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Managing Cashew Rootstock Grafting Size Through Organic Fertilizers

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Abstract

Seed born cashew (*Anacardium occidentale* L) seedlings are planted directly when they are produced from polyclonal orchards. In a common scenario, cashew seedlings are grafted before transplanting. For this purpose, adjusting the size between scions and rootstock is highly important for the success of grafts and it can be achieved through a visual selection of scions. However, when working with large numbers of seedlings physical and visual selection becomes laborious and time consuming for the workers. Therefore, creating uniformity in seedlings size before grafting is crucial. We present experimental results showing the linear regression between the fertilization level and seedling stem size. Two experiments were conducted in Mozambique: One at Nassuruma cashew Research Station, Nampula province, following a Completely Randonmized Block Design (CRBD), seven treatments, ten bags per treatment and five replicates. The treatments consisted of a fertilizer organically composted from cashew nut shells and applied at rates of 0, 4, 8, 16, 32, 40 and 48% of the total amount of soil in each bag. The second experiment was carried out at Chizavane nursery, in Gaza Province, also based on CRBD, in factorial arrangement of 4 and 3 levels of Kelp and Stimu biofertilizers respectively. Two stem size variables, diameter and height, were considered and data collected at 120 days after seedlings emergence in Nampula and 45 days after emergence in Gaza Province. Polynomial or simple regression analysis model for stem diameter and plant height was performed. The stem diameter was linearly described as an increasing equation. The height was also linearly related to fertilizer but following a decreased equation. We concluded that applying appropriate dosage of fertilizer in the soil or on the leaves could adjust the stem size of the rootstock required for grafting and therefore adjust the stem to the size of scions available. The treatments with high level of Kelp, Stimu and cashew compost fertilization resulted in increase of 8,5%, 6% and 16,6% of diameter respectively. However, the treatments caused a reduction of height at rate of 14,3%, 3,2% and 25,08% respectively. The stem and scion size adjustment are highly important for increasing the grafting success rate in a cashew nursery.

Keywords: cashew seedling, scion, foliar and soil fertilization

1. Introduction

The cashew (*Anacardium occidentale*, L.) belongs to Anacardeaceae family and it's originated in South America, Central region of Brasil (Dendena and Corsi, 2014). A global data estimate from Ricau (2019) indicates countries with higher productions in the following sequence: Ivory coast (875 000 MT), India (675 000 MT), Vietnam (450 000 MT), Tanzania (295 000 MT), Nigeria (240 000 MT), Guinea Bissau (185 000 MT) and among others Mozambique with only (70 000 MT). The Portuguese sailors were responsible for the cashew initial spread throughout the world (Milheiro and Evarsito, 1994) and thus introduced the crop in Mozambique in the sixteenth century (Martin et al., 1997). Since then, cashew has been cultivated all over the coastal areas of Mozambique (Milheiro and Evaristo, 1994) but yields in general have been less than one metric ton per hectare or just less than 16 kgs per tree (Grobe-Rüschkamp e Seelige, 2010). Such low levels of productivity have been attributed to aging of trees (Frei, 2013) associated to high disease and pests pressure (Low et al., 2001). In response, the government of Mozambique has been acting in integrated cashew management approach which includes planting more seedlings as a key for cashew farms rehabilitation.

