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Godavari Ratna - New Oil Palm Hybrid Released for Coastal Region of Maharashtra

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Palm oil is an important source of vegetable oil used in a wide range of products. In India, an area of 19.33 lakh ha in 18 states is identified as the potential area for oil palm cultivation by various Expert Committees constituted by the Government of India. Oil palm (*Elaeis guineensis*), being a potential carbon-sequestering perennial crop by biological means, has helped in mitigating global warming and climatic fluctuations. Considering the need for potentially high-yielding oil palm variety for plantation, ICAR-Indian Institute of Oil Palm Research (IIOPR), Pedavegi, supplied ten new hybrids for testing their performance under different agro-climatic conditions in India. The present study conducted under the All India Coordinated Research Project (AICRP) on Palms (Oil palm) at the College of Horticulture, Mulde, Maharashtra revealed that out of ten different hybrids (NRCOP-01 to NRCOP-10), hybrid NRCOP-2 performed consistently better in terms of yield. NRCOP-2 recorded the highest bunch weight (19.22 kg bunch^{-1}), number of fresh fruit bunches per palm (8.14), highest fresh fruit bunches (FFBs) yield (22.14 t ha^{-1}) and highest oil yield (5.36 t ha^{-1}) as compared to other hybrids. Based on twelve years of evaluation, NRCOP-2 was consistently found to be high oil yielding and hence was released for cultivation in the coastal region of Maharashtra and Western Ghat under the name Godavari Ratna during the 2019 Annual Group Meeting of AICRP on Palms.

(***Key words:*** *Fresh fruit bunches, Godavari Ratna, Growth, Oil palm, Tenera hybrids, Yield*)

Oil palm (*Elaeis guineensis*) is one of the mostimportant agricultural crops in the tropics with theextensive production of 85% of global palm oil byMalaysia followed by Indonesia. It is one of the most valuable cash crops in the tropical worldwhich covers an area to the extent of 12 million hectares (Henderson and Osborne, 2000; Rakesh *et al.,* 2020). Changing climatic situations may lead to an increase in temperature and variability in rainfall patterns and under such situations oil palm could be the best sustainable option for vegetable oil yield among the oil seed crops.

Oil Palm (*Elaeis guineensis* Jacq.) is the highest vegetable oil-yielding crop among all the oil seed crops with a potential oil yield of 3-4 t ha^{-1}. However, it is a highly nutrient-demanding crop and the yield levels of 5-6 t ha^{-1} of oil are quite possible provided the crop is supplied with all the necessary inputs. It is a crop of the future, is a source of nutrition and has tremendous scope for value addition, crop diversification, import substitution and sustainability.

Oil palm has the potential to fill the demand and supply gap of edible oil requirements in India. The cultivation of oil palm has got considerable attention from policymakers, researchers and farmers. It is an eco-friendly crop, environmentally sustainable and plays a vital role in the food, industry and bio-fuel sectors. Malaysia and Indonesia have played a dominant role in the production of palm oil. The total vegetable oil production in the world was 16.1 million tons in 1960 which increased to 81.8 million tons in 1998, while in

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2013 it was 159.4 million MT with a major contribution from palm oil of about 56.2 million MT (Rethinam, 2014).

India occupies a prominent place in the global oilseeds scenario with 12-15% of the area, 6-7% of vegetable oil production, 9-10% of the total edible oil consumption and 13.6% of vegetable oil imports (Kalidas *et al.,* 2014). Domestic consumption of edible oils has increased substantially over the years and has touched the level of more than 24.50 million tons in 2015-16. The per capita consumption which was 15.8 kg person^{-1} yr^{-1} in 2012-13 has increased to 19.57 kg person^{-1} yr^{-1} in 2015-16 and it is likely to increase further with enhancement in income (Anonymous, 2019). The production of domestic edible oils (8.77 million tons in 2015-16 Prov.) has not been able to keep pace with the growth in consumption and the gap between production and consumption is being met through imports which amounted to ₹ 68,000 crores (2015-16 Prov.). Palm oil contributes 70% of total vegetable oil import and is one of the cheapest oil due to high productivity per hectare.

