Heterosis and Combining Ability Studies in Bitter gourd (*Momordica charantia* L.)

THESIS

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1. Introduction

Bitter gourd or balsam pear (*Momordica charantia* L.) is one of the most important cucurbitaceous vegetable crops grown throughout the country. It belongs to the family Cucurbitaceae, subfamily-Cucurbitodeae, tribe-Joliffeae and subtribe-Thalithaneae.

The original place of domestication of *Momordica charantia* is unknown (Li, 1970). However, the areas of southern China or eastern India have been proposed as probable centre of origin (Raj *et al.*, 1993; Walters and Decker-Walters, 1998). Archaeology has provided almost no insights into the time and place of domestication (Yen, 1997). A comparison of plant remains from different archaeological sites of India does not list *M. charantia* but does refer to its cultivation in Indian land since 1590 A.D. (Kajale, 1991). Wild or small fruited cultivated forms are mentioned in Ayurvedic texts of the time 2000-200 B.C by members of Indo-Aryan culture (Decker-Walter, 1999) indicating an earlier (than 1590 A.D.) use in India. The Indo-Aryan word for *M. charantia* may have been borrowed from the Dravidian culture, resident before Indo-Aryans arrived, indicating an even earlier awareness of the plant (Decker-Walters, 1999). The earliest written reference to *M charantia* in China is 1370 A.D. in northern China (Yang and Walters, 1992), and probably refers to a cultivated form, as northern China is out of range of the wild-types. Grubben, 1977 refers that the origin of bitter gourd is probably India, with a secondary centre of diversity in China.. It is most widely grown in India, Indonesia, Malaysia, Singapore, China, Japan, South-East Asia, Tropical Africa and South America. In India, the leading. states in bitter gourd cultivation are Tamil Nadu, Maharastra, Uttar Pradesh, Andhra Pradesh besides Kerala and Karnataka.

The crop demonstrates wide diversity (Behera *et al*., 2007). India is endowed with a wide range of diversity in this crop so there is a vast opportunity for genetic improvement. The consumer's preference for fruit shape, size and colour is region specific. The north Indians prefer long or medium long and spindle shaped glossy green fruits whereas south Indians require long but white fruits. In eastern parts of the country small and dark green-fruited (var. *muricata*) types are preferred.

The fruit morphology varies greatly in colour, size and the exocarp characteristics. (Behera *et al*., 2007). For instance, Indian *Momordica charantia* var *charantia* cultivars bear large fusiform fruit while wild, free living *Momordica charantia* var *muricata* ecotypes develop small, round fruits (Chakravarty, 1990).

2. Research Issues

Among the cucurbits, it is considered a prized vegetable because of its high nutritive value especially ascorbic acid and iron. It contains number of important antioxidants like carotenoids, phenolics and high amount of momordicin which have manifold health benefits. It has been used for centuries in the ancient traditional medicine of India, China, Africa, and Latin America as its extract possesses antioxidant, antimicrobial, antiviral, anti-hepatotoxic, anti-ulcerogenic properties and also has the ability to lower blood sugar (Welthinda *et al* 1986). During the past decade, the anti-diabetic properties of the crop have been studied extensively and a hypoglycemic principle called "Charantin" has been isolated. The bitterness of bitter gourd is due to the cucurbitacin like alkaloid momordicine and triterpene glycosides *viz*., momordicoside K and L (Jeffrey, 1980 and Okabe *et al*, 1982). However, recently the cultivation of bitter gourd has become quite popular, because of its growing awareness of the anti-diabetic property and nutritive value of the crop among the consumers.

It is an excellent source of vitamins B1, B2, and B3, C, magnesium, folate, zinc, phosphorus, manganese, and has high dietary fibre. It is rich in iron, and contains twice the beta-carotene of broccoli, twice the calcium of spinach, and twice the potassium of a banana, according to Health.com.

Health benefits of bitter gourd

- Acts as a blood purifier: The antimicrobial and antioxidant properties present in karela juice help in treating skin problems, blood disorders, removing toxins from the blood and purifing it. It also improves blood circulation and helps to cure issues like rashes, acne, psoriasis, blood boils and even hinders the growth of cancerous cells in the body.
- Helps in weight loss: Eating or drinking the juice of karela stimulates the liver to secrete bile acids that are essential for metabolising fat in the body. Besides, a 100g serving of bitter gourd contains just 17 calories making it a great option for fitness enthusiasts.

- Improves immunity: Karela is an extremely rich source of vitamin C, which helps boost immunity. It also has powerful antiviral property, which stimulates the immune system and also aids in digestion.
- Great for diabetes: Bitter gourd has a certain insulin-like protein called polypeptide P that mimics the action of insulin and lowers blood sugar levels in diabetic patients.
- Fight acne: Consuming karela can help you get rid of acne, blemishes and skin infections and gives you a healthy and glowing skin.

