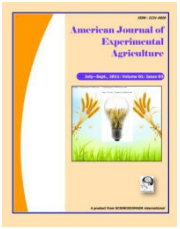

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Influence of the Size of Nursery Bag on the Growth and Development of Cashew (*Anacardium occidentale)* Seedlings

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Research Article

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ABSTRACT

Cashew is one of the most important cash crops in Ghana where it is largely grown in the coastal, transitional and guinea savannah belt. Its cultivation is largely a small holder activity and serves as their main source of income. However, cashew orchards in these areas are expanding as a result of its economic potentials. Therefore cashew (*Anacardium occidentale)* seedling growth as influenced by the size of polythene bag for nursing was investigated using 4x6 inches, 4x7 inches, 5.5x6 inches, 5x7 inches, 5.5x7 inches and 7x10 inches polythene bag size categories in order to assess the possibility of using other polythene bag sizes smaller than what farmers use currently (7x10 inches) in relation to germination ability of the cashew seeds and seedling growth in order to minimize nursery production cost. The complete randomise design was used for two months of nursery trial with four replications. Data was collected on percentage germination, days to seedling emergence, number of leaves, plant height (cm), stem girth (mm), leaf area (cm^2) and root length (cm) and were statistically analysed. The results showed a relationship between the parameters and the polythene bag sizes. The results showed that seedlings of polythene bag sizes 5.5x7 inches and 7x10 inches were superior to the sizes of polythene bag 4x6 inches, 4x7 inches, 5.5x6 inches and 5x7 inches seedlings both at emergence and seedling growth. The size of the nursery bag had a significant influence on seed germination, seedling vigour, number of leaves, plant height, stem girth, leaf area and root length at nursery growth. It was concluded that optimum performance was observed with bag size of 5.5 x 7 inches.

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Keywords: Cashew; polythene bags; germination; seedling growth;

1. INTRODUCTION

Cashew (*Anacardium occidentale*) is a tropical evergreen plant, belonging to the family of *Anacardiaceae*, known for its nuts that are consumed worldwide (Tullo, 2008). It is a hardy crop which grows well on marginal land and therefore seen as an ideal crop for soil conservation and afforestation, especially in savannah areas in Ghana.

Cashew was introduced into Ghana by the Government in the 1960s in the savannah, coastal savannah and forest-savannah transition zones in Greater Accra, Eastern, Volta and Brong-Ahafo regions (Anonymous, 2005). During the last six years, there has been growing interest in cashew cultivation in Ghana because of its importance to farm families, coupled with high demand and a flourishing export market. The Ghana Cashew Industry Study conducted by the Ministry of Food and Agriculture (MOFA) estimated that Ghana has enough land to develop new plantations of about 60,000 ha by 2008 and up to 100,000 ha by 2020 (Anonymous, 2010).

Cashew is grown as a cash crop in Ghana and its cultivation is largely a small holder activity with majority of farmers having an average farm size of between 0.8 and 2.5hectares. More than 60,000 small holder farmers are engaged in cashew cultivation in the country in the coastal belt thus Central, Greater Accra, and Volta Regions; the transitional belt of Ashanti and Brong-Ahafo, as well as the guinea savannah belt being parts of Northern, Upper West and Upper East regions (Anonymous, 2008).

In Ghana, the raw cashew nut is the main commercial product of the cashew tree, though yields of the cashew apple are eight to ten times the weight of the raw nuts. Raw nuts are either exported or processed prior to export. In 2007 about 41,000 metric tonnes of cashew nut was exported and this contributed to about $30 million foreign exchange to the Ghanaian economy (Anonymous, 2007). In 2008, 61,590 t of raw cashew nuts valued at US$ 45.37 million were exported for processing, mainly to India, while annual local production was estimated to be 26,454 tonnes (Anonymous,2010). Processing of the raw nuts releases the by-product cashew nut shell liquid which is the caustic oil located in the tissue between the two walls of the nut. The industrial and medicinal uses of cashew nut shell liquid include automobile and airplane brake fluid, adhesives, paints and varnishes, insecticides, electrical insulation, and anti-microbial. In addition to cashew nut shell liquid, resins and gums from fruit stems or bark is used as a varnish for books, wood, and flooring to protect from ants and other home-invading insects. The skin of the nut is high in tannins and can be recovered and used in the tanning of hides **(**FAO**,** 2000).

