

Nada Bharyava, CRS Tomar, DPS, and Rawson HM. 1996. Phonological development of *Brassica compestris, B. Juncea, B. napus* and *B. carinata* grown in controlled environments and form 14 sowing dates in the field. *Field Crops Research.* **46**: 93-10.

Poorenbos J. 1977. Guidelines for predicting. Crop water requirements. Food and agriculture organization of united. Rom. Italy.

Muller J, T Behrens and W Diepenbrock. 2006. Use of a new sigmoid growth equation to estimate organ area indices from canopy area index in winter oilseed rape (*Brassica napus* L.). *Field Crop Research*, **96**: 279-295.

Morrison MJ, and DW Stewart. 2002. Heat stress during flowering in summer Brassica. *Crop Science*, **42**: 797-803.

Robertson M J, and Holland J F. 2004. Australian Journal of Exp. Agriculture Indian Mustard to sowing date in the grain belt of North-eastern Australia. *Australian journal of Experimental Agriculture,* **44**: 43-52.

Hocking PJ, M Stapper. 2001. Effect of sowing time and nitrogen fertilizer on canola and wheat, and nitrogen fertilizer on Indian mustard. *Australian Journal of Agricultural Science. Camb.* **97**: 389-415.