Research Article

doi:10.19071/jpc.2016.v44.i3.3162
Journal of Plantation Crops, 2016, 44(3): 141-146

Initial performance of ten oil palm cross combinations under three agro-climatic conditions in India

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(Manuscript Received: 21-07-16, Revised: 02-09-16, Accepted: 13-09-16)

Abstract

High yielding hybrids can play an important role in increasing the productivity of oil in the oil palm. With a view to evaluate high yielding new oil palm cross combinations, a field experiment was conducted in different agro-climatic regions of India *viz*., Zone No-10 Southern Plateau and Hills (Gangavathi, Karnataka), Zone No-12 Western Coastal Plains and Ghats (Mulde, Maharashtra) and Zone No-11 Eastern Coastal Plains and Hills (Vijayarai, Andhra Pradesh) involving ten cross combinations of tenera oil palm (NRCOP 1-10). The data from three locations over two years indicated that, significantly higher annual rate of leaf production per palm was recorded in NRCOP-6 (21.7) compared to NRCOP-3 and it was on par with other hybrid combinations. Significantly higher sex ratio was recorded with NRCOP-4 (63.1%) compared to NRCOP-1 (54.6%) and NRCOP-6 (54.8%) and was on par with other hybrid combinations.The hybrid cross combination, NRCOP-4 recorded significantly higher fresh fruit bunches (FFBs) yield 12.5 t ha^{-1} compared to NRCOP-1, NRCOP-3, NRCOP-7 and NRCOP-9 and it was on par with remaining hybrids and a similar result in bunch weight and number of bunches per palm was recorded. Pooled data on FFB yield for 2013-15 indicated that the hybrid combination NRCOP-4 which recorded higher FFB yield (12.6 t ha^{-1}) at Gangavathi and at Vijayarai (22.6 t ha^{-1}) have better prospects for adaptation under Tungabhadra command area and coastal region of Andhra Pradesh. For Konkan region of Maharashtra, the hybrid NRCOP-8 recorded the highest FFB yield.

Keywords: Fresh fruit bunches, growth, oil palm, tenera hybrids, yield

Introduction

The oil palm (*Elaeis guineensis* Jacq.) is the highest edible oil yielding crop giving up to four to six metric tonnes of mesocarp oil and 0.4 to 0.6 MT of palm kernel oil per hectare per annum. It has the highest productivity compared to any other major oil producing crops, thus cutting the cost of land infrastructure, maintenance and harvesting. It is a crop of the future and source of nutrition and has tremendous scope for value addition, crop diversification, import substitution and sustainability. Realizing the potential of the crop in reducing the shortage of edible oil requirement in India, the cultivation of oil palm has got considerable attention from policy makers, researchers and farmers. The country has got a potential of two million ha for cultivation of the crop against the present area coverage of 2.6 lakh ha (Rethinam, 2014).

The global production of vegetable oils has made tremendous impact, of which progress made in palm oil, soybean, rapeseed and sunflower oil is worth mentioning. Malaysia and Indonesia have played a dominant role in the production of palm oil. The total vegetable oil production in the world has increased from 16.1 million tons in 1960 to 81.8 million tons in 1998 and to 159.4 million MT

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in 2013 with major contribution from palm oil (56.2 millon MT) (Rethinam, 2014).

High yielding hybrids can play an important role in increasing the oil productivity in the oil palm. Previous reports have suggested that the enhanced performance of hybrid cross combinations at Chithara and Gangavathi (Mastana Reddy *et. al*., 2009). In the present study, different cross combinations of Dura x Pisifera hybrids, developed at ICAR-Indian Institute of Oil Palm Research, were evaluated for their yield performance at agro-climatically different locations.

Materials and methods

The present study was carried out at three centres of All India Coordinated Research Project (AICRP) on Palms, representing different agro-climatic zones *viz*., Zone No-10 Southern Plateau and Hills (Gangavathi, Karnataka), Zone No-12 Western Coastal Plains and Ghats (Mulde, Maharashtra) and Zone No-11 Eastern Coastal Plains and Hills (Vijayarai, Andhra Pradesh).

The weather parameters, such as rainfall, maximum minimum temperature and relative humidity of all three experimental zones, were collected from representative weather observatory of respective zones and is presented in Figure 1. The mean rainfall of the Gangavathi station for a period of 26 years was 570 mm distributed over 35-36 rainy days and mean of two years (2013 and 2014) rainfall was 626.9 mm with a peak rainfall observed during the month of October and May (120.2 mm and 115.4 mm). Higher mean monthly maximum temperature was observed in the month of April and May (37.5 ^{o}C and 37.2 ^{o}C), while mean minimum temperature was the lowest in the months of December (14.5 ^{o}C) and November (16.3 ^{o}C). The mean relative humidity was higher in the month of July and September (78.6 and 78.1%), while it was lowest in the month of March (50.4%).