Such seedlings quantities require substantial amounts of substrate that can hold nutrients long enough before transplanting. However, this would mean counter facing the effect of irrigations that has been found to significantly reduce nutrients from the substrate (Aguiar et al., 2006) and indeed affects the seedlings quality (Costa et al., 2011 & Rickli e Peres, 2016) and thus extend the period before grafting and/or transplanting. The problem of nutrient depletion in potted substrates can be overcome through appropriate formulations of organic and inorganic composts (Cavalcanti & Chaves, 2001). On seedlings, inorganics may have adverse effect on the microflora associated with root (Dixit E., 2011; Mostafa e Abo-Boker, 2010). Upon seedlings transplanting, inorganics fertilizers may also enter the groundwater later and cause environmental impact to other living systems and crops productivity (Roy et al, 2006). Therefore, organics such as bovine manure, sugar cane bagasse (De Lima et al., 2001) or biofertilizers are found to be environmentally healthy despite requiring extra care in handling (Bhardwaj et al., 2014). Moreover, organics have been a joice in modern agriculture because they promote and stimulate gradual release of nutrients into the soil (Serrano et al., 2018; Shankarappa et al., 2017). Based on this realization, several studies have explored the use of vermicompost and sugar cane bagasse (De Lima et al., 2001), carbonized rice or coco nut fiber (Correia et al., 2003) and pine burk (Serrano et al., 2016) in cashew seedling production systems. Among organics, biofertilizers are known to be an efficient approach for essential nutrient supplementation that induces rapid growth and plant robustness (Shehata et al., 2003). This is because bio-fertilizers in their composition include calcium and magnesium which are essential components in formulations (Dendena and Corsi, 2014). They have been found to balance the negative effect of irrigation saline water on cashew seedlings (Torres et al., 2014). Additionally, biofertilizers may also contain nitrogen fixing microflora and also microorganisms that play special role in converting and releasing none easily accessible nutrients to the roots (Mostafa & Abo-Boker, 2010). In rice and maize, biofertilizers have been found to increase yield in 10 and 28% respectively (Walker, 2009). On cashew seedlings production systems, biofertilizers, have been found to improve total dry matter of plantlets in Brazil as well as in India (Melo Filho et al., 2015 and Shankarappa et al., 2017). Our focus is how to use these fertilizers to ensure seedling size uniformity on time for grafting. Therefore the objective of the current study was to determine the stem size response, diameter and height, to different dosages application of Kelp-p-max biofertilizers (Omnia Nutriology-Bryanston, South Africa) and Stimu-phos (Arysta-LyfeScience, South Africa) and different proportions of organic compost integration formulated from cashew nut shells.

2. Material and Methods

2.1 Trial Sites, Soils and Climate

One trial was conducted at Nassuruma Cashew Research Center, attached to Agriculture Research Institute of Mozambique, IIAM-North East Zional Centre, located between 14º 59’ and 38.162’’ South and 039º 42’ 53.304’’ East. The area is part of agro-ecological zone R8 characterized by predominance of lixisols, leptosols and arenosols. The average annual temperature is between 24 and 26ºC and annual rainfall of 800 to 1200 mm with relative humidity, a characteristic of humid semi-arid, with spots sub-humid and an extensive spots of dry semi-arid (Salustiano et al., 2014).

The second trial was implemented at Chizavane, located between the coordinates 24°54’45.2’’S and 33° 59’47.3’’E, Chidenguele Administrative Post, Mandlakazi District. The area is part of agro-ecological zone R2 with prevalence of arenosol, fluvisols and manangas. The zone is characterized by average annual temperature of 24 to 26ºC, annual rainfall of 800 to 1000 mm and relative humidity typically humid semi-arid, with some sub-humid spots in the littoral (Salustiano et al., 2014).

2.2 Trials, Design and Implementation

A CRBD with seven treatments in five blocks was followed (Peterson, 1994). The treatments (T1 to T7) consisted of amended common top soil with different proportions of cashew nut shell compost at 40% decomposition level. T1 was not amended and therefore was the experiment negative control while T2 to T7 were amended with 4, 8, 16, 32, 40 and 48 %

(w/w) mixture of compost and the commonly used nursery top soil as described: T1 = Control; T2 = 96% Common Soil (CS) + 4% Cashew Nut Shell (CNS); T3 = 92% CS + 8% CNS; T4 = 84% CS + 16% CNS; T5 = 68% CS + 32% CNS; T6 = 60% CS + 40% CNS; e T7 = 52% CS + 48% CNS. Each experimental plot consisted of 10 polyethylene black pots (9 x 27 cm). The nutritional composition of the cashew nut shell organic compost was analyzed at North East Zonal Center of Mozambique, Agrarian Research Institute (IIAM), Plant and Soil Analysis Laboratory (15° 08' 51.53" South and 39° 18' 82.98 "East) and the results are presented on Table 1.