Propagation of cashew is often done by seed. Two seeds are planted per hill at 15cm apart and at a depth of 3 to 5cm with the stalk end pointing upwards (Azam-Ali and Judge, 2007). The process of planting more than one seed at stake and thinning out weaker seedlings afterwards causes wastage of seed which is the main planting material, hence, the need to nurse seeds before transplanting into the field.

According to Opoku-Ameyaw *et. al*., (2007) the Ghanaian Ministry of Food and Agriculture is recommending the use of nursed seedling for establishment of cashew farms. Currently in

Ghana, cashew farmers use the 7x10inches size polythene bags for raising cashew seedlings. Different sizes of polythene bags have an effect on the germination, emergence, and growth of cashew seedlings. It is very important to determine the polythene bag size which will have the same effect as the one in use because large polythene bags require more soil takes a lot of labour to fill and demands more resources for transporting to the field. They occupy a large nursery space and require more water in contrast to smaller polythene bags. There is therefore the need to assess the possibility of using other polythene bag sizes smaller than what the farmers use currently in relation to germination ability of the cashew seeds and seedling growth.

The objective of this study was therefore to determine the most appropriate polythene bag size for the nursing of cashew that will maximize the growth of cashew seedlings.

2. MATERIALS AND METHODS

The experiment was set up at the Department of Horticulture, Kwame Nkrumah University of Science Technology (KNUST), Kumasi. The area is in the South Western forest zone of Ghana and has a bi-modal rainfall. Polythene bags of six different sizes were used as nursery containers. Perforations were made in the bottom part of the bags to let excess water drain easily. The sizes of the polythene bags were 4 x6inches (10x15 cm), 4x7inches (10x17.5 cm), 5.5x6inches (13.75x15 cm), 5x7inches (12.5x17.5 cm), 5.5x7inches (13.75x17.5 cm) and 7x10inches (17.5x25 cm). The size of the polythene bags also represents treatment one to six respectively where the sixth treatment is control.

It was replicated four times for each treatment. In each treatment, there were 80 polythene bags with 20 in each replication making a total of 480 polythene bags in the experiment. Top soil from Horticulture Department was sieved through a mesh to remove undecomposed rubbish, broken bottles, debris and stones. Each group of polythene bag size was filled with the same amount of soil by weighing and taking care to have no void by shaking and knocking regularly. Seeds were collected from the Cocoa Research Institute of Ghana (CRIG) farms at Bole in the Northern region. The variety is the open pollinated Brazilian dwarf cashew.

The seeds were soaked in water for five minutes and the floated seeds were discarded. The remaining seeds were left overnight to enable the seed coat to be permeable to air and water. The seeds were sown with one seed per polythene bag. Watering was done judiciously as and when necessary. Weeds were pulled by hand from the polythene bags and also between rows as they appear.

Germination count started 12 days after sowing. The number of days between sowing and emergence were recorded for each seed that germinated. The number of leaves was counted for the seeds that germinated for every month within the two months in the nursery after sowing. Data was collected on leaf area with leaf area meter, stem girth with a veneer calliper, plant height and root length with a ruler. The experimental design used was complete randomise design (CRD). Data was subjected to analysis of variance (ANOVA) with GenStat Discovery Edition 3 software and the treatment means separated by least significant difference (LSD) test.

3. RESULTS AND DISCUSSION

3.1 Results

There were significant differences between the germination percentages of the polythene bag sizes 4x6inches and 7x10inches and 4x7inches and 7x10inches with a least significant difference of means at 5% level and a probability of 0.135 but there were no significant differences between the rests of the polythene bag sizes.

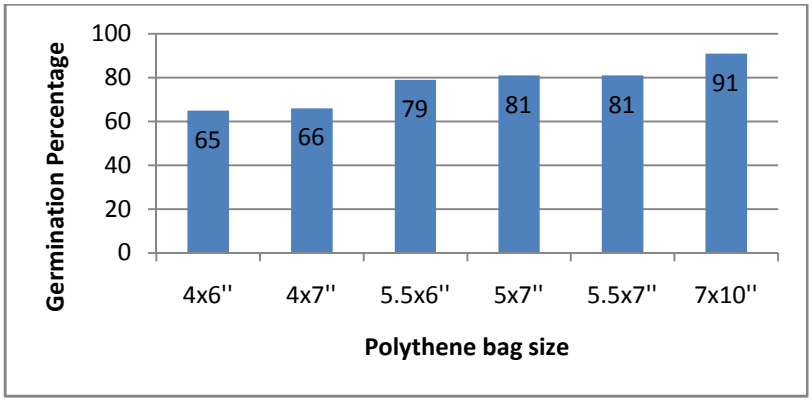

Fig. 1: Effect of Different Polythene Bag Sizes on Germination of cashew seeds

(LSD = 21.28)

