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Short communication

Effect of temperature on seed germination parameters in Kalmegh (*Andrographis paniculata* Wall. ex Nees.)

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ABSTRACT

Kalmegh (*Andrographis paniculata* Wall. ex Nees) is a medicinal herb of tropical south east Asia and native to India and Sri Lanka. It has been used herb for liver ailment in all prevailing systems of medicine viz. Ayurvedic, Unani, Homeopathic and modern throughout most of the south East Asian countries viz. China, India, Sri Lanka, Indonesia, Thailand, Burma, and Vietnam, etc. Commercially cultivation of Kalmegh is done through seeds. Optimal germination potential, temperature and first as well as final count day are three primary parameters for developing the seed quality standards. Germination of Kalmegh variety 'CIM-Megha' was carried out at six constant temperatures at an interval of every '5 °C' from '15 to 40 °C' temperatures coupled with 16 h light and 8 h dark photo period. The temperature of '25 °C' was found optimally suitable with '94.6' and '23.6' percentage of germination and germination energy, respectively, while the temperature at '40 °C' was deleterious with no germination. Significant decrease in percentage of germination and germination energy was observed at '15 °C', '20 °C', '30 °C' and '35 °C' of temperature in comparison to '25 °C'. The study further revealed that days 5-6 and days 7-9 after seed sowing were the ideal for first and final count, respectively for seed germination of Kalmegh.

1. Introduction

Kalmegh (*Andrographis paniculata* Wall. ex Nees. Family: Acanthaceae) is an important indigenous medicinal plant commonly known as 'King of Bitters' (Saraswathy et al., 2004; Chauhan et al., 2009; Gomathinayagam et al., 2009). Kalmegh grows abundantly in south eastern Asian countries viz. India, Sri Lanka, Pakistan, Java, Malaysia, and Indonesia but cultivated extensively in India, China, Thailand, East and West Indies and Mauritius (Mishra et al., 2007; Kanokwan and Nobuo, 2008; Niranjan et al., 2010; Kataky and Handique, 2010). It thrives well in tropical climatic conditions i.e. hot and humid. However, it can be cultivated in subtropical regions during the monsoon season. The extract of Kalmegh is used as anti-pyretic, anti-periodic, antibacterial, anti-malarial, anti-inflammatory, anti-thrombogenic, blood purifier, hepatoprotective, besides the treatment of jaundice, dermatological diseases, dyspepsia, febrifuge and anthelmintic disorders (Saraswathy et al., 2004; Chauhan et al., 2009; Gomathinayagam et al., 2009; Kapadi et al., 2010; Niranjan et al., 2010). Consumption of Kalmegh herb is estimated to be 250 tones (Shrama et al., 2008; Kataky and Handique, 2010). The demand of Kalmegh is increasing day by day (Chauhan et al., 2009). Since the plant is seed propagated, it is essential to assess the seed quality for ensuring the crop stand and herb yield which depend on quality seed.

Germination of a seed in a laboratory test is the emergence and development of a seedling to a stage where the aspect of its essential structures (root system, shoot axis, cotyledons, terminal buds) indicates whether or not it is able to develop further into a satisfactory plant under favourable soil conditions (ISTA Rule, 2006). Since germination is a complex biological process and at a point of time several factors have to enact simultaneously the resultant effect is reflected, in the form of emergence of seedling, after a certain period of time. The percentage of germination happens to be one of the most important characteristics of the seed to be used for cultivation. Germination energy is a measure of the speed of germination and hence, it is assumed, to be responsible for the vigor of the seed and of the seedling which it produces (Czabator, 1962). Only those seeds which germinate rapidly and vigorously under the favourable situation under controlled conditions are likely to be capable of producing vigorous seedlings in field conditions. The period during which maximum number of seedlings could be obtained is called as germination period (Czabator, 1962). Effective stand after the germination (associated germination parameters like germination energy, germination period, etc.) is another important characteristic that gives an idea about the final population. Thus, it would be desirable to have information regarding these parameters for producing good quality seed.

Temperature is one of the most critical factors affecting the germination of the seed (Bewley and Black, 1994; Verma et al.,

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2010). In many agricultural and vegetable species effect of temperature on seed germination has been well depicted, elucidating the critical lower and upper temperatures for germination, and the temperature at the highest rate of germination and its germinative capacity (Wagenvoort and Bierhuizen, 1977; Garcia-Huidobro et al., 1982; Covell et al., 1986; Ellis et al., 1987; Mwale et al., 1994; Jensen, 2001) but in case of Kalmegh there is no such report available till date. A systematic study to generate information on standardization of germination parameter is essential for any seed propagated crop. Keeping this in view, the present study was undertaken with the objectives to standardize germination parameters under varying temperature conditions and to elucidate suitable temperature conditions to optimize maximum seed germination percent in Kalmegh (Cv. 'CIM-Megha').