Table1: Nutritional composition of cashew nut shell compost at 40% decomposition.

pH (H_2O)	CE	P	K	Ca	Na	Fe	Zn	Cu	Mn	N	M.O
---	[µS/cm]	[ppm]	[cmol (+)/kg]			[ppm]				[%]	
6.4	13.4	618.2	26.5	13.7	5.38	169.2	182	2.4	118	0.6	24.9

Source: Mozambique, Agriculture Research Institute, IIAM – North East Zonal Center, Plant and Soil Analysis Laboratory, 2017. Where CE is Electric conductivity, P-phosforhus, K-Potassium, Ca-Calcium, Na-Sodium, Fe-Iron, Zn-Zinc, Cu-Copper, Mn-Manganese, N-Nitrogen and M.O - Organic matter.

The trial was conducted during seedling production season from January to April 2018, at almost same size nuts from clone 5.12 PA were visualy inspected for physical damage and then tested for density by submersion in water (Torres et al., 2014; Awodun et al., 2015). All other practices such as watering and pest and disease managament were conducted following the nursery normal procedures.

The experiment at Chizavane, was conducted between September and December, 2018 in a netted insect proof plant house. As the nursery normal practice, the substrate consists of top soil collected from underneath nearby trees up to 20 cm deep from the surface. This substrate is typically derived from decomposed organic debris. The collected substrate was chemically analyzed before planting and after 90 days of seedling germination per treatment as shown in table 2.

Both, substrate and cashew seeds were disinfected with copper oxycloride at a ratio of 5g/L of water. The seeds from 12.8 P.A e 5.12 P.A cashew clones with similar size were dipped in to the solution for 24 hours and then placed for pre-germination under a juta bag. Ten days later, uniform germinated seedlings were selected and transferred in to polyethylene bags.

All experimental plots were sprayed with 111ml of mixture of biofertilizers and water according to the treatment per seedlings, 15 days after germination and repeated in equal intervals up to day 85 after germination.

The trial was conducted following a CRBD (Gomez and Gomez, 1984) in a two factorial scheme with 4 and 3 levels (Banzatto et al., 2006). That is, two biofertilizers (Kelp-p-max (Kp), from Omnia Nutriology, Bryanston, South Africa and Stimu-phos (St), from Arysta-Lyfe Science, South Africa) with 4 and 3 application doses respectively in a total of 12 treatments as follows: T1= 75ml of Kelp-p-max (Kp) + 0ml of Stimu-phos (St); T2=150ml Kp + 0ml St; T3=215ml Kp + 0ml St; T4=0ml Kp + 15ml St; T5=0ml Kp +30ml St; T6=75ml Kp + 15 ml St; T7=75ml Kp +30ml St; T8=150ml Kp + 15 ml St; T9=150ml Kp + 30ml St; T10=215ml Kp + 15ml St; T11=215ml Kp + 30ml St; e T12=0ml K + 0ml St (control).

Table 2. Chemical composition of the substrate, per treatments, used in cashew seedlings production at Chizavane, Chidenguele Administrative Post, Gaza Province - Mozambique, before planting and 90 days after seedling germination

Treatment	Ca	Mg	Na	P	K	N	C	MO	pH	CE
	[meq/100g]							[%]	[-]	[mS/cm]
Chemical composition of the substrate before planting										
	2.10	0.83	0.22	1.25	0.18	-	3.21	5.53	5.95	0.05
Chemical composition of the substrate 90 days after planting										
T1	2.00	0.80	1.34	0.58	1.14	1.43	0.35	0.68	5.74	0.07
T2	2.40	0.40	0.42	1.14	0.75	0.45	0.36	0.72	5.76	0.19
T3	2.40	-	1.16	3.31	0.93	0.11	0.42	0.82	5.36	0.12
T4	2.00	0.40	0.60	0.47	0.70	0.12	0.38	0.75	5.43	0.10
T5	2.40	0.40	0.66	0.72	0.76	0.15	0.29	0.58	6.11	0.06
T6	1.60	1.20	0.74	2.06	0.77	0.29	0.33	0.65	5.76	0.06
T7	2.40	0.40	0.47	2.21	0.67	0.07	0.33	0.65	5.61	0.05
T8	2.00	0.80	1.16	2.31	0.89	0.10	0.31	0.61	5.54	0.05
T9	1.20	1.20	0.64	4.09	1.01	0.12	0.26	0.51	5.57	0.05
T10	2.00	1.60	0.49	2.81	0.74	0.10	0.24	0.48	5.84	0.05
T11	2.80	0.40	0.63	2.89	0.71	0.11	0.24	0.48	5.42	0.07
T12	2.00	2.40	0.92	-	0.70	0.11	0.31	0.61	5.92	0.08

Source: Eduardo Mondlane Faculty of Agricultural Engineering and Forestry - Soil Analysis Laboratory (25° 57' 06.29" South and 32° 36' 10.53" East), 2018.

