Short communication

Seed source and size variation influences the germination and seedling growth of *Strychnos nux-vomica*

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Abstract

The present study focuses on seed source and size variation on germination and seedling performance of *Strychnos nux-vomica*. The Strychnos fruits were collected from dry and moist deciduous and riparian forests of Kerala and the seeds were extracted and graded into 18-21, 21 -24, 24-27 and 27-30 mm classes and their dimensions and germination were assessed. At six months after planting, the growth and biomass production of the seedlings belonging to respective seed sources and size classes were determined. The study revealed that the seed characters differed significantly due to seed source and size and those from moist deciduous and riparian forests, recorded higher dimensions. Seed source and size significantly influenced the germination parameters also and seeds from dry deciduous and riparian forests recorded higher germination parameters than moist deciduous forest, and the larger seeds recorded higher germination parameters than smaller ones. The height and collar diameter of seedlings varied due to seed source and size, but biomass production did not vary statistically.

Key words: Germination energy, Germination value, Vigour index, Biomass production

Strychnos nux-vomica L. is an important medium-sized deciduous medicinal tree species native to southeast Asia, especially India and Myanmar. It belongs to family *Loganiaceae* and grows naturally in wastelands and degraded forests in the West Coast as well as Eastern and Western Ghats of India. In Kerala, it occurs in the natural forests, waste lands, river banks and homesteads. The seeds, leaves and bark of *S. nux-vomica* are a rich source of drugs in Ayurvedic and Homoeopathic systems of Medicine. It belongs to high volume trade or consumption category, i.e. 100 t year^{-1}, among medicinal plants in India (Ved and Goraya, 2008). Massive fruit collection by industries and indigenous medical practitioners has reduced the availability of *S. nux-vomica*. Hence, large scale cultivation on both private and public lands has to be initiated to meet the market demands. However, scientific studies on seed technological aspects of *Strychnos* are lacking. Seed traits such as seed size, seed coat thickness, shape and moisture content are already known to affect germination and early seedling establishment (Jijeesh and Sudhakara, 2013). Similarly, fruit or seed trait variation due to seed source has been proven (Jayasankar et al., 1999) which can serve as a valuable tool in tree improvement programmes. Variation in the fruit and seed characteristics of the species from different natural habitats should be properly documented for future use in domestication, cultivation and tree improvement programmes, thereby controlling its over exploitation from natural habitats. Hence, the present investigation was carried out to study the influence of source and size of the seed on germination and seedling growth of *S. nux-vomica*.

The study was carried out at College of Forestry, Kerala Agricultural University, Thrissur, Kerala during 2010-2011. Fruits of *Strychnos nux-vomica* were collected in bulk from three sources viz. dry

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deciduous (Chinnar Wildlife Sanctuary), moist deciduous (Pattikkad Reserve Forest) and riparian (Peechi-Vazhani Wildlife Sanctuary) forests of Kerala. Immediately after collection, weight, volume and number of seeds per fruit were recorded (from 100 fruits of each source). To extract the seeds, fruits were split open and the seeds with pulp were soaked in water overnight. Seeds were squeezed off from the pulp, cleaned and their dimensions were recorded. The size of the seeds ranged from 18-30 mm. Based on the size (mean of the longest diameter along the direction of the embryo axis and its orthogonal diameter), the seeds were graded into size categories 18-21, 21-24, 24–27 and 27- 30 mm. Twenty five seeds from each size class were randomly selected to record length, breadth, thickness, weight and density. Air dried and de-pulped seeds belonging to each size grade and seed source were soaked in water for 48 hours and sown in root trainers of 24 cells (Tray length = 35 cm, breadth= 22 cm, with cells of 5x2x10 cm^3) after filling with the soil, dried cowdung and sand in the ratio of 3:2:1, to record daily germination counts (50 seeds in four replications). The germination parameters of the seeds were calculated as suggested by Czabator (1962). The germinated seeds in the root trainers were kept in a green house and timely weeding and irrigation were carried out. The seedling growth attributes like height, collar diameter, number of leaves, biomass production of stem, leaf and root, root: shoot ratio and vigour index were recorded at 180 days after planting. Destructive sampling was carried out using three plants per treatment. Seedling vigour index was calculated as the product of the germination percentage of the seed lot (respective seed source or size grade) and the seedling dry weight (Yari et al., 2010). Two-way analysis of variance was conducted to find the variation in seed and seedling parameters due to seed source and size grading using SPSS 17. The treatment means were compared using LSD.

