Germination Dynamics of *Cratevaadansonii*D.C. and *Sarcocephaluslatifolius*(Smith) Buce: Key Forest Trees of Burkina Faso

ABSTRACT

Cratevaadansonii D.C. (Capparaceae) and *Sarcocephaluslatifolius* (Smith) Buce (Rubiaceae) are two African tree species widely known as multipurpose species for rural populations. Unfortunately, these species are threatened in their natural stands by inappropriate management practices. In addition, their germination capacitiesare poor in their natural stands Our hypothesis is that the seeds of both species are capable of germination under certain conditions of temperature, light and germination medium.This work aims to study the germination capacity of these species under different conditions. Germination tests were carried out in the laboratory and in the field. 400 seeds of *C. adansonii* were used in five treatments and 960 seeds of *S. latifolius* in six treatments. Blotting papers and soil were used as media. Seeds were germinated under different temperature and light conditions over a period of 30 days. A seed was germinated when part of the embryo appeared. The maximum germination rate was obtained after 28 days for *C. adansonii* and 22 days for *S. latifolius*. The results show that the best germination rates of *C. adansonii* (85%) and *S. latifolius* (82%) are obtained when the seeds are exposed to white light for 12 hours, alternating with 12 hours of darkness. For generative propagation of these plants, it is recommended to germinate the seeds under optimal conditions and then to plant them instead of sowing them in the field.

Keywords: Seed multiplication, Germination rate, Germination test, Germination kinetics, influence of light and temperature on germination.

1. INTRODUCTION

In Burkina Faso, certain widely used woody species are undergoing a rapid decline in their ecosystems as a result of uncontrolled exploitation and lack of domestication measures, partly linked to a lack of forest management control. This is the case of *Cratevaadansonii* D.C. (Capparaceae) and *Sarcocephaluslatifolius* (Smith) Buce (Rubiaceae), two woody plants that are widely used (Arbonier 2019) but threatened in different regions of their African range, such as Uganda (Tabuti et al. 2003), Togo (Attoh & Ahama, 2018) and Burkina Faso (Thiombiano et al., 2010). The leaves of *Cratevaadansonii* are edible. *Sarcocephaluslatifolius* is a medicinal plant used for various ailments such as malaria, diarrhoea and sore eyes (Kaboré et al., 2014).In particular, the use of its roots poses a threat to individuals of this species (Kaboré et al., 2015).*Cratevaadansonii* treatshigh blood pressure and asthma (Todou et al.,2022).The aqueous extract of the bark of the species has a higher anti-urolithiasis activity on the formation of CaC2O4 crystals (Madawala et al. 2022).In Camerron, Todou et al. (2022) find that overexploitation and inappropriate management practices are the main threats to the species' populations.

Severalspecies have difficultyestablishing in certain environments. Severalclimaticfactorssuch as humidity, temperature and light influence the germination and growth of theirseedlings. This is the case for *Sarcocephaluslatifolius* (Smith) Buce, whichneeds optimum temperature and light to germinate (Stangeland et al, 2007). The multiplication of *C. adansonii*isdifficultbecause of poorseed germination (Tyagi et al. 2010). Our hypothesisisthat the seeds of bothspecies are capable of germination under certain conditions of temperature, light and germination medium.The aim of thisstudywas to contribute to a betterunderstanding of the regenerationcapacity of local species, by determining the best conditions for seedgermination.To do this, tests wereconducted in the laboratory and in the field to determine the impact of light and temperature on the germination of the seeds of thesetwospecies.