The fertilizers nutrients contents are shown in table 3. Experimental unit consisted of 9 pots suspended on a wood table matrix, constructed from local sticks and chicken net, at 50 cm high, to hinder the roots from direct contact with the soil.

Table 3. Nutrients contents of the Kelp-p-max and Stimu-phos fertilizers

Fertilizer	N	P	K	Amino acid	B	Mo	Cu	Fe	Mn	Zn	Auxins	Citokinins
	[g/kg]				[mg/kg]							
Kelp-p-max	35.0	-	49.0	-	2,368.0	166.0	-	2,368.0	1,184.0	1,184.0	+	+
Stimu-phos	33.0	100.0	66.0	3.6	215.0	1,209.0	395.0	807.0	410.0	411.0	-	-

(-) no information; (+) present

Source: Arysta LifeScience, South Africa (Pty) Ltd; and Omnia Nutriology Bryanston, South Africa.

2.3 Data Collection

At Nassuruma, height measurements were taken 120 days after seedling germination. A milimetric roller was used to vertically measure the height from the soil surface to the insertion of the last seedling leaf (Torres et al., 2014). A digital milimetric paquimeter was used to assess the steam diameter at collar height (Gomes et al. 2003; Torres et al., 2014). At Chizavane trial site, seedling diameter and height were measured 45 days after germination following the same procedure described for trial at Nassuruma.

2.4 Statistical Analysis

All data were processed in STATA 12 statistical package. From Chizavane factorial trial data were subjected to ANOVA procedure. Verification of ANOVA assumptions was done for error normality and homogeneity through Shapiro Wilk and Breusch Pagan test respectively (Peterson, 1994), transforming original data to Log_{10} (Yij) as data were not following normal distribution. Because no interaction effect was detected between treatment factors, (Kelp*Stimu, $P=0.8192$, for seedling height) as well as for seedling diameter (Kelp* Stimu, $P=0.1086$) 45 days after emergence, each biofertilizer (Kelp or Stimu) effect was analyzed separately (Peterson, 1994; Dias and Barros, 2009). For both trials, diameter and height data, collected 45 days after seedling emergence, was subjected to ANOVA regression. Moreover, polynomial regression analysis was performed for Nassuruma data, where soil substrate fertilization was tasted for seven levels of organic fertilizer, similarly with Chizavane data, were foliar biofertlizer Kelp had four concentration levels. However, because biofertilizer Stimu had only 3 levels, for this treatment, only simple regression was used (Dias and Barros, 2009) to analyze seedling height and diameter data from Chizavane trial site.

3. Results and Discussion

The results of ANOVA regression for cashew seedling diameter and height response to different fertilizers in both trial (Nassuruma and Chizavane) are shown in Table 4.

Table 4. ANOVA for polynomial and linear regression cashew seedling diameter and height response to different fertilizers on polyethylene pots in Mozambique, 2019

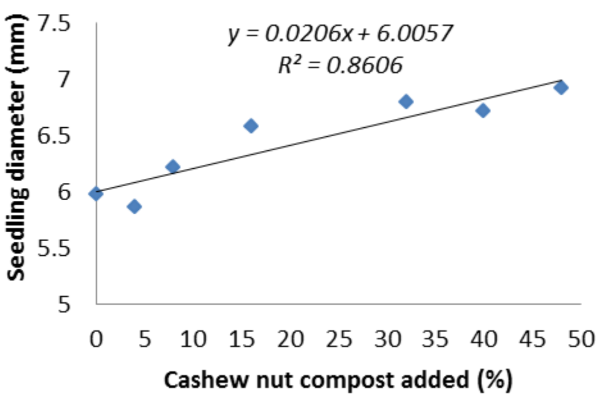
Trial Site	**Fertilizer involved**	**Seedling Variable**	**Regression model**	**R^2**	**R^2 Adj**	**MSQ**
Nassuruma	Cashew compost	Diameter	Polynomial Regression			1.67048225**
			Linear	88.5220578 1	86.2264693 7	4.76071627**
			Quadratic	89.2845336 9	92680054	0.04100595 ns
			Cubic	93.1842089 8	86.3684179 7	0.20972454 ns
		Height	Polynomial Regression			28.97151761**
			Linear	85.1956956 6	82.2348347 9	79.95457135**
			Quadratic	92.5662914 2	88.8494371 4	6.91716665
			Cubic	92.6119128	85.2238256	0.04281481 ns

