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Short Communication

Thermal indices for suitable sowing time of chickpea in Jabalpur region of Madhya Pradesh

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Chickpea is an important crop of the state of Madhya Pradesh. Appropriate time of sowing enables the crop to take full advantage of favourable weather condition during the *Rabi* season (winter), Determination of sowing time depends upon the thermal time and thermal use efficiency of the crops. Chickpea is a thermo-sensitive winter season crop. The most important factors affecting chickpea are temperature and photoperiod (Summerfield *et al.* 1980 and Sandhu and Hodges, 1971). Several workers (Agrawal *et al.* 2002, Shrivastva *et al.* 1990 and Sahu et *al.* 2007) studied the response of chickpea cultivars under different sowing times in different regions of country. The heat use efficiency of winter crop in Haryna (Rao *et al.* 1999), in peninsular India (Sengupta *et al.* 2003). Sahu *et al.* (2007) identified time of sowing of chickpea for optimal thermal regime under South Saurashtra agro climatic zone of Gujrat.

Therefore, in this paper agrometeorological indices and heat use efficiency were used to identify suitable sowing time of chickpea in Jabalpur region of Madhya Pradesh.

The investigation was carried out during two consecutive *rabi* season (2003-04 and 2004-05) at the Research Farm of Department of Physics & Agrometeorology, J.N. Agricultural University , Jabalpur (23 ^{0} 09^{l}N, 79 ^{0} 58^{l} E and 411 m above msl). The field experiments was laidout in split plot design with three replications keeping three dates of sowing (standard meteorological week (SMW) 45, 47 and 50 week as D1, D2 and D3 respectvly) in main plots and five varieties of three chickpea types viz,V1- JGG-1 (*Gulabi type*),V2- JG-74 and V3- JG-322 (*Desi type*) and V4- JGK-1 & V5- JGK-3 (*Kabuli or Chhola type*), The crop was raised using the recommended agronomic practices for the region.

Growing degree days (GDD) were calculated using base temperature of 5 ^{0}C from daily mean temperature. The photothermal units (PTU) and heliothermal units (HTU) were calculated as the product of maximum possible sunshine hours and actually measured bright hours with GDD, respectively. The thermal use efficiency (TUE) for seed or biomass yield was computed:-

$$\text{Heat use efficiency (HUE)} = \frac{\text{Seed or Biomass yield (kg ha}^{-1})}{\text{GDD }^{0}\text{C day}}$$

Seed yield

Highest and almost similar mean seed yield (1585 and 1597; 1601and 1681) of chickpea was noted under first (45 SMW) and second (47 SMW) dates of sowing as compared to crop sown on 50 SMW during both the crop seasons. Yield levels were higher during second year than first year in all the sowing dates, except in third date of sowing. *Desi* types recorded higher seed yield (V2 – 2000 and 1438; V3 -1902 and 1754 kg ha $^{-1}$ during I st II nd year respectively) followed by *Gulabi* and *Kabuli* type. Lowest seed yield (651 & 1070, 973 & 1157 kg ha $^{-1}$ in I and II year in V4 and V5 varieties of *Kabuli* respectively) was in *Kabuli* type during both the year of experimentation.

Thermal indices

The GDD, HTU and PTU varied with different stages of crop growth under different sowing times (Table 1). The units required for attaining all the phases decreased consistently with delay in planting in both the crop seasons. Among the different types of chickpea cultivars the mean thermal units for physiological maturity ranges from 1384 to 1473, HTU from 11177 to 12026 and PTU from 15110 to 16244.

Thermal use efficiency

Thermal use efficiency (HUE) of chickpea cultivars for biological and seed yield under three dates of sowing are given in Table 2. The results indicated that the thermal use efficiencies were the highest in second sowing date (SMW No. 47) followed by first (SMW No. 45) and third sowing (SMW No. 50). Poorest efficiency was noted under third sowing. This indicates that the crop got exposed to the suboptimal thermal regime with delay in sowing and there by in delayed sowing all the varieties were less efficient in heat use. Similar results have been reported by Sahu *et el.*

Table 1: Accumulated growing degree day (GDD ^{0}C Day), heliothermal (HTU ^{0}C day hrs) and photothermal unit (PTU ^{0}C day hrs) for various phenophase in different chickpea types.

