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Productivity Zoning of Indian Mustard (*Brassica* spp.) in Haryana State by Climatic and Physical Factors

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ABSTRACT

The present study aim conceptualized the productivity zoning of Indian mustard growing area of the Haryana on the basis of winter season temperature and rainfall, soil characteristics and area and production under the crop. All parameters were plotted in Geographical Information System for identifying productivity zone. Six different zones were delineated showing potential for mustard crop. Western, southern and central parts of state showed better physio-climatic properties whereas north eastern districts were found poor for this crop. Winter isotherm of 18 ^{o}C and isohyets of 50 mm showed dominance over mustard growing regions in the state. Although rainfall increasing, yet decrease in temperature towards north eastern districts may be the reason to control the mustard crop there. Hisar and Rewari found foremost districts having suitable soil and climatic conditions. The research can be helpful for agricultural planning and policy formulation.

Key words: *Winter rainfall, Isohyets, Isotherm, soil texture, productivity zones, GIS*

INTRODUCTION

The present work aim to delineation of zones of productivity of Indian mustard on the basis of used of long term winter temperature, rainfall and soil texture and mustard yield data of Haryana state. Trans-Gangetic Plains of India that encompasses the states of Punjab, Haryana and Delhi, Union Territories of Chandigarh and Sriganganagar district of Rajasthan have much regular phenomena in the winter season to receive three to four western disturbances (WD) thereby receive good amount of rain to meet the irrigation requirement of standing Indian mustard in the region[4]. The concept for productivity zonation is very useful for understanding and managing agricultural planning in this area[1]. Different concept for productivity zoning and agroclimatic characterization of mustard growing zones in different states were accomplished based on area, production and productivity of crops. Temperature, rainfall, soil, topography and humidity play a direct role in crop production[2]. Temperature affects the cropping pattern, amount of rainfall, intensity of rain and its distribution, soil determine the crops grown and soil treatment needed. Soil fertility and soil structure influences the cropping pattern and soil management practices adopted by the farmers.

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MATERIAL AND METHODS

Delineation of Agroclimatic zones

The average data on area and productivity of rapeseed and mustard for different districts of Haryana were used for zoning. The data were retrieved from Statistical Abstract of Haryana. The district wise percentage was calculated with respect to area and production. Ascending order of data was then divided into three categories with the help of "cumulative percentage of total" method. When, instead of cumulative frequency, cumulative percentages are shows, the distribution is called the cumulative percentage distribution[4]. The long term winter season rainfall data (past 30 years) of Haryana state were collected from different stations (55 rain gauge stations of Deptt. of Land Record) and analyzed in GIS. Five Isohyets zones viz. <50 mm, 50 to 75 mm, 75 to 100 mm, 125 to 150 mm and 150 to 200 mm were drawn over the Haryana map. The relevant information on soil textural classification of the Haryana state was collected from Resource Atlas of Haryana and Deptt. of Soil Science, CCS HAU Hisar and plotted as digital maps. Eight soil textural types were observed in the whole of the Haryana state.

Weather yield relations: Long term data on actual rainfall, maximum (T_{max}) and minimum temperature (T_{min}), relative humidity (RH) was collected for five representative locations in Haryana (Ambala, Karnal, Hisar, Gurgaon and Mahendergarh). Maximum and minimum temperature were averaged for three periods of two months each viz. October +November; December + January and February + March. Point station data was then interpolated and distribution of average temperature during winter was generated in GIS. The isotherms of 16 to 19^{o}C were drawn over isohyets.

RESULTS AND DISCUSSION

Classification of Growing environment

For the classification of growing environment of rapeseed and mustard in the state, total area under crop, production and productivity in different districts of the state during recent five year (2010-11 to 2014-15), the winter season normal temperature and rainfall were analyzed in GIS along with textural classification of soil of Haryana.

Area, production and productivity of rape and mustard

District-wise averaged area, production and productivity of mustard during rabi seasons of 2010-11 to 2014-15 (5 years) were computed on basis of data available in Statistical Abstract of Haryana. While applying the cumulative frequency distribution methods based on cumulative total frequency of area and productivity of mustard in districts of state as input, the criteria and categorization of the districts was determined (Table 1). Districts were divided into three categories based on cumulative percentage of total. Following this, three categories were formulated for area and productivity, each as follows:

i. Area: three categories were selected on area viz. High spread (H) area > 60,000 hectares, Medium spread (M) area from 40,000 to 60,000 hectares and Low or poor spread (L) where area was <40,000 hectares.

ii. Productivity: for this also, three categories were selected viz. High productivity zone (H) having yield >1700 kg/ hectare, Medium productivity zone (M) with yield ranging from 1600 to 1700 kg/ hectare, and Low or poor productivity zone (L) where yield was <1600 kg/ hectare.