Chizavane	Stimu	Diameter	Simple Regression	14.88	10.83	0.50816**
		Height	Simple Regression	0.77	-3.95	0.98568 ns
	Kelp	Diameter	Polynomial Regression			0.26308333 ns
			Linear	91.1297255 7	86.6945883 6	0.52490266 *
			Quadratic	91.3491722 1	74.0475166 4	0.001264 ns
			Cubic			
		Height	Polynomial Regression			14.06178457 ns
			Linear	68.6380909 3	52.9571364	27.87214688 *
			Quadratic	69.2572446 7	7.77173401	0.25142226 ns
			Cubic			

* Significant at 5% level of probability (p<0,05); ** significant at 1% level of probability (p<0,01); ns – not significant.

3.1 Cashew Seedling Stem Size Response to Organic Compost at Nassuruma

The diameter data were found to follow a reasonable normal distribution (X^2 Probability =5. 3%) and were acceptably homogeneous (calculated Bartlet's X^2= 8.7). Cashew seedlings diameter was significantly (*P>F, <0.0001*) increased when the substrate was gradually amended with cashew nut shell compost (Figure 1).



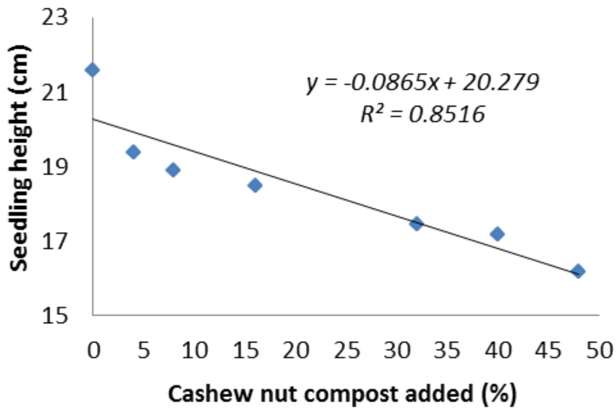


Figure 1. Regression line of cashew seedling diameter (left) and height (right) to different proportions of cashew nut shell compost, 120 days after planting on polyethylene pots, at Nassuruma cashew research center, Mozambique, 2019. The CV values were 7.9% and 12.4% for the diameter and height respectively

In fact, seedling diameter increased from 6 mm, with 0% fertilizer, to almost 7 mm with 48% (w/w) substrate amendment. This represents 16.6% increase in seedlings diamter. Mário et al. (2014), studied the biofertilizers doses effect and substrate volume, also observed an increase of diameter in cashew seedlings. Our results are in agreement with the offered experiment on the organic fertilizer effect. Opposite results were found with Serrano et al., (2018), working with dwarf varieties, 60 days after sowing. They found that formulated slow release substrates HS-citros, Biomix Flores and Germina plant, highly reduced the seedlings diameter (5.4% and 6.1% respectively in CCP06 and CCP76 varieties) when compared to conventional NKP fertilizer. The experiment however did not include a zero fertilizer check, neither our trial included a positive conventional control. The two experiments adopted opposite controls, negative in one and positive in another and therefore the results are also contrary. Previous study, Awodun et al., (2015), also revealed an increased effect of stem girth (5.5. to 9.2%) which can be correlated to seedling diameter, 56 days after planting. The effect range was influenced by the type of organic material used. Similarly, Akanbi et al., (2013) having applied organic materials 6 weeks after seedling sprouting, six months later, found an increased diameter varying between 18.2 and 30.8%. The key to this positive effect is the choice of appropriate proportion of organic matter to be incorporated, based on the most required plant nutrient, to compensate deficiency in the preplanting soil.