Fruit of *S. nux-vomica* is a berry containing light greyish discoid seeds. Seeds are extremely compact

Table 1. Correlation matrix laid out among number of seeds per fruit, weight and volume of *Strychnos nux-vomica* fruits from different seed sources

Seed sources	Fruit weight	Fruit volume
Dry deciduous forest	0.83**	0.77**
Moist deciduous forest	0.80**	0.76**
Riparian forest	0.81**	0.84**

and with a satiny or glistening appearance. The morphological description of fruit and seeds agreed with that of Dey (1980). In general, number of seeds per fruit amongst the three sources varied from 1.5 ±0.09 to 2.4 ±0.13, weight of individual fruits from 27.4 ±1.23 to 47.3 ±1.89 g and its volume from 18.9 ±0.95 to 33.1 ±1.39 cm^3. The moist deciduous and riparian forests were superior in fruit traits compared to dry deciduous forest. The number of seeds per fruit was positively and significantly correlated with fruit weight and volume (Table 1). Hence, the larger fruits can be collected to obtain more number of seeds. Significant differences in seed dimensions due to seed source x size interactions ($p = 0.01$) was observed. In general, length of the individual seeds ranged from 19.6±1.09 to 28.6±1.42 mm, width from 19.0±1.15 to 27.9±1.18 mm and thickness from 4.2±0.52 to 5.6 ±0.89 mm amongst seed sources of *S. nux-vomica*. Individual seed weight varied from 1.4±0.20 to 3.4±0.31 g and density from 0.3±0.06 to 0.8±0.05 cm^3 (Table 2). The seeds from moist deciduous and riparian forests recorded higher dimensions except seed thickness. The seed dimensions increased with increase in seed size. Highest seed weight and density also were observed for largest size class seeds of moist deciduous source.

Seed source and size variations are observed to exert significant influence on seed and seedling quality. Better seedling growth, quality and adaptability could be achieved only through careful selection of the best sources and raising tree seedlings from the selected sources in any plantation programme (Kjaer and Foster, 1996). In the present investigation, seed source significantly influenced the fruit traits. Better fruit traits obtained for those from moist deciduous

Table 2. Variations in seed traits of *Strychnos nux-vomica* as affected by seed source and seed size class

