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# Effect of temperature on seed germination and emergence of *Salvia plebeia* R.BR. In vindhyan region climatic condition

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**Abstract**
The temperature of the air around plants has a big effect on how they grow and develop. The *Salvia plebeia* R.Br. plant is sensitive to temperature and grows best in mild climates. Its original habitat is above 2,000 meters above sea level, but it has been successfully planted as a winter crop in subtropical plains. In subtropical climates, seed growth rates changed depending on the temperature. A study was done using the laboratory incubation method to look at how seed germination and emergence change when the temperature changes. Every day, changes in temperature from 5°C to 30°C, with 5°C steps, were used to see how they affected the germination and appearance of seeds. The study found that temperature had a big effect on how quickly *Salvia plebeia* R.Br. seeds sprouted and grew. At 25°C, seeds grew the most (78.48%), then at 20°C (74.41%), and then at 15°C (65.77%). At 5°C, they grew the least (2.31%). Similarly, the first seed to sprout took four days at 25°C. For this reason, it was decided that the best temperature range for *Salvia plebeia* R.Br. seeds to germinate is from 25°C to 15°C, with 25°C being the hottest and 15°C being the coolest.

**Keywords:** *Salvia plebeia* R.Br, temperature, seed germination, emergence, sub-tropical climate

## Introductions
*Salvia plebeia* R. Br., also called clary or clary sage, is a leafy plant that grows every two years, perennially, or for a short time. It is in the genus *Salvia* and the Lamiaceae family. It mostly spreads through seeds. Clary sage has been grown since ancient times for its essential oil, as an ornamental plant, and for its healing benefits. A plant called *Salvia plebeia* R.Br. grows wild in southern Europe and central Asia. Russia, Bulgaria, France, and Morocco all grew it for business reasons (Chand *et al.* 2015) [1].The crop grows best in temperate and sub-temperate climates, and it makes about 150 metric tons of oil every year (Anonymous, 2005 and Yaseen *et al.* 2014) [2, 3]. India only makes a small amount of essential oils in the Kashmir valley (Yaseen *et al.* 2014) [3]. Because of this, most of India's essential oils are brought in from other countries. The phyto-compounds in them can be used as medicine because they are antioxidants, kill germs, and kill cells. Essential oils and the whole herb are used to add flavor to food, make perfumes, treat illnesses, and make things smell nice (Tadtong *et al.* 2012) [4]. Linalool and linalyl acetate are the main parts of the oil. They are taken from the salvia plant's flower buds. Because it matures slowly, it couldn't be used in regular farming methods or with seeds that need a certain temperature to germinate.
Temperature is the most important external factor that affects plant growth and development, as it is the most important factor for germination (Heidari *et al.* 2014) [6]. Depending on the temperature (optimum), different crops have different sprouting and emergence rates. You can find out how temperature affects the germination and emergence of crop seeds by finding the cardinal temperature. This lets you know how different crops will react to low and high temperatures and what weather conditions will help them germinate and grow (Koger *et al.* 2004) [7].
Some information is missing about how *Salvia plebeia* R.Br. seeds germinate and grow at different temperatures. The current study is therefore related to the process of seed germination and emergence of *Salvia plebeia* R.Br. when many factors are managed, especially temperature.

## Materials and Methods

**Seed source:** *Salvia plebeia* R.Br. seeds were gathered from the experimental farm of the Agronomy Department of Agriculture College Rewa (M.P.). That plant's seeds were circular, and 1000 of them weighed 3.27 grams.

### Temperature regimes

During the germination and emergence tests, the temperatures in the incubators stayed the same. They went from 5°C to 30°C (5°C, 10°C, 15°C, 20°C, 25°C, and 30°C) with 5°C increases in the control condition. Set the seed germinators to the temperature that was given above, and then put the Petri dishes in them. All of the tests were kept warm for 14 days, or 336 hours. In all of the tests, the seeds were always in the light. Each process was done three times, with three hundred seeds each time. In controlled incubators, the copies were put in blocks that were totally random.

### Germination study

When the cotyledons were visible, it was considered that seeds had emerged and radicle had protruded (Heidari *et al.* 2014 & Maraghni *et al.* 2010) [6, 8]. When the fungal growth appeared in seeds, it was immediately removed from the population. The germination was calculated according to the following formula (ISTA, 1999 and Czabator, 1962) [9, 10].

