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Seasonality in sprouting and growth of black pepper rooted cuttings under sub-Himalayan Terai region

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Black pepper is mainly propagated through cuttings obtained from runner shoots. The floral shoot is also used as propagation materials; however, it results in the production of bush pepper, losing its vine nature. Seedlings can also be raised from seeds but they lose viability quickly. Being a cross-pollinated crop, it is difficult to get true to the type planting materials from seeds. Hence, for commercial cultivation, planting material from runner shoot is used. As the global demand for this valuable crop is increasing, its area expansion is being taken up in both traditional and non-traditional areas of cultivation. In traditional areas, planting materials are produced throughout the year however, planting material production is restricted only in summer months in non-traditional subtropical areas since low temperature is the main limiting factor during winter months. Considering this, a study was conducted to understand the effect of climatic parameters on growth of black pepper cuttings and selection of suitable time/month(s) for raising of rooted cutting of this crop under sub-Himalayan terai region of India. Heat stress is often defined as where temperatures are hot enough for sufficient time that affects substantial development or, functions in plants (Warrag and Hall, 1984). Effective temperature affects the level of heat stress to which cuttings are exposed. Many environmental factors may influence effective temperature such as air temperature, humidity, rainfall (precipitation), air movement, solar radiation, presence of greenhouse gasses and so on. Several approaches to quantify heat stress have been proposed; those range from complex measures (Moran *et al.,*1994; Epstein and Moran, 2006) to simpler ones such as temperature-humidity index (THI). The THI measure estimates the level of heat stress by combining temperature and humidity information into a single indexing variable for a given period. The study was also emphasized on calculation of THI to see the optimum value of THI on production of good quality rooted cuttings of black pepper.

The experiment was conducted for three years during the year 2015 to 2017 at ICAR-Central Plantation Crops Research Institute, Research Centre, Mohitnagar, West Bengal. The area is located at 26°.31" N latitude and 88°.50" E longitude and the altitude of the experimental area is about 91.3 m above mean sea level. One-year-old runner shoots of black pepper cv. Panniyur 1 planted on arecanut as mixed crop was used for the experiment. Hardwood portion having two nodes of the vine was separated from the main runner shoot by using the stainless steel blade and were treated with carbendazim (Bavistin) @ 0.3 per cent for 10 minutes and kept overnight in room condition. Each node was placed in perforated poly bags of 10 × 15 (cm) of 200 gauge with few holes for drainage. Polybags were filled with a soil mixture of top soil, sand, and FYM at a ratio of 2:1:1. The soil was sterilized through solarization. The experiment was laid out in a complete

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Table 1. Statistical summary for experimental data of four months old black pepper raised cuttings

Month in which cuttings were planted	Days to First Sprout	Days to last sprout	Total sprout (%)	No. of Leaves	Leaf Length (cm)	Leaf Width (cm)	Vine length (cm)	No. of prim. roots	Length of prim. roots (cm)	No. of sec. roots	Good sprout (%)
January	67.7±2.52	91.7±1.53	70.0±17.32	2.3±0.20	9.5±0.50	6.7±0.10	4.1±0.25	5.4±0.12	12.6±0.32	15.33±1.53	0.0±0.00
February	29.33±4.04	59.3±4.04	100.0±0.00	3.4±1.00	17.0±0.50	7.9±0.10	23.0±4.94	10.3±0.25	21.8±1.71	22.0±2.00	43.3±20.82
March	15.7±0.58	34.0±1.00	100.0±0.00	8.2±1.72	18.0±1.00	8.2±0.25	40.7±7.07	15.2±0.25	31.5±1.5	31.7±1.53	96.7±5.77
April	4.3±0.58	21.7±1.53	100.0±0.00	7.7±1.82	17.6±0.53	8.5±0.25	43.1±7.18	11.3±0.25	25.6±2.3	25.7±1.15	60.0±17.32
May	5.0±0.00	20.7±0.58	100.0±0.00	4.1±1.28	11.7±1.53	7.2±0.25	30.8±2.33	9.2±0.25	24.5±0.50	23.7±1.53	60.0±20.00
June	9.3±0.58	25.0±1.00	100.0±0.00	4.0±1.00	12.5±0.50	7.6±0.17	27.8±3.21	7.2±0.21	27.1±3.00	27.3±0.58	36.7±28.87
July	8.3±0.58	21.7±0.58	100.0±0.00	5.2±0.44	15.8±1.04	8.2±0.20	25.0±3.82	9.2±0.38	26.2±1.10	24.7±1.53	40.0±17.32
August	11.0±1.00	28.3±0.58	90.0±0.00	3.7±0.31	15.5±0.50	6.6±0.20	20.1±1.30	10.2±0.25	27.8±2.16	29.0±1.00	56.7±15.28
September	8.7±0.58	29.7±3.51	83.3±5.77	3.4±0.21	13.8±0.76	8.8±0.29	19.7±1.15	8.0±0.10	32.6±0.86	24.7±2.31	40.0±0.00
October	11.0±1.00	30.3±3.51	86.7±15.28	2.2±0.46	14.3±0.58	7.7±0.21	8.6±1.65	7.3±0.26	26.5±0.61	24.7±1.53	0.0±0.00
November	49.0±1.00	134.0±3.61	76.7±11.55	1.9±0.51	14.7±1.53	6.9±0.15	4.8±1.35	8.1±0.21	25.3±2.96	24.3±2.08	0.0±0.00
December	69.7±1.53	119.3±7.02	33.3±15.28	1.7±0.29	10.2±0.25	6.9±0.35	5.1±1.50	5.1±0.66	12.9±0.64	13.0±1.00	0.0±0.00
MSE	**2.46**	**5.72**	**68.94**	**0.92**	**0.74**	**0.04**	**14.61**	**0.07**	**2.86**	**2.15**	**207.32**
CD –Val.	**2.66**	**4.05**	**14.06**	**1.62**	**1.45**	**0.34**	**6.47**	**0.45**	**2.86**	**2.48**	**24.38**

