GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS OF POINTED GOURD (*Trichosanthes dioica* Roxb.)

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This is to certify that the thesis entitled, ***"GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS OF POINTED GOURD (Trichosanthes dioica Roxb.)*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS)*** *in* ***HORTICULTURE AND POSTHARVEST TECHNOLOGY*** *embodies the result of a piece of bona fide research work carried out by* ***MD. EUSUF KABIR,*** *Registration No.* ***26305/00583*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or sources of information, as has been availed of during the course of this investigation has duly acknowledged.

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ABSTRACT

The experiment was conducted on variability and estimation of genetic parameter, correlation, path analysis and genetic diversity of 24 accessions of pointed gourd (*Trichosanthes dioica*) at Regional Agricultural Research Station, BARI, Ishurdi, Pabna during the period from November 2005 to November 2006. Significant variations were recorded among the pointed gourd accessions in respect of different parameters such as days to first flower, fruit length, fruit breadth, single fruit weight, pulp seed ratio, number of fruits per plant, weight of fruit per plant and yield of fruit. The accession PG020 showed the highest performance in weight of fruits per plant, single fruit weight and yield. The highest genotypic and phenotypic coefficients were recorded in the parameter number of fruits per plant (5415.55% and 5623.67%) and second highest was recorded from yield of fruits ton per hectare (410.30% and 410.98%). How ever, days required to first flowering(49.86% and 52.41%), fruit length (7.4% and 7.42%), fruit breadth (23.56% and 26.79%), single fruit weight (172.27% and 173.28%), and weight of fruit per plant (161.87% and 162.85%) recorded moderate GCV and PCV. Correlation coefficient indicated that fruit yield per plant was highly significant and there was a positive association with weight of fruit per plant, number of fruits per plant and single fruit weight. In respect of path analysis, fruit breadth, number of fruits per plant, weight of fruit per plant directly contributed to the yield of pointed gourd accessions. The accessions were also tested for genetic divergence utilizing the multivariate analysis. The accessions were grouped into five clusters. The cluster I and III had the highest number of accessions (6) followed by cluster II (4), IV (3) and V (5). No relationship was found between genetic divergence and geographic distribution of the accessions. In this study Clusters I and III contained the highest number of accessions (6) followed by cluster V (5) and cluster II (4) respectively. The lowest accessions (3) were found in the clusters IV. The highest intra cluster distance was computed for cluster IV (35.80) composed of six accessions followed by cluster I (28.12) and cluster V (26.63). The minimum intra cluster distance was found in cluster III (18.87). Higher inter and intra- cluster distance indicates higher genetic variability among accessions between and within clusters, respectively.

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LIST OF ABBREVIATIONS AND SYMBOLS USED

Acronyms	Abbreviations/ Symbols
Agro Ecological Zone	AEZ
Analysis of Variance	ANOVA
Bangladesh Bureau of statistics	BBS
Bangladesh Agricultural Research Institute	BARI
Bangladesh Agricultural University	BAU
Bangabandhu Sheikh Mujibur Rahman Agricultural University	BSMRAU
Coefficient of Variation	CV
Canonical Vector Analysis	CVA
Degree of freedom	Df
Error mean square	EMS
Figure	Fig.
Genotypic coefficient of variation	GCV
Least significant difference	LSD
Muriate of Potash	MP
Nitrogen	N
Organic carbon	OC
Phosphorus	P
Parts per million	Ppm
Pointed gourd	PG
Phenotypic coefficient of variation	PCV
Regional Agricultural Research Station	RARS
Randomized Complete Block Design	RCBD
Randomly Amplified Polymorphic DNA	RAPD
Restriction Fragment Length Polymorphism	RFLP
Sulphur	S
Standard error	SE
Ton per hectare	t/ha
Triple super phosphate	TSP
United states	US
Zinc	Zn
Percentage	%
Sum	$\sum$

Chapter I

INTRODUCTION

Pointed gourd (*Trichosanthes dioica* Roxb.) is one of the most important and widely used cucurbitaceous summer vegetables in Bangladesh . It belongs to the family Cucurbitaceae. Most of the authors agree that India or Indo-Malayan region is the original home of pointed gourd (Bose and Som, 1986). Pointed gourd is cultivated in Bangladesh, Assam, West Bengal, Bihar, Orissa and Uttar Pradesh of India. In Bangladesh, pointed gourd is widely cultivated in the districts of greater Rajshahi, Pabna, Bogra, Kustia and Jessore (Rashid, 1999).

It is a popular and relatively costly vegetable. In Bangladesh, pointed gourd is grown during summer and available in the market from February to October. Its keeping quality is considerably high, containing 5.4g protein 0.5g mineral 153 micro gram carotene and 29mg vitamin c per 100g fresh weight (Gopalan, *et al*,1982) . It has also some medicinal value being easily digestible, diuretic and laxative, invigorates the heart and brain and is useful in the disorder of the blood circulatory system. (Rice *et al*., 1992 ; Yawalkar, 1985).

In Bangladesh, vegetable production is not uniformly distributed round the year due to climate and edaphic factors and most of the vegetables are produced in winter. So, there is a scarcity of vegetables during summer or rainy season and only small amount of vegetables are produced during the months of April to October. Among these, pointed gourd contributes a significant portion of vegetable production during lean period in summer season of Bangladesh. In 2003-04 growing season, pointed gourd was produced in about 6986 hectares of land with total production of 41160 metric tons with an average yield of only 5.89 tons per hectare (BBS, 2004).

The yield of pointed gourd is very low compared to the other countries like India (7.5 to 8 tons per hectare). Several factors are responsible for such a low yield of pointed gourd in Bangladesh; the most important one is the lack of high yielding varieties. However, many cultivars of pointed gourd with lot of variability found in Bangladesh

(Rashid, 1999). Selection of a high yielding germplasm can therefore significantly increase the pointed gourd production.

Like any other crops, yield in pointed gourd is a complex component character. In a breeding programme for increasing yield, quality, resistance to disease and pests in the exploration of genetic variability in presence of available germplasms is pre-requisite. Therefore, evaluation of germplasm to local conditions is very important.

The knowledge of the interrelationships between yield and yield components is necessary; determination of correlation among plant characteristics is a matter of considerable importance in selection of correlated response. Correlation studies between yield and other traits of the crop will be of interest to breeders in planning the hybridization programme and evaluating the individual plants in segregating populations. But it does not give an exact position of the relative importance of direct and indirect effects of various traits on yield or any other attributes. Path coefficient analysis is useful for evaluating the relative contribution of each component traits both direct and indirect to the yield. Path co-efficient analysis helps to specify the cause and effect and to measure their relative significance. Following correlation analysis, the path coefficient analysis would provide a true picture of genetic association among different traits (Bhatt, 1973). So, correlations in combination with the path co-efficient analysis quantify the direct and indirect contributions of one characteristic upon another (Dewey and Lu 1959).

The phenotypic and genotypic variations of the yield contributing characters are considerably high in pointed gourd (Sarkar *et. al.*, 1990) which points to the possibility of developing a variety with high yield. In a hybridization programme, knowledge of the interrelationship among yield and yield contributing characters are necessary. Thus, determination of correlation among the characters is a matter of considerable importance in selection of correlated response.

In crop improvement programme genetic diversity has been considered as an important factor which is also essential pre-requisite/tool for hybridization programme to obtain high yielding progenies. For planning and executing of genetic improvement programme a clear understanding of the magnitudes of genetic diversities for yield and its component characteristics are important to plant breeders

for both cross and self pollinated crops (Griffing and Lindstrom, 1954). Selecting genetically diverse parents for a successful hybridization programme, this helps in quantification of genetic diversity (Jain et al., 1975).

In view of the above facts, the present study has been under taken to fulfill the following objectives:

i) To study the variability for yield and yield contributing characters of pointed gourd

ii) To determine correlations among the economic parameters and their direct and indirect effects on yield in pointed gourd and

iii) To study the genetic diversity among the accessions and also screen out superior genotype among the variable population.

Chapter II

REVIEW OF LITERATURE

Pointed gourd (*Trichosanthes dioica* Roxb) is one of the popular cucurbitaceous vegetables cultivated in Bangladesh. Very few research works have been done for the improvement of this crop in Bangladesh and other countries in the world. However, available literature related to the present study on pointed gourd and related cucurbitus crops have been reviewed and presented in this section under the following headings.

Pointed gourd (*Trichosanthes dioica* Roxb.) is said to be originated in India. Bengal-Assam is the primary centre of origin (Choudhury, 1990). Wide variations are found among the exiting germplasm of pointed gourd. As it is a clonally propagated plant, variations in fruit shape, size and markings on them are known (Bose and Som, 1986). They grouped pointed gourd geremplasm of India in to four major types. Rashid (1999) also stated that, several cultivars are under cultivation in different parts of Bangladesh, and wide variation in yield and other parameters is present in those cultivars.

Nath and Subramanayam (1972a) reported that pointed gourd is widely cultivated in eastern part of India particularly in Bengal, Assam, Bihar and Uttar Pradesh, and a wide diversity is present among the germplasm in those areas.

2.1 Variability of pointed gourd and other related crops

The assessment of variability present in the crop helps for successful utilization of plant characters in developing suitable varieties for yield and stability. Twelve genotypes of pointed gourd were evaluated at the Central Horticulture Experiment Station, Ranchi, India during 1985-86 and 1987-88 growing seasons to study the yield and yield components. The genotypes exhibited significant difference in all traits (Krishnaprasad and Singh, 1991).

Prasad and Singh (1989) found low genotypic and phenotypic variance for node order of first female flower opening (2.68 to 7.42) in ribbed gourd. Arora et al. (1983)

found moderate heritability and high genetic advance (69.98 and 48.39) for first female flower opening in sponge gourd.

Significant variation among the cultivars for fruits per plant was also found in ribbed gourd and sweet gourd (Rahman *et al.* 1990). On the other hand Vashistha *et al.* (1983) found low range of variation (1.37 to 2.09) for fruits per plant in water melon.

A wide range of variability in fruit shape was reported in pumpkin (Chingwe, 1991) and water melon (Gill and Kummar, 1986) .Fruit size also found significant variation among sweet gourd (Rahman *et al.* 1990).

Yawalkar (1985) reported that in pointed gourd flowering started from 70-80 days after planting and harvesting of fruits commenced within 80-90 days of planting.

Rahman (1988) also stated that it took 2 to 3 weeks for sprouting and 3 month for flowering / fruiting after planting of vine or roots.

Shanmugavelu (1989) reported in pointed gourd that it took 136 to 158 days for first flowering after planting. He also reported that fruits were 10 to 16 cm long with very faint stripes and pale green in colour .

Saha *et al.* (1991) reported wide genetic variations among six genotypes of teasle gourd in respect of days to flowering, individual fruit weight and number of fruits per plant. High heritability along with high genetic gain was observed in days to flowering, fruit weight, number of fruits and yield per plant.

Mondal *et al.* (1989) studied the genetic variability of 31 water melon genotypes and observed a wide range of variability for days to first fruit harvest, fruit length, fruit diameter, number of fruits per plant and fruits yield per plant.

Abusaleha and Dutta (1990) were carried out an experiment in India to assess the genetic variation and heritability of 65 ridge gourd accessions. Significant variability was observed for all the characters at phenotypic as well as genotypic level with a very wide range of values.

Kumar and Brahmachari (1995) studied variability of Hilly, Dandali , Nimia and Santokhwa cultivars of pointed gourd . Santokhwa had the longest vines (11.06 and 10.14 m in the 2 seasons, respectively) and longest fruits. Dandali and Santokhwa had the heaviest fruits. Hilly had the highest fruits per plant and the highest yield (175.50 and 156.75 t / ha) and Nimia had the lowest yield (140.25 and 125.20 t / ha) respectively. From genetic variability study in 9 local germplasms of ash gourd Hamid *et al.* (1989) found a wide range of variability among the lines in respect of their vine growth , flowering habit , fruit bearing , weight and size of fruit .

