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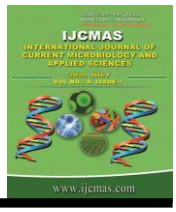

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Genetic Variability, Heritability and Genetic Advance in Bitter Gourd: A Review

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A B S T R A C T

Bitter gourd (*Momordica charantia* L.) is a monoecious and cross pollinated crop with a high degree of variability, having enormous chances of either exploiting hybrid vigour or selection in segregating population. Information on different qualitative and quantitative characters with respect to genetic variability, heritability and genetic advance are of great interest to plant breeders as they play a vital role in the development of a successful crop improvement programme. This article reviews a brief research work carried out both at national and international levels on the genetic variability; heritability and genetic advance of bitter gourd.

Introduction

Bitter gourd (*Momordica charantia* L.) is an important vegetable crop belongs to family Cucurbitaceae. It is locally known as Bitter Melon, Karela, Maiden apple and Balsam pear etc. Being an important contributor of vitamins and minerals particularly iron, phosphorus and ascorbic acid, bitter gourd ranks first among other cucurbits (Singh *et al.,* 2012). The fruit contains two alkaloids *viz*., momordicin and cucurbitacin. A hypoglycemic principle called "charantin" has been isolated which is used for the treatment of diabetes (Raman and Lau, 1996). Due to increasing awareness about the nutritional and anti-diabetic value of bitter gourd, its demand has been increased both in domestic and international market. It has been identified as one of the potent vegetable for export by Agricultural Processed Food Products and Export Development Authority (APEDA) next to onion and okra in India. For any planned breeding programme aimed to improve yield potentials of crops, it is necessary to obtain adequate information on the magnitude of genetic variability, heritability and genetic advance present in the population (Singh *et al.*, 2017).

Genetic Variability

The selection of superior genotypes is the most important aspect of any crop improvement programme and the effectiveness of the selection primarily depends on the existence of genetic variability within or between the populations subjected for selection. Therefore, any successful breeding programme requires the study of genetic variability. Knowledge of the nature and magnitude of genetic variation in terms of quantitative plant growth characteristics coupled with yield and its components is essential for improvement of a crop. The variability in the population can be estimated by various parameters like mean, range, genotypic and phenotypic coefficient of variations *i.e.* GCV and PCV together with heritability and genetic advance (GA).

The variability ascertained for any character is not solely because of variations in genetic constitutions of the population, rather conjointly due to the environmental conditions. The evident quantitative attribute is just the phenotype which may be simply assessed for selection. Hence, phenotypic selection is insufficient since it is the sum total effect of genotype, environment and interaction of genotype and environment. However, phenotypic selection also creates difficulty to establish whether variability is heritable or non-heritable (environmental). This needs the partitioning of total variations or phenotypic variations into two groups such as heritable and non-heritable.

In bitter gourd wide range of variability for a number of characters has been observed by several workers in India (Agasimani *et al.*, 2008; Yadav *et al.*, 2008; Rajput *et al.*, 2012; Singh *et al.*, 2012; Nandakumar *et al.*, 2014; Kumari *et al.*, 2015; Gupta *et al.*, 2016 and Talukdar *et al.*, 2018). Ram *et al.*, (2006) and Agasimani *et al.*, (2008) reported maximum coefficient of variations for characters like days to male flower emergence, seed weight fruit^{-1}, yield plant^{-1}, fruit weight and fruit length in bitter gourd. While evaluating 17 genotypes of bitter gourd, Khan *et al.,* (2015) observed highest variation in vine length. Talukdar *et al.,* (2018) showed that there was significantly higher amount of variations among the genotypes for all the characters studied *viz*., vine length, branches vine^{-1}, nodes vine^{-1}, days to 1st male flowering, days to 1st female flowering, fruit length, fruit diameter, fruit weight, fruits plant^{-1} and fruit yield plant^{-1} but on the contrary, for these characters the variation due to replication was found to be non-significant. Similar results were also revealed by Singh *et al.,* (2017) except for total soluble solids (TSS).