2. MATERIAL AND METHODS

The laboratory germination test was carried out using eighty (80) Petrie dishes, one hundred and forty-four (144) blotting papers and soil. We sterilised tap water to moisten some of our tests. The Petri dishes and blotting papers were also sterilised before the tests. We used tweezers to place the tiny *S latifolius* seeds on the blotting papers and used a hand-held magnifying glass to observe the germination of these tiny seeds. We used 100% ethanol to disinfect our hands and tweezers before handling the seeds. We placed a thermometer in the different test conditions to observe the temperature.Before the experiments, weestimated the weight of the sheathsusing a precision balance. To estimate the weight of a seed, one hundredseeds of eachspecieswererandomlyselected and weighed.32 jours après le début de l'expérience, 15 plants de chaque espèce sont sélectionnés au hasard et la longueur de leurs racines et de leurs tiges est mesurée pour le lot qui présente le meilleur taux de germination.

2.1 Germination trial of *C.adansonii*

The *C.adansonii*seeds came fromplantedtrees. The seedswere not subjected to anypre-treatment. Five lots wereformed and assigned to different conditions. The first four lots consisted of eight Petri disheseach. Tenseedswereplaced in eachdish. The fifth lot was a plot established in the field. In each Petri dish of lots 1, 3 and 4, threeblottingpaperswereplaced and the seedswerearranged in a circular pattern on the blottingpapers, whichhadpreviously been moistenedwithsterilisedtap water. For lot 4, the Petri disheswereplaced in an incubation chamber for 12 hoursunder white light, alternatingwith 12 hours in the dark, at a temperaturebetween 20 and 30°C. For lot 5, weprepared a small plot, 2.5 m long and 1 m wide, where the soilwasloosenedwith a pickaxe;itissandy in texture and containsgravel. Eightyseedsweresown 5 cm above the soil in the plot, with one seed per stake. A total of 400seeds of *C. adansoniiwere* uses in thisessayof germination(Table 1). Rain was the only source of water for the plot. The trial wasestablished in September, the wettestmonth of Bobo-Dioulasso. The wholeexperimentwasestablished on the sameday.

Table 1 : Experimentalprotocols for germination tests on *C adansonii*seeds.

Lots	Number of repetitions	Total seedsnumber	Germination medium	SeedingTechnology	Temperature (°C)	Lighting
1	8	80	Blottingpaper	Deposit on blottingpaper	25-30	Daylight
2	8	80	Soil	Deposite on the soil	25-30	Daylight
3	8	80	Blottingpaper	Deposit on blottingpaper	30	Darkness 24h/24h
4	8	80	Blottingpaper	Deposit on blottingpaper	20-30	light 12 h /Darkness 12 h
5	8	80	Soil (Field)	Sowing5 cm below the surface	Natural conditions	Natural conditions
Total	40	400				

2.2 Germination trial of *S. latifolius*

*Sarcocephalus. latifolius*seedswerecollectedfrom ripe fruits harvested in the naturalenvironmentnear the BontioliReserves (0°40' North and 2°53' West). Theywerestored for six months at a temperaturebetween 25°C and 30°C. To extract the seeds, the dried fruits werebroken, the seedswerecollected and the impuritieswereremoved by manualsorting. The seedswere not subjected to anypre-treatment. Six lots of eight Petri disheseachwereprepared. For lots 1, 4, 5 and 6, threeblottingpaperswereplaced in each Petri dish. The Petri dishes for lots 2 and 3 werefilledwithsoil. Each Petri dishcontainedtwentyseedsarranged in a circular pattern and each lot wasassigned to specific conditions. For lot 5, the Petri disheswereplaced in an incubation room (Figure 1) under UV (ultraviolet) light for 12 h, alternatingwith 12 h in the

dark, at a temperaturebetween 20 and 25°C. A total of 960 seeds of *S. latifolius*were uses in thisexperiment(Table 2).The system was set up on the sameday. The blottingpapersweremoistenedwithsterilisedtap water ; the soil lots weremoistenedwithunsterilisedtap water.

Table 2 : Experimentalprotocols for germination trial of *S. latifolius*seeds.