Sarkar *et al.* (1989) noted in pointed gourd that mean node number for the emergence of first female flower was 37.4 .Pathak and Singh (1950) found that female flowers of pointed gourd open within 8 to 12 days and male within 13 to 16 days from their bud appearance.

Seshadri (1986) reported in pointed gourd that anthesis takes place during night and night temperature favours anthesis and fruit set in the early hours of the morning when the insects visit them.

Sachan *et al.* (1989) which crop observed that, the male and female flower buds took 11-16 days and 7-12 days, respectively to mature. They also noticed that, the stigma become receptive 6 hours before anthesis .

Rashid (1976) reported that the fruit of pointed gourd was elliptical or oblong in shape, 2.0 to 3.5 inch in length. The surface of fruit is smooth, green or grey in colour and striped.

Singh and Prasad (1989) reported that fruit length, width and weight of pointed gourd were in the range of 4.95-9.81cm, 2.98-3.56 cm and 15.48-57.66 g, respectively depending on various genotypes.

Prasad and Singh (1990) reported in pointed gourd that the first flower appeared at 5^{th} to 8^{th} node based on various varieties. Fruits length and breadth of pointed gourd were 6.0 to 9.4 cm and 3.0 to 3.4 cm respectively. The weight of a single fruit varied from

25.0 to 34.6 g and fruits per plants were 40.36 to 140.55. They also reported that the number of seeds per fruit varied from 14.5 to 19.9 in CHES-4 and CHES-14.

Singh and Singh (1988) studied 18 lines of pointed gourd in India for yield per plant and 10 related characters and observed that significant differences were found for all the characters. Fruits per plant, fruit length and yield showed high heritability and genetic advance.

Singh *et al.* (1985) evaluated 20 types of pointed gourd and found that the cultivar 'Dandali' produced the highest yield (5.53 kg) per plant. The lowest yield was recorded in the cultivar Lalpur (2.70 kg) per plant. The number of seeds per fruit in pointed gourd was 6.06 in "Karella" and 9.37 in "Muzaffarpuri". According to them 100 seed weight and size ranged from 7.48 to 12.59 g and 1.17 to 1.50 cm respectively.

Ahmed *et al.* (2000) were conducted to study the different genetic variability in snake gourd at the experimental field of BSMRAU during February to July, 1997. Eight fruit morphotypes of snake gourd were studied to measure the variability. Among the morphotypes , all the characters except node number of first flower showed significant variation. The highest genetic variability was observed for fruit length, fruit yield per plant showed maximum differences between genotypic and phenotypic coefficient of variation indicating highest environmental influences it.

Indiresh (1982) studied twenty four lines of bitter gourd and observed high genotypic co-efficient of variations for fruit fresh weight, yield per plant and fruit length. Heritability estimates were high for all the characters except yield per plant and days for fruit development.

Lalta *et al.* (1988) studied the genetic variability of water melon among 9 germplasms for 14 characters. They reported high values for phenotypic and genotypic co-efficient of variation for fruits per plant, average fruit weight, seeds per fruit, fruit yield per plant. High heritability and high genetic advance were obtained for fruit length, fruit weight and fruit girth.

Rashid (1999) observed globular shaped seeds in pointed gourd having 0.3 to 0.5 cm in diameter.

Miah *et al.* (2000) studied 30 genotypes of bitter gourd and observed the highest genotypic as well as phenotypic coefficient of variation were found for fruit length followed by days to female flowering, fruit yield / plant, fruit weight and nodes / vine.

2.2 Path analysis and correlation between yield and yield contributing characters

Fruit yield in pointed gourd is the character which is contributing by a complex chain of interrelating characters is related to fruit yield. Association of these yield contributing characters with yield and among its components is important for making selection in the breeding programme. Such correlation studies may also differ due to agroclimatrological variation from year to year. Many authors have studied correlation between yield and yield contributing characters of pointed gourd.

Dora *et al.* (2002) conducted an experiment to determine the important yield attributing characters required for the selection of high yielding types from 11 selections of pointed gourd collected from different part of Orissa and Bihar, India. Fruit retention percentage and the number of fruit per plant were the most important yield attributing characters. Hence, these two characters must be given emphasis in the selection of high yielding types.

Sarkar *et al.* (1989) carried out an experiment in India to studied correlation and path analysis of 16 divergent types of pointed gourd indicate that fruit weight , fruit diameter and number of primary branches / plant were positively and significant correlated with yield / plant at genotypic and phenotypic levels. The path analysis revealed that fruit volume followed by fruit weight and fruit diameter have maximum positive direct effects on yield The indirect effects of all the components through fruit volume were relatively high in magnitude in respective of direction. Therefore, emphasis should be given on fruit weight followed by fruit diameter, fruit volume and number of primary branches / plant in selecting good genotype for improvement of yield in pointed gourd.

Kumaran *et al.* (1998) carried out an experiment on correlation and path analysis studies in pumpkin. They found that positive and significant correlation of vine length, mean fruit weight, number of fruit per plant and number of seeds per fruit with fruit yield per plant. They also found that number of fruit per plant exhibited the highest direct effect on yield. High positive indirect effects were exerted by number of fruit per plant and mean fruit weight.

Singh *et al.* (1986) stated that yield was positively and significantly correlated with fruits / plant (r = 0.95) and vine length (r = 0.60) in pointed gourd. Days to flowering and days to fruit set were negatively correlated with all the other characters with the exception of a positive correlation between days to flowering and fruit weight.

Agronomic and morphological characters were studied in pointed gourd by Krishnoprasad and Singh (1991). They found a positive correlation between yield and late flowering.

Miah *et al.* (2000) noted that fruit yield showed significant positive association with average fruit weight, fruit breadth and number of nodes per vine in genotypic and phenotypic correlation with days to male flowering in bitter gourd. Path analysis revealed that average fruit weight, number of fruits per plant, days to male flowering and fruit length had positive direct effect on fruit yield.

Matsuura and Fujita (1995) observed correlation study among 98 cucumber (*Cucumis sativus*) cultivars. Morphological characters were not correlated with the number of fruits produced. However, the no. of fruits was correlated with leaf size; none of the cultivars with a high fruiting ability had small leaves.

Rahman *et al.* (1986) reported negative but significant correlation between yield per plant and fruit length (r = 0.588) and strong positive significant correlation with fruit diameter (r = 0.571) in bottle gourd . Path analysis revealed that fruit length and diameter had high positive direct effect on yield and number of fruits per plant had also considerable positive direct on yield per plant in bottle gourd.

Saha *et al.* (1992) found positive but non-significant association between fruit yield and fruit length (r = 0.375) where as strong positive and significant association between fruit yield and fruit diameter (r = 0.609) indicating selection of fruit diameter in pumpkin.

Path analysis of yield and its components revealed that vine length (1.21) ,days to female flower appearance (0.752) , fruit weight (6.126) and fruit length (1.082) had positive direct effect on yield in cucumber (Prasad and Singh , 1992) .

Abusaleha and Dutta (1988) carried out path coefficient analysis in 75 cucumber varieties. The reported that fruits per vine and fruit length had the greatest direct effects on yield.

2.3 Genetic diversity

Genetic diversity is one of the important tools to quantify genetic variability in both self and cross-pollinated crops (Guar *et al.* 1978). The relative contribution of a trait, however, depends on the population and also on the environmental conditions in which the population is grown (Akther, 1990). Selection of genetically diverse parents for a successful hybridization program is now possible through biometric procedure, which helps in quantification of genetic diversity (Jain *et al.* 1975). Tomooka (1991) reported that evaluation of genetic diversity is important to know the source of gene for a particular trait within the available germplasm.

Hazra *et al.* (2003) grouped 167 accessions of pointed gourd into eight non-overlapping clusters, with cluster IV comprising the highest number of accessions (37 accessions) and cluster VI comprising of the lowest number of genotypes (6 accessions). Intracluster distance ranged from 1.25 in cluster I to 1.65 in cluster VII. Cluster VII and V were the most diverse as indicated by the maximum intercluster distance between them (6.04).

Mahalanobis D^2 statistics of multivariate analysis (Jeshwani *et al.*, 1970; Mital *et al.*, 1975) is a useful tool in quantifying the degree of divergence between the biological

population of different components to the total divergence, both at inter and intra cluster levels.

D^2 analysis (originally outlined by Mahalanobis, (1936) and extended by Rao, (1952) is one of potential methods of estimating the degree of genetic diversity. It also enables to quantify the relative contributions of different characters to the total diversity. The relative contribution of character, however, depends on the population and also on the environmental conditions in which the population is grown (Akter, 1990).

Ramachandran *et al.* (1981) grouped 25 bitter gourd germplasm into 10 clusters based on their D^2 values. The inter-cluster distance values observed were higher between cluster VI and VIII (8569.31) and the minimum was between cluster II and III (393.62). The coefficient of variation estimated for different characters among the 10 clusters showed greater role for yield per plant (38.84), fruit per plant, (25.68), female flowers per plant (19.82) and fruit length (19.05) in determining the inter-cluster distance. It was further observed that the characters yield per plant, fruits per plant, and female flowers per plant and fruit length contributed predominantly to divergence.

A study involving 45 diverse lines of *Cucumis melo* revealed high diversity as indicated by the range of D^2 values for 2.52 to 210.14 among the lines (Kalloo *et al.*, 1982). Depending on the genetic divergence, the 45 strains were grouped into 14 clusters. The maximum distance at inter-cluster level was 14.50 followed by 13.29. The intra-cluster distance ranged from 9.36 to 19.86. It was also found that the genotypes usually did not cluster according to the geographical origin.

Kadam and Kale (1987) observed highly significant difference between cultivars suggesting considerable divergence among 30 ridge gourd cultivars. Thirty cultivars were grouped into 20 clusters based on their D^2 values. Cluster A having two cultivars had the lowest intra-cluster D^2 values (8.22) while cluster I which had two cultivars with the highest intra-cluster value of 18.59. The highest inter cluster distance was observed between clusters V and XIII (387.11) and it was minimum between cluster IV and VIII (19.79)

Dora *et al.* (2001) groupted eleven genotypes of *Trichosanthes dioica* into four clusters based on Mohanobis D^2 statistics and found that intercluster distances were greater than intracluster distances, indicating considerable genetic diversity among genotypes. The highest D^2 value (984.3) was recorded between cluster II and cluster IV.

Ram (2001) grouped 167 diverse accessions of pointed gourd (*Trichosanthes dioica* Roxb) on the being genetic divergence, in to 8 non- overlapping clusters. Cluster 8 and cluster 5 were most diverse as indicated by maximum intercluster distance between them (6.049). Considerable variation in cluster means was observed for most of the characters. The minimum distance was observed between cluster I and cluster 7 (1.676), indicating close relationship among accessions in them. The intra-cluster distance ranged from 1.258 to 1.655. They also found that the first principle component had highest eigen roots and also showed highest proportion of total variation (47.92 %), followed by second component with the variation of 22.52 %. The first five components accounted for more than 95 % variations. Thus, the five components were used for non hierarchical euclidean cluster analysis.

Masud *et al.* (1995) grouped 27 genotypes of pumpkin into seven clusters. No relationship was found between genetic divergence and geographic distribution of the genotypes. The results of PCA revealed that in vector 1 (Z_1) the important characters responsible for genetic divergence in the major axis of differentiation were yield per plant, fruit length, fruit weight and fruits per plant. In vector, II (Z_2) fruits per plant and yield per plant played a major role while rest of the characters played a minor role in the second axis of differentiation. The clustering pattern of the genotypes revealed that the genotypes collected from the same place did not form a single cluster. Thus genetic diversity and geographic distribution were not directly related.