Seed dimension	Seed source	Seed size class (mm)				Mean
		27-30	24-27	21-24	18-21	
Length (mm)	1	28.6±1.42	26.1± 0.89	21.5± 1.17	19.6± 1.09	24.0^{A} ± 3.6
	2	28.4± 0.91	25.6± 0.92	22.8± 0.82	20.2± 1.09	24.3^{AB} 2.4
	3	28.3± 1.22	26.1± 0.83	23.3± 1.14	20.7± 1.9	24.6^{B}± 2.6
	Mean	28.4^{D}± 1.2	26^{C}± 0.9	22.5^{B}± 1.1	20.2^{A}± 1.5	24.3± 3.3
Width (mm)	1	26.2 ±1.38	25.1 ±0.87	23.1 ±1.35	19.0 ±1.15	23.4^{A}±3.1
	2	27.9±1.18	24.8±1.03	22.5±1.02	19.7±1.1	23.7^{B}±2.3
	3	27.8±0.94	24.9±1.08	22.1±0.88	19.4±0.77	23.6^{B}±2.4
	Mean	27.3^{D} ±1.4	25^{C}±1	22.6^{B}±1.2	19.4^{A}±1.0	23.6 ±3.2
Thickness (mm)	1	5.3 ±0.45	5.6 ±0.89	5.1 ±0.32	5.2 ±0.64	5.3^{B}±0.7
	2	5.1±0.49	4.9±0.48	5.0±0.55	4.2±0.52	4.8^{A}±0.6
	3	4.6±0.62	5.1±0.44	4.5±0.59	5±0.59	4.8^{A}±0.5
	Mean	5.0^{A}±0.6	5.2^{B}±0.7	4.9^{A} ±0.7	4.8^{A} ±0.6	4.6±0.7
Weight (g)	1	2.8 ±0.24	2.5 ±0.28	1.9 ±0.30	1.4±0.20	2.2^{A} ±0.6
	2	3.4 ±0.31	2.4±0.60	2.0±0.55	1.6±0.28	2.4^{B}±0.6
	3	3.3±0.28	2.6±0.22	2.1±0.43	1.9±0.40	2.5^{B} ±0.5
	Mean	3.2^{D}±0.4	2.5^{C}±0.4	2.0^{B}±0.4	1.6^{A} ±0.4	2.4 ±0.7
Density	1	0.6±0.07	0.6±0.07	0.4±0.07	0.3±0.06	0.48^{A}±0.2
	2	0.8±0.05	0.4±0.09	0.3±0.14	0.3±0.08	0.45^{A}±0.1
	3	0.8±0.04	0.5±0.10	0.4±0.10	0.4±0.10	0.53^{B}±0.1
	Mean	0.73^{C} ±0.1	0.5^{B} ±0.1	0.37^{A} ±0.1	0.33^{A}±0.1	0.49±0.2

Note: Seed source 1: Dry deciduous forest, 2: Moist deciduous forest and 3: Riparian forest, *Mean values with same superscript for seed source and size are homogenous*

forests in our study was in conformity with the studies on *Terminalia alata* in which the trees growing in moist deciduous forests produced fruits with higher weight compared to semi-evergreen and dry deciduous forests (Sivaprasad and Channabasappa, 2011). Field observations revealed that *S. nux-vomica* trees growing in the moist deciduous forests were comparatively larger in size with dense less spreading crown, having more or less columnar shape. The fruits were largest in size and more concentrated in certain parts of the crown and number of seeds per fruit was also greater. Whereas, trees in the riparian site were smaller in size, leaning towards water; greater portion of the crown was concentrated towards the water body and all the fruit traits under consideration were of intermediate values. The improved fruit traits recorded in moist deciduous forests might be due to the crown and site characteristics, and the lower values obtained with respect to these in fruits of dry deciduous forests may be because of the lower vigour of the trees combined with reduced site quality. The source variation in seed and seedling quality has been reported in species like *Jatropha curcas* (Ginwal and Gera, 2005), *Tectona grandis* (Jijeesh and Sudhakara, 2007; Sudhakara and Jijeesh, 2008), etc. All seed traits improved with increase in size irrespective of the source. Our results are in conformity with the finding that the seed source and size influence the seed attributes (Gunaga et al., 2010; Dlamini, 2011) in many tree species.

Influence of seed source and size was obvious in germination parameters and their interaction effect was significant (p=0.01) in germination percentage, germination energy, MDG, PV and GV and not significant in speed of germination. In general, irrespective of the seed source, the germination characteristics drastically reduced with decreasing

Table 3. Germination parameters of *Strychnos nux-vomica* seeds as influenced by seed source and size class

