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Evaluation of the germination and development potential of cashew seeds in nursery in Benin

Ibouraïman Balogoun*, Sylvain Ladékpo Ogoudjobi, Charlotte Carmelle Zoundji, Ezéchiel Orou Bero, Sylvaine Affagle, Djourédji Moussa

Research Unit of Soil Sciences, Laboratory of Crop, Horticultural and Forestry Sciences, National University of Agriculture, Ketou, Benin

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Abstract

Cashew is an important crop worldwide and its production contributes to the economic development of producing countries. In order to evaluate the evaluation of the germination and development potential of cashew seeds in nursery in Benin, an experiment has been set up in the Ketou municipality. The objective was to improve the agronomic performance of cashew trees by improving the germination rate of cashew seeds. To achieve this, two factors were studied: the type of seed (dried collected seed; non-dried collected seed; dried picked seed; non-dried picked seed) and the type of phytosanitary treatment applied to the seeds (untreated control, treatment with aqueous neem leaf extract and treatment with Momtaz fungicide), the combination of which gave twelve treatments repeated three times in a complete randomized block design. Data collected during the experiment included germination rate, plant height and plant mortality rate. These data have been subjected to a two-factor analysis of variance and the Student Newman-Keul test using R software version 3.4.3. The results showed that the highest germination rates were obtained with dried and undried collected seeds respectively (73.33 and 83.33%). The lowest mortality rate (13.33%) was obtained with Momtaz fungicide treatment of collected and dried seeds. This study recommends that growers use collected, dried seeds treated with Momtaz fungicide to produce cashew seedlings. The study contributes to the knowledge of phytosanitary treatments for cashew seedlings in cashew seedlings and the type of plant material to be used in nurseries for a better production of cashew trees in Benin.

* **Corresponding Author:** Ibouraïman Balogoun ✉ iboubalogoun@gmail.com

Introduction

Cashew (*Anacardium occidentale* L.) is among the first nut crops exported in the world with 5.35 million hectares of plantation (FAO, 2014). Its production can solve the economic, social and environmental problems in the world (Yabi *et al.*, 2013; Balogoun *et al.*, 2014; Yelouassi *et al.*, 2021). Formerly used for reforestation, the cashew tree is currently more cultivated for its fruit, the walnut cashew nut (Lacroix, 2003). Cashew nut production is an important business economic situation in many tropical countries (De Figueiredo *et al.*, 2001; Das *et al.*, 2004; Santos *et al.*, 2007). Indeed, the nut cashew, which is the main product tree sales (Martinez *et al.*, 2011), is a profitable product used in various sectors such as agrifood, cosmetology, medicine, industry (Das *et al.*, 2004; Yabi *et al.*, 2013; Balogoun *et al.*, 2014; Koffi and Oura, 2019).

According to Tokore Orou Mere *et al.* (2021a), cashew is used for reforestation in Benin and in countries such as Tanzania, Côte d'Ivoire and Nigeria. In Benin, it has been an economic currency crop since the 1930s (Yabi *et al.*, 2013). Cashew production is profitable, simple and easy to manage (Balogoun *et al.*, 2014). The Beninese state then took to heart the redevelopment of certain sectors such as cashew. To this end, producers have become aware of the advantages of cashew nuts, which had previously been neglected in favor of cotton (Tokore Orou Mere *et al.*, 2021a). Moreover, Benin is one of the countries in the sub-region with a high added value to be developed thanks to cashew nuts as part of the Government's Action Program (Balogoun *et al.*, 2014; Yelouassi *et al.*, 2021).

Despite the advantages and benefits of cashew nut production in Benin, nut yields in production fields remain low (Adégbola *et al.*, 2005; Balogoun *et al.*, 2014). These yields are very low compared to 820 kg ha^{-1} obtained every year in India (Thimmappaiah *et al.*, 2009; Dasmohapatra *et al.*, 2014). To remove this constraint, it is envisaged to produce quality seedlings for the benefit of producers. This is the purpose of this study, which aims to improve the agronomic performance of cashew trees by improving the germination rate of cashew seeds.

Materials and methods

Study areas

The present study was carried out in the municipality of Ketou (Fig. 1). This municipality is located at the northern end of the Plateau department, between latitudes 7°10' and 7°41'17'' North and longitudes 2°24'24'' and 2°47'40'' East (INSAE, 2008). It covers an area of 2,183 km^2 according to the 4^{th} General Population and Housing Census in Benin (MPD, 2019). The climate is tropical with a bimodal rainfall regime composed of two nuances: a long rainy season, a short dry season, a short rainy season and a long dry season. The average annual rainfall is about 1073 mm in 365 days (Boko *et al.*, 2021). The two maxima of this regime are centered on June and September.