The Konkan region has a characteristic feature of assured and high annual rainfall (3000-3500 mm) restricted between the months from June to September, high humidity and modest climate with the temperature ranging from 15 ^{o}C to 35 ^{o}C. At Mulde, mean of two years rainfall was 3504 mm with a peak observed during the month of July and August (1575 mm and 728 mm). Higher mean monthly maximum temperature was observed in the month of April and May (36.2 ^{o}C and 36.0 ^{o}C), while mean minimum temperature was the lowest in the months of January (16.3 ^{o}C) and February (17.2 ^{o}C). The mean relative humidity was higher in the month of July and August (84.8 and 82.6%), while it was lowest in the month of March (62.5%).

At Vijayarai, mean of two years rainfall was 940 mm with peak observed during the month of October and July (255 mm and 223 mm). Higher mean monthly maximum temperature was observed in the months of May and April (39.1^{o}Cand 37.9 ^{o}C), while mean minimum temperature was the lowest in the months of July (17.4 ^{o}C) and June (18.7 ^{o}C). The mean relative humidity was higher in the month of July and August (91.5 and 89.3%), while it was the lowest in the month of February (64.2%).

The experiment was laid out in a RBD with ten different new hybrid cross combinations developed at ICAR-IIOPR (Table 1), Regional Station, Palode and were planted during 2007 in three replications and six palms per treatment. The recommended package of practices of 1200:600:1200 g N, P_2O_5, K_2O per plant per year and irrigation based on potential evapo-transpiration were followed.

The observations (growth characters, FFB yield and yield attributes) were recorded during 2013-14 and 2014-15 and were subjected to statistical analysis.

Table 1. Different cross combinations and their parents

Cross combinations	Parents
NRCOP-1	78D x 435P
NRCOP-2	90D x 577P
NRCOP-3	158D x 116P
NRCOP-4	131D x 435P
NRCOP-5	5D x 577P
NRCOP-6	173D x 435P
NRCOP-7	183D x 577P
NRCOP-8	70D x 577P
NRCOP-9	28D x 435P
NRCOP-10	345D x 577P

(D – Dura, P – Pisifera)

