

Inbreeding Depression on Morphological Markers in Mapanget Tall Coconut Line No. 32

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ABSTRACT

The objective of this research was to determine inbreeding depression based on morphological markers in Mapanget Tall coconut line No.32. The result showed that inbreeding depression for vegetative characters in S2 generation was expressed only in girth of stem 100 cm from soil (3.28%) and width of leaflet (1.17%). Inbreeding depression in S3 generation expressed in girth of stem 20 cm and 100 cm from soil (13.01% and 8.03%), height of 11 leafscars (11.80%), and number of leaflet (6.15%). In S4 generation, inbreeding depression expressed in girth of stem 20 cm and 100 cm from soil (5.39% & 14.41%), height of 11 leafscars (17.40%), width of leaflet (4.87%), and number of leaves (13.62%). Inbreeding depression also expressed in characters number of inflorescence per palm per year (7.41%), length of inflorescence stalk (34.18%), number of female flowers (21.32%), and length of male flowers bunch (10.84). In S3 generation inbreeding depression expressed in characters number of inflorescence per palm per year (14.90%), number of fruit per inflorescence (11.51%), length of inflorescence stalk (38.17%), number of female flowers (47.91%), and length of male flowers bunch (5.31%), but not expressed in width of inflorescence stalk (-11.07%) and thick of inflorescence stalk (-8.73%). Inbreeding depression expressed in S4 for all generatif characters ranged from 29.09% to 85.92%. In fruit components, inbreeding depression in S2 expressed in total fruit (9.01%), coconut water (16.07%), coconut shell (8.41%), and endosperm (7.55%) except on coconut fiber (-1.03%). In S3, inbreeding depression expressed in total fruit (5.20%), coconut fiber (0.58%), and endosperm (6.37%), except on coconut shell (-2.05%) and coconut water (-4.50%). In S4, inbreeding depression expressed in all characters of fruit component, total fruit (47.68%), coconut fiber (45.86%), coconut water (4.00%), coconut shell (51.82%), and endosperm (54.04%). Due to inbreeding depression, morphological performance of S4 generation nearly the same to that of Dwarf coconut.

Keywords: Mapanget Tall line No.32, inbreeding depression, morphology.

ABSTRAK

Depresi Silangdalam pada Galur Kelapa Dalam Mapanget No. 32 Berdasarkan Penanda Morfologi

Penelitian ini bertujuan untuk mengetahui depresi silangdalam berdasarkan penanda morfologi pada tanaman kelapa Dalam Mapanget No.32 (DMT-32) akibat penyerbukan sendiri pada generasi S2, S3, dan S4. Pengamatan morfologi dilakukan sesuai STANTECH COGENT. Hasil penelitian me-nunjukkan bahwa depresi silangdalam pada karakter vegetatif untuk DMT-32 S2 dite-mukan pada karakter lingkaran batang 150 cm di atas permukaan tanah, dan lebar anak daun