[Germination (%) = (Number of germinating seeds/ number of seeds) × 100]

Germination associate parameters were calculated by using following formulas:

### Speed of germination

Speed of germination was calculated by the following formula given by (Ellis & Roberts, 1981) [11].

$$[\text{Speed of germination} = \sum\left(\frac{n_1}{d_1} + \frac{n_2}{d_2} + \cdots \frac{n_x}{d_x}\right)]$$

Where, n = number of germinated seeds, d= number of days

### Mean germination Time (MGT)

Mean germination time was calculated by the formula given by Larcher (1996) [12].

$$[MGT = \frac{\sum(n \times d)}{N}]$$

Where, n= number of germinated seed, d = number of days, and N= total number of seeds germinated at the termination of the experiment.

### Mean daily germination (MDG)

Mean daily germination can be calculated by the following formula given by Ellis and Roberts (1981) [11].
[MDG = Total number of germinated seeds/ Total number of days]

### Peak Value (PV)

Peak value was calculated by the following formula given by Ellis and Roberts (1981) [11].
[PV = Highest seed germinated/ Number of days]

### Germination Value (GV)

Germination value was calculated by the following formula given by Ellis and Roberts (1981) [11].

[GV = PV X MDG]

### Statistical analysis

Data (n=3) were analyzed using SPSS 20 software package for Windows and subject to one -general linear model ANOVA (analysis of variance). The Duncan's test was used for post-hoc comparisons to determine difference between means at $p \leq 0.05$ level of significance.

## Results and Discussion

There was a wide range of temperature changes that affected the germination of seeds. In the same way, the seeds of *Salvia plebeia* R.Br. had a significant effect on the temperature changes shown in Fig. 1. The highest germination rate was found at 25°C (78.18%), followed by 20°C (74.41%) and 15°C (65.77%). The lowest rates were found at 5°C (2.31%). Similarly, the germination rate showed that the first seed to sprout appeared after four days or 96 hours at 25°C, then after seven days or 168 hours at 20°C and eight days or 192 hours at 15°C. At 5°C, it took the longest time of 14 days or 336 hours for the seed to sprout. The study's results showed that salvia seed development is temperature-dependent and changes when the temperature changes. At 5°C, almost no germination happened because the seed didn't sprout at that low of a temperature, and the percentage of germination kept going down as the temperature dropped.

A lot of difference was found in different factors related to seed germination at different temperature ranges, just like with germination percent. The rate at which *Salvia plebeia* R.Br. seeds sprouted was very fast at 25°C (11.1°) and very slow at 5°C (0.15). Even so, the average daily germination rate was best (5.63) at 25°C and lowest (0.17) at 5°C. Both the daily germination rate and the rate of germination were statistically different when the temperatures were different. The average time it takes for seeds to germinate at different temperatures ranges from 7.63 hours at 25°C to 14 hours at 5°C. The differences between the temperatures were statistically very significant. Based on these results, the temperature at which there was the most germination was 25°C, and the temperature at which there was the most mean germination time was 5°C. In this study, it was found that the best temperature for seed development in *Salvia plebeia* R.Br. was between 25°C and 15°C.

Temperature plays a big part in seed sprouting because it is one of the most important factors that controls how plants grow physiologically. However, weather has a very different effect on each stage of the germination process. This means that other things must also be taken into account. Some seeds will take a long time to sprout if it is too cold, and seeds will also take longer to grow if it is too warm. Too much heat will make the seeds take a long time to sprout. When it is far too hot or too cold, seeds don't grow. By looking at information about temperature patterns, it was found that temperature affected the sprouting of Salvia plebeian R.Br. seeds and that 25-15°C is the best temperature range for subtropical climates. Taking these temperature ranges into account, October and November are good months for seeds to sprout. The species or type of seed determines how hot it needs to be for the seed to sprout.