Phenophases		Gulabi Type (JGG-1)		Desi Type JG-74		JG-322		Kabuli Type JGK-1		JGK-3	
Season		03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05
D1- Sowing											
Emergence	GDD	119	104	104	104	119	104	104	104	119	104
	HTU	1021	873	891	873	1021	873	891	873	1021	873
	PTU	1321	1154	1154	1154	1321	1154	1154	1154	1321	1154
50% Flowering	GDD	840	1046	829	894	840	884	760	799	713	799
	HTU	6520	8021	6504	6760	6520	6690	5928	6325	5689	6325
	PTU	8903	11101	8796	9505	8903	9405	8072	8515	7588	8515
Pod Initiation	GDD	947	1152	882	1046	873	1046	855	884	753	884
	HTU	7368	8671	6798	8021	6709	8021	6553	6690	5883	6690
	PTU	10031	12281	9354	11101	9250	11101	9065	9405	8005	9405
Beginning of	GDD	1004	1566	933	1342	905	1288	882	1046	775	1046
Grain filling	HTU	7872	12250	7247	10194	7001	9691	6798	8021	6058	8021
	PTU	10638	16911	9887	14384	9596	13774	9356	11101	8224	11101
Physiological	GDD	1716	1647	1700	1586	1716	1586	1530	1610	1530	1610
Maturity	HTU	14002	12793	13847	12421	14002	12421	12235	12323	12235	12323
	PTU	18829	17834	18435	17143	18829	17143	16497	18061	16497	18061
D2 – Sowing											
Emergence	GDD	87	125	87	125	87	125	857	125	87	125
	HTU	587	1089	587	1089	587	1089	587	1089	587	1089
	PTU	909	1326	909	1326	909	1326	909	1326	909	1326
50% Flowering	GDD	885	1125	764	921	748	921	613	735	613	735
	HTU	6753	8519	5819	6848	5665	6848	4632	5560	4632	5560
	PTU	9364	11980	8012	9703	7783	9703	6411	7704	6411	7704
Pod Initiation	GDD	1066	1238	1002	1141	1050	1141	743	812	743	812
	HTU	8392	9592	8044	8672	8244	8672	5665	6199	5665	6199
	PTU	11383	13254	11001	12160	11204	12161	7783	8523	7783	8523
Beginning of	GDD	1066	1496	1126	1333	1126	1238	854	1272	847	1272
Grain filling	HTU	8392	11623	8951	10426	8951	9593	6461	9833	6393	9833
	PTU	11383	16203	12063	14333	12063	13254	9016	13634	8937	13634
Physiological	GDD	1487	1511	1507	1477	1487	1496	1448	1530	1468	1511
Maturity	HTU	12222	11623	12402	11501	12222	11623	11873	11754	12050	11623
	PTU	16206	16377	15070	15983	16206	16203	15766	16594	15978	16377
D3 - Sowing											
Emergence	GDD	83	103	96	103	96	103	96	103	96	103
	HTU	631	836	739	836	739	836	739	836	739	836
	PTU	866	1076	1003	1076	1003	1076	1003	1076	1003	1076
50% Flowering	GDD	698	878	724	1033	749	1033	655	889	669	878
	HTU	5396	6607	5619	7816	5846	7816	5023	6644	5155	6607
	PTU	7465	9471	7764	11236	8036	11236	6983	9601	7144	9471
Pod Initiation	GDD	856	956	841	781	841	781	841	973	781	956
	HTU	6860	7276	6715	5687	6715	5687	6715	7442	6156	7276
	PTU	9256	10350	9085	8378	9085	8378	9085	10550	8405	10350
Beginning of	GDD	943	878	926	973	871	973	960	890	856	878
Grain filling	HTU	7670	6607	7501	7441	7014	7441	7827	6644	6860	6607
	PTU	10245	9471	10043	10550	9429	1055	10434	9601	9256	9471
Physiological	GDD	1194	1260	1134	1260	1194	1260	1173	1279	1173	1260
Maturity	HTU	9853	9609	9324	9609	9853	9609	9676	9798	9676	9609
	PTU	13135	13843	12434	13843	13135	13843	12894	14076	12896	13843

Table 2: Heat use efficiency (HUE) of different types of chickpea cultivars under different growing environment

Cultivars	Year	Biomass (g m^{-2} ^{0}C day^{-1})				Grain (kg ha^{-1} ^{0}C day)			
		D1	D2	D3	Mean	D1	D2	D3	Mean
JGG-1	(2003-04)	0.40	0.48	0.32	0.40	1.07	1.01	0.94	1.00
	(2004-05)	0.47	0.43	0.37	0.42	0.96	1.22	0.63	0.94
JG-74	(2003-04)	0.44	0.49	0.30	0.41	0.91	1.32	0.68	0.97
	(2004-05)	0.52	0.44	0.39	0.45	1.35	1.49	1.31	1.38
JG-322	(2003-04)	0.41	0.47	0.34	0.40	1.17	1.27	1.14	1.19
	(2004-05)	0.47	0.43	0.40	0.43	1.41	1.39	1.09	1.30
JGK-1	(2003-04)	0.37	0.55	0.44	0.45	0.85	1.61	0.41	0.95
	(2004-05)	0.51	0.52	0.32	0.45	0.76	0.76	0.35	0.62
JGK-3	(2003-04)	0.41	0.47	0.48	0.45	0.86	0.91	0.47	0.75
	(2004-05)	0.44	0.41	0.29	0.38	0.43	0.44	0.48	0.45

(2007) and Rao *et al*.(1999). Among different chickpea types *Gulabi* and *Desi* showed better efficiencies compared to *Kabuli* type during both the years.

From the present study it can be concluded that sowing of chickpea varieties of *Desi* or *Gulabi* types can be done during the SM week No. 45 to 47 (10-25 Nov) in Jabalpur region of Madhya Pradesh based on thermal indices and thermal use efficiencies for getting higher productivity and stable production.

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