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EFFECT OF SEED WEIGHT ON GERMINATION AND SEEDLING CHARACTERS OF *ANACARDIUM OCCIDENTALE* L. : AN IMPORTANT PLANTATION CROP OF INDIA

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Abstract

The present study was undertaken to evaluate the response of size graded of *Anacardium occidentale* into different weight classes 4-6, 6.1-8, 8.1-10 and >10 g categories. This experiment was carried out in the Nursery, College of Forestry, Vellanikkara, Kerala (India) during the May-June, 2013. The germination percentage, peak value of germination, mean daily germination and germination value of very large weight class were significantly differed from other seed classes. The results showed that the germination percentage was slightly higher in very large class seeds (88.49±1.52) followed by medium (83.53±0.14), small (78.17±0.18) and large class (67.01±0.22) seeds. The girth of seedlings produced from very large seeds during the 10th fortnight was found to be slightly higher (11.13mm) followed by large (10.60mm), medium (10.37mm) and low (9.43mm) class seeds. It is evident that the germination percentage significantly declined with reduction in size and weight of the seeds.

Key words : *Anacardium occidentale* L., seed weight, soil conservation, nutritional value.

Introduction

Cashew (*Anacardium occidentale* L.) is a tropical evergreen plant, belonging to the family of Anacardiaceae, known for its nuts that are consumed worldwide (Tullo, 2008). Cashew plants vary in size from shrubs (rarely subshrubs) to large trees, and are mainly restricted to tropical and subtropical regions, with relatively few representatives in temperate climates (Barros *et al*., 1999). It is a hardy crop which grows well on marginal land and therefore seen as an ideal crop for soil conservation, afforestation, farm forestry and wasteland development programmes. Hence, cashew is considered as the 'Gold Mine' of wasteland. The crop was introduced into Africa and India by the Portuguese Adventurers in the 16th century (Johnson, 1973 and Frankel, 1991). It's native to South America with centre of origin in Central Brazil (Mitchell and Mori, 1987). The major producing countries of cashew are Tanzania, India, Mozambique, Sri Lanka, Kenya, Madagascar, Thailand, Malaysia, Indonesia, Nigeria, Senegal, Malawi and Angola. World Bank data estimates that 97% of production is from wild trees and only 3% is from established plantations (Rosengarten, 1984 and Aletor *et al*., 2007). Gibbon *et al*. (1981) reported that many trees are found growing wild and that the plant germinates poorly, those that are cultivated are propagated by seed which are planted at a rate of 2-3 per hole due to poor germination rates. It is a commercially valuable tree. The kernel which is considered to be of high nutritional value is for direct human consumption (Howes, 1953; Jain *et al*., 1954; Morton, 1961; Babatunde and Oyenuga, 1974; Joseph, 1975; Onifade *et al*., 1998; Achal, 2002; Aletor *et al*., 2002; Cavalcanti and Wilkinson, 2007; Akinhami and Akintokun, 2008). A number of processes have now been developed for converting the cashew apple into various products such as juice, jam, syrup, chutney and beverage (Winterhalter, 1991).

Cashew is one of the major foreign exchange earning horticulture crops of India. Though India exports annually about 1.2 lakh tones of cashew kernels worth about 2,500 crores (Bhat *et al*., 2007), shortage of raw nuts still remains to be the major problem in the cashew industry and export earnings. According to FAO (2004) major production is centralized in the third world countries like India, Nigeria, Brazil and Tanzania with current annual raw nut production of 460,000; 186,000; 178,343 and 123,000 metric tons, respectively. High germination and vigorous seedlings are major important factors in the