In India, a total of about one million hectares have been identified as potential areas suitable for its cultivation. An area of about 10,000 hectares has been identified as a potential area for oil palm cultivation in Maharashtra (Chadha, 2006). The high-yielding hybrids can play an important role in increasing the oil productivity in the oil palm. Earlier research on oil palm conducted at Gangavathi, Mulde, Pattukkottai and Vijayarai suggested the scope for newly developed high-yielding hybrids from ICAR-Indian Institute of Oil Palm Research (IIOPR), Pedavegi for cultivation at various locations throughout the country (Mastana Reddy *et. al.,* 2009; Reddi *et al.,* 2016).

Considering the need of developing potentially high-yielding oil palm varieties for commercial plantation, ICAR-IIOPR, Pedavegi, supplied ten hybrids of different combinations to four different All India Coordinated Research Project (AICRP) on Palms (Oil Palm) centres for evaluating its performance under different agroclimatic conditions of India in the year 2007. In order to identify the best-performing oil palm hybrid in the Western Coastal Plains and Ghats agro-climatic region (Zone No. 12) of India, the evaluation of the varieties was carried out at the College of Horticulture, Dr. B.S. Konkan Krishi Vidyapeeth, Mulde, Maharashtra.

MATERIALS AND METHODS

The experimental site, AICRP on Palms (Oil Palm), College of Horticulture, Dr. B.S. Konkan Krishi Vidyapeeth, Mulde in Kudal Taluka and Sindhudurg District of Maharashtra represents the agro-climatic zone No-12 *i.e.*, Western Coastal Plains and Ghats covering the Konkan region of Maharashtra. The experimental site is having characteristic features of assured and high annual rainfall (3000-3500 mm) received from June to September, high humidity and a moderate climate with the temperature ranging from 15 to 35°C. The experiment was laid in a randomized block design with ten different hybrid cross combinations supplied by Research Centre, ICAR-IIOPR, Palode, Kerala. The treatments were replicated three times and nine palms per replication was an experimental unit. Palms were planted at a spacing of 9 × 9 m in the year 2007. All experimental palms were grown following the recommended package of practices. Daily irrigation (38 L day^{-1}) was provided to ensure proper growth and development after the cessation of monsoon (from October onwards) by providing two micro sprinklers in the basins having a discharge of 19 L hr^{-1}.

The data on palm height, girth, number of leaves andsex ratio for the year 2019 were considered for the interpretation of the results. The sex ratio was calculated as the ratio of the number of female inflorescences to the total number of inflorescences (male + female). The data on the number of bunches, bunch weight and fresh fruit bunch yield (FFB) from the year 2015 to 2018 and the pooled mean are discussed in the present investigation. Bunch analysis and oil estimation was carried out as per the process described by Mandal and Kochu Babu (2008). The data were subjected to ANOVA as per the method given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The data pertaining to the growth and sex ratio (Table 1) revealed that at the age of twelve years, there was a significant difference observed among the

Table 1. *Growth performances and sex ratio of different oil palm hybrids during 2019*

Sl. No.	Cross combination	Code number assigned	Palm height (m)	Palm girth (m)	No. of leaves palm^{-1} yr^{-1}	Sex ratio
1.	78 D X 435 P	NRCOP-01	5.13	3.40	24.9	0.66
2.	90 D X 577 P	NRCOP-02	4.92	3.52	25.8	0.70
3.	158 D X 116 P	NRCOP-03	5.16	3.48	25.0	0.63
4.	131D X 435 P	NRCOP-04	4.89	3.45	24.8	0.62
5.	5 D X 577 P	NRCOP-05	4.56	3.79	25.1	0.62
6.	173 D X 435 P	NRCOP-06	4.83	3.42	24.7	0.72
7.	183 D X 577 P	NRCOP-07	4.93	3.35	25.4	0.68
8.	70 D X 577 P	NRCOP-08	5.45	3.67	24.6	0.65
9.	28 D X 435 P	NRCOP-09	5.25	3.60	25.1	0.67
10.	345 D X 577 P	NRCOP-10	4.48	3.48	23.9	0.52
SEm±			0.37	0.06	0.7	0.2
CD at 5%			NS	0.16	2.1	0.7