Winter season rainfall

Rainfall is important weather parameters which influences the rapeseed and mustard growth and yield. Amount of winter or seasonal rainfall, its intensity and distribution determine the crops growth in rabi season in north western India. Long term winter season rainfall data (past 30 years) of Haryana state were collected and analyzed. The pattern of isohyets of winter season rainfall was described by five Isohyets i.e. <50 mm, 50 to 75 mm, 75 to 100 mm, 125 to 150 mm and 150 to 200 mm and demarcated for the state (Table 1). As evident from the Fig. 1, the state receives winter season rainfall in the range of <50 to 200 mm. The areas lying between various Isohyets have been detailed below:

Bhiwani, Mahendergarh, Rewari and part of Hisar districts receive below 50 mm rainfall. Where some parts of Sirsa, Bhiwani, Gurgaon and Rohtak and Faridabad were situated between Isohytes of 50 and 75 mm rainfall area. Western part of Kurukshetra and Karnal, Eastern part of Sonepat districts had winter season rainfall between 75 and 100 mm. Kurukshetra, Karnal, western part of Ambala had rainfall of 100 to 125 mm. Extreme northern parts of Ambala district recorded rainfall of around 150 mm during the winter season.

Winter temperature (Isotherm)

The district of Sirsa, west part of Fatehabad, Hisar, Palwal, Sonipat had winter normal mean temperature of 18 °C. Mahendergarh, Rewari and Mewat district were having higher temperature of 19 °C in winters during the crop season as compared to the other district. In the north east of Haryana Ambala, Yamunanagar, Panchkula districts had winter temperature of 16 °C which was lowest in the state. The average winter temperature was noticed with the range of 16 to 19 °C (Fig. 1)

Soil of Haryana

Soil is one of vital parameters which significantly influence the production and productivity of mustard crop. Productivity also depends upon soil type or soil fertility gradient and mechanical compositions along with soil moisture and temperature. The texture and structure of soils differ from one location to another. Therefore, texture classification (eight soil textured classes) of soil in the state (Fig. 1) was considered for further elaborating the rapeseed and mustard production zones. The texture classes were clay loam, clay to clay loam, sandy, loamy sand, sandy loam to clay loam, silt and hills (Hills spread over a small area i.e. western parts of Faridabad, eastern and central part of Gurgaon, western part of Mewat, parts of Mahendergarh district). Majority of the districts of Haryana belong to loamy soils followed by sandy soils. Parts of Sirsa, Hisar, Northern part of Bhiwani, southern part of Ambala, Jind, Sonepat and some part of Rohtak districts have loam to clay loam soils. Sandy types of soils dominate along Rajasthan-Haryana boundary i.e. parts of Sirsa, Hisar, Bhiwani Mahendergarh and Rewari districts.

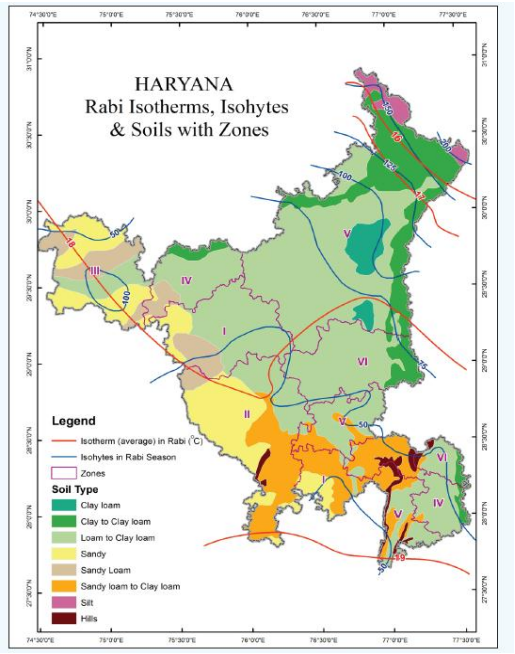

Fig. 1: Soil texture with rabi season Isotherms, Isohyets in Haryana

Adopting the above described inputs i.e. the area, productivity, winter season temperature and rainfall and soil texture classification, analysis was carried out by super imposing the information in GIS. Results emerged are shown in the form of map. Zones were

differentiated from one another as per district boundary to maintain the administrative uniformity. Thus based on above mentioned criteria the state of Haryana was divided in six rapeseed and mustard production zones as mention below and depicted in Fig. 2 and Table 2. Each zone was ascribed with two letters where former represents level of spread (area) of crop and later its productivity as mentioned above.

