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# Genetic Variability, Correlation And Path Co-Efficient Analysis Based On Vegetative Characters In Bottle Gourd (*Lagenaria Siceraria* L.)

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**A B S T R A C T**

Variability, correlation and path analysis among different characters of thirty one bottle gourd genotypes were studied. There was a great deal of significant variation for all the characters among the genotypes. High genotypic co-efficient of variation (GCV) was observed for days to first male flowering and female flower pedicel length whereas low genotypic co-efficient of variation was observed for leaf petiole length and male flower pedicel length. In all cases, phenotypic variances were higher than the genotypic variance. Differences between genotypic and phenotypic coefficients revealed that the major portion of the phenotypic variance was genetic in nature. High heritability with low genetic advance in percent of mean was observed in leaf petiole length which indicated that non-additive gene effects were involved for the expression of this character and selection for such trait might not be rewarding. High heritability with high genetic advance in percent of mean was observed for days of first male flowering and female flower pedicel length indicated that this trait was under additive gene control and selection for genetic improvement for this trait would be effective. Correlation studies revealed that highest significant association of yield per plant with vegetative characters no. of branches per vine followed by leaf breadth at genotypic and phenotypic level. Path co-efficient analysis revealed maximum direct contribution towards yield per plant with vegetative traits of no. of branches per vine followed by leaf breadth. Considering all the characters the $G_4$ (BD-4580), $G_{31}$ (BD-8948), $G_{26}$ (BD-4560) and $G_{28}$ (BD-4569) were selected for future breeding programme.



**Key words:** *Variability, Vegetative characters, Correlation, Path co-efficient and Bottle gourd*

## Introduction

Vegetables are considered as one of the most important groups of food crops due to their high nutritive value, relatively higher yield and higher return. The bottle gourd farmers received the highest gross return and net return compared to bean producers (Khayer et. al. 2011). Current vegetable production in Bangladesh is considerably below domestic demand. Whereas, vegetable production is around 1.8 million MT, demand is estimated to be 10 million MT. This demand-supply gap is likely to expand with the increase of population and increase in per capita income (Katalyst: Vegetables).

With an average national per capita consumption of 23 g of leafy vegetables, 89 g of non-leafy vegetables and 14 g of fruit, the average Bangladeshi eats a total of 126 g of fruit and vegetables daily. This is far below the minimum daily consumption of 400 g of vegetables and fruit recommended by FAO and the World Health Organization (WHO). Cultivable land is a scarce resource in densely populated Bangladesh, which is mostly employed for production of rice and other field crops. Vegetables occupy 16% of the total cultivated land area of Bangladesh (BBS, 2006). Besides, our cultivable land is decreasing day by day as compensation to our extreme population. That is why, it is very difficult for us to produce more

vegetables from the existing lands but we have huge amount of fallow lands like pond dikes, land levees, roadsides, homestead etc. which have great potentiality to produce crops (Hasan et. al. 2012). If we can bring these lands under vegetables cultivation, huge amount of vegetables will be produced every year. Bottle gourd can be grown with less cost and additional land is not required, can be grown in homestead area.

Bottle gourd (Lagenaria siceraria L.), locally known as lau is an important home garden vegetable. It is a fast growing climbing annual. Bottle gourd is a tropical and subtropical vine. Bottle gourd belongs to the family Cucurbitaceae having chromosome number, 2n = 22, under the order cucurbitales, class magnoliopsida (Bose and Som, 1986). Bottle gourd is one of the cultivated annual monoecious species. It is widely grown for edible fruit. The original home of the species is not known, other than that it is a native of the tropics. It is widely grown in South and Southeast Asia, China, and Africa. The herbaceous tendril-bearing vine grows to 5 m. It bears simple; alternate leaves 4-12 cm across, with 3-7 separated lobes and velvety texture because of the fine hairs. Each plant bears separate white male and female flowers (Rashid, 2004).