Height data were found to follow a reasonable normal distribution (X^2 Probability =1. 6%) and were acceptably homogeneous (calculated Bartlet's X^2=7.1). Seedling height was significantly ($P>F= 0.0026$) and proportionally ($R^2= 0.7884$) decreased from 20 cm, with 0% incorporation of cashew nut shell compost, to about 17 cm at 48 % (w/w) amended substrate (Figure 2). This represents 15% decrease in height, 120 days after planting. In Serrano et al., (2018) experiments, height reduction due to organic compost dose increase from 0 to 8 Kg/m^3 was 13.0%, in CCP06 variety, 60 days after planting. Before the two experiments discussed above, the effect of soil amendment with organic material had been experimental examined by Awodun et al., (2015). The authors compared five different organic composts with a negative control and the impact was an increased height varying from 5.2 to 8.8%, depending on the nature of organic material, 56 days after planting. Akanbi et al., (2013), analyzed the approximate composition of preplanting soil and that of the organic materials to be applied, and then decided on nitrogen as reference, to weigh the organic composts for incorporation. The result was a significant increase in plant height, from 5.99 to 36.9 %, six months after application. This practical approach contrary to our findings a gradual increase in chlorosis (Figure 2).

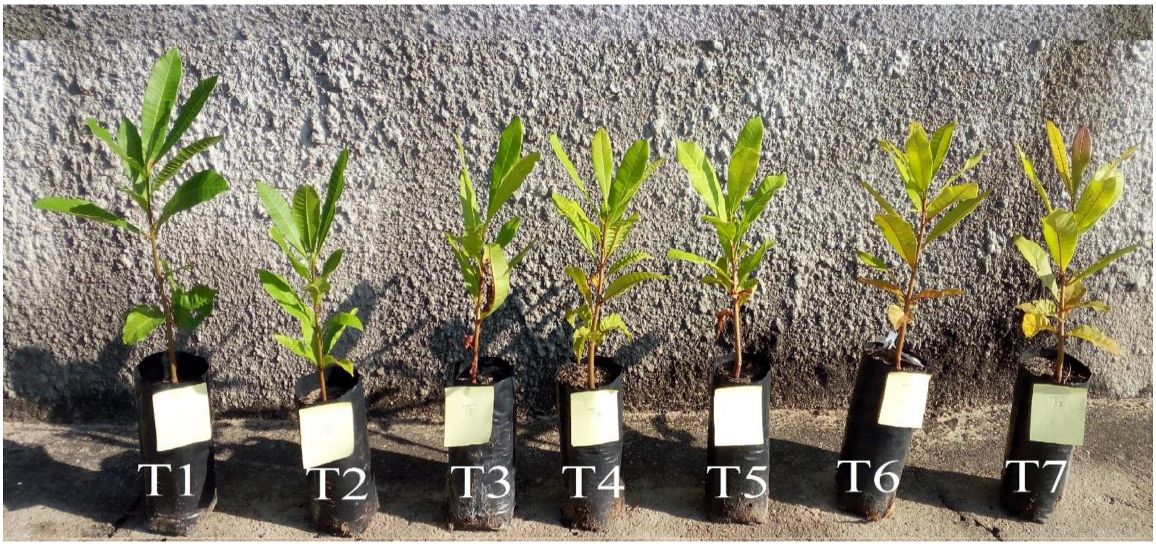


Figure 2. Cashew seedling chlorosis in response to different proportions of cashew nut shell compost, 120 days after planting on polyethylene pots, at Nassuruma cashew research center, Mozambique, 2019

3.2 Cashew Seedling Stem Size Response to Foliar Biofertizers

3.2.1 Kelp Effect

For both variables, height as well as diameter, the data were reasonably acceptable for a normal distribution and homogeneous variances for analysis.

Cashew seedling diameter response to quarterly foliar applications of Kelp fertilizer was best adjusted to a first degree regression equation (Figure 3) and the observed diameter increase was 5.1 mm above 4.5 mm which is considered to be suitable for seedlings to be grafted.

