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Genetic diversity in phalsa (*Grewia subinaequalis* D.C.) under semi- arid ecosystem of western India

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Abstract

An investigation was undertaken to evaluate the performance of 10 genotypes of phalsa at experimental farm of Central Horticultural Experiment Station (ICAR-CIAH), Vejalpur, Panchmahal (Godhra), Gujarat under rainfed hot semi-arid ecosystem of western India during 2015 and 2016. These genotypes were studied to observe the variability in respect to flowering, fruiting and fruit quality attributes under hot semi-arid conditions. The period of full bloom was recorded in February and March in all the genotypes. Fruit set percent was noted highest (58.53) in CHESP-9, whereas fruit ripening started from 1st week of April and continued up to 1st week of May in different genotypes. Flower length, flower breadth, calyx tube length, calyx tube breadth, petal length, petal breadth, stamen length, ovary length and ovary breadth ranged between 25.30-30.20mm, 60.15-69.18mm, 3.64-4.18mm, 4.63-5.22 mm, 7.89-8.25mm, 4.95-5.21mm, 8.84-9.94 mm, 3.94-4.16 mm, 7.00-7.15mm respectively. The maximum fruit yield (3.28 kg/ plant), TSS (20.12^0 Brix), total sugar (12.42% was recorded in CHESJ-9. Based on the various desired horticultural traits, the genotypes, CHESP-9 and CHESP-7 were found to be promising.

Key words: Acidity, divergence, fruit set, genetic

Introduction

The phalsa (*Grewia subinaequalis* D.C.) belongs to the family Tiliaceae. Its fruit is mildly acidic and rich source of Vitamin A, C and minerals. It is mostly used as fresh fruit and has cooling effect. The unripe phalsa fruits alleviate inflammation and are also being administered in respiratory, cardiac, and blood disorders. The ripe phalsa fruits are consumed fresh, in desserts, or processed into refreshing fruit and soft drinks enjoyed during summer months in India.

It is one of the important rainfed semi-arid fruit crops, rich in nutrients, hardy in nature, having good processing potential with wider adaptability to grow under varied climatic conditions**.** Gradually, it is attaining its position among the important fruits of India.

It is a heterozygous, cross-pollinated fruit crop and as such existing seedling population exhibits diversity, which aids in the selection of the superior desirable genotypes. Elite genotypes were collected from diversity rich areas based on the horticultural traits and evaluated under field condition to identify elite genotypes having earliness, precocity in bearing, high yielding, high pulp content and suitability for commercial cultivation at closer spacing. Such variations were observed in terms of flowering, fruiting, yield and fruit quality attributes in jamun, chironji, mahua, tamarind, bael, custard apple and khirni in different agro-climatic conditions (Patel *et al*., 2005, Singh *et al.,*2006, Singh and Singh, 2005, Singh *et al.,* 2007, Singh *et al.,* 2008, Singh and Singh, 2012, Singh *et al*., 2014, Yadav *et al*., 2017 , Malik *et al*., 2012 and Malik *et al*., 2013). The plant can tolerate drought conditions for shorter period as well as heavy rainfall conditions. Present investigation was carried out to find out variability in plant growth, flowering, fruiting and fruit quality attributes of different genotypes of phalsa to identify suitable genotypes for commercial cultivation.

Materials and Methods

The experiment was carried out at 113 m above msl, latitude 22° 41' 38" N and longitude 73° 33' 22" E which is characterized by hot semi-arid climate. The annual rainfall is mainly confined to three months (July- September) and actual mean precipitation is about 750 mm with 32 numbers of rainy days. The mean summer temperature prevails at 32.9^0 C while the mean winter temperature 21.3^0 C indicating that the area falls under hyperthermic soil regime. The mean annual maximum and minimum temperature varies from 42 - 44^0 C (May) and 8 - 12^0 C (January), respectively. The experimental soil type was having available N (151.25 kg/ha), P (8.22 kg/ha) and K (143.50kg/ha) and organic carbon (0.33%), while EC and pH, bulk density and hydraulic conductivity of soil were 0.14 dSm^{-1}, 7.50, 1.42g/cc and 0.29 cm/hr, respectively. The soil depth of experimental field ranged from 0.65 to 1.0 m derived from mixed alluvial basalt, quartzite, granite and layers of limestone which falls under semi-arid hot climate.

A total of 10 genotypes planted, established through cutting, was laid out in randomized block design with 3 replications. Observations on flowering, fruiting and fruit quality attributes were observed during 2015 and 2016 and mean data were subjected to statistical analysis. Ten shoots spread over four directions on each tree were tagged and observations on floral traits were recorded. Forty fruits were

randomly selected from all the directions of the plant for fruit quality attributes. Total soluble solids, vitamin C and sugars were analyzed by the methods as outlined by AOAC (1980). The mean data were statistically analyzed as per method suggested by Gomez and Gomez (1984).

