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Studies on genotypic response of nutmeg to softwood grafting

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Abstract

An experiment was conducted to study the success rate of softwood grafting in 22 female, 12 hermaphrodite and 5 male nutmeg genotypes. The variation among genotypes for sprouting, survival and growth parameters was statistically significant. The magnitudes of GCV, PCV, habitability and genetic advance were low for sprouting and survival of nutmeg grafts. The graft survival has strong negative correlation with leaf width. Maximum graft sprouting was associated with the faster production of new leaves with less breadth and longer petiole. The genotypes, N66, N24, N61, N1, N5, N29, N38 and N49 gave the best response to grafting.

Key words: variability, grafting, *Myristica fragrans*, plant growth, sprouting, survival genotypic

Introduction

Nutmeg (*Myristica fragrans* Houtt.) is a promising tree spice in India. It occupies an area of about 3,763 ha with an annual production 3,457t (Sivaraman & Peter 1999). The production of nutmeg in the country is still insufficient to meet the increasing domestic demand. One of the ways to increase the production is to expand the area under nutmeg. The farmers face problem of male (50%) plants when nutmeg is planted by seedlings, as it is dioecious and sex is known only after 6 or 7 years when it flowers. Further, considerable variation with respect to yield and size of nut is noticed in seedling progeny of nutmeg. To get uniformly high yielding and desirable population of nutmeg, vegetative propagation is the best alternative. A technique of softwood grafting is developed in nutmeg (Haldankar *et al.* 1999). The present experiment was conducted to study the graft take of various nutmeg genotypes for softwood grafting technique.

Materials and methods

An experiment was carried out at the Regional Coconut Research Station, Bhatye, Ratnagiri, Maharashtra from September 1999 to December 2000. The genotypes consisted of 22 female, 12 hermaphrodite and 5 male seedling genotypes as follows. Female genotypes: N1, N5, N10, N11, N24, N29, N30, N34, N36, N37, N38, N41, N42, N43, N46, N49, N51, N57, N66, N70, N72, N74; Hermaphrodite genotypes: N4, N7, N22, N23, N26, N27, N32, N33, N55, N56, N61, N63 and Male genotypes: N15, N35, N60, N53, N69.

The experiment was conducted in a randomized block design with two replications. The genotypes constituted the treatments. Softwood grafting was performed by using scion sticks of various nutmeg genotypes. The grafts were prepared in the month of October during the year 1999 and 2000. Ten grafts were prepared per replication for two replications in a year. The scion sticks selected were terminal having medium maturity, plageotropic with one

terminal leaf retained on them. The length of scion stick was 7.5 cm with thickness of 12 to 15 mm. The selected rootstock was one-year-old nutmeg seedling of 25 to 30 cm height and 40 mm thickness at the bottom. The sprouting was recorded from 20 days of grafting. The number of sprouted grafts surviving after 60 days of grafting was recorded. Three survived grafts were randomly selected to record the growth observations *viz.* length of new shoot, total number of leaves, length and breadth of leaf and length of leaf petiole. Ten mature leaves were randomly collected per parent tree from all the directions to record length and breadth. The statistical analysis was done as per the method suggested by Sukhatme & Amble (1995) and Singh & Chaudhary (1985).

Results and discussion

Sprouting, survival and growth parameters of grafts are presented in Table 1. The pooled population mean for sprouting in nutmeg was 85.71 per cent and was maximum in N5 and N7 (97.5%), whereas it was minimum in N23 (67.5%). The genotype, N66 featured highest graft survival (92.5%). The other genotypes namely N4, N24 and N61 also showed relatively high survival (87.5%). The pooled population average for survival was 72.88 per cent.

The average length of the new growth produced on graft was 3.38 cm. It was maximum in N61 and N70 (4.71 cm) followed by N10 (4.5 cm). The grafts of N30 exhibited shortest length of new shoot (2.15 cm) followed by N37 (2.27 cm). The population mean for total new leaves was 2.09. In N1 it was maximum (3.3) followed by N 60 (3.1). The production of new leaves on the graft was minimum in N49 (1.3) followed by N23 (1.4). The grafts prepared by using the scion of N7 produced relatively smaller leaves having shortest length (6.23 cm) and breadth (2.42 cm). The highest length of leaf was recorded in the grafts of N41 (11.34 cm) followed by N70 (10.67 cm). Among the parent nutmeg trees the longest leaves were noticed in N41 (11.80 cm) followed by N57 (11.63 cm) and shortest leaves were recorded in N 4 (8.23 cm). The broadest leaves were observed in the grafts of N24 (4.42 cm). The leaves of N23 (4.96 cm) were broadest among the parent nutmeg trees followed by N53 (4.78 cm). The minimum leaf length was observed in N4 (3.65 cm). The population mean for the length (10.09 cm) and breadth (4.16 cm) of parent trees were higher as compared to those of grafts (8.85 and 3.21 cm, respectively). However the genotypes possessing broader leaves like N23 (4.96 cm), N53 (4.78 cm) and N60 (4.65 cm) recorded remarkably low success in grafting (42.5, 57.5 and 55%, respectively).

