Journal of Agrometeorology 6 (2) : 284 - 287 (Dec 2004)

Short Communication

Phenological development and thermal time in pulses and oilseed crops grown in summer season

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The growth and productivity of crops depend on the elements of the physical environment in a particular ecosystem. The performance of the green gram and black gram varies as per their specific photo-thermal requirement (Faroda *et al*, 1983; Ali and Meena, 1986; Saini and Jaiswal, 1991). This study was under taken to identify the optimum time of sowing during summer season for pulses and oilseeds with an analysis of crop physiology and thermal environment.

The field experiment was conducted in sandy loam soils during summer season of 2002 at Research Farm of College of Agriculture Engineering, Jawaharlal Nehru Agricultural University, Jabalpur (Madhya Pradesh). The treatments comprised of three planting dates (20 February, 4 March and 27 March) and four crops [i.e. moong (JM-721), urd (LBG-20), soybean (JS-335) and sunflower (Modern-1)]. All the corps were grown under recommended package of practices for the region. After sowing, come up irrigation was given and subsequent irrigations were applied at 8 to 10 day interval. The season was characterized with high air temperature with an average of 19.6 to 35.2°C and the extreme air temperature was reached above 44 °C. for six days in the month of May. Total 55.6 mm rainfall was received during the crop season. The observation on different phenophases were recorded when 50 percent of plant attained specific growth stage. Daily maximum and minimum temperature and actual sunshine hours of the crop period were noted form the meteorological observatory of the University located at 23°09^{D} N, 79°59^{D} E at 411m. altitude. Growing degree days (GDD) were determined by subtracting the base temperature of 10°C form daily mean temperature following Ghadekar and Sethi (1986) for summer crop like beans. Heliothermal units (HTU) were calculated multiplying growing degree days with actual sunshine hours. Photothermal unit (PTU) were calculated by multiplying growing days with possible sunshine hours (Rajput *et al*. 1987). Heat use efficiency in term of economic yield (seed yield kg ha^{-1} day^{-1}) was also calculated as suggested by Rao *et al*. (1999).

Moong and urd

Emergence took 3 to 5 days in all the sowing dates. Number of days from sowing

Table 1 : Heat units from sowing to different stages of moong, urd, soybean and sunflower crops

Crops	Growing degree days (GDD)														
	Flower Initiation			50% Flowering			Grain Filling			Physiological Maturity			Maturity		
	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
Moong	877	675	817	990	811	842	1039	925	972	1276	1218	1184	1431	1377	1685
	(48)	(41)	(40)	(-)	(-)	(-)	(69)	(50)	(46)	(75)	(63)	(54)	(77)	(70)	(70)
Urd	627	678	766	701	743	843	771	830	998	1128	1351	1288	1201	1079	1882
	(45)	(39)	(38)	(-)	(-)	(-)	(60)	(51)	(48)	(69)	(67)	(58)	(70)	(70)	(70)
Soybean	650	881	742	855	1116	1243	1106	1297	1712	1773	2341	-	2072	2351	-
	(44)	(32)	(37)	(44)	(32)	(37)	(70)	(63)	(76)	(96)	(87)	(98)	(108)	(100)	(102)
Sunflower	855	972	1130	1015	1092	1288	1128	1243	1472	-	-	-	2170	2184	2843
	(48)	(41)	(40)	(-)	(-)	(-)	(80)	(78)	(70)	(-)	(-)	(-)	(105)	(100)	(87)
Helio-thermal units (HTU)															
Moong	7440	6467	7024	8398	6988	7177	8882	7877	8323	11062	10348	9914	12208	11671	13412
Urd	5313	5613	6585	5720	6255	7177	6398	6988	8544	9639	11452	10661	10239	11874	17094
Soybean	5509	7463	8810	7244	9502	9480	9495	11022	16049	15316	17337	-	16823	17962	-
Sunflower	7244	8309	9490	8649	9284	10661	9638	10580	12086	-	-	-	14479	16900	15297
Photo thermal units (PTU)															
Moong	10526	9369	10217	11942	10822	10555	12552	11367	12249	15933	15161	15044	17627	13302	21695
Urd	7432	8290	9561	8337	9097	10555	9215	10233	12549	13666	16901	16415	14623	15495	24318
Soybean	7717	10822	9245	10258	13827	10217	13393	16198	22039	23105	28267	-	26110	26235	-
Sunflower	10258	12206	14326	12251	13510	16415	13666	15495	18860	-	-	-	27417	25493	26461