3. Objectives of the Research Study

The basic aim of the present investigation is to identify potential combiners for development of hybrid and to curve out the future road map for utilization of gynoecious lines in bitter gourd breeding. Keeping in view the importance of this crop, the present investigation titled **"Heterosis and Combining Ability Studies in Bitter gourd (*Momordica charantia* L.)"** while being under taking with the following objectives:

The objectives of present study are as follows.

(1) To estimate the general and specific combining ability effects of parents and their crosses.

(2) To assess the standard heterosis, heterobeltiosis and inbreeding depression for different characters.

(3) To investigate the genetic variability, heritability and genetic advance.

(4) To find out the genetic correlation coefficient and path coefficient analysis among the different economic traits under study.

4. Summary of the Thesis

Among the female parental lines, VRBT-23 and Hirkani were found to be good combiners for most of the characters, whereas, male parental line Pusa Ashaudhi, Arka Harit was found good general combiners for yield and its related component characters. Out of thirty six hybrids Phul Ujjwala x Arka Harit and NDBT-09 x Pusa Vishesh for days to fifty percent germination, Selection-5 x Pusa Vishesh and HABG-22 x Arka Harit for days to first male flower anthesis, Selection-5 x Pusa Ashaudhi and NDBT-07 x Arka Harit for days to first female flower anthesis, Preethi x Pusa Vishesh and HABG-22 x Arka Harit for node number to first male flower, Priya x Pusa Vishesh and VRBT-23 x Pusa Ashaudhi for node number to first female flower, Preethi x Pusa Vishesh and NDVT-09 x Pusa Vishesh for vine length, Selection-5 x Pusa Ashaudhi and HABG-22 x Arka Harit for number of nodes per vine, Phul Ujjwala x Pusa Ashaudhi and NDBT-07 x Pusa Vishesh for number of primary branches per plant, Selection-5 x NDBT-07 and Arka harit for days to first picking, Hirkani x Pusa Vishesh and VRBT-23 x Arka Harit for length of fruit, Phul ujjwala x Arka Harit and preethi x Pusa Vishesh for fruit diameter, Selection-5 x Pusa Ashaudhi and Meghana-2 x Pusa Vishesh for weigth per fruits (g), Priya x Arka Harit and Meghana-2 x Pusa Vishesh for number of fruits per plant, Selection-5 x Pusa Ashaudhi and NDBT-09 x Arka Harit for fruit yield per plant (kg), Priya x Arka Harit and Hirkani x Pusa Visjhesh for number of fruits per vine and Selection-5 x Pusa Ashaudhi and NDBT-09 x Arka Harit for fruit yield per vine were exhibited significant specific combining ability effects.

The genetic component of variance for the dominance showed higher value than the additive variance for all the characters with value of greater than one (>1) degree of dominance. The variance of specific combining ability was also recorded to be higher than the general combining ability variance with the value of less than one (<1) predictability ratio for all the characters under study. This indicates that the presence of heterosis governed by over dominance type of gene action for all the characters. This indicates that the presence of heterosis governed by over dominance type gene action for the characters.

The heterosis over standard variety and better parent for different characters were carried out. The best cross combinations Phul Ujjwala x Pusa Ashaudhi and HABG-22 x Arka Harit over standard variety and VRBT-23 x Arka Harit and Phul Ujjwala x Pusa Ashaudhi over better parents studied for days to fifty percent germination. cross combinations Nakhara x Pusa Ashaudhi and Nakhara x Pusa Vishesh showed early days to first male flower anthesis over standard variety and Nakhara x Pusa Ashaudhi and Nakhara x Pusa Vishesh showed early days to first male flower anthesis over better parents, cross combinations (Priya x Pusa Ashaudhi) and (Selection-5 x Arka Harit) over standard variety and cross combinations (Priya x Pusa Ashaudhi), Priya x Pusa Vishesh and Priya x Arka Harit over better parents for days to first female flower anthesis, cross combinations (HABG-22 x Pusa Vishesh) and (Preethi x Pusa Ashaudhi) over standard variety and (Priya x Pusa Ashaudhi), (Priya x Pusa Vishesh) and (NDBT-09 x Pusa Vishesh) over better parents noticed early node number to first male flower, cross combinations Cross combinations (HABG-22 x Pusa Vishesh) and (HABG-22 x Pusa Ashaudhi) over standard variety and (HABG-22 x Pusa Ashaudhi) and (Preethi x Pusa Ashaudhi) showed earliness for node number to first female flower over better parents showed significant and desirable standard heterosis and heterobeltiosis for yield and its related component traits under study.

