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Significance of weather forecasting on oilseeds crop production in India: A-review

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ABSTRACT

Oilseed production in India is on cross-roads and has major dependency on the imports. The majority of oilseeds were introduced in India since ages and well-adopted by the farmers. Like other crops oilseed production also invariably depends on weather variables as major oilseeds are grown in rainfed situation. Therefore, an accurate weather forecast for the sowing time, growing season and pest-disease situation is need of hour to overcome the weather vagaries. In this review we have tried to mention important environment factors which affect oilseed production vis-a-vis disease situation in the oilseed crops and to measure the changing scenario.

Key words: Diseases and Pests, Mustard, Groundnut, Weather forecast.

Weather plays an important role in agricultural production. It has a profound influence on the growth, development and yields of a crop, incidence of pests and diseases, water needs and fertilizer requirements in terms of differences in nutrient mobilization due to water stresses and timeliness and effectiveness of prophylactic and cultural operations on crops. Weather Forecast is referred to as the prediction of weather in advance. Weather forecast assumes considerable importance for agricultural activities for the purpose of effective planning of modern agricultural practices such as sowing, high efficient irrigation, management of crop diseases and pests and harvest planning. India is the largest producer of oil seeds in the world and oil seed sector occupies an important position in the agricultural economy of the country. India is the fifth largest vegetable oil economy in the world, next only to USA, China, Brazil and Argentina, and has an annual turnover of about Rs 80000 crore. India accounts for 12-15 per cent of oilseeds area, 7-8 per cent of oilseeds production, 6-7 per cent of vegetable oils production, 9-12 per cent of vegetable oils import and 9-10 per cent of the edible oils consumption Jha *et al*. (2012).

The average productivity of oilseed in India is 1168.9 kg/ha DAC, (2014).India has rich diversity of annual oilseed crops on account of diverse agro-ecological conditions. Nine annual oilseeds, which include seven edible oilseeds, *viz*., groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger and two non-edible crops, *viz*., castor and linseed are grown in the country. The productivity of oil seed crops in India is depicted in (Fig.1). Groundnut thrives best in the tropical climate and requires 20-30°C temperature and 50-75 cm rainfall and sesame is a rainfed crop and requires 45-50 cm rainfall. Seasonal evapotranspiration of sesame was measured 497 mm in hot arid region Meena and Rao, (2015). It thrives well in areas having 21-23°C temperature. Mustard is much sensitive to climatic variables and hence climate change could have significant effect on its production. Change in favorable conditions in relation to rise in temperature may be useful to assess the impact of climate change on the disease. Temperature induced incubation and /or latent period models could describe developmental or generation rate of the pathogen on host Madden *et al.* (2007) as incubation period is generally characterized by a decrease in duration as temperature rises from the minimum to the optimum, then an increasing duration with higher temperatures (Analytis, 1977; Logan *et al*, 1976; Pfender, 2001).Weather forecasts are short range forecast (1-3 days), medium range forecast (4-10 days) and long range forecast (more than 10 days to season). The medium range forecast would be more likely to be of value in helping farmers to decide farm activities from crop sowing to harvesting. Agromet advisory bulletin prepared based on the medium range .

Weather forecasting and its importance: Now, weather forecasting has a wide range from now-casting means current to seasonal means advance in 4 months forecasting with the help of various new models, radar and satellites.

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Now-casting: It is recently forecast system based on Doppler radar, satellite and observational data are able to make analysis of the small-scale features present in a small area such as a city and make an accurate forecast for the following few hours (0 to 6 hours).

Short-range weather forecasts: The rang is from12 hours and up to 72 hours for description of weather parameters. These forecasts include expected cloudiness, probability of rain and expected rainfall, wind speed and direction, dew duration and intensity and range of high and low temperatures. The forecasts are helpful to farmers for decision taking to irrigate the crop or not, when to apply fertilizer and whether to start harvesting or withhold it, and livestock from cold or heat. It also improved efficiency in crop production by efficiently managing day to day weather related farm operations.

Medium range weather forecast: These forecasts range from 3 days to 10 days. It is very important forecast to agricultural operations for increasing inputs efficiency. The medium range weather forecast for next 4 days biweekly based issued by national center for medium range forecast at New Delhi. Weather parameters cover in the forecast, which are rainfall quantity, maximum and minimum temperature, wind speed and direction, and cloud cover. It is useful for farmer's community to take decision for agriculture operation that are decide depth of sowing for optimum seedling emergence, decide whether sow or not, plan for irrigation based on expected rainfall, ensure more efficiency of spray and also manage labor and equipments, plan for animal feed requirement and protect to livestock from adverse weather conditions.