Green bottle gourds are used as curry. It is reported as an easily digestible vegetable which keeps the body cool and prevents constipation. It contains considerable amount of water (96.1g), carbohydrates (2.5g), protein (.2g), fat (.1g), minerals (0.5g), fiber (0.6g) and energy (12kcal) per 100g of edible fruit (Gopalan et. al. 1982). Its early production ensures a handsome price for the commercial growers. Leafs and soft stem of bottle gourd are very nutritious and delicious vegetable (Mawla, 1998). As a vegetable it is easily digestible. It has cooling effect and has diuretic and cardiotonic properties. Fruit pulp is used as an antidote against certain poisons and is good for controlling constipation, night blindness and cough. A decoction made out of leaf is taken for curing jaundice. Seeds are used in dropsy.

In Bangladesh, no comprehensive systematic research has been done in this crop. The yield potential of this crop needs to be improved through an effective breeding program. The present study was, therefore, undertaken in estimating the amount of variation, the correlation coefficients and path-coefficient in the thirty one genotypes of bottle gourd based on vegetative characters.

**Materials And Methods**

The genetically pure and physically healthy seeds of these genotypes were collected from Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI). The crop was grown at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207 during October 2008 to March 2009. The experimental area was situated at 23°77'N latitude and 90°33'E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004). The experimental field belongs to the Agro-ecological zone of "The Modhupur Tract", AEZ-28 (Anon., 1988a). Soil pH ranged from 6.0- 6.6 and had organic matter 0.84%. Thirty one genotypes of bottle gourd were used for the research work. The experiment was laid out RCBD design with three replications. The genotypes were distributed into the pit of each block of the prepared layout of the experiment. The thirty one genotypes of the experiment were assigned at random into pits of each replication. The distance maintained spacing pit to pit 3 m. The distance maintained between two blocks was 1 m. Due to uncertain rainfall during the period of the study, the seeds were dibbled in poly bag for higher germination percentage and to get healthy seedlings and when the seedlings the seedlings become 20 days old, those were transplanted in the main field in the pit. Seeds were sown 15$^{th}$ October, 2008. The experiment plot was prepared by several ploughing and cross ploughing followed by laddering and harrowing with tractor and power tiller to bring about good tilth in the first week of October 2008. After final land preparation, pits of 55 cm × 55 cm × 45 cm were prepared in each plot with a spacing of a spacing of 3 m × 1 m. To control field cricket 5 mg Furadan was also mixed with the soils of each pit before making it ready for dibbling. The doses of manure and fertilizers such as Cowdung, Urea, TSP and MOP applied @ 10 ton/ha, 125 Kg/ha, 125 Kg/ha and 150 Kg/ha respectively to the plots for bottle gourd cultivation (Anonymous, 1991). Total cowdung, half of TSP and one third MOP were applied in the field during final land preparation. Remaining TSP and one third MOP and whole gypsum and zinc oxide and one third of urea were applied in pit one week prior to transplantation. Remaining urea and MOP were applied as top dressing in four installments at 20, 40, 60 and 75 days after transplanting. Germination of seeds was completed within 12 days and the seedlings of different accessions were planted in the pit on 5$^{th.}$ November, 2008. The standard agronomic intercultural operations were done from time to time throughout the cropping season for proper growth and development of the plants. In mature stage fruit fly caused severe damage to the fruit. For protection from fruit fly, MSGT (Mashed Sweet Gourd Trap) and Pheromone bait was used along with ripcord, sevin powder. Fruits were picked on the basis of horticultural maturity, size, color and age being determined for the purpose of consumption as the fruit. Fruits were picked with sharp knife and care was taken to avoid injury of the vine. Data were recorded on the parameters from the studied plants during the experiment such as number of branches per vine, Leaf length (cm), Leaf breadth (cm), Leaf petiole length (cm), Internodes distance (cm), Days to first male flowering, Days to first female flowering, Pedicel length of male flower (cm) and Pedicel length of female flower (cm). The data were analyzed to estimate genotypic and phenotypic co-efficient of variation using the formula of Burton (1952), heritability in broad sense and genetic advance was estimated (Lush 1943) by the following formula, suggested by Johnson et al. (1955) and correlation co-efficient by Miller et al. (1958). Mean data of the characters were subjected to multivariate analysis. Univariate analysis of the individual character was done for all characters under study using the mean values (Singh and Chaudhury,

1985) and was estimated using MSTAT-C computer programme. Mean, range and co-efficient of variation (CV %) were also estimated using MSTAT-C.