Zone-I (HH): The zone had high spread and high productivity (HH) lies in district of Rewari and Hisar (Fig. 2). **Zone-II (HM):** Next zone had high spread and medium productivity (HM) falling in district of Bhiwani and Mahendergarh. **Zone-III (MH):** This zone had medium spread and high productivity of rapeseed and mustard and covered the districts of Sirsa only. **Zone-IV (LH)**: Fourth zone had low spread and high productivity. It extended in Fatehabad, Gurgaon and Palwal districts. **Zone-V (LM):** Zone had low spread and medium productivity and district of Jhajjar, Mewat and all districts in north east Haryana (from Jind, Panipat onwards) lies in this zone. The zone V fall in lower and medium productivity, it might be due to the lower value of winter temperature impacted on the yield and more abnormal weather condition might be influenced the final production on Indian mustard under these districts. **Zone-VI (LL):** The last zone had low spread and low productivity. This zone comprised of the districts of Rohtak, Sonepat and Faridabad.

Table 1: Agroclimatic environment of various production zones (based on cumulative total frequency) of rape and mustard

Sr #	Zone	Rabi rain (mm)	Soil texture	Category of Zone	Districts
1.	Zone I	<50 and 50 to 75	Loamy to clay loam, sandy	HH	Hisar, Rewari
2.	Zone II	<50	Sandy loam, sandy	HM	Bhiwani, Mahendergarh
3.	Zone III	50 to 100	Sandy loam, Clay loam, sandy	MH	Sirsa
4.	Zone IV	<50 and 50 to 75	Loam to clay loam, Sandy loam	LH	Fatehabad, Gurgoan, Palwal
5.	Zone V	75 to 200	Loam to clay loam, Clay loam, silt	LM	Panchkula, Ambala, Kurukshetra, Karnal, Yamuanagar, Kaithal, Jind, Panipat, Jhajjar and Mewat
6.	Zone VI	50 to 75	Loam to clay loam, Clay to clay loam	LL	Sonipat, Rohtak, Faridabad

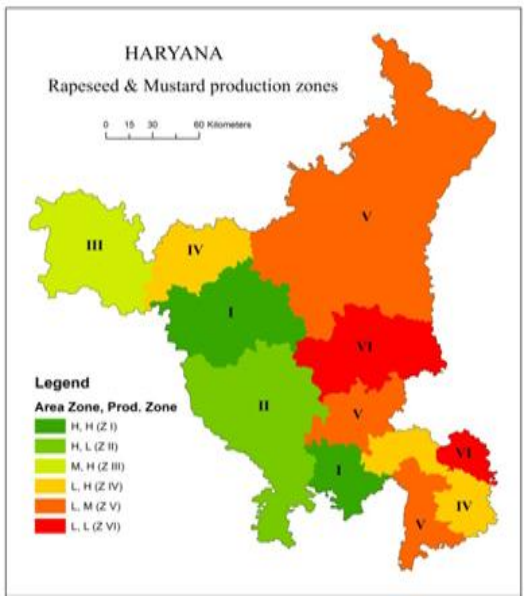

Fig. 2: Rape and mustard production zones based on cumulative frequency distribution of area and productivity, climate and soils in Haryana

The highest variation in the productivity and production in the region of isotherm 18 °C (winter seasonal average temperature) and rainfall (rabi season) of around 50 mm. It covered larger area as well more number of districts as compared to other isotherms and isohyets. This zone had low spread to high spread and high, medium and low productivity. The 16 °C covered the small area i.e. only two districts (north east part of Haryana state) with lower spread of crop.

CONCLUSION

State of Haryana has varied topography and climatic condition. The texture and structure of soils differ from one location to another. Based on climate and soil properties, six different zones were formulated. The zone describes spread (area under crop) and productivity of mustard crop as high spread and high productivity (HH), high spread and medium productivity (HM), medium spread and high productivity (MH), low spread and high productivity (LH), low spread and medium productivity (LM), and low spread and low productivity (LL). Hisar and Rewari have comp up as most potential districts for mustard crop in state. Highest variation in the productivity and spread was observed in the region of isotherm of 18 °C (winter average temperature) and *rabi* isohyets of 50 mm. It covered the larger area as well more number of district and distributed over western, southern and central parts of state. Region with comparatively better rainfall and lower temperature experienced lower to medium productivity and spread.

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