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Performance of hybrid progeny formed between red and white cultivars of dragon fruit

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Abstract
With recent cultivation in India, the dragon fruit still have lacks related to the selection of promising materials and there are not yet commercial varieties in the country. Therefore, manual pollination was carried out between the red and white cultivars of dragon fruit. Cultivars of Red and White were reciprocally crossed to develop hybrids. To assess the progenies' genetic diversity for use in breeding programmes in the future using cladodes characteristics, five characteristics were evaluated: days taken for vegetative bud formation, number of primary branches, number of secondary branches, distance between the areoles and spines per areole. The analysis of variance indicated that genotypes D 22/6, D 22/7 were most similar, while genotypes of D 22/1 is the most different. Studies in other countries have found high variation in characteristics of agronomic importance, even within the same species of *H. undatus* which is considered favorable for future breeding studies.

Keywords: Dragon fruit, hybrid progeny, morphology, variability

Introduction
Cactaceae-family member dragon fruit (*Hylocereus* spp.), which originated in southern Mexico, has undergone extensive commercial development in northern, central, and southern America. (Wichienchot *et al*., 2010) [11]. It had gained interest among the consumers due to its attractive color (Adnan *et al*., 2011) [1], pleasant taste (Castellar *et al*., 2006) [14], high nutrients content (Tze *et al*., 2012) [10], senescence-retarding (Lim *et al*., 2010; Zhuang *et al*., 2012) [7, 13] and cancer-preventing effects (Yusof *et al*., 2012) [12]. Long-lasting droughts are not harmful to dragon fruit. As a result, it has shown a strong potential for horticultural growth, particularly in regions where drought is a constraint for other fruits. Area and production under its cultivation is expanding rapidly in the Asian and American countries. The red–skin with white flesh (*Hylocereus undatus*), red–skin with red flesh (*Hylocereus polyrhizus*), and red–skin with purple flesh (*Hylocereus costaricensis*), and yellow–skin with white flesh (*Selenecereus megalanthus*) accounts for approximately 94, 4.0, 1.5, and 0.5% shares in the world market. Guess estimates can put on current world dragon fruit production to be more than 2.1 million tonnes over an area of 1.12 lakh ha (2017–18). Vietnam, China, Indonesia, Thailand, Taiwan, Malaysia, Philippines, and USA are the leading producers, and Vietnam, China, and Indonesia alone contribute to >93% of the total dragon fruit production of the world.

One of the obstaclesn increasing production of dragon fruit is the plant ability to form fruit [fruit set]. Due to the self-incompatibility of dragon fruit, the natural fruit setting rate is quite low. Self-incompatibility causes failed pollination and fertilization of the flower. The stigma of flower is extruded outside, while the anther [male organ] position intrude shorter than the female organ [stigma]. Genetically, genus *Selenecereus* and *Hylocereus* are self-incompatible and not many insects are attracted to come to assist the natural pollination (Mizrahi *et al.* 2004) [15]. Manual pollination conducted by farmer will be very helpful and give significant effect. that pollen derived from the types and varieties of different plants will produce fruit different weights, and the crossing affected on quality of fruit. (Mizrahi *et al.*, 2014) [16]. So, farmers must plant at least two clones that bloom in one season [the same time] and compatible. Efforts to get a hybrid clone that are self-compatible [SC] will be very beneficial to farmers so that farmers do not need to plant a variety of clones for the crossing (Tel-zur *et al.*, 2012) [5]. Genotype is the determining factor in the success of fruiting process [fruit set]. The disadvantage properties of plants [self- incompatibility] can be solved through technical challenges and out-crossing.

However, before the research on hybridization of this plant completed and is fruitful, traditional farmers must do the manual crossing if they want to get their plantation a better yield and that study on the crossing of dragon fruit flower is required to be done, either crossing in a single flower or crossing between flowers, and the crossing between varieties [interspecies crossing]. It makes it possible to obtain hybrid genotypes characterized by new traits such as increased resistance/tolerance to biotic and abiotic stresses, reduced growth vigour, improved fruit quality (attractiveness, shelf-life, flavour), or higher levels of bioactive compounds in the fruit. So, the objective of this study was to evaluate pitaya inter and intra-specific hybrids, through morphological characters related to the vegetative characters in order to separate the more dissimilar, to be used as the basis for breeding programs.