Cross combinations (HABG-22 x Arka Harit) and (NDBT-09 x Pusa Ashaudhi) over standard variety and (Meghana-2 x Pusa Vishesh) and (Preethi x Pusa Vishesh) showed positive and significant heterosis and better parents for highest length of vine, cross combinations (HABG-22 x Pusa Vishesh) and (Preethi x Pusa Ashaudhi) over standard variety. Whereas, cross combinations (HABG-22 x Pusa Vishesh)and (Preethi x Pusa Ashaudhi) showed negative and significant heterosis over better parents for number of nodes per vine, cross combinations (VRBT-23 x Arka Harit) and (Preethi x Arka Harit) showed negative and significant heterosis over standard variety and cross combinations (Meghana-2 x Pusa Vishesh) and (NDBT-09 x Pusa Vishesh) showed positive and significant heterosis over better parents for number of primary branches per plant, cross combinations (VRBT-23 x Arka Harit) and (Phul Ujjwala x Arka Harit) showed over standard variety and cross

combinations (HABG-22 x Pusa Vishesh) and (HABG-22 x Pusa Ashaudhi) showed heterosis over better parents for days to first picking.

Cross combinations (Nakhara x Pusa Ashaudhi) and (Priya x Arka Harit) over standard variety and (Hirkani x Pusa Vishesh) and (VRBT-23 x Arka Harit) over better parents for maximum length of fruit, cross

combinations (VRBT-23 x Pusa Ashaudhi) and (Priya x Pusa Vishesh) over standard variety and (Priya x Arka Harit) and (Selection-5 x Arka Harit) over better parents showed for maximum fruit diameter, cross combinations (VRBT-23 x Pusa Ashaudhi) and (NDBT-09 x Arka Harit) over standard variety and (Priya x Pusa Ashaudhi)and (NDBT-09 x Pusa Vishesh) over better parents showed negative and significant heterosis for maximum weight per fruit, cross combinations (Pant Karela-1 x Arka Harit) and (Priya x Arka Harit) over standard variety and (Preethi x Arka Harit) and Phul Ujjwala x Pusa Vishesh) over better parents showed negative and significant heterosis for maximum number of fruit per plant, cross combinations (NDBT-07 x Pusa Ashaudhi) and (Selection-5 x Pusa Vishesh) over standard variety and (Selection-5 x Pusa Ashaudhi) and (VRBT-23 x Pusa Vishesh) over better parents showed negative and significant heterosis for fruit yield per plant, cross combinations (Nakhara x Pusa Vishesh) and (Pant Karela-1 x Pusa ashaudhi) over standard variety and (Nakhara x Arka harit) and (Hirkani x Arka harit) over better parents showed negative and significant heterosis for number of fruit per vine and cross combinations (VRBT-23 x Pusa Vishesh) and (NDBT-09 x Arka Harit) over standard variety and (VRBT-23 x Pusa Vishesh) and (Selection-5 x Pusa Ashaudhi) over better parents showed negative and significant heterosis for fruit yield per vine.

Some of the crosses exhibited significant negative inbreeding depression for different characters such as days to fifty percent germination, days to first male and female flower anthesis and node number to first male and female flower. It is desirable for this trait. Whereas, most of the yield related component traits showed positive and

significant inbreeding depression such as number of primary branches per plant, length of fruit, weight per fruit, number of fruits per plant and fruit yield per plant. The maximum inbreeding depression was recorded for node number to first male flower.

Medium to high range of genotypic and phenotypic coefficient of variation were observed for all the characters except days to fifty percent germination, number of fruit yield per vine, fruit yield per plant, vine length and node number to first male flower indicating low effect of environmental factors. High range of heritability was recorded for most of the characters except days to fifty percent germination and fruit yield per vine. may not be useful as broad sense heritability is based on total genetic variance which indicates both fixable (additive) and non fixable (dominance and epistatis) variance. The highest genetic advance as percent of mean was found for fruit yield per plant (kg) followed by number of fruit per plant and fruit diameter.

5.CONCLUSION

The positive and significant genotypic and phenotypic correlation coefficient of fruit yield per vine with number of fruits per vine, number of fruits per plant, fruit yield per plant(kg), length of fruit(cm), days to first male flower anthesis, days to first female flower anthesis, node number to first male flower, vine length, number of primary branches per plant and node number to first female flower. It can be suggested that these traits are desirable for improvement in yield of bitter gourd. The highest positive direct effect on fruit yield per vine was showed by length of fruit, fruit yield per plant(kg), node number to first male flower, days to first male flower anthesis, vine length, weight per fruit, fruit diameter and number of fruits per vine.

The result obtained in the present investigation, it was concluded that more number of fruits per vine, more number of fruits per plant, more fruit yield per plant (kg), more length of fruit (cm), more days to first male flower anthesis, early days to first female flower anthesis, less node number to first male flower, more vine length, more number of primary branches per plant and more node number to first female flower. These traits are major yield contributing traits and are correlated with each other. Therefore, these characters can be taken into consideration either alone or simultaneously for the selection of a high yielding bitter gourd genotype in hybrid breeding for future breeding programmes.