PCV is the sum total of GCV and environment coefficient of variation (ECV). The closeness between PCV and GCV simply indicate the stability of traits in different environment. For effective selection of any traits, the PCV and GCV value should have minimum difference. In bitter gourd, several studies indicated higher PCV values than corresponding GCV values (Bhave *et al.*, 2003; Narayan *et al.*, 2006; Rajput *et al.*, 2012; Singh *et al.*, 2012 and Gupta *et al.*, 2016) indicating influence of environmental factors in expression of these traits. In F_2 and F_3 segregating generations of bitter gourd, Rajput *et al.,* (2012) reported high GCV and PCV for primary branches vine^{-1}, sex ratio, fruits vine^{-1}, female flowers vine^{-1}, fruit yield vine^{-1}, average yield vine^{-1}, fruit flesh thickness and average weight of fruit. They also suggested that there was presence of greater amount of variability for yield attributes and this could be further improved by simple selection method. Similarly, for F_3 and F_4 generations of bitter gourd, the GCV and PCV were higher for primary branches vine^{-1}, average yield vine^{-1}, average weight of fruit and fruit yield (tha^{-1}) (Nandakumar,

2014). Similar findings were reported by Gupta *et al.,* (2016) for marketable fruit yield ha^{-1} along with branches plant^{-1} and total fruit yield plant^{-1} while studying 26 genotypes of bitter gourd. Pathak *et al.,* (2014) estimated the same for the characters like fruits plant^{-1}, fruit weight and fruit length. Higher magnitude of GCV and PCV was recorded for fruit yield vine^{-1} (Singh *et al.,* 2015 and Singh *et al.,* 2017), fruits vine^{-1} (Singh *et al.,* 2015), fruit girth and fruit length (Gowda, 2017). A narrow difference was observed between the values of PCV and GCV indicating the least influence of environment in the expression of the traits (Singh *et al.,* 2014 and Rani *et al.,* 2015). Singh *et al.,* (2014) and Iqbal *et al.,* (2016) observed that majority of variations in traits was due to genetics through the differences between GCV and PCV.

Highest estimates of GCV were obtained for yield vine^{-1} (Singh *et al.,* 2014), average fruit weight and fruits vine^{-1} (Dey *et al.,* 2005; Khan *et al.,* 2015; Rani *et al.,* 2015 and Talukdar *et al.,* 2018). Along with these traits, characters like branches vine^{-1} (Khan *et al.,* 2015) and fruit length (Talukdar *et al.,* 2018) also showed highest GCV values. On the other hand, Singh *et al.,* (2012) assessed high PCV for yield vine^{-1}, number of fruits vine^{-1} and fruit diameter. Similarly, maximum PCV was observed for branches plant^{-1} (Dalamu and Behera, 2013), yield vine^{-1}, fruit weight, seed weight fruit^{-1}, length of fruit, number of seeds fruit^{-1}, internodal distance vine^{-1} (Yadagiri *et al.,* 2016) and total carotenoid content and fruit yield (Sindhu *et al.,* 2017).

Characters like vine length, number of primary branches vine^{-1}, fruit length, fruit weight and fruit diameter showed moderate GCV and PCV in bitter gourd (Singh *et al.,* 2017). Similar results had also been reported by Kutty and Dharmatti (2004) in bitter gourd.

Lower estimates of GCV and PCV were observed for number of nodes bearing the 1st male flower, percent of fruit setting, days to 1st fruit harvest, number of fruits vine^{-1}, ascorbic acid, total soluble solids (Singh *et al.,* 2017 and Kutty and Dharmatti, 2004) and days to 1st male flower and female flower (Khan *et al.,* 2015; Singh *et al.,* 2017 and Talukdar *et al.,* 2018).