Material and Methods

The investigation was conducted in the Central Horticultural Experimental Station, Hirehalli, Karnataka, India (Latitude: 28◦38′ N, Longitude: 77◦11′ E and Altitude: 845 m above mean sea level). The progenies under examination were created manually through inter and intra specific cross-pollination. carried out manually in 2022. Crossing was carried between red and white cultivars, the treatments were; 1. H-W X H-R (D 22/1) 2. H-W X K-R (D 22/2) 3. H-W X KK-R (D 22/3) 4. W X R (D 22/4) 5. R X W (D 22/5) 6. MK-W X KK-R (D 22 6) 7. MK-W X K-R. (D 22 7). The denomination in brackets denotes the crop, the year of hybridization carried and accession number.

Seed extraction, sowing and germination

Seed extraction

The crossed fruits were harvested from the plant when they attain full maturity. Seeds were extracted manually by crushing the pulp between the fingers. Extracted seeds were immersed in water immediately. Floating seeds were discarded, while those that sunk were used for propagation.

Sowing

Seeds were washed and allowed to shade drying for three days then sown in potray filled with sterilized pot mixture medium of sand: red soil: farmyard manure at a ratio of (2:1:1) respectively.

Seed germination

Potrays were kept in a polyhouse and observed for germination for 7 to 10 days. At five leaf stage, the seedlings were removed and transplanted separately in larger pots containing sterile pot mixture. A total of 300 seedlings of F_1 population was raised. The eleven-month-old F_1 seedling morphological characters were observed *viz.*, days taken for vegetative bud formation, number of primary branches, number of secondary branches, distance between the areoles and spines per areole.

Statistical design

Experimental design used was Random Block Design [RBD] with seven treatments and three replications

Results

The results of analysis of variance for five traits revealed that the F1 population from the variable crosses showed significant differences for all the traits, indicating the existence of enormous amount of genetic variability for these traits.

Vegetative growth parameters

Days taken for vegetative bud formation

Results revealed that among F_1 crosses, D 22/5 recorded significantly lesser number of days (20.13) followed by D 22/1) (22.73) and more number of days has taken D 22/7 (29.80). (Table 1, fig.1).

Number of primary branches/cladodes

Data pertaining to the number of primary branches per cladode (table 1, fig 2) showed significantly highest primary branches per cladode by D 22/7 (5.67) followed by D 22/6 (5.60) and lowest in D 22/2 (2.00).

Number of secondary branches/cladodes

The perusal data (table 1, fig 3) showed that the secondary branches per cladode significantly varied among the F_1 crosses D 22/6) showed the highest number of secondary branches (4.73) per cladode followed by D 22/7) 4.47 and lowest number of secondary branches was observed in D 22/1 (1.53).

Distance between areoles (cm)

The analysis of variance of distance between areoles (table 1, fig 4) was highly significant in D 22/2) 3.50 cm among the F_1 crosses, followed by D 22/6) was recorded (1.09 cm) and lowest distance between areoles was observed in D 22/3) (0.49 cm).

Spines/Areole

Results revealed that the (Table 1, fig 5) higher spines per areole was recorded in D 22/5 (8.13) followed by D 22/7 (8.07) and lower number was recorded in (3.07) (D 22/1).