There were no significant differences in the number of days the seedlings emerged after sowing between 4x6inches and 4x7inches, 4x6inches and 5.5x6inches, 4x6inches and 5x7inches, 5.5x6inches and 5x7inches, 5.5x6inches and 5.5x7inches, 5.5x6inches and 7x10inches, and 5.5x7inches and 7x10inches polythene bag sizes at a least significant difference of means at 5% level and a probability of <. 001.

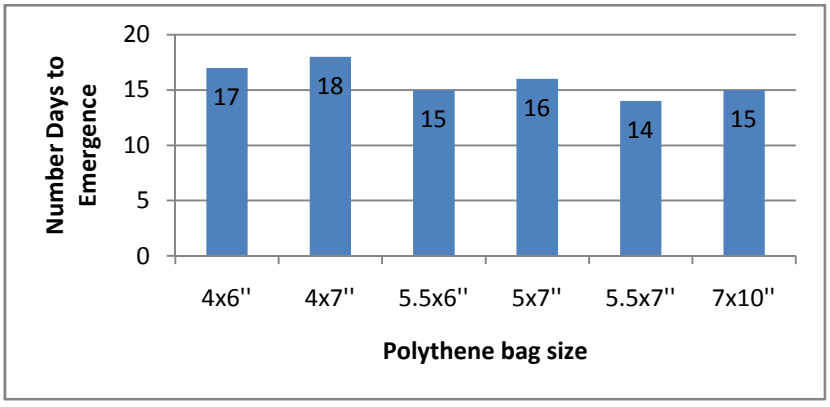

Fig. 2: Effect of Different Polythene Bag Sizes on the Number of Days to Emergence (LSD = 1.310)

There were no significant differences in the number of leaves in the various polythene bag sizes in the first month at a probability of 0.281. There were also no significant differences in the number of leaves in the second month between the polythene bag sizes 4x6inches and 5.5x6inches, 4x7inches and 5.5x6inches, 5x7inches and 5.5x7inches, and 5.5x7inches and 7x10inches at a probability of < .001.

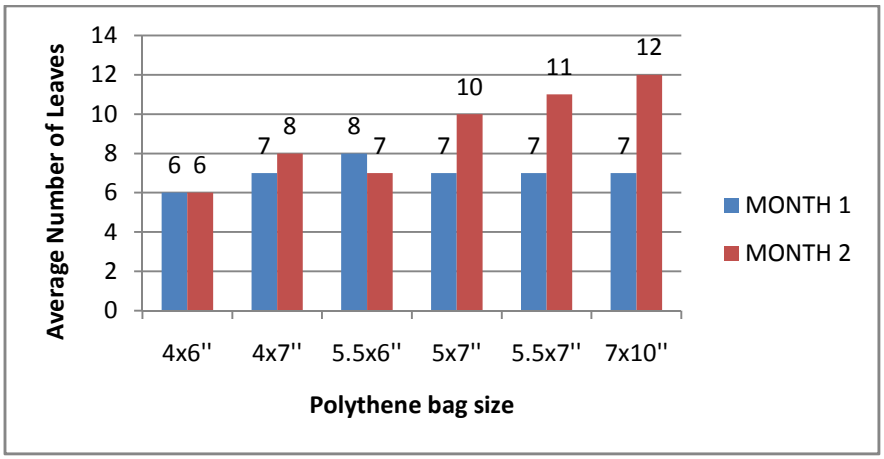

Fig.3: Effect of Different Polythene Bag Sizes on the Number of Leaves (LSD 1 = 1.652; LSD 2 = 1.006)

The highest leave area was recorded in polythene bag size 7x10inches with average value of 31.4cm^2 followed by 5.5x7inches, 5.5x6inches, 5x7inches, 4x7inches and 4x6inches.