Heritability

Heritability is the heritable component which can be passed from generation to generation whereas; GA is the expected percent of gain of a particular character in the next generation. So, to get the desirable characters in bitter gourd, a number of workers has been reported high, medium or low heritability (h^2) coupled with GA (high, medium or low) as percent of mean. Higher values of heritability was observed for characters like average fruit length, fruits plant^{-1}, fruit yield vine^{-1}, vine length and branches vine^{-1} (Singh *et al.,* 2012; Gupta *et al.,* 2013; Rani *et al.,* 2015; Singh *et al.,* 2017 and Talukdar *et al.,* 2018). Addition to these characters, Rani *et al.,* (2015) noticed the same for days to 1st female flower and pulp thickness. Similarly, moderate heritability was observed for fruits vine^{-1}, fruit weight, fruit girth, seeds fruit^{-1}, days to 1st male flower and days to 1st female flower (Rani *et al.,* 2013); fruit length, number of node bearing 1st male and female flower, internodal length, days to 1st male flower appearance and sex ratio (Rani *et al.,* 2015); days to 1st seed germination, germination rate (Singh *et al.,* 2017) and fruit weight (Singh *et al.,* 2012 and Rani *et al.,* 2013), which revealed that the additive gene effects coupled with high environment impact on these traits. In contradiction to these findings, Rani *et al.,* (2013) observed lower values of heritability for fruit length, plant height, laterals vine^{-1}, number of node bearing 1st male and female flower, sex ratio and pulp thickness. Similar

values were obtained for days to 1st picking (Gupta *et al.,* 2013) and number of seeds fruit^{-1} (Rani *et al.,* 2015).

Heritability and genetic advance

High heritability coupled with high GA was noticed for yield vine^{-1} (Rajput *et al.,* 1996; Kutty and Dharmatti, 2004; Devmore *et al.,* 2010; Rani *et al.,* 2015 and Yadagiri *et al.,* 2016), number of fruits vine^{-1} (Narayan *et al.,* 2006; Pathak *et al.,* 2014; Rani *et al.,* 2015 and Sidhu *et al.,* 2017), average fruit weight (Pathak *et al.,* 2014; Singh *et al.,* 2014; Rani *et al.,* 2015; Yadagiri *et al.,* 2016 and Gowda, 2017), fruit length (Narayan *et al.,* 2006; Pathak *et al.,* 2014; Singh *et al.,* 2014; Rani *et al.,* 2015; Iqbal *et al.,* 2016 and Yadagiri *et al.,* 2016), vine length (Rani *et al.,* 2015 and Yadagiri *et al.,* 2016), number of node bearing 1st male and female flower (Sidhu *et al.,* 2017), pH, ˚Brix (Iqbal *et al.,* 2016), total marketable fruit yield (Gupta *et al.,* 2016), fruit size (Gupta *et al.,* 2013 and Gupta *et al.,* 2016), plant height (Singh *et al.,* 2006), vitamin C (Iqbal *et al.,* 2016 and Sidhu *et al.,* 2017) and seeds fruit^{-1} (Singh *et al.,* 2014; Gupta *et al.,* 2016 and Yadagiri *et al.,* 2016). On the other hand, Pathak *et al.,* (2014) reported high heritability with lower GA for days to 1st male flower anthesis, days to 1st female flower anthesis and days to marketable maturity from anthesis. In addition to these characters, Singh *et al.,* (2006), Islam *et al.,* (2009), Singh *et al.,* (2014) and Kundu *et al.,* (2016) observed the same for branches vine^{-1}, fruit diameter, fruit length, fruits plant^{-1}, seeds fruit^{-1} and yield fruit^{-1}. High heritability with moderate GA was observed for fruit length (Singh *et al.,* 2006).

High GCV along with high heritability and greater GA was noticed for fruits plant^{-1}, fruit weight (Mangal *et al.,* 1983; Devmore *et al.,* 2010; Dalamu and Behera, 2013 and Rani *et al.,* 2015), fruit yield vine^{-1}, fruit length, branches vine^{-1} (Mangal *et al.,* 1983; Narayan *et al.,* 2006 and Rani *et al.,* 2015), fruit diameter (Narayan *et al.,* 2006), number of nodes vine^{-1} and days to 1st fruit harvest (Rajput *et al.,* 1996; Kutty and Dharmatti, 2004 and Devmore *et al.,* 2010) which would be of great use for indirect selection for improvement in yield plant^{-1} in bitter gourd. On the other hand, traits like number of lobbings leaf^{-1}, number of days to 1st female flower showed low heritability along with low GA and low GCV (Mangal *et al.,* 1983).

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