Table 1: Morphological characterization of F_1 crosses in dragon fruit

Crosses	Days taken for vegetative bud	No of primary branches	No of secondary branches	Distance b/w areoles	Spines/areole
D 22/1	22.73	3.20	1.53	0.64	3.07
D 22/2	27.20	2.00	1.60	3.50	5.27
D 22/3	26.00	3.27	2.47	0.49	3.80
D 22/4	25.13	3.87	2.47	0.98	4.80
D 22/5	20.13	2.47	3.40	0.92	8.13
D 22/6	28.00	5.60	4.73	1.09	5.67
D 22/7	29.80	5.67	4.47	1.08	8.07
SEm±	0.26	0.10	0.10	0.11	0.42
CD@5%	0.81	0.32	0.31	0.36	1.29

Discussion

Results on overall performance of seven F1 crosses of dragon fruit showed that crosses viz., H-W X H-R, H-W X K-R, H-W X R-KK, W-I X R-I, R X W, MK- W X RXKK, MK-W X R-K were identified as superior for various vegetative growth parameters under study. It can be seen that in the morphological characterization of days taken to vegetative bud formation, Number of primary branches, Number of secondary branches, distance between areoles and the spine number per areole (Table 1). According to De Dios (2005) [2], most species of *Hylocereus* were similar in stem morphology. Morillo *et al*. (2016) [8] stated that several morphological characteristics can be described to distinguish various types of dragon fruit species. One of the most important characteristics of *Hylocereus* sps to distinguish it is the morphology of the stem (Grimaldo-Juarez *et al*. 2007) [4]. Studies in other countries have found high variation in characteristics of agronomic importance, even within the same species of *H. undatus* which is considered favorable for future breeding studies (Tel-zur *et al*. 2011) [9]. The results of this study coincide with those of Ramírez (1999) [17], Maldonado (2000) [18] and Grimaldo (2001) [3], who concluded that the distance between areoles, the number of thorns per areole and their average length are descriptive variables of the stem. We coincide with Maldonado (2000) [18] in that the diameter of the thorns is a valuable variable because it allows differentiation of some genotypes. The importance of the areoles to distinguish species was also indicated by Kimnach (1955) [6]. The height of the undulation between adjacent areoles also showed to be a valuable trait for distinguishing genotypes in this study.