Table 1. Estimation of genetic parameters of nine vegetative characters in thirty one (31) bottle gourd genotypes

| Characters | Days to first male flowering | Days to first female flowering | No. of branch per vine | Leaf length (cm) | Leaf breadth (cm) | Leaf petiole length (cm) | Internodedistance (cm) | Male flower Pedicel length (cm) | Female flower pedicel length (cm) | Yield/ plant (kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| MSG | 207.21** | 484.03** | 59.34** | 29.72** | 42.60** | 33.58** | 15.73** | 51.64** | 9.75** | 388.28** |
| %CV | 2.4 | 3.12 | 14.28 | 5.88 | 7.19 | 8.72 | 0.85 | 1.94 | 2.47 | 15.75 |
| Mean | 73.78 | 84.24 | 11.27 | 18.7 | 23.01 | 12.01 | 17.92 | 9.71 | 5.66 | 21.54 |
| SE | 0.87 | 1.32 | 0.48 | 0.34 | 0.41 | 0.36 | 0.23 | 0.43 | 0.19 | 1.2 |
| $\sigma^2g$ | 326.92 | 39.22 | 4.84 | 14.14 | 1.28 | 68.03 | 169.04 | 5.24 | 17.23 | 125.55 |
| $\sigma^2e$ | 22.14 | 4.26 | 0.02 | 0.04 | 0.02 | 3.13 | 6.9 | 0.02 | 0.03 | 11.51 |
| $\sigma^2p$ | 349.06 | 43.48 | 4.86 | 14.18 | 1.29 | 71.16 | 165.94 | 5.26 | 17.26 | 137.06 |
| $h^2_b$ | 93.66 | 90.2 | 99.62 | 99.69 | 98.58 | 95.6 | 95.84 | 99.55 | 99.8 | 91.6 |
| GCV | 48.03 | 32.09 | 17.89 | 22.63 | 22.87 | 11.18 | 14.97 | 12.77 | 42.72 | 52.02 |
| PCV | 49.63 | 33.79 | 17.92 | 22.67 | 23.04 | 11.43 | 15.29 | 12.79 | 42.76 | 54.35 |
| ECV | 12.5 | 10.58 | 1.1 | 1.26 | 2.74 | 2.4 | 3.12 | 0.85 | 1.91 | 15.75 |
| GA | 46.2 | 15.7 | 5.8 | 9.91 | 2.96 | 21.29 | 32.59 | 6.03 | 10.95 | 28.31 |
| GAPM | 122.71 | 80.46 | 47.14 | 59.65 | 59.96 | 28.85 | 38.69 | 33.63 | 112.67 | 131.43 |

Here, ** indicates significant at 1% level of significance, MSG = Mean sum of squares due to genotypes, CV = Co-efficient of Variation, SE = Standard Error, $\sigma^2e$ = Environmental variance, $\sigma^2g$ = Genotypic variance, $\sigma^2p$ = Phenotypic variance, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, ECV= Environmental coefficient of variation, $h^2_b$ = Heritability, GA = Genetic advance, GAPM= Genetic advance in percent of mean

Table 2. Genotypic and phenotypic correlation of nine vegetative characters on yield of thirty one bottle gourd genotypes