Figures given in Paranthesis are the days taken to attain different stages.
P_1 – 20 February, P_2 – 4, March and P_3 – 27 March Planting dates.

Table 2 : Seed yield (kg ha^{-1}) and heat use efficiency HUE, (kg ha^{-1} ^{0} day^{-1}) under different planting dates

Crops	P_1		P_2		P_3	
	Yield	HUE	Yield	HUE	Yield	HUE
Moong	1375	0.96	1082	0.78	680	0.40
Urd	1875	1.56	1308	1.21	830	0.44
Soybean	613	0.29	580	0.24	405	-
Sunflower	1815	0.83	1730	0.79	704	0.24

to flower initiation, 50% flowering, grain filling and physiological maturity decreased as the planting was delayed (Table 1). Highest seed yield of moong (1375kg ha^{-1}) and Urd (1875 kg ha^{-1}) was noted in the 20th February sowing dates (Table 2) Reduction in seed yield in later sowings by 21 & 30% and 30 & 56% in moong and urd, respectively was observed. It might be due to favorable environment at the time of fruiting and maturity of crop (Jaiswal, 1995). Flower initiation started after accumulating 877, 765 and 817 GDD, 7440, 6467 & 7024 HTU and 10526, 9369 and 10217 PTU in moong crop under P_1, P_2 and P_3 sowing dated respectively (Table-1). While in Urd crop total GDD accumulated was 627, 678 and 766 and 5513, 5613 and 6585 HTU and 7432, 8290 and 9561 PTU in different sowing dates.

Heat use efficiency (HUE) in term of economic yield was more (0.96 and 1.56) in early sowing in moong and urd respectively (Table 2). The lowest HUE (0.40 and 0.44) was noted with P_3 sowing date, the low HUE in case of delayed sowing can be expected due to lowest seed yield.

Soybean

Under Jabalpur condition of Madhya Pradesh, the summer grown soybean crop comes, to harvest at about 100-108 day in different planting dates. Early planting took more number of day to mature compared to delayed planting. Seed yield in early planting dates was higher than delayed sowing (Table 2). For flower initiation of soybean the GDD accumulations were 650, 881 and 742 in P_1 P_2 and P_3 planting date respectively. For maturity P_2 planting accumulated more HTU (17962) than P_1 (16823). The maximum possible energy summation index (PTU) for the P_1 and P_2 planting was 26110 and 2635 respectively. Heat use efficiency (Table 2) was more in 20 February planting (0.29) compared to 4th March planting (0.24).

Sunflower

Seed yield of sunflower was the highest in 20th February sown crop and delay in sowing beyond this resulted in reduction in yield (Table 2). Agrawal *et al*. (2002) also observed that seed decreased significantly with delayed sowing. Day for attaining different stages were decreased as the

sowing was delayed beyond 20th February. GDD, HTU and PTU from sowing to maturity were more in the P_1 and P_2 compared to P_3 planting (Table 1). The heat use efficiency ($kgha^{-1}$ $^{o}day^{-1}$) was calculated based on the growing degree days accumulated to produce unit amount of seed yield. The P_1 planting had shown the highest HUE (Table 2) and lowest in P_3 planting and it ranges between 0.24 to 0.83.

ACKNOWLEDGEMENT

Authors gratefully acknowledge to the project Coordinator (Agro-meteorology) ICAR, Hyderabad for providing the financial assistance for conducing the research work on agro-meteorology.

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