The vegetation is characterized by wooded savannahs of *Daniella oliveri*, *Lophira lanceolata*, *Parkia biglobosa* and forests (Ketou Dogo) covering around forty-seven thousand hectares (Boko *et al.*, 2021). The soils are impoverished, weakly desaturated and indurated, and are associated with vast sheets of ferruginous cuirass bearing sparse vegetation (MPD, 2019).

Experimental setup

The experiment highlights two factors: the type of seed [dried collected seed (RS); non-dried collected seed (RNS); dried picked seed (CS); non-dried picked seed (CNS)] and the type of treatment given to the seeds (untreated control, treatment with aqueous neem leaf extract and treatment with Momtaz fungicide). Fungicides are chemicals used to control fungi that can damage cashew seeds.

However, it is important to note that the use of fungicides can have adverse effects on the environment and human health. It is therefore recommended to choose fungicides that are both effective and environmentally friendly (Touré *et al.*, 2017). That is why Momtaz was chosen over other fungicides.

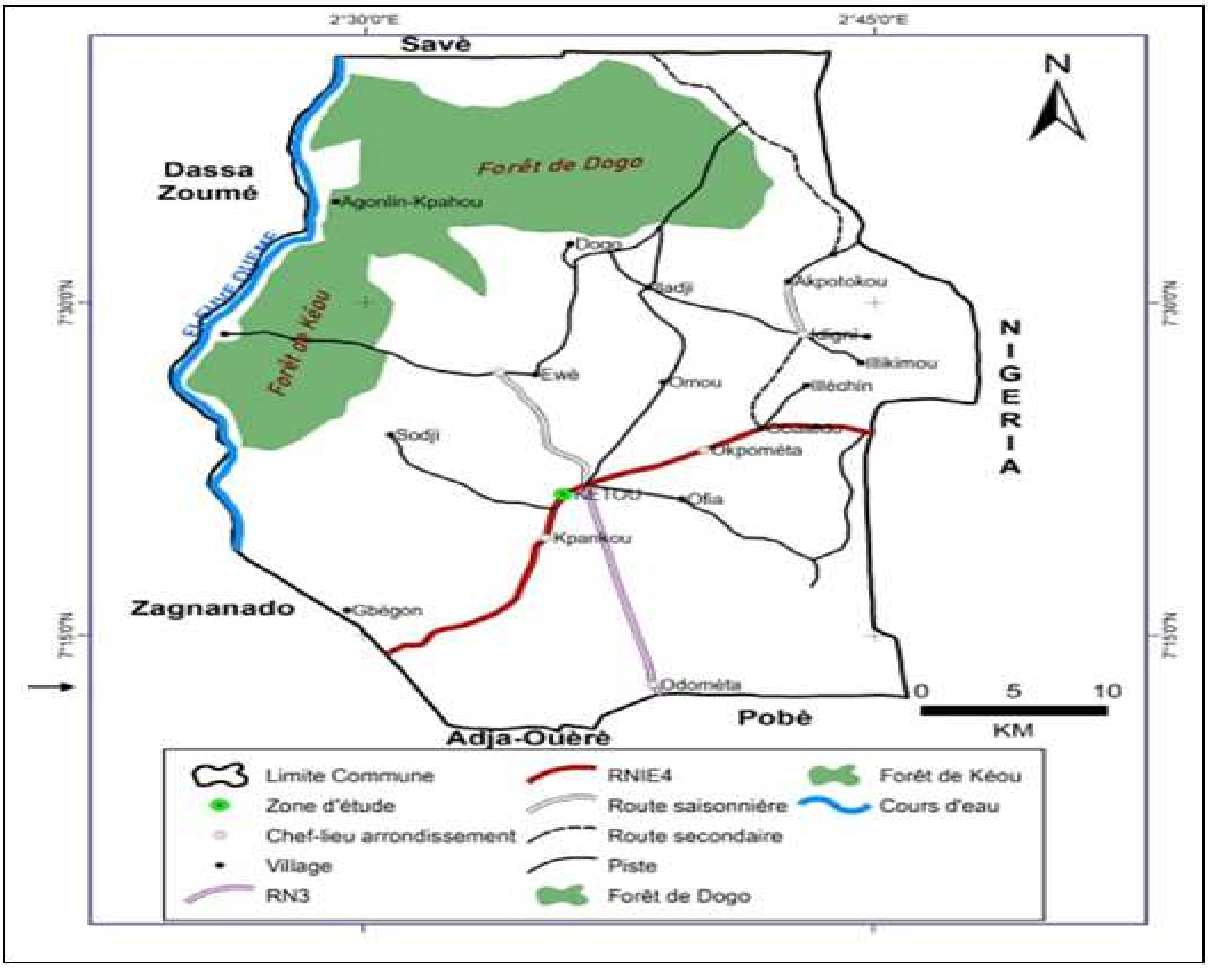

Fig. 1. Map of the study area.

The combination of which gave twelve (12) treatments spread over three (3) replications in a complete randomized block design.

Test set-up

The plant material used was cashew seeds (picked and harvested). The seeds were collected and partly dried. On the day the seeds were dried in the shade, a solution of aqueous neem leaf extract was also prepared. The aim of starting production of the neem leaf aqueous extracted on the same day as the seeds were dried is to enable a solution to be obtained on the sixth day, coinciding with the third day of seed soaking when the aqueous extracted was to be used.For the aqueous extract manufacturing procedure, 1.8 kg of neem leaves were chopped, ground and then soaked in 10 liters of water at ordinary temperature, i.e. after 1 liter of aqueous neem leaf extract to treat each quantity of seed (Baoua *et al.*, 2013; Mondedji *et al.*, 2014). The soaking time of neem leaves in plain water was four days (4 days) before the addition of chopped *palmida* soap on the sixth day of soaking to allow the solution to be viscous to cling to the seeds during soaking (Mondedji *et al.*, 2014).A fungicide solution was also prepared on the same day as the seeds were soaked. To do this, a beer cap filled to the brim with Momtaz was poured into a container containing the quantity of seed to be treated. This is sprinkled with a few drops of water and stirred to homogenize the distribution of the product on the surface of the seeds (Mondedji *et al.