Note: Each value represent mean ± SD and Critical Difference (CD) Value is calculated based on t-value at 1% significance level with 22 error degrees of freedom (df).

randomized block design with three replications. In first week of every month, cuttings were placed in poly bags. A total of 100 polybags were used for each treatment and each replication. All the cuttings were kept in net house (6.0 m height) with 50 per cent green shade net cover. Observation on days to first and last sprouting and total numbers of sprout obtained were recorded for 100 cuttings. Twenty cuttings were randomly selected and observation on growth rate at monthly interval, number of leaves, leaf length and width, vine length at four months of cutting were recorded. Sixty cm vine length was used for planting in main field. The required height is usually achieved at 120 days (DASD, 2015). Hence final observation was recorded after 4 months. Weather data on minimum, maximum temperature, rainfall, and relative humidity were collected from District seed Farm (200 m away from the experimental site), Mohitnagar, Jalpaiguri, West Bengal.

For calculation of THI, the formula reported by Davis *et al*. (2003) as detailed below was used.

$$THI = (0.8 \times \text{mean maximum ambient temperature for a given period}) + [(\text{mean relative humidity percent for that given period} / 100) \times (\text{mean ambient temperature for that given period} - 14.4)] + 46.4$$

Correlation of mean temperature deviation, total rainfall received during four months and THI with different growth parameters of black pepper was also calculated by using Pearson's correlation (Kelley, 1947). Further, data analysis was carried out R-statistical package, version 3.5.0 (R Core Team, 2018).

Days to first and last sprouting, total sprout obtained, vine length, number of leaves, leaf length and leaf width, number of primary and secondary roots and length of primary root was recorded and exploration of a statistical summary of that experimental data is depicted in Table 1. It was observed by performing analysis of variance (ANOVA) that each growth parameter of four months old black pepper raised cuttings significantly differed between the months at one per cent significance level. It was found that fewer days were required for first sprouting of the cuttings when cuttings were planted during the summer months (March to October); however, it took more time during the cooler months *i.e.,* November to February. A similar result was also obtained in case of days to last sprouting. In November and December, it took more than 100 days for last sprouting. Hundred per cent sprout was obtained when it was planted from the months between February to July. Higher number of leaves, leaf length, and width, number of primary and secondary roots were recorded in cuttings planted during summer months. More number of leaves (approx. 8.2) was obtained from the cuttings planted in the month of March, while it was the lowest (approx. 1.7) in cuttings planted during December. More height (approx. 25 cm to 40.7 cm) was recorded during July and March. In the months of October to December, vine length was less. The number of primary roots was obtained maximum (approx. 15.2) from the cuttings of March and minimum (approx. 5.1) was recorded in cuttings of December. The percentage of good quality planting materials was obtained based on the vegetative growth like leaf number, leaf length and width, vine length and primary root numbers. From the experiment it was found that higher percentage of good quality vine was obtained when the cuttings were planted during March, April, and May months.

Considering the climates, it was observed that where the value of mean temperature deviation is less, the performance of growth parameters of black pepper cutting was good. It indicates that heat can play a major role in growth of black pepper. Based on the observation, THI was calculated considering the temperature deviation and humidity in subsequent four months. THI had a major role on days to first sprouting of the cutting. Less number of days were required for first sprouting of cuttings at higher value of THI which prevails during the month of April to September (Fig. 1). A similar result was also found in case of days to last sprout of the cutting (Fig. 2). More than 100 days was required for days to last sprouting when the THI was less than 73. With the increase of THI, the days to last sprout were decreased and it was maximum when the THI varied between 80-85. The total sprouting percentage was maximum (100%) in the cuttings placed from February to July at higher (78- 85) THI value (Fig. 3).

