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Repeatability of nut yield in nutmeg

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Abstract

An investigation was made to study the repeatability of nut yield in 34 nutmeg genotypes under Maharashtra conditions. Remarkable variation for nut yield was recorded among genotypes. The mean sum of squares of variation between genotypes was predominantly larger than within genotypes. The magnitudes of repeatability were relatively low but the upper confidence limits were reasonably high. The study suggested that, in nutmeg yield record over a wider period is more consistent than single yield records at early stages. The genotypes N42, N72, N41 and N37 were found to have potential for nut yield.

Key words: genotypes, kernels, mace, *Myristica fragrance,* nutmeg, repeatability

Introduction

The precious tree spice, nutmeg (*Myristica fragrance* Houtt.), produces two distinctly different spices *viz.* nutmeg and mace. It is an obligatory cross pollinated crop and eventually the variation in its nut yield is remarkable. Nut yield is expressed in number of fruits per tree as well as weight of nuts per tree. Exploitation of the natural variability for yield improvement of this spice crop has great practical significance. Being a tree spice of perennial nature, it is rather inconvenient to apply the biometrical techniques which are commonly applicable for annual field crops. Flaconer (1981) has proposed the concept of repeatability of multiple measurement of yield attributes. Repeatability sets an upper limit of heritability in broad sense. It includes all types of genetic as well as environmental influences which contribute to real differences among individuals. It indicates the extent to which an early performance can be taken as an indication of subsequent performance (Jain 1982). The present investigation aims to study the repeatability of nut yield in nutmeg genotypes.

Materials and methods

The experiment was conducted at the Regional Coconut Research Station, Bhaty, Ratnagiri, Maharashtra during 1995 to 2000. It is situated at 17.00^0 North latitude and 73.40^0 East longitude. Thirty four nutmeg genotypes consisting of 22 female and 12 hermaphrodite types were utilized 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. The genotypes were planted as mixed crop under 20 year old WCT coconut plantation in 1979 and were well maintained by giving nutrients and irrigation regularly.

Yield of individual genotypes in number as well as weight was recorded separately from

1995 to 2000. The repeatability was estimated according to the method suggested by Prem Narain *et al.* (1979).

Results and discussion

The yield of 34 nutmeg genotypes in terms of number of fruits per year over six bearing seasons from 1995 to 2000 is presented in Table 1. The average number of fruits obtained from the genotypes under study was 275.29. The standard deviation for nut number was 175.41 whereas the coefficient of variation was 63.72. Among the nutmeg genotypes, N42 produced the maximum number of nuts per tree (789.16) followed by N72 (711) and the minimum was recorded in N23 (46.83).

The yield of 34 nutmeg genotypes on weight basis for 6 years from 1995 to 2000 is given in Table 2. The critical perusal of data revealed that the mean nut yield obtained from the genotypes under study was 1.24 kg. The standard deviation and the coefficient of

Table 1. Yield of nutmeg genotypes (number of fruits per tree)

