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## EVALUATION OF DIFFERENT COCOA CLONES UNDER DIFFERENT ECOLOGICAL CONDITION OF TAMIL NADU FOR FLOWERING, POD SET AND YIELD

K. Murali and J. Suresh

### KEYWORDS

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K. MURALI\* AND J. SURESH

<sup>1</sup>Department of Spices and Plantation Crops, HC&RI, TNAU, Coimbatore-3  
e-mail: muralihort@yahoo.com

## ABSTRACT

Field experiments were undergone in three different agro-ecological condition (Coimbatore, Aliyar Nagar and Thadiyankudisai) of Tamil Nadu with seven improved clones of cocoa were planted and evaluated for flowering, pod set and yield attributing characters of clones in two seasons during 2014-2015. The results revealed that CCRP 3 recorded the highest number of flower cushions per tree at Aliyar Nagar (60.0, 62.2) and Coimbatore (53.1, 55.4), percentage of pod set at Aliyar Nagar (4.23, 4.17 per cent) and Coimbatore (3.20, 2.90 per cent), number of pods per tree at Aliyar Nagar (24.5, 22.1) and Coimbatore (18.2, 16.2) and pod value at Aliyar Nagar (16.8, 22.1) and Coimbatore (19.2, 23.6) conditions whereas CCRP 4 recorded the highest number of flower cushions per tree (40.7, 44.7), percentage of pod set (2.98, 2.70 per cent), number of pods per tree (11.7, 10.7) and pod value (18.1, 18.6) at Thadiyankudisai condition during first season (July - December) and second season (January - June). The results were indicated that there is a significant differences were observed in different locations and finally concluded that CCRP 3 is performing well under Coimbatore and Aliyar Nagar conditions whereas CCRP 4 at Thadiyankudisai condition.

## INTRODUCTION

Cocoa (*Theobroma cacao* L.) is a preferentially allogamous, Neotropica tree species of the family Malvaceae (Alverson *et al.*, 1999). *Theobroma* originated in several native areas of the tropical rainforest of equatorial America (Bailey *et al.*, 2005). *Theobroma cacao*, is a tropical understory tree that is a major economic resource to several tropical countries (Brown *et al.*, 2007; Lanaud *et al.*, 2009). Although, all cultivated cocoas show great variability, it is generally agreed that they can be divided within the species, into three large groups: Criollo, Forastero and Trinitarios (Cheesman, 1944; Gordon, 1976). Improvement in any crop is proportional to the magnitude of its genetic variability present in germplasm. Greater the variability in a population, there are the greater chance for effective selection for desirable types (Janaki *et al.*, 2015). Cocoa is an ever flowering plant and is highly floriferous. But flowering is not uniform throughout the year and there are peaks of flowering during some months of the year. Depending upon the pattern of rainfall and prevailing temperature, the peak flowering varies in different areas of cocoa cultivation. Climatic factor viz. temperature, Humidity, rainfall, wind and sunshine affects the growth, flowering, fruit set, yield and quality of fruits (Rajesh *et al.*, 2014). To know the flowering behaviour, pod set and yield, study has been conducted in three different locations of Tamil Nadu with the seven improved varieties of Forastero released by Kerala Agricultural University.

These improved clones viz., CCRP 1, CCRP 2, CCRP 3, CCRP 4, CCRP 5, CCRP 6 and CCRP 7 were selected based on their performance at hot humid tropical conditions of Kerala. However, their performance under hot tropical conditions in Tamil Nadu, particularly under coconut plantations as an undestroyed crop is not known. This has prompted to identify varieties specific to those hot tropical conditions of Tamil Nadu. As development of new varieties is a long term process, the immediate step is the evaluation which has been taken in cocoa with already released varieties to assess their suitability to different locations of Tamil Nadu. Therefore, the present investigation was undertaken to know the performance of different cocoa clones under different ecological condition of Tamil Nadu for flowering, pod set and yield.

## MATERIALS AND METHODS

Polyclonal gardens were established in three different locations of Tamil Nadu, viz., Coconut Research Station, Aliyar Nagar, Horticulture Research Station, Thadiyankudisai and Coconut Nursery, Horticultural College and Research Institute, Coimbatore. The released variety from Kerala Agricultural University viz., CCRP 1, CCRP 2, CCRP 3, CCRP 4, CCRP 5, CCRP 6 and CCRP 7 were taken for this experiment. Grafted plants of there varieties has been planted at spacing of 3 m between 2 rows of coconut at Horticultural College and Research Institute, Coimbatore (a warm tropical cocoa growing area in Tamil Nadu) and Coconut Research Station, Aliyar Nagar (the traditional cocoa growing area in Tamil Nadu). In Horticulture Research Station, Thadiyankudisai (mid elevation of enjoying a humid tropical climate) the clones were planted as mono crop at a spacing of 3m x 3m. The age of the crops is 4 years old at Coconut nursery, Coimbatore and 5

\*Corresponding author

years old at CRS, Aliyar Nagar and HRS, Thadiyankudisai.