Lots	Number of repetitions	Total seedsnumber	Germination medium	SeedingTechnology	Temperature (°C)	Lighting
1	8	160	Blottingpaper	Deposit on blottingpaper	25-30	Daylight
2	8	160	Soil	Deposite on the soil	25-30	Daylight
3	8	160	Soil	Sowingunder the soil	25-30	Daylight
4	8	160	Blottingpaper	Deposit on blottingpaper	30	Daylight
5	8	160	Blottingpaper	Deposit on blottingpaper	20-25	12 h ultra violet/12 h darkness
6	8	160	Blottingpaper	Deposit on blottingpaper	20-30	12 h white light /12 h darkness
Total	48	960				

Germination was observed every two days for thirty days. We adopted the definition of germination given by Binet & Brunel (1968), who consider that germination corresponds to the appearance of part of the embryo outside the seed envelopes.

Figure 1 : Seedsplaced in the incubation chamber.

Data analysis

Data were entered into Excel 2019. The number of germinatedseedswassummed per day of observation and per treatment. This sumwasaccumulated as the observation progresseduntil the 30th day. The germination kinetics per treatment and per specieswereobtained by following the germination rate (Gr) over time, calculated by the following formula

$$Gr = \frac{n}{N}100$$

where n= number of seeds germinated; N= total number of seeds.

3. RESULTS

The germination of *C. adansonii* and *S. latifolius*ishypogeous. The weight of 100 seeds of *C. adansonii*is 15.44g, so the weight of one seedis 0.1544g. Figure 2 shows the germination kinetics of *C.adansonii*. The best germination rate (85%) wasobserved in lot No. 4, i.e. when the seedswereplaced on blottingpaper and subjected to alternatingperiods of 12 hours

light and 12 hoursdark at a temperaturebetween 20 and 30°C. However, none of the seedsfrom lot 1 (blottingpaper + 25-30°C + very variable light conditions) and lot 5 (sown in the field) germinated. The resultsalso show that the seeds do not germinate in the dark (lots 2 and 5). Germination did not start until 8-12 daysaftersowing. The maximum germination rate wasreached 28 daysaftersowing (Figure 2). At 32daysaftersowing, germinatedseedsfrom lot 4 (Figure 3) had the followingcharacteristics: stem length 4.75±1.08 cm; root length 5.60±1.16 cm.

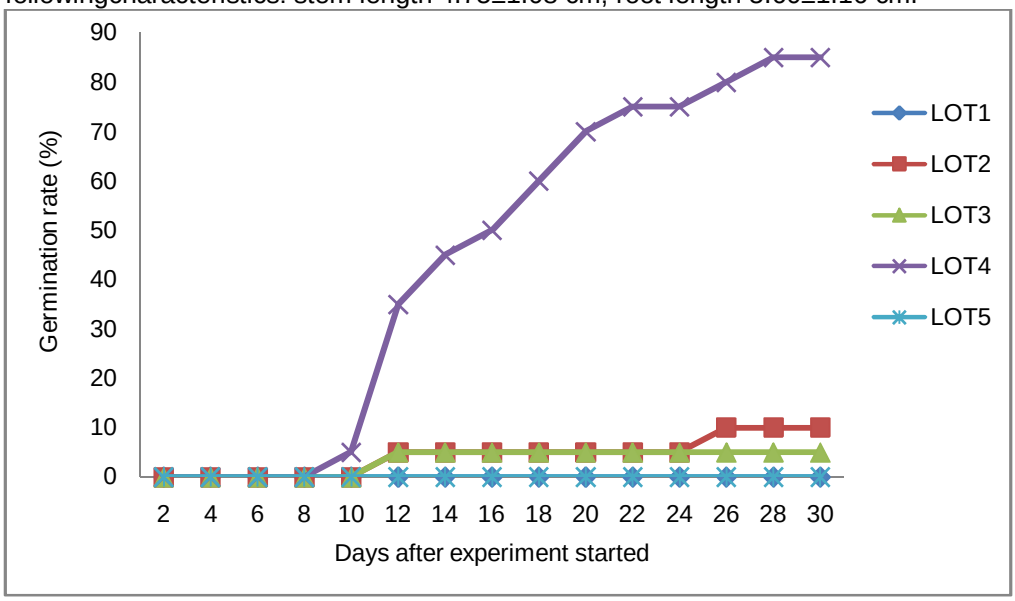

Figure 2 : Germination kinetics of *C. adansonii* as a function of treatment. Lot 1: blotting paper + 25-30°C+ highly variable light conditions; Lot 2: soil + 25-30°C+ highly variable light conditions; Lot 3: blotting paper + 30°C + total darkness; Lot 4: blotting paper + 20-30°C +12 h light and 12 h darkness; Lot 5: seeds sown in the field.

