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Studies on germination and seedling vigour characters for genotype selection in nutmeg (*Myristica fragrans* Houtt.)

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Abstract

An experiment was conducted at Ratnagiri (Maharashtra) to study the regeneration ability and variability of 34 nutmeg (*Myristica fragrans*) seedling genotypes. The variations recorded for germination percentage, period required for germination and seedling growth parameters were significant. Higher magnitudes of genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance on per cent mean basis were recorded for fresh seed weight, germination percentage, days for germination and root length. The selection of nutmeg genotypes at seedling stage on the basis of vigour of the characters such as number, length and breadth of leaves, collar thickness and petiole length would help to identify genotypes for propagation. Among the genotypes studied, N22, N24, N26, N29, N34, N37, N38, N42, N43, N51, N63 and N72 were promising.

Key words: *Myristica fragrans*, nutmeg seedlings, variability.

Introduction

Nutmeg (*Myristica fragrans* Houtt.) is dioecious in nature and hence vegetative propagation is desirable to eliminate the occurrence of male plants by retaining the desirable properties of parental genotype. However, the saplings raised from seeds for rootstock may also play an important role in graft propagation. The rootstocks used for grafting may influence the performance of the grafted plant (Hartmann *et al.* 1997). Furthermore, the seedlings directly used for planting in the field ensure longer life span, hardiness and resistance to biotic and abiotic stresses. Hence, assessment of the genotypes for propagation by seeds is also important in nutmeg and an attempt was made to study

the variability and regeneration ability of nutmeg genotypes.

Materials and methods

The experiment was carried out at Regional Coconut Research Station, Bhatye, Ratnagiri (Maharashtra) (17.00° N and 73.40° E; 3 m MSL; average annual rainfall : 2970 mm; average humidity : 73%; average minimum and maximum temperatures : 22.8°C and 31.1°C, respectively) for two years during 1999–2000. Thirty four nutmeg genotypes namely, N1, N4, N5, N7, N10, N11, N22, N23, N24, N26, N27, N29, N30, N32, N33, N34, N36, N37, N38, N41, N42, N43, N46, N49, N51, N55, N56, N57, N61, N63, N66, N70, N72 and N74 were selected for the study. These genotypes were raised from seeds collected

from existing nutmeg trees in the konkan region of Maharashtra. The experiment was conducted in a Randomized Block Design with two replications. The freshly harvested fruits were randomly selected to extract nuts (seeds) and 50 seeds were selected per treatment per replication. These seed nuts were sown on sand raised beds of 150 cm width and 20 cm height under shade. The nutmeg seeds were collected as and when available and were immediately sown in horizontal position, 1 cm deep on the bed surface. The beds were mulched with dry grass and watered regularly. The germination percentage and period required for germination were recorded. The date of germination was considered when the sprout just appeared above the bed surface. The average time of germination of first seed and last seed of a treatment was considered as time required for germination. Five seedlings per replication were randomly selected 90 days after germination to record growth observations namely, shoot height, collar thickness, total number of leaves, petiole length, leaf length, leaf breadth and root length. Statistical analysis was done as per the methods suggested by Panse & Sukhatme (1995) and Singh & Chaudhari (1985).

Results and discussion

Significant variability was observed among the seedling progenies for various characters. The mean period required for germination was 70 days and was longest in N46 (107 days). The success of germination in the population was 68.87% and was highest in N42 and N43 (87.00%) (Table 1). At 90 days after sprouting, the mean shoot length was 14.34 cm and was maximum in N24 (16.73 cm). The mean collar thickness and number of leaves was 0.35 cm and 3.51 cm, respectively. The thickness of the collar was maximum in N24, N29 and N72 (0.38 cm) whereas, maximum production of leaves was noticed in N38 (4.3). The mean petiole length was 0.84 cm, which was maximum in N72 (1.01 cm). The mean leaf length and width at 90 days were 10.71cm and 4.00 cm respectively, with 1.12 secondary roots. The genotypes, N26, N22

and N37 had maximum leaf dimensions namely, 12.15 cm leaf length, 4.51 cm leaf width and 3.53 secondary roots. The mean root length was 11.52 cm and was maximum in N72 (15.04 cm) (Tables 2–4).

