

## Germination and morphological characteristics on cashew seedling (*Anacardium occidentale* L.) yellow type

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### Abstract

Cashew is worldwide accepted by its fruit and multiple uses of it and of the tree, and characteristics of the existent materials for their use as a pattern are unknown, therefore, germination and the morphological characteristics of cashew seedlings yellow type. A total of 240 seeds were sowed with the distal area up in gumbo limbo composed by sand and organic matter (2:1). The number of germinated seeds was quantified daily for 14 days to determine the germination rate (TG), and was registered weekly for 28 days to measure the germination percentage (PG). Within 28 days, variables were measured such as high of the plant (AP), root's longitude (LR), number of leaves (NH), and number of nodes (NN) per seedling. For each response variable, the frequency distribution, descriptive statistics and Spearman coefficient were used to correlate variables. Germination was of 86.9% at 14 days and extended to 28 days with a PG of 97.9%, TG was of 99.9 days, AP of 33.7±6.8 cm, LR de 20.6±4.1 cm, NH de 10.4±1.4 cm y NN de 7.2±1.4 cm. A highly positive lineal positive correlation was determined ( $P < 0.01$ ) among variables AP-LR ( $r = 0.30409$ ), AP-NH ( $r = 0.53097$ ), AP-NN ( $r = 0.51626$ ), LR-NH ( $r = 0.29787$ ), LR-NN ( $r = 0.23845$ ), NH-NN ( $r = 0.66826$ ). AP and LR frequencies were classified in five well defined groups, each one representing 20% of the population. NH tendency was from 10 to 11 and the one of NN was from 7 to 8 with frequency percentages of 59.4% and 54.3% respectively.

**Key words:** germination, morphological characteristics, seedling, *Anacardium occidentale*.

### Introduction

Cashew, also known in Venezuela as «marañón, cauñil, pauñil, pauñil, caracolí, chorote and lacre rosado», is

a tree coming from America, which grows widely from the South of México to Brazil. It is in Asia and Africa as

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a crop, but with less quantity compare to America, where it is sowed by the value of the fruits (10). Likewise, it is well adopted in semiarid regions and in less deep, sandy, rocky and normally poor soils, in savannahs and even in small hills, from the sea level of approximately 1000 m altitude (2, 10).

Two types of cashews are known according to the fruit's color or pseudo fruit: scarlet red cashew, and yellow cashew. The first seems to have the best and most juicy fruits, with a higher content of citric acid and tannins. Fruits, botanically speaking, are achene with a reniform shape and shiny brownish-grey, suitable to eat after being toasted, from 2 to 4 cm length on a periform thickened peduncle (10).

Cashew is valued by its multiple uses: the ripe and enlarge pseudo fruit or peduncle is eaten as a fresh fruit, which is very nutritive and with high content of pectin and vitamin C (250 mg 100 ml<sup>-1</sup> of juice); its juice is digestive, antibacterial and antidiysenteric. Likewise, when fermented it is applied in the preparation of wines, vinegars and liquors. The almond has an industrial use in the elaboration of cosmetics, resins, varnishes, dyes, as well as products for pantries among others. From the seed cortex or botanic fruit the anacardiaceous acid is extracted heating it, which is highly caustic and poisonous (2, 15).

The wood is sometimes used in some countries, carpentry constructions, boats, cardboard preparation, and others. From the resin and gum segregated by the tree,

a mucilaginous substance has been extracted, which repulses the insects and is an excellent substitute of the Arabic gum. It can be also used as medicinal infusions that are done through leaves, sprouts or new shoots and cortex; it is also used as an ornamental tree in gardens (10).

Plant's yields vary in function of the development of the crop: 150 kg annually of nuts within five years with 400 trees ha<sup>-1</sup>; 500 kg annually within 10 years, with 200 trees ha<sup>-1</sup> and 1000 kg within 20 years with 100 trees ha<sup>-1</sup> (6).

Among the main producer countries of cashew's almond are India, Brazil, Nigeria, Tanzania, Guinea Bissau, Vietnam, Thailand and Indonesia. India and Brazil cover 90% of the processing and exportation of the industrialized almond. India, which systematically imports almond from Africa with the aim of improving its industrial processing and commercialization, exports annually from 65.000 to 75.000 tn of almond. On the other hand, Brazil also imports almond from Africa and exports from 30.000 to 35.000 tn (18).