They studied the genetic distance among five botanical varieties of *Cucumis melo*. The genetic distance was calculated for nodes to first female flower, fruit weight, and seeds per fruit and fruits per plant. Total D^2 was estimated according to Mahalanobis (1936). The magnitude of D^2 indicated closeness among the varieties. The characters, fruits per plant contributed maximum to total divergence (80%). Seeds per fruit did not contribute to the total divergence; selection of botanical varieties based on fruits

per plant would be a logical step in the selection of divergent parents in any hybridization programme as reported by Mathew *et al.* (1986).

While studying 19 genotypes of sponge gourd (*Luffa cylindrica*) collected from local and exotic sources Masud *et al.* (2001) grouped the genotypes into five clusters. The genetic divergence of the genotypes did not follow their geographical distribution and was at random. There was no evidence of close relationship between geographical distribution and genetic divergence as estimated by D^2 statistics. Maximum inter cluster distance (45.9) was observed between cluster II and V and minimum (10.3) between cluster II and IV. Fruit length and diameter were significant contributors to genetic divergence.

Prasad *et al.* (2001) used D^2 analysis in 60 inbred lines of cucumber to select a suitable germplasm for a hybridization program. Thirteen characteristics involving growth, flowering, fruiting, ability and yield were used and found ten different clusters irrespective of their allelic relationship and geographical areas of collections. The node number followed by number of branches and node at which first female flower appeared to contribute maximum to genetic divergence.

Rasheed *et al.* (2002) evaluated the genetic divergences of 47 pumpkin genotypes collected from different places of Bangladesh. The genotypes under study were grouped into seven cluster. Cluster III had the maximum (11) and cluster IV and VII had the minimum (both 4) number of genotypes. The intra cluster value was higher in cluster IV. The inter cluster distance were larger than the intra cluster distance suggesting wider genetic diversity among the genotypes of different groups. The characters like fruit weight, yield per plant, flesh thickness etc. contributed maximum towards total divergence.

Genetic divergence using Mahalanobis D^2 statistics was studied for seven quantitative characters including yield per vine in a collection of twenty diverse cultivars of bottle gourd by Badade *et al.* (2001). The cultivars differed significantly for almost all the characters and were grouped into 10 clusters based on the similarities of D^2 value. Considerable diversity within and between clusters was noted and it was observed for

the characters viz. vine length, number of branches, fruit per vine, length and diameter of fruit and yield per vine.

Mliki *et al.* (2003) examined genetic diversity among 26 cucumber accessions from five African countries present in the U.S. Multivariate analysis identified three distinct groupings of African accessions. Data suggested that some Egyptian accessions possess unique genetic variations; these germplasm had potential for broadening the genetic base of commercial cucumber.

From the above review it was revealed that wide degree of variation for yield and yield contributing characters are observed in pointed gourd by different author. The difference in the range of characters reported could be due to the difference in genetic materials used and the environmental where they were grown.

Chapter III

MATERIALS AND METHODS

The experiment was carried at the Regional Agricultural Research station, BARI, Ishurdi, Pabna during the period from November 2005 to November 2006. The materials and methods used in conducting the experiments have been described below with sub headings.

3.1 Experimental site

The field experiment was conducted at the Regional Agricultural Research Station of Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna. The site of the field experiment was situated between 24.03^0 N latitude and 89.05^0 E longitudes at the elevation of 16 m above the sea level.

3.2 Climate

The experimental area was under the sub-tropical climatic zone and characterized by moderate rainfall, high temperature, high humidity and relatively long days during the Kharif season (April to September) and scanty rainfall, low humidity, low temperature, and short day during Rabi season (October to March).

3.3 Soil

The soil of the experimental plot was clay loam in texture belonging to the High Ganges River Flood Plain under AEZ 11 (Anonymous, 1971). The selected plot was well-drained high land with pH 8.5. Soil was analyzed before conducting the experiment at the Regional Laboratory of Soil Resources Development Institute, Rajshahi. Details of the soil characteristics are shown in Table1.

Table 1. Physical and chemical properties of soils at RARS, Ishurdi, Pabna

Land category	Textural class	pH	OC* (%)	Total N (%)	P (ppm)	K (me / 100 g)	S (ppm)	Zn (ppm)
High	Silt loam	8.5	0.58	0.06	12.20	0.25	25	0.70

*Organic carbon

3.4 Plant materials used

Twenty four pointed gourd accessions were collected from different parts of Bangladesh. The places from where these pointed gourd accessions have been collected are given in Table 2. There was a male accession for natural pollination.

Table 2. Accession number and Source of 24 pointed gourd germplasm

Accession number	Source
PG001	Rangpur
PG002	Rangpur
PG003	Natore
PG004	Rangpur
PG005	Kushtia
PG006	Pabna
PG007	Kushtia
PG008	Kushtia
PG009	Kushtia
PG010	Pabna
PG011	Pabna
PG012	Kushtia
PG013	Kushtia
PG014	Kushtia
PG015	Kushtia
PG016	Bogra
PG017	Rangpur
PG018	Rangpur
PG019	Rangpur
PG020	Natore
PG021	Rangpur
PG022	Rangpur
PG023	Pabna
PG024	Pabna

3.5 Land, bed and pit preparation

The land selected for the experiment was opened 15 days before planting of the crop with a disc plough. It was then thoroughly prepared by ploughing and cross ploughing with a power tiller followed by laddering to obtain good tilth. During land preparation, weeds and stubbles were collected and removed from the field and the

clods were broken with the help of hand. The surface of the land was leveled. Finally irrigation and drainage channels were made around the plots. Final land preparation was done one week before pit preparation. Beds were made on the plots. Each bed was 1.25 m x 4 m in size. A space of 0.75m was kept between two beds. Pits of 50 cm × 50 cm × 30 cm size were prepared in each bed and plant to plant spacing maintained was 1.0 m.

3.6 Transplanting of vine cutting

Immediately after collection the fresh vine cuttings were transplanted on 15th October 2005 in the nursery. After two month the rooted cuttings were planted in the main field. Every morning watering was done after transplanting.

3.7 Treatments and experimental design

The treatment comprised twenty four accessions of pointed gourd. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of a unit plot was 1.25 x 4.0m, which accommodated 4 plants at a spacing of 1.0m x 1.25 m.

3.8 Manuring and fertilization

Manures and fertilizers were applied as per recommendation of Rashid (1993). N, P_2O_5 and K_2O were applied in the form of Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) as follows.

Manures and Fertiliser	Rate per hectare
Cowdung	10 ton
N	62.10kg
P_2O_5	86.40kg
K_2O	60 kg

Total amount of cowdung and TSP were applied during final land preparation. Urea and Muriate of Potash were top dressed in three equal installments at 20, 60 and 90 days after emergence.

3.9 Intercultural Operations

The plants were always kept under careful observation. After planting of vine cutting, different intercultural operations as mentioned below were accomplished.

3.10 Staking

During the growing period, bamboo stick was used to support the plants, and the plants were allowed to creep on a bamboo pandal. Bamboo pandal helped the plants for proper growth and to protect the fruits from damaging by soil pathogens. It also helped in easy harvesting of the fruits.

3.11 Pruning of lateral vines

The lateral vines which emerged out from the branch near the soil level were pinched. This operation was continued during the growing period.

3.12 Irrigation

Irrigation was given as and when necessary depending on soil moisture status and crop conditions and particularly after each application of fertilizers.

3.13 Weeding and mulching

Weeding and mulching were accomplished as and when required to keep the crop free from weeds and to keep the soil loose for proper aeration. Mulching was done after irrigation at appropriate time to break the soil crust and to make the soil loose.

3.14 Plant protection measures

Diazinon 60 EC @ 3.5 ml/l of water was sprayed at an interval of 10 days from the beginning of infestation for controlling Epilachna beetle. After fruit setting, Neembicidin @ 0.2% was sprayed at an interval of 10 days for controlling fruit flies.

3.15 Harvesting

Fruits were harvested regularly when they attained horticultural maturity, ie. immediately before hardness of seeds. Harvesting was started from the first week of March and continued up to second week of November 2006.

3.16 Data collection

Two Plants were selected at random from each plot for recording data. The following characters were considered in this study.

(i) Days to first flowering

The number of days from the date of planting to the date of first flower opening was recorded.

(ii) Number of node at first harvest

The number of nodes at first harvest was recorded in the main vine.

(iii) Internodes length at first harvest (cm)

The length of 10 inter nodes of the main vine was measured by a measuring scale the average was calculated.

(iv) Vine length at first harvest (cm)

The length of the vine at first harvest was recorded from the collar region to the tip of the main vine.

(v) Days to first harvest

The number of days at first harvest was recorded in first harvest of fruits.

(vi) Fruit length (cm)

Ten edible fruits were selected randomly and harvested from each genotype belong to each replication. The length of fruit was measured immediately after harvest and the average was worked out in cm.

(vii) Fruit breadth (cm)

The breadth at the middle part of 10 fruits selected from each genotype was measured immediately after harvest, and the average was worked out in cm.

(viii) Single fruit weight (g)

Weight of single edible fruits of each genotype was weighted just after harvest and the average was worked out.

(ix) Pulp weight per fruit (g)

The weight of pulp per fruit was recorded from ten fruits harvested from each accession, and the average was worked out.

(x) Pulp: Seed ratio

The ratio of pulp and seed was calculated dividing the pulp weight by seed weight.

(xi) Number of fruits per plant

The total number of fruits produced in a plant was counted and recorded.

(xii) Weight of fruit per plant (kg)

The total weight of all the harvested fruits from each plant was recorded.

(xiii) Yield of fruit (t/ha)

The total yield per plot was converted into per hectare to record the yield per hectare.

(xiv) Number of seeds per fruit

The number of seeds per fruit was counted from 10 fruits harvested from every plant, and the average was worked out.

(xv) Seed weight per fruit (g)

The weight of seeds per fruit was recorded from 10 fruits harvested from every plant, and the average was worked out.

3.17 Statistical analysis

i. Analysis of variance (ANOVA)

The collected data on various parameters were statistically analyzed to find out the statistical significance of the experimental results. The means for all treatments were calculated and analysis of variance for all the parameters was performed by F-variance test. The significance of the difference between treatment means was evaluated by the Least Significance Difference (LSD) test for the interpretation of the results (Gomez and Gomez, 1984). Univariate analysis of the individual character (analysis of variance) was done by computer using MSTAT-C software.

ii. Estimation of genetic parameters

(a) Phenotypic and genotypic variances

The phenotypic and genotypic variances were calculated according to Johnson *et al.* (1955) using following formula:

$$\sigma^2 g = \frac{VMS - EMS}{r}$$

Where, *VMS* and *EMS* are the varietals and error mean squares and r is the number of replications.

The phenotypic variance (δ^2ph) was derived by the following formula:

$$\sigma^2 ph = \sigma^2 g + \sigma^2 e$$

Where, $\sigma^2 g$ is the genotypic variance and $\sigma^2 e$ is the effective error mean square.

(b) Genotypic and phenotypic coefficient of variation (GCV and PCV)

Genotypic and phenotypic coefficient of variation was commutated using the formula suggested by Burton (1952).

$$\text{Genotypic coefficient of variation (GCV)} = \frac{\delta g \times 100}{\bar{x}}$$

Where, δg = Square of genotypic variance and

$\bar{x}$ = Population mean.