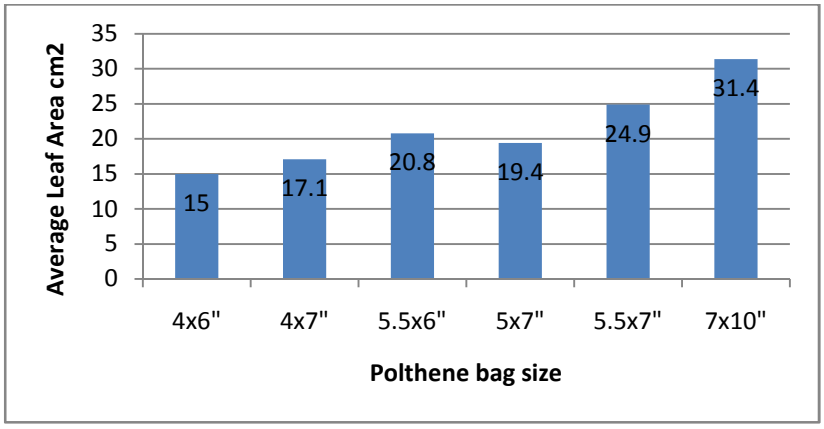

Fig. 4: Effect of Different Polythene Bag Sizes on Leaf Area (cm^2) (LSD = 8.07)

There were significant differences between the treatment means of polythene bag sizes 4x6inches and 7x10inches, 4x7inches and 7x10inches, 5.5x6inches and 7x10inches and 5x7inches and 7x10inches in average plant height but there were no significant differences between the others at probability of 0.006 and a least significant difference of mean at 5% level.

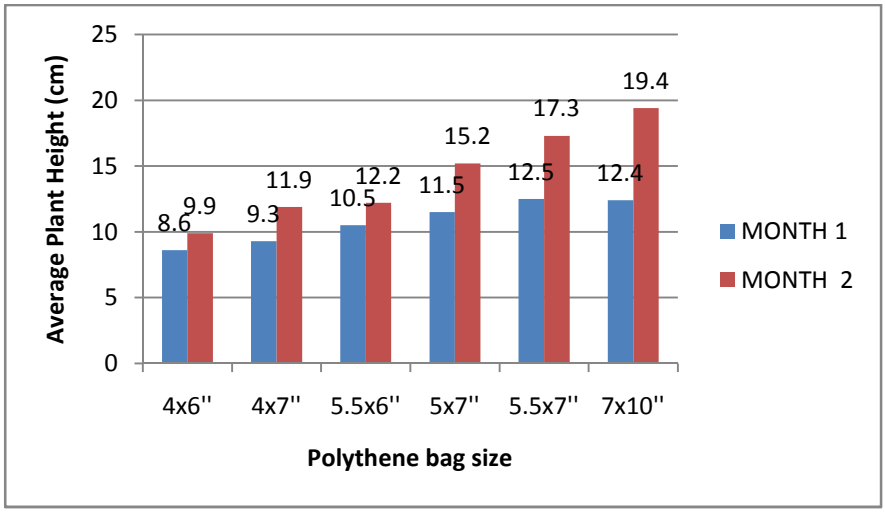

Fig. 5: Effect of Different Polythene Bag Sizes on Plant Height (cm)
(LSD 1 = 2.293; LSD 2 = 2.235)

No significant differences ($p < 0.001$) were observed in the stem girth between polythene bag sizes of 4x6inches and 4x7inches, 4x7inches and 5.5x7inches, 5.5x6inches and 5x7inches, 5.5x6inches and 5.5x7inches, and 5x7inches and 5.5x7inches in the first month of growth.

Stem girth in the second month of growth showed no significant differences ($P = 0.002$) between the treatment means of polythene bag sizes 4x6inches and 4x7inches, 4x6inches and 5.5x6inches, 4x7inches and 5.5x6inches, 4x7inches and 5x7inches, 4x7inches and 5.5x7inches, 5.5x6inches and 5x7inches, 5.5x6inches and5.5x7inches, and 5x7inches and 5.5x7inches.