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establishment of a good cashew orchard. Therefore, selection for seedling vigour indicators should always be considered in any breeding programme designed to improve a crop species. Many of cashew plantations in the major producing countries of Indian continent today produce poor yield probably because of low vegetative vigour of the seedlings used in the establishment of such farms (Ohler, 1979; Martin and Kasuga, 1995; Topper *et al.,* 2001; Aliyu, 2004). One of the major production constraints in the country is that most of the plantations are senile and unproductive which has to be replaced with clones of high yielding variety (Huballi, 2009). To boost the cashew production and become self sufficient, there is a need to produce quality planting materials since large planting materials is needed for area expansion and replanting of senile and unproductive cashew orchards. As the viability of nuts deteriorated rapidly on storage (Aravindakshan and Gopikumar, 1979), there is a problem for year round production of good planting material. Sowing of mixed or upgraded seeds give rise to non-uniform density of nursery stock. Many times, this results in the production of unhealthy and heterogeneous seedlings in the nursery. One of the reasons for the heterogeneity in the nursery stock is the high amount of variation in size and weight. Variation in the seedling size could be avoided to a great extent if the seed of uniform grade could be used for nursery sowing. Grading will also help in reducing the wastage of seeds in the nursery, if the influence of seed size on germination and growth of seedlings were established. Many pre-sowing treatments used worldwide to improve and synchronize the germination. Grading of seeds based upon their size and weight is a common practice in a majority of plant species as it has been found to regulate the germination and subsequent seedling growth in many species (Ajeesh *et al*., 2014; Vikas Kumar *et al*., 2014a, b; Vidyasagaran *et al*., 2014a-b-c; Vikas Kumar *et al*., 2015a,b,c,d). Hence, the present study was undertaken to evaluate effect of different pre-sowing treatments to hasten germination in the size graded *A. occidentale* seeds and to evaluate the influence of seed size variation on initial nursery performance of seedlings.

Materials and Methods

The present investigation was carried out at College of Forestry, Kerala Agricultural University, Thrissur, Kerala during May to December 2013. *A. occidentale* seeds were collected during May- June 2013 from the mature trees with well developed crowns Cashew research station, Madakkathara, Kerala Agricultural University, Thrissur, Kerala. Seed lots were thoroughly hand mixed to improve the homogeneity and graded into weight classes 4-6, 6.1-8, 8.1-10 and >10 g. From each weight class, 25 seeds were randomly selected to record weight, length and breadth. The sowing of the seeds was done in well prepared nursery beds at a spacing of 10 x 10cm to record daily germination counts. From these observations, Germination Percentage, Mean Daily Germination (MDG), Peak Value of germination (PV) and Germination Value (GV) were calculated (Czabator, 1962). The Seeds belonging to each weight class were transplanted to polybags filled with medium soil, sand and cow dung in the ratio 2:1:1 to record height, girth and number of leaves at fortnight intervals in CRD (Complete Randomized Block Design).

Statistical analysis

The data was analyzed using the IBM SPSS Statistics 20. One-way ANOVA was used compare the between weight class variation in all parameters.

Results

Seed characteristic

Prominent variation in seed size was obvious. Number of seeds per kg of 4-6, 6.1-8, 8.1-10 and >10g of these weight classes was 220.33±10.11, 145.33±3.48, 114.33±3.18 and 85.67±3.53, respectively. Mean weight of seeds was varied from 5.53±0.23 to 10.57±0.15 gm. Length and breadth was recorded for the very large size class (35.30±0.10 and 22.54±0.09, respectively). The length x breadth value was highest for very large size class (table 1). Analysis of variance revealed significant variations in all parameters due to weight class at 1 per cent level.

Germination parameters of the seeds were significantly influenced by weight classes at one per cent level. The germination percentage, peak value of germination, mean daily germination and germination value of very large weight class were significantly differed from other seed classes. A higher germination percentage, PV, MDG and GV were observed in very large weight class and the lowest was recorded in small weight class (table 2).

It is evident from the data that the height of seedlings ranged from 15.33 cm during the 1st fortnight in low class seeds to 38.83 cm at the end of 10th fortnight. The corresponding increase in medium, large and very large seeds ranged from 15.33 cm to 35.83cm, to 35.33cm, 15.03 to 34.10 cm respectively. There was significant difference between various classes of seeds with regard to height of seedlings in many fortnights. Generally, it can be seen that there is significant difference in height

of the seedlings.