masing-masing 3.28% dan 1.17%. Pada DMT-32 S3 ditemukan pada karakter lingkaran batang 20 cm dan 150 cm di atas permukaan tanah (13.01% & 8.03%), tinggi 11 bekas daun (11.80%), dan lebar anak daun (6.15%). Pada DMT-32 S4 ditemukan pada karakter lingkaran batang 20 cm dan 150 cm di atas permukaan tanah (5.39% & 14.41%), tinggi 11 bekas daun (17.40%), lebar anak daun (4.87%), dan jumlah daun (13.62%). Pada karakter generatif, depresi silangdalam untuk DMT-32 S2 ditemukan pada karakter jumlah tandan per pohon per tahun (7.41%), panjang tangkai tandan (34.18%), jumlah bunga betina (21.32%), dan panjang rangkaian bunga jantan (10.84%). Untuk DMT-32 S3 depresi silangdalam ditemukan pada karakter jumlah tandan per pohon per tahun (14.90%), panjang tangkai tandan (38.17%), jumlah bunga betina (47.91%), dan panjang rangkaian bunga jantan (5.31%), namun hal sebaliknya terjadi pada lebar tangkai tandan dan tebal tangkai tandan yaitu masing-masing -11.07% dan -8.73%. Pada DMT-32 S4 depresi silangdalam terekspresi pada karakter jumlah tandan per pohon per tahun (60.86%), jumlah buah per tandan (74.72), panjang tangkai tandan (56.89%), lebar tangkai tandan (33.11%), tebal tangkai tandan (38.18%), jumlah bunga betina (85.92%), dan panjang rangkaian bunga jantan (29.09%). Untuk komponen buah ditemukan depresi silangdalam terekspresi pada beberapa karakter untuk DMT-32 S2 yaitu daging buah (7.55%), air kelapa (16.07%), kecuali pada sabut (-1.03%). Pada DMT-32 S3 terekspresi pada karakter buah utuh (5.20%), sabut (0.58%), dan daging buah (6.37%). Hal sebaliknya terjadi pada tempurung dan air kelapa masing-masing -2.05% dan -4.50%. Depresi silangdalam ditemukan pada semua karakter komponen buah DMT-32 S4, yaitu buah utuh (47.68%), sabut (45.86), air kelapa (4.00%), tempurung (51.82%) dan daging buah (54.04%). Akibat terjadinya depresi silangdalam sehingga penampilan tanaman pada populasi kelapa DMT-32 S4 cenderung mendekati penampilan kelapa Genjah.

Kata kunci: Kelapa Dalam Mapanget No. 32, depresi silangdalam, morfologi.

INTRODUCTION

Mapanget Tall Coconut (DMT) is amongst the HYV coconut varieties released by ICOPRI. This cultivar have been used in many crossing program such as Dwarf x Tall for hybrid coconut development, Tall x Tall for developing superior Tall coconut and composite coconut varieties.

Mapanget Tall Coconut was originally collected from around countryside of Mapanget by Dr. Tammes and planted in Mapanget Experimental Garden in Manado in 1927. The first population consisted of 100 lines, each representing by 10 plants, and later known as Tammes Collection. In 1955, a Germany plant breeder, Ihne, conducted negative selection on Tammes Collection based on production, and got 42 selected lines. Further selection has yielded 29 lines. These were later used as parents in

opened and controlled pollination for pedigree test (Novariant et al.1998).

Self pollination have been done till fourth generation (S4). Lines No 10, No 32, and No 55 were self pollinated and their first generation were planted in Mapanget Experimental Garden in 1957, forming first generation of population of DMT (S1). Population of S1 were selected and self pollinated, to form S2 generation that were planted in Kima Atas Experimental Garden in 1967. In the same way, third generation were developed and planted in 1979, while fourth generation (S4) were obtained through truly selfing of the selected tree, which were planted in 1995.

Tall coconut types, in general, are cross pollinated so that their progeny will have heterogenous appearance because of heterozygote nature (Menon and Pandalai 1958; Child 1961; Fremont *et al.*, 1966; Foale, 1992). Homozygote

parent in Tall coconut can be obtained through self pollination technique (selfing) until some generation. Generation obtained from self pollination will have high degree of homozygosity which shows degradation of vigor as a result of inbreeding depression.

Inbreeding depression and heterosis are in fact two opposite phenomenon found in animal and plant. Inbreeding depression relates to the degradation of vigor of generation resulting from self pollination (Stebbins, 1958), on the contrary, heterosis relates to excellence of hybrid (F1) over its parents' mean or value.

The objective of this research was to determine the level of inbreeding depression expressed in vegetative, generative, and fruit component characters of Mapanget Tall coconut line No.32.

MATERIALS AND METHOD

Materials used in this research are coconut open pollinated population of DMT-32 (DMT-32OP), and self pollinated Mapanget tall coconut line No. 32 which has undergone second, third, and fourth selfing, and is henceforth refer to as, DMT-32 S2, DMT-32 S3, and DMT-32 S4, respectively. This population are collection of the Research Institute of Coconut and Other Palm (ICOPRI) grown at Kima Atas Experimental Garden, North Sulawesi.

