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Temperatures and qualities of light in Niger (*Guizotia abyssinica* (L.f.) Cass.) seeds germination in Mato Grosso do Sul, Brazil

Temperaturas y cualidades de luz en la germinación de semillas de Níger (*Guizotia abyssinica* (L.f.) Cass.) en Mato Grosso do Sul, Brasil

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Abstract

For each vegetable species, there is a specific environment conditions to occur the seed germination process. However, there is a little information regarding the necessary conditions for Niger (*Guizotia abyssinica* (L.f.) Cass.) seeds germination. The aim of this research was to evaluate the influence of different temperatures and types of light on Niger (*Guizotia abyssinica* (L.f.) Cass.) seeds germination. Seeds were sown on two sheets of "germitest" paper inside plastic box type "gerbox" and placed on B.O.D. Treatments were constituted of two constant temperatures (15 °C and 25 °C, respectively) and an alternating temperature (20-30 °C) under 10 hours for the lowest temperature and 14 hours for the highest temperature and they were associated to the wavelengths as follows: blue (440 nm), green (560 nm), red (660 nm), extreme red (730 nm), white light and dark. The experiment was conducted in a completely randomized design with four replicates of 50 seeds. Effects of different temperatures and qualities of light were evaluated by seeds germination and vigor. Higher germination of Niger seeds is observed in temperatures of 25 and 20-30 °C and they can be considered as non-photoblastic.

Keywords: Environment conditions, germination test, non-photoblastic, oilseed crop, wavelengths.

Resumen

Para cada especie vegetal, hay un entorno específico para que se produzca el proceso de germinación de las semillas. Sin embargo, hay poca información sobre las condiciones necesarias para la germinación de las semillas de Níger (*Guizotia abyssinica* (L.f.) Cass.). El objetivo de esta investigación fue evaluar la influencia de diferentes temperaturas y tipos de luz sobre la germinación de semillas de Níger (*Guizotia abyssinica* (L.f.) Cass.). Las semillas se sembraron en dos hojas de papel "germinado" dentro de la caja de plástico tipo "gerbox" y se colocaron en B.O.D. Los tratamientos fueron constituidos por dos temperaturas constantes (15 °C y 25 °C, respectivamente) y una temperatura alterna (20-30 °C) por debajo de 10 horas para la temperatura más baja y 14 horas para la temperatura más alta y se asociaron a las longitudes de onda como sigue: azul (440 nm), verde (560 nm), rojo (660 nm), rojo extremo (730 nm), luz blanca y oscuridad. El experimento fue conducido bajo un diseño completamente al azar con cuatro repeticiones de 50 semillas. Los efectos de las diferentes temperaturas y cualidades de luz, fueron evaluados por germinación y vigor de las semillas. La germinación más alta de las semillas de Níger se observa en temperaturas de 25 y 20-30 °C y pueden considerarse como no fotoblásticas.

Palabras clave: Condiciones ambientales, longitudes de onda, no fotoblástico, oleaginosas, pruebas de germinación.

Introduction

Guizotia gender, belonging to the Asteraceae family, is native of Tropical Africa with the highest concentration of species in Ethiopia (Geleta *et al.*, 2010). Niger (*Guizotia abyssinica* (L.f.) Cass.), is an annual herb whose oil is extracted from its seeds and is used as follows: for human consumption, soap making, paints, lubricants and illuminants, and stand out as potential specie for the biodiesel production and medical use from the dry seeds and flour from dried seeds (Solomon & Zewdu, 2009; Sarin *et al.*, 2009). However, there is a little information about the necessary conditions for the germination of their seeds and about the germination test procedures.

It is necessary to understand the local environmental events, which affects the seed germination for conclude the time emergency for particular specie, due to the initial phases of germination are crucial for the full crop establishment in field conditions (Karlsson *et al.*, 2008). Temperature is one of the environmental factors that interferes with seed germination, and it influences the speed and the final germination percentage, affecting the capacity and germination rate.

Quantity and quality of light can also regulate the seed germination of many plant species (Dobarro *et al.*, 2010). Although the light is not be considered an essential factor for the process in non-dormant seeds, its presence can contribute to reduce problems caused for the low water potential in the soil and for the effects of temperatures above the optimum (Marcos-Filho, 2005). Light action in the physiological regulation of plants is preceded for its absorption by photoreceptors such as the phytochrome that stimulates or inhibits the germination according to the radiation level of red or extreme red lights (Victório & Lage, 2009). Generally, light with high levels of extreme red inhibits the germination, while light with high levels of red stimulates the germination (Dissanayake *et al.*, 2010).