Genotype	1995	1996	1997	1998	1999	2000	Total	Average
N1	377 (377)	149 (162)	376 (342)	111 (129)	489 (346)	379 (265)	1881 (1621)	313.50 (270.16)
N4	16 (16)	172 (187)	51 (46)	49 (57)	157 (111)	71 (50)	516 (467)	86.00 (77.83)
N5	270 (270)	136 (148)	447 (407)	29 (34)	196 (139)	92 (64)	1170 (1062)	195.00 (177.00)
N7	58 (58)	373 (405)	185 (168)	173 (201)	239 (169)	557 (389)	1585 (1390)	264.16 (231.66)
N10	130 (130)	475 (516)	163 (148)	295 (342)	237 (167)	744 (520)	2044 (1823)	340.67 (303.83)
N11	638 (638)	59 (64)	651 (592)	20 (23)	472 (334)	615 (430)	2455 (2081)	409.17 (346.83)
N22	86 (86)	307 (333)	274 (249)	246 (286)	432 (305)	411 (287)	1756 (1546)	292.67 (257.66)
N23	26 (26)	66 (72)	12 (11)	48 (56)	89 (63)	40 (28)	281 (256)	46.83 (42.66)
N24	348 (348)	309 (335)	253 (230)	89 (103)	260 (184)	338 (236)	1597 (1436)	266.16 (239.33)
N26	130 (130)	301 (327)	35 (32)	566 (657)	131 (93)	80 (56)	1243 (1245)	207.16 (207.50)
N27	190 (190)	166 (180)	57 (52)	79 (92)	67 (47)	117 (82)	676 (643)	112.66 (107.16)
N29	355 (355)	385 (418)	209 (190)	368 (427)	247 (175)	468 (327)	2032 (1892)	338.66 (315.33)
N30	121 (121)	423 (459)	4 (4)	219 (254)	621 (439)	214 (149)	1602 (1426)	267.00 (237.66)
N32	39 (39)	103 (112)	11 (10)	185 (215)	211 (149)	39 (27)	588 (552)	98.00 (92.00)
N33	292 (292)	173 (188)	113 (102)	240 (279)	159 (112)	313 (219)	1290 (1192)	215.00 (198.66)
N34	365 (365)	89 (97)	265 (241)	873 (1013)	108 (76)	1001 (699)	2701 (2491)	450.16 (415.16)
N36	388 (388)	289 (314)	210 (191)	652 (757)	621 (439)	529 (370)	2689 (2459)	448.16 (409.83)
N37	393 (393)	347 (377)	966 (879)	86 (100)	1391 (983)	241 (168)	3424 (2900)	570.66 (483.33)
N38	299 (299)	278 (302)	36 (33)	205 (238)	417 (295)	90 (63)	1325 (1230)	220.83 (205.00)
N41	930 (930)	260 (282)	830 (755)	33 (38)	1194 (844)	107 (75)	3354 (2924)	559.00 (487.33)
N42	304 (304)	644 (699)	364 (331)	1550 (1799)	334 (236)	1539 (1075)	4735 (4444)	789.16 (740.66)
N43	102 (102)	54 (59)	76 (69)	172 (200)	318 (225)	185 (129)	907 (784)	151.16 (130.66)
N46	66 (66)	10 (11)	160 (146)	19 (22)	102 (72)	233 (163)	590 (480)	98.33 (80.00)
N49	188 (188)	74 (80)	98 (89)	48 (56)	300 (212)	404 (282)	1112 (907)	185.33 (151.16)
N51	226 (226)	105 (114)	261 (238)	18 (21)	213 (150)	519 (363)	1342 (1112)	223.66 (185.33)
N55	97 (97)	233 (253)	3 (3)	36 (42)	118 (83)	180 (126)	667 (604)	111.16 (100.66)
N56	50 (50)	315 (342)	15 (14)	43 (50)	97 (69)	172 (120)	692 (645)	115.33 (107.50)
N57	174 (174)	174 (189)	116 (106)	125 (145)	331 (234)	464 (324)	1384 (1172)	230.66 (195.33)
N61	274 (274)	194 (211)	52 (47)	43 (50)	109 (77)	72 (50)	744 (709)	124.00 (118.16)
N63	24 (24)	34 (37)	78 (71)	168 (195)	96 (68)	177 (124)	577 (519)	96.16 (86.50)
N66	84 (84)	199 (216)	381 (347)	158 (183)	255 (180)	216 (151)	1293 (1161)	215.5 (193.50)
N70	117 (177)	334 (363)	211 (192)	253 (294)	425 (300)	484 (338)	1824 (1604)	304.00 (267.33)
N72	1041 (1041)	467 (507)	1078 (981)	107 (124)	1179 (833)	394 (275)	4266 (3761)	711.00 (626.83)
N74	261 (261)	122 (132)	721 (656)	30 (35)	210 (148)	474 (331)	1818 (1563)	303.00 (260.50)
Total	8459	7819	8762	7336	11825	11959		9359.90
Mean	248.79	229.97	251.71	215.76	347.79	351.73		275.29
S.D.	231.63	145.32	278.86	299.79	318.53	301.25		175.41
C.V.	93.10	63.19	108.21	138.78	91.59	85.65		63.72

Figures in parantheses are converted yield using Sander's conversion factor.