Observation of morphological characters was done according to Stantech Manual (Santos *et al.*, 1996). Vegetative characters observed were girth of stem 20 cm and 150 cm from soil, height of 11 leafscars (cm), (cm), length of petiole (cm), length of lamina (cm),

thickness of petiole (cm), width of petiole (cm), number of leaflet, width of leaflet (cm), length of leaflet (cm), and number of leaves. Generative character observed include number of fruit per bunch, number of bunch per plant per year , length of inflorescence stalk (cm), width of inflorescence stalk (cm), thickness of inflorescence stalk (cm), length of male flower bunch (cm), number of female flower.

Fruit Components observed include weight of total Fruit (g), weight of fruit without coconut fiber (g), weight of fruit without water and coconut fiber (g), weight of coconut shell (g), weight of fresh endosperm (g). Observation for number of fruit per bunch and fruit components per tree were made for 2 year successively. Observation of fruit component was made on 2 fruits per tree. In one year there are 6 times observation. Criterion of fruit productivity used are: few (1-20 no/tree/year), medium (21-80 no/tree/year), and high (> 81 no/tree/year) (Santos *et al.*, 1996).

Level of inbreeding depression based on morphological markers were calculated using the following formula (Lande and Schemke, 1985):

$$ID = 1 - \frac{F_{ib}}{F_{ob}} \times 100\%$$

- ID = inbreeding depression
- F_{ib} = mean value of phenotypic characters of self pollination
- F_{ob} = mean value of phenotypic characters of open pollination

RESULT AND DISCUSSION

Self pollination which was done to Mapanget Tall coconut No. 32 (DMT-

32) for four generation have caused inbreeding depression in vegetative, generative, and fruit components characters.

Result showed that inbreeding depression in S2 was expressed in girth of stem 150 cm from soil, and width of leaflet. In S3 inbreeding depression was found in girth of stem 20 cm and 150 cm from soil, height 11 leafscars, and is width of leaflet. In S4, we found greater inbreeding depression for girth of stem 20 cm and 150 cm from soil, height of 11 leafscars, width of leaflet, and number of leaves (Table 1).

Leaf functions, among others, is to sustain the fruit bunches. Number of leaves in a crown of coconut trees correlated positively with the number of bunches of fruit produce. Generally, each leaf produce one bunch. A lengthy leaf stalk is unable to sustain the fruit bunches so that the stem and stalk out of the sag (Mahmud *et al.*, 1990). Number, length, and width of leaflet affect to relative wide of leave, so that more sunlight can be absorbed for the photosynthesis process (Awuy *et al.*, 1999). Leave characters desired on coconut

Table 1. Inbreeding depression on vegetative characters of selfed Mapanget Tall Line No. 32 (DMT-32).

Character	Mean Value				Inbreeding Depression		
	OP	S2	S3	S4	S2	S3	S4
Girth of stem 150 cm	101.10	97.78	92.98	86.53	3.28	8.03	14.41
Width of leaflet	5.97	5.90	5.60	5.68	1.17	6.15	4.87
Girth of stem 20 cm	166.80	167.22	145.10	157.89	-0.25	13.01	5.39
Height of 11 leafscars	113.90	115.56	100.45	94.08	-1.45	11.80	17.40
Number of leaves	25.50	25.67	25.53	22.03	-0.65	-0.09	13.62
Number of leaflet	102.80	105.67	106.68	112.18	-2.78	-3.76	-9.13
Length of leaflet	124.80	131.11	127.90	127.32	-5.05	-2.48	-2.01
Thick of petiole	2.61	2.74	2.74	3.26	-5.15	-4.78	-24.72
Width of petiole	6.55	6.96	6.95	7.24	-6.19	-6.10	-10.52
Length of petiole	100.70	108.33	126.08	152.71	-7.58	-25.19	-51.65
Length of lamina	339.70	403.33	426.15	470.16	-18.73	-25.44	-38.40

Inbreeding depression of girth of stem 20 cm from soil especially at DMT-32 S4, causing size of bole smaller. Inbreeding depression in girth of stem 150 cm from soil and height of 11 leafscars tended to be greater in each generation of self pollination, resulting smaller and shorter coconut stem, representing to the appearance of Dwarf coconut.

plant are the size of petiole slightly shorter, wider and thicker so it will be more powerful prop fruit bunches that has a lot of fruit and weight (Tampake, 1987; Novarianto *et al.*, 1999).