*, 2014). A liter of water at ordinary temperature is poured over the seeds homogenized with the product for soaking. For installation, polyethylene bags previously potted with undergrowth potting soil were placed on the plot units. Each plot unit has ten (10) pots. Each pot received one seed for sowing. The soaked seeds were sown in potted polyethylene bags. The seeds were not pushed too far into the bags. Sowing was done in such a way that the hilum of the seed is slightly inclined downwards and a little superficial to avoid seed rot. Labels were made from the can pieces and placed at the head of each experimental unit to serve as a reminder of what was being planted in that unit.

Data collection

To assess the effectiveness of each treatment on the germination, growth and development of cashew seedlings, the following parameters were taken into account during data collection:

Seed germination rate

The seed germination rate has begun ten (10) days after sowing. Germinated seeds were counted every day for two weeks. This rate (T) was determined according to the formula:

$$T = \frac{Total\ of\ germinated\ seed}{Total\ seeds\ sown} x\ 100$$

Plant height

Plant heights were measured using a ribbon meter. This collection was begun twenty (20) days after sowing and it was taken every 15 days during two (2) months. The centimeter was placed at the neck of the plant and stretched to the youngest leaf.

Mortality rate

For the mortality rate, collection was carried out every 15 days by counting dead plants or seeds and lasted two (2) months. It was also done by subtracting the number of seeds sown from the number of seeds germinated, and checking to see if other germinated plants had died.

It began on the twentieth day after sowing. Each item of data collected was recorded on a collection sheet using a pen. Five (5) of the ten (10) plants were selected for data collection.

Statistical analysis

Statistical analyses were performed using R software version 3.4.3. The three-way analysis of variance (ANOVA), considering time as a random factor, was performed for each repeated-measure growth parameter. The two-way analysis of variance was performed for the mortality rate and the germination rate). Before running ANOVA, variance homogeneity was tested. Therefore, no data transformation especially mortality rate and germination rate were needed. The Student Newman-Keuls test was performed to compare differences in means among treatments at the 5%.