Similarly the phenotypic coefficient of variation was calculated by the following formula:

$$\text{Phenotypic coefficient of variation (PCV)} = \frac{\delta ph \times 100}{\bar{x}}$$

Where, δph = Square root of phenotypic variance and

$\bar{x}$ = Population mean

(iii) Estimation of simple correlation coefficient

Simple correlation coefficient (r) among 10 important parameters of pointed gourd accessions was estimated by the formula Singh and Chaudhury, (1985).

iv. Estimation of path coefficient analysis

Path co-efficient analysis was done according to the procedure reported by Dewey and Lu (1959) using simple correlation values. In path analysis, correlation co-efficient was partitioned into direct and indirect effects of independent variable on the dependent variable.

v. Analysis of genetic divergence

For analysis of the divergence data on nine quantitative characters of 24 accessions of pointed gourd were recorded Those were (i) Days to 1st flowering, (ii) Node at which 1st flower appeared, (iii) Fruit length, (iv) Fruit breadth, (v) Single fruit weight, (vi) Pulp seed ratio, (vii) Number of fruits per plant, (viii) Weight of fruits per plant and (ix) Yield of fruit (t/ha). As per analysis of variance, all the characters showed significant differences among the genotypes indicating the presence of notable variability and therefore, diversity.

(a) Cluster analyses (CA)

Cluster analysis was carried out according to Mahalanobis (1936). It divides genotypes in to group on the basis of a data set in to some number of mutually exclusive groups.

(b) Principal component analysis (PCA)

Principal components were computed from correlation matrix and genotype scores obtained for the first components with roots greater than unit (Jager *et al*, 1983). It provides two dimensional plots, which helps in separating different populations involved. Contribution of the different characters towards divergence is discussed from the latent vectors of the first two principal components.

(c)Principal coordinate analysis (PCO)

Principal coordinate analysis is equivalent to PCA is used to calculate the inter genotype distance. Through the use of all dimensions of p, it gives distance between pair of the n points using similarity matrix (Digby *et al.*, 1989).

(d)Canonical vector analyses (CVA)

Canonical vector analysis finds linear combination of original variability that maximize the ratio of between groups to within groups variation, thereby giving functions of the original variables that can be used to discriminate between the groups.

(e)Computation of average intra-cluster distances

The average intra cluster distance for each cluster was calculated by taking all possible D^2 values within the members of a cluster obtained from PCO. The formula used to measure the average intra cluster distance was:

Intra-cluster distance = D^2/n

Where,

D^2 is the sum of distances between all possible combinations (n) of the genotypes included in a cluster.

The square root of the D^2 values represents the distance (D) within cluster.

(vi)Analysis of data

Mean data for each character was subjected to multivariate analysis technique viz., principal component analysis (PCA), principal coordinate analysis (PCO), cluster analysis (CA) and canonical vector analysis (CVA) were done by computer using the GENSTAT 5.13 and Microsoft Excel 2000 software.

Chapter IV

RESULTS AND DISCUSSION

The experiment was conducted to study the variability, estimation of genetic parameter, correlation, path coefficient analysis and genetic diversity of 24 pointed gourd accessions. The analysis of variances of the data on different yield and yield contributing characters are given in Appendix 6-7. The results of the present study have been presented and discussed in this chapter under the following heading.

4.1 PLANT, FLOWERS, FRUITS AND SEEDS CHARACTERS

The plant, flowers, fruits and seeds characteristics like days required to first flowering, number of node at first harvest, Inter node length at first harvest, Vine length at first harvest, Date at first harvest, fruit length, fruit breadth, single fruit weight, Pulp weight per fruit, pulp seed ratio, number of fruits per plant, weight of fruits per plant, fruit yield, Number of seeds per fruit and Seed weight per fruit were recorded and shown in the following Table 3-6.

4.1. A. Plant and Flowers characters

The plant and flowers characteristics like days required to first flowering, Number of node at first harvest, Inter node length at first harvest, Vine length at first harvest, Date at first harvest was recorded and results are presented in Table 3 and 4.

4.1. A.1 Days required to first flowering

It was observed that days to first flowering varied significantly among the accessions and ranged from 77 days to 97 days with the mean value of 86 days (Table 3). The plants accession PG001 required the minimum days to first flowering (77 days) which was statistically similar with PG002, PG004, PG006, PG007, PG010, PG016 and PG020 (83, 84, 83, 82, 83, 79, and 79 days) respectively. The days to first flowering was observed in this study agrees with the findings of Rahman (1988). PG014 and PG015 took maximum days to first flowering (97 days). This result agree with that of Yawlkar (1985) who reported significant variation among the genotypes for days required to first flowering.

Considerable differences between genotypic (42.99 days) and phenotypic (45.19days) variance as well as genotypic (49.86%) and phenotypic (52.41%) coefficient of variation indicating considerable environmental effect upon the expression of the character of days to first flowering (Table 4).

4.1. A.2 Number of node at first harvest

Wide variation was observed among the accessions in number of nodes (Table 3). The maximum number of nodes per vine was recorded (45) in accession PG010 and the minimum (19) was recorded from PG019. Number of nodes per vine increased with increase in length of vine. Singh and Prasad (1989) also reported the wide range of variability in pointed gourd for number of nodes per vine.

Considerable differences between genotypic (38.78) and phenotypic (46.459) variance as well as genotypic (112.77%) and phenotypic (135.10%) coefficient of variation. It indicates considerable environmental effect upon the expression of the character of number of node at first harvest (Table 4).

4.1. A. 3 Internode length at first harvest

Internode length at first harvest varied significantly among the accessions and ranged from 6.15 cm to 17.38 cm with the mean value of 9.14 cm (Table 3). The plants of PG013 had the maximum length of internode (17.38 cm) which was statistically different from other accessions. The plants of PG022 had the minimum length of internode (6.15cm). Accessions with short internode are preferable which produce more fruits per plant. Prasad and Singh (1990a) obtained an increase in fruit yield per plant in pointed gourd from plants with short internodes as compared to the long one.

Considerable differences between genotypic (1.75) and phenotypic (14.26) variance as well as genotypic (19.15%) and phenotypic (156.07%) coefficient of variation. It indicates considerable environmental effect upon the expression of the character of internode length at first harvest (Table 4).

4.1. A.4 Vine length at first harvest

The vine length at first harvest varied significantly among the accessions studied and ranged from 0.95 m to 4.70 m with the mean value of 2.23. The longest vine (4.70m) was recorded from PG010 which was significantly different from other accessions. The shortest vine length (0.95m) was recorded from PG019 (Table 3). Kumar *et al.* (1995) also observed significant variation in vine length of three pointed gourd genotypes. Vine length depends on genetic make up of the plant.

Slight differences between genotypic (0.51) and phenotypic (0.55) variance as well as genotypic (22.90%) and phenotypic (24.70%) coefficient of variation were observed and indicating slightly genetical, physiological, nutritional or environmental effect upon the expression of the character of vine length at first harvest (Table 4).

4.1. A.5 Days to first harvest

The days to first harvest varied significantly among the accessions studied and ranged from 93 to 115 days with the mean value of 102. The highest days to first harvest (115 day) were recorded from PG015 which was significantly different from other accessions. The shortest days to first harvest (93 day) were recorded from PG001 and PG020 (Table 3).

Considerable differences between genotypic (51.46) and phenotypic (54.24) variance as well as genotypic (50.60%) and phenotypic (53.33%) coefficient of variation indicating considerable environmental effect upon the expression of the character of days to first harvest (Table 4).

Table 3. Plant and flowers characteristics of different accessions of pointed gourd (*Trichosanthes dioica*Roxb.)

Treatment	Days required to first flowering	Number of node at first harvest	Inter node length at first harvest	Vine length at first harvest	Days to first harvest
PG001	77.00	36.00	9.26	2.46	93
PG002	83.00	34.00	8.34	1.80	99
PG003	89.00	42.00	6.33	2.00	106
PG004	83.67	34.00	10.53	1.85	102
PG005	94.00	34.00	7.28	2.50	108
PG006	83.00	42.00	10.34	2.30	95
PG007	82.00	41.33	7.94	2.30	95
PG008	93.00	35.00	7.31	2.60	112
PG009	95.00	36.00	7.38	2.80	110
PG010	83.00	45.00	10.33	4.70	97
PG011	84.00	40.00	10.30	2.42	96
PG012	80.00	40.00	7.99	2.20	97
PG013	93.00	35.00	17.38	2.90	109
PG014	97.00	25.33	8.35	1.41	113
PG015	97.00	25.33	7.44	1.50	115
PG016	79.00	23.00	7.48	1.26	96
PG017	80.00	39.33	8.02	2.50	95
PG018	81.00	38.00	10.25	2.40	97
PG019	87.00	19.00	7.24	0.95	102
PG020	79.00	32.00	9.83	2.80	93
PG021	80.67	34.00	13.20	1.90	97
PG022	81.00	34.00	6.15	1.90	95
PG023	93.00	30.00	10.28	1.90	109
PG024	95.00	31.00	10.31	2.10	110
LSD (0.05)	2.439	4.554	5.813	0.345	2.738
CV (%)	1.72	8.06	38.71	9.39	1.64

Table 4. Genotypic variance, phenotypic variance, genotypic coefficient of variation, phenotypic coefficient of variation, range and mean of yield and yield contributing characters of 24 pointed gourd accessions

Genetic components	Days required to first flowering	Number of node at first harvest	Inter node length at first harvest	Vine length at first harvest	Days to first harvest
Genotypic variance	42.99	38.78	1.75	0.51	51.46
Phenotypic variance	45.19	46.459	14.26	0.55	54.24
Genotypic coefficient of variation (%)	49.86	112.77	19.15	22.90	50.60
Phenotypic coefficient of variation (%)	52.41	135.10	156.07	24.70	53.33
Range	77.00-97.00	19.00-45.00	6.15-17.39	0.95-4.70	93-115
Mean ± SE	86.22± 1.21	34.39± 2.26	9.14± 2.89	2.23± 0.17	101.71±1.36

PG001

PG002

PG003

PG004

PG005

PG006

Plate 1. Photographs showing different plant growth habits of pointed gourd accessions (PG001-PG006)

PG007

PG008

PG009

PG010

PG011

PG012

Plate 2. Photographs showing different plant growth habits of pointed gourd accessions (PG007-PG012)

PG013

PG014

PG015

PG016

PG017

PG018

Plate 3. Photographs showing different plant growth habits of pointed gourd accessions (PG013-PG018)

PG019

PG020

PG021

PG022

PG023

PG024

Plate 4. Photographs showing different plant growth habits of pointed gourd accessions (PG019-PG024)

4.1. B Fruit and seed characters

Fruit and seed characters in respect of fruit length, fruit breadth, single fruit weight, Pulp weight per fruit (gm),pulp seed ratio, number of fruits per plant, weight of fruits per plant ,yield of fruits ton per hectare, Number of seeds per fruit and Seed weight per fruit were studied and results have been presented in Table 5 and 6.

4.1. B.1 Fruit length

Length of fruit varied significantly among the 24 pointed gourd accessions and ranged from 8.06 cm to 11.94 cm with the mean value of 10.14 cm (plate 5-8), (Table 5). Longest fruit was recorded from PG002 (11.94 cm) while the shortest fruit (8.06 cm) was recorded from PG003 which was significantly different from other accessions. These findings agree with the results of Prasad and Singh (1990a).

Slight differences between genotypic (0.75) and phenotypic (0.753) variance as well as genotypic (7.4%) and phenotypic (7.42%) coefficient of variation were observed and indicating slightly environmental effect upon the expression of the character of fruit length (Table 6).

4.1. B.2 Fruit breadth

Fruit breadth varied significantly among the 24 pointed gourd accessions and ranged from 3.26 to 4.64 cm. The mean value was 3.78 cm (plate 5-8), (Table 5). The highest fruit breath was recorded from PG023 (4.64cm) while the lowest fruit breath (3.26cm) was recorded from PG015 which was significantly different from other accessions.

A little bit differences between genotypic (0.89) and phenotypic (1.012) variance as well as genotypic (23.56%), and phenotypic (26.79%) coefficient of variation indicating considerable environmental effect upon the expression of the character of fruit breadth (Table 6).