The production data for 1999 indicates that the highest producer is the Asiatic continent, which provides 638.037 tn of nut, which mostly comes from India and Malasia. Then comes Africa, with a total of 411.068 tn and finally America with 130.403 tn, from which 90% is produced in Brazil. In Venezuela, the production concentrates in Bolivar state, where in 1996, 87 tn of nuts were sowed in 1300 ha in production. This is the result of the project developed by Palmaven in 1992,

with the help of the Agriculture enterprise Mereyera Tiragua. The support and help to this and other projects are very important, due to all parts are useful by the good price in the international market, where almond is highly paid, even reaching six dollars the kilogram; its good natural adaptability to our climatic conditions, among others, increases its importance as a potential source of currency and employment, considering that worldwide just half of the organic matter is produced to supply the food, pharmaceutical, print and aeronautic industries, and others (15).

This fruit propagates through the botanic seeds, which germinate passed three to four weeks from the sow (2, 6, 14). This type of reproduction is simple, cheap and safe, also the developed plants tend to go deeper and clamped firmer in the land than in the patterns obtained from stakes (9).

The vegetal dissemination with stakes is very difficult (5, 14). The method with highest success is the grafting of selected cultivars on young patterns coming from seeds (2, 4).

For the establishment of commercial plots, the grafting technique is a valuable tool to obtain genetically uniform plantations, also in most cases the period from the crop to the beginning of the plant's production (from 2 to 4 years) reduces; but to be practiced it is required that the pattern be six years old or at least a cm of diameter, so it is

important to evaluate the grow and development of these (8, 10), due to in cashew the plant's characteristics are unknown for their use as a pattern. Duarte *et al.* (5) have indicated that cashew dissemination is one of the most important factors to improve the crop, since grafting is one of approaches of it, and for this it is necessary to achieve a uniform germination and a fast growth of seedlings.

Most fruit crops are heterozygote and of crossed pollination, including cashew. These conditions generate the existence of a considerable genetically variable in plants obtained by seed, which is not recommendable for the establishment of a plantation (2). However, there are important reasons that justify the plant's production per seed, as the obtaining of pattern and seedlings in species, as cashew, which reproduces difficulty by vegetative methods (9). Therefore, a careful selection of parents chosen for the seed production as well as a maintenance of the genetically characteristics with the aim of allowing that the genetic variability be lower in the decadency, when seeds are employed in the propagation of fruit species (16).

This research was done with the purpose of evaluating the germination and morphological characteristics of cashew seedlings yellow type in greenhouse conditions, to be used as a pattern for grafting.

## Materials and methods

The research was done at the propagator of la Universidad del Zulia greenhouse, located at Maracaibo's plain, which is on an ecological area with very dry tropical forest, with relative humidity of 79%, average temperature 29°C and an evapotranspiration of 2500 mm year<sup>-1</sup> (7).

Seeds and the botanic fruit were collected from mother plant of cashew, of the yellow type, located at «Santa Ana» farm, road to Palito Blanco, Lössada municipality, Zulia state, Venezuela. These were divided from the peduncle and were immediately washed with water and commercial soap (3 g L<sup>-1</sup> of soap, sodium sulfate and sodium sulfonate dodecylbenzene) and were rinsed four times with water. The selection of seeds was done according to the size and weight, discharging those that floated once immersed in water. Seeds were dried in the shadow and with environment temperature for an hour, with the purpose of eliminating the excess of humidity in the cover of the seed, avoiding its dehydration. Then, were put inside a plastic bag and frozen in a temperature of 10 ± 1°C for 20 days.

An effective area of seed bed from 1 m width and 2 m length was used, filled with sand (vegetal surface) and organic matter (river manure), with 2:1 proportion, and previously disinfected with quaternary formol at 37%, in a dose of 150 ml m<sup>-2</sup> for each 5 L of water. The propagator was

covered with a saffron mesh which offered 40% of shadowing.

A total of 240 seeds were sowed with the distal area up (12), considering a separation between rows and seeds of 7 cm approximately. Prior to the sow, the fungicide Ridomil<sup>®</sup> (Metalaxyl-Mancozeb), by means of 3 g L<sup>-1</sup> was applied. Irrigation was done every other day.

The number of germinated seeds was daily quantified for 14 days to determine the germination rate (TG) and was later registered weekly for 28 days to measure the germination percentage (PG). TG was obtained using the determination method of the number of days required for germination, through the following equation (9): Average days = (N<sub>1</sub>T<sub>1</sub> + N<sub>2</sub>T<sub>2</sub> + ... + N<sub>n</sub>T<sub>n</sub>) / (N<sub>1</sub> + N<sub>2</sub> + ... + N<sub>n</sub>). Where: N<sub>1</sub> = number of germinated seeds, N<sub>2</sub> = number of germinated seeds between the interval of time T<sub>1</sub> T<sub>2</sub>. Within 28 days, the number of leaves and number of buds were counted. The seedling height was measured from the apex to the base or neck of the stem, and the root's longitude from the base to the apex of the main root.

The obtained data was processed using the statistical analysis system SAS version 6 (19). In order to correlate variables frequency distribution, descriptive statistics and the Spearman's correlation coefficient were used, since these were far from reality (20).