Of seedlings from very large seeds compared to low, medium and large classes during the 2nd fortnight. The observations recorded from the 6th, 8th and 10th fortnights showed significant difference between the height of seedlings in the low and very large class seeds. However, the seedlings raised from low class seeds were showing a tendency to produce more height during certain fortnights. The height of seedlings recorded was 38.83 cm while the corresponding values of medium, large and very large class seeds were 35.83cm, 335.67cm and 34.10cm respectively. The total increment in height of low class seeds was more medium, very large and large seeds respectively. The total increment in height of low class seeds was more (23.5cm) compared to 20.5cm 19.07cm and 16.34cm for medium, very large and large seeds respectively. No statistical correlation was observed between seed characters and height of seedlings.

The fortnightly observations on girth of seedlings are tabulated in table 3. At the end of the study, the girth of seedlings ranged from 9.43mm in low class to 11.13mm in very large class and the difference is highly significant. The girth increment of very large class seeds (5.7mm) was found to be more compared to medium (5.4mm), large (4.99mm) and low (3.96mm) class seeds. The girth of seedlings varied significantly between different classes of seeds particularly during 1st, 2nd, 5th, 9th, and 10th fortnights. The girth of seedlings raised from very large class of seeds was found to be 11.13 compared to 10.60mm, 10.37mm and 9.43mm, respectively for seedlings from large, medium and low class seeds. The simple during the 2nd month and seed weight correlation worked out revealed significant effect of seed size and girth (r=.5474) during the 3rd month. Also there was significant effect of seed weight and size with girth of seedling 4th and 5th month as is evidenced from the correlation coefficients.

Observations on number of leaves as influenced by seed weight are presented in table 5. The number of leaves produced by seedlings of low class and very large class seeds at the beginning and end of the study was 5.33 and 4.33, and 11.67 and 8.3 respectively. The number of leaves produced by seedlings of various classes of seeds was statistically significant in most of the fortnights. The correlation coefficients between size of the seeds and leaf production was also found to be significant in the 4th month (r=.4763). The total increment in number of leaves of large class seeds was found to be more (8.33) while it was least (3.67) in very large class seeds. The seedlings of large class tended to produce slightly more number of leaves (12.33) compared to low, medium, and very large class seeds, where the number of leaves compared to low, medium and very large class seeds, where the number of leaves was 11.67, 11 and 8, respectively.

Discussion

In *A. occidentale*, the germination percentage was slightly higher in very large class seeds (88.49±1.52) followed by medium (83.53±0.14), small (78.17±0.18) and large class (67.01±0.22) seeds. The more quantity of stored food materials in the heavy seeds might have contributed for early and better germination. (Banik, 1978) Studies on the seedlings of *Leucaena leucocephala* from large, medium and small seeds showed higher initial field emergence and growth rate for seedlings from large seeds. The germination differences due to size variation were also statistically significant (Gupta *et al*., 1983). In *Causuarina equisetifolia* the estimation of three weight grades of cones into light, medium and heavy revealed that seeds from heavy cones into light, medium and heavy revealed that seeds from maximum height (Maiden *et al*., 1990). In *Terminalia catappa*, the germination percentage was highest in heavy class followed by medium and light class seeds (Assos *et al*., 1991). Ponnammal *et al*. (1993) grouped *Hardwickia binate* seeds into small, medium and large categories based on seed size and weight and reported that seed germination, seedling growth and biomass of seedlings increased with increase in seed size and weight. Sujith (1994) reported that seed size seed size did not have any influence in germination of *Ceiba pentandra*. Jayasankar *et al*. (1999) reported that seed size characteristics had no or weak correlation with germination percentage of teak seeds. Indira and Basha (1999) found out that teak, fruits of <9mm diameter had a low germination percentage, leading to fewer seedlings. Manonmani and Vanangamudi (2003) have reported enhanced germination with increase in drupe size.

