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Short communication

Varietal effect on germination parameter at controlled and uncontrolled temperature in Palmarosa (*Cymbopogon martinii*)

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ABSTRACT

Palmarosa (*Cymbopogon martinii*) is a major essential oil bearing crop commercially cultivated in India. However, the potentiality of its commercial cultivation is restricted due to the supply of poor quality seed material, i.e. poor seed germination percent/vigour and lack of knowledge about the seed rate for nursery raising/direct sowing and viability period under storage conditions. Seed germination tests of varieties PRC-1, Trishna, Tripta, Vaishnavi were carried out in Petri plates under two temperature regimes: uncontrolled, i.e. room temperature (average minimum 27 °C–average maximum 39 °C) and controlled and constant (15 °C, 20 °C, 25 °C with 16 h light and 8 h dark photoperiod). Maximum germination percentage and germination energy percent were recorded in 'Trishna' (34.25 and 8.56), followed by 'PRC-1' (34.25 and 8.56), 'Tripta' (15.75 and 3.94) and 'Vaishnavi' (10.25 and 2.56) on final count day at controlled and constant temperature. The corresponding data were recorded (26.00 and 6.50), followed by (25.50 and 6.37), (9.50 and 2.37) and (10.00 and 2.50) under uncontrolled temperature. Differential behavior of the said varieties under different temperature regimes was attributable to their genetic make-up. Results showed that day 2 and days 3–4 was the best for first count, day 5 and days 6–7 for final count and day 5 and days 6–7 for germination period at uncontrolled and controlled and constant temperature, respectively.

1. Introduction

Palmarosa (*Cymbopogon martinii*) is an important essential oil bearing perennial aromatic crop, which is cultivated in India, Brazil, Paraguay, Madagascar, Guatemala and Indonesia (Singh et al., 1998; Sahu et al., 2000; Singh and Kumar, 2000). The oil of Palmarosa is used world-wide in the soap, perfumery and cosmetic industries due to its rose resembling aroma (Singh et al., 1998; Sahu et al., 2000). India is a major producer and supplier of Palmarosa oil to the world market. However, the production of Palmarosa oil in India has remained constant at 75 ± 5 t annually for several years (Singh et al., 1998). About 57.2 t of Palmarosa oil was exported to about 21 countries including France and USA during 2008–2009 from India (Anonymous, 2009). However, the main constraint in its commercial cultivation the supply of poor quality seed material, i.e. poor seed germination percent/vigour and lack of knowledge about the seed rate for nursery raising/direct sowing and viability period under storage conditions. Germination parameters of different varieties of Palmarosa under different temperature conditions are not studied so far; systematic study gives an idea for determination of seed germination percent and ultimately seed rate of the crop. Temperature is one of the most important factors affecting the germination behavior of seeds (Bewley and Black, 1994). Temperature requirement of seeds for germination vary according to species, varieties and other parameters mainly the agroclimatic condition of the area of its cultivation. Optimum germination temperature is also related to the ecology of the specific location. The optimum temperature is the temperature that results in the highest germination percentage within the shortest duration of time. Temperature can affect the percent and rate of germination though its effect on loss of dormancy and the germination process itself (Roberts, 1988). Palmarosa can be propagated by using different methods, namely by planting the slips by splitting of clumps, direct sowing of seeds or planting nursery raised seedlings. However, use of seedlings is most common for commercial production. Production of healthy seedlings is essential for the establishment of a vigorous crop stand (Singh et al., 1998). Keeping all these in background the present investigation was done to elucidate the optimum condition of germination of Palmarosa seeds in controlled and uncontrolled temperature.

2. Materials and methods

2.1. Seed

Seeds of Palmarosa varieties viz. 'PRC-1', 'Trishna', 'Tripta' and 'Vaishnavi' were collected in month of October 2007 ('Vaishnavi')

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and October 2008 ('PRC-1', 'Trishna' and 'Tripta') from the crops, grown at research farm of Central Institute of Medicinal and Aromatic Plants, Lucknow, India. The seeds were removed from inflorescence and stored in paper bags at 27–39 °C till experiment was done.

2.2. Germination test in Petri dish

The experiments on germination percentage in seeds of Palmarosa varieties were conducted during June–November, 2009 at two temperature regimes, i.e. controlled and constant (15 °C, 20 °C, and 25 °C) and uncontrolled temperature (average minimum 27 °C–average maximum 39 °C). At constant controlled temperature, the experiment was conducted at three different seed germinators holding temperature 15 °C × 183 lux, 20 °C × 187 lux and 25 °C × 180 lux with16 h light and 8 h dark regime. Seeds were placed in Petri plates (16 cm diameter × 3 cm deep) with filter paper (15 cm diameter) soaked with sterile distilled water. The entire experiment was replicated four times with 5 Petri dishes (100 seeds per Petri dish) in each replication for a total of 20 Petri dishes for each variety at each temperature regime. The mean data of 5 Petri dishes, each having 100 seeds, were used, as one set of experiment was compiled and at the time of statistical analysis each set of experiment was treated as a replicate. Counts of germination were checked daily as normal (bearing both root and shoot) and abnormal (lacks either root or shoot or stunted growth) seedlings. Counting of normal seedling was recorded and used for the experiment from first day of counting till the day of maximum seed germination percentage (Kumar et al., 2008a, 2008b, 2009, 2010). Using the daily counts, germination percentage, germination energy (%) and germination period was calculated for each set using the formula cited by Czabator's index (1962):

- Germination percentage $= \frac{\text{total number of seeds germinated}}{\text{total number of seeds in all replicates}} \times 100$
- Germination energy $= \frac{1/4 \text{ of maximum number of seeds germinated in a day}}{\text{total number of seeds in all replicates}} \times 100$
- Germination period (GPD) = days from seeding to when maximum number of seeds germinated.