Substantial variability at genotypic and phenotypic levels were observed for root length, germination percentage and days for germination (Tables 5 & 6). For remaining characters the coefficient of variation at phenotypic and genotypic levels were relatively low. Further, the heritability in broad sense was very high for germination percentage, duration of germination, height of seedling, petiole length, leaf breadth and root length. Moreover, the magnitudes of genotypic coefficients of variation for germination, duration for germination and root length were very high. This suggested that these characters are governed by additive gene action. For weight of fresh seed to be used for germination, the variability at genotypic and phenotypic levels as well as magnitudes of heritability and genetic advance were very high. Hence, this character could also be considered under the control of additive genes. The results thus indicated that there is good scope for selecting an elite material at the stage of germination itself preferably on the basis of per cent germination, duration for germination, root length and fresh seed weight.

Correlation studies at genotypic level indicated that the germination percentage did not show any association with any other character under study. The duration for germination showed negative correlation with total leaves, petiole length and fresh seed weight. This suggested that genotypes with bolder fresh seeds can produce seedlings with longer roots, profuse foliage having long and broad leaves with longer petiole in a short period from sowing. Better vigour in seedlings by using bold seeds was also noticed by Mathew (1992) in nutmeg. The strong thick petiole and broad leaves thus appeared to be the direct determinants of boldness of seeds and hence the selection can be executed even at seedling stage for bolder seeds on the basis of the leaf breadth and petiole

Table 1. Time required for germination and germination percentage of nutmeg genotypes

Genotype	Time required for germination (days)			Germination (%)		
	1999	2000	Pooled	1999	2000	Pooled
N1	74	73	74	66 (54.33)	84 (66.42)	75 (60.00)
N4	61	63	62	36 (36.87)	35 (36.27)	36 (36.87)
N5	69	73	70	37 (37.47)	43 (40.98)	40 (39.23)
N7	83	74	68	69 (56.17)	67 (54.94)	68 (55.55)
N10	75	74	75	64 (53.13)	71 (57.42)	68 (55.55)
N11	63	60	62	72 (58.05)	85 (67.21)	79 (62.72)
N22	59	62	60	73 (58.69)	72 (58.05)	73 (58.69)
N23	53	57	55	58 (49.60)	51 (45.57)	55 (47.87)
N24	60	57	59	55 (47.87)	49 (44.43)	52 (46.15)
N26	55	54	54	39 (38.65)	31 (33.83)	35 (36.27)
N27	71	69	70	48 (43.85)	50 (45.00)	49 (44.43)
N29	75	74	75	78 (62.03)	86 (68.03)	82 (64.90)
N30	68	71	69	56 (48.45)	64 (53.13)	60 (50.77)
N32	86	94	90	33 (35.06)	30 (33.21)	32 (34.45)
N33	114	72	93	60 (50.77)	46 (42.71)	53 (46.72)
N34	61	74	68	65 (53.73)	77 (61.34)	71 (57.42)
N36	64	62	63	42 (40.40)	49 (44.43)	46 (42.71)
N37	68	75	71	63 (52.53)	75 (60.00)	60 (50.77)
N38	65	57	61	59 (50.18)	69 (56.17)	64 (53.13)
N41	77	75	74	35 (36.27)	32 (34.45)	34 (35.67)
N42	72	76	74	82 (64.90)	92 (73.57)	87 (68.87)
N43	62	62	62	79 (62.72)	94 (75.82)	87 (68.87)
N46	108	106	107	31 (33.83)	42 (40.40)	37 (37.47)
N49	86	79	82	71 (57.42)	75 (60.00)	73 (58.69)
N51	88	92	90	70 (56.79)	76 (60.67)	73 (58.69)
N55	76	74	75	58 (49.60)	50 (45.00)	54 (47.29)
N56	56	53	54	62 (51.94)	58 (49.60)	60 (50.77)
N57	74	74	74	37 (37.47)	32 (34.45)	35 (36.27)
N61	69	66	68	61 (51.35)	60 (50.77)	61 (51.35)
N63	69	66	67	66 (54.33)	74 (59.34)	70 (56.79)
N66	64	68	66	63 (52.53)	78 (62.03)	71 (57.42)
N70	48	57	53	73 (58.69)	82 (64.90)	78 (62.03)
N72	63	60	61	67 (54.94)	78 (62.03)	73 (58.69)
N74	80	76	78	75 (60.00)	85 (67.21)	80 (63.44)
Mean	71.06	69.97	70.00	58.91	63.00	60.91
SEm \pm	2.88	4.91	1.60	1.92	1.76	1.22
CD (P=0.05)	8.30	14.15	4.61	5.54	5.09	3.52