4.1. B.3 Single fruit weight

Single fruit weight varied significantly among the accessions and ranged from 24.33 g to 56.33 g (plate 5-8), (Table 5). The fruits of PG020 had the highest fruit weight (56.33 g) followed by PG022 (55.93 g) and PG017 (54.00 g). On the contrary, the lowest single fruit weight (24.33 g) was recorded from PG016. The variation of fruit weight could be due to

the genetical, physiological, nutritional or environmental influence. Prasad and Singh (1990a) reported similar results in respect of single fruit weight in pointed gourd.

Slight differences between genotypic (73.41) and phenotypic (73.84) variance as well as genotypic (172.27%) and phenotypic (173.28%) coefficient of variation were observed and indicating slightly environmental effect upon the expression of the character of single fruit weight (Table 6).

4.1. B.4 Pulp weight per fruit

Pulp weight varied significantly among the 24 pointed gourd accessions and ranged from 22.60 g to 52.83 g with the mean value of 39.93g (Table 5). The maximum weight of the pulp (52.83 g) was obtained from the fruits of accession PG022 that was significantly different from other accessions. Whereas, the minimum weight of the pulp (22.60 g) was obtained from PG003. The result revealed that pulp weight per fruit had direct influence on average fruit weight. It was observed that larger the size of the fruit, the higher the pulp weight and lower number of seeds per fruit.

Considerable differences between genotypic (64.79) and phenotypic (79.15) variance as well as genotypic (162.25%) and phenotypic (198.21%) coefficient of variation indicating considerable environmental effect upon the expression of the character of Pulp weight per fruit (Table 6).

4.1. B.5 Pulp seed ratio

Pulp: seed ratio varied significantly among the accessions and ranged from 7.76 to 20.37 with the mean value of 13.24 (Table 5). The maximum pulp seed ratio (20.37) was found in PG017, which was statistically different from other accessions. The higher pulp: seed ratio might be due to the lowest weight of seeds per fruit, which is a very important character for selection of quality pointed gourd lines. While the minimum pulp: seed ratio (7.76) was recorded in fruits of PG003, which was statistically similar to PG007 and PG012.

Slight differences between genotypic (6.782) and phenotypic (6.931) variance as well as genotypic (51.23%) and phenotypic (52.35%) coefficient of variation were observed and indicating slightly genetical, physiological, nutritional or environmental effect upon the expression of the character of pulp seed ratio (Table 6).

4.1. B.6 Number of fruits per plant

The number of fruits per plant differed significantly among the 24 accessions of pointed gourd and ranged from 41.33 to 405.7 (Figure 1). The plants of PG007 produced the maximum number of fruits that was statistically similar to and PG012 where as the accession PG019 produced the minimum number of fruits. Prasad and Singh (1990a) observed also significant variation among the genotypes of pointed gourd in respect of number of fruits per plant. The variation in number of fruits per plant might be due to genetical characteristics. Considerable differences between genotypic (13141.76) and phenotypic (13646.80) variance as well as genotypic (5415.55%) and phenotypic (5623.67%) coefficient of variation indicating considerable environmental effect upon the expression of the character of number of fruits per plant (Table 6). This finding was supported by Lalta *et al.* (1988) observed similar result in water melon.

4.1. B.7 Weight of fruits per plant

Weight of fruits per plant varied significantly among the accessions (Figure 2). The highest weight of fruits per (13.56kg) plant was found in the accession PG020 that was statistically different from other accessions. Whereas, PG019 produced the lowest weight of fruits per plant (1.03kg). Prasad and Singh (1990a) also observed the significant variation among the different genotypes of pointed gourd in respect of weight of fruits per plant. Slight differences between genotypic (13.23) and phenotypic (13.31) variance as well as genotypic (161.87%) and phenotypic (162.85%) coefficient of variation were observed and indicating slightly genetical, physiological, nutritional or environmental effect upon the expression of the character of weight of fruits per plant (Table 6).

4.1. B.8 Yield of fruit (t/ha)

Among the 24 pointed gourd accessions studied, yield of fruit varied significantly (Figure 3). The maximum yield of fruit (40.05t/ha.) was obtained in PG020, which was statistically different from other accessions. Whereas, the minimum yield of fruit (3.08t/ha.) was obtained in PG019. Slight differences between genotypic (104.82) and phenotypic (104.99) variance as well as genotypic (410.30%) and phenotypic (410.98%) coefficient of variation were observed and indicating slightly genetical, physiological, nutritional or environmental effect upon the expression of the character of yield of fruit ton per hectare (Table 6). This finding was supported by Lalta *et al.* (1988) in water melon.

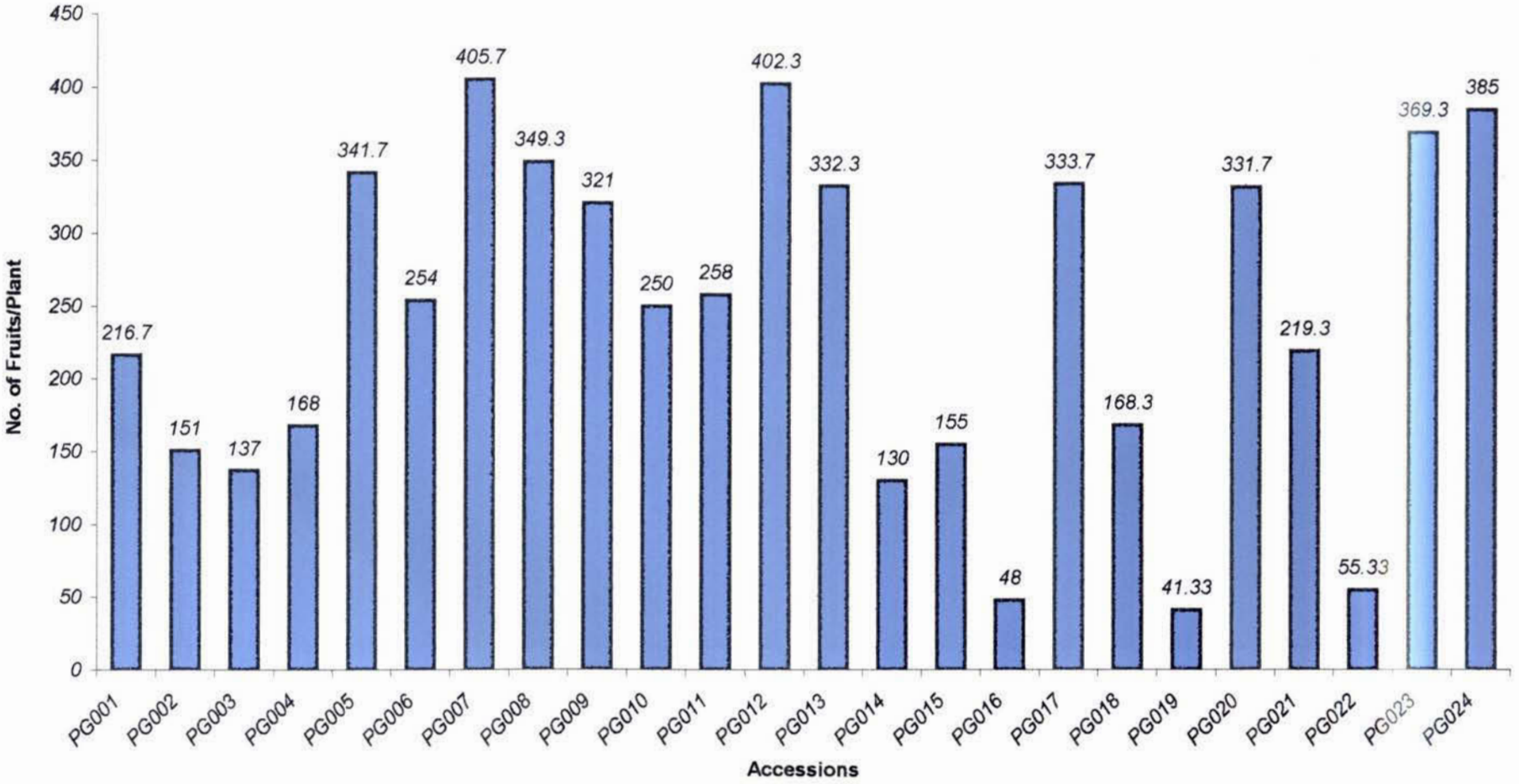


Fig.1 Number of fruits per plant of 24 accessions of pointed gourd.

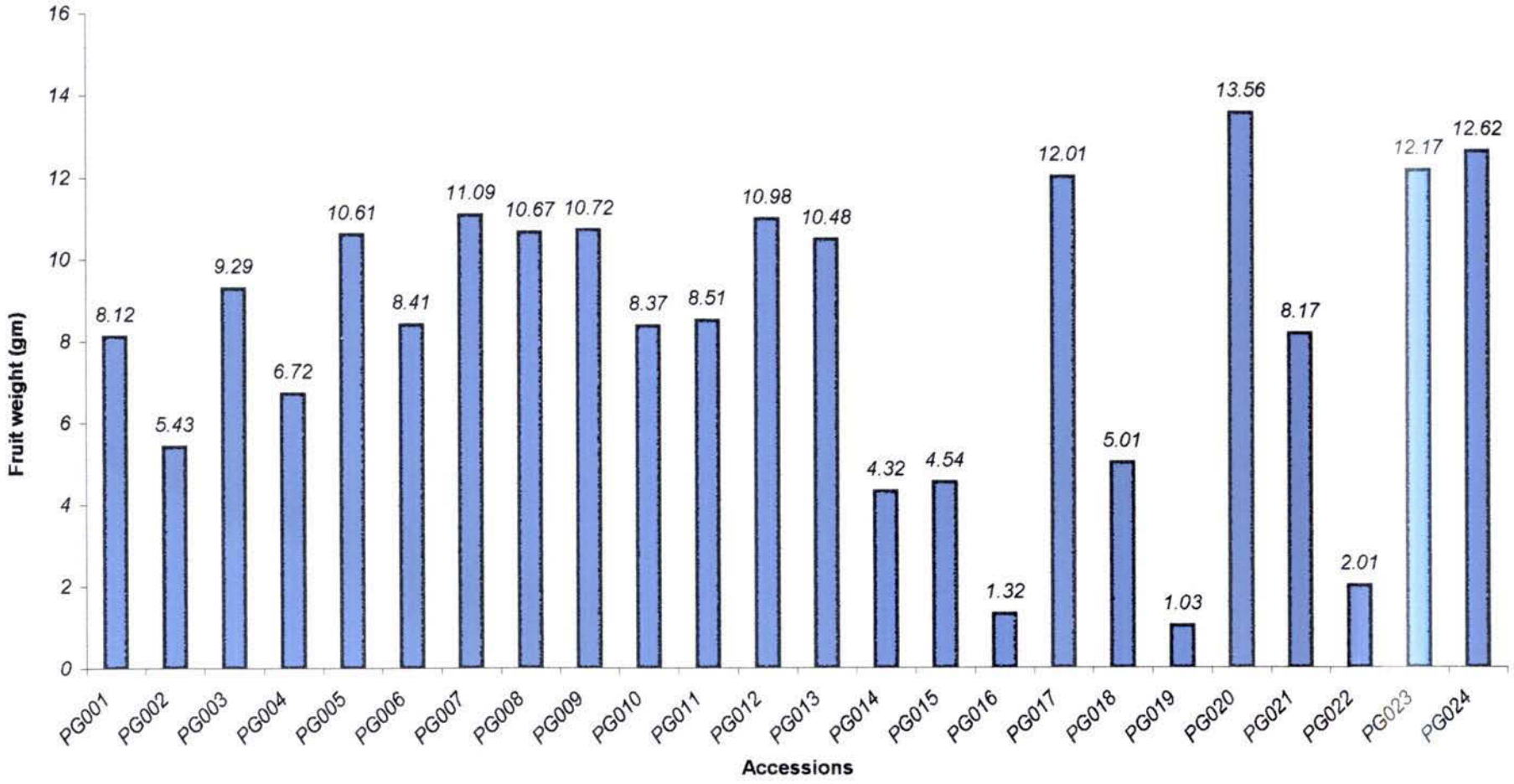


Fig.2 Fruit weight of 24 accessions of pointed gourd.

