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Performance of tenera oil palm hybrids in cauvery delta region of India

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ABSTRACT

A study was conducted to find prospective tenera hybrids for cultivation in the Cauvery Delta region. The experiment was set up in a randomized block design with three replications involving ten cross combinations of tenera hybrids (NRCOP 11-20). The data of twelve years indicated that palm height, stem girth, and no. of leaves produced per palm per year revealed significant variations among the ten hybrids. In addition, a higher sex ratio was documented with NRCOP 17 (72 %), with the highest number of female inflorescence (10.60) and least number of male inflorescence (4.10) followed by NRCOP 12 and NRCOP 19 recorded 70% sex ratio with 10.45 female and 4.2 male inflorescences. Regarding productivity and bunch parameters, NRCOP 17 recorded significantly higher fresh fruit bunches (FFBs), yield (198.38 kg palm^{-1}), no. of fruits (17.23) in 250 gm sample, weight of fresh mesocarp (130.53 g), fresh nuts (120.11g), dry mesocarp (70.09 g), dry nuts (110.28 g), shell (100.12 g), kernel (20.58 g) and oil content (21.28 %), respectively. The growth and yield parameters of the tenera hybrid revealed that the NRCOP 17 is a promising hybrid for cultivation in the Cauvery Delta area.

Keywords: *Elaeis guineensis* Jacq, Hybrids, *Tenera*, Bunch yield, Sex ratio

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is currently India's most important oil-yielding crop, with high productivity (4–6 oil t ha^{-1}) and a 25–30 year economic life cycle, divided into three phases: immature (1-3 years), stabilising (4–8 years), and stabilised (>8 years) phase. The genus *Elaeis* belongs to the Arecaceae family (monocot), which has a single terminal apical point from which leaves arise in a double spiral pattern at regular intervals (Rees, 13). Palm oil; edible oil, is produced from the fruits fleshy orange-yellow mesocarp, while palm kernel oil (PKO) derived from the stony seed's kernel. Generally, oil palm is referred to as a smallholder's irrigated crop grown under varied agro-climatic conditions of India. Andhra Pradesh, Karnataka, Kerala, Odisha, Tamil Nadu, and the North-eastern states of Arunachal Pradesh, Assam, and Mizoram are the key oil palm growing states.

The growing domestic requirement for palm oil in the upcoming years will perhaps be met through area expansion and increasing productivity by using elite planting material (hybrids). To encourage oil palm cultivation, the Government of India launched a special programme on oil palm area expansion, which resulted in an increase in oil palm area from 8585 hectares in 1991-92 to 3.45 lakh hectares in 2018-19 (NMOOP, 11). High-yielding hybrids could be critical to improving oil yield. *Tenera* (*dura* × *pisifera)* palms are generally selected (Barcelos *et al.,* 3) due to their higher oil yield. Earlier reports have suggested (Maheswarappa *et al.,* 10; Sanjeevraddi *et al.,* 15; Sumathi *et al.,* 16) tenera hybrids have better prospects for adaptation in different agro-climatic zones of India. Hence, the present investigation was conducted to evaluate ten *tenera* hybrids and select the most promising hybrid for the cauvery region in terms of growth and productivity.

MATERIALS AND METHODS

Ten *tenera* hybrids established at the farmer's field in Peraiyur village (Thiruvarur district) of Tamil Nadu, India were utilized for the study. The area is located in longitude of 79° 37' E, Latitude of 10° 65' N, altitude of 28.88 m MSL, with a mean minimum temperature 25.4°C and a mean maximum temperature 37.3°C. Although oil palm is grown in irrigated conditions in Tamil Nadu, Table 1 shows rainfall data for Peraiyur Village, Thiruvarur district, from 2010 to 2019. The average annual rainfall is 978.8 mm, with a peak of 683.2 mm in October and November. The experimental soil was medium black with alkali in reaction (7.5 to 8.0), low in available nitrogen (81.2 kg N/ha) and phosphorous (11 kg P_2O_5/ha) and medium in available potassium (77.5 kg K_2O/ha). The experimental material consisted of *dura* × *pisifera* cross combinations developed at ICAR-Indian Institute of Oil Palm Research, Pedavegi, West Godavari-District, Andhra Pradesh *viz.,* NRCOP 11 (49 D × 66 P), NRCOP 12 (25 D ×

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Table 1. Rainfall data of Peraiyur Village, Thiruvarur district during 2010 to 2019