Results and Discussion

The data on flowering and fruiting of different genotypes depicted in Table 1 showed significant differences in respect to flowering and fruit set of the plants. In general, peak period of flowering was observed in the month of February and March in all the genotypes and these genotypes exhibited considerable variations. It was noted in 2nd week of February in CHESP-1, CHESP-3, CHESP-6, CHESP-7and CHESP-9. Flowering took place in 3rd week of February in CHESP-2. It was observed in 4th week of February in CHESP-5, and CHESP-10 (Table 1). Flower bud differentiation is influenced by the prevailing agro- climatic conditions of the area. More or less similar findings have been reported by earlier workers in different fruit crops viz., jamun (Patel *et al*., 2005), jamun (Singh and Singh, 2012), bael (Singh *et al.,* 2014), khirni (Singh *et al*., 2016b), mahua (Singh and Singh, 2005) under different climatic conditions.

Table 1 clearly indicates the significant variation in the per cent fruit set which varied from 0.12 to 58.53 cm in all the genotypes of phalsa. The maximum fruit set was recorded in CHESP-9 (58.53%) followed by CHESP-2 (55.50%) and CHESJ-6(55.12%), while it was recorded minimum in CHESP-1 (50.12%).Variation in fruit set may be due to genetic makeup and their adaptability to varied climatic conditions. These findings are in accordance with results as reported by Singh *et al*. (2010) in chironji.

Fruits reached at the ripening stage in April and May in different genotypes. The earliest ripening took place in 1st week of April in CHESP-2, while CHESP-1 ripened at the last in 1st week of May (Table 1). Such variations in fruit ripening have been reported in different fruit crops like chironji (Singh *et al*., 2016a) and bael (Singh *et al*., 2014). In all the genotypes, significant variation was observed for flower size, calyx tube size, petal size, stamen and style length (Table 2). The minimum flower length (25.30 mm) was observed in CHESP-2 and the maximum length was recorded in CHESP-5 (30.20 mm), whereas calyx tube length ranged between 3.73-4.18 mm being the maximum in CHESP-7. The maximum petal length was recorded in CHESP-7 and it was noted minimum in CHESP-3. Wide variation in stamen length was observed which ranged between 8.84-9.94 mm. Differences for ovary size and petal breadth could not reach the level of significance among the genotypes. Such variations in floral organs of fruit crops have been reported by Singh *et al*. (2014) in bael under different agro-climatic conditions..

Variability recorded in yield and fruit weight is presented in Table 1. Results of study revealed significant differences in yield and fruit weight among the genotypes. Yield per plant was recorded the maximum in CHESJ-9 (3.78kg/ plant) followed by CHESJ-7 and it was recorded the lowest in CHESP-1 (2.32kg/plant). The maximum fruit weight was recorded in CHESP-4 (1.93g) followed by CHESP-8 (1.90g), while it was recorded lowest in CHESP-5 (1.25g). Variation in fruit yield and weight in various fruit crops have been reported by Singh *et al.* (2014) in bael, under rainfed semi-arid conditions of western India. Pulp content was recorded maximum in CHESP-1 (93.02%), closely followed by CHESP-4 (90.67%) and CHESP-7 (88.88%), it was found to be the minimum in CHESP-3 (81.08%).

Phalsa fruits are also rich source of total soluble solids, sugars and vitamin C, and these values varied significantly in different genotypes (Table 3). Total soluble solids and total sugar content of fruits ranged from 13.42 to 16.60^{0}Brix and 10.00 to 12.92%, respectively in different genotypes. The maximum total soluble solids was found in CHESP-2 (16.60^{0}Brix), closely followed by CHESP-7 (15.80 ^{0}brix) and CHESK-8 (15.50^{0}Brix), it was found least in CHESP-4 (13.42^{0}Brix). The highest total sugar content was also recorded in CHESP-2 (12.92%), followed by CHESP-7 (11.80%) and CHESP-8 (11.50%) and it was recorded least in CHESP-4(10.20%). Vitamin C content recorded the maximum in CHESP-9 (19.12mg/100g) and it was noted the lowest in CHESP-5 (16.90 mg/ 100g). Malik *et al.* (2012) and Singh *et al*. (2016b) have also recorded the remarkable

Table 1. Plant growth, flowering and fruiting pattern of phalsa genotypes (Mean data 2015 and 2016).