2. Materials and methods

2.1. Germination test in Petri dish

The experiment was conducted during July–August 2010 at six controlled and constant temperature regimes i.e. '15 °C', '20 °C', '25 °C', '30 °C', '35 °C' and '40 °C' with the seeds of the Kalmegh variety 'CIM-Megha' collected in the month of December 2009 from the research farm of Central Institute of Medicinal and Aromatic Plants, Resource Centre, Hyderabad, India. The experiment was conducted at constant controlled temperature in different seed germinators having temperatures viz., '15 °C' × '180 lx', '20 °C' × '183 lx' and '25 °C' × '180 lx', '30 °C' × '180 lx', '35 °C' × '180 lx' and '40 °C' × '183 lx' with16 h light and 8 h dark regime. Seeds were placed on the top of the filter paper (TP) (15 cm diameter) soaked with sterile distilled water in Petri plates (16 cm diameter × 3 cm deep). The treatments (temperature) were replicated eight times and each Petri dish contained 100 seeds. Counts of germination were checked daily for normal (bearing both root and shoot) and abnormal (lacks either root or shoot or stunted growth) seedlings from first day of germination till the day of maximum seed germination (Kumar et al., 2008a,b, 2009, 2010). Germination percentage, germination energy (%) and germination period were calculated using the formula cited by Czabator's index (1962);

$$\text{Germination percentage} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds in all replicates}} \times 100$$

$$\text{Germination energy} = \frac{1/4 \text{ of maximum number of seeds germinated in a day}}{\text{Total number of seeds in all replicates}} \times 100$$

$$\text{Germination period(GPD)} = \text{Days from seeding to when maximum number of seeds germinated}$$

At the end of experiment, data was subjected to analysis of variance (ANOVA) and mean separation. The statistical analysis was done using GenStat® Release 7.21. The least significant difference (LSD) at 5% level was used to compare the means of different test parameters under different temperature conditions.

3. Results and discussion

The temperature regimes and number of days to counting affected the germination of Kalmegh seeds. Variation due to temperatures, number of days to counting and their interactions were highly significant. The percent germination and days to germination varied with temperatures. The first emergence of seedlings was observed on 3rd day at '30 °C', 4th day at '25 °C' and '35 °C', 5th day at '20 °C' and 9th day at '15 °C' temperatures. The maximum seed germination was found on 7th day at '25 and 30 °C', 9th day at '20 and 35 °C', and 16th day at '15 °C' temperatures.

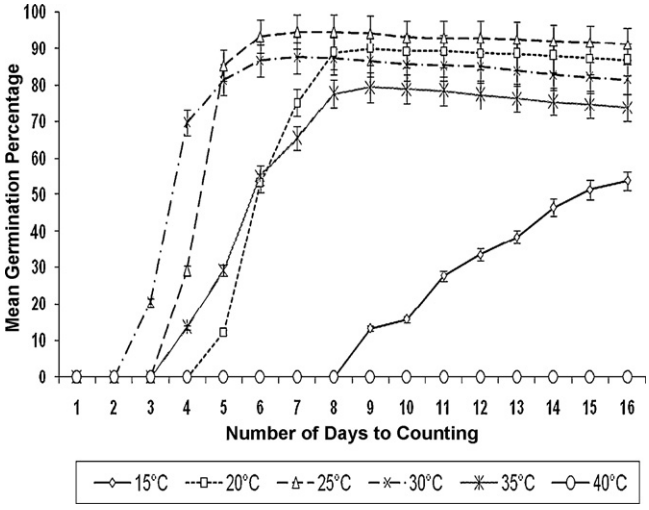

Fig. 1. Mean germination percentage of Kalmegh seeds at different temperatures with standard error.

The mean seed germination percentage over the temperatures for number of days to counting varied from 17.55 ('15 °C') to 71.14 ('25 °C') (Table 1). Among the temperatures '25 °C' had the highest mean germination percentage (71.14) followed by '30 °C', '20 °C', '35 °C' and '15 °C' while among the number of days to counting, days 16 and 15 were at par (77.47 and 77.45) while day 14 was significantly different from them with slightly lower mean germination percentage for remaining count days i.e. 13–3 which were in descending order (Table 1). A similar trend was observed for germination energy percent too (Table 1). Overall, '25 °C' was the best temperature in respect to germination percentage and germination energy percent followed by '30 °C', '20 °C', '35 °C' and '15 °C'. Considering these two factors simultaneously i.e. number of days to counting and temperatures, '25 °C' temperature was found the best with maximum mean germination percentage and germination energy percent (94.62 and 23.65) at day 7 and was followed by '20 °C' (89.88 and 22.47) at day 9, '30 °C' (87.50 and 21.87) at day 7, '35 °C' (79.50 and 19.87) and '15 °C' (53.75 and 13.44) at day 16 of constant and controlled temperatures (Figs. 1 and 2).

Thus, it seems that temperature is a critical factor in the germination of Kalmegh seeds as in *Tagetes minuta* and *Cymbopogon martinii* (Forsyth and Van Staden, 1983; Verma et al., 2010). Chauhan et al. (2009) conducted seed germination experiment on Kalmegh using different substratum under '25 °C' constant temperature and found 72, 75 and 78 germination percentage in filter paper, soil and sand, respectively. Among the tested temperatures, since 95 percent seeds germinated under '25 °C', it seems to be the optimum for germination of Kalmegh. Significant reduction in percentage of germination and germination energy at above or below at 25 °C temperature is an indication of threshold high and low cut-off between studied range of temperature i.e. '15–40 °C'. Optimum germination temperature was reported to be '30 °C' for Kalmegh seed (Chaudhary, 1975; Baskin and Baskin, 2001). In a previous study with Kalmegh seed, day 18 was found to best for final count day with 84 percent germination (Saraswathy et al., 2004). The present study revealed that the first and final count day was 5–6 and 7–9 days, respectively at '25 °C'. The germination period (i.e. the period during which maximum number of seedlings could