

Evaluation of safe periods for germination of a few vegetable crops

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ABSTRACT. Soil temperature is an important critical factor for germination of vegetable seeds. Utilising daily soil temperature data recorded on the sandy loam soils of Delhi for 16 years from 1955-70, a method has been described to delineate favourable periods for seed germination of cabbage, carrot, onion and peas varieties of varied tolerance to unfavourable soil temperature. It is suggested that by following suitable agronomic practices like irrigation and mulching, the seedling periods could be extended by a few weeks.

1. Introduction

The temperature of the soil is one of the most critical factors of the environment which exerts a profound influence in controlling plant growth throughout the growing season. It also influences soil moisture movement, aeration, microbial and enzyme activity, the decomposition of plant residues and the availability of nutrients to the plant. It affects plant growth first during the germination of seeds for which it is necessary that the soil temperatures remain above a critical limit corresponding to the requirements of the given plant. In the present study, the variation of soil temperature in the Kharif and Rabi seasons at Delhi in relation to the critical temperatures of seed emergence of vegetables has been discussed. Frequencies of continuous 7 and 3 day periods of occurrence of certain critical temperatures have also been presented and discussed.

2. Material and Methods

Soil temperature data for 16 years (1955-70) at 5 and 15 cm depths for Indian Agriculture Research Institute (IARI) station, New Delhi were utilized to determine the range of temperature at various depths in the Kharif and Rabi seasons and to delineate from the data relating to the 5 cm depth the favourable weeks for seed germination for a few vegetables namely cabbage, carrot, onion and peas. Analysis was carried out to locate the weeks in which critical soil temperatures prevailed for continuous periods of 7 and 3 days at a time in different seasons of the year. Standard weeks listed by India Meteorological

Department for agro-climatic work have been followed for this analysis.

The critical soil temperatures and threshold values for seed germination of cabbage, carrot, onion and peas as reported by Wang (1967) are shown in Table 1. Daily soil temperature data recorded at 0700 LMT (Local Mean Time) and 1400 LMT for each of the years 1955-70 at 5 cm depth were analysed to identify the weeks in which critical temperatures prevailed (i) consecutively on 3 days or more in a week, (ii) continuously on all 7 days in a week above or below any given threshold value. These two consecutive periods of 3 and 7 days have been chosen to see if there would be any significant difference in the length of the favourable periods for germination of seeds between these two intervals of analysis as the seeds generally take 3 to 7 days to germinate. A week has been considered favourable when temperatures remained within the threshold values for atleast 11 out of 16 years (70 per cent of the period considered for the analysis). The analysis was carried out for the different threshold values shown in Table 1.

3. Soil temperatures on bare sandy loam soils of Delhi during Kharif and Rabi seasons

Analysis of soil temperature data for Delhi (IARI farm area) revealed that the maximum temperature at 5 cm depth during very low rainfall periods remains around 40°C and when the monsoon rains are active, it drops down to a value of about 30°C. The extreme of soil temperature

TABLE 1
Critical soil temperatures ($^{\circ}\text{C}$) for vegetable seed germination

Vegetable	Lower		Optimum	Upper	
	Lethal	Threshold		Threshold	Lethal
Cabbage	0.0	4.4	7.2-35.0	37.8	—
Carrot	-1.1	4.4	7.2-29.4	35.0	—
Onion	0.0	1.7	10.0-35.0	35.0	37.8
Peas	2.2	10.0	15.6-29.4	35.0	—

TABLE 2 (a)

Average soil temp. ($^{\circ}\text{C}$) during Kharif sowing season

Depth (cm)	Time (LMT)	Jun 15	Jul 15	Aug 15
5	0700	32	29	27
	1400	43	37	34
15	0700	34	31	28
	1400	38	35	32

TABLE 2 (b)

Average soil temp. ($^{\circ}\text{C}$) during the Rabi sowing season

Depth (cm)	Time (LMT)	Oct 15	Nov 1	Nov 15	Dec 15	Jan 15
5	0700	21	16	13	9	8
	1400	32	29	26	21	19
15	0700	22	19	15	12	10
	1400	27	24	21	17	16

in degrees centigrade during the main Kharif and Rabi sowing seasons at 5 and 15 cm depths are given in Tables 2 (a) and 2 (b).

During the Kharif season the diurnal range of soil temperature at 5 cm depth is of the order of 7° to 11°C whereas at 15 cm depth, it is about 4°C . The difference in temperature between 5 and 15 cm depths both at maximum and minimum epochs of the day is about 20°C after the onset of the southwest monsoon. Just before the onset of the monsoon, however, the difference at 1400 LMT is of the order of 5°C which clearly reveals the effect of moist conditions on the behaviour of soil temperature.