Figures in parentheses indicated arcsin transformed values

Table 2. Shoot characters of seedlings of nutmeg genotypes

Genotype	Shoot height (cm)			Thickness at collar (cm)			Root length (cm)		
	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled
N1	10.49	19.10	14.61	0.25	0.37	0.31	9.85	10.12	9.99
N4	13.71	13.51	13.61	0.35	0.35	0.35	14.00	12.78	13.39
N5	13.80	14.84	14.32	0.37	0.37	0.37	13.79	9.95	11.87
N7	11.50	16.53	14.02	0.29	0.38	0.34	13.57	9.74	11.66
N10	10.77	14.21	12.49	0.27	0.31	0.29	9.73	8.89	9.31
N11	9.86	13.91	11.89	0.28	0.38	0.33	10.95	10.61	10.78
N22	13.07	14.70	13.89	0.38	0.38	0.38	11.81	9.85	10.83
N23	13.70	15.27	14.49	0.32	0.36	0.34	13.10	10.42	11.77
N24	16.08	17.38	16.73	0.38	0.38	0.38	13.02	9.48	10.80
N26	15.32	12.88	14.09	0.34	0.33	0.33	13.30	8.75	11.03
N27	12.74	16.77	14.75	0.32	0.37	0.34	12.96	9.86	11.41
N29	11.78	17.76	14.77	0.34	0.41	0.38	10.10	11.96	11.03
N30	11.15	16.57	13.86	0.29	0.36	0.33	11.05	10.15	10.60
N32	13.02	13.84	13.43	0.30	0.34	0.32	13.47	9.92	11.70
N33	11.72	15.33	13.53	0.33	0.39	0.37	12.15	14.18	13.17
N34	12.01	19.10	15.56	0.33	0.35	0.34	12.25	9.51	10.88
N36	10.25	16.85	13.55	0.30	0.35	0.33	10.85	8.95	9.90
N37	13.11	16.05	14.58	0.34	0.40	0.37	15.30	13.08	14.19
N38	11.30	19.42	15.36	0.31	0.40	0.36	13.10	15.20	14.15
N41	11.67	14.18	12.93	0.29	0.36	0.33	10.16	9.92	10.04
N42	12.43	19.14	15.79	0.35	0.38	0.37	12.01	14.78	13.40
N43	12.63	20.24	16.44	0.32	0.37	0.35	12.51	12.66	12.59
N46	14.21	16.54	15.33	0.35	0.36	0.36	12.27	8.35	10.32
N49	12.54	15.24	13.89	0.33	0.39	0.36	11.58	8.90	10.24
N51	12.53	15.02	13.78	0.32	0.37	0.35	10.62	12.26	11.44
N55	15.27	16.19	15.73	0.34	0.36	0.35	12.97	9.30	11.17
N56	14.70	15.22	14.96	0.33	0.33	0.33	11.68	8.72	10.20
N57	13.55	15.46	14.51	0.34	0.33	0.35	14.80	9.42	12.11
N61	14.85	16.31	13.08	0.36	0.36	0.36	16.61	9.78	13.20
N63	13.43	16.45	14.94	0.32	0.39	0.36	14.45	9.85	12.15
N66	11.98	14.35	13.17	0.30	0.39	0.35	10.57	9.95	11.52
N70	7.68	20.48	14.08	0.24	0.36	0.30	13.35	11.65	12.50
N72	11.57	19.28	15.43	0.34	0.41	0.38	15.20	14.87	15.04
N74	10.85	17.19	14.02	0.32	0.36	0.35	10.56	11.34	10.95
Mean	12.51	16.33	14.34	0.33	0.36	0.35	12.46	10.74	11.52
SEm±	0.60	0.77	0.59	0.02	0.01	0.01	1.00	0.78	0.73
CD (P=0.05)	1.74	2.23	1.72	0.05	0.04	0.04	2.89	2.26	2.12