| Character | | Days to first male flowering | Days to first female flowering | Internodes distance (cm) | Male flower pedicel length(cm) | Female flower pedicel length (cm) | Number of branch per vine | Leaf length (cm) | Leaf breadth (cm) | Leaf petiole length (cm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Days to first female flowering | G | 0.713** | - | | | | | | | |
| | P | 0.694** | - | | | | | | | |
| Internodes distance (cm) | G | -0.192 | -0.19 | - | | | | | | |
| | P | -0.190 | -0.187 | - | | | | | | |
| Male flower pedicel length(cm) | G | -0.088 | -0.130 | -0.051 | - | | | | | |
| | P | -0.084 | -0.127 | -0.051 | - | | | | | |
| Female flower pedicel length (cm) | G | -0.297 | -0.286 | 0.483** | 0.134 | - | | | | |
| | P | -0.266 | -0.246 | 0.415** | 0.117 | - | | | | |
| Number of branches per vine | G | -0.067 | -0.128 | -0.275 | -0.140 | -0.141 | - | | | |
| | P | -0.078 | -0.136 | -0.255 | -0.134 | -0.830** | - | | | |
| Leaf length (cm) | G | 0.394* | -0.555** | 0.248 | -0.088 | 0.166 | 0.247 | - | | |
| | P | -0.371* | -0.519** | 0.236 | -0.085 | 0.146 | 0.226 | - | | |
| Leaf breadth (cm) | G | -0.422** | -0.465** | 0.269 | -0.085 | 0.280 | 0.302* | 0.892** | - | |
| | P | -0.387* | -0.438** | 0.246 | -0.078 | 0.257 | 0.270 | 0.762** | - | |
| Leaf petiole length (cm) | G | -0.304* | -0.340* | 0.236 | -0.254 | 0.065 | 0.121 | 0.649** | 0.552** | - |
| | P | -0.281 | -0.316* | 0.223 | -0.242 | 0.106 | 0.123 | 0.578** | 0.476** | - |
| Yield per plant (kg) | G | -0.044 | 0.065 | -0.329* | -0.163 | -0.094 | 0.471** | 0.005 | 0.167 | 0.047 |
| | P | -0.056 | 0.057 | -0.313* | -0.156 | -0.079 | 0.440** | 0.027 | 0.149 | 0.040 |

* indicates significant at 5% level of significance, ** indicates significant at 1% level of significance, G = Genotypic correlation, P = Phenotypic correlation

Phenotypic and genotypic correlation co-efficient among different pairs of characters of bottle gourd are presented in table 2. Correlation studies showed that in most cases, genotypic correlation appeared to be higher than the corresponding phenotypic correlation (Table 2). These observations indicated that in majority of the cases, the environment had not appreciable influenced the expressions of characters associations. In the present finding, no. of branches per vine has positively and highly significant influence on yield per plant and internodes distance (cm) has negative and significantly related with yield. Days to first male flowering were highly significant and positively correlated with the days to first female flowering. Leaf length (cm) was positively and highly significant correlated with leaf breadth (cm) and leaf petiole length (cm). But days to first female flowering produced significant and negative correlation with leaf length, leaf breadth and leaf petiole length (cm) at both genotypic and phenotypic level indicated that if the female flowering delayed, then leaf length, leaf breadth and

leaf petiole length are increased. Fig. 1 showing path diagram of nine vegetative characters of thirty one genotypes of bottle gourd.

Table 3. Path analysis of nine vegetative characters on yield of thirty one bottle gourd genotypes

| Character | Days to first male flowering | Days to first female flowering | Internodes distance (cm) | Male flower pedicel length (cm) | Female flower pedicel length (cm) | Number of branches per vine | Leaf length (cm) | Leaf breadth (cm) | Leaf petiole length (cm) | Genetic correlation with yield |
|---|---|---|---|---|---|---|---|---|---|---|
| Days to first male flowering | -0.084 | 0.055 | 0.057 | 0.009 | -0.006 | -0.022 | 0.278 | -0.292 | -0.038 | -0.044 |
| Days to first female flowering | -0.060 | 0.077 | 0.056 | 0.013 | -0.006 | -0.042 | 0.392 | -0.322 | -0.043 | 0.065 |
| Internodes distance (cm) | 0.016 | -0.015 | -0.296 | 0.005 | 0.010 | -0.091 | -0.175 | 0.187 | 0.030 | -0.329* |
| Male flower pedicel length(cm) | 0.007 | -0.010 | 0.015 | -0.103 | 0.003 | -0.046 | 0.062 | -0.059 | -0.032 | -0.163 |
| Female flower pedicel length (cm) | 0.025 | -0.022 | -0.143 | -0.014 | 0.021 | -0.047 | -0.117 | 0.194 | 0.008 | -0.094 |
| Number of branches per vine | 0.006 | -0.010 | 0.081 | 0.014 | -0.003 | 0.332 | -0.174 | 0.209 | 0.015 | 0.471** |
| Leaf length (cm) | 0.033 | -0.043 | -0.073 | 0.009 | 0.004 | 0.082 | -0.706 | 0.618 | 0.082 | 0.005 |
| Leaf breadth (cm) | 0.035 | -0.036 | -0.080 | 0.009 | 0.006 | 0.100 | -0.630 | 0.693 | 0.069 | 0.167 |
| Leaf petiole length (cm) | 0.026 | -0.026 | -0.070 | 0.026 | 0.001 | 0.040 | -0.458 | 0.382 | 0.126 | 0.047 |
| Residual effect | | | | | | | | | | 0.777 |

