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Research Article

REPRODUCTIVE CAPACITY OF *BIXA ORELLANA* L., AN IMPORTANT NATURAL FOOD DYE YIELDING PLANT

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ABSTRACT

Bixa orellana L a tropical plant belonging to the Bixaceae is a food dye yielding plant with medicinal properties. We have already reported that this species exhibit morphological variations in the different accessions occurring in the Bangalore City, Karnataka. The present study indicated that the different accessions also differed physiologically in terms of their Reproductive capacity and Quantity of Bixin. The percent seed germination ranged from 40% to 92% and percent dye content ranged from 0.39% to 1.03% in different accessions. From this study we could identify the accessions with high reproductive capacity and high Bixin content for mass multiplication through *in vitro* techniques for the sake of Bixin, the food dye.

Key Words: *Bixa orellana* L Accessions, Reproductive capacity, Seeds, Bixin, Dye, Physiological diversity.

INTRODUCTION

Bixa orellana L a tropical plant belonging to Bixaceae is a natural food dye yielding plant. It is well known for Bixin, the dye present in the seed coat. This is non carcinogenic and is widely used in food, dairy and cosmetics (Mercandante and Pfander, 1998). This species is grown as an avenue tree in parts of Bangalore & hence is seen mainly on the roadsides. Following a detailed survey, the studies conducted by us revealed that this species exhibited wide variations in its habit and morphology (Ambika and Poornima, 2004; Poornima, 2006; Poornima and Ambika, 2009; 2012). In continuation to this we were interested to explore whether this species also exhibited variations in its physiology. In this study we used *Bixa orellana* L., plants collected from different parts of Bangalore City, Karnataka. Each of these collections were referred as accessions, for the sake of convenience and these accessions include plants bearing white, pink and rose coloured flowers that is all the available diverse accessions from Bangalore, Karnataka.Further, we proposed to identify the best accession in terms of high reproductive capacity and maximum dye (Bixin) content.

MATERIALS AND METHODS

8 sites comprising of 20 trees identified from South of Bangalore (Jayanagar, Banashankari and N R Colony of 2, 6 & 1 tree each) North of Bangalore (Yelahanka and Hessarghatta of 2 and 3 trees each), West of Bangalore (West of Chord Road and Sai-Sports Authority of India of 2 and 3 trees each) and East of Bangalore (K R Puram of 1 tree) were selected for sampling of *Bixa orellana* L from Bangalore Karnataka. These are named as accessions as they are from geographically different areas of Bangalore.

The data on the habit, height of the tree, total number of branches, number of capsules per branch, number of seeds per capsule, length and breadth of the Capsules etc, were collected from the plants found in the above stated 8 areas.

The capsules were collected from these trees during January 2003, air dried & seeds were separated. The dry seeds were stored in pearl pet bottles under the laboratory conditions of temperature ranging between

25±1°C and 28±1°C and Relative Humidity of 55% - 65%. The seeds were drawn periodically for experimentation as described below.

Seed Production

20 trees from 8 sampling areas were chosen to determine the total number of seeds per plant. Using the data on the seed germination and the average seed output per plant, the reproductive capacity were calculated following Salisbury, 1942.Reproductive Capacity = Total no. of branches **X** total no. of capsules/branch **X** Total no. of seeds / capsule **X** percent germination of seeds.

Extraction and Estimation of Dye

The dye Bixin found in the outer covering of the seed was extracted and estimated from the seeds of all the above mentioned accessions following the procedure of McKneown and Mark (1962) with slight modifications (Ambika and Poornima, 2004).The total dye content per tree (g) was calculated using the data on the reproductive capacity of all the 20 trees.

Statistical Analysis

The data from all the above tests were analysed using one way Annova, Duncan's multiple comparison test (Montgomery, 2003).