Results

Effect of seed type and treatments on cashew seed germination rate

Table 1 shows the analysis of variance of the effect of seed type and seed treatment on cashew seed germination rate. From this table, it emerges that the two factors studied (seed type and seed treatment) have no significant influence on seed germination rate ($P > 0.05$). Fig. 2 shows the evolution of cashew seed germination rates according to seed type and treatment. Considering seeds collected under the trees and dried (RS) and seeds collected under the trees but not dried (RNS), there is no significant difference between the different treatments applied. For both types of seed, the controls (untreated seeds) had the highest germination rates (RS with 73.33% and RNS with 83.33%). As for seeds picked from trees, whether dried or not (CS and CNS), untreated seeds had the lowest germination rates. Those treated with Momtaz fungicide had the highest germination rates (CS with 86.66 and CNS with 83.33%).

Table 1. Analysis of variance results for the effect of seed type and treatment on cashew seed germination rate.

Source of variation	df	Sum of mean squares	Medium square	F value	Probability
Seed types	3	856	285,2	1,267	0.308
Seed treatment	2	117	58,3	0,259	0.774
Seed type* Seed treatment	6	2528	421,3	1,872	0.127

df = degree of freedom.

Effect of seed type and treatments on cashew plant height

Table 2 presents the analysis of variance of the effect of seed type and treatments on height growth of cashew seedlings. From this table, it is noted that seed type highly influenced height growth ($P < 0.001$). Height growth did not depend on seed treatment ($P > 0.05$). But the combination of the two factors (seed type and seed treatment) had a strong influence ($P < 0.001$) on the height growth of cashew plants. The height of cashew plants also varied with time.

Table 2. Analysis of variance results for the effect of seed type and treatment on cashew seedling height growth.

Source of variation	df	Sum of mean squares	Medium square	F value	Probability
Seed types	3	448	149	6,058	0,004
Seed treatment	2	138	69	2,805	0.061
Time	3	21132	7044	285,498	P<0,001
Type of seed* Seed treatment	6	1998	400	16,196	P<0,001
Type of seed* Time	9	76	8	0,343	0.960
Seed treatment*Time	6	108	18	0,727	0.628
Seed type* Seed treatment* Time	18	290	19	0,783	0.697

df = degree of freedom.

Fig. 3 shows the evolution of plant height growth in cashew nurseries according to time. From this analysis, it can be seen that the seeds harvested dried and treated are the best performance in height growth (34.32 cm for CST2 compared to 32.80 cm for CST1). There was no significant difference between these two treatment combination (CST2 and CST1).

Table 3. Analysis of variance results for the effect of seed type and treatment on cashew seedling mortality.

Source of variation	df	Sum of mean squares	Medium square	F value	Probability
Seed types	3	1586	528,7	2,409	0.091
Seed treatment	2	406	202,8	0,924	0.410
Seed type* Seed treatment	6	772	128,7	0,586	0.737

df = degree of freedom.

Effect of seed type and treatments on cashew seedling mortality rate

Table 3 presents the analysis of variance of the effect of seed type and seed treatment on cashew seedling mortality rate. Analysis of this table shows that the two factors studied (seed type and seed treatment) have no influence ($P > 0.05$) on cashew seedling mortality in the nursery. Fig. 4 shows the mortality rate of cashew seedlings in the nursery according to seed type and treatment. Analyses of this parameter shows that seeds collected from under the trees and dried have the lowest mortality rates, despite the absence of any significant difference between treatments. It should be noted that the Momtaz fungicide treatment of collected and dried seeds produced the lowest mortality rate (13.33%).

Discussion

Effect of seed type and treatments on cashew seed germination rate

The results of the present study show an improvement in the germination rate of the seeds, but also good growth and a reduction in the mortality rate with the different treatments. Of these results, the use of seeds collected from the trees, dried and then treated with the fungicide Momtaz (RST2) gave the best results in terms of germination rate (73.33%) and low seedling mortality rate (13.33%).

