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RESEARCH

A STANDARDIZED MEASURE FOR GERMINATION OF KALMEGH (*ANDROGRAPHIS PANICULATA*) SEEDS UNDER DIFFERENT TEMPERATURES CONDITIONS

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Abstract: Kalmegh (*Andrographis paniculata* Wall. ex Nees, Acanthaceae) stands out as a prominent indigenous medicinal plant, often referred to as the "King of Bitters." Renowned for its therapeutic properties, Kalmegh extract is utilized in the treatment of various ailments, including jaundice, dermatological and anthelmintic disorders. It also serves as an antibacterial, anti-malarial, anti-inflammatory, anti-thrombogenic, and blood purifier. Given that Kalmegh is propagated through seeds, assessing seed quality becomes imperative to ensure successful crop stand and herb production, both of which hinge on the use of high-quality seeds. The percentage of germination is a pivotal characteristic when selecting seeds for cultivation, with three main criteria shaping seed quality standards: ideal germination potential, temperature, and the number of days for the first and final counts. In our study, the Kalmegh variety "Vallabh Kalmegh" underwent germination trials under five constant temperature conditions, maintaining a 16-hour photoperiod of light and an 8-hour photoperiod of darkness. Our findings revealed that a temperature of "25 °C" with high humidity yielded the highest germination rate at 91.5 percent, establishing it as the ideal condition. We concluded that temperature significantly influences the germination percentage in Kalmegh. To validate our objectives, we recorded early seedling growth parameters, including seedling length, root length, shoot length, fresh and dry weight, and Seedling Vigour Index I. Notably, the Kalmegh seeds exhibited the highest germination rate under constant "25 °C" with high humidity, with the peak Seedling Vigour Index I recorded on days 7-8 and day 14 as the first and final count days, respectively. These findings contribute valuable insights to seed quality assessment and cultivation practices for Kalmegh, enhancing our understanding of the optimal conditions for germination and early seedling growth.

Keywords: Germination percentage, Photoperiod, Seed quality standards, Seedling emergence, Temperature

INTRODUCTION

Kalmegh, scientifically identified as Andrographis paniculata Wall. ex Nees and belonging to the Acanthaceae family, is a native medicinal plant widely recognized as the 'King of Bitters' (Chauhan *et al*., 2009, Gomathinayam et al., 2009). Its therapeutic properties are attributed to adrographolide, an alkaloid, and associated diterpenoid compounds such as deoxandrographolide and neonandrographolide (Shen *et al*., 2002). Thriving in tropical climates with high temperatures and humidity, Kalmegh can also be cultivated in subtropical regions during the monsoon season. Abundant in Southeast Asian nations like India, Sri Lanka, Pakistan, Java, Malaysia, and Indonesia, it is extensively grown in countries such as India, China, Thailand, and the East and West Indies, including Mauritius

In Ayurveda, Kalmegh is recognized for its diverse qualities, including antidiabetic activity, to cure covid-19, jaundice, fever, malaria (Tomar, 2019, 2020, 2022a, 2022b & 2023) and bitterness, pungency, cooling effect, laxative properties, wound-healing abilities, antipyretic, anti-periodic, anti-inflammatory, expectorant, blood-purifying, sleep-inducing, anthelmintic, and digestive properties (Bhattacharya *et al*., 2012, Kumar *et al*., 2011, Kumari *et al*., 2012). Meeting the rising demands of the pharmaceutical industry for active plant components underscores its significance. Successful crop production hinges significantly on the quality of planting seeds, making information on germination and related parameters crucial (Kumari *et al*., 2015).

Despite its value, limited information exists on the seed quality and germination of Kalmegh, posing a challenge to successful seed germination. Improving seed germination becomes imperative for producing robust and healthy seedlings to meet current demands. In a laboratory context, seed germination refers to the emergence and growth of a seedling, indicating its potential to develop into a viable plant

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under favorable soil conditions. Germination, a complex biological process, involves various factors acting simultaneously, leading to the emergence of a seedling after a specific duration. The percentage of germination is a vital trait for cultivation, and germination energy, indicating the speed of germination, is presumed to influence seed and seedling vigor (Ranal and Santana, 2006).

While the influence of temperature on seed germination is well-documented for various agricultural and vegetable species, there is currently no such information available for Kalmegh. Therefore, a systematic investigation is crucial to gather data for establishing standard germination parameters in this seed-propagated crop. The current study aims to standardize germination parameters across different temperature conditions and determine the optimal temperature conditions for achieving the highest percentage of seed germination in Kalmegh.