different genotypes with respect to plant girth, number of leaves and sex ratio. Though the genotype NRCOP-10 exhibited the lowest plant height (4.48 m) and genotype NRCOP-08 recorded the maximum plant height (5.45 m), the effect was statistically non-significant. The maximum palm girth (3.79 m) was recorded in the genotype NRCOP-05 and was significantly superior over the other genotypes. Data regarding annual leaf production indicated that the number of leaves produced in a year was significantly higher (25.8) in genotype NRCOP-02 followed by 25.4 in NRCOP-07. The lowest number of leaves was recorded in genotype NRCOP-10 (23.9). Gajbhiye *et al.* (2011) while evaluating the performance of drought tolerance genotypes found that the average rate of leaf production was in the range of 18.1 to 22.7. Similar results were reported by Mastana Reddy *et al.* (2009), Pillai *et al.* (2005) and Reddi *et al.* (2016).

The yield potential of the variety depends on the sex ratio. In the present study, significantly highest sex ratio was registered by NRCOP-06 (72.0) followed by NRCOP-02 (70.0). The genotype NRCOP-10 exhibited the lowest (52.0) sex ratio. However, Gawankar *et al.* (2002) reported yearly variation in the sex ratio of individual genotypes and stated that it was obviously due to the age of the early-growing palms. Corley (1976) suggested that the sex ratio in oil palm can be modified by the application of plant growth substances. This warrants that the hybrids under study have variability for hormonal constitution related to sex expression.

The data on the rate of yearly fresh fruit bunch productions (FFB) in different hybrids under study revealed that there was no significant difference observed in respect of the average number of bunches per year (Table 2). However, data indicated that genotype NRCOP-02 recorded the maximum number of bunches palm^{-1} yr^{-1} and pooled mean over the years (8.14) except in the year 2018-19.

Data on average bunch weight per year from 2015-16 to 2018-19 and pooled over the years are presented in Table 3. The critical analysis of data revealed that there was no significant difference among the different genotypes observed during the year 2015-16, genotype NRCOP-02 recorded maximum bunch weight (17.54 kg bunch^{-1}) whereas, NRCOP-01 recorded 18.41 kg bunch weight and it was maximum during the year 2016-17. During the year 2017-18 and 2018-19, genotype NRCOP-02 recorded maximum bunch weight *i.e.*, 19.31 and 21.97 kg bunch^{-1}, respectively. Pooled mean over the years also indicated that NRCOP-02 recorded a maximum bunch weight of 19.22 kg bunch^{-1}. The significance of bunch weight is that it is one of the attributes responsible for higher productivity. The present investigation suggested that NRCOP-02 has the potential to produce bunches with higher weight which helps to increase the total fresh fruit yield.

Table 2. *Rate of bunch production in different hybrids*

Sl. No.	Cross combination	Code number assigned	No. of bunches palm^{-1} yr^{-1}				Mean
			2015-16	2016-17	2017-18	2018-19	
1.	78 D X 435 P	NRCOP-01	5.74	8.1	7.17	4.75	6.44
2.	90 D X 577 P	NRCOP-02	8.88	8.7	8.20	6.79	8.14
3.	158 D X 116 P	NRCOP-03	6.97	7.1	6.30	5.64	6.50
4.	131D X 435 P	NRCOP-04	6.10	7.0	5.53	5.88	6.13
5.	5 D X 577 P	NRCOP-05	6.88	6.1	6.33	5.73	6.26
6.	173 D X 435 P	NRCOP-06	8.25	8.6	8.37	6.92	8.04
7.	183 D X 577 P	NRCOP-07	8.12	7.5	7.97	6.38	7.49
8.	70 D X 577 P	NRCOP-08	6.33	7.6	7.63	6.18	6.94
9.	28 D X 435 P	NRCOP-09	7.67	9.4	5.93	6.72	7.43
10.	345 D X 577 P	NRCOP-10	4.71	6.1	6.07	5.24	5.53
SEm±			1.02	1.0	0.84	0.79	0.9
CD at 5%			NS	NS	NS	NS	NS