Table 3. Leaf characters of seedlings of nutmeg genotypes

Genotype	No. of leaves			Petiole length (cm)		
	1999	2000	Pooled	1999	2000	Pooled
N1	3.1	3.3	3.2	0.84	0.89	0.87
N4	3.7	3.5	3.6	0.80	0.75	0.77
N5	3.4	4.2	3.8	0.87	0.88	0.88
N7	3.0	3.8	3.4	0.72	0.99	0.86
N10	2.8	3.2	3.0	0.67	0.84	0.76
N11	3.4	3.9	3.7	0.62	0.84	0.73
N22	3.0	3.5	3.3	0.95	0.93	0.93
N23	3.6	3.7	3.7	0.95	0.85	0.90
N24	3.8	3.6	3.7	0.90	0.86	0.88
N26	4.0	3.3	3.6	0.98	0.88	0.93
N27	3.4	3.2	3.3	0.78	0.91	0.85
N29	3.0	3.8	3.4	0.74	0.92	0.83
N30	3.3	3.3	3.3	0.70	0.82	0.76
N32	3.2	3.0	3.1	0.75	0.73	0.75
N33	3.2	3.3	3.3	0.77	0.94	0.86
N34	3.5	3.7	3.6	0.87	1.06	0.97
N36	3.3	3.3	3.3	0.85	0.86	0.86
N37	4.1	3.9	4.0	0.85	0.82	0.84
N38	3.5	5.1	4.3	0.71	0.94	0.83
N41	2.8	3.9	3.4	0.70	0.85	0.78
N42	3.8	4.3	4.1	0.71	0.84	0.78
N43	3.1	3.9	3.5	0.70	0.86	0.78
N46	3.2	3.4	3.3	0.70	0.88	0.79
N49	3.4	3.8	3.6	0.67	0.82	0.75
N51	3.2	3.1	3.2	0.78	0.90	0.84
N55	3.9	3.7	3.8	0.90	0.85	0.88
N56	3.6	2.8	3.2	0.94	0.84	0.90
N57	4.0	3.3	3.7	0.88	0.82	0.85
N61	3.5	3.9	3.7	0.85	0.85	0.85
N63	3.3	4.0	3.7	0.82	0.83	0.83
N66	3.1	4.3	3.7	0.70	0.89	0.80
N70	3.0	3.5	3.3	0.59	0.85	0.72
N72	3.3	4.3	3.8	0.86	1.16	1.01
N74	3.5	3.2	3.4	0.88	0.91	0.90
Mean	3.38	3.60	3.51	0.79	0.87	0.84
SEm \pm	0.24	0.28	0.15	0.04	0.04	0.03
CD (P=0.05)	0.69	0.80	0.44	0.11	0.11	0.09

Table 4. Leaf characters of seedlings of nutmeg genotypes

Genotype	Leaf length (cm)			Leaf breadth (cm)		
	1999	2000	Pooled	1999	2000	Pooled
N1	9.66	12.22	10.94	3.26	4.81	4.02
N4	10.01	10.83	10.42	3.75	3.95	3.85
N5	11.40	11.33	11.37	4.36	4.06	4.21
N7	9.85	11.61	10.73	3.24	4.09	3.67
N10	9.47	10.44	9.96	3.46	3.86	3.66
N11	8.27	11.44	9.86	3.18	4.22	3.70
N22	9.74	12.97	11.36	4.12	4.89	4.51
N23	9.93	11.27	10.67	4.22	4.40	4.31
N24	11.61	10.69	11.15	3.39	4.46	4.43
N26	11.76	12.55	12.15	3.87	4.38	4.13
N27	9.73	11.40	10.57	3.58	4.09	3.84
N29	9.79	12.18	10.99	4.13	4.53	4.33
N30	7.92	10.35	9.14	2.90	3.87	3.99
N32	10.98	9.24	10.11	3.82	3.63	3.73
N33	10.17	12.59	11.38	3.87	4.06	3.97
N34	10.35	12.80	11.58	3.95	4.36	4.16
N36	8.42	11.09	9.76	2.85	3.94	3.40
N37	11.28	12.04	11.66	3.93	4.18	4.06
N38	10.42	12.02	11.22	3.61	4.71	4.16
N41	9.86	10.97	10.42	3.92	3.99	3.96
N42	10.50	10.98	10.74	3.88	4.17	4.03
N43	10.21	12.84	11.53	3.79	4.44	4.12
N46	10.27	10.82	10.55	4.05	4.09	4.04
N49	8.91	10.35	9.63	3.31	4.04	3.68
N51	10.32	12.03	11.18	3.68	4.34	4.01
N55	10.33	10.15	10.24	3.95	4.09	4.02
N56	10.19	9.53	9.86	4.36	3.96	4.16
N57	9.90	12.25	11.08	3.88	4.36	4.12
N61	9.96	10.99	10.48	4.05	4.05	4.05
N63	10.01	10.85	10.43	3.82	3.86	3.84
N66	9.30	12.49	10.90	3.46	4.97	4.22
N70	7.56	12.08	9.97	2.50	4.29	3.40
N72	9.61	12.22	10.92	3.66	5.34	4.50
N74	10.36	11.95	11.16	4.09	4.34	4.22
Mean	9.94	11.46	10.71	3.73	4.26	4.00
SEm \pm	0.41	0.44	0.32	0.16	0.17	0.12
CD (P=0.05)	1.17	1.28	0.91	0.48	0.50	0.34