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

3. Results and discussion

A seed is regarded as germinated following the emergence and development of a seedling from the seed embryo (Willan, 1985). 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 favorable soil conditions (ISTA Rule, 2006). The varieties and number of days to counting affected the germination of Palmarosa seeds. Variation due to varieties and number of days to counting and the interactions due to varieties × number of days to counting, number of days to counting × temperatures and varieties × number of days to counting × temperatures were highly significant. In the present study, percent germination was recorded from day 1 onwards. Assuming the interaction of varieties with other factors to be negligible we used the overall means of comparison. The pattern for days to germination and percent maximum germination varied for varieties of Palmarosa. In general, the longest times to germination for all varieties occurred at controlled constant temperature (15 °C) but the fastest germination occurred at uncontrolled temperature in all the studied varieties. The germination of seedlings was observed on 2nd day irrespective of the variety and the maximum seed germination was found on 5th day. At uncontrolled temperatures maximum germination occurred at 5th day in all four varieties while at controlled constant temperature it occurred at 6–7th day depending up on varieties. The mean germination percentage of Palmarosa varieties over the number of days to counting varied from 5.73 ('Vaishnavi') to 20.13 ('Trishna') and over the varieties for number of days to counting from 5.42 (day 2) to 20.17 (day 6) (Table 1). Among the varieties 'Trishna' had the highest mean germination percentage (20.13) was followed by 'PRC-1', 'Tripta' and 'Vaishnavi' while among the number of days to counting days 6, 7 and 5 were almost at par with 20.17, 20.09 and 19.66 mean germination percentage and were followed by days 4, 3 and 2 (Table 1). A similar trend was reported for germination energy percent of Palmarosa varieties over the number of days to counting and over the varieties for number of days to counting (Table 1). Among the temperature regimes controlled and constant temperature (25 °C) was found to be the best with maximum mean germination percentage (15.49) and was followed by uncontrolled temperature (RT), controlled and constant temperatures (20 °C) and (15 °C) (Table 1). Further, the mean germination percentage over various temperature regimes for number of days to counting shows that days 6, 7 and 5 were at par to each other and they differ significantly from days 4, 3 and 2. A similar trend was also reported for germination energy percent over the varieties and temperatures for the number of days to counting (Table 1). Overall, 'Trishna' was the best variety in respect to germination percentage and germination energy percent and was followed by 'PRC-1', 'Tripta' and 'Vaishnavi' while among the temperatures, controlled constant (25 °C) was most suitable and was followed by uncontrolled (RT), controlled constant (20 °C and 15 °C) (Table 1). Considering simultaneously all the three factors i.e. number of days to counting, varieties and temperatures, variety Trishna was found the best with maximum mean germination percentage and germination energy percent (34.25 and 8.56) at day7 of controlled constant temperature (20 °C) and was followed by 'PRC-1' (34.25 and 8.56) at day 6 of controlled constant temperature (25 °C), 'Tripta' (15.75 and 3.94) at day 7 of controlled constant temperature (20 °C) and 'Vaishnavi' (10.25 and 2.56) at day 6 of controlled constant temperature (20 °C) (Graphs 1 and 2). The corresponding data were recorded in 'Trishna' (26.00 and 6.50), followed by 'PRC-1' (25.50 and 6.37), 'Tripta' (9.50 and 2.37) and 'Vaishnavi' (10.00 and 2.50) at 5th day of uncontrolled temperature (Graphs 1 and 2). The present study revealed that the germination percentage in Palmarosa varieties ranged from 26.00 to 34.25 in Trishna, 25.50–34.25 in PRC-1, 9.50–15.75 in Tripta and 7.75–10.25 in Vaishnavi under different controlled and uncontrolled temperatures. Differential behavior of the said varieties under different temperature regimes indicated the germination capacity of the varieties was attributable to their genetic make-up. Detailed presentation of the percent of germination and germination energy percent from putting day to till the end of the experiment in respect to controlled and uncontrolled temperature conditions is depicted in Graphs 1 and 2. On the basis of results of seed germination percentage in Palmarosa varieties at different days to counting, day 2 was found to be optimum for the first count and day 5 for final count under uncontrolled temperature condition. The corresponding days were 3–4 and 6–7 day under controlled and constant temperature condition (Graph 1). The germination period (i.e., the period during which maximum number of seedlings could be obtained) was found to be 5 day under uncontrolled and 6–7 day under controlled temperature conditions (Graph 1).

Since germination is a complex biological process and at a point of time several factors have to enact simultaneously the resultant