Table 3. *Average weight of bunch in different hybrids*

Sl. No.	Cross combination	Code number assigned	Average bunch weight (kg)				
			2015-16	2016-17	2017-18	2018-19	Mean
1.	78 D X 435 P	NRCOP- 01	15.64	18.41	16.02	17.74	16.95
2.	90 D X 577 P	NRCOP- 02	17.54	18.07	19.31	21.97	19.22
3.	158 D X 116 P	NRCOP-03	13.82	14.77	15.62	16.78	15.25
4.	131D X 435 P	NRCOP - 04	14.21	15.13	17.56	16.74	15.91
5.	5 D X 577 P	NRCOP- 05	14.46	14.94	16.07	16.38	15.46
6.	173 D X 435 P	NRCOP- 06	15.35	15.35	15.80	17.04	15.89
7.	183 D X 577 P	NRCOP- 07	15.04	15.69	15.73	15.94	15.60
8.	70 D X 577 P	NRCOP- 08	15.61	15.89	16.34	16.93	16.19
9.	28 D X 435 P	NRCOP- 09	15.67	15.11	16.29	16.99	16.02
10.	345 D X 577 P	NRCOP- 10	15.71	14.30	16.42	16.27	15.68
SEm±			0.88	0.76	0.84	0.67	0.46
CD at 5%			NS	2.2	NS	1.93	1.33

The data on fresh fruit bunch yield (t ha^{-1}) of ten Tenera oil palm genotypes from the year 2015-16 to 2018-19 and pooled mean over the years are given in Table 4. Data revealed that in the years 2015-16 and 2017-18, the variation in yields was not statistically significant. However, during 2016-17, 2018-19 and pooled mean over four years, the genotype NRCOP-02 recorded significantly the highest yield over the rest of the genotypes. Nevertheless, genotype NRCOP-02 recorded consistently higher yields over the years under study. The pooled yield data indicated that NRCOP-02 recorded the highest yield of fresh fruit bunches *i.e.*, 22.14 t ha^{-1} yield followed by NRCOP-01 (16.95 t ha^{-1}). The lowest yield of 12.35 t ha^{-1} was recorded by the genotype NRCOP-10. The higher yield in NRCOP-02 could be attributed to higher leaf production, more sex ratio, more number of bunches and higher bunch weight. The quality components such as the percentage of mesocarp to fruit and oil to bunch, which are economic traits of oil palm were also estimated and are presented in Table 4. Among the genotypes percentage of mesocarp to fruit ranged from 47.0%

Table 4. *Comparative yield of fresh fruit bunches (FFB) of different hybrids*

Sl. No.	Cross combination	Code number assigned	FFB yield (t ha^{-1})					Mesocarp to fruit (%)	Oil to Bunch (%)
			2015-16	2016-17	2017-18	2018-19	Mean		
1.	78 D X 435 P	NRCOP 1	12.81	21.49	16.20	12.03	15.63	68.7	19.9
2.	90 D X 577 P	NRCOP 2	22.21	22.43	22.69	21.22	22.14	75.7	21.2
3.	158 D X 116 P	NRCOP 3	14.82	15.06	14.08	13.55	14.38	60.9	19.8
4.	131D X 435 P	NRCOP 4	12.52	15.42	13.73	14.13	13.95	47.0	18.0
5.	5 D X 577 P	NRCOP 5	14.67	13.25	14.62	13.49	14.01	60.2	17.1
6.	173 D X 435 P	NRCOP 6	18.04	18.92	18.74	17.05	18.19	56.7	16.1
7.	183 D X 577 P	NRCOP 7	17.24	16.86	17.79	14.63	16.63	55.6	21.1
8.	70 D X 577 P	NRCOP 8	14.26	17.28	17.81	14.94	16.07	48.1	18.1
9.	28 D X 435 P	NRCOP 9	17.09	20.39	13.74	16.30	16.88	57.6	20.6
10.	345 D X 577 P	NRCOP10	10.59	12.27	14.34	12.22	12.35	53.5	12.6
SE m±			2.29	2.17	1.71	2.07	1.08	0.97	0.22
CD at 5%			N.S.	6.27	4.94	N.S.	3.14	2.19	2.07