Extended range weather forecast: The extended range of weather forecasts is from 10 days and up to 30 days, but it is mainly from 15 to 30 days. The extended range forecast is important in agriculture production, especially for policy planning and strategy decision making. So that, advance weather information on the month, it is more helpful to manage weather-associated crop production losses.

Long range weather forecast: the range of the forecast is beyond 30 days up to two years. Knowledge of seasonal rainfall, in advance, helps in proper agricultural planning. Agriculture can benefit substantially from long-range weather forecasts, for the month or the season, which can help to optimize farming operations and deal more effectively with the adverse impacts of climate variability, including extreme weather events.

Weather based disease forewarning models: Plant disease forecasting involves all the activities in ascertaining and notifying the farmer in an area/community that the conditions are sufficiently favorable for certain diseases, that application of control measures will result in economic gain or that the amount of disease expected is unlikely to be enough to justify the expenditure of time, money and energy for its control. Plant disease forecasting requires complete knowledge of epidemiology i.e. the development of disease in plant population under the influence of the factors associated with the host, the pathogen and the environment. Forecasting is actually, the applied epidemiology. Plant disease forecasting is made more reliable if the reasons for a particular disease developing under certain conditions and not others are known. It is the intricate relationship between the weather and diseases that makes predictions difficult. An understanding of the complexities of the interrelationships between the environment, the pathogen, and its host are required. The disease tetrahedron (Fig.2) is the classic way