## Results and discussion

The germination percentage within 14 days of sow was of 86.9%, value that tended to increase until reaching 97.9% within 28 days (figure 1). It is important to highlight that 7.5% of seedlings showed to be abnormal, which in most cases did not surpass 8 cm high.

The obtained germination percentage turned to be different to the mentioned by Duarte *et al.* (5), 56 % of germination, though are similar to those registered by Menon *et al.* (13) and Naranjo *et al.* (12), who obtained 97% and 86.7% during all the essay, respectively. This last percentage differs to the results obtained in this research which increased in the time. The germination pattern of cashew was epigeal (9), because the hypocotyl enlarged and elevated the cotyledons in the area (figure 2).

The germination rate obtained was of 9.99 days, which represents the average of days required for the

emergency of seedlings, which turned out to be superior to the obtained by Naranjo *et al.* (12) of 8.1 days.

On the other hand, the beginning of germination resulted to be different to the cited by other authors (2, 6), which indicated that it happened from 21 to 30 days, approximately after the sow. These differences at the beginning of the germination might had been related to the high temperatures that were at Maracaibo's plain (29°C), which carried a higher speed of the physiological reactions, and the acceleration of the germination process (9). On this matter, germination can take place in two weeks in warm areas, when temperatures are around 30°C, or in two months in template areas (14, 17). Gonzaga *et al.* (8) obtained that the seed germination with cover under controlled conditions initiated within 7.7 days and ended at 10.7 days.

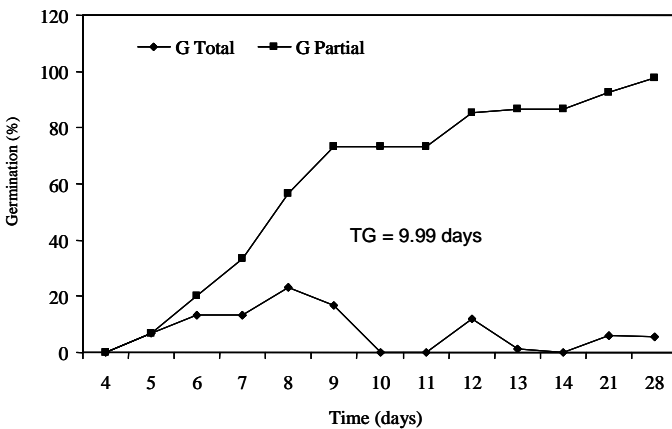
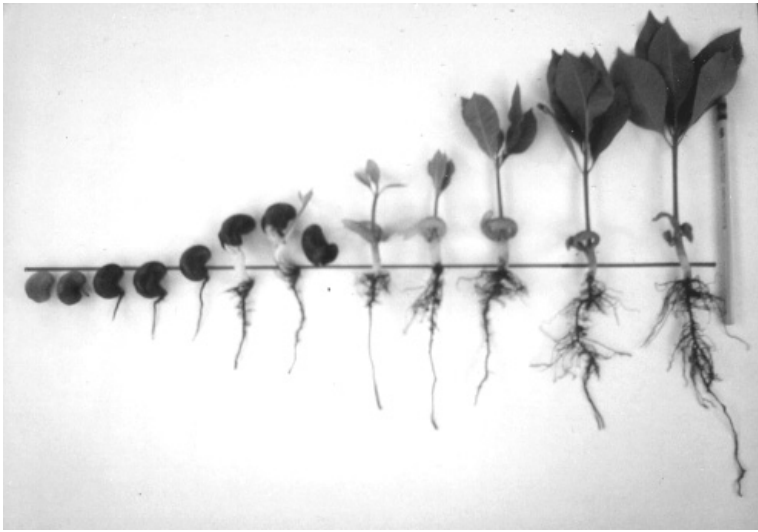


Figure 1. Germination percentage (G) and germination rate (TG) in cashew seeds yellow type.



**Figures 2. Germination of seeds and growth of seedlings of mery Yellow type.**

The morphological characteristics of seedlings showed variability among them, which was considered low according to the coefficient values of variation lower or the same to 20%, and the obtained standard deviation (table 1). Observing the minimum and maximum values a wide range was seen, especially regarding the variables high of the seedling and root's longitude from 33 to 26.5 cm respectively. In relation to values of central tendency, mode and mean, mode showed that the high of the plant and root's longitude that most repeated in the studied population were of 37 and 22 cm respectively. The median, which occupies the central place inside the population of studied values ordered on a increased or decreased sense, was very similar to the mean in all variables. This shows that variables had a normal tendency.

Seedling high, in this case, resulted to be higher (33.7 cm) than the described by Naranjo *et al.* (12), which was of 18 cm within 30 days.