## RESULTS AND DISCUSSION

The data related to geographical locations of the different experimental sites were furnished in the following Table 1.

### Flower characters

Cauliflorous flowering is observed in cocoa and it flowers throughout the year. But peak season of flowering is seen during January to June. Among the flower characters, flower cushion number per tree and number of flowers per cushion are considered as the important trait for consideration of yield in cocoa. In the present investigation (Table 2), significant difference observed between the clones for the numbers of flower cushions per tree in two seasons. CCRP 3 recorded more number of flower cushions per tree at Aliyar Nagar (60.0 and 62.2), Coimbatore (53.1 and 55.4) whereas, CCRP 4 recorded the highest value at Thadiyankudisai (40.7 and 44.7) during first and second season respectively. Pooled mean values showed that, CCRP 3 registered the highest number of

flower cushions per tree at Aliyar Nagar (61.1) and Coimbatore (54.3) and in Thadiyankudisai the clone CCRP 4 recorded 42.7 flower cushions per tree.

Number of flowers per cushion showed significant difference among the clones at all the three locations (Table 3). CCRP 3 recorded more number of flowers per cushion at Aliyar Nagar (5.00 and 5.10) and Coimbatore (4.21 and 4.55) whereas, CCRP 4 recorded the highest value at Thadiyankudisai (3.87 and 4.35) during first and second season respectively. Pooled mean values revealed that CCRP 3 registered the highest number of flowers per cushion at Aliyar Nagar (5.05), Coimbatore (4.38) and CCRP 4 recorded (4.11) at Thadiyankudisai. Flowering in cocoa is controlled by multi-various factors such as environmental factors, soil moisture, availability of nutrients and genetic factor of the tree. Environmental factors like temperature, light intensity and rainfall positively affected the production of flower cushion and production of open flowers. However, rainfall had the greater influence on phenological cycle of the cocoa plant (Adjaloo *et al.*, 2012). The present study also indicated that

**Table 1: Geographical locations of the three different experimental sites**

S. No.	Particulars	Aliyar Nagar	Thadiyankudisai	Coimbatore
1.	Longitude	76° 58' 48" E	77°E	77° E
2.	Latitude	10° 29' 30" N	10°N	11°N
3.	Altitude	288 m above MSL	1098 m above MSL	412 m above MSL

**Table 2: Number of flower cushions/tree of cocoa clones grown under different locations of Tamil Nadu**

Varieties	Number of flower cushions per tree Aliyar Nagar			Coimbatore			Thadiyankudisai		
	Season I	Season II	Mean	Season I	Season II	Mean	Season I	Season II	Mean
CCRP 1	50.9	54.7	52.9	44.7	49.5	47.1	37.6	41.3	39.5
CCRP 2	48.4	51.4	49.9	49.1	52.4	50.8	34.1	38.2	36.1
CCRP 3	60.0	62.2	61.1	53.1	55.4	54.3	33.9	37.5	35.7
CCRP 4	49.0	54.3	51.7	40.9	41.3	41.1	40.7	44.7	42.7
CCRP 5	56.1	59.3	57.7	51.8	56.0	53.9	31.3	34.6	32.9
CCRP 6	36.9	42.4	39.7	44.1	50.6	47.4	26.1	29.3	27.7
CCRP 7	39.3	45.7	42.5	-	-	-	28.5	30.1	29.3
Mean	48.7	52.8	50.8	47.3	50.9	49.1	33.2	36.5	34.9
SEd	1.06	1.13	1.09	0.96	1.23	1.10	0.44	0.63	0.54
CD (0.05)	2.31	2.48	2.27	2.13	2.75	2.30	0.95	1.38	1.12
CD (0.01)	3.25	3.48	3.08	3.03	3.91	3.14	1.33	1.93	1.52
Season I : July to December				Season II: January to June					