The variation among genotypes for the sprouting, survival and growth parameters was statistically significant (Table 2). The extent of variance at genotypic levels was very high for sprouting and survival. The growth parameters of graft showed lower levels for genotypic and phenotypic variance. The magnitudes of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were lowest for sprouting followed by survival (Table 3). The heritability in broad sense for width of leaf was very high (91.3). It was moderately high for other components. The relatively low genetic advance on percent mean basis for sprouting and survival suggested that these parameters for softwood grafting in nutmeg are governed by nonadditive gene action.

The correlation coefficients of grafting components with graft survival at genotypic as well as phenotypic level are given in Table 3. The graft survival showed strong positive correlation with graft sprouting which means that higher magnitude of graft sprouting lead to higher magnitude of survival of graft. In the genotypes N5, N7, N4, N11, N24, N1, N61 & N66 the sprouting was over 92.5 per cent which lead to survival over 77.5 per cent whereas in genotypes N23, N53 and N60 the low sprouting below 72.5 per cent resulted in low survival below 57.5 per cent. The study of association of growth parameters of graft at the time of survival indicated that the graft survival had strong negative correlation with leaf breadth. The other growth parameters such as number of leaves, length of new growth, petiole length had weak but positive correlation with the survival both at genotypic as well as at phenotypic level. Nutmeg is a slow grower as compared

Table 1. Sprouting, survival and growth parameters of grafts prepared from different nutmeg genotypes

Genotype	Sprouting (%)			Survival (%)			Total new leaves			Length of leaf petiole (cm)			Length of leaf (cm)				Breadth of leaf (cm)			
	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	Parent tree	1999	2000	Pooled	Parent tree
N 1	100.00 (90.00)	85.00 (67.21)	92.5 (74.11)	90 (71.56)	80 (63.44)	85.0 (67.21)	3.2	3.5	3.3	1.0	1.0	1.0	9.04	9.80	9.42	9.37	3.05	3.27	3.16	3.99
N 4	100.00 (90.00)	90 (71.56)	95.0 (77.08)	95 (77.08)	80 (63.44)	87.5 (69.30)	2.0	2.1	2.1	0.9	0.9	0.9	11.04	10.43	10.74	8.23	3.93	3.91	3.92	3.65
N 5	100.00 (90.00)	95 (77.08)	97.5 (80.90)	90 (71.56)	80 (63.44)	85.0 (67.21)	2.8	2.6	2.7	0.8	0.8	0.8	9.70	10.77	10.24	9.89	3.19	3.40	3.30	3.72
N 7	100 (90.00)	95 (77.08)	97.5 (80.90)	75 (60.00)	75 (60.00)	75.0 (60.00)	1.7	1.5	1.6	0.8	0.7	0.7	7.31	5.15	6.23	9.93	2.51	2.32	2.42	4.29
N 10	90 (71.56)	90 (71.56)	90.0 (71.56)	70 (56.79)	75 60.00)	72.5 (58.37)	2.6	2.3	2.2	0.8	0.7	0.8	8.34	8.20	8.27	9.82	2.92	2.79	2.86	4.36
N 11	100 (90.00)	90 (71.56)	95.0 (77.08)	80 (63.44)	75 (60.00)	77.5 (61.68)	2.4	2.6	2.5	0.7	0.8	0.7	7.34	6.68	7.03	9.59	2.88	2.86	2.87	3.92
N 22	95 (77.08)	80 (63.44)	85.0 (67.21)	70 (56.79)	65 (53.73)	67.50 (55.24)	2.2	1.5	1.8	0.9	0.7	0.8	9.44	9.09	9.27	10.10	3.31	3.25	3.28	4.41
N 23	70 (56.79)	65 (53.73)	67.5 (55.24)	50 (45.00)	35 (36.27)	42.50 (40.69)	1.5	1.3	1.4	0.9	0.7	0.8	8.97	7.44	8.21	11.25	3.25	2.83	3.04	4.96
N 24	100 (90.00)	90 (71.56)	95.0 (77.08)	95 (77.08)	80 (63.44)	87.50 (69.30)	2.1	1.6	1.9	0.8	0.7	0.7	10.81	8.66	9.74	9.73	4.81	4.03	4.42	3.80
N 26	90 (71.56)	70 (56.79)	80 (63.44)	80.00 (63.44)	65 (53.73)	72.5 (58.37)	3.6	1.5	2.6	0.7	0.6	0.7	9.07	9.07	9.07	10.64	2.94	2.84	2.89	4.20
N 27	95 (77.08)	80 (63.44)	87.5 (69.3)	75.00 (60.00)	65 (53.73)	70.0 (56.79)	2.0	1.3	1.7	0.9	0.8	0.8	9.20	9.20	9.20	9.59	3.18	2.52	2.85	4.03
N 29	90 (71.56)	90 (71.56)	90.0 (71.56)	90.00 (71.56)	80 (63.44)	85.0 (67.21)	2.7	1.0	1.9	1.0	0.9	0.9	10.12	10.55	10.34	10.40	4.19	2.36	3.28	3.93
N 30	90 (71.56)	70 (56.79)	80.0 (63.44)	70.00 (56.79)	60 (50.77)	65.0 (53.73)	2.2	1.9	2.0	0.7	0.7	0.7	8.41	8.57	8.49	10.22	3.25	2.82	2.80	4.48
N 32	100 (90.00)	70 (56.79)	85.0 (67.21)	85 (67.21)	70 (56.79)	77.5 (61.68)	2.5	1.3	1.9	0.6	0.6	0.6	7.42	7.13	7.28	8.59	4.27	3.16	3.72	4.39