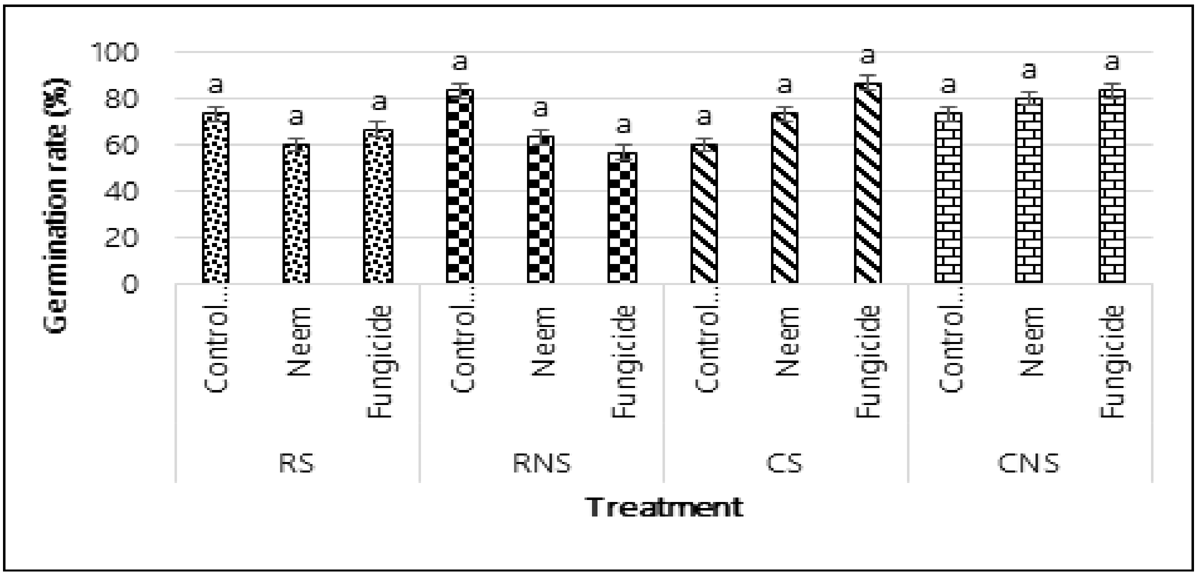

Fig. 2. Evolution of cashew seed germination rate according to type and different treatments.

On the other hand, seeds harvested from trees, whether dried or not (CS and CNS) and untreated, showed the lowest germination rates.

The fact that seeds picked from trees treated with the fungicide Momtaz had the highest germination rates compared with un-treated seeds suggests that treating cashew seeds with Momtaz has a positive effect on germination. It is in this context, that Ndour *et al.* (2021) assert that seed treatment plays an important role in the species' survival. Momtaz fungicide therefore has the capacity to promote germination, stimulate emergence and combat pest and disease attacks.

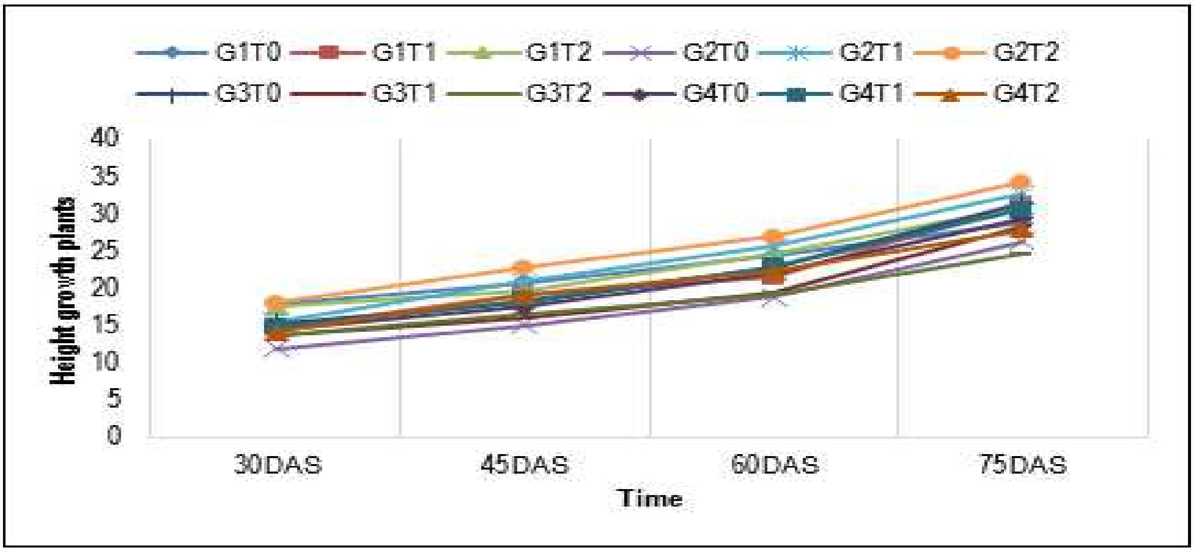

Fig. 3. Growth in plant height in cashew nurseries.