Table 5. Mean squares and components of variance of seedling characters in nutmeg genotypes

Character	Mean	Mean sum of squares for variety	Mean sum of squares for error	Phenotypic variance	Genotypic variance	Environmental variance
Germination (%)	51.69	205.46**	2.98	104.22	101.24	2.98
Time required for germination (days)	70.02	287.10**	5.11	146.10	140.99	5.11
Shoot height (cm)	14.34	2.34**	0.71	1.52	0.82	0.71
No. of leaves	3.51	0.17**	0.05	0.11	0.06	0.05
Petiole length (cm)	0.84	0.01**	0.001	0.00	0.004	0.002
Leaf length (cm)	10.71	0.90**	0.20	0.55	0.35	0.200
Leaf breadth (cm)	4.00	0.17**	0.03	0.10	0.07	0.028
Thickness at collar (cm)	0.35	0.01*	0.003	0.00	0.00	0.00
Root length (cm)	11.52	4.65**	1.08	2.86	1.79	1.08
Fresh seed weight (g)	6.79	3.77**	0.17	1.97	1.80	0.17

*, ** Significant at P=0.05 and P=0.01, respectively

Table 6. Genetic parameters of seedling characters in nutmeg genotypes

Character	Phenotypic coefficient of variation	Genotypic coefficient of variation	Environmental coefficient of variation	Heritability (h ² b)	Genetic advance	Genetic advance on % mean basis
Germination	19.75	19.46	0.29	97.10	20.42	39.51
Time required for germination	17.26	16.96	0.30	96.50	24.03	34.32
Shoot height	8.61	6.30	2.31	53.50	1.36	9.49
No. of leaves	9.40	7.08	2.32	56.70	0.39	10.98
Petiole length	9.28	7.57	1.71	69.50	0.11	13.28
Leaf length	6.94	5.54	1.40	63.70	0.98	9.11
Leaf breadth	7.91	6.71	1.20	72.40	0.47	11.80
Thickness at collar	9.16	0.00	9.16	43.70	0.03	8.25
Root length	14.67	11.59	3.08	62.40	2.17	18.87
Fresh seed weight	20.65	19.76	0.89	91.50	2.64	38.93

Table 7. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficient of seedling characters in nutmeg types

Character	Germination (%)	Time required for germination	Shoot height	No. of leaves	Petiole length	Leaf length	Leaf breadth	Thickness at collar	Root length	Fresh seed weight
Germination	-	-0.177	0.169	0.119	-0.016	0.061	0.095	0.108	0.162	-0.267
Time required for germination	-0.172	-	-0.138	-	-0.342*	-0.37	-0.131	0.148	-0.131	-0.390*
Shoot height	0.146	-0.076	-	0.366*	0.448**	0.494**	0.633**	0.579**	0.419*	0.116
No. of leaves	0.096	-0.260	0.297	0.467*	0.224	0.433*	0.492**	0.790**	0.714**	0.336
Petiole length	-0.024	-0.277	0.301	0.149	-	0.673**	0.703**	0.444**	0.119	0.484**
Leaf length	0.043	-0.031	0.274	0.266	0.463**	-	0.746**	0.545**	0.478**	0.184
Leaf breadth	0.069	-0.080	0.348*	0.259	0.601**	0.658	-	0.733**	0.306	0.490**
Thickness at collar	0.105	0.095	0.312	0.416*	0.281	0.372	0.574**	-	0.672**	0.335
Root length	0.140	-0.074	0.179	0.493*	0.145	0.321	0.285	0.374*	-	-0.179
Fresh seed weight	-0.242	-0.386	0.054	0.290	0.378*	0.139	0.393*	0.211	-0.127	-

*, ** Significant at P=0.05 and P=0.01, respectively

length (Table 7). In general, it can be concluded that selection of genotypes would be ideal for propagation of nutmeg at seedling stage on the basis of number, length and breadth of leaves, thickness of collar and petiole length and the genotypes N22, N24, N26, N29, N34, N37, N38, N42, N43, N51, N63 and N72 were promising.

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