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Short Communication

Seasonal changes in soil temperature within mustard crop stand

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Soil temperature of any agroecological region is an important soil indicator not only because of its influence on crop establishment, growth and root activity but also significantly contributing to other essentially important soil processes (Riley, 1957; Wang, 1962; Gupta, 1986). The geochemical processes of nutrient release and movement, water movement, organic matter decomposition, microbial and enzymatic activity are significantly influenced by soil thermal regimes. It is thus the surface as well as root zone soil thermal regime that are actually governing a number of chemical, physiological and physiochemical processes occurring within the soil (Gosselin and Trudel, 1986; Cabrera and Boyd, 1990) . However, soil temperature is also significantly influenced by other soil parameters and that of weather parameters particularly rainfall, air temperature and solar radiation. In arid and semi-arid regions, apart from soil moisture, soil temperature plays a vital role in crop establishment. Therefore how soil temperature is changing over the season in both the surface and root zone soil are of immense important from view point of its dynamics within soil and quantification of its relationship with crop's biophysical variable are also needed (Cable, 1969; Gupta, 1983).

Normally mustard is grown during winter season from October/November to February/March under rainfed conditions. However, precipitation may occur during winter season in northern and north-western parts of the country as western disturbances causing a change in prevailing hydrothermal regimes. Apart from two recommended irrigation at flowering and pod developmental stages (critical stages), the crop may also suffers from moisture and temperature stress within the phenophases particularly during maturity stages when temperature significantly increased as compared to flowering stage. Thus, there is a need to have thorough understanding of the seasonal behaviour of soil temperature and its relationship with crop growth parameters.

The experiment was laid out in the experimental research farm of Indian Agricultural Research Institute, New Delhi with two cultivars of *Brassica juncea* viz., Pusa Jaikisan and BIO169-96 grown during two consecutive seasons of 2005-07. The cultivars were sown at 15 days interval from 15th October i.e. 15th October and 30th October in both the years. The experiment was laid out in a randomized block design with three replications in a 5 m x 5 m plot. Apart from pre-sowing irrigation, two irrigations of 50 mm each were applied at two critical stages, namely, flowering and pod developmental stages. The total amount of rainfall received during the two crop seasons were 26.0 mm (in 3 days) and 18.4 mm (in 6 days), respectively.

Surface and root zone soil temperatures were measured at 5 and 15 cm soil depth using platinum resistant thermometers. Digital logger was used to record the temperature. The instrument was continuously recording soil temperature. However to avoid over parameterization and lag time of soil temperature with depths, weekly average soil temperature was reported at morning (1130 hrs) and afternoon (1430 hrs) hours. This weekly average soil temperature was then cumulated over weeks to determine the soil heat accumulation;

Cumulative soil heat =

$$\sum \{(\text{Soil temp}_{max} + \text{Soil temp}_{min})/2 - \text{Soil temp}_{base}\}$$

Soil base temperature of 5^{0}C was taken.

Average soil temperature during both the seasons was (Table 1)) observed to be differing between the season and among the treatments. The average surface and root zone soil temperatures ranged between 10-23^{0}C in two seasons however, they varied in their magnitude differently over the seasons. Normally first season showed marginally higher soil temperature as compared to second season. The average surface soil temperatures decreas from 17-18^{0}C during emergence to 10^{0}C at about 82 days after sowing which coincided with the pod developmental stages. The temperature again increased with the advancement of summer months and the values reached up to 22^{0}C. In case of root zone depth, soil temperature also decreased up to the value of 11^{0}C and again increased to the value of 23^{0}C at maturity stage. When the average soil temperature was compared up to maximum leaf area index (95 days after sowing), it was found that the soil temperature was slightly higher in the

Table 1: Average surface (5 cm depth) and root zone soil temperature (^{0}C) (15 cm soil depth) during the crop growing