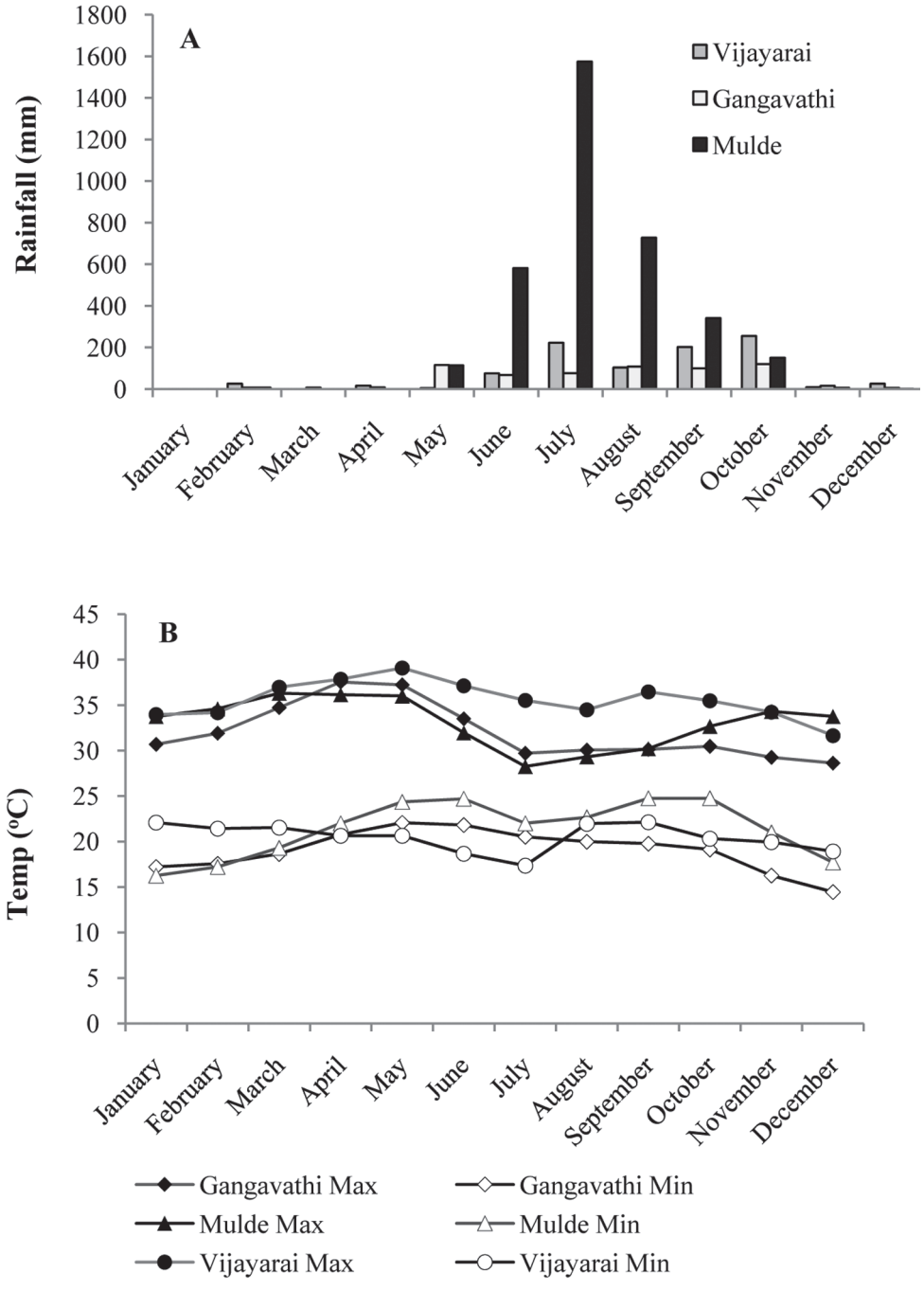

Fig. 1. Mean monthly meteorological data of three locations A) Rainfall and B) Temperature (Average of two years)

Results and discussion

Annual leaf production

At Gangavathi, pooled data of two years (2013-14 and 2014-15) indicated that the annual rate of leaf production differed significantly among the different hybrids (Table 2) and significantly higher annual leaf production was recorded by NRCOP-2 (18.9) compared to NRCOP-6 (17.0), whereas, it was on par with other hybrid combinations. At Mulde, significantly higher annual rate of leaf

Table 2. Annual leaf production in different oil palm hybrid cross combinations (per palm) under three agro-climatic regions

Hybrids	Gangavathi (Karnataka)			Mulde (Maharashtra)			Vijayarai (Andhra Pradesh)			Average over
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	3 locations
NRCOP-1	17.7	18.7	18.2	18.4	23.5	20.9	23.7	26.4	25.0	21.4
NRCOP-2	18.7	19.1	18.9	18.7	21.6	20.1	23.4	24.6	24.0	21.0
NRCOP-3	17.2	17.9	17.5	17.7	20.4	19.0	18.8	26.9	22.8	19.8
NRCOP-4	18.2	18.9	18.5	17.4	21.1	19.2	23.1	25.3	24.2	20.6
NRCOP-5	18.1	17.0	17.5	15.8	21.6	18.7	22.8	26.3	24.5	20.3
NRCOP-6	16.7	17.3	17.0	19.2	22.3	20.7	28.2	26.6	27.4	21.7
NRCOP-7	16.8	17.9	17.3	17.9	23.4	20.6	24.0	25.2	24.6	20.8
NRCOP-8	17.9	17.7	17.8	18.0	19.1	18.5	22.2	26.2	24.2	20.2
NRCOP-9	17.4	18.5	17.9	19.2	21.7	20.4	22.8	25.8	24.3	20.9
NRCOP-10	19.7	18.4	19.0	16.7	21.6	19.1	25.6	26.6	26.1	21.4
S. Em+	1.4	0.5	0.6	0.9	0.7	0.7	0.7	0.8	0.9	0.6
CD (P=0.05)	NS	1.4	1.7	N.S.	2.0	2.1	2.2	NS	2.4	1.7

production was recorded by NRCOP-1 (20.9) compared to NRCOP-5 and NRCOP-8 which was on par with other hybrid combinations. At Vijayarai, annual rate of leaf production was significantly higher in NRCOP-6 (27.4) compared to all other hybrid combinations except NRCOP-1 and NRCOP-9. The results were in conformity with those of Pillai *et al.* (2005) and Mastana Reddy *et al*. (2009).