RESULTS AND DISCUSSION

For all the 20 trees of *Bixa orellana* L, studied from different parts of Bangalore, the morphological parameters like habit, height of the tree, number of capsules per branch, total number of branches, number of seeds per capsule, flower colour etc. were studied. In addition to this we also studied the reproductive capacity and dye content in each of the above mentioned 20 accessions. Based on the capsule characters, the accessions were grouped as per the table 1. The characters considered were number of capsules/branch, average number of seeds per capsule, length and breadth of the capsules.With respect to the capsule number per branch, accessions J_2, S_2, B_3 and N_1 collected from South and West of Bangalore were totally different, while others could be grouped as (K_1, Y_3, B_6), (W_2, B_2, Y_2, J1), (Y_1, B_1, B_5, H_1), (B_5, H_1,B_4), (B_4, S_1), (H_2, H_3) and (H_3, W_1).With respect to the seed number per capsule, accessions B_1 N_1, H_2 and H_3 collected from South and North of Bangalore were totally different, while others could be grouped as (W_2, K_1), (S_2, W_1, B_6), (W_1, B_6, B_5, B_2), (B_5, B_2, Y_3, B_4, Y_1, S_1), (Y_3, B_4, Y_1, S_1, B_3), (Y_1, S_1, B_3, J_1) and (H_1, Y_2, J_2).With respect to the length of the Capsule, only Accession N_1 was totally different, while others could be grouped into (B_6, B_2, W_2, K_1), (Y_3, B_3), (B_4, Y_2, J_2, B_5, S_1), (J_2, B_5, S_1, S_2), (S_2, B_1), (B_1, Y_1), (J_1, H_3, W_1, H_1) and (H_1, H_2).With respect to the breadth of the Capsule, the 2 accessions N_1 and W_1 collected from South and West of Bangalore were totally different, while others could be grouped into (B_2, B_6), (S_1, J_2), (B_5, B_3, W_2, K_1), (B_3, W_2, K_1, B_4), W_2, K_1, B_4, B_1, H_1, Y_3, H_3), (B_1, H_1, Y_3, H_3, H_2, S_2), (H_2, S_2, Y_2) and (Y_1, J_1).

The table 2 gives the reproductive capacity and the total dye produced per tree.

Three accessions from Yelahanka (Y_1, Y_2 and Y_3), two accessions from Jayanagar (J_1 and J_2), Six accessions from Banashankari (B_1, B_2, B_3, $B_{J4,}$ B_5 and B_6), single accessions from N R Colony and K R Puram (N_1 and K_1), 2 accessions from West of Chord Road (W_1 and W_2), 2 accessions from SAI (S_1 and S_2) and 3 accessions from Hessaraghata (H_1, H_2 and H_3) were considered for the above mentioned studies.

The reproductive capacity is the average seed output per plant multiplied by the average seed germination for a particular accession. The differences were seen among all the 20 accessions. The N_1 accession collected from South of Bangalore seemed to produce more while K_1 accession from east of Bangalore produced the least. Among the remaining 18 accessions Y_1, Y_2, B_2, B_5, W_1 and H_2 were better with regard to their reproductive capacity when compared to the others. The Similarity was noticed in Y_3, B_1, B_3 and H_1 accessions.

The Total dye (Bixin) content per tree (g) was calculated using the data of reproductive capacity and the percent dye content in seeds of all 20 accessions. It was highest in N_1 and least in J_2, both the accessions from South of Bangalore. It was almost the same in W_1 and H_2 accessions from west and North of

Bangalore and in B_4 and H_3 from South and North of Bangalore. The variations were also observed among all the other accessions.

Table 1: Capsule characters of *Bixa orellana* L., accessions analyzed using SPSS

Sl. No.	Parameters	Accessions Similar	Accessions Different
1.	Number of Capsules/ branch (Average of 50)	(K_1, Y_3, B_6), (W_2, B_2, Y_2, J_1), (Y_1, B_1, B_5, H_1), (B_5, H_1, B_4), (B_4, S_1), (H_2, H_3) and (H_3, W_1).	J_2, S_2, B_3 and N_1
2.	Number of Seeds /Capsule (Average of 50 capsules)	(W_2, K_1), (S_2, W_1, B_6), (W_1, B_6, B_5, B_2), (B_5, B_2, Y_3, B_4, Y_1, S_1), (Y_3, B_4, Y_1, S_1, B_3), (Y_1, S_1, B_3, J_1) and (H_1, Y_2, J_2).	B_1, N_1, H_2 and H_3
3.	Length of the Capsule (Average of 10)	(B_6, B_2, W_2, K_1), (Y_3, B_3), (B_4, Y_2, J_2, B_5, S_1), (J_2, B_5, S_1, S_2), (S_2, B_1), (B_1, Y_1), (J_1, H_3, W_1, H_1) and (H_1, H_2).	Only N_1
4.	Breadth of the Capsule (Average of 10)	(B_2, B_6,), (S_1, J_2), (B_5, B_3, W_2, K_1), (B_3, W_2, K_1, B_4), (W_2, K_1, B_4, B_1, H_1, Y_3, H_3), (B_1, H_1, Y_3, H_3, H_2, S_2), (H_2, S_2, Y_2) and (Y_1, J_1).	Only N_1 and W_1

