Journal of Agrometeorology 20 (3) : 244-245 (September 2018)

Short Communication

Thermal requirement of small millets in Chhattisgarh plateau under rainfed cropping situation

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Small millets (finger millet, kodo millet and little millet) are a thermo-sensitive crops. Temperature is a major determinant for its growth and productivity. Late sowing of small millets in rainfed faming system exposes pre-anthesis phenological events to prevailing temperature that influence grain development and ultimately the yield (Nagarajan *et al.*, 2008). Phenological development from sowing to maturity is related to accumulation of heat units above threshold or base temperature. A quantified value of heat units is required to reach a particular phenophase. Physiological and morphological development in plant is influenced by various meteorological factors. During growth and development of a cereal crop several growth stages are distinguishable in which important physiological processes occur (Sikder, 2008). Air temperature based agromet indices, *viz*., growing degree days (GDD), photothermal units (PTU), heliothermal units (HTU), phenothermal index (PTI) have been used to describe changes in phenological behaviour and growth parameters (Kumar *et al.*, 2010). Various workers have worked out the heat unit requirements of different crops viz. rice (Jayapriya *et al*, 2006), wheat (Prasad *et al*, 2017), and Okra (Dhankar and Singh, 2013). The present study was planned to work out the heat unit requirement of different rainfed small millets for Bastar plateau of Chhattisgarh.

A factorial experiment was laid at the S.G. College of Agriculture and Research Station, Jagdalpur during the *Kharif* season of 2012 and 2013. The treatments included two sowing dates in factor A (D1: June 15 and D2: June 30) and three methods of sowing (M1: Line sowing, M2: Broad casting and M3: Transplanting) in factor B. The cultivars GPU 28, JK 155 and JK 8 were used as test varieties for finger millet, kodo millet and little millet, respectively. The phenological stages of the crops were recorded by visual observations. Growing degree days were calculated by simple arithmetic accumulation of daily mean temperature above the base temperature value of 10°C considered for the small millets. The different indices viz. growing degree days (GDD), heliothermal unit (HTU), photothermal unit (PTU) and photothermal Index (PTI) were calculated as used by Singh *et al.* (2015).

The finger millet and little millet took 3-4 days to emergence whereas kodo millet took 8-10 days. Early (15th June) sown crops acquired less days as compared to late sown (30th June) small millets. Physiological maturity also differed remarkably by 5-9 days with two sowing dates. The little millet took shortest days (71-73 days) for its physiological maturity followed by kodo millet (107-112 days) and finger millet (120-129 days).

Tables 1 shows that the lowest GDD requirement for maturity was 1794-1848 degree days in little millet and highest (3057-3164 degree days) was observed in finger millet. The requirement of heat unit was higher for late sown crop than early sown crop due to longer period for all the phenological stages in the late sown crop. The early sowing decreased the duration of phenophases which caused a decrease in agroclimatic indices during various phenophases and forced the crop to attain proper maturity. This decline in agroclimatic indices accumulation was due to prevailing low temperature during vegetative phases and high temperature during reproductive phases of development in late-sown crop.

The accumulated heloithermal units (HTU) taken from the date of sowing to maturity presented in Tables 1 shows that different phenological stages of small millets required different heliothermal units. Finger millet, kodo millet and little millet took accumulated HTU of 24456-25309, 21801-22748 and 14349-14784 units respectively for their maturity.

The accumulated photothermal units (PTU) taken from the date of sowing to maturity also differed with dates of sowing and crop. The lowest accumulated PTU was with little millet followed by kodo millet and highest with finger millet. Late sown crop acquired higher PTU than early sown crop. Similar results have been reported by Pal *et al.* (1996).

Table1: Crop phenology, AGDD, APTU and AHTU for small millets crop sown on 15& 30 June (Mean over two year)

Phenophases	Phenology (DAS)			AGDD (^{0}C day)			AHTU (^{0}C day hr)			APTU (^{0}C day hr)			APTI (^{0}C day hr)		
	FM	KM	LM	FM	KM	LM	FM	KM	LM	FM	KM	LM	FM	KM	LM
15 June sowing															
Emergence	3	8	3	91	227	91	182	453	183	1211	3012	1211	25.9	26.6	25.9
Jointing	30	32	23	792	840	615	3169	3359	2458	10506	11133	8161	8.6	7.0	9.2
Flag leaf	55	43	37	1383	1105	964	6917	5523	4822	18195	14595	12768	4.2	2.7	4.0
Heading	69	63	47	1742	1595	1200	10453	9572	7201	22777	20905	15838	1.8	3.4	2.6
Physiological maturity	120	107	71	3057	2725	1794	24456	21801	14349	38686	34767	23407	3.9	3.4	2.1
30 June sowing															
Emergence	4	10	4	123	284	123	246	569	246	2827	4894	2423	26.81	26.72	26.41
Jointing	33	35	25	837	873	650	2510	2618	1951	16026	13880	11687	7.80	6.36	7.81
Flag leaf	58	47	41	1460	1184	1024	8760	7103	6143	20717	18545	14118	4.76	3.40	4.56
Heading	71	66	49	1797	1666	1236	12576	11665	8655	24861	23992	17116	1.83	3.13	3.29
Physiological maturity	129	112	73	3164	2844	1848	25309	22748	14784	46211	39840	26204	2.56	3.36	1.41

* FM=Finger millet, KM = Kodo millet and LM = Little millet

Phenothermal index (PTI) from sowing till maturity was influenced by the combination of growing conditions and crops (Table 1). All the small millets had higher PTI up to tillering. Early sown crop showed higher PTI compared to late sown crops. Under two sowing dates (June 15 and June 30), the finger millet had the highest PTI (26.81 in emergence) followed by kodo millet in emergence (26.72), whereas little millet had lowest PTU in emergence (26.41) under late sown condition, similar trend was observed in early sowing.

Hence, it can be concluded that the finger millet had longer phenophases, more GDD, PTU and HTU requirement for different phenophases than kodo millet and little millet irrespective of sowing time. The timely sown crops performed better in terms of accumulation and utilization of heat units at Bastar plateau of the state as indicated by the meteorological condition prevailed during the crop season.

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Received : July 2017; Accepted: July 2018