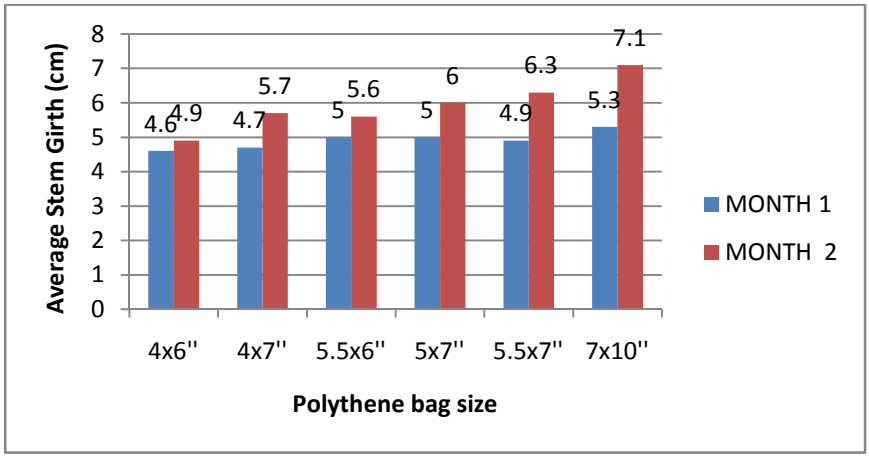

Fig. 6 Effect of Different Polythene Bag Sizes on Stem Girth (cm) of cashew seedlings
(LSD 1 = 0.2561; LSD 2 = 0.926)

The length of the tap root increased from 7.8cm to 15.3cm with the polythene bag sizes after the nursery stage of growth.

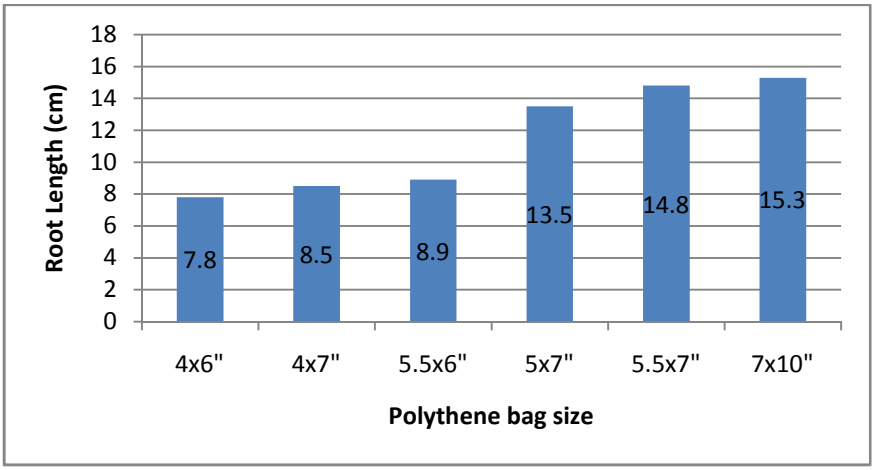

Fig. 7: Effect of Different Polythene Bag Sizes on Root Length of cashew seedlings

3.2 Discussion

From figure 1, the different polythene bag sizes did have significant effect on the germination percentage of seeds. The differences can be attributed to the difference in soil moisture, contact between the seed and soil of non-dormant seeds as reported by Moorby and Milthorpe, (1979). They reported that contact between the seed and the soil is influenced by the size of the soil aggregates as well as the soil water content.

Mean diameter of soil aggregates greater than one fifth of the seed may retard germination and uptake of water even with high soil water content. Since the soil in the smaller polythene bags became compacted after few days thereby making the soil aggregates to be greater than one fifth of the seed after breaking the compacted soil in order to ensure water and air passage, this had effect on the germination of the seeds in those polythene bags therefore affecting the germination percentage.

Emergence of cashew during the period under study was between 14-18 days after sowing from figure 2. According to Purseglove (1968), seedlings may appear two weeks after sowing but many nuts take much longer to germinate. Nuts with high specific gravity germinate more quickly and have a total viability than those with a low specific gravity and they also produce more vigorous seedlings. Very large nuts have low density and give poor germination. Large seeds are also likely to take more days to germinate and emerge due to the presence of thicker nut coat as reported by Maggs, (1973), Crane and Forde (1974) and Casini and Conticini (1979). Other authors have also reported that seeds will germinate within 1 to 2 weeks after sowing by Amoah (2005), Anonymous (2000) and (http://www.da.gov.ph/tips/Cashew.pdf).