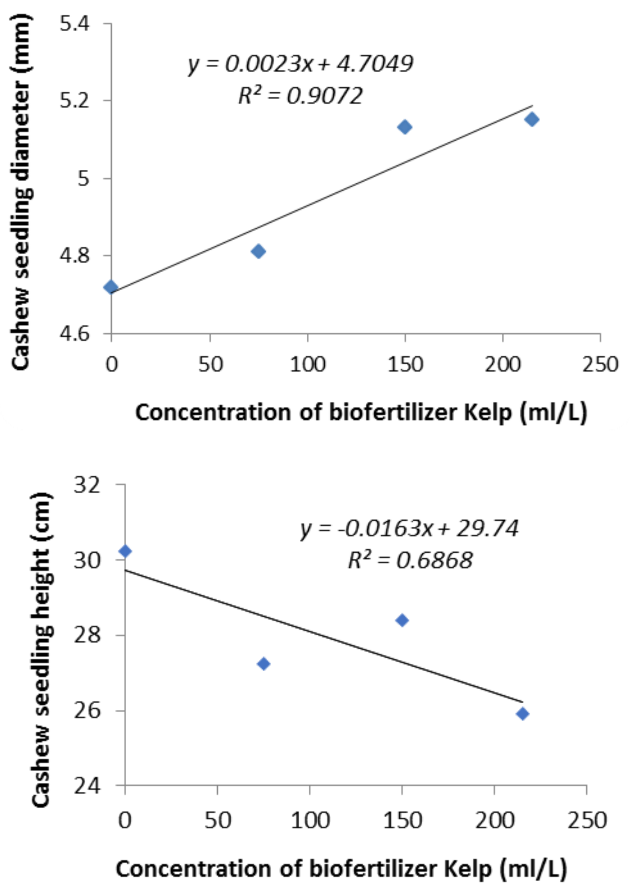
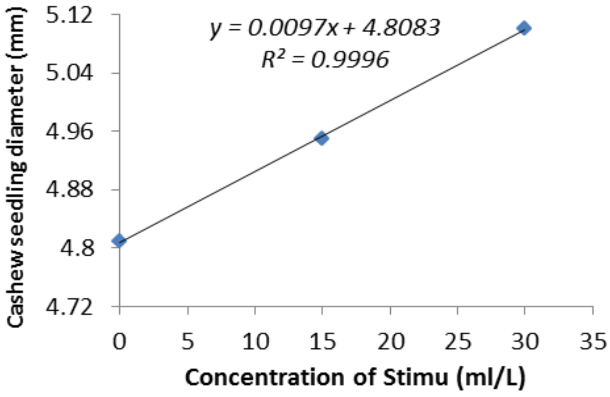


Figure 3. Regression line of cashew seedling diameter (left) and height (right) response to different foliar biofertilizers (Kelp) quarterly applications, 45 days after germination on polyethylene pots, at Chizavane cashew Nursery, Mozambique, 2019; T1= Kp0 ml/L; T2= Kp75ml/L; T3= Kp150ml/L; T4= Kp215ml/L

The ANOVA regression was not statistically significant ($P=0.3246$) despite a relatively low CV= 2.2%. Nevertheless, the general trend of cashew seedlings diameter was to increase depending on the foliar applications of biofertilizers. Seedling height response was opposite to that of diameter (Figure 3) in which it was observed a decreasing trend.

3.2.2 Stimu-phos Effect

The cashew seedling diameter response to quarterly stimu-phos foliar applications was adjusted to simple regression equation and a typical trend of increase was observed from 4.8 to 5.15 mm (Figure 4). As in Kelp scenario, seedling height tends to respond negatively to the Stimu-phos foliar applications, however simple regression analysis showed no adjustment as proportional shown by R^2 that was very low (Figure 4).



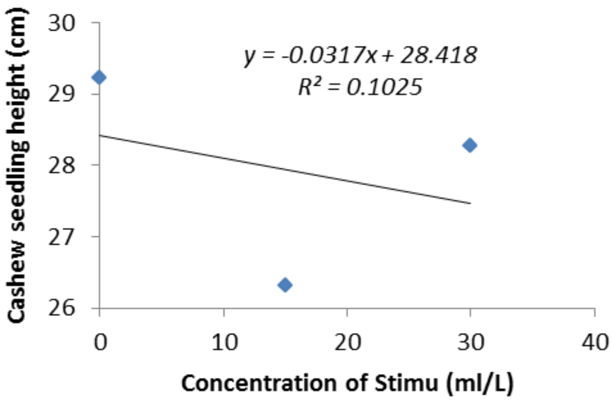


Figure 4: Regression line of cashew seedling diameter (left) and height (right) response to different foliar biofertilizers (Stimu) quarterly applications, 45 days after germination on polyethylene pots, at Chizavane cashew Nursery, Mozambique, 2019; T1=0 ml/L; T2= 15 ml/L and T3= 30 ml/L.