The interaction between light and temperature is also related to action of different phytochrome forms, which control the seed germination process. In some cases, according to Vieira *et al.* (2007), some seeds at low temperatures are insensitive to light and they germinate in presence or absence of light, but under milder temperatures they have photosensitivity, germinating only in presence of light and they present dormancy or loss of viability in higher temperatures.

Considering all these questions, it is reasonable to infer the need about the appropriate temperature and light for the seed germination of oilseed crops such as Niger that is expanding in traditional areas of world agriculture. Thus, the aim was to evaluate the Niger (*Guizotia abyssinica* (L.f.) Cass.) seeds germination under different temperatures and qualities of light in Mato Grosso do Sul, Brazil.

Materials and methods

The experiment was conducted at the Seed Technology Laboratory of the Facultad de Ciencias Agricolas, Universidade Federal da Grande Dourados, Mato Grosso do Sul, Brazil. Seeds used were harvested during the growing season of 2010 at latitude of 15°33’32” S, longitude of 54°17’46” W and altitude of 636 m.a.s.l., both harvest and thresh of chapters, were performed manually and then seeds were stored in permeable packages at 15 °C and 60% HR until the experiment installation. It was determined, the seed water content by the oven method at 105 ± 3 °C for 24 hours (Brasil, 2009), with four replicates from whole seeds. The results were calculated based on the weight of moisted seeds and they were expressed as a percentage.

For germination test, seeds were sown in plastic boxes type “gerbox” on two sheets of germitest paper moistened with distilled water to the equivalent to 2.5 times the mass of dry paper. The germination test was conducted in germination chambers type B.O.D. with four fluorescent lamps of 20 W and the treatments were constituted of two constant temperatures (15 °C e 25 °C) and an alternating temperature (20-30 °C) under 10 h for the lower temperature and 14 h for the higher temperature. Temperatures were associated to absence and presence of light in the blue (440 nm), green (560 nm), red (660 nm), extreme red (730 nm) and constant white light.

Transparent “gerbox” and wrapped with aluminum paper were used to conducted the treatments with white light and absence of light, respectively. For the others specters were made color filters for wrap the “gerbox”. Two sheets of blue, green and red cellophane were used as a filter for the blue, green and red specters, respectively. For extreme red specter, the filter was made of two sheets of blue cellophane and two sheets of red cellophane.

It was evaluated the effect of different temperatures and qualities of light by germination percentage considering the normal seedlings formation (shoot and root developed). In addition, length of shoot and root, obtained by dimensions of 10 normal seedlings taking at random, with digital caliper rule, which results were expressed in millimeters seedlings^{-1}, by fresh and dry mass of seedlings, which were performed with the same seedlings used in the length test. In the first case, seedlings were weighed on analytical balance and for dried mass, seedlings were allocated in an oven with forced air circulation at 65 ºC for 72 hours and subsequently, they were weighed on analytical balance and the obtained results, were expressed in grams.seedlings^{-1}.

A completely randomized experimental design was used in a factorial 3 x 6 (temperatures and qualities of light) with four replicates of 50 seeds. Results of germination, length and dried mass of seedlings were submitted to variance analyze and, in case of significance, the means treatment were compared to Tukey test at 5% of probability by the SISVAR software ® (Ferreira, 2011).

Results and discussion

Seed water content of Niger (*Guizotia abyssinica* (L.f.) Cass.) seeds was 8.1%. There was a significant interaction between light and temperatures for shoot germination, root length and fresh mass of Niger seedlings. Dried mass of Niger seedlings, was not influenced by the factor in isolation or together.

Germination tests conducted at 25 and 20-30ºC provided no statistical difference among studied wavelengths. Only at 15ºC, was verified as lower germination percentage of seeds incubated under white light when it was compared to other wavelengths, which not differ among them (Figure 1).

Tested temperatures did not differ among them in all wavelengths evaluated, except in the blue wavelength and white light, which when associated to temperatures of 25 and 20-30ºC provided higher performance to seeds compared to seeds incubated at 15ºC (Figure 1).