Genotype	Sprouting (%)			Survival (%)			Total new leaves			Length of leaf petiole (cm)			Length of leaf (cm)				Breadth of leaf (cm)			
	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	Parent tree	1999	2000	Pooled	Parent tree
N 33	100.00 (90.00)	80.00 (63.44)	90.0 (71.56)	85 (67.21)	65.0 (53.73)	75.0 (60.00)	2.1	1.3	1.7	0.7	0.7	0.7	8.68	7.03	7.86	10.45	3.24	2.65	2.95	4.27
N 34	80.00 (63.44)	70.00 (56.79)	75.0 (60.00)	60 (50.77)	55 (47.87)	57.5 (49.31)	2.9	2.0	2.4	0.9	1.0	0.9	8.66	6.43	7.55	10.69	3.20	2.73	2.97	4.40
N 36	95.00 (77.08)	70.00 (56.79)	82.5 (65.27)	70 (56.79)	60 (50.77)	65.0 (53.73)	2.2	1.2	1.7	0.8	0.7	0.7	10.42	10.42	10.42	10.91	3.41	3.09	3.26	4.26
N 37	90 (71.56)	80 (63.44)	85.0 (67.21)	85 (67.21)	70 (56.79)	77.5 (61.68)	1.9	1.5	1.7	0.9	0.9	0.9	11.05	8.80	9.93	11.40	3.24	3.15	3.19	3.75
N 38	95 (77.08)	85 (67.21)	90.0 (71.56)	90 (71.56)	80 (63.44)	85.0 (67.21)	2.7	2.3	2.5	0.8	0.8	0.8	7.97	7.27	7.62	9.80	2.95	3.12	3.04	3.72
N 41	85 (67.21)	75 (60.00)	80.0 (63.44)	70 (56.79)	70 (56.79)	70.0 (56.79)	2.4	1.0	1.7	1.0	1.0	1.0	12.19	10.48	11.34	11.80	3.97	3.23	3.60	4.20
N 42	95 (77.08)	80 (63.44)	87.5 (69.30)	80 (63.44)	65 (53.73)	72.5 (58.37)	2.4	1.5	2.0	0.9	0.8	0.8	9.91	8.83	9.37	10.11	3.67	3.08	3.38	4.04
N 43	80 (63.44)	70 (56.79)	75.0 (60.00)	50 (45.00)	50 (45.00)	50.0 (45.00)	2.0	1.0	1.5	1.0	0.8	0.9	8.13	6.85	7.49	11.31	3.03	2.60	2.82	4.76
N 46	95 (77.08)	75 (60.00)	85.0 (67.21)	85 (67.21)	70 (56.79)	77.5 (61.68)	1.9	1.2	1.5	0.8	0.7	0.7	8.14	6.97	7.56	10.40	2.75	2.43	2.60	4.19
N 49	95 (77.08)	85 (67.21)	90.0 (71.56)	95 (77.08)	75 (60.00)	85.0 (67.21)	1.5	1.0	1.3	0.8	0.8	0.8	10.10	8.12	9.11	10.01	3.33	2.68	3.01	3.88
N 51	85 (67.21)	70 (56.79)	77.5 (61.68)	75 (60.00)	65 (53.73)	70.0 (56.79)	1.9	1.5	1.7	0.9	0.7	0.8	8.50	7.43	7.97	8.62	2.91	2.60	2.76	3.89
N 55	100 (90.00)	70 (56.79)	85.0 (67.21)	80 (63.44)	65 (53.73)	72.5 (58.37)	2.1	2.0	2.1	0.8	0.8	0.8	9.02	8.46	8.74	9.52	3.38	3.27	3.33	4.41
N 56	100.00 (90.00)	80.00 (63.44)	90.0 (71.56)	90 (71.56)	75 (60.00)	82.5 (65.27)	2.5	2.5	2.5	0.9	0.9	0.9	10.15	8.90	8.52	9.51	4.02	3.37	3.70	4.08
N 57	100 (90.00)	70.00 (56.79)	85 (67.21)	80 (63.44)	65 (53.73)	72.5 (58.37)	2.1	2.3	2.2	0.9	0.9	0.9	9.82	8.18	9.00	11.63	3.85	3.48	3.67	4.77