Genotype	Initiation of flowering	Peak period of flowering	End of flowering	Fruit set (%)	Ripening time	Fruit yield/ Plant (kg)	Fruit weight (g)
CHESP-1	1st week February	2nd week February	1st week March	50.12	1st week May	2.32	1.72
CHESP-2	2nd week February	3rd week February	1st week March	55.50	1st week April	2.50	1.54
CHESP-3	1st week February	2nd week February	1st week March	54.17	2nd week April	2.65	1.35
CHESP-4	3rd week February	1st week March	3rd week March	50.17	4th week April	2.20	1.93
CHESP-5	2nd week February	4th week February	2nd week March	52.15	4th week April	2.42	1.25
CHESP-6	1st week February	2nd week February	1st week March	55.12	4th week April	2.65	1.77
CHESP-7	1st week February	2nd week February	1st week March	53.25	3rd week April	3.28	1.65
CHESJ-8	3rd week February	1st week March	3rd week March	51.24	3rd week April	2.70	1.90
CHESP-9	1st week February	2nd week February	3rd week March	58.53	2nd week April	3.78	2.15
CHESP-10	2nd week February	4th week February	2nd week March	54.22	4th week April	2.83	1.50
CD P=(0.05)	----	------	-----	0.28	----	0.31	0.11

variability in relation to fruit quality attributes of khirni. Based on the horticultural traits studied, the genotypes, CHESJ-7 was found to be promising under rainfed hot semi-arid conditions of western India.

Table 2. Floral traits and pollen characters in different phalsa genotypes. (Mean data 2015 and 2016)

Genotypes	Flower length (mm)	Flower breadth (mm)	Length of calyx tube (mm)	Breadth of calyx tube (mm)	Petal length (mm)	Petal breadth (mm)	Stamen length (mm)	Ovary length (mm)	Ovary breadth (mm)	Style length (mm)
CHESP -1	26.92	60.15	3.73	4.80	8.20	5.02	9.22	3.98	7.10	7.13
CHESP -2	25.30	60.24	3.94	4.74	8.24	5.12	8.84	3.94	7.12	7.18
CHESP -3	27.24	62.29	3.96	4.63	7.89	4.95	9.00	3.90	7.14	7.15
CHESP -4	28.32	65.13	3.86	5.22	8.12	5.00	9.94	3.95	7.10	7.17
CHESP -5	30.20	69.18	4.16	5.20	8.22	5.11	9.15	3.95	7.15	7.14
CHESP -6	26.25	60.23	3.64	4.93	8.25	5.21	9.26	4.16	7.15	7.11
CHESP -7	30.03	65.02	4.18	4.75	8.32	5.13	9.53	4.05	7.13	7.15
CHESJ -8	29.03	66.12	4.13	5.07	8.23	5.10	9.32	4.10	7.10	7.10
CHESP -9	28.20	65.50	4.11	5.12	8.20	5.00	9.40	4.00	7.12	7.00
CHESP -10	28.02	64.11	4.03	5.20	8.10	5.10	9.30	4.10	7.00	7.12
CD P=(0.05)	0.11	0.09	0.07	0.06	0.08	NS	0.05	NS	NS	0.04

Table 3. Fruit quality attributes of phalsa genotypes (Mean data 2015 and 2016)

Genotype	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Pulp weight (g)	Pulp percent	TSS (Degree Brix)	Acidity (%)	Total sugar (%)	Vitamin C (mg/100 g)
CHESP-1	1.72	0.81	0.96	1.60	93.02	14.95	3.14	10.90	18.13
CHESP-2	1.70	0.77	0.90	1.40	82.35	16.60	3.19	12.92	18.43
CHESP-3	1.85	0.90	0.92	1.50	81.08	14.90	3.18	10.80	18.13
CHESP-4	1.93	0.86	0.91	1.75	90.67	13.42	3.17	10.20	18.07
CHESP-5	1.75	0.80	0.91	1.49	85.14	14.50	3.11	11.35	16.90
CHESP-6	1.77	0.80	0.90	1.50	84.74	14.60	3.12	10.30	17.80
CHESP-7	1.80	0.79	0.93	1.60	88.88	15.80	3.14	11.80	18.11
CHESJ-8	1.90	0.89	0.96	1.63	85.78	15.50	3.18	11.50	17.60
CHESP-9	2.15	0.88	0.98	1.80	83.72	15.12	3.12	11.42	19.12
CHESP-10	1.80	0.82	0.94	1.56	86.66	14.02	3.20	10.00	18.15
CD P=(0.05)	0.11	0.12	0.09	0.20	0.25	0.20	0.01	0.43	1.10

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