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Short communication

Phenophasic model based on growing degree days for sunflower crop in Punjab region

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Prevailing weather conditions during the crop growing season have direct bearing upon the onset as well as duration of different phenological events of any crop. Heat unit concept is the agro-meteorological application of temperature effect on plant growth (Dwyer and Stewart, 1986), which has been variously applied to correlate phasic development in crops to predict sowing and maturity dates (Wurr *et al.*, 2002). Degree days required for a crop to progress from one stage to the other is based on the concept of real time to attain a given developmental event and is approximately linearly related to temperature in the range between base and optimum temperature (Monteith, 1981). The application of thermal indices provides a scientific basis for predicting growth and developmental processes. In view of the significance of thermal influence on plant growth, the present investigation was carried out to develop a thermo based phenophasis model for predicting the occurrence of different phenological growth stages.

A field experiment was conducted during three consecutive *spring* seasons of 2005 to 2007 at Oilseeds Research Farm of Punjab Agricultural University, Ludhiana. The soil of the experimental field was sandy loam in texture having pH 8.1 tested low in organic carbon and high in available phosphorus and potassium. Treatments comprising of 5 sowing dates (20 Dec, 5 Jan, 20 Jan, 5 Feb and 20 Feb) and 4 hybrids (PSH 569, PSH 652, PSFH 118 and SH 3322) were laid out in split plot design with 3 replications by relegating sowing dates as main plot treatments and hybrids as sub plot treatments. Due to some unavoidable circumstances, one of the test hybrid could not be sown on 20 December and 5 January during 2005. The test hybrids were sown as per treatments by manual dibbling on the southern side of the ridges made in east-west direction at 60cm x 30cm spacing using 5 kg seed per hectare. The locally recommended cultural practices were adopted to raise the crop during all the years. Meteorological data was collected from agro-meteorological observatory situated near the experimental field. The data regarding number of days required to reach emergence, star bud, completion of flowering and physiological maturity were recorded when 75% of the plants in each plot attained the specific growth stage. Phenological differences within the test hybrids were almost similar under all the sowing dates. Therefore, days taken to attain a particular phenological stage were averaged over hybrids to evaluate the influence the sowing time on the occurrence and duration of specific growth stage. Growing degree days (GDD) were calculated employing standard formula using 4°C as base temperature for sunflower (Nuttonson, 1955). GDD were calculated from the date of sowing to each date of sampling to give accumulated GDD. Linear regression model based on the phenophase wise data pooled over different sowing dates in three cropping seasons was derived for predicting the onset of a particular phenophase based on GDD.

Crop phenology

Sowing dates markedly influenced the onset and duration of different phenophases in all the three cropping seasons. The number of days required to attain physiological maturity decreased with each successive fortnight delay in sowing time from 20 December to 20 February. Sunflower crop took 122 days when the crop was sown on 20 December, however, it required 92 days when it was sown on 20 February. The differences with in number of days required to attain physiological maturity under different sowing dates could be attributed to the extended vegetative growth period due to prevalence of comparatively cooler temperature under earlier sown dates in comparison to later sown crop.

Table 1: Accumulated growing degree days (°C days) required to attain various phenophases of sunflower under different sowing dates

Sowing dates	Phenophasic period				
	Sowing to emergence	Emergence to star bud	Star bud to completion of flowering	Completion of flowering to physiological maturity	Sowing to physiological maturity
			20 December		
2005	-	-	-	-	-
2006	131	531	465	489	1616
2007	121	629	335	564	1648
			5 January		
2005	-	-	-	-	-
2006	127	579	427	514	1641
2007	107	625	385	668	1783
			20 January		
2005	81	595	337	625	1637
2006	104	493	515	625	1737
2007	111	590	395	649	1746
			5 February		
2005	117	560	432	553	1667
2006	152	595	484	716	1946
2007	130	650	455	608	1835
			20 February		
2005	74	691	455	589	1809
2006	141	595	529	646	1911
2007	107	699	504	619	1929
Mean	116	603	440	605	1762
SD	22.0	58.1	63.1	62.8	118.0
CV (%)	19.1	9.6	14.3	10.4	6.7

Growing degree days (GDD)

The temperature response to growth and development of crop i.e. GDD required for completion of each phenophase varied with the date of sowing. An increasing trend in accumulated GDD was observed with each fortnight delay in sowing time from 20 December onwards. Although the days taken to physiological maturity decreased with delayed sowing, the progressive increase in temperature regime during the reproductive period could be possible reason for higher thermal unit requirement under late sown conditions. Sunflower crop accumulated GDD ranged between 1673-1809 °C days during 2005, 1616-1911 °C days during 2006 and 1648-1929 °C days during 2007 from sowing to physiological maturity under different sowing dates. The average value of accumulated GDD upto physiological maturity was 1762°C days with coefficient of variation (CV) of 6.2 per cent. When longer periods were considered for accumulation, comparatively high standard deviation (SD) with relatively low CV was observed (Table 1).

Phenophasic model

A linear regression model taking into account the phasic developmental data pooled over different sowing dates in three cropping seasons on the basis of thermal unit requirement was developed as under.

$Y = 0.054\ AGDD + 4.5603 \quad (R^2 = 0.9044)$

Where,

Y is the number of days predicted.

AGDD is the accumulated growing degree days for the particular phenophase.

The model indicated that accumulated thermal units accounted for nearly 90 per cent verification of the occurrence/onset of different phenophases in sunflower.

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