Geno-type	Sprouting (%)			Survival (%)			Total new leaves			Length of leaf petiole (cm)			Length of leaf (cm)				Breadth of leaf (cm)			
	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled	Parent tree	1999	2000	Pooled	Parent tree
N 61	100 (90.00)	85 (67.21)	92.5 (74.11)	95 (77.08)	80 (63.44)	87.5 (69.30)	2.7	2.4	2.5	0.8	0.9	0.8	8.58	8.20	8.39	8.62	3.40	3.23	3.32	3.67
N 63	100 (90.00)	80 (63.44)	90.0 (71.56)	70 (56.79)	60 (50.77)	65.0 (53.73)	2.5	1.5	2.0	0.8	0.8	0.8	8.85	8.85	8.85	10.22	3.42	2.98	3.20	4.48
N 66	100 (90.00)	85 (67.21	92.5 (74.11)	100 (90.00)	85 (67.21)	92.5 (74.11)	2.5	2.2	2.3	0.9	0.8	0.8	7.73	7.73	7.73	10.40	2.89	3.28	3.09	3.71
N 70	90 (71.56)	75 (60.00)	82.5 (65.27)	75 (60.00)	60 (53.73)	67.5 (55.24)	2.8	2.0	2.4	1.0	1.0	1.0	10.92	10.41	10.67	11.11	3.68	3.30	3.49	4.28
N 72	95 (77.08)	75 (60.00)	85.0 (67.21)	70 (56.79)	70 (56.79)	70.0 (56.79)	2.3	1.9	2.1	0.8	0.8	0.8	9.15	8.55	8.85	9.88	3.02	3.67	2.85	4.00
N 74	100 (90.00)	80 (63.44)	90.0 (71.56)	75 (60.00)	65 (53.73)	70.0 (56.79)	2.5	2.0	2.2	0.7	0.8	0.8	8.63	8.00	8.32	8.86	2.94	2.82	2.88	3.78
N 15	100 (90.00)	75 (60.00)	87.5 (69.30)	65 (53.73)	70 (56.79)	67.5 (55.24)	2.8	2.6	2.7	1.1	1.0	1.0	9.39	8.04	8.72	9.14	3.82	3.21	3.51	4.19
N 35	95 (77.08)	80 (63.44)	87.5 (69.30)	85 (67.21)	70 (56.79)	77.5 (61.68)	2.3	2.0	2.2	1.1	1.0	1.0	9.88	9.88	9.88	10.55	3.51	3.33	3.42	3.95
N 53	90 (71.56)	55 (47.87)	72.5 (58.37)	65 (53.73)	50 (45.00)	57.5 (49.31)	2.2	2.2	2.2	0.7	0.7	0.7	11.16	9.20	10.18	10.72	4.46	3.26	3.86	4.78
N 60	90 (71.56)	55 (47.87)	72.5 (58.37)	60 (50.73)	50 (45.00)	55.0 (47.87)	3.3	2.9	3.1	0.7	0.7	0.7	8.53	7.83	8.19	10.12	2.92	2.92	2.92	4.65
N 69	80 (63.44)	70 (56.79)	75.0 (60.00)	75 (60.00)	65 (53.73)	70.0 (56.79)	2.3	1.7	2.0	0.9	0.9	0.9	10.12	9.24	9.68	12.15	4.07	3.25	3.66	4.18
Mean	93.71 (79.17)	77.82 (62.47)	85.71 (68.46)	78.07 (63.23)	67.69 (55.67)	72.88 (59.06)	2.36	1.84	2.10	0.85	0.81	0.82	9.28	8.48	8.85	10.09	3.40	3.14	3.21	4.16
SEM ±	6.61	4.49	3.80	6.68	3.49	3.58	0.31	0.19	0.21	0.07	0.03	0.04	0.76	0.46	0.55	0.14	0.28	0.18	0.17	0.34
C.D. at 5%	18.90	12.84	10.85	19.08	9.98	10.23	0.88	0.54	0.60	0.19	0.07	0.11	2.18	1.32	1.56	0.40	0.80	0.51	0.49	0.97