Year	Jan.	Feb.	March	April	May	June	July	August	Sep.	Oct.	Nov.	Dec.	Total
2010	0.0	0.0	0.0	0.0	55.8	25.2	132.0	NA	154.7	180.6	336.4	286.2	1170.9
2011	26.4	2.6	0	125.0	11.2	25.6	104.8	156.0	140.4	215.4	289.8	77.8	1175.0
2012	3.6	0.0	5.6	0.0	29.4	27.6	32.2	21.4	124.4	415.0	87.6	30.4	777.2
2013	44.0	13.8	113.45	0.0	0	24.02	10.05	30.02	33.0	19.0	19.0	31.2	337.54
2014	17.3	32.5	0.0	0.0	115.7	11.0	14.0	138.0	60.0	215.4	261.0	150.5	1015.4
2015	0	0.0	14.0	101.0	71.0	18.4	59.4	47.0	97.6	152.0	310.3	250.2	1120.9
2016	0	0.0	0.0	0.0	138.4	10.0	79.4	128.5	27.4	72.6	48.2	125.2	629.7
2017	130.6	12.0	9.4	0.0	13.2	20.6	9.1	245.0	26.4	63.4	202.3	120.2	852.2
2018	24.8	0.0	26.0	69.2	42.4	52.2	13.2	7.0	25.6	218.8	464.6	35.5	978.8
2019	7.8	0.0	0.0	17.6	0.0	0.0	26.2	67.2	147.2	185.8	159.6	134.2	745.4

Values are in mm; NA- Not Available

214 P), NRCOP 13 (25 D × 66 P), NRCOP 14 (68 D × 36 P), NRCOP 15 (21 D × 214 P), NRCOP 16 (131 D × 66 P), NRCOP 17 (350 D × 66 P), NRCOP 18 (107 D × 214 P), NRCOP 19(61 D × 66 P) and NRCOP 20 (28 D × 68 P) were collected and planted with a triangular spacing (9 × 9 × 9 m) in randomized block design with three replications @ 6 palms per replication. The experiment was initiated in the year 2006 and evaluated for growth and yield characters till 2019 with the recommended package of practices (ICAR-IIOPR, Pedavegi) with soil application in four equal split (June/ September/ December /March) dose by following drip irrigation.

The palm height was measured annually from the ground level (tree base) to the base of spear leaves. Stem girth also measured annually by tying a measuring tape; 60 cm above ground level to take the circumference. At monthly intervals, the number of leaves produced palm^{-1}, the number of female inflorescence, and the number of male inflorescence were recorded. The yield data was computed by recording the No. of fresh fruit bunches (FFB) and the weight of individual fruit harvested at 10 days intervals (Bhagya *et al.,* 2). Further cumulative yield data of each month was quantified to generate FFB yield^{-1}. The following formula was used to compute the sex ratio:

$$\text{Sex ratio} = \frac{\text{Number of female inflorescence} \times 100}{\text{Total number of inflorescence}}$$

The bunch analysis was done as per the method described by Mandal *et al*. (9). The oil content in dried mesocrap was analyzed in Soxhlet apparatus by drawn pooled samples of each hybrid over replication and oil yield per palm was computed. The data on growth and yield parameters were statistically analysed as per the method described by Panse and Sukhatme (12).

RESULTS AND DISCUSSION

The palm height and stem girth in the stabilized phase (12 years) differed significantly among ten *tenera* hybrids, NRCOP 16, recorded the lowest palm height (4.93 m) and was on par with other hybrids, whereas NRCOP 14 recorded the highest palm height (6.2 m) (Table 2). The stem girth at 60 cm height ranged from 2.76 to 3.33 m. The solitary columnar stems of the *Elaeis* genus have a relatively constant diameter but unpredictable height due to the formation of phytomers (palm-supporting leaves and fruit bunches) at the stem top. The increase in palm height seen in this study could be ascribed to physiological processes such as phytomer synthesis that occur throughout the juvenile period. Stem elongations, which enhance palm height, are caused by new phytomers generated at the apical bud (Legros *et al.,*7). The variation in stem girth was examined and clarified by the fact that the hybrids (NRCOP 11 to NRCOP 20) with different genetic make-up (*dura × pisifere*) were planted. Similar results were also reported by Sanjeevraddi *et al.*(15) and Sumathi *et al.*(16). In the present investigation, significant differences were observed in respect to the number of opened leaves and inflorescences production (Table 2 & Fig 1), whereas the hybrid NRCOP 13 recorded significantly higher number of opened leaves (25.2) and inflorescences (16.7) followed by NRCOP 11, NRCOP 15, NRCOP 17 and NRCOP 20 compared to other hybrids. Since an inflorescence is began at the axil of each new leaf, Lotte *et al.,*(8) discovered that leaf initiation indicates the number of inflorescence production. As a result, the present investigation was justified by the enhanced production of leaves and inflorescences.