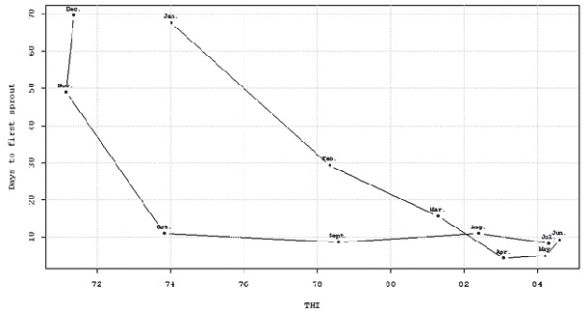

Fig. 1. THI and days to first sprout

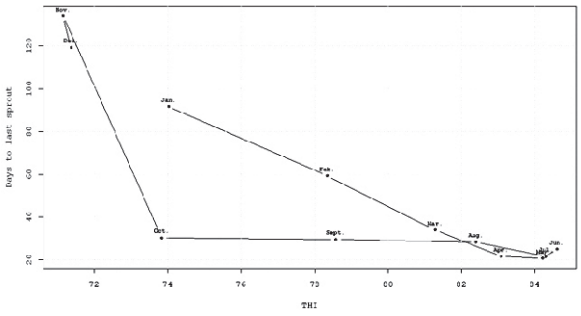

Fig. 2. THI and days to the last sprout

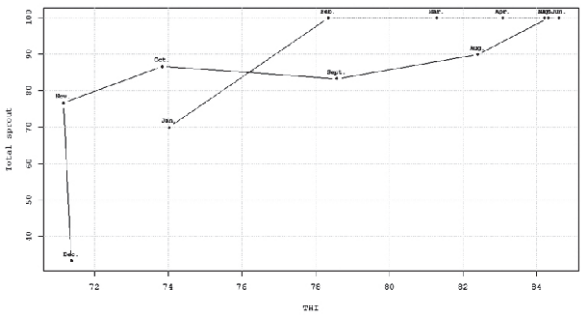

Fig 3. THI and the total number of sprouts

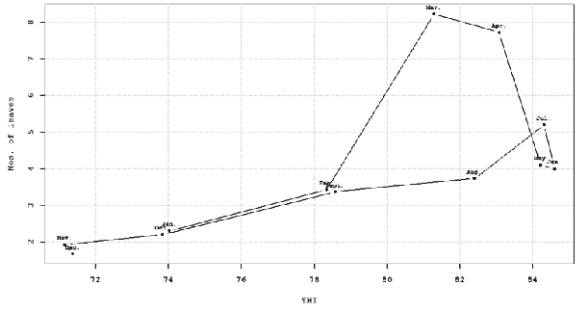

Fig. 4. THI and leaf production

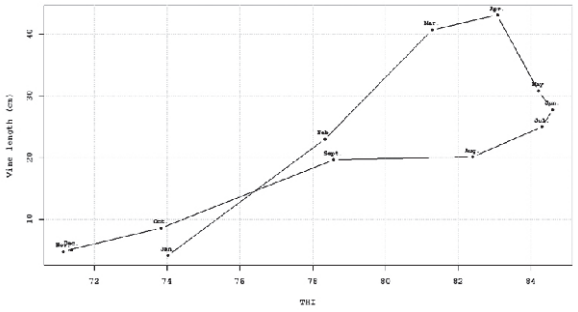

Fig. 5. THI and Vine length (cm)

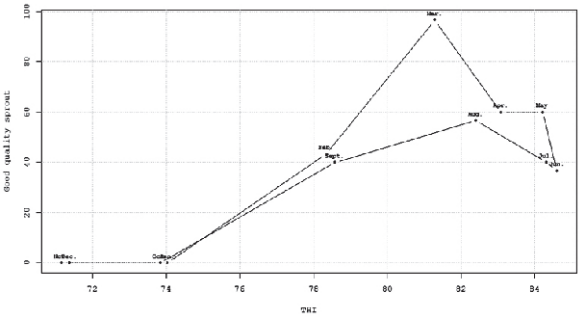

Fig. 6. THI and good quality cuttings

At a higher level of THI, higher values of leaf production were recorded (Fig. 4). It was maximum in cuttings prepared in March and April and gradually it decreased with the decrease of THI and found less number leaf in the month of November, where THI was only 65. The vine length was observed maximum at 80-82 THI level which prevailed during the month of March and April. The vine length was observed minimum (4-5 cm) in the month of November to December when the THI value was less. With the increase of THI value up to certain level, the vine length was also increased. It was also found that more than 82 THI, the vine length was started decreasing. The result indicates that the vine length depends on the optimum THI value. The vine length of black pepper is being influenced at both sub-optimal and supra-optimal THI values. A similar type of result was also found in case of good quality planting materials (Fig. 6).

Correlation of temperature fluctuation, total rainfall received during the experimental period and THI with different growth parameters were also calculated. It was found that vine length, days to first sprout, sprouting duration, total sprout obtained, length of primary and secondary roots of

cuttings were highly correlated with temperature fluctuation. Vine length, days to first sprout and total sprouts obtained were correlated with temperature fluctuation. All the growth parameters were highly correlated with THI except leaf and root parameters.

Based on the study, it is concluded that mean temperature deviation and humidity play a major role in growth of black pepper during the raising of black pepper cutting. It is also concluded that March and April months at sub-Himalayan humid Terai region of India is the best time to get good quality planting materials of black pepper through cuttings of runner shoots.

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