The differences in the number of days it took for the seeds to emerge after sowing can be as a result of the different sizes of seeds used since they were randomly selected and the specific gravity of the different seeds.

Since the seeds were all planted 3cm deep irrespective of the polythene bag sizes, the depth of sowing and the temperature did not have any effect on the germination and emergence of the seeds because the greater the depth of sowing, the less the danger that the soil will dry out and the more uniform the temperature to which the seed is exposed as reported by Moorby and Milthorpe, (1979). Generally, the different polythene bag sizes, their respective soil nutrients in them and the seeds did have influence on the germination and the emergence after sowing the seeds.

According to Moorby and Milthorpe, (1979) the rate of leave production by a plant as a whole can be determined by the rate of differentiation of leaves from the apex. Ridge (1991), also reported that, the number of leaves produced by a plant is directly proportional to photosynthate produced. From figure 4, the higher leave area in the plants was obtained as a result of high rate of photosynthesis with resultant increase in carbohydrate production and hence increases in leave size.

From Figure 3, it is clear that the number of leaves increased progressively in the nursery stage in all the treatments with a decrease in the second month of 5.5x6 inches polythene bag size but the significant differences that were obtained in the various treatments is as a result of the different rates of differentiation of the leaves as reported by Moorby and Milthorpe, (1979), the amount of nutrients in the soil and the photosynthetic rates of the various leaves. The number of leaves in the second month of 4x6 inches polythene bag size remained constant since most of the leaves dropped as a result of disease infection (Anthracnose) and infestation by grasshoppers. The seedlings were therefore sprayed with Cypadem 43.6% EC to control the pests. The Anthracnose disease was confirmed from a pathological report from the Crops and Soil Science Department of KNUST pathology Lab test and revealed that, the spores of the fungus *Collectorichum gloeospoides* dropped on the leaves of the seedlings and thereby causing the disease. The seedlings were therefore sprayed with Shavit F 71.5 WP to control the disease.

The result of the experiment indicated a relationship between plant heights, stem girth and leave production. There was an increase in leaves production with subsequent increase in plant height and stem girth. Growth involves increase cell number which leads to an increase in size. As plant height increased, stem girth also increased as shown in figure 6 thereby ensuring enough strength to prevent breakages and lodging.

From Figure 5 it could be stated that there was gradual increase in plant height over the experimental period. Plant height increased with polythene bag size which means that as more leaves were produce, the rate of photosynthesis was high, therefore resulted in growth of plant height which is the expression of the vegetative growth. It can be deduced from the experiment that, the larger the polythene bag size, the more the volume of soil therefore the more available nitrogen for leave production, hence, the greater the absorption of sunlight for photosynthesis, therefore the faster growth of the plant.

From figure 7, root length increase with polythene bag sizes as 7x10 inches polythene bag size obtained the longest followed by 5.5x7inches, 5x7 inches, 5.5x6 inches, 4x7 inches, and 4x6 inches polythene bag size. According to Moorby and Milthorpe, (1979), during germination, roots grow as a consequence of a cell division in their apical meristem and the subsequent extension of these cells. Cell division in the root is usually more than in the leave primordial, which in turn is greater than in the stem. They also reported that the rate of elongation during seedling stages is retarded by nutrient concentrations which are sub-optimal for shoot growth. However, the differences in the root length in the various polythene

bag sizes are as a result of differences in leave growth and the supply of photosynthate to the root.

4. CONCLUSIONS

The results showed clearly that seedling characters such as number of leaves, leaf area, plant height, stem girth, and root length consistently ranked highest for the seedlings in the polythene bag sizes 7x10 inches (T6) and 5.5x7 inches (T5) during the nursery growth followed by 5x7 inches (T4), 5.5x6 inches (T3), 4x7 inches (T2) and 4x6 inches (T1). Although both 7x10 inches and 5.5x7 inches came out as the best in terms of seedling growth, 5.5x7 inches size polythene bag was the appropriate since the cost of raising seedlings in that polythene bag size is economical in terms of cost of buying the polythene bags, the amount of top soil, labour, water and cost of transporting to the field. Therefore, it can be said that a good and efficient polythene bag size has a high effect on the germination, emergence, growth and development on cashew seedlings.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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