Seed dimension	Seed source	Seed size class (mm)				Mean
		27-30	24-27	21-24	18-21	
Germination percentage	1	58±0.15	44 ±0.05	32 ±0.10	22 ±0.04	39^{B} ±0.19
	2	20 ± 0.02	18± 0.10	17 ± 0.10	11± 0.05	16^{A}± 0.09
	3	54 ± 0.16	39 ± 0.04	34 ± 0.08	22 ± 0.05	37^{B} ± 15
	Mean	44^{D}± 0.23	33^{C}± 0.13	27^{B}± 0.12	18^{A}± 0.09	31± 0.18
Germination energy	1	78 ±0.26	52±0.16	37±0.09	28 ±0.09	49^{B} ±0.30
	2	26 ±0.13	21 ±0.13	21 ±0.17	38 ±0.21	26^{A} ±0.17
	3	67±0.18	47±0.11	38±0.13	23±0.05	44^{B} ±0.23
	Mean	57^{C}±0.35	40^{B} ±0.20	32^{A} ±0.15	30^{A} ±0.15	40±0.26
Speed of germination	1	0.27±0.05	0.18 ±0.02	0.14±0.04	0.10±0.02	0.17^{B}±0.08
	2	0.09±0.02	0.08±0.04	0.08±0.03	0.06 ±0.01	0.07^{A}±0.03
	3	0.24±0.07	0.16±0.01	0.15±0.05	0.10±0.02	0.16^{B}±0.08
	Mean	0.20^{C}±0.09	0.14^{B}±0.05	0.12^{B}±0.05	0.09^{A}±0.03	0.14±0.07
Mean daily germination	1	0.80±0.15	0.61±0.06	0.42±0.19	0.33±0.06	0.54^{B}±0.22
	2	0.31±0.02	0.28±0.16	0.24±0.14	0.21±0.03	0.26^{A}±0.10
	3	0.76±0.15	0.54±0.03	0.49±0.11	0.32±0.08	0.53^{B}±0.19
	Mean	0.62^{D}±0.23	0.48^{C}±0.18	0.38^{B}±0.18	0.29^{A}±0.09	0.44±0.22
Peak value of Germination	1	0.83±0.16	0.60±0.06	0.41±0.20	0.33±0.07	0.54±0.23
	2	0.30±0.02	0.27±0.16	0.24±0.13	0.20±0.03	0.26±0.10
	3	0.77±0.17	0.54±0.02	0.48±0.11	0.32±0.08	0.53±0.19
	Mean	0.63±0.27	0.48±0.17	0.38±0.18	0.28±0.08	0.44±0.22
Germination value	1	0.66 ±0.07	0.36 ±0.07	0.17 ±0.07	0.10 ±0.06	0.32^{A} ±0.2
	2	0.24 ±0.05	0.07 ±0.09	0.05 ±0.14	0.04 ±0.08	0.10^{A} ±0.1
	3	0.58 ±0.04	0.29 ±0.10	0.23 ±0.10	0.10 ±0.10	0.30^{B} ±0.1
	Mean	0.49^{C} ±0.13	0.24^{B} ±0.19	0.15^{A} ±0.09	0.11^{A} ±0.07	0.24 ±0.18

Note: Seed source 1: Dry deciduous forest, 2: Moist deciduous forest and 3: Riparian forest

size class (Table 3). The largest size class seeds from dry deciduous source recorded the highest germination (58%) followed by large seeds of riparian source (54%) whereas, those of moist deciduous source gave lower germination (20%). Germination energy also showed a pattern similar to germination percentage. The speed of germination and MDG of the seeds also showed similar trend in seed source variation and declined with decrease in seed size. The dry deciduous and riparian sources excelled over the moist deciduous source in MDG, with an increase of 107%. Similarly, the PV for the seeds collected from dry deciduous and riparian sources were on par and were 108% higher that of moist deciduous seeds. As GV is the product of MDG and PV, it also showed a similar trend. In the case of GV, the dry deciduous and riparian sources were at par and were 700% higher when compared to the moist deciduous source. Contrary to fruit and seed traits, seeds from dry deciduous and riparian forests recorded higher germination parameters than moist deciduous forests and higher germination parameters were obvious in large seeds. The observed results with regard to seed germination are in concurrence with increase in germination with increase in seed size and weight reported in various trees (Suresh et al., 2003; Singh and Saxsena, 2009).