The average data of all three locations over the years indicated that significantly higher annual rate of leaf production was recorded by NRCOP-6 (21.7) compared to NRCOP-3 and it was on par with other hybrid combinations.

FFB yield and yield parameters

At Gangavathi, pooled data of two years indicated that the hybrid NRCOP-4 recorded significantly higher FFB yield (12.6 t ha^{-1}) compared to NRCOP-3 and NRCOP-10 and it was on par with remaining hybrids (Table 4). The higher FFB yield in NRCOP-4 was attributed to improvement in growth and yield parameters like increase in annual

Table 3. Sex ratio of oil palm hybrid cross combinations under different agro-climatic regions

Hybrids	Gangavathi (Karnataka)			Mulde (Maharashtra)			Vijayarai (Andhra Pradesh)			Average over
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	3 locations
NRCOP-1	59.0	66.3	62.6	38.8	47.2	43.0	59.9	56.3	58.1	54.6
NRCOP-2	54.8	61.4	58.1	60.4	55.9	58.2	64.5	54.2	59.3	58.5
NRCOP-3	52.7	67.7	60.2	46.0	55.3	50.7	53.2	54.5	53.9	54.9
NRCOP-4	62.7	70.1	66.4	42.9	59.1	51.0	69.8	73.8	71.8	63.1
NRCOP-5	61.9	70.7	66.3	53.3	48.1	50.7	77.4	46.0	61.7	59.6
NRCOP-6	60.9	68.7	64.8	37.2	61.2	49.2	45.6	55.0	50.3	54.7
NRCOP-7	64.7	70.6	67.7	42.9	69.6	56.3	55.3	64.6	59.9	61.3
NRCOP-8	55.0	72.2	63.6	48.1	59.8	54.0	54.0	48.9	51.4	56.3
NRCOP-9	53.4	69.9	61.6	38.3	55.7	47.0	65.7	59.9	62.8	57.1
NRCOP-10	62.4	66.6	64.5	37.5	44.2	40.9	64	65.7	64.9	56.7
S. Em+	3.9	4.3	2.3	5.7	4.4	5.1	6.8	7.2	6.9	3.0
CD (P=0.05)	11.6	NS	8.2	17.1	13.1	15.0	20.6	21.9	20.9	8.3

Table 4. FFB yield (t ha^{-1}) of oil palm hybrid cross combinations under different agro-climatic regions

Hybrids	Gangavathi (Karnataka)			Mulde (Maharashtra)			Vijayarai (Andhra Pradesh)			Average over 3 locations
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	
NRCOP-1	10.4	12.3	11.3	3.1	2.4	2.8	10.8	15.1	12.9	9.0
NRCOP-2	10.0	11.5	10.7	4.1	5.0	4.6	15.1	15.3	15.2	10.2
NRCOP-3	6.0	10.6	8.3	3.4	2.9	3.2	11.5	16.1	13.8	8.4
NRCOP-4	10.6	14.6	12.6	2.1	3.4	2.8	19.6	24.9	22.2	12.5
NRCOP-5	8.0	14.3	11.1	2.9	2.5	2.7	14.8	19.9	17.3	10.4
NRCOP-6	7.3	14.0	10.6	3.4	4.9	4.2	10.6	17.8	14.2	9.7
NRCOP-7	8.4	13.2	10.8	3.4	5.7	4.6	8.2	17.4	12.8	9.4
NRCOP-8	8.7	13.0	10.8	4.3	5.7	5.0	10.9	17.3	14.1	10.0
NRCOP-9	8.0	11.7	9.8	4.0	4.8	4.4	13.0	18.8	15.9	10.1
NRCOP-10	8.7	12.1	10.4	2.6	2.8	2.7	10.9	15.8	13.4	8.8
S. Em+	1.0	0.9	0.9	0.8	0.7	0.7	1.3	2.1	1.7	1.0
CD (P=0.05)	2.8	2.5	2.7	N.S	2.0	2.1	3.9	4.4	4.1	3.0