Based on the last study (Senel *et al.* 2007) [13], reported that the suitable temperature for germination and development of plants in the tropical region are at 15°C to 30°C; plants in the temperate region germinate at 8°C to 25°C; and alpine plants germinate at 5°C to 30°C. With the confirmatory of present investigation results, Oberczian and Bernath (1988) [14] also mentioned in the study that, *Salvia dicroantha* R.Br. germinated at the highest rate at 20°C. Researchers Zutic and Dudai (2008) [15], found that the optimal temperature for *S. plebeia* was 15-20°C in temperate conditions when evaluating the effect of 12 temperature treatments (between 5 and 40°C) on germination in light (12 h) and darkness on *S. officinallis* and *S. plebeia*. Changing day/night temperatures of 30°C/20°C were as effective as a constant 25°C for *S. officinalis*, but they were less desirable for *S. plebeia* than a consistent 15-20°C. From the previous studied (Gairola *et al.* 2012) [16] the germination of 5-year-old *S. officinalis* seed at temperatures of 20, 25, and 30 degrees Celsius under continuous light or in the dark, and discovered that the highest rate of germination (63 percent) was achieved at 25 degrees Celsius with continuous light.

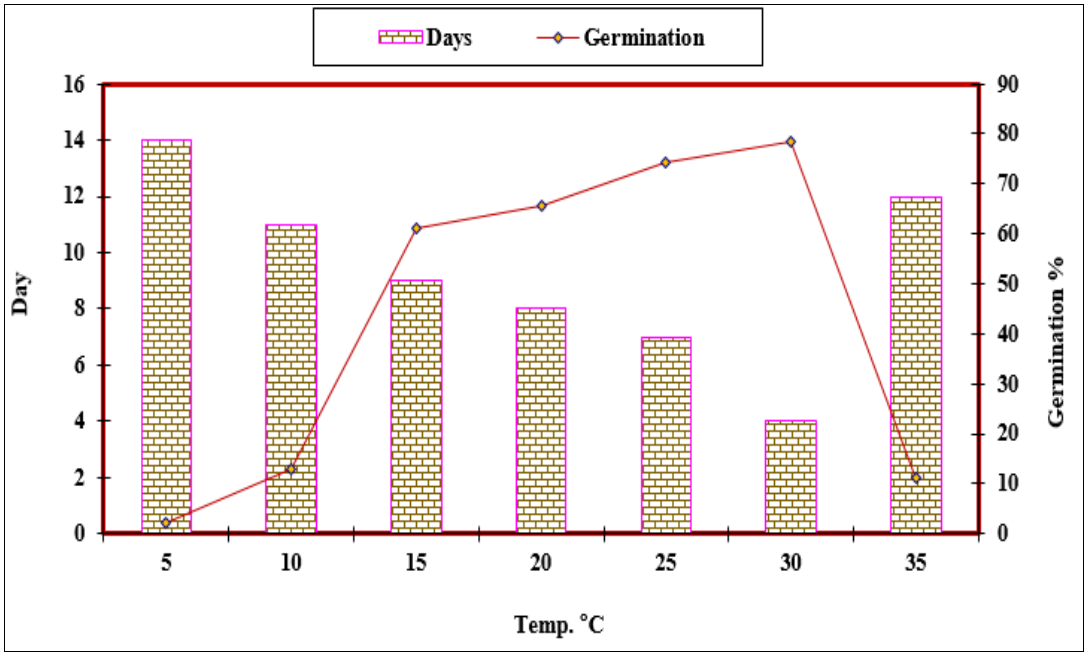


**Fig 1:** Effect of temperature on seed germination and emergence of Salvia sclarea R.Br.

## Conclusion

Several environmental factors affect the germination of seeds, but temperature is the most important one. It's important for the growth and progress of seedlings, which in turn affects the end production of the salvia crop. The expert needs to find the best temperature for salvia seeds to germinate and grow leaves. Based on this study, it is clear that the best temperature for maximum germination rate and speed of germination was 25°C, while the best temperature for mean germination time was 5°C. It can be concluded from the tests that the best temperature for salvia seed germination was between 15°C and 25°C. With this new information, it can also be said that October and November are the best months for farmers in subtropical parts of India to plant crops.

- An ambient temperature is necessary for regulating plant growth.
- *Salvia plebeia* R.Br. is a temperature sensitive crop and prefers temperate climatic conditions.
- Assessment of suitable temperature for germination and emergence of seed in sub-tropical climatic conditions is required for proficient cultivation of the crop.
- October-November months are most favorable for seed germination in sub-tropical climatic condition.

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