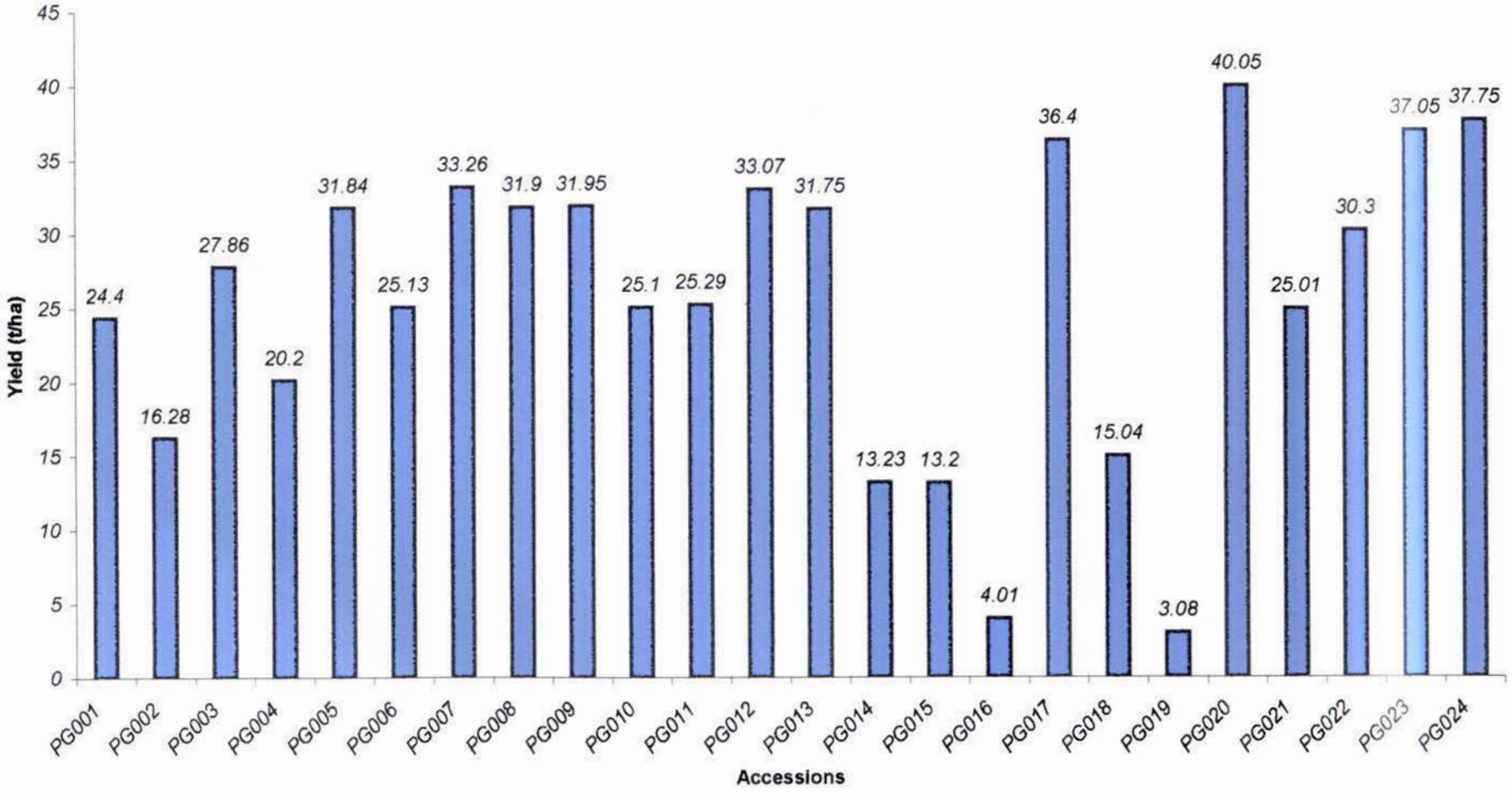


Fig.3 Fruit yield (t/ha) of 24 accessions of pointed gourd.

4.1. B.9 Number of seeds per fruit

Significant variation was observed among 24 pointed gourd accessions in number of seeds per fruit and ranged from 13.97 to 32.33 with the mean value of 24 (Table 5). The maximum number of seed (32.33) was found in PG012 that was statistically different from other accessions whereas, the minimum number of seeds per fruit (13.97) was found in PG015. Singh *et al.* (1985a) and Prasad and Singh (1990a) also observed significant variation among the genotypes of pointed gourd for number of seeds per fruit.

Very few differences between genotypic (24.15) and phenotypic (26.37) variance along with genotypic (101.40%) and phenotypic (110.72%) coefficient of variation indicating considerable environmental effect upon the expression of the character of Number of seeds per fruit (Table 6).

4.1. B.10 Seed weight per fruit

Seed weight per fruit varied significantly among the accessions and ranged from 1.60 g to 4.66 g with the mean value of 3.054 g (Table 5). The maximum weight of seeds was recorded from PG020 (4.66 g), which was statistically similar to PG007 (4.26 g) and PG012 (4.04 g). Whereas, the minimum weight of seeds (1.60 g) was recorded from PG016.

Slight differences between genotypic (0.50) and phenotypic (0.55) variance as well as genotypic (16.37%) and phenotypic (18.01%) coefficient of variation were observed and indicating slightly genetical, physiological, nutritional or environmental effect upon the expression of the character of Seed weight per fruit (Table 6).

Table 5. Fruits and Seeds characteristics of different accessions of pointed gourd (*Trichosanthes dioica* Roxb.)

Treatment	Fruit length (cm)	Fruit breadth (cm)	Single fruit weight (g)	Pulp weight / fruit (g)	Pulp seed ratio	Number of seeds per fruit	Seed wt. per fruit (g)
PG001	10.33	3.29	52.00	49.34	16.03	24.00	2.98
PG002	11.94	3.51	31.33	29.79	13.77	18.37	2.16
PG003	8.06	4.02	26.00	22.60	7.76	22.33	3.09
PG004	11.12	3.36	41.83	39.35	13.30	21.33	2.95
PG005	10.47	3.41	43.00	39.90	12.90	26.17	3.10
PG006	9.90	3.58	45.53	41.37	12.40	22.33	3.43
PG007	10.35	3.36	45.02	40.76	9.60	31.63	4.26
PG008	10.46	3.45	43.50	40.16	12.40	31.67	3.23
PG009	10.50	3.45	45.30	41.60	12.20	29.33	3.40
PG010	9.91	3.58	44.97	41.63	12.26	23.33	3.38
PG011	9.90	3.58	44.33	40.60	12.16	21.00	3.34
PG012	10.34	3.36	44.33	39.96	9.80	32.33	4.04
PG013	10.48	3.45	43.97	40.60	12.79	27.33	3.20
PG014	10.33	3.82	35.97	33.71	14.52	20.01	2.65
PG015	9.05	3.26	36.30	33.52	14.07	13.97	2.50
PG016	9.40	3.45	24.33	24.00	14.00	26.33	1.60
PG017	9.25	3.56	54.00	51.47	20.37	18.00	2.56
PG018	9.06	3.61	44.00	50.40	17.50	19.33	2.10
PG019	10.06	3.28	28.33	26.00	12.99	25.00	1.99
PG020	11.20	4.20	56.33	51.44	11.02	30.33	4.66
PG021	10.22	4.12	48.00	45.10	12.01	23.33	3.70
PG022	11.75	3.66	55.93	52.83	16.46	26.87	3.17
PG023	9.67	4.64	44.33	41.00	13.70	19.37	2.66
PG024	9.65	3.63	44.27	41.19	13.72	17.87	3.12
LSD(0.05)	0.090	0.574	1.095	0.921	0.632	2.450	0.375
CV (%)	0.53	9.27	1.56	1.40	2.91	6.26	7.47

Table 6. Genotypic variance, phenotypic variance, genotypic coefficient of variation, phenotypic coefficient of variation, range and mean of yield and yield contributing characters of 24 pointed gourd accessions

Genetic components	Fruit length (cm)	Fruit breadth (cm)	Single fruit weight	Pulp wt. per fruit (gm)	Pulp seed ratio	Number of fruits per plant	Weight of fruit per plant	Yield of fruit ton per hectare	Number of seeds per fruit	Seed wt. per fruit
Genotypic variance	0.75	0.89	73.41	64.79	6.782	13141.76	13.23	104.82	24.15	0.50
Phenotypic variance	0.753	1.012	73.84	79.15	6.931	13646.80	13.31	104.99	26.37	0.55
Genotypic coefficient of variation(%)	7.4	23.56	172.27	162.25	51.23	5415.55	161.87	410.30	101.40	16.37
Phenotypic coefficient of variation (%)	7.42	26.79	173.28	198.21	52.35	5623.67	162.85	410.98	110.72	18.01
Range	8.06-11.94	3.26-4.64	24.33-56.33	22.60-52.83	7.76-20.37	41.33-405.7	1.03-13.56	3.08-40.05	13.97-32.33	1.60-4.66
Mean ± SE	10.14±0.045	3.78±0.285	42.61±0.537	39.93±3.09	13.24±0.32	242.67±8.35	8.17±0.22	25.55±0.34	23.82±1.22	3.054±0.19

PG001

PG002

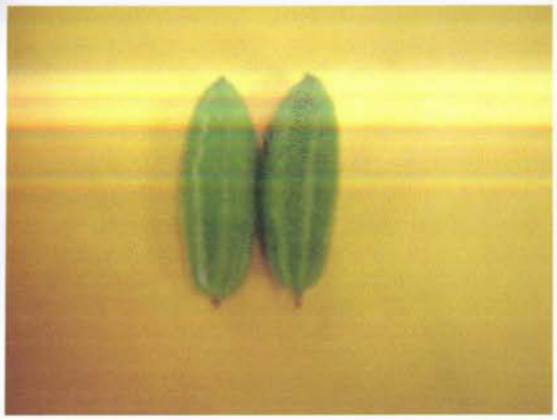
PG003

PG004

PG005

PG006

Plate 5. Photographs showing the variability of fruits of the pointed gourd accessions (PG001-PG006)

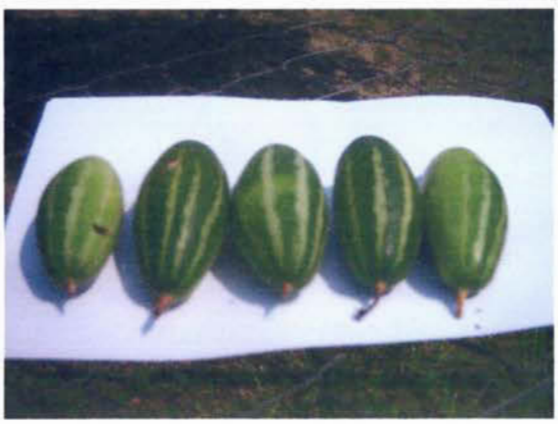


PG007

PG008

PG009

PG010



PG011

PG012

Plate 6. Photographs showing the variability of fruits of the pointed gourd accessions (PG007-PG012)

PG013

PG014

PG015

PG016

PG017

PG018

Plate 7. Photographs showing the variability of fruits of the pointed gourd accessions (PG013-PG018)

PG019

PG020

PG021

PG022

PG023

PG024

Plate 8. Photographs showing the variability of fruits of the pointed gourd accessions (PG019-PG024)

4.2 CORRELATION COEFFICIENT:

Estimation of simple correlation coefficient was made among eight important yield contributing characters with yield of the 24 pointed gourd accessions. The value of 'r' and the characters correlated are presented in (Table 7).