Figures in the parenthesis indicate arcsine transformed values.

Table 2. Mean, mean sum of squares and genetic variance of graft parameters of nutmeg genotypes

Character	Mean	Mean sum of squares for treatment	Mean sum of squares for error	Genotypic variance	Phenotypic variance	Environmental variance
Sprouting (%)	83.62	82.25**	28.89	26.68	55.58	28.89
Survival (%)	72.75	104.20**	25.67	39.28	64.96	25.68
Mortality (%)	27.25	104.20**	25.04	39.62	64.67	25.04
New shoot length (cm)	3.38	0.91**	0.23	0.34	0.57	0.23
New leaves	2.09	0.40**	0.09	0.16	0.25	0.09
Length of leaf petiole (cm)	0.82	0.03**	0.003	0.01	0.02	0.003
Length of leaf (cm)	8.89	2.61**	0.60	1.01	1.61	0.60
Breadth of leaf (cm)	3.04	1.31**	0.06	0.63	0.69	0.06

** Significant at 1 per cent level of significance

Table 3. Genetic components of graft parameters of nutmeg genotypes

Character	Phenotypic coefficient of variation (PCV)	Genotypic coefficient of variation (GCV)	Environmental coefficient of variation (ECV)	Heritability (h^2 b)	Genetic advance	Genetic advance on % mean basis
Sprouting (%)	10.85	7.52	3.33	48.0	7.37	10.73
Survival (%)	13.64	10.61	3.03	60.5	10.05	17.00
Mortality (%)	26.03	20.37	5.66	61.3	10.15	32.86
New shoot length (cm)	22.34	17.25	5.09	59.6	0.93	27.40
New leaves	23.92	19.14	4.78	64.0	0.65	31.26
Length of leaf petiole (cm)	17.25	12.20	5.05	79.4	0.20	24.43
Length of leaf (cm)	14.27	11.30	2.97	62.8	1.64	18.46
Breadth of leaf (cm)	27.32	26.11	1.21	91.3	1.56	51.24

Table 4. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients of graft parameters in nutmeg types

Particulars	Sprouting	New shoot length	New leaves	Petiole length	Leaf length	Leaf breadth	Survival
Sprouting	1.000	0.257	0.222	–0.115	–0.066	–0.154	0.891**
New shoot length	0.225	1.000	0.658**	0.328*	0.004	0.040	0.211
New leaves	0.129	0.597**	1.000	0.302	0.002	–0.339*	0.256
Petiole length	0.021	0.268	0.161	1.000	0.466**	–0.161	0.043
Leaf length	–0.050	0.083	0.057	0.325*	1.00	–0.280	0.236
Leaf breadth	–0.163	0.051	–0.243	–0.126	–0.191	1.000	–0.331*
Survival	0.707**	0.165	0.128	0.034	0.043	–0.222	1.000

*, ** Significant at 5% and 1% level of significance, respectively.

to other perennial trees (Nazeem 1979). In the present investigation the magnitudes recorded for various growth parameters indicted a slow growth of graft, which might be the reason for its weak association with the survival. Survival had strong negative correlation with leaf breadth. However, it did not exhibit any kind of association with any other character under study.

In general, it is evident that sprouting percentage of graft is the most important factor to be considered for identification of suitable nutmeg genotypes. Available literature on such type of work is limited on tree spices like nutmeg. However, in mango the significant effect of scion on success in epicotyl grafting (Radhamony 1987) and softwood grafting (Kulwal & Tayade 1985) were reported. The present study revealed that for higher sprouting of grafts and faster production of new leaves with less breadth and longer petiole are ideal. In this context, the genotypes N66, N24, N61, N1, N5,

N29, N38 and N49 can be rated as the most promising genotypes.

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