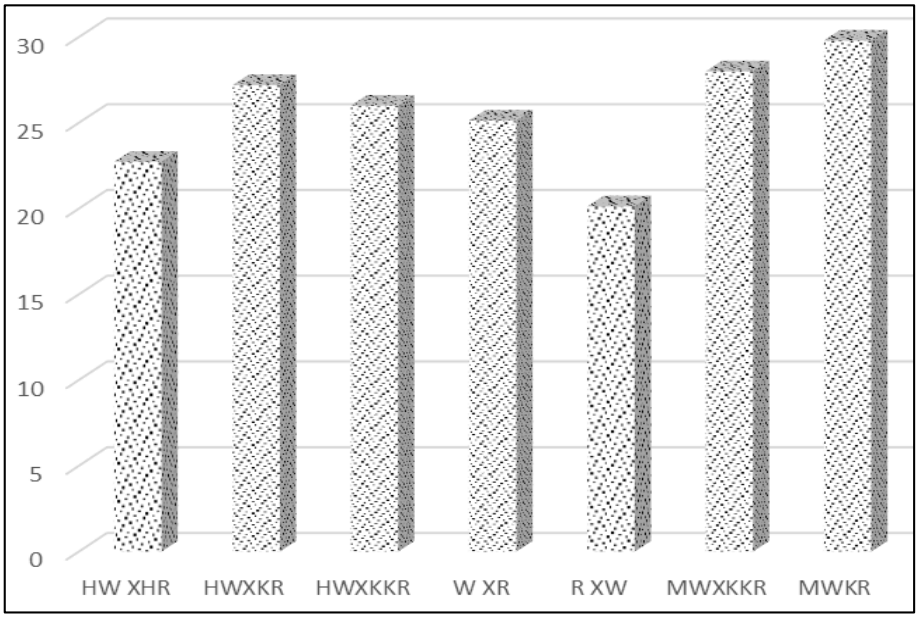

Fig 1: Days taken for vegetative bud

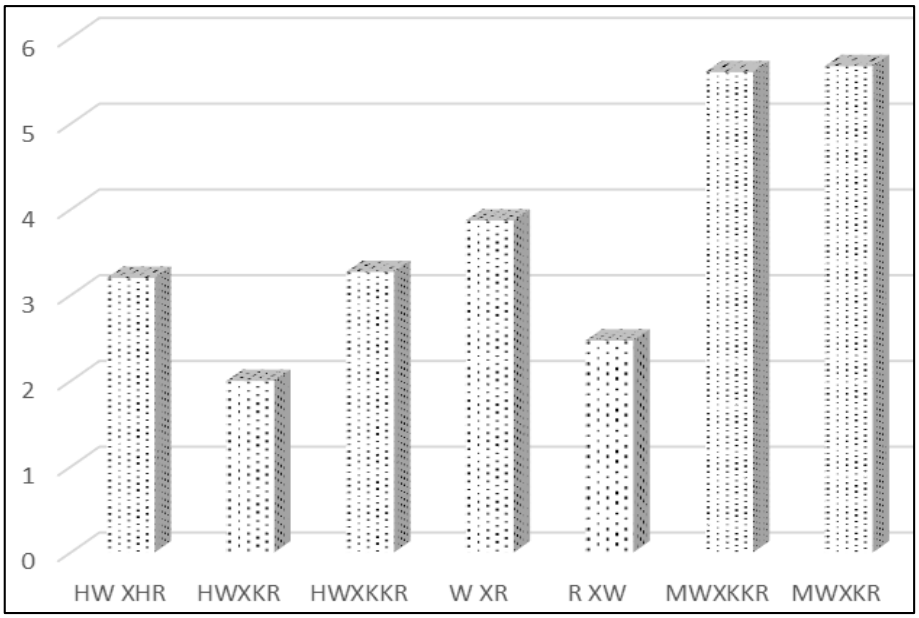

Fig 2: No of primary branches

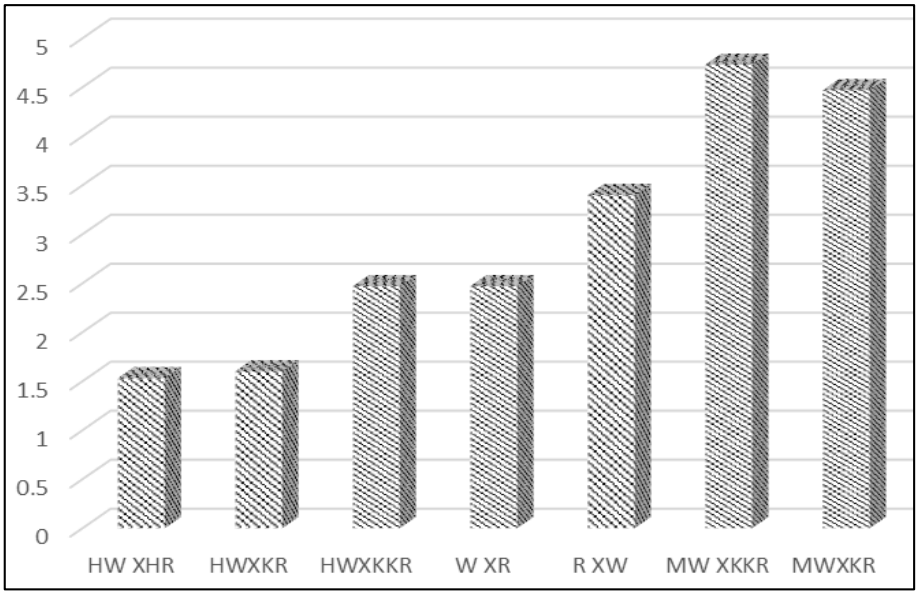

Fig 3: No of secondary branches

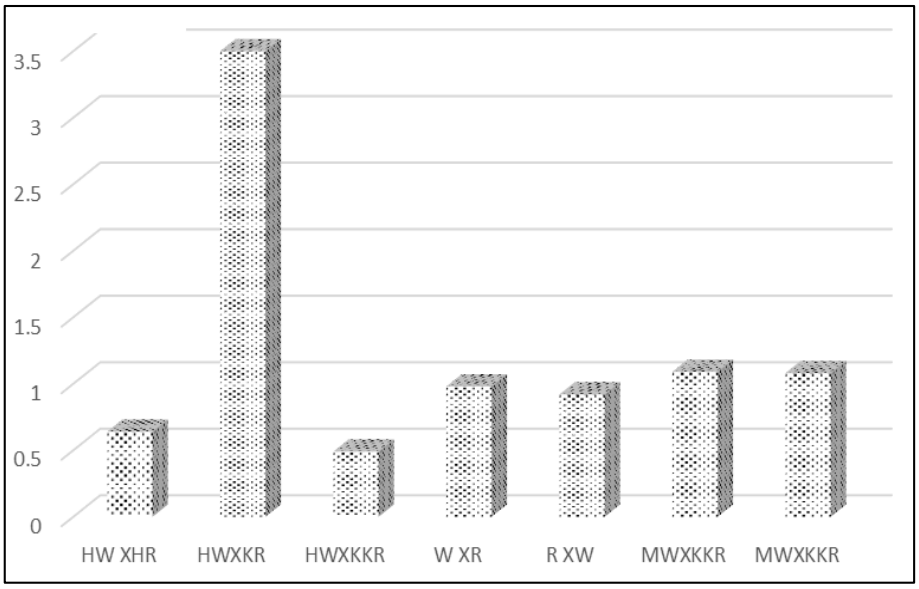

Fig 4: Distance b/w areoles

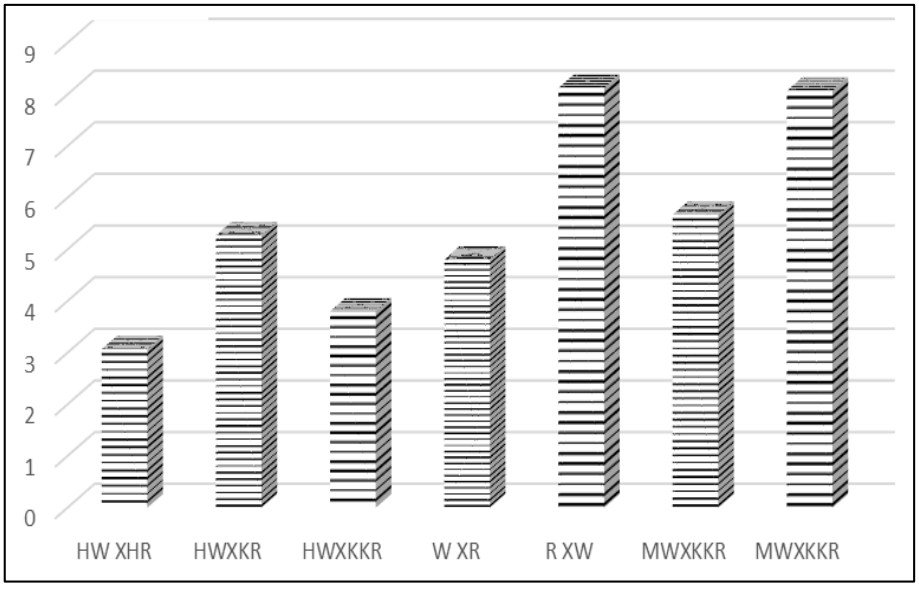

Fig 5: Spines/areole

Conclusions

The seven F_1 crosses differ in vegetative characteristics. The characteristics of the morphological were the most important in differentiating genotypes. The analysis of variance indicated that genotypes D 22/6, D 22/7 were most similar, while genotypes of D 22/1 is the most different. Studies in other countries have found high variation in characteristics of agronomic importance, even within the same species of *H. undatus* which is considered favorable for future breeding studies (Tel-zur *et al*. 2011) [9]. Several accessions of dragon fruit plants have distinctive morphological characters and can be used as a good material source breeding programs or as propagation materials due to several characters, such characteristics are attractions for dragon fruit marketing.

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