15th October sowing					30th October sowing				
DAS	2005-06		2006-07		DAS	2005-06		2006-07	
	Pusa Jaikisan	BIO169-96	Pusa Jaikisan	BIO169-96		Pusa Jaikisan	BIO169-96	Pusa Jaikisan	BIO169-96
Average surface soil temperatures (^{0}C)									
33	18.2	18.3	18.2	17.6	18	18.7	18.7	17.3	17.2
40	17.3	18.1	17.9	17.5	25	17.5	17.5	17.0	16.6
47	13.1	13.1	16.5	17.4	32	13.4	13.4	16.0	15.9
54	14.2	13.8	15.0	16.0	39	14.6	14.6	15.3	14.7
61	12.2	12.1	13.9	14.8	46	12.7	12.7	14.3	15.0
68	11.1	11.1	12.9	13.7	53	11.7	11.5	13.6	14.5
75	12.2	11.6	12.2	12.5	60	13.0	12.5	12.4	12.7
82	10.0	10.2	10.7	13.5	67	10.4	10.4	11.3	13.0
89	11.3	12.0	9.9	14.0	74	12.0	12.0	10.2	13.4
96	13.5	14.1	10.8	13.6	81	14.9	14.9	11.0	12.7
103	11.9	12.1	11.7	14.8	88	12.8	12.8	11.8	14.2
110	16.2	15.9	14.6	16.7	95	16.0	16.0	15.9	14.7
117	17.9	15.7	20.0	18.6	102	16.2	16.6	20.4	16.9
124	21.2	19.3	20.5	20.3	109	19.6	19.9	20.4	16.9
131	22.8	20.3	21.8	21.3	116	20.6	20.6	22.0	19.7
Average root zone soil temperatures (^{0}C)									
33	19.3	19.9	18.0	17.9	18	21.1	21.1	20.2	20.3
40	18.5	18.8	17.9	17.5	25	19.5	19.5	19.3	18.9
47	15.4	15.0	16.8	16.7	32	15.2	15.2	16.7	16.9
54	14.9	14.9	15.3	16.0	39	15.4	15.4	16.9	16.1
61	12.9	12.7	14.5	15.3	46	13.9	13.9	14.9	15.0
68	11.5	11.3	12.8	13.8	53	11.9	11.9	12.6	14.2
75	12.9	12.7	12.2	12.8	60	12.6	12.6	13.6	13.5
82	11.9	11.4	10.9	14.2	67	11.7	11.7	12.3	13.2
89	11.9	11.8	10.3	14.7	74	11.6	11.6	11.2	14.0
96	14.1	14.1	10.4	13.8	81	13.7	13.7	12.3	13.8
103	11.9	11.5	12.7	14.7	88	11.9	11.9	12.6	14.6
110	14.5	14.0	15.6	16.4	95	13.8	13.8	16.4	15.7
117	18.2	14.7	19.6	18.1	102	14.8	15.6	19.9	17.3
124	20.9	20.1	20.4	19.4	109	19.8	19.8	20.5	18.1
131	23.2	21.0	21.5	20.8	116	20.8	20.8	22.2	19.1

second season as compared to first season at the surface soil irrespective of cultivars and sowing dates. In contrast, at root zone soil depth the average soil temperature was higher during entire crop phenological stages indicating prevalence of differential soil thermal regimes during these two seasons.

Soil temperature varied by the interaction effect of sowing dates, seasons and treatments in both the cultivars. In order to have the compounded effect of all the treatments and to reduce error, pooled data were used to quantify cumulated soil temperature. The average soil temperature was cumulated during the crop growing period (from 20 to 140 days after sowing) and the observed value ranged between 20-200^{0}Cd; with increasing trend from emergence to maturity. The progressive change in cumulative soil temperature was predicted as a function of time i.e. $f(t)$ using linear regression analysis and it was found that around 88-93% variations at surface and root zone soil depth temperatures in both the seasons may be attributed to time variations (Fig 1).

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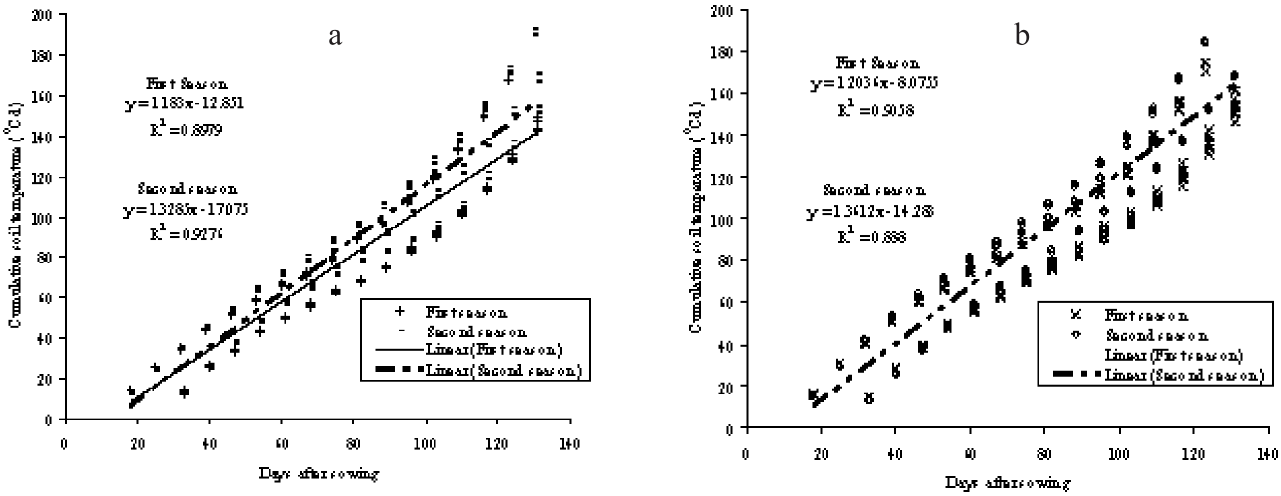

Fig. 1: Correlation between cumulative soil temperatures with the time function (days after sowing) at surface (a) and root zone soil depth (b) respectively

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