These results are in agreement with those of Silue *et al.* (2018), who showed that fungicide use has advantages on plant germination. The same authors claim that the biological fungicide NECO inhibits the pathogen's in vitro mycelial growth, maintains anthracnose serenity and has antifungal activity. Apart from seed processing, this difference in performance between collected and harvested seeds is linked to their degree of ripeness. According to Djaha *et al.* (2008), seeds are collected when the fruit falls from the tree on its own when fully ripe. Ndour *et al.* (2021) have shown that chemical substances produced by the plant and accumulated in the fruit or seed may be plant hormones that inhibit germination in the case of abscisic acid, for example, germination may be faster after elimination. Considering seeds collected under trees and dried (RS) and seeds collected under trees but not dried (RNS), the absence of any significant difference observed suggests that they have very similar intrinsic characteristics.

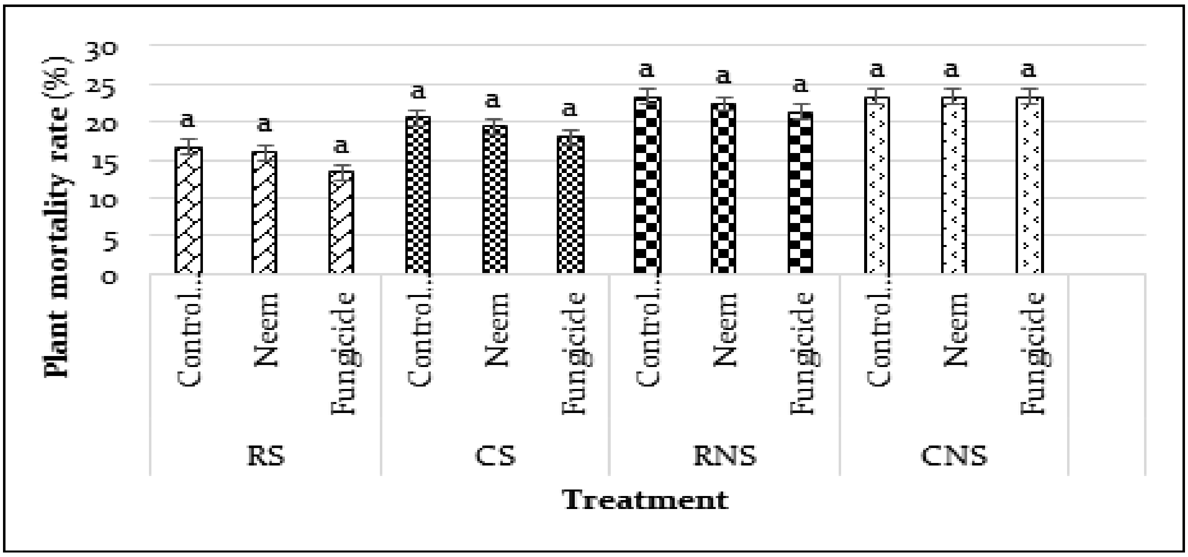

Fig. 4. Mortality rate of cashew seedlings in nurseries, by type and seed treatment.

Effect of seed type and treatments on cashew plant height and cashew seedling mortality rate

The results of this study show a good growth and a reduction in the mortality rate with the different treatments. Of these results, the use of seeds collected from the trees, dried and then treated with the fungicide Momtaz (RST2) gave the best results in terms of low seedling mortality rate (13.33%).

As far as the use of aqueous neem leaf extract is concerned, experimental results showed that this treatment did not give better performance on the various growth parameters. However, some authors, including Tokore Orou Mere *et al.* (2021b), have shown that the use of aqueous extracts, as in the case of false Ashoha (*Polyalthia longifolia*) applied directly for grafting, induces better performance in terms of plant height growth and leaf area.

In the same sense, Yao *et al.* (2022) showed that the aqueous extract of neem seeds was effective on most pests, and these aqueous extracts can be used in an integrated control program against major crop pests such as cabbage.

Conclusion

The present study assessed the effect of the seed types (dried collected seed; non-dried collected seed; dried picked seed; non-dried picked seed) and the types of seed phytosanitary treatment (Momtaz fungicide and neem leaf solution and aqueous solution) on the agronomic performance of cashew seedlings in the nursery. The use of seeds collected then dried and treated with Momtaz fungicide induced good performance on germination rate as well as on seedling mortality rate. For this reason, growers are advised to use cashew seeds collected then dried and treated with the fungicide Momtaz in the production of nursery seedlings. With this in mind, growers need to be sure of the origin of the seeds.

The germination capacity of seeds collected from under the trees should also be studied over time.

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