4. Discussion

In two experiments, we focused in understanding the response of cashew seedling size measured as stem diameter and height to applications of different fertilizers proportions. In one case we used organic compost added into the soil and thus nutrients absorbed through the root system, on the other hand we used two formulated biofertilizers for foliar application. The results indicate a similar trend whereby cashew seedling diameter increased due to addition of fertilizer while the height decreased. However, the relatively low number of treatments means that, due to lack of factorial interaction at Chizavane, up to 45 days after seedling emergence, it affected the regression probability for no statistical significance (Dias and Barros, 2009).

Cashew seedling growth vigor can be evaluated in many different ways, for instance the number of leaves over time (Silva et al., 2019), stem diameter and height (Fonseca et al., 2002), dry matter accumulation (Clement and Bovi, 2000), leaf area (Schmildt et al. 2016), root system volume (Rossielo et al., 1995) and quality index (Eloy et al., 2013). In our experiments we focused on cashew seedling diameter because it is associated with survival rate in the field (Caldeira et al., 2003), it assures better fixation in definitive soil (Rickli and Peres, 2016) and subsequent better growth of the root system and the plant aerial parts (Eloy et al, 2013).

The stem diameter varied from 5 to 7 mm and between 3 and 6 mm at Nassuruma and Chizavane trial respectively. It is worthwhile mentioning that previous work by Serrano and Cavalcanti, (2016) in Brazil, indicated that a size of 4.5 mm would be suitable for seedlings to be grafted.

Furthermore, soil based organic fertilizers contain growth regulating substances such as auxins that promote secondary roots and improves water and nutrients absorption capacity (Pes and Arenhardt, 2015). Therefore, stem diameter growth in relation to fertilizers applications can be explained by the Nitrogen content (N: 41g/l) and Phosphorous (P: 58g/l) in the formulated Kelp and N:33g/kg and P:100g/kg in biofertilizer Stimu. These nutritional elements are associated with protein synthesis and cell division in plants (Almeida et al., 2012; Rick and Pires, 2016). In sun flour seedlings, for instance, omission of NPK was found to reduce the stem diameter (Prado and Leal, 2006). Except for N, cashew nut shell compost used at Nassuruma trial had high content of P and K (Table 1).

Cashew leaves may develop wax on the surface during growth (Sijaona et al., 1999). The wax may hinder nutrient absorption through the leaf laminae (Sijaona et al., 1999) and thus leading to a relatively lower effect of foliar applications of fertilizers on to stem size as observed in these trials. In addition, the use of seeds from two clones at Chizavane trial, may have increased the variability and subsequent high CV's in Gaza experiment in relation to Nassuruma, where only seeds from one cashew clone were used.

The application of organic fertilizers in the soil or on the leaves, for potted cashew seedlings, resulted in a common trend of height reduction. This ananicant effect is possibly due to nutrients saturation (Cruz et al., 2006) or accumulation of nossive salt levels (Mudita et al., 2014) which may lead to high levels of electric conductivity (Bezerra et al., 2017) and subsequent impact on plant growth by disturbing its physiological processes such as the apical meristems and leaf primordia emission. From our analysis, the level of salts observed in T9 raised form 0.05 $mS.cm^{-}$ up to 3.4 $mS.cm^{-}$ in the irrigation water collected in the present test, which also contain some fertilizers dropped from leaves during irrigation process. Studies regarding the electrical conductivity effect on cashew seedlings indicate negative relationships (Viegas et al., 2004).

5. Concluding Remarks

Two trials were conducted to determine the effect of different rates of cashew nut seedling fertilization on stem diameter and height. The diameter was linearly increased by increasing the rate of fertilizer regardless of being organic and thus incorporated in the soil or foliar sprayed on the leaves surface. The seedling stem height was linearly reduced by increased levels of fertilizer. Therefore fertilization can be used to adjust the stem size to the scions size available nearby the nursery.

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