With respect to the male and female inflorescence, the hybrids exhibited significant differences for this

Table 2. Performance of *tenera* hybrids for growth and yield characters

Tenera Hybrids	Palm height (m)	Palm girth (m)	No of Leaves produced palm^{-1} year^{-1}	Sex-ratio (%)	No. of bunches/ palm	Bunch weight (kg)
NRCOP 11	5.02^{d}	3.09^{c}	24.20^{cde}	66^{d}	11.2^{d}	15.27^{bc}
NRCOP 12	5.25^{bc}	3.20^{b}	23.30^{def}	70^{ab}	11.0^{d}	15.27^{b}
NRCOP 13	5.86^{a}	3.02^{c}	25.20^{a}	63de	13.5^{a}	12.40^{f}
NRCOP 14	6.20^{a}	3.31^{b}	24.40^{cde}	61^{f}	11.3^{d}	13.68^{de}
NRCOP 15	5.34^{b}	3.33^{a}	23.80^{bcd}	64^{cd}	10.3^{e}	15.68^{a}
NRCOP 16	4.93^{d}	2.76^{e}	23.20^{ef}	62^{e}	13.4^{a}	13.21^{e}
NRCOP 17	5.29^{cd}	3.01^{d}	22.40^{g}	72^{a}	14.0^{a}	14.17^{de}
NRCOP 18	5.03^{d}	3.02^{cd}	23.20^{f}	65de	13.0^{b}	14.00^{d}
NRCOP 19	5.02^{d}	3.18^{b}	24.20^{bc}	70^{ab}	12.4b^{c}	14.48^{c}
NRCOP 20	5.89^{a}	3.22^{b}	24.80^{ab}	67^{bc}	12.0^{c}	15.08^{b}
S.Em±	0.09	0.04	0.29	0.79	0.15	0.17
CD (P=0.05)	0.22	0.11	0.85	2.27	0.43	0.51
CV (%)	2.15	2.08	2.06	2.03	2.06	2.07

The values in the column that are preceded by the same superscript letter represent NS differences (P 0.05 level)

trait (Fig 1), whereas the highest number of female inflorescence (10.60) with the least number of male inflorescence (4.10) was recorded in NRCOP 17. Throughout its life, a mature oil palm will naturally alternate between male and female inflorescence production. In high rainfall regions, sex ratio of oil palm tend to fluctuate little throughout the year, although oil palm grown as irrigated crop (drip irrigation) in Tamil Nadu, the south-west monsoon begins in June and lasts until October-November. Sex ratio percentage of oil palm was observed to be an important trait (Table 2) which influencing the FFB production, and in the present study, it was ranged from 61 to 72 and maximum sex ratio (72 %) was obtained in NRCOP 17 followed by NRCOP 12 and NCROP 19 (70 %) and the lowest sex ratio of 61 % observed in NRCOP 14. Sumathi *et al.,* (16) however, have previously reported on heterogeneity in the sex ratio percentage of tenera hybrids. According to Adam *et al.*, (1) climatic elements have a significant impact on oil palm sex determination; in general, water deficiency situations encourage the formation of more male inflorescences.

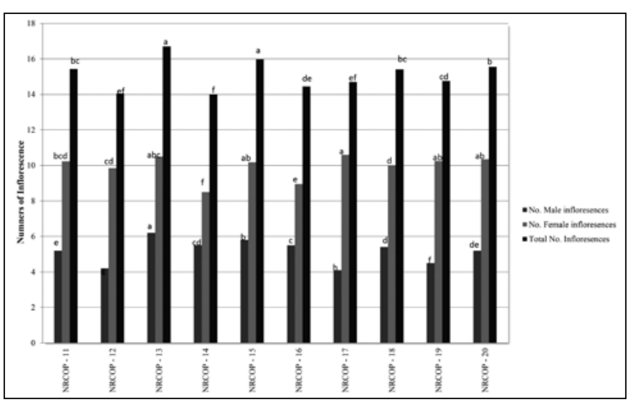

Fig. 1. Reproductive characters of tenera hybrids.