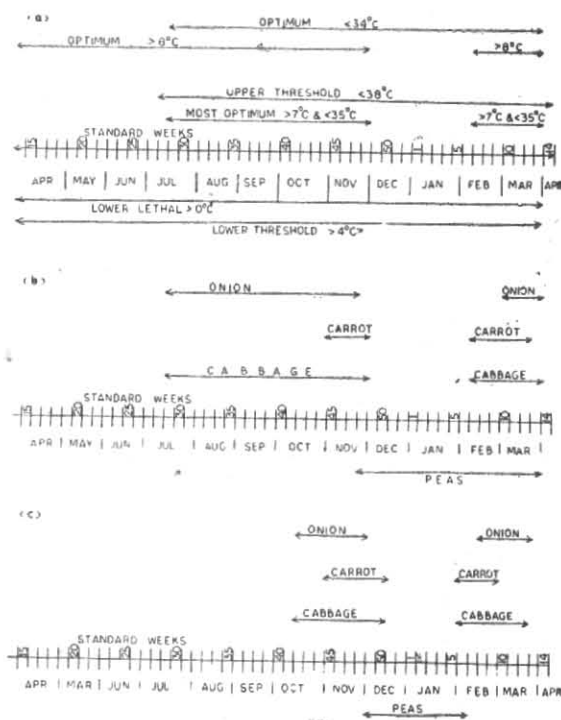


Fig. 1

- (a). Favourable weeks for seed germination of cabbage (7-day method)
 (b and c). Most optimum periods for germination of vegetable seeds (7-day and 3-day method)

During the Rabi season, the diurnal range at 5 cm depth is 12°C whereas at 15 cm depth, it gets damped to 5° to 6°C . The difference in temperature between 5 and 15 cm depths at the minimum epoch of the day is of the order of 2° to 3°C whereas at the maximum epoch, it increases to 5°C .

In carrying out the analysis the emphasis in the Kharif season was on the soil temperature exceeding the upper limit of the optimum range while in the Rabi season, the aim was to see if the soil temperature dropped down below the

TABLE 3
Frequency of occurrence of soil temperature at 5 cm depth
(a) Kharif Season

	Number of years of occurrence in 16 years at week ending on									
	17/6	24/6	1/7	8/7	15/7	22/7	28/7	5/8	12/8	17/8
Temperature > 34°C for 3 consecutive days (1400 LMT)	15	16	16	16	12	10	13	8	9	5

(b) Rabi Season

	Number of years of occurrence in 16 years at week ending on									
	18/11	25/11	2/12	9/12	16/12	23/12	31/12	7/1	14/1	21/1
Temperature > 4°C for 3 consecutive days (0700 LMT)	16	16	16	16	16	16	16	16	16	15

TABLE 4
Favourable weeks for the most optimum germination

Vegetable	7-day period	3-day period
Cabbage	Mid. July to end of November and February to March	Mid-October to mid-December and February to 3rd week of March
Carrot	November to 1st week of December and second week of February to 3rd week of March	November to mid-December and February
Onion	Mid July to 3rd week of November and March to 1st week of April	Mid-October to November and mid-February to mid-March
Peas	Last week of November to March	December to January

lower limit of the optimum range. As maximum and minimum values at 5 cm soil depths are reached at about 1400 and 0700 hr local mean time, respectively, these values were examined in Kharif and Rabi crop periods. An illustration relating to cabbage is given in Tables 3 (a) and 3(b) which show the number of years of occurrence in 16 years (i) of temperatures greater than 34°C for 3 consecutive days in the Kharif season at maximum epoch and (ii) temperatures greater than 4°C for 3 consecutive days during Rabi season. These limits correspond to the highest optimum and lower threshold temperatures for germination of cabbage. Tables 3(a) and 3(b) show that even after the onset of the monsoon the temperatures at 1400 LMT during Kharif season reach 34°C or above for 3 consecutive days till the end of July. There was no occasion when morning temperatures (0700 LMT) at 5 cm depth remained

below 4°C continuously for 3 days in the Rabi season.

4. Safe periods for seed germination of vegetables

Weekly periods when optimum conditions prevailed in the different seasons, for continuously 7 days in respect of seed germination of cabbage, at different threshold values are shown in Fig. 1 (a). From this diagram, the most optimum period was obtained during which the temperatures remained favourable when all the threshold values, namely lower lethal, lower threshold, optimum, upper threshold and upper lethal temperatures mentioned in Table 1 are taken together into consideration. It is seen that for cabbage the most optimum period prevails from middle of July to November (29th week to 48th week) and middle of February to March (7th week to

13th week). Similar analysis was carried out for seven and three consecutive day periods (when temperatures remain at optimum level continuously for 7 and 3 days in a week) also for other vegetables, *viz.*, carrot, onion and peas. These are shown in Figs. 1(b) and 1(c) respectively and favourable weeks for the most optimum germination for vegetable seeds are shown in Table 4.

5. Discussion

This type of analysis is helpful in examining the feasibility of proposing and extending the seedling dates, provided certain precautions against flooding of seed beds, disease control operations are practised. For example, for cabbage between 49th and 6th week (*i.e.*, December to mid February) the temperatures remain below the optimum values but above the lower threshold value. It should be possible to utilize these periods also for seedling of cabbage by adopting agronomic practices like irrigation and mulching of the soil

surface to keep the temperatures above the lower threshold value or at the optimum level.

3-day analysis is based on the assumption on the analogy of drought tolerance experiments.

6. Summary

A method for analysing daily soil temperature for delimiting weekly periods when most optimum conditions prevail for germination of vegetable seeds has been described. It is suggested that by adopting suitable agronomic practices the seedling operations of cabbage can be extended towards July and continued till November. Factors other than soil temperature, like soil moisture have not been considered for purpose of this study since it is aimed at obtaining a climatologically favourable period for germination of vegetable seeds with specific reference to soil temperature in the top layers of the soil.

REFERENCE

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