* indicates significant at 5% level of significance, ** indicates significant at 1% level of significance, Residual effect, R = 0.117

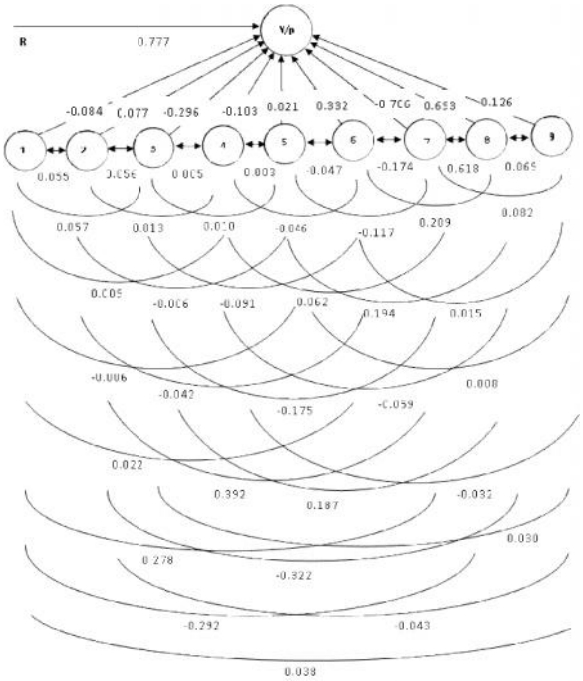


Figure 1. Showing path diagram of nine vegetative characters of thirty one genotypes of bottle gourd.

1= Days to first male flowering, 2 = Days to first female flowering, 3 = Internodes distance, 4 = Male flower pedicel length, 5 = Female flower pedicel length, 6 = No. of branches / vine, 7 = Leaf length, 8 = Leaf breadth, 9 = Leaf petiole length, Y/P = Yield per plant, R = Residual effect

The results of the path analysis revealed that leaf breadth had the maximum direct effect (0.693) followed by no. of branches per vine (0.332), leaf petiole length (0.126), days to first female flowering (0.077) and female flower pedicel length (0.021) (Table 3). Days to first male flowering (0.084), internodes distance (0.296), male flower pedicel length (0.103) and leaf

length (0.706) represented negative direct effects. The contribution of yield components like no. of branches per vine was higher in the present study. Positive direct effect was exhibited by yield per plant in building up the correlation with yield. Days to first female flowering, leaf length, leaf breadth and petiole length had the positive insignificant genotypic correlation on yield. Days to first male flowering, internodes distance and male female flower pedicel length had the negative insignificant genotypic correlation on yield. The contributions of negative and positive indirect effects via different parameters were responsible for exhibiting the positive total genotypic correlation with yield. The estimated residual effect was 0.777 indicating that 23% of the variability in Bottle gourd yield was contributed by the characters studied in the path analysis.

**Results And Discussion**

The analysis of variance indicated the existence of highly significant variability for all the characters studied (Table 1).The mean sum of squares due to genotypes were high for most of the characters. The highest mean was observed for days to first female flowering. In order to obtain a clear understanding of the pattern of variations, the phenotypic variance has been partitioned into genotypic and environmental variance. Considerable genotypic, environmental and phenotypic variances were found in days to first male flowering followed by internodes distance (cm). The differences between GCV and PCV were high yield per plant indicating vulnerability of traits to environmental influences. High GCV and PCV was observed yield per plant (kg), days to first male flowering, female flower pedicel length (cm) and days to first female flowering. The highest Environmental coefficient of variation was observed in yield per plant and days to first male flowering. High heritability estimates associates with fairly high estimates of Genetic Advance in percent of mean (GAPM) for yield per plant and days to first male flowering which in fact demonstrate the presence of additive genes effect and selection for genetic improvement for this trait would be effective. Such high GA may be due to the action of additive genes (Panse, 1957).

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