Inbreeding depression on generative characters have the same trend with the vegetative characters, namely the many characters who have expressed inbreeding depression with a bigger value

in each generation of self pollination (Table 2).

DMT-32 generation S2 expressed inbreeding depression on number of characters per cluster tree, number of

averaging 24.89 flower per bunch (Rompas *et al.*, 1989). Shorter inflorescence stalk of DMT-32 S4 (56.89% IB), is desirable, as it can hold more fruit. Mahmud *et al.* (1990), indicated that the

Table 2. Inbreeding depression on generative characters of selfed Mapanget Tall No. 32 (DMT-32).

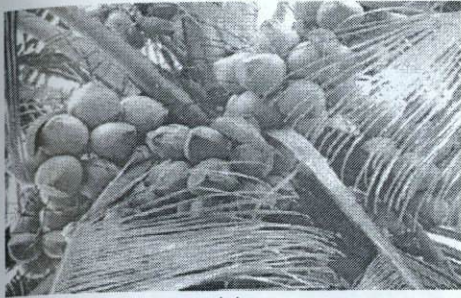
Character	Mean Value				Inbreeding depression		
	OP	S2	S3	S4	S2	S3	S4
Number of bunch / tree	15.60	14.44	13.28	6.11	7.41	14.90	60.86
Number of female flower	37.00	29.11	19.28	5.21	21.32	47.91	85.92
Length inflorescence stalk	65.50	43.11	40.50	28.24	34.18	38.17	56.89
Length of male flower	32.40	28.89	30.68	22.97	10.84	5.31	29.09
Number of fruit / bunch	7.60	9.67	6.73	1.92	-27.19	11.51	74.72
Width of inflorescence stalk	3.23	3.39	3.59	2.16	-4.92	-11.07	33.11
Thick of inflorescence stalk	2.12	2.41	2.31	1.31	-13.73	-8.73	38.18

female flowers, length of inflorescence stalk, and length of male flower. In the DMT-32 S3, inbreeding depression occurred in number of bunches per tree, number of fruits per bunch, number of female flowers, length of inflorescence stalk, and length of male flowers. In the DMT-32 S4, inbreeding depression had been seen almost on all generative characters and have very high values, especially on the number of female flowers per bunch (85.92%), number of fruit per tree per year, 74.72%, number of bunches per tree per year, 60.86%, length of inflorescence stalk 56.89%, length of male flower 29.09%, width of inflorescence stalk 33.11%, and thick of inflorescence stalk 38.18%.

Characters directly correlated to production of coconuts per tree are number of bunches and number of female flowers per stem. Mapanget Tall coconut is one type of Tall coconut that have a lot of the female flowers,

longer the stalk inflorescence, the heavier the fruit number will be; but, they get easily broken.

Coconut Mapanget No. 32 which were selected based on the production of fruits per tree per year and bunches per tree per year, and self pollinated for four generations, has appeared inbreeding depression in each generation of self pollination (Figure 1, Figure 2, and Figure 3).



(a)



(b)

Note : (a) highest fruit production coconut tree
(b) lowest fruit production coconut tree

Figure 1. Performance of the highest and lowest fruit producing coconut trees in second generation of selfed DMT No. 32 (DMT-32 S2).



(a)



(b)

Note : (a) The highest fruit producing coconut tree
(b) The lowest fruit producing coconut tree

Figure 2. Performance of two different fruit producing coconut trees in third generation of selfed DMT No line.32 (DMT -32 S3).

Figure 1 (a) is a fruit tree that is at most 165 fruits per tree per year of next-generation DMT-32 S2, while Figure 1 (b) is a fruit tree that is at least 104 fruits per tree per year from a population of DMT-32 S2.