MATERIALS AND METHODS

Germination test

The germination test was conducted during the period of August to September 2022, utilizing seeds of the 'Vallabh Kalmegh' variety obtained from the Directorate of Medicinal and Aromatic Plants Research in Anand, Gujarat, India. The experiment involved subjecting the seeds to controlled environmental conditions, specifically four consistent temperature and relative humidity settings: '20 °C,' '25 °C,' '30 °C,' and room temperature. Germination trials were executed using seed germinators set at different constant temperatures.

The percentage of germination was calculated using the formula:

Germination percent =

(Total number of seeds germinated)/

(Total number of seeds placed) ×100

Additionally, the Germination Period (GP) was also calculated asper the duration in days from seeding to the point of maximum seed germination.

Seedling growth and vigour

After a 14-day incubation period, the evaluation of seedling growth encompassed assessing root and shoot length, seedling fresh weight, and the Seed Vigor Index (SVI). The SVI, calculated as the multiplication of germination percentage and seedling length (measured in centimeters), served as a key metric. The experiments were executed in triplicate, with each replication comprising 50 seeds. Subsequent to the experimentation, the data underwent analysis of variance (ANOVA), employing mean separation for statistical analysis. The least significant difference (LSD) test, conducted at a 5% significance level, facilitated comparing means across different test parameters under varied conditions.

RESULTS AND DISCUSSION

The germination process of Kalmegh (*Andrographis paniculata*) seeds exhibited notable sensitivity to fluctuations in temperature and humidity levels, as well as the duration until assessment. The impact of temperature variations, in conjunction with the counting days, demonstrated a profound influence on seedling growth and vigor, exhibiting statistical significance. Initial seedling emergence occurred earliest at 30°C on the 4th day (18 seeds, equivalent to 36% germination), while the latest emergence was observed at 20°C on the 10th day (10% germination). Notably, the germination percentage observed on the final count was highest at 25°C with more than optimum humidity (91.5%), followed by 25°C at low humidity (89.5%), room temperature or uncontrolled temperature (85%), and lowest at 20°C (18%).

Temperature variations significantly impacted seedling characteristics, with the highest seedling length observed at room temperature (5 cm), followed by 25°C at high humidity (3.78 cm), 25°C at low humidity (3.45 cm), and 30°C (3.36 cm). Shoot length was similarly affected, with maximum length observed at room temperature (4.3 cm), followed by 25°C at high humidity (2.8 cm), 25°C at low humidity (2.5 cm), and 30°C (2.2 cm). Root length reached its maximum at 25°C with high humidity (1.65 cm), followed by 25°C with low humidity (1.45 cm), 30°C (1.3 cm), and minimum at uncontrolled temperature (0.85 cm).

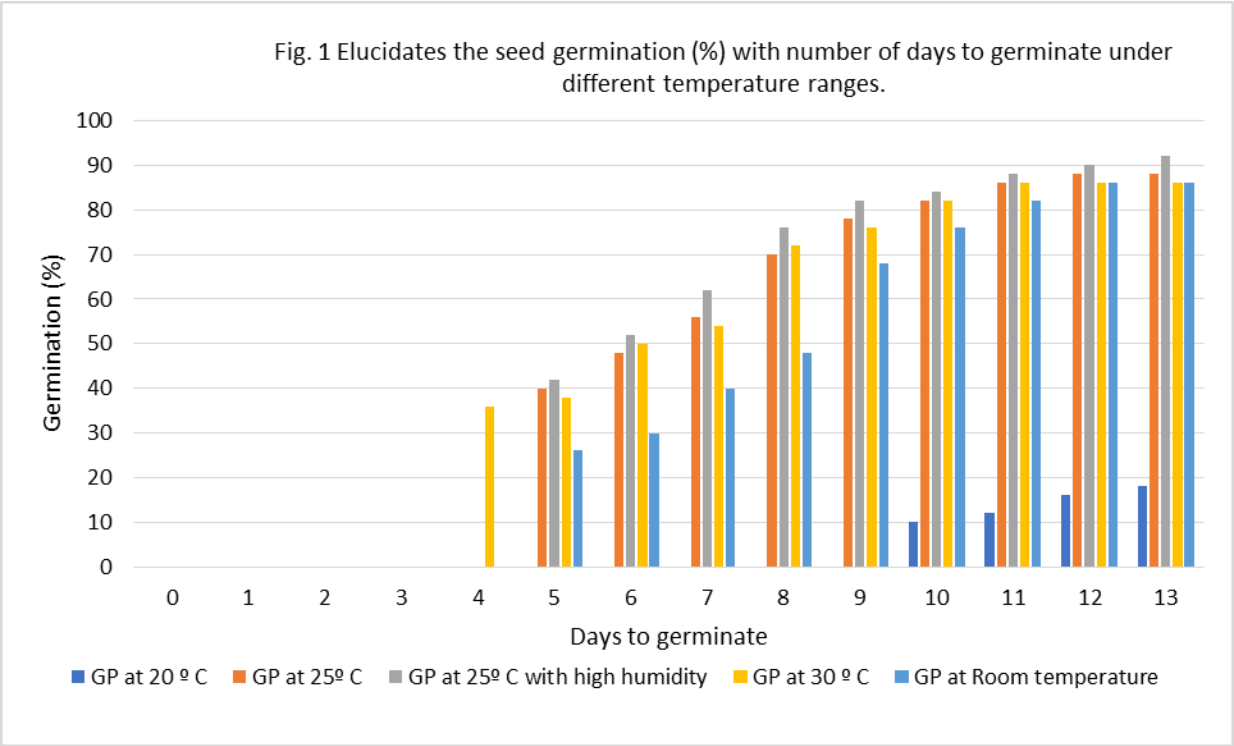
The Optimum Seedling Vigour Index-I was attained at 25°C with variations in humidity (300.15 and 267.4), while the highest vigour index was recorded at room temperature (434.35 for SVI-I and 463.1 for SVI-II), and the minimum at 30°C (285.7 and 278.2). Similar trends were observed for seedling fresh and dry weight, with the maximum recorded at non-controlled temperature (194 mg and 6.06 mg), followed by 25°C high humidity (166.9 mg and 5.96 mg), 25°C low humidity (159.3 mg and 5.41 mg), and minimum at 30°C (147.85 mg and 5.1 mg).