Vegetative growth parameters of seedlings in the nursery

The vegetative growth parameters like height, girth and leaf production were recorded for the species. There was significant difference in height between small seed class with that of medium, large and very large class seeds of *A. occidentale*. However at the height of seedlings produced from small seeds during the 10th fortnight was found to be slightly higher (38.83cm) followed by medium (35.83cm), large (35.67cm) and very large (34.10cm) class seeds. The height of seedlings was not statistically correlated with the weight and size of the

Table 1 : Variations in seed attributes of *Anacardium occidentale* among different weight classes.

Seed classes	Number of seeds per kg	Mean weight (gm)	Mean length (mm)	Mean breadth (mm)	Length × breadth
Small (4-6g)	220.33±10.11a	5.53±0.23a	28.48±0.20a	17.63±0.10a	502.08±6.56a
Medium (6.1-8g)	145.33±3.48b	7.40±0.40b	34.45±0.09b	19.28±0.06b	664.14±3.88b
Large (8.1-10g)	114.33±3.18c	8.57±0.09c	34.27±0.08b	20.14±0.03c	690.25±2.72c
Very large (>10g)	85.67±3.53d	10.57±0.15d	35.30±0.10c	22.54±0.09d	795.87±5.45d

Values with same superscript with in a row are homogenous.

Table 2 : Germination parameters of *Anacardium occidentale* seeds as affected by weight.

Seed classes	Germination percentage	Mean daily germination	Peak value of germination	Germination value
Small (4-6g)	78.17±0.18a	0.35±0.01a	0.15±0.01a	0.02±0.00a
Medium (6.1-8g)	83.53±0.14b	0.58±0.01b	0.22±0.04b	0.14±0.03b
Large (8.1-10g)	67.01±0.22c	1.41±0.02c	0.26±0.01b	0.38±0.01c
Very large (>10g)	88.49±1.52d	1.85±0.02d	0.39±0.02c	0.65±0.02d

Values with same superscript with in a row are homogenous.

seeds as is evident from the results of correlation studies. This indicates that any type of seeds could be sown in the nursery with regard to height of the seedlings.

A nursery study conducted in cashew by Gopakumar *et al*. (1979) revealed that height of cashew seedlings was significantly influenced by weight and size of nuts. They also emphasized the importance of selection of seeds based on weight in relation to vigour of seedlings in nursery. Muhle *et al*. (1985) also could not establish any significant correlation between seed size and seedling height in Scots pine, Douglus fir and Norway spruce. Sobor (1987) also obtained a positive correlation between seed weight and seedling height in silver fir.

A study conducted by Syam (1988) revealed that large fruits (above 15 mm diameter) were superior to other grades with respect to germination characteristics, seedling growth and dry matter production. In Chinese chestnut, bigger nuts produced largest seedlings Emily *et al*. (1989). Assis *et al*. (1992) recorded a positive correlation between seed weight and height of the seedlings in case of *Terminalia catappa*, while there was no such correlation in *Terminalia bellarica* seedlings. The study conducted by Dileep *et al*. (1995) revealed that seed size has got an influence on seedling performance in case of *Ceiba pentandra*. Mandal *et al*. (1997) found that seedlings growth of *Acacia nilotica* were greatest from large class seeds and decreased as seed size decreased.

There was significant difference between various classes of seeds of *A. occidentale* in relation to girth. In this species, the girth of seedlings produced from very large seeds during the 10th fortnight was found to be slightly higher (11.13mm) followed by large (10.60mm), medium (10.37mm) and low (9.43mm) class seeds. In Cashew the very large and medium class seeds produced a girth increment of 5.7 mm and 5.44 mm, respectively with a span of 5 months. Statistical analysis revealed a positive correlation with seed characters and seedling girth.

Sarowart (1964) found that seed size did not influence the girth of seedlings of teak in the Nursery. Nazeen *et al*. (1980) reported that in jack, weight of seeds did not affect seedling growth characters in the nursery. Gross (1984) indicated that seedling growth of some selected monocarpic perennial plants was completely independent of the effect of seed size.

The number of leaves produced by seedlings did not vary significantly in low, medium and large seed class. Statistical correlation was found to exist only in the case of seed size in the 4th month.