Table 2. Yield of nutmeg genotypes (nut weight (kg) per tree)

Genotype	1995	1996	1997	1998	1999	2000	Total	Average
N1	1.69 (1.69)	0.67 (0.72)	1.68 (1.73)	0.50 (0.47)	2.19 (1.78)	1.69 (1.18)	8.42 (7.57)	1.40 (1.26)
N4	0.07 (0.07)	0.85 (0.91)	0.25 (0.26)	0.24 (0.22)	0.77 (0.62)	0.35 (0.24)	2.53 (2.32)	0.42 (0.38)
N5	1.35 (1.35)	0.68 (0.73)	2.23 (2.30)	0.15 (0.14)	0.98 (0.79)	0.46 (0.32)	5.85 (5.63)	0.98 (0.94)
N7	0.23 (0.23)	1.45 (1.55)	0.72 (0.74)	0.67 (0.63)	0.93 (0.75)	2.17 (1.51)	6.17 (5.41)	1.03 (0.90)
N10	0.51 (0.51)	1.85 (1.98)	0.64 (0.66)	1.15 (1.07)	0.92 (0.75)	2.90 (2.02)	7.97 (6.99)	1.33 (1.17)
N11	2.75 (2.75)	0.25 (0.27)	2.81 (2.90)	0.09 (0.08)	2.03 (1.65)	2.65 (1.85)	10.58 (9.50)	1.76 (1.58)
N22	0.56 (0.56)	1.99 (2.13)	1.78 (1.83)	1.60 (1.49)	2.81 (2.28)	2.68 (1.87)	11.42 (10.16)	1.90 (1.69)
N23	0.17 (0.17)	0.42 (0.45)	0.08 (0.08)	0.31 (0.29)	0.57 (0.46)	0.26 (0.18)	1.81 (1.63)	0.30 (0.27)
N24	1.31 (1.31)	1.16 (1.24)	0.95 (0.98)	0.34 (0.32)	0.98 (0.79)	1.27 (0.89)	6.01 (5.53)	1.00 (0.92)
N26	0.70 (0.70)	1.63 (1.74)	0.16 (0.16)	2.61 (2.44)	0.61 (0.49)	0.37 (0.26)	6.08 (5.79)	1.01 (0.97)
N27	0.88 (0.88)	0.77 (0.82)	0.26 (0.27)	0.37 (0.35)	0.31 (0.25)	0.54 (0.38)	3.13 (2.95)	0.52 (0.49)
N29	1.81 (1.81)	1.96 (2.10)	1.06 (1.09)	1.87 (1.75)	1.25 (1.01)	2.38 (1.66)	10.33 (9.42)	1.72 (1.57)
N30	0.54 (0.54)	1.89 (2.02)	0.02 (0.02)	0.98 (0.92)	2.78 (2.25)	0.96 (0.67)	7.17 (6.42)	1.20 (1.07)
N32	0.13 (0.13)	0.35 (0.37)	0.04 (0.04)	0.63 (0.59)	0.71 (0.58)	0.14 (0.10)	2.00 (1.81)	0.33 (0.30)
N33	1.03 (1.03)	0.61 (0.65)	0.40 (0.41)	0.85 (0.79)	0.56 (0.45)	1.10 (0.77)	4.55 (4.10)	0.76 (0.68)
N34	1.68 (1.68)	0.41 (0.44)	1.22 (1.26)	4.01 (3.75)	0.50 (0.40)	4.61 (3.22)	12.43 (10.75)	2.07 (1.79)
N36	1.70 (1.70)	1.27 (1.36)	0.92 (0.95)	2.86 (2.67)	2.73 (2.21)	2.32 (1.62)	11.8 (10.51)	1.96 (1.75)