Figure 3: Seeds of *Cratevaadansonii* 20 days after sowing of the lot 4 (blotting paper + 20-30°C +12 h light and 12 h darkness).

The weight of 100 seeds of *S. latifolius* is 0.022g, so the weight of one seed is 0.00022g. The results show that for *S. latifolius*, only the seeds in lot 3 (seeds placed in soil + 25-30°C + very variable light conditions) and lot 4 (blotting papers + 30°C + total darkness) did not germinate (Figure 4). As with *C. adansonii*, the best germination rate for *S. latifolius* (82%) was observed in lot 6 (blotting paper + 20-30°C + alternating 12 h of white light and 12 h of darkness). In terms of kinetics, a delay of 8 to 10 dayswasobservedbefore the first germinations. The maximum germination rate wasreached at 22 days (lots 6 and 2) (Figure 5). At 32daysaftersowing, the germinatedseeds of lot 6 had the followingcharacteristics:stemlength 0.85±0.45 cm: radiclelength: 0.85±0.40 cm.

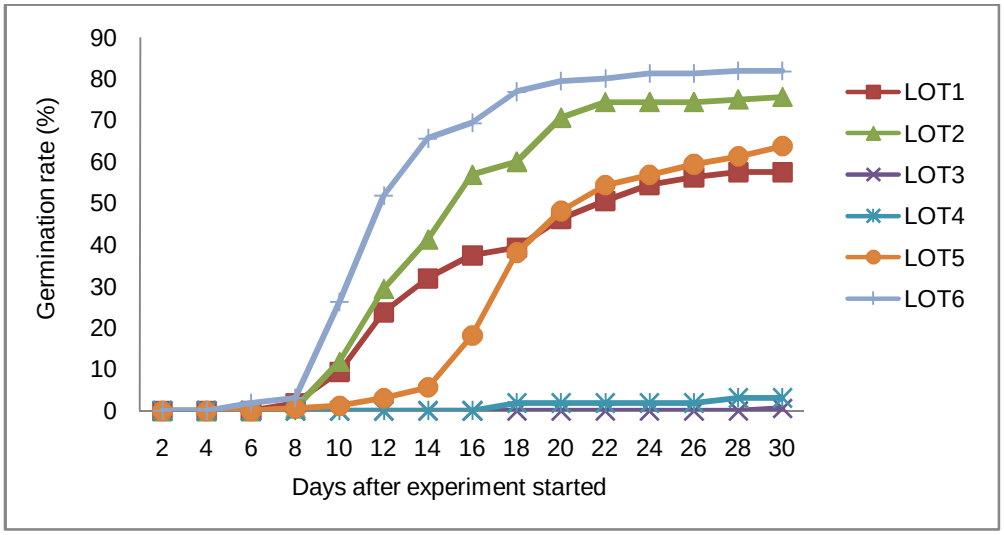

Figure 4 : Germination kinetics of*Sarcocephaluslatifolius*as a function of treatment. Lot 1: blotting papers + 25-30°C+ highly variable light conditions; Lot 2: seeds placed on soil + 25-30°C+ highly variable light conditions; Lot 3: seeds placed underground + 25-30°C+ highly variable light conditions; Lot 4: blotting papers + 30°C+ total darkness; Lot 5: blotting papers + 20 and 25°C.+ alternating 12 h ultra violet light and 12 h darkness; Lot 6: blotting papers + 20-30°C + alternating 12 h white light and 12 h darkness.