**Table 3: Number of flowers/ cushion of cocoa clones grown under different locations of Tamil Nadu**

Varieties	Number of flowers per cushion Aliyar Nagar			Coimbatore			Thadiyankudisai		
	Season I	Season II	Mean	Season I	Season II	Mean	Season I	Season II	Mean
CCRP 1	4.21	4.61	4.41	3.12	3.67	3.39	3.06	3.14	3.09
CCRP 2	4.00	4.71	4.36	3.43	3.88	3.66	2.90	3.09	2.99
CCRP 3	5.00	5.10	5.05	4.21	4.55	4.38	3.15	3.23	3.19
CCRP 4	3.99	4.39	4.19	3.67	3.88	3.77	3.87	4.35	4.11
CCRP 5	4.89	5.02	4.96	4.13	4.11	4.12	3.06	3.14	3.09
CCRP 6	3.32	4.40	3.86	3.23	3.66	3.45	2.94	2.89	2.91
CCRP 7	3.65	4.12	3.89	-	-	-	2.71	2.55	2.63
Mean	4.15	4.62	4.39	3.63	3.96	3.79	3.09	3.19	3.15
SEd	0.08	0.10	0.09	0.06	0.07	0.06	0.11	0.17	0.13
CD (0.05)	0.18	0.23	0.19	0.13	0.15	0.14	0.14	0.37	0.26
CD (0.01)	0.26	0.32	0.26	0.19	0.22	0.18	0.20	0.51	0.36
Season I : July to December				Season II: January to June					

**Table 4: Percentage of pod set per tree of cocoa clones grown under different locations of Tamil Nadu**

Varieties	Percentage of pod set Aliyar Nagar			Coimbatore			Thadiyankudisai		
	Season I	Season II	Mean	Season I	Season II	Mean	Season I	Season II	Mean
CCRP 1	3.50	3.40	3.45	2.80	2.20	2.50	2.68	2.38	2.53
CCRP 2	3.40	3.40	3.40	2.60	2.00	2.30	2.31	2.21	2.26
CCRP 3	4.23	4.17	4.20	3.20	2.90	3.05	2.71	2.37	2.54
CCRP 4	3.00	3.03	3.01	2.62	2.30	2.46	2.98	2.70	2.84
CCRP 5	4.03	3.80	3.91	3.10	2.70	2.90	2.53	2.29	2.41
CCRP 6	3.23	3.10	3.17	2.19	1.86	2.03	2.71	2.65	2.68
CCRP 7	3.17	2.97	3.07	-	-	-	2.21	2.08	2.14
Mean	3.51	3.41	3.46	2.75	2.33	2.54	2.59	2.38	2.49
SEd	0.07	0.08	0.08	0.14	0.19	0.17	0.04	0.08	0.06
CD (0.05)	0.17	0.17	0.16	0.32	0.42	0.35	0.08	0.18	0.13
CD (0.01)	0.23	0.24	0.22	0.45	0.59	0.47	0.11	0.25	0.18
Season I : July to December						Season II: January to June			

**Table 5: Number of pods per tree of cocoa clones grown under different locations of Tamil Nadu**

Varieties	Number of pods per tree Aliyar Nagar			Coimbatore			Thadiyankudisai		
	Season I	Season II	Mean	Season I	Season II	Mean	Season I	Season II	Mean
CCRP 1	21.7	18.1	19.9	12.4	11.4	11.9	7.67	7.00	7.33
CCRP 2	18.3	16.4	17.4	10.7	10.3	10.5	7.00	6.90	6.95
CCRP 3	24.5	22.1	23.3	18.2	16.2	17.2	9.33	9.00	9.17
CCRP 4	19.4	15.3	17.4	6.55	10.4	8.48	11.7	10.7	11.2
CCRP 5	22.8	20.2	21.5	16.8	15.2	15.9	6.33	5.60	5.96
CCRP 6	18.3	14.7	16.5	2.55	2.24	2.39	6.67	6.12	6.39
CCRP 7	14.2	11.7	12.9	-	-	-	5.33	4.23	4.78
Mean	19.9	16.9	18.4	11.2	10.9	11.1	7.71	7.07	7.39
SEd	0.46	0.30	0.39	0.21	0.19	0.20	0.22	0.14	0.19
CD (0.05)	1.01	0.66	0.81	0.47	0.43	0.42	0.49	0.29	0.38
CD (0.01)	1.42	0.92	1.09	0.67	0.61	0.58	0.68	0.42	0.52
Season I : July to December						Season II: January to June			

season - II (January - June) recorded the higher number of flower cushions than season - I (July - December) in all the three locations due to the temperature and rainfall prevailed during the period. These results were in line with findings of Aikopodian *et al.* (2011) and Karthikkumar (2014).