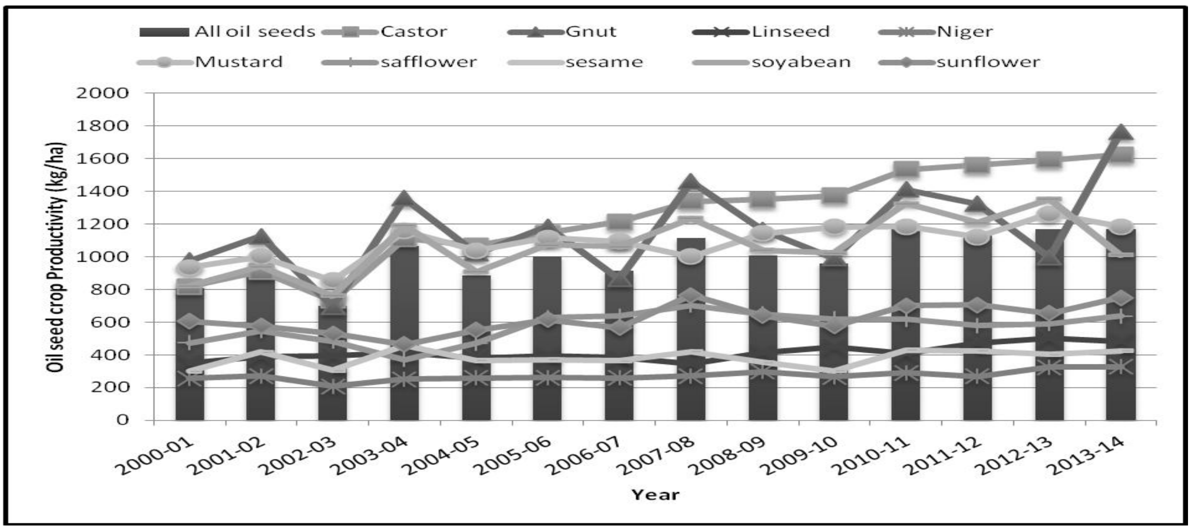

Fig 1: Status of oil seed production

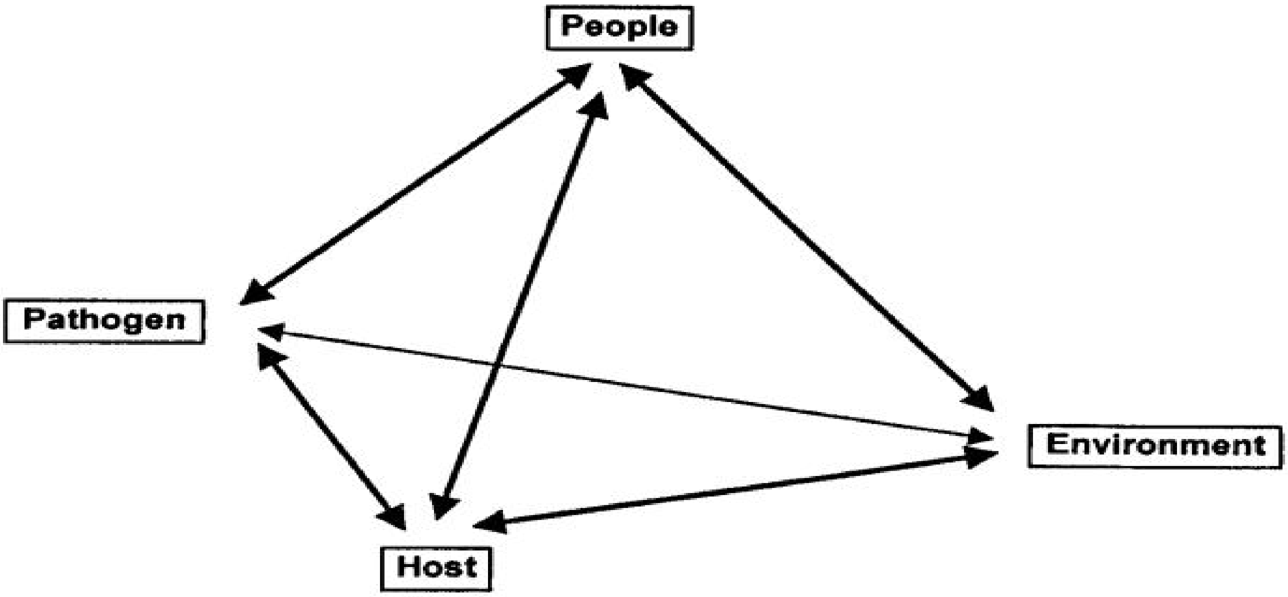

Fig 2: Plant Disease tetrahedron

Table 1: Examples of the relationships between leaf spots and weather conditions in Groundnut

Country	Disease	Weather conditions	Reference
India	Early and late leafspots	High Relative Humidity and dew	Wangikar and Shukla,1977
U.S.A	Early andlate leafspots	Rainfall and leaf wetness	Jensen and Boyle, 1965
Nigeria	Early leaf spots	Rainfall, relative humidity and low temperature	Garba *et al.* 2005
India	Early and late leaf spots	Maximum temp., 31-35 ºC, minimum temp.,18-23ºC, mean monthly rainfall at least 60 mm	Venkataraman and Kazi,1979
USA	Early and late leaf spots	Rainfall	Davis *et al.*, 1993
USA	Early and late leaf spots	Rainy days during June -September	Johnson *et al.*,1986
USA	Early leaf spot	shortly after the onset of rainfall	Smith and Crossby, 1973
India	Late leaf spot	Leaf wetness index of 2.3 or more	Butler *et al.*, (1994)
Central India	Leaf spots	Rainfall 200-500 mm, Temperature 25-30°C and RH 74 to 87% during crop season	Lokhande and Newaskar, 2000; Mayee, 1985
USA	Leaf spots	No. of hours with RH > or = 95% and Minimum temperature	Jensen and Boyle, 1966
USA	Leaf spots	Temperature>16 °C and Leaf wetness	Alderman and Beute,1986S
India	Leaf spots	Decrease in maximum temperatureand increase in relative humidity	Adiver *et al.*, 1998
India	Late leaf spot	Temperature (negative relation)	Mayee, 1989
USA	Leaf spots	Rainfall, RH 80% and mean temp., 23.2°C	Frag *et al.*,1992
USA	Early leaf spots	Temperature and duration of wetness	Wu *et al.*,1999
USA	Early leaf spots	Nearly 100% humidity and 16-25°C temperature	Alderman and Beute, 1987
India	Leaf spots	Maximum temp<34°C, Mininum temp<22°C, morning RH>82% and afternoon RH>78%	Samui *et al.*, 2005

*Source-http://www.agrometeorology.org/files-folder/repository/gamp_chapt13B.pdf

of understanding the interaction between the main elements which combine to produce disease Zadoks and Schein, (1979). Some of examples of relationship of weather and disease incidence for leaf spot of groundnut over the world are summed up (Table.1). Experimental investigation is necessary to show that exactly what stage during the disease development is critical for variable incidence or intensity of disease. A timely and reliable forecast gives the farmer many options to choose from that he can weigh the risks, costs and benefits of his possible decisions. Temperature-based developmental rate model is also likely to facilitate temperature rise effect on diseases that may happen under