4.2.1 Number of node at first harvest

Correlation coefficient revealed that number of node at first harvest had negative significant correlation with fruit breadth -0.457* (Table 7). Correlation coefficient revealed that number of node at first harvest had positive association with single fruit weight, pulp seed ratio, number of fruits per plant and yield of fruits ton per hectare. On the other hand number of node at first harvest had negative correlation with fruit length and weight of fruits per plant. Similar findings were noticed by Sarkar *et al.* (1989).

4.2.2 Days required to first flowering

It is observed that days to first flowering had positive association with fruit breadth, number of fruits per plant, weight of fruit per plant and yield. .On the other hand days to first flower had negative correlation with number of node at first harvest, single fruit weight, pulp seed ratio and fruit length (Table 7). Singh *et al.* (1986) reported similar result in water melon.

4.2.3 Single fruit weight

Correlation coefficient revealed that single fruit weight had positive significant correlation with number of fruits per plant (r = 0.502*), weight of fruit per plant (r = 504*) and yield of fruit ton per hectare (r = 0.697**). On the other hand single fruit weight had positive correlation with pulp seed ratio (Table 7).

4.2.4 Fruit breadth

Correlation coefficient revealed that fruit breadth had negative significant correlation with pulp seed ratio (-0.404*) (Table 7). On the other hand fruit breadth had negative correlation with single fruit weight, number of fruits per plant and positive correlation with weight of fruit per plant and yield of fruit ton per hectare.

4.2.5 Pulp seed ratio

Correlation coefficient revealed that pulp seed ratio had negative correlation with weight of fruit per plant and yield of fruit ton per hectare (Table 7). On the other hand pulp seed ratio had positive correlation with number of fruits per plant (Table 7).

4.2.6 Fruit length

Correlation coefficient revealed that fruit length had negative significant correlation with fruit breadth (-0.457*) (Table 7). Fruit length had positive correlation with single Fruit weight, pulp seed ratio, number of fruits per plant and yield of fruit ton per hectare. On the other hand, negative correlation with weight of fruit per plant. Saha *et al.* (1992) reported similar results in respect of fruit length in pumpkin.

4.2.7 Number of fruits per plant

Number of fruits per plant had positive significant correlation with weight of fruits per plant (0.915**) and yield of fruit ton per hectare (0.813**) which indicates that weight of fruits per plant will be increased with the increase of fruit number (Table 7). Similar findings were noticed by Singh *et al.* (1986).

4.2.8 Weight of fruits per plant

Weight of fruits per plant had positive significant correlation with yield of fruit ton per hectare (0.890**) which indicates that yield per plant will be increased with the increase of fruit number (Table 7). Similar findings were noticed by Singh *et al.* (1986).

As evident from correlation studies the fruit length and single fruit weight, pulp seed ratio, number of fruits per plant and weight of fruits per plant were important for pointed gourd yield, which showed moderate and positive relationship with yield, selection could be effective for breeding about the improvement of pointed gourd. Similar result was also observed by Khan (2005).

Table 7. Correlation coefficient between yield and yield contributing characters of 24 pointed gourd accessions

Character	Days to first flower	Number of node at first harvest	Fruit length (cm)	Fruit breadth (cm)	Single fruit weight	Pulp seed ratio	Number of fruits per plant	Weight of fruit per plant	Yield of fruit ton per hectare
Days to first flower		-0.288	-0.172	0.080	-0.271	-0.127	0.166	0.131	0.057
Number of node at first harvest			-0.061	-0.457*	0.349	0.027	0.024	-0.052	0.157
Fruit length (cm)				-0.457*	0.349	0.027	0.024	-0.052	0.132
Fruit breadth (cm)					-0.284	-0.404*	-0.107	0.160	0.157
Single fruit weight						0.301	0.502*	0.504*	0.697**
Pulp seed ratio							0.221	-0.274	-0.161
Number of fruits per plant								0.915**	0.813**
Weight of fruit per plant									0.890**

*indicate 5% level of significant (using mean values)

** indicate 1% level of significant (using mean values)

df = N- 2 = 24-2 = 22 (.05 = 0.404, .01 = 0.515)

4.3 PATH COEFFICIENT ANALYSIS:

Association of characteristics determined by correlation may not provide an exact picture of the relative significance of direct and indirect influence of each of the yield components towards yield. In true sense, in order to find a clear picture of the interrelationships among the fruit yield and yield contributing characteristics, direct and indirect effects were worked out using path analysis. This analysis at both the genotypic and phenotypic levels was done with the help of genotypic and phenotypic correlation coefficients, respectively. Genotypic path analysis is explained in the following headings (Table 8).

4.3.1 Days required to first flowering

Days to first flowering showed highly negative direct effect (-0.0803) on yield per plant. It also showed negative indirect effect on yield per plant through fruit length, single fruit weight, pulp seed ratio and weight of fruits per plant. On the other hand, it showed positive indirect effect on yield via number of node at first harvest, fruit breadth and number of fruits per plant (Table 8).

4.3.2 Number of node at first harvest

Number of node at first harvest showed highly negative direct effect (-0.1909) on yield per plant. It also showed negative indirect effect on yield per plant through fruit length, single fruit weight and pulp seed ratio. On the other hand, it showed positive indirect effect on yield via days to first flower, fruit breadth, number of fruits per plant and weight of fruits per plant (Table 8).

4.3.3 Fruit length

From the results of path analysis, it revealed that fruit length had positive direct effect (0.4321) on yield per plant (Table 8). It showed negative indirect effect on yield through fruit breadth and weight of fruit per plant. Oppositely, it showed positive indirect effect on yield per plant through days to first flower, number of node at first harvest, single fruit weight, pulp seed ratio and number of fruits per plant.

4.3.4 Fruit breadth

From the results of path analysis, it revealed that fruit breadth had positive direct effect (1.3495) on yield per plant (Table 8). It showed negative indirect effect on yield through days to first flower, number of node at first harvest, fruit length, single fruit weight, pulp seed ratio, number of fruits per plant and weight of fruit per plant. This is may be due to environmental effect.

4.3.5 Single fruit weight

It is revealed that single fruit weight had considerable direct and positive effect (0.4848) on fruit yields per plant (Table 8). Mishra and Mishra (1990) reported single fruit weight was one of the most important characters contributing towards fruit yield in brinjal. Vikram and Kohli (1980) studied path coefficients in brinjal and reported that single fruit weight was one of the most important yield contributing characters. This information and the result of the present experiment also suggest that selection for single fruit weight would in increasing fruit yield of this crop. It showed negative indirect effect on yield through number of node at first harvest, fruit breadth and number of fruits per plant. Oppositely, it showed positive indirect effect on yield per plant through days to first flower, fruit length, pulp seed ratio and weight of fruit per plant.

4.3.6 Pulp seed ratio

From the results of path analysis, it revealed that pulp seed ratio had positive direct effect (0.3283) on yield per plant (Table 8). It showed negative indirect effect on yield through fruit breadth, number of fruits per plant and weight of fruit per plant. Oppositely, it showed positive indirect effect on yield through days to first flower, number of node at first harvest, fruit length and single fruit weight.

4.3.7 Number of fruits per plant

Number of fruits per plant had positive direct effect (0.5683) on yield per plant. It also showed negative indirect effect on yield through days to first flower, number of node at first harvest, fruit breadth, pulp seed ratio and weight of fruit per plant. On the contrary, it showed positive indirect effect on yield through fruit length and single fruit weight. Vijay (1987) also found similar result in muskmelon (Table 8).

4.3.8 Weight of fruits per plant

Weight of fruits per plant exhibited positive direct effect (0.9351) on the yield per plant. It showed negative indirect effect on yield via days to first flower, number of node at first harvest, fruit length, single fruit weight, pulp seed ratio and number of fruits per plant. On the counter part, it showed positive indirect effect on yield via fruit breadth (Table 8).

Table 8. Path analysis showing direct and indirect effects of yield components towards yield in pointed gourd

Character	Days to first flower	No. of node at first harvest	Fruit length (cm)	Fruit breadth (cm)	Single fruit weight	Pulp seed ratio	Number of fruits per plant	Weight of fruit per plant	Yield of fruit ton per hectare
Days to first flower	**-0.0803**	0.0668	-0.0766	0.1330	-0.1366	-0.0461	0.4336	-0.2329	0.0608
Number of node at first harvest	0.0281	**-0.1909**	-0.0307	0.3070	-0.2139	-0.0695	0.2381	0.0708	0.5668
Fruit length (cm)	0.0142	0.0135	**0.4321**	-0.6595	0.1703	0.0088	0.0620	-0.0782	0.0138
Fruit breadth (cm)	-0.0079	-0.0434	-0.2111	**1.3495**	-0.1464	-0.1435	-0.3383	-0.0086	0.4500
Single fruit weight	0.0226	-0.0842	0.1518	-0.4075	**0.4848**	0.0995	-0.3201	0.0840	0.6713
Pulp seed ratio	0.0112	0.0404	0.0116	-0.5900	0.1470	**0.3283**	-0.6009	-0.1414	0.7935
Number of fruits per plant	-0.0135	-0.0920	0.0104	-0.1777	0.2492	-0.0768	**0.5683**	-0.2610	0.2067
Weight of fruit per plant	-0.0106	-0.1016	-0.0225	0.2237	-0.2456	-0.0916	-0.4018	**0.9351**	0.5798

4.4 GENETIC DIVERGENCE STUDIES

4.4.1 Principal Component Analysis

The Principle Component analysis Yielded Eigen values of each Principal component axes of ordination of accessions with the first axes totally accounting for the variation among the accessions, while three of these with Eigen values above unity accounted for 99.67 %. The first two principal axes accounted for 99.39 % of the total variation among the 9 characters describing 24 accessions (Table 9).

Table 9 Latent roots (Eigen values) and percent of variation in respect of nine characters in pointed gourd

Principal component axis	Eigen values	% of total variation accounted for	Cumulative per cent
1	28.65	98.73	98.73
11	3.63	0.66	99.39
111	0.80	0.28	99.67
1V	0.42	0.20	99.87
V	0.978	0.09	99.96
V1	0.817	0.03	99.99
V11	0.689	0.01	100
V111	0.566	0.00	0.00
1X	0.269	0.00	0.00

4.4.2 Construction of scatter diagram

On the basis of principal axes I and II from the principal component analysis, a two dimensional scatter diagram (Z1-Z2) using component score 1 as X- axis component score 2 as Y- axis was constructed, which is presented in Figure 4. The distribution of accessions in scattered diagram was apparently distributed into five groups, which revealed that there exists considerable diversity among the accessions.