N37	1.81 (1.81)	1.59 (1.70)	4.44 (4.58)	0.40 (0.37)	6.40 (5.19)	1.11 (0.77)	15.75 (14.42)	2.63 (2.40)
N38	1.42 (1.42)	1.32 (1.41)	0.17 (0.18)	0.97 (0.91)	1.98 (1.61)	0.43 (0.30)	6.29 (5.83)	1.05 (0.97)
N41	3.80 (3.80)	1.06 (1.13)	3.39 (3.49)	0.13 (0.12)	4.88 (3.96)	0.44 (0.31)	13.7 (12.81)	2.28 (2.14)
N42	1.38 (1.38)	2.92 (3.13)	1.65 (1.70)	7.04 (6.58)	1.52 (1.23)	6.99 (4.88)	21.5 (18.90)	3.58 (3.15)
N43	0.33 (0.33)	0.18 (0.19)	0.25 (0.26)	0.56 (0.52)	1.04 (0.84)	0.61 (0.43)	2.97 (2.57)	0.50 (0.43)
N46	0.26 (0.26)	0.04 (0.04)	0.64 (0.66)	0.08 (0.07)	0.41 (0.33)	0.93 (0.65)	2.36 (2.01)	0.39 (0.34)
N49	0.84 (0.84)	0.33 (0.35)	0.44 (0.45)	0.22 (0.21)	1.35 (1.09)	1.81 (1.26)	4.99 (4.20)	0.83 (0.7)
N51	0.77 (0.77)	0.36 (0.39)	0.90 (0.93)	0.06 (0.06)	0.73 (0.59)	1.78 (1.24)	4.60 (3.98)	0.77 (0.66)
N55	0.55 (0.55)	1.33 (1.42)	0.02 (0.02)	0.21 (0.20)	0.67 (0.54)	1.03 (0.72)	3.81 (3.45)	0.64 (0.58)
N56	0.30 (0.30)	1.88 (2.01)	0.09 (0.09)	0.26 (0.24)	0.58 (0.47)	1.03 (0.72)	4.14 (3.83)	0.69 (0.64)
N57	1.05 (1.05)	1.05 (1.12)	0.70 (0.72)	0.76 (0.71)	2.01 (1.63)	2.81 (1.96)	8.38 (7.19)	1.39 (1.20)
N61	1.37 (1.37)	0.97 (1.04)	0.26 (0.27)	0.21 (0.20)	0.55 (0.45)	0.36 (0.25)	3.72 (3.58)	0.62 (0.59)
N63	0.11 (0.11)	0.15 (0.16)	0.35 (0.36)	0.76 (0.71)	0.43 (0.35)	0.80 (0.56)	2.6 (2.25)	0.43 (0.38)
N66	0.49 (0.49)	1.17 (1.25)	2.23 (2.30)	0.93 (0.87)	1.49 (1.21)	1.27 (0.88)	7.58 (7.00)	1.26 (1.16)
N70	0.41 (0.41)	1.18 (1.26)	0.75 (0.77)	0.90 (0.84)	1.50 (1.22)	1.71 (1.19)	6.45 (5.69)	1.08 (0.95)
N72	4.19 (4.19)	1.88 (2.01)	4.34 (4.47)	0.43 (0.40)	4.75 (3.85)	1.59 (1.11)	17.18 (16.03)	2.86 (2.67)
N74	1.05 (1.05)	0.49 (0.52)	2.91 (3.00)	1.21 (1.13)	0.85 (0.69)	1.91 (1.33)	8.42 (7.72)	1.40 (1.29)
Total	37.24	36.11	38.76	34.34	52.77	53.46		42.09
Mean	1.10	1.06	1.14	1.01	1.55	1.57		1.24
S.D.	0.96	0.67	1.20	1.36	1.39	1.36		0.76
C.V.	87.20	63.35	105.22	134.30	89.37	86.34		62.14