leaf production, sex ratio and bunch weight. The hybrid NRCOP-2 (17.4 kg) recorded significantly higher mean bunch weight compared to NRCOP-3 and NRCOP-7 whereas it was on par with the remaining hybrids (Fig. 2). The sex ratio differed significantly among the different hybrids (Table 3) and significantly higher sex ratio was recorded with NRCOP-7 (67.7%) which was on par with other hybrid combinations and the hybrid NRCOP-2 recorded significantly lower sex ratio (58.1%). At Mulde, significantly higher FFB yield was recorded with NRCOP-8 (5.0 t ha^{-1}) and was on par with other hybrid combinations, except NRCOP-5 and NRCOP-10. The same trend of higher yield was reported by the different centres (AICRPP, 2014). Significantly higher sex ratio was recorded with NRCOP-2 (58.2%) and it was on par with other hybrid combinations except NRCOP-1 and NRCOP-10, which had recorded significantly lower sex ratio. At Vijayarai, the highest yield of fresh fruit bunches per palm per year was recorded in NRC OP-4 (22.2 t palm^{-1} year^{-1}). Higher yield in the NRCOP 4 was attributed to higher bunch weight (18.4 kg) (Fig. 2) and significantly higher sex ratio

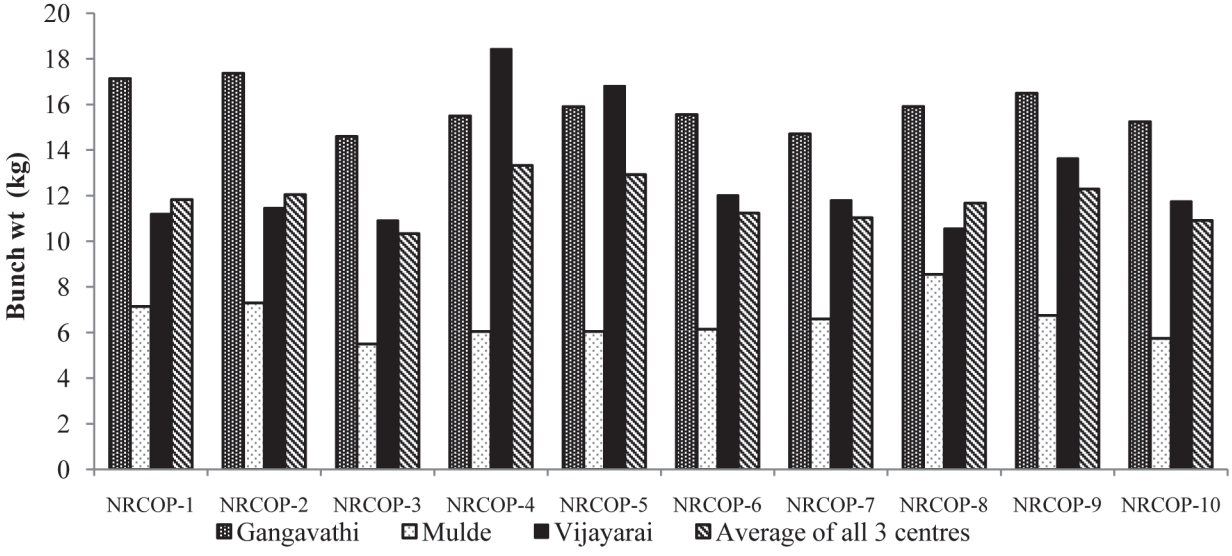

Fig. 2. Bunch weight (kg) of oil palm cross combinations in three locations

(71.8%). Similar superior performance of Dura x Pisifera combination was reported from Mastana Reddy *et al*. (2009). The variation in the yield across the locations is due to varied environmental conditions, soil nutrient status as well as management practices.

The average data of all three locations over the years indicated that, the hybrid cross combination NRCOP-4 gave significantly higher FFB yield (12.5 t ha^{-1}) than NRCOP-1, NRCOP-3, NRCOP-7 and NRCOP-9 whereas it was on par with remaining hybrids. The same trend was also reported by the different centres (AICRPP, 2015). Significantly higher sex ratio was recorded by NRCOP-4 (63.0%) which was on par with other hybrid combinations, except NRCOP-1 and NRCOP-6. Similar trials of Dura x Pisifera combinations at Chithara and Gangavathi had revealed that maximum number of bunches and weight of FFB with the combination of 104D x 291P and 109D x 291P respectively (Mastana Reddy *et al*., 2009).

Conclusion

The evaluation of tenera hybrids indicated that at the age of seven years, the hybrid cross combination NRCOP-4 recorded higher FFB yield and appeared to have better prospects for adaptation under Tungabhadra command area (Karnataka) and West Godavari area (Andhra Pradesh). At Mulde (Maharashtra), the hybrid NRCOP-8 recorded higher FFB yield with better prospects for adoption under Konkan Maharashtra. This study will have to be continued for few more years to evaluate the stabilised yield of the hybrids across the three locations in Karnataka, Andhra Pradesh and Maharashtra.

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