Figure 2 (a) is a fruit tree that is at most 135 fruits per tree per year of had next-generation DMT-32 S3, while Figure 2 (b) is a fruit tree that is at least 48 fruits per tree per year from the DMT-32 S3.



(a)



(b)



(c)

Note : (a) The highest fruit producing coconut tree
(b) The medium fruit producing coconut tree
(c) The lowest fruit producing coconut tree

Figure 3. Performance of three different fruit producing coconut trees in fourth generation of selfed DMT No line.32 (DMT -32 S4).

Figure 3 (a) is a segregant that possessed 105 fruits per tree per year of generation DMT-32 S4, Figure 3 (b) is a segregant that yielded 60 fruits per tree per year from the DMT-32 S4, while Figure 3 (c) is segregant without fruit, or at least until the age of 11 years have not bore fruit, yet.

Fruit components

Inbreeding depression also found for all characters in fruit components. In the DMT-32 S2 inbreeding depression occurred in the range of 7.55% in endosperm of the fruit up to 16.07% in

the coconut water, except the fiber (-1.03%). Inbreeding depression on DMT-32 S3 occurred at the fiber 0.58%, whole fruit 5.20%, endosperm 6.37%. In general, inbreeding depression on DMT S2 is higher than the DMT S3. This results in line with research conducted by Akuba (2002).

Inbreeding depression in the fruit component characters of DMT-32 S4 is very high, generally above 45% except for coconut water (4%). The size and weight of fruit on the DMT-32 S4 was approaching the size of the dwarf coconut fruit. Very strong inbreeding depression, $(\delta) > 0.5$, is generally occur

Table 3. Inbreeding depression on fruit component characters of selfed Mapanget Tall line No. 32 (DMT-32).

Character	Mean Value				inbreeding depression		
	OP	S2	S3	S4	S2	S3	S4
Whole fruit (g)	1290.26	1173.98	1223.13	675.04	9.01	5.20	47.68
Endosperm (g)	425.55	393.43	398.44	195.59	7.55	6.37	54.04
Coc. water (g)	310.20	260.36	324.15	297.78	16.07	-4.50	4.00
Coc. shell(g)	195.00	178.60	199.00	93.95	8.41	-2.05	51.82
Coc. fiber (g)	320.30	323.61	318.44	173.40	-1.03	0.58	45.86

in plants that are generally open pollinated. While (δ) < 0.5 , weak category inbreeding depression, occurs in the self pollinated plant (Lande and Schemke, 1985). Results of this research also showed that inbreeding depression on the DMT-32 S2 was higher than the DMT-32 S3, and increased again in the DMT-32 S4, allegedly caused by a population of DMT-32 is small, and the used of bulk pollen of the selected trees each pollination to self-generation of DMT-32 S3

Inbreeding depression has made the coconut plant possessed stems of Dwarf type that have shorter smaller and without bole, small fruit, the quality of copra is relatively low, and less tolerant to environment variation compared with the Tall coconut type (Akuba, 2002).

CONCLUSION

Population of self pollinated Mapanget Tall coconut Line No.32 using a mixture pollen of selected trees until the third generation and pollination using pollen from the same tree on the fourth generation, showed symptoms of inbreeding depression for several vegetative, generative and fruit component characters. Inbreeding depression for vegetative characters were found in

girth of stem, height, leaflet and number of leaves. While in generative characters inbreeding depression were found in number of bunches per tree, number of fruits per bunch, and number of female flowers per bunch, length of male flowers and length of inflorescence, and width of the inflorescence stalk. Mapanget Tall coconut No. 32 (DMT-32) expressed increased inbreeding depression in every generation of selfed pollination, both in number and percentage of inbreeding depression on the observed characters. Inbreeding depression of fruit components decreased in the third generation population of DMT-32 and increased again in the fourth generation. In the fourth generation of DMT-32 population, all the fruit expressed high inbreeding depression on whole coconuts weight, coconut fiber weight, coconut water weight, coconut shell weight, and weight of endosperm compared with the results of open pollination.

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