Figures in parantheses are converted yield using Sander's conversion factor.

variation were 0.76 and 62.14, respectively. N42 produced the highest yield of nuts 3.58 kg followed by N72 (2.86 kg). The minimum yield was recorded in N23 (0.30 kg).

Variation noticed for all the characters could be attributed to two major components. Firstly, there was a wide range of variation due to the genotypes under study. Secondly, there was variation due to seasons. Falconer (1981) proposed the term spatial environmental variance and general environmental variance to refer to 'within individual variance' and 'between individual components of variance', respectively. The mean sum of squares

Table 3. Mean sum of squares for yield of nutmeg

Source	d.f.	Yield (no. of nuts) $tree^{-1}$	Yield (weight of nuts in kg) $tree^{-1}$
Between genotypes	33	153362.8302	2.983241606
Within genotypes	170	41253.23431	0.776045321

due to 'between genotypes' and 'within genotypes' obtained from the converted data of yield parameters indicated that the variation due to 'between genotypes' component was predominantly larger than 'within genotypes' (Table 3). The variation recorded due to 'within genotypes' represent the variation due to spatial environmental circumstances. The results thus revealed that such conditions play very little role in nutmeg yield. The variation obtained due to 'between genotypes' which is the sum total of genotypic variance and general environmental variation plays major role in the yield parameters of nutmeg. Improvement of crop in respect of any character by selection requires collection of genetically varying population. The nutmeg population under study exhibited a high variation in the yield components studied. This suggested good scope for identifying genotypes with relevant potential yield components.

The repeatability coefficients were obtained by fitting polynomials and Sander's conversion factor was estimated (Table 4).

The coefficients of repeatability for yield components with their 95 per cent confidence limits are presented in Table 5. The magnitudes of repeatability for all the parameters were

Table 4. Polynomials fitted and conversion factor and standard error (SE) of conversion factor for yield in nutmeg genotypes.

Character	Polynomial	R^2 (%)
Yield as no. of nuts $tree^{-1}$	$y = 1.06513772 + (0.047442284)\ \Sigma'_2 + (0.025408271)\ \Sigma'_2 + (-0.003177417)\ \Sigma'_2 + (-0.026674885)\ \Sigma'_2$	81.62
Yield as weight of nuts $tree^{-1}$ (kg)	$y = 1.127685289 + (0.046215599)\ \Sigma'_2 + (0.02259965)\ \Sigma'_2 + (-0.001989912)\ \Sigma'_2$	

Character	Order of yield	Conversion factor	SE of conversion factor
Yield as no. of fruits $tree^{-1}$	1	1.00000000	0.00000000
	2	1.085687488	0.659401068
	3	0.910022772	1.425332185
	4	1.160750052	2.282175668
	5	0.706666668	0.368325316
	6	0.698509772	0.381273553
Yield as weight of nuts $tree^{-1}$ (kg)	1	1.00000000	0.00000000
	2	1.070388431	0.221664101
	3	1.037069716	0.203305643
	4	0.934118789	0.338643813
	5	0.810675085	0.152552174
	6	0.697444067	0.135408699

Table 5. Coefficient of repeatability and its 95 % confidence limits for yield in nutmeg genotypes.

Character	Repeatability coefficient 'R'	95% confidence limits of R	
		Ru	Rl
Yield as no. of nuts $tree^{-1}$	0.115211039	0.254363086	0.006842571
Yield as weight of nuts $tree^{-1}$ (kg)	0.117426327	0.25705115	0.008486004

similar and relatively low. However, the upper confidence limits were reasonably high. The relatively low magnitudes of repeatability could be on account of confounding influencs of general environmental variance with genotypic variance. In the current investigation however, the repeatability coefficients are not showing extreme values. The upper limits (Ru) remained to the extent of 0.25. Hence, the records of earlier observations are not much dependable. Instead of single earlier record, the consistency over a wider period is more reliable. In *Garcinia indica* higher magnitudes of repeatability for fruit yield were recorded (Khanvilkar 1984). The concept of repeatability has been seldom studied in the tree spices like nutmeg. Krishnamoorthy *et al.* (1996) noticed wide range of yield from 525 to 843 in number of fruits per tree among the nutmeg seedlings studied. Wide variation in yield among nutmeg genotypes was also recorded by Haldankar *et al.* (1999).

The converted yield of nutmeg with the help Sander's conversion factor is presented in Tables 1 and 2. Based on this data, the nutmeg genotypes – N1, N10, N11, N22, N34, N36, N37, N41, N42, N70, N72, N74 and N29 could be rated as promising genotypes.

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