The present study established the "first and final count" duration as approximately 7-8 days and 13-14 days, respectively. Consistent with previous research, 25°C was identified as the optimal temperature for germination percentage and days to purpose. This aligns with findings from Kumar et al. (2011), who investigated various temperature regimes, and Chauhan et al. (2009), who evaluated different substrates, both confirming 25°C as optimal for Kalmegh germination.

Table 1. Elucidating the seed germination percentage, seedling growth and seed vigour of Kalmegh at different temperatures ranges.

Temperature	Germination Percentage (%)	Seedling Shoot length (cm)	Root length (cm)	Seedling Length (cm)	Fresh weight (mg)	Dry weigth (mg)	Seedling vigour Index-I	Seedling Vigour Index- II
Room Temp.	85 ± 2.25	4.3 ± 0.19	0.85 ± 0.11	5 ± 0. 32	194 ± 3.73	6.06 ± 0.38	434.35 ± 8.36	463.1 ± 8.54
at 25 with low humidity	89.5 ± 1.14	2.5 ± 0.18	1.45 ± 0.10	3.45 ± 0.13	159.3 ± 0.74	5.41 ± 0.27	300.15 ± 0.23	267.4 ± 0.43
at 25 with high humidity	91.5 ± 1.46	2.8 ± 0.17	1.65 ± 0.14	3.78 ± 0.14	166.9 ± 1.09	5.96 ± 0.13	345.2 ± 0.21	340.5 ± 0.19
at 30	83 ± 2.16	2.2 ± 0.08	1.3 ± 0.18	3.36 ± 0.07	147.85 ± 5.74	5.1 ± 0.08	285.7 ± 0.79	272.8 ± 0.87
at 20	18 ± 1.47	-	-	-	-	-	-	-
C.D	3.461	2.134	1.453	2.112	1.976	3.43	1.234	1.234
CV	2.556	3.213	1.234	3.456	3.154	4.567	2.789	3.115
Significant	*	*	*	*	*	*	*	*

(Note: Values are indicated as Mean with standard errors)



CONCLUSION

The experiment aimed to establish a standardized measure for the germination of Kalmegh (*Andrographis paniculata*) seeds under varying temperature conditions. The results obtained provide valuable insights into the germination behaviour of these seeds and offer a basis for understanding the impact of temperature on the germination process.

Temperature affected time to germinate and germination percentage in Kalmegh.The seeds showed maximal germination of 91.5% at '25 °C' temperature with high Humidity and least was recorded at 20°C and the first and final days account to 7-8 days and 14th days, respectively for the variety "Vallabh Kalmegh".

The findings suggest that the germination of Kalmegh seeds is influenced by temperature, with certain temperature ranges promoting optimal germination rates. The data obtained at different temperature conditions can be used to create a standardized measure or model for predicting germination outcomes under varying environmental temperatures. The establishment of such a measure can contribute to enhancing agricultural practices, optimizing seedling production, and promoting the successful cultivation of Kalmegh crops.

However, further research may be warranted to explore additional factors that could influence germination, such as soil composition, moisture levels, and light conditions. Additionally, long-term studies could provide insights into the overall growth

and development of Kalmegh plants originating from seeds germinated under different temperature conditions.

In summary, this experiment lays the groundwork for a standardized measure for the germination of Kalmegh seeds under various temperature conditions, offering valuable information for agricultural applications and contributing to the broader understanding of seed germination processes.

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