Figure 5: Seeds of *Sarcocephaluslatifolius*20 days after sowing of the lot 6 (blotting papers + 20-30°C + alternating 12 h white light and 12 h darkness).

4. DISCUSSION

The different treatments to which the seeds of the two species were subjected revealed the germination behaviour of the seeds as a function of light, temperature and germination medium. The results show thattemperaturesbetween 20 and 30°C and light of at least 12 hours per dayfavour the germination of seeds of bothspecies. The work shows that*C. adansonii*germinatespoorlyundernatural conditions, as alsoreported by Attoh &Ahama (2018). However, shelling of theseseedsfacilitates germination, which can reach 100% (Attoh &Ahama 2018). The seedcoatthereforelimits the plant'sseedregeneration. Fortunately, the plant reproduces by suckering. However, suckeringlimits the spread of *C. adansonii* over large areas (Tyagi et al, 2010). Sharma et al (2003) suggest propagation by graftingaxillarybuds onto rootstocks.

Stangeland et al (2007) also show that the best germination rates for *S latifolius* are obtained at temperaturesbetween 20 and 35°C and that the speciesneeds light to germinate. The best germination rate of *S latifolius*obtained by theseauthorsis 60%, whichissignificantlylowerthan the best germination rate found in thisstudy (82%). This difference of more than 20% between the tworesultscouldbeexplained by the factthat the individuals of *S latifolius*from Uganda and Burkina Faso belong to differentecotypes.

In the studies by Stangeland et al (2007), no *S latifolius*seedsgerminated in the naturalenvironment (savannah conditions), whereas in ourlaboratory trials weobserved a good germination rate in the lot containingsoilfrom the naturalenvironment (lot no. 2). This shows thatenvironmentalfactorsotherthan the condition of the soilinhibit germination. A good germination aidcouldimprove the germination rate of *S. latifolius* in the naturalenvironment.

By comparing the germination kinetics of the twospecies, wefindthat the germination time of *Slatifolius*is shorter thanthat of *C adansonii*. Seed germination kinetics have receivedless attention, sothere are no unifiedmodels to describe the rate and kinetics of seed germination (Zhou et al. 2019). Germination rates differbetween the twospecies. The morphology and physiology of the seeds of thesetwospeciesmayexplainthisdifference. Although the seed sizes of the twospecies are different, they have the same type of germination. Our results show that germination of bothspeciesisinhibited by total darkness, evenwhen the temperatureis optimal for germination. The results of Stangeland et al (2007) also show a verylow germination rate for the *S latifolius*speciesunder conditions of total darkness. Light and temperature seem to be two complementary factors necessary for germination of *C adansonii* and *S latifolius*.

4. CONCLUSION

The aim of thisstudywas to characterise the germination capacity of *C. adansonii* and *S. latifolius*. A temperaturebetween 20 and 30°C and alternating 12 h of light and 12 h of darkness are the optimal conditions for germination of the twospeciesstudied. Temperature and germination medium acted as complementaryfactorsinfluencing the germination of thesespecies. Based on the mostoptimistic future climate scenarios, whichpredict an increase in temperature, seedswith positive photosensitivitythatrequire a certain temperature range will have more difficulty in germinatingproperly. It isstronglyrecommendedthattheseseeds are germinatedunder optimal conditions (12 hours of white light alternatingwith 12 hours of darkness and a temperaturebetween 20°C and 30°C) and thenplantedratherthansown in the field. Future workshould test the resistance of seedlings of the twospecies to abiotic stresses such as water stress and temperatureextremes on plant growth and vigour.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

Sibiry Albert Kaboré designed the study, wrote the protocol, andwrote the first draft of the manuscript. 'Norbert Ouédraogocollect the data, analyse the data and wrote the first draft.
Jérôme Tégawendé Yaméogo, andZézouma Sanon give advices and managed the literature searches. Hien Mipro, give advices and supervice the study.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text to-image generators have been used during writing or editing of this manuscript.

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