Yield characters are decisive in assessing the real oil palm yield. Across ten tenera hybrids, the ANOVA revealed a significant (P 0.05) variation in the number of fruit bunches, bunch weight, and yield metrics. As water is so vital for leaf emergence and flowering, its also crucial for fruit bunch production and yield. NRCOP 17 recorded the highest number of harvested fruit bunches (14.0) followed by NRCOP 13 and 16 and the least was recorded in NRCOP 15 (10.3). The bunch weight was significantly higher in NRCOP 15 (15.68 kg) followed by NRCOP 11 and 12 (15.27 kg). In similar way FFB productivity and yield in NRCOP 17 (198.38 kg palm $^{-1}$ and 28.37 t ha $^{-1}$) was higher than other hybrids (Table 3). Variation in fruit bunches produced depends on three parameters *viz.,* rate at which the inflorescence develops (Legros *et al.*,6), sex ratio (Henson and Harun 5) and early stage of abortions of inflorescence (Breure and Menendez 4). As a result, the increased yield may be supported by the rate of inflorescence production and sex ratio observed in this study. Bunch characters of NRCOP 17 (Table 4) showed as a potential hybrid, yielding 28.37 t ha $^{-1}$ of FFB. Fruit colour ranges from orange to deep red, with a total of 17.23 fruits per 250 gm sample, a fruit/bunch ratio of 0.65, and weights of fresh mesocarp (130.53 g), fresh nuts (120.11 g), dry mesocarp (70.09 g), dry nuts (110.28 g), shell (100.12

Table 3. Fresh fruit bunch (FFB) production and oil content of *tenera* hybrids (mean of three year)

Tenera Hybrids	FFB productivity (kg palm^{-1})	FFB yield (t ha^{-1})	Oil content/ bunch (%)
NRCOP 11	171.00^{c}	24.45^{c}	19.89^{c}
NRCOP 12	168.00^{c}	24.02^{c}	19.80^{c}
NRCOP 13	167.44^{c}	23.94^{c}	21.05^{a}
NRCOP 14	155.00^{d}	22.17^{d}	18.01^{d}
NRCOP 15	162.00^{c}	23.17^{c}	17.10^{d}
NRCOP 16	177.27^{b}	25.35^{b}	16.11e
NRCOP 17	198.39^{a}	28.37^{a}	21.28^{a}
NRCOP 18	182.00^{b}	26.03^{b}	18.05^{d}
NRCOP 19	179.80^{b}	25.71^{b}	20.59^{ab}
NRCOP 20	180.92^{b}	25.87^{b}	12.30^{f}
S.Em±	2.09	0.30	0.22
CD (P=0.05)	6.20	0.90	0.62
CV (%)	2.05	2.09	2.07

The values in the column that are preceded by the same superscript letter represent NS differences (P 0.05 level)

Table 4. Bunch characters of NRCOP 17

S. No.	Fruit Characters	
1.	Colour of fruit (as per munsell colour cascade)	Orange to deep red
2.	Fruit form	Oval
3.	Bunch weight (kg)	Tenera
4.	Weight of the stalk (kg)	13.59
5.	Length of the stalk (cm)	1.40
6.	Number of spikelets/bunch	168.56
7.	Weight of the empty spikelets	2.32
8.	Number of sterile fruits/bunch	550.02
9.	Number of normal fruits/bunch	1397.41
10.	Percent sterile fruits	39.37
11.	Weight of fruits (kg)	14.17
12.	Fruits/bunch	0.65
13.	No. of fruits in 250 gm sample	17.23
i	Weight of fresh mesocarp (g)	130.53
ii	Weight of fresh nuts (g)	120.11
iii	Weight of dry mesocarp (g)	70.09
iv	Weight of dry nuts (g)	110.28
v	Weight of the shell (g)	100.12
vi	Weight of the kernel (g)	20.58

g), and kernel (20.58 g). In general, *tenera*, a natural hybrid between thick shell (*dura)* and the no shell (*pisifera)*, which has a relatively thin shell and extracts 22–30% of the oil (Rajanaidu and Kushairi, 14). Oil content is altered by nature of planting material. In the present study, the highest oil content (21.28 %) was recorded in NRCOP 17 which is closely followed by NRCOP 13 (21.05 %). Oil yield is determined by a number of parameters, including the number of harvested fruit bunches, bunch weight, fruit oil content, and environmental conditions.

NRCOP-17 was determined as the superior hybrid among the 10 hybrids based on morphological features, FFB yield performance for three consecutive years following yield stability, and oil analyses. In comparison to other hybrids, the hybrid NRCOP-17 has a greater FFB output (28.37 t/ha/year), a higher sex ratio (72 percent), a higher number of bunches per palm (14) and a higher oil yield/ha (6.00 T). The XXVIII Annual Group Meeting of AICRP on Palms on June 7, 2019 at TNAU, Coimbatore, approved the release of NRCOP-17 as Godavari Gold for the Cauvery delta zone in Tamil Nadu. At ICAR-IIOPR-RC, Palode, there are enough mother palms available for seed production.

AUTHORS' CONTRIBUTION

Conceptualization of research (HPM, RKM); Designing of the experiments (RKM, MTS, SS); Contribution of experimental materials (RKM); Execution of field/lab experiments and data collection (AN, MTS); Analysis of data and interpretation (TP, SS); Preparation of the manuscript (SS, MTS).

DECLARATION

There were no conflicts of interest to declare by the authors.

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