With respect to the yield of dye (Bixin) in seeds among the 3 accessions of Yelahanka, Y_1 produced 0.83%, Y_3 – 0.60% and Y_2 – 0.45%. Among the 2 accessions of Jayanagar, J_2 produced 0.75% compared to J_1 produced 0.57%. Among the 6 accessions of Banashankari maximum Yield of Bixin was in B_6 0.86%, followed by B_2 – o.73%, B_{41} – 0.69%, B_3 – o.51%, B_1 – 0.J15% and B_5 – 0.39% respectively. Among the 2 accessions of West of Chord Road, maximum yield was in W_2 – 0.80% and W_1 – 0.64% Among the 2 accessions of Sai, maximum yield was in S_1 – 0.81 and S_2 – 0.75%.

Among the 3 accessions of Hessaraghata, maximum yield was in H_3 – 1.0% followed by H_1 – 0.97% and H_2 – 0.70%. While the Single accession of N R Colony (N_1) and K R Puram (K_1) yielded 1.03% and 0.85% respectively.

Therefore, maximum yield of Bixin was recorded in single accession of N.R. Colony-N_1, followed by third accession of Hessaraghata, H_3 and first accession of Hessaraghata, H_1 and minimum was recorded in fifth accession of Banashankari, B_5.

The data analysed statistically for the dye content was found to be highly significant. The results of this is presented in the Table 3.

With respect to the seed Bixin, accessions B_5, B_3, J_1, Y_3, W_1, B_2, S_2, Y_1, J_2, H_1, H_3, N_1 were totally different, while others could be grouped into (Y_2, B_1), (B_4, H_2), (W_2, S_1), and (K_1, B_6).

From the above study we could see that diversity existed in all the 20 accessions studied with respect to various parameters irrespective of the area from where they were collected. This diversity was noticed even in the dye content and reproductive capacity. They seemed similar only in the flower color and dye

constitution but each tree seemed different morphologically & physiologically. Finally we could identified tree No. 12 – N_1 from N.R. Colony to be the best tree with respect to the total amount of the dye and this tree can be chosen for mass multiplication.

Table 2: Reproductive capacity and total dye content of *Bixa orellana* L., accessions

Sl. No.	Acces-sions	Total Number of Bran-ches	Total Number of Cap-sules / bunch	Total Number of seeds / capsule	Percent germination	Reproductive capacity	Dye content (%)	Total Dye content per tree (g)
1	Y_1	25	20.26	28.80	80%	1,166,976.00	0.83	9685.90
2	Y_2	24	18.56	38.48	92%	1,576,928.00	0.45	7096.18
3	Y_3	15	13.28	28.75	90%	515,430.00	0.60	3092.58
4	J_1	18	19.3	31.47	72%	787,152.00	0.57	4486.76
5	J_2	10	6.84	39.9	50%	136,458.00	0.75	1023.44
6	B_1	16	20.82	35.42	60%	569,435.00	0.45	2562.45
7	B_2	28	19.07	27.27	84%	1,223,131.00	0.73	8928.85
8	B_3	13	33.14	30.44	72%	593,200.00	0.51	3025.32
9	B_4	15	22.54	28.49	92%	886,187.00	0.69	6114.67
10	B_5	20	21.18	27.30	88%	1,017,656.00	0.39	3968.85
11	B_6	15	17.23	26.08	80%	737,598.00	0.86	6343.30
12	N_1	30	38.38	58.1	80%	5,351,707.00	1.03	5,5122.58
13	K_1	13	15.09	19.50	40%	126,750.00	0.85	1077.38
14	W_1	24	29.24	26.87	72%	1,357,653.00	0.64	8688.97
15	W_2	22	18.24	18.96	80%	609,662.00	0.80	4877.30
16	S_1	18	23.8	29.04	80%	995,258.00	0.81	8061.58
17	S_2	12	10.84	23.6	64%	196,472.00	0.75	1473.54
18	H_1	15	21.04	38.00	50%	599,640.00	0.97	5816.50
19	H_2	16	26.94	53.25	54%	1,237,455.00	0.70	8676.18
20	H_3	08	29.96	44.5	64%	614,256.00	1.0	6142.56

Table 3: Statistical data for seed dye content

Parameter	Accessions Similar	Accessions Different
Seed Bixin	(Y_2, B_1), (B_4, H_2), (W_2, S_1), and (K_1, B_6)	B_5, B_3, J_1, Y_3, W_1, B_2, S_2, Y_1, J_2, H_1, H_3, N_1

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