Significant variation in seedling height and collar diameter due to main effect of seed source and size (p=0.01) was obvious but their interaction effects were not significant. Of the seed sources, seedlings raised from riparian source were the tallest (18.1 cm) and those from dry deciduous source were the shortest (16.3 cm). The seedlings from the largest

Table 4. Seedling attributes of *Strychnos nux-vomica* as influenced by seed source and size class

Seed source	Seed size class (mm)			
	27-30	24-27	21-24	18-21
Seedling height (cm)				
1	19.14 ±3.05	17.07 ±5.71	18.81 ±5.51	18.16 ±5.94
2	18.99 ±2.20	17.78 ±4.10	17.62 ±4.45	20.22 ±4.55
3	20.83 ±5.82	20.31 ±3.98	20.16 ±4.52	19.54 ±5.32
Collar diameter (mm)				
1	4.19 ±0.71	3.97 ±0.94	4.10 ±0.96	4.19 ±1.01
2	3.60 ±0.36	3.66 ±0.76	3.63 ±0.67	3.86 ±0.82
3	3.82 ±0.46	3.71 ±0.55	3.49 ±0.99	3.37 ±0.48
Number of leaves				
1	13.51 ±4.12	12.96 ±4.07	13.15 ±4.78	13.57 ±4.03
2	12.78 ±2.13	13.17 ±4.13	13.50 ±3.99	12.88 ±4.03
3	13.61 ±3.75	13.27 ±3.65	12.95 ±2.86	12.95 ±4.41
Stem biomass (g)				
1	0.64 ±0.10	0.73 ±0.11	0.61 ±0.15	0.66 ±0.16
2	0.74 ±0.17	0.65 ±0.13	0.82 ±0.24	0.59 ±0.25
3	0.83 ±0.15	0.79 ±0.18	0.78 ±0.24	0.67 ±0.29
Leaf biomass (g)				
1	0.19 ±0.03	0.25 ±0.06	0.21 ±0.06	0.20 ±0.08
2	0.19 ±0.03	0.17 ±0.08	0.19 ±0.11	0.15 ±0.11
3	0.17 ±0.17	0.12 ±0.08	0.24 ±0.06	0.14 ±0.06
Root biomass (g)				
1	1.76±0.39	1.83±0.97	1.83±1.02	1.82±0.65
2	1.70±0.43	1.39±0.61	1.45±0.82	1.56±0.67
3	2.03±0.71	1.74±0.63	1.61±0.36	1.51±0.75
Vigour index				
1	2.12±0.38	1.96±1.16	2.16±0.81	2.20±0.78
2	1.89±0.59	1.63±0.51	1.36±0.50	2.08±0.78
3	2.11±0.86	1.90±0.45	1.67±0.60	2.01±1.10
Root:shoot ratio				
1	2.10±0.35	1.97±1.05	2.21±0.89	2.31±0.75
2	1.89±0.59	1.63±0.51	1.36±0.50	2.08±0.78
3	2.11±0.85	1.90±0.45	1.67±0.60	2.01±1.10

Note: Seed source 1: Dry deciduous forest, 2: Moist deciduous forest and 3: Riparian forest

size grade were taller (17.6 cm) and superior to those from other grades which were at par (Table 4). Seedlings raised from the seeds of dry deciduous source had greatest collar diameter (3.6 mm) and those from riparian source had the lowest value (3.2 mm). Collar diameter of the seedlings also decreased with decrease in size class. Seed source did not affect the number of leaves of the seedlings but it varied due to seed size class and seedlings obtained from largest size class seeds had greatest number of leaves and those from the rest of the grades were at par. Similarly, analysis of variance did not reveal any significant difference in biomass production, root: shoot ratio and vigour index due to seed source or size. In the present investigation, although seed source and seed size could influence the seed germination, seedling growth was unaffected except in height and collar girth. The effect of seed source and size on seedling performance was visible only in growth parameters but biomass production of the seedlings was at par. Our findings suggest that seed size is not always a good indicator of seedling quality.

In the present investigation, the riparian and moist deciduous sources recorded better seed traits compared to dry deciduous source and seed traits lowered with decrease in size class. Germination in seeds of dry deciduous and riparian forest was higher compared to that of moist deciduous forests and larger seeds recorded higher germination. However, in the light of the present study, as the influence of seed source and size was not significant on seedling growth, seeds belonging to moist deciduous forest source and the larger size grade can be recommended only for planting stock production as the germination is high.

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