There has also been a low variability in medlar's seedlings (3), this behavior associated to the high quality of employed seeds creating seedlings with normal and homogeneous development, important aspects in the quality measurement of the fruit (1). The resultant variability of seedlings was associated to the heterozygote aspect of cashew, and at the same time to the crossed pollination, conditions that caused a considerable genetic variable in its decreasing (2, 9).

On the other hand, was found that for variables seedling's high and root's longitude in the frequency distribution (table 2), that there were five well defined types or categories, each one constituted approximately

**Table 1. Statistical analysis of the morphological characteristics of cashew seedlings yellow type, within 28 days of sow.**

Morphological characteristics	Mean $\pm$ DE	CV (%)	Minimum value	Maximum value	Mode	Median	Range
Seedling's height (cm)	33.7 $\pm$ 6.8	20.2	13	46	37	35.0	33
Root's longitude (cm)	20.6 $\pm$ 4.1	19.7	9	35.5	22	20.0	26.5
Leaves' number	10.4 $\pm$ 1.4	13.7	6	14	11	11	8
Nodes' number	7.2 $\pm$ 1.4	19.4	3	12	7	7	9

N<sup>o</sup> of observations: 217. DE: standard deviation. CV: variation coefficient.

20% of the population. Meanwhile, three categories generated for variables leaves' number and nodes' number per seedling with a lower variability, where the group that had from 10 to 11 leaves with 59.4% from

**Table 2. Frequency distribution and percentage of variables seedling's height, root's longitude, number of leaves and number of nodes of cashew seedlings yellow type, 28 days after the sow.**

Variable	Type or category	Frequency	Percentage
Seedling's height (cm)	13 $\leq$ - < 28.4	44	20.3
	28.5 $\leq$ - < 34	46	21.2
	34.1 $\leq$ - < 36.8	42	19.3
	37 $\leq$ - < 39.1	43	19.8
	39.2 $\leq$ - < 46	42	19.4
Root's longitude (cm)	9 $\leq$ - < 17.5	45	20.7
	17.6 $\leq$ - < 19.5	44	20.3
	19.6 $\leq$ - < 21	44	20.3
	21.3 $\leq$ - < 23.9	41	18.9
	24 $\leq$ - < 35.5	43	19.2
Number of leaves	6 - 9	51	23.5
	10 - 11	129	59.4
	12 - 14	37	17.1
Number of nodes	3 - 6	65	30.0
	7 - 8	118	54.3
	9 - 12	34	15.7

Number of observations: 217.

the total of seedlings predominated, NN had the same behavior, presenting from 7 to nodes, with 54.3% from the total of seedlings.

Correlation between variables seedling's high, root's longitude, leaves' number and nodes' number was highly significant and positive ( $P < 0.01$ ), specially variables leaves' number and nodes' number (table 3), which indicated that with a higher height of the plant a higher longitude of its root, also with a higher height of the seedling, a higher number of nodes in the stem, and this variable

was at the same time correlated with the highest number of leaves. Pérez *et al.* (13), found on mango c.v. Pico de Loro seedlings a similar behavior in relation to the correlation of the response studied variables.

Though, when there was a positive and highly significant correlation, the obtained values were mean for seedling's high and leaves' number ( $r = 0.53097$ ), and nodes' number ( $r = 0.51626$ ), and between leave's number and nodes' number ( $r = 0.66826$ ), but the other variables were low.

**Table 3. Spearman's correlation coefficient of variables seedling's height (cm), root's longitude (cm), leaves' number and nodes' number of cashew seedlings yellow type, within 28 days of sow.**

	Root's longitude	Leaves' number	Nodes' number
Seedling's height	0.30409**	0.53097**	0.51626**
Root's longitude		0.29787**	0.23845**
Leaves' number			0.66826**

Each row shows the correlation coefficient. \*\*Highly significant ( $P < 0.01$ ).

## Conclusions

Seeds germination of cashew initiated within 5 days, at 14 days was of 86.9 and extended until 28 days with 97.9%. The germination rate was of 9.99 days.

High and root's longitude of cashew seedlings was  $33.7 \pm 6.8$  cm and  $20.6 \pm 4.1$  cm, respectively, in 28 days of the sow.

Cashew seedlings presented from 10 to 11 leaves and from 7 to 8

nodes, with a frequency of 59.4% and 54.3% respectively, in 28 days of sow.

Variables seedling's high, root's longitude, leaves' number, nodes' number, showed a positive lineal correlation and also highly significant.

Seedling's height and root's longitude were in five well defined groups, which represented 20% of the population each.

## Recommendations

Sowing directly from seed to bags or pots, since seedlings showed a fast development.

To consider a sowing time of seedlings in the field no longer than

30 days, because root's longitude was from 20 to 35 cm in 28 days, also leaves' number was enough to adapt to field's conditions.

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