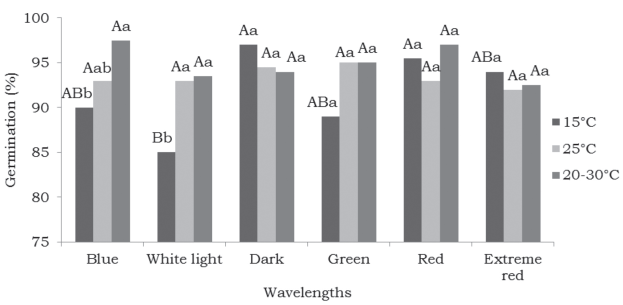

Figure 1. Germination percentage of Niger (*Guizotia abyssinica* (L.f.) Cass.) seeds submitted to different temperatures and wavelengths.

Means followed for the same uppercase among wavelengths or the same lowercase among temperatures, do not differ by Tukey test at 5% of probability.

Given these concerns, these results suggest the germination was adversely affected at lower temperature (15ºC) on blue wavelength, since the radiation promoting of germination, according to Marcos-Filho (2005), placed on red wavelength, while blue wavelength usually inhibits seed germination.

Red light is a stimulator of seed germination for many species. According to this author, the phytochrome is the physiologic sensor of light on seeds and it exists in two reversible main forms upon exposure to different qualities of light (Barros *et al.*, 2005). Through different forms of phytochrome (phy), seeds may perceive the very low fluence light (phytochrome A – PhyA) and have their germination inhibit for the white light or they perceive the reason red: extreme red action of phytochrome B (phyB) and have the promoting (Mello & Barbedo, 2007). The active phytochrome is responsible to gene expression which have allowed the gibberellin synthesis, which is a germination promoter, while the inactive phytochrome is responsible to abscisic acid synthesis, a germination inhibitor (Marcos-Filho, 2005).

Niger seeds can be classified as indifferent or insensitive to light, because they did not present higher germination percentage (over 80%) in all temperatures and light treatments, even in the dark (Guollo *et al.*, 2015), showing that this species had sufficient phytochrome in active form to induce the germination in the light absence (Takaki, 2001; Marcos-Filho, 2005). Possibly, the variations found for the seeds are more closely related to the temperature reduction.

It is important to note the temperature is one of the environmental factors which more limits the seed germination due to imbibition and metabolic processes, determining the range and germination capacity and interfering on the water absorption speed on the biochemist reactions (Marcos-Filho, 2005). Low temperatures can reduce the metabolic rates until the essential pathways to the start of germination can no operate, while higher temperatures have allowed decreasing the supply of free aminoacyls, RNA and protein synthesis even the decrease of metabolic reactions speed (Mello & Barbedo, 2007).

Niger seedlings growth was more sensitive to higher temperatures and qualities of light than the seed germination (Figure 2). The temperature of 25 ºC is associated to the wavelengths, which provided the highest results of shoot length (48.06 mm), except in the white light, where the higher shoot length was observed in alternating temperature of 20-30 ºC (26.93 mm).

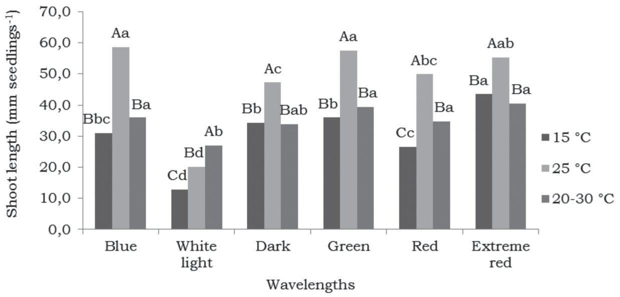

Figure 2. Shoot length of Niger (*Guizotia abyssinica* (L.f.) Cass.) seedlings submitted to different temperatures and wavelengths.

Means followed for the same lowercase among wavelengths or the same uppercase among temperatures, do not differ among them by the Tukey test at 5% of probability.

Similar results were observed for the salvia (*Salvia splendens* Sellow ex Schult.) seeds at 25 °C, verifying the white and red lights, which had similar effects, due to the phytochrome spectral compound and absorption characteristics (Menezes *et al*., 2004).

At temperature of 15 °C associated to white and red light was computed the results of shoot length, showing the negative effect of low temperature in the Niger seedlings formation. This temperature also delayed the seed germination of salvia and made impossible the evaluation of seedlings length on red band, according to Menezes *et al*., (2004).