Table 5. *Descriptors information about NRCOP-02 (Godavari Ratna)*

1	ACCESSION DATA	
1.1	Cultivar name	Oil Palm (*Elaeis guineensis* Jacq.)
1.2	Accepted abbreviation	NRCOP-02
1.3	Accession number	90 D x 577 P
1.4	Fruit Form	Tenera
1.5	Country/Place of collection	ICAR-Indian Institute of Oil Palm Research, Pedavegi, West Godavari & Research Centre, Palode, Kerala.
1.6	Acquisition date/year	2005
2	PLANT MORPHOLOGY	
2.1	Age of measurement (years)	12 years
2.2	Category	Tall Type
2.3	Crown shape	Normal
2.4	Plant height (m)	4.92
2.5	Total number of leaves	41
2.6	Length of petiole (cm)	163
2.7	Length of leaflets bearing portion (cm)	547
2.8	Number of leaflets (right)	158
2.9	Number of leaflets (left)	158
2.10	Length of leaflet (cm)	81
2.11	Breadth of leaflets (cm)	4.56
2.12	Relative Water Content (%)	63.56
2.13	Girth of trunk (cm)	352
2.14	Number of leaf scars in 1 m length	55
3	REPRODUCTIVE BIOLOGY	
3.1	Pollination group	Cross pollination
3.2	Age at first flowering (months)	30 months
3.3	Bunch depth (cm)	20.0
3.4	Length of female inflorescence (cm)	30.5
3.5	Length of male inflorescence (cm)	45.2
3.6	Total number of female inflorescences	9.5
3.7	Total number of inflorescences yr^{-1}	13.6
3.8	Sex ratio	0.70

4	HARVEST DATA	
4.1	Age at first harvest (months)	35.5
4.2	Number of bunches yr^{-1}	8.14
4.3	Bunch weight (kg $bunch^{-1}$)	19.22
4.4	Bearing habit	Regular
5	FRUIT CHARACTERISTICS	
5.1	Colour of fruit	Orange to deep red
5.2	Shape of fruit	Oblong
5.3	Spine length (cm)	6.7
5.4	Spine colour	Green
5.5	Length of fruit (cm)	4.6
5.6	Breadth of fruit (cm)	3.4
5.7	FFB $palm^{-1}$ yr^{-1} (t ha^{-1})	22.14
6	OIL ESTIMATION	
6.1	Weight of the oil (g)	1.98
6.2	% Mesocarp $fruit^{-1}$	58.7
6.3	% Kernel $fruit^{-1}$	7.73
6.4	% Shell $fruit^{-1}$	13.38
6.5	% Oil dry $mesocarp^{-1}$	79.2
6.6	% Oil wet $mesocarp^{-1}$	53.56
6.7	% Oil $bunch^{-1}$	24.1
6.8	Oil yield (t ha^{-1})	5.36

Fig. 1. *High yielding NRCOP-02 palm (Godavari Ratna)*

Fig. 2. *Fresh fruit bunch of NRCOP-02 palm (Godavari Ratna)*

Fig. 3. *Fruits of NRCOP-02 (Godavari Ratna)*

Fig. 4. *Cross-section of fruits*

in NRCOP-04 to 75.7% in NRCOP-02. In the present study, NRCOP-02 had the maximum oil to bunch percentage (21.2%) followed by NRCOP-7 (21.1%). The other descriptive characters of hybrid NRCOP-02 studied during the evaluation are described in Table 5.

The critical evaluation of the tenera hybrids indicated that the hybrid NRCOP-02 (90D x 577P) recorded consistently higher yield of fresh fruit bunch with a high percentage of mesocarp (75.7%) and high oil content of 21.2% under the Konkan region of Maharashtra and Western Ghats. Hence, NRCOP-02 was recommended for commercial cultivation in the coastal Konkan region of Maharashtra and Western Ghats during the Annual Group Meeting of All India Coordinated Research Project on Palms in the year 2019 under the name Godavari Ratna.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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