Table 2: Impact of the AAS service on oil seeds production

Crop	Season	Station	Total cost of cultivation (Rs/acre)		Net return (Rs/acre)		Benefit to cost ratio (Rs/acre)	
			AAS	Non-AAS	AAS	Non-AAS	AAS	Non-AAS
Oil seedsMustard	2003-04	Kalyani	3,179.2	3,145.2	10,594.7	9,993.9	3.33	3.18
	2004-05	Kalyani	3,085.4	3,163.4	9,896.8	9,187.0	3.21	2.90
	2005-06	Kalyani	3,599.3	3,943.3	11,894.0	10,197.7	3.30	2.59
	2003-04	Hisar	4,906.0	4,956.4	11,057.8	10,673.4	2.25	2.15
	2004-05	Hisar	7,375.0	4,763.8	19,501.2	9,859.9	2.64	2.07
	2005-06	Hisar	5,638.4	5,714.9	10,899.9	10,665.0	1.93	1.87

Source: Maini and Rathore, 2011

climate change regime. Disease distribution models are powerful tools to predict future disease epidemics, and provide support for developing strategies against new threats might occur. Distribution models predict potential geographical range for a disease based on two types of geo referenced data, biological data describing the species known distribution (presence and absence) and meteorological data which describe the landscape conditions where the species is found (Paul *et al*. 2005). Because of their reliance on climatic or weather data, these models are well suited to studies of the effects of climate change on plant disease, and exotic pest introductions.

Role of weather forecasting in oil seed production: Weather significantly affects every phase of agricultural activity from the preparatory tillage to harvesting, routine agricultural operation to plant protection measure and storage (Saxena *et al*. 2015). Maini and Rathor (2011) reported that the AAS farmers accrued a net benefit of 10–15% in the overall yield and a reduction by 2–5% in the cost of cultivation over the non-AAS farmers. Vashist *et al*. (2013) also reported that application of agromet advisory bulletin, based on current and forecasted weather is a useful tool for enhancing the production and income. AAS farmers received weather forecast based agro-advisories, including optimum use of inputs for different farm operations. Due to judicious and timely utilization of inputs, production cost for the AAS farmers reduced. The increased yield level and reduced cost of cultivation led to increased net returns. Maini and Rathore (2011) reported economic impact of weather based advisories on oilseed crops cultivated at Kalyani and Hisar station by weather sensitive users (Table 2). Indirectly it assesses what the impacts might have been had the forecasts-cum-advisories not been available. One study conducted and reported that increase in CO_2 to 550 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%. Increase in temperature 1oC may reduce yields of wheat, soybean, mustard, groundnut, and potato by 3-7%. Productivity of most crops to decrease only marginally by 2020 but by 10-40% by 2100 due to increases in temperature, rainfall variability, and decreases in irrigation water (Mahato, 2014). However, these reductions have spatial variation in different mustard growing region of India. In both irrigated and rainfed conditions, yield reduction would be higher in eastern India (67and 57%) followed by central India (48 and 14%) and northern India (40.3 and 21.4%). This was due to maximum temperature rise in eastern part of the country, projected for 2080. In northern India, yield reduction of irrigated mustard was comparatively less due to prevailing lower temperature in this region during the crop growth period. But rainfed crop was found to be more susceptible to changing climate in north India due to projected reduction in rainfall in future scenarios. Adoption of adaptation measures like late sowing and growing long-duration varieties would be helpful in preventing yield loss of irrigated mustard in different locations of the country (Boomiraj *et al*. 2010). Mustard is much sensitive to climatic variables and hence climate change could have significant effect on its production. Apart of the decline and/or stagnation in mustard yields causing negative growth rate from 1997 was possibly due to unfavorable monsoon which created moisture stress (drought and excess rainfall) and temperature increases (Kumar, 2005). High temperature during mustard crop establishment (mid September to early November), cold spell, fog and intermittent rains during crop growth also affect the crop adversely and cause considerable yield losses by physiological disorder along with appearance and proliferation of aphid pest, white rust, downy mildew and stem rot diseases. *Alternaria* leaf blight disease appeared in mid-December when the relative humidity was more than 80% with maximum temperature ranging between 18-25 p C and minimum between 10-14 PC. The yield was reduced due to disease from 32 to 57% and disease showed a negative effect on oil content causing losses on oil between 4.2 to 4.5% (Shrestha *et al*. 2005). Mall *et al*. (2004) suggested that delaying the sowing dates of soybean crop should be able to mitigate the detrimental effect of thermal stress due to climate change. Also, soybean sowing in the second season, *i.e*. in the month of December could be favorable for higher yields particularly at north Indian stations.

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