It was verified higher root length at 25 and 20-30°C associated to blue, red and white light wavelengths, indicating the inhibition band of 440 nm, was attenuated by higher temperatures (Figure 3).

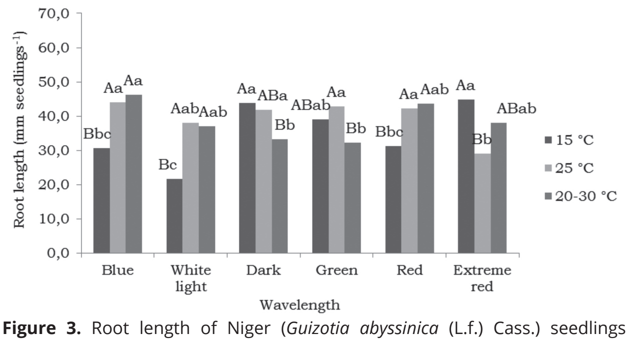

Figure 3. Root length of Niger (*Guizotia abyssinica* (L.f.) Cass.) seedlings submitted to different temperatures and wavelengths.

Means followed for the same lowercase among wavelengths or the same uppercase among temperatures, do not differ by Tukey test at 5% of probability.

On the other hand, at dark and green specter, the temperatures of 15 and 25 °C, provided higher root length than 20-30°C. Only in the extreme red wavelength, the temperature of 25 °C provided lower results than other temperatures.

According to Penfield *et al*. (2005), the seedlings growth as well as the germination, is a phenomenon promoted by synergic effect among temperature and light, which signal pattern is related to gene regulation of gibberellin biosynthesis. However, Dobarro *et al*. (2010), show the possibility of a lack of correlation among light requirements for seed germination and light requirements for seedlings and plants that explains a higher sensibility of Niger seedlings to seed treatments.

The temperature of 25 °C provided the best results of seedlings in terms of the fresh mass in all evaluated wavelengths (Figure 4).

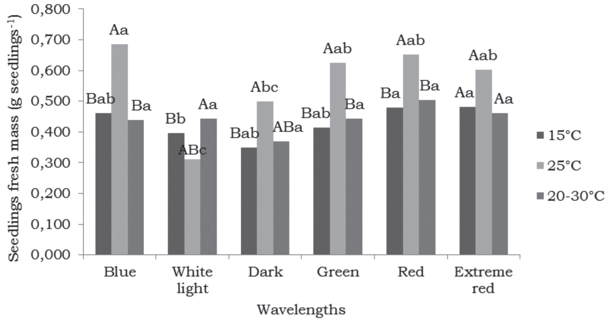

Figure 4. Fresh mass of Niger (*Guizotia abyssinica* (L.f.) Cass.) seedlings submitted to different temperatures and wavelengths.

Means followed to the same uppercase among wavelengths or the same lowercase among temperatures, do not differ among them by Tukey test at 5% of probability.

However, did not differ statistically from the temperature of 20-30 °C when was associated to white light, dark and extreme red wavelengths, respectively.

Wavelengths studied did not differ among them at 20-30 °C about the seedlings fresh mass. At 15 °C the white light provided lower results when compared to the others wavelengths and at 25 °C the lower results were also obtained in white light and in the dark (Figure 4).

Overall, no differences were observed among temperatures and wavelengths for seedlings dry mass, verifying mean result of 0.029 g. seedling^{-1} (data not shown). These results suggest the translocation reserves for seedling formation, which not were influenced by temperature treatments and light applied to Niger seeds.

Such an environmental compound, the light interferes on plant growth because provide energy to photosynthesis and signals, which regulates the plant development by sensitive light receptors in different intensity, spectral quality and state of polarization (Rego & Possamai, 2006). In addition, different light spectrums can increase the proportion of active forms in terms of phytochromes triggering answers in plant development (Victório & Lage, 2009).

Therefore, Niger seeds can be considered as non-photoblastic because performed germination percentage above 80% at dark in the blue, green, red, extreme red and white light spectrums, verifying better performance at 25 and 20-30 ºC.

Conclusion

Temperatures of 25 and 20-30 °C, favor the seed germination and seedlings growth of Niger (*Guizotia abyssinica* (L.f.) Cass.). This information is useful and provides more accurate and reliable estimates of Niger seeds, which are sensitive to temperature of 15°C and insensitive to light, being considered as non-photoblastics.

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