Dunlap and Barnett (1984) found out that large seeds of Loblolly pine produced vigorous seedlings particularly in terms of needles. A study conducted by Ponnammal *et al*. (1993) reported that biomass of seedlings increased with increase in seed size and seed weight, Sudhakara *et al*. (1995) reported the advantage of large seeds, which produced seedlings of more height, collar diameter and number of leaves in *Ceiba pentandra*.

It could be seen from the results that, there was significant correlation between seed characters and

Table 3 : Variation in height (cm) of seedlings of cashew as influenced by various classes of seeds at fortnightly intervals.

Seed class	Fortnights										Total increment
	1	2	3	4	5	6	7	8	9	10	
Low	15.33	20.17	23.33	25.67	26.67	32.00	33.00	36.67	37.67	38.83	23.5
Medium	15.33	20.33	22.67	24.67	28.18	29.23	30.83	30.83	34.50	35.83	20.5
Large	19.33	20.67	24.83	26.67	28.83	29.77	32.17	32.17	33.33	35.67	16.44
Very large	15.03	16.00	20.33	23.67	26.00	27.33	30.67	30.67	33.33	34.10	19.07
F test	**	**	**	**	**	**	**	**	**	**	
CD(5%)	2.61	3.62	4.07	4.31	4.60	4.33	4.33	4.29	4.43	4.25	
S.Em.±	2.61	3.62	4.07	4.31	4.60	4.33	4.33	4.29	4.43	4.25	

Table 4 : Variation in girth (mm) of seedlings of Cashew as influenced by various classes of seeds at fortnightly intervals.

Seed class	Fortnights										Total increment
	1	2	3	4	5	6	7	8	9	10	
Low	5.47	6.07	7.53	7.70	8.03	8.27	8.53	8.57	8.83	9.43	3.96
Medium	4.93	5.47	7.33	7.57	7.97	8.44	8.80	9.27	9.67	10.37	5.44
Large	5.61	6.43	7.63	7.67	8.20	8.43	8.87	9.33	9.77	10.60	4.99
Very large	5.43	7.07	9.20	9.30	9.68	9.87	10.28	10.63	10.83	11.13	5.9
F test	**	**	**	**	**	**	**	**	**	**	
CD (5%)	0.44	0.63	0.93	0.95	0.95	0.96	0.59	0.88	0.87	0.83	
S.Em.±	0.43	0.61	0.91	0.92	0.92	0.93	0.87	0.86	0.85	0.81	

Table 5 : Variation in number of leaves of seedlings of cashew as influenced by various classes of seeds at fortnightly intervals.

Seed class	Fortnights										Total increment
	1	2	3	4	5	6	7	8	9	10	
Low	50.33	8.67	11.67	11.67	12.00	12.33	11.00	11.00	12.00	11.67	6.34
Medium	4.00	7.00	8.00	8.67	10.00	9.33	9.67	10.00	10.33	11.00	7.00
Large	4.00	8.33	12.33	11.33	11.33	11.33	12.33	13.00	12.33	12.33	8.33
Very large	4.33	6.67	7.00	6.67	7.33	11.67	7.67	8.00	8.33	8.00	3.67
F test	**	**	**	**	**	**	**	**	**	**	
CD(5%)	0.84	1.53	1.45	1.24	1.16	1.54	1.46	1.32	0.99	0.92	
S.Em.±	0.81	0.74	0.70	0.60	0.56	0.75	0.76	0.64	0.48	0.45	

** Significant at 1 per cent level.

seedling growth attributes in *A. occidentale*. Further detailed studies with more number of samples need to be undertaken on these lines. Chemical composition of seeds and seedlings also has to be studied for getting conclusive results.

Conclusion

It is evident that the germination percentage significantly declined with reduction in size and weight of the seeds. The results showed that the germination percentage was slightly higher in very large class seeds (87.5) followed by medium (83.9), small (75.0) and large class (73.4) seeds. The girth of seedlings produced from very large seeds during the 10th fortnight was found to be slightly higher (11.13mm) followed by large (10.60mm), medium (10.37mm) and low (9.43mm) class seeds.

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