#### Pod set

Pod set is an important factor which decides the productivity in cocoa. A well bearing plant can produce several thousand flowers per year, some times more than 50,000 of which only a small proportion (usually less than 5 per cent) are pollinated and an even smaller portion (0.5 - 2.0) per cent (Alvim, 1984). Alvim (1966) will set into fruits. The clones exhibited significant differences for percentage of pod set at different locations (Table 4). Among the different clones, CCRP 3 registered higher pod set at Aliyar Nagar (4.23 and 4.17 per cent), Coimbatore (3.20 and 2.90 per cent) whereas, CCRP 4 at Thadiyankudisai (2.98 and 2.70 per cent) in first and second season respectively. Pooled mean values showed that, CCRP 3 registered the highest percentage of pod set at Aliyar Nagar (4.20 per cent), Coimbatore (3.05 per cent) and CCRP 4 at Thadiyankudisai (2.84 per cent). In cocoa, pod set per cent was very low during dry season. Pod set was observed to be low in April but gradually increased till it reaches the peak in September (Aneja *et al.*, 1999). Similar results were observed in all the locations indicated that the pod set per cent was high during season - I (July-December, 2014). Even though season

- II (January - June, 2015) recorded more number flowers per tree, the pod set per cent was very low which might be due to poor rainfall and less humidity during dry months (January, February and March). In addition to this, the pollinators which are moisture-loving dipterans, might be much less in number during the dry seasons thus lead to poor pod set per cent in cocoa. The similar results were also in line the findings of Falque *et al.* (1993) in cocoa.

#### Yield and yield contributing characters:

Yield is the main selection criterion (Eskes *et al.*, 2000) for any crop. The number of pods per tree in a year is the prime factor determining the yield in cocoa. In cocoa, yield is determined by yield contributing characters such as number of pods per tree, dry bean yield per tree and pod value (Thondaiman *et al.*, 2013). These characters are influenced both by genetic as well as environmental factors which includes soil moisture and nutrient status. Data presented in Table 5. revealed that significant difference was observed in the number of pods per tree among the clones at all the three locations. Among the different clones used, CCRP 3 registered highest number of pods per tree at Aliyar Nagar (24.5 and 22.1), Coimbatore (18.2 and 16.2) and CCRP 4 at Thadiyankudisai (11.7 and 10.7) during first and second season respectively. The pooled data revealed that CCRP 3 registered the highest number of pods per tree at Aliyar Nagar (23.3), Coimbatore (17.2) whereas, CCRP 4 at Thadiyankudisai (11.2). In the present

**Table 6: Pod value of cocoa clones grown under different locations of Tamil Nadu**

Varieties	Pod value Aliyar Nagar			Coimbatore			Thadiankudisai		
	Season I	Season II	Mean	Season I	Season II	Mean	Season I	Season II	Mean
CCRP 1	19.2	24.3	21.8	23.6	32.2	27.9	24.3	24.8	24.6
CCRP 2	20.9	27.9	24.4	20.0	27.3	23.7	26.5	27.0	26.8
CCRP 3	17.8	22.9	20.4	19.8	25.4	22.6	20.4	21.6	21.0
CCRP 4	21.6	26.3	23.9	24.5	28.2	26.3	18.1	18.6	18.4
CCRP 5	16.8	22.1	19.4	19.2	23.6	21.4	19.8	19.9	19.9
CCRP 6	24.0	28.7	26.4	24.2	27.4	25.8	26.3	27.6	26.9
CCRP 7	23.3	27.5	25.4	-	-	-	26.9	27.6	27.3
Mean	20.5	25.7	23.1	21.9	27.4	24.6	23.2	23.9	23.5
SEd	0.51	0.71	0.58	0.35	0.64	0.51	0.53	0.52	0.52
CD (0.05)	1.10	1.42	1.20	0.78	1.42	1.11	1.15	1.21	1.11
CD (0.01)	1.61	1.99	1.63	1.10	2.01	1.51	1.62	1.62	1.51
Season I : July to December				Season II: January to June					

study, pod set per cent was observed to be more during season – I (July –December) than season – II (January – June) which would have contributed to more number of pods per tree in season I.

In cocoa, pod value or index is defined as the number of pods required to produce one kg of dry beans. Lower pod value is preferred to have higher bean yield (Karthikkumar, 2014). In the present study, all the yield contributing traits have shown remarkable variation among the clones at different locations. Pound (1932) observed that the pod value was found to vary from 6 to 22 pods per kg of dry cocoa beans. Significant difference were noticed among the clones at different location of Tamil Nadu for pod value. CCRP 5 recorded the lowest pod value at Aliyar Nagar (16.8 and 22.1), at Coimbatore (19.2 and 23.6) and CCRP 4 at Thadiankudisai (18.1 and 18.6) during first and second season respectively. The pooled data revealed that CCRP 5 registered the lowest pods value at Aliyar Nagar (19.2), Coimbatore (21.4) whereas, CCRP 4 at Thadiankudisai (18.4). These results are in line with the findings of Bekele *et al.* (2006) and Elain Apshara *et al.* (2008) in cocoa.

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