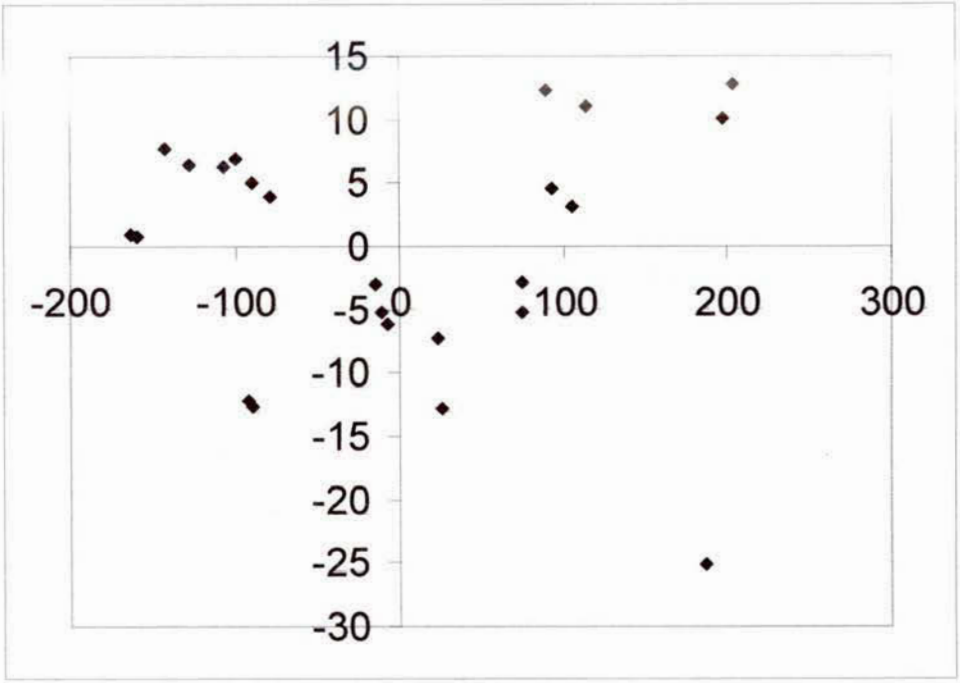


Fig. 4 Scattered diagrams of 24 pointed gourd accessions based on their principal Component scores

4.4.3 Principal co-ordinate analysis

Inter genotypic distances was obtained by Principal co-ordinate analysis for selective 10 combination (Table 10). Showed that the highest distance (366.9) was observed between the accession number 19 and 7 and the lowest distance was observed between 12 and 7 (4.2). By using these inter genotypic distances intra- cluster genotypic distances were calculated (Table 13) as suggested by Sing and Chowdhury (1985). The highest intra cluster distance was computed for cluster IV (35.80) composed of six accessions followed by cluster I (28.12) and cluster V (26.63). The minimum intra cluster distance was found in cluster III (18.37).

Table. 10 Ten of each lower and higher inter- accessions distances between pairs of accessions

10 lower D^2 values	Accessions Combination	10 higher D^2 values	Accessions Combination
4.2	12 x 7	366.9	19 x 7
4.7	10 x 6	363.4	19 x 12
5.0	9x6	360.1	16 x 7
7.6	21 x 1	350.8	22 x 7
7.8	8x5	347.4	22 x 12
8.9	18 x 4	346.0	24 x 19
9.5	11 x 10	339.9	24 x 16
9.6	13 x 5	330.5	24 x 22
13.1	20 x 17	324.2	23 x 16
17.0	13 X 8	303.9	16 x 8

4.4.4 Clustering of accessions

None hierarchical clustering using co-variance matrix grouped 24 pointed gourd accessions into five different clusters (Table 11). These results are in confirmatory with the clustering pattern of the genotypes obtained through principal component analysis. Ram (2001) carried out principal component analysis and cluster analysis in 167 pointed gourd accessions and stated that 167 accessions were divided into 8 groups. In this study Clusters I and III contained the highest number of accessions (6) followed by cluster V (5) and cluster II (4) respectively. The lowest accessions (3) were found in the clusters IV. The clustering pattern of the accessions under this study revealed that the accessions collected from the same location were grouped into different clusters. The accessions collected from were distributed in different clusters. Masud *et al.* (1995) reported similar results in sweet gourd, Mannan *et al.* (1993) in pani kachu, Singh and Singh (1979) in okra and Khan *et al.* (2006) in pointed gourd.

Table 11. Distribution of 24 pointed gourd accessions in 5 clusters

Cluster no.	Total no. of accessions in cluster	Accessions included in different clusters	Origin
I	6	PG002,PG003 and PG004	Rangpur, Natore
		PG014,PG015 and PG018	Kushtia, Rangpur
II	4	PG007 and PG012	Kushtia
		PG023 and PG024	Pabna
III	6	PG005,PG008 and PG009	Kushtia
		PG013,PG017 and PG020	Kushtia, Rangpur,Natore
IV	3	PG016,PG019 and PG022	Bogra,Rangpur
V	5	PG001,PG006 and PG010	Rangpur,Pabna
		PG021 and PG011	Rangpur,Pabna

The cluster means of different characters of 24 accessions of pointed gourd are presented in Table 12. Cluster I was composed of six accessions. None of the 9 characters had the highest mean value but lowest fruit length (9.93) was found in cluster I. Cluster II comprising four accessions, the mean values of cluster II ranked first for number of fruits per plant (391), weight of fruit per plant (11.72) and yield (35.28). Prasad *et al.* (1993) also reported similar findings in cucumber. Cluster II comprising six accessions had the highest cluster mean value for days to first flowering (89.0) and fruit weight (47.69). Cluster IV was composed of three accessions and had the highest mean value was found in fruit length (10.40cm) and pulp seed ratio (14.48). Lowest number of fruits per plant (48) was found in IV. Cluster V was composed of 5 accessions and had the highest cluster mean value for node order at first flower (96.86days) and fruit weight (46.97). Accessions of the cluster V had late maturity.

Table 12. Cluster mean values for yield and yield contributing characters of pointed gourd

Characters	I	II	III	IV	V
Days to 1st flowering	88.45	87.50	89.00	82.33	81.53
Number of node at first harvest	33.11	35.58	35.22	25.33	39.40
Fruit length (cm)	9.93	10.00	10.33	10.40	10.05
Fruit breadth (cm)	4.27	3.75	3.59	3.46	3.63
Single fruit weight (g)	35.91	44.50	47.69	36.09	46.97
Pulp seed ratio	13.49	11.70	13.61	14.48	12.97
Number of fruits per plant	152	391	335	48	240
Weight of fruit per plant(kg)	5.88	11.72	11.34	1.45	8.32
Yield(t/ha)	17.64	35.28	33.98	12.46	24.99

4.4.5 Canonical vector analysis (CVA)

Canonical vector analysis was performed to obtain the cluster distance (Mahalanobis D^2 value). The values of intercluster distance (D^2) are presented in Table 13. Statistical distances represent the index of genetic diversity among the clusters. The intercluster distances were larger than the intracluster distances suggesting wider genetic diversity among the genotypes of different groups (Table 11). Uddin and Mitra (1994) and Khan (2005) obtained higher intercluster distances than the intracluster distances in multivarivariate analysis in sesame and pointed gourd.

Based on the nine quantitative characters of pointed gourd accessions, PCO was carried out to determine interaccession distance (D^2). The intracluster distance, obtained by using the values of inter accessions distance under each cluster as suggested by Singh and Chaudhuary (1985), and intracluster distance was obtained from CVA are presented in Table 13.

The intra cluster distance was computed by using the values of inter accession distance from distance matrix according to Singh and Chaudhuary, (1985). The highest intra cluster distance was computed for cluster IV (35.80) composed of six

accessions followed by cluster I (28.12) and cluster V (26.63). The minimum intra cluster distance was found in cluster III (18.87). The clusters IV and II were more diverse as indicated by maxi mum intercluster distances between them (41.56) followed by the distance among clusters IV and III (36.35), II and I (27.41), V and IV (24.15), III and I (21.44), V and II (19.44), IV and I (16.15) and between V and III (13.25). The maximum values of intercluster distance indicated that the accessions belonging to cluster IV were far away from those of cluster II. The minimum inter cluster divergence was observed between cluster III and II (6.84) indicating that the genotype of these cluster were genetically closed. Similar results were also found by Khan *et al.* (2000) in pointed gourd between clusters V and X. Higher inter and intra-cluster distance indicates higher genetic variability among accessions between and within clusters, respectively. The minimum inter and intra-cluster distance indicates closeness among the accessions of two clusters and within the cluster also. These relationships were also reflected in the scatter diagram (Fig. 4).

Table 13. Average inter and intra-cluster distance (D2) for 24 pointed gourd accessions

Cluster	I	II	III	IV	V
I	**28.12**	27.41	21.44	16.15	8.72
II		**23.53**	6.84	41.56	19.44
III			**18.87**	36.35	13.25
IV				**35.80**	24.15
V					**26.63**

4.4.6 Contribution of different characters towards divergence

The characters contributed the maximum to the divergence are given greater emphasis for deciding on the cluster for the purpose of further selection and the choice of patterns for hybridization (Jagadev *et al.*, 1991). The results of CVA revealed that in vector I (Z1), the important characters responsible for genetic divergence in the major axis of differentiation were days to first flowering, fruit length and pulp seed ratio

(Table 14). In vector II (Z2), days to first flowering, number of node at first harvest, fruit breadth, number of fruit per plant, weight of fruit per plant and yield played a major role in the second axis of differentiation. The role of days to first flowering in both the vectors indicated the important component of genetic divergence among the 24 pointed gourd accessions. Negative values in both the vectors for fruit weight indicated that the lowest contribution to the total divergence. Hence, considerable emphasis should be given on these characters to increase fruit yield in pointed gourd. Mathew *et al.* (1986) reported that fruit weight per plant was the major contributor towards divergence in *Cucumis melo*. Masud *et al.* (1995) found that fruits weight was one of the important contributors to genetic divergence in sweet gourd. Khan (2005) observed that fruit weight, number of fruits per plant and weight of fruits per plant were the higher contributors to the divergence in pointed gourd. Based on D^2 analysis, Anitha and Dorairaj (1990) grouped 8 parents and 56 hybrids into 15 clusters and concluded that the days to flower was the important contributors to the genetic divergence.

Table 14. Relative contribution of different characters towards divergence

Characters	Vector I	Vector II
Days to 1st flowering	0.0136	0.2937
Number of node at first harvest	-0.3567	0.0609
Fruit length (cm)	0.351	-0.4584
Fruit breadth (cm)	-0.0364	0.5612
Single fruit weight	-0.399	-0.4062
Pulp seed ratio	0.1145	-0.4484
Number of fruits per plant	-0.4742	0.0267
Weight of fruits per plant	-0.4925	0.1344
Yield of ton per hectare	-0.5010	0.01224

4.4.7 Selection of accessions for future improvement

The crosses involving parents belonging to the maximum divergent clusters were expected to manifest maximum heterosis and also wide variability in genetic architecture. Medium D^2 values exhibited significant and positive heterosis. Similar findings were also observed by Masud *et al.* (1995) in sweet gourd and Khan (1995) in pointed gourd. Considering the magnitude of genetic distance, contribution of different characters towards the total divergence and magnitude of cluster means for different characters performance, the following genotypes were considered to perform better if used in hybridization program. The accessions PG001, PG006, PG0010, PG0011 and PG0021 of cluster V could be selected for earliness. The accessions PG007, PG012, PG023 and PG024 of the cluster II could be selected for number of fruits per plant, higher fruit weight per plant and yield. The accessions PG016, PG019 and PG022 of the cluster IV could be selected for fruit length.

Chapter V

SUMMARY AND CONCLUSION

The present experiment was undertaken with a view to study the variability, correlation, path analysis, and genetic divergence of 24 pointed gourd accessions. The experiment was conducted at the Horticulture Division of Regional Agricultural Research Station (RARS) Bangladesh Agricultural Research Institute (BARI) Ishurdi, Pabna during the period from November 2005 to November 2006. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on yield contributing characters and yield of fruit were recorded. The statistical analysis of variance indicated the existence of wide variability for different characters.

In case of variability study, the range of variation was observed high in case of Number of fruits per plant(41.33-405.7), yield of fruit (3.08-40.05 t/ha), days to first flowering(77-97), pulp seed ratio(7.76-20.37), weight of fruit per plant(1.03 -13.56 kg), number of node at first harvest(19-45), fruit length(8.06-11.94 cm), fruit breadth (3.26-4.64cm), single fruit weight(24.33-56.33g), inter node length at first harvest(6.15-17.39cm), vine length at first harvest(0.95-4.70m), date at first harvest(93-115day),seed weight of per fruit(1.60-4.66kg), pulp weight of per fruit(22.60-52.83g), number of seeds per fruit(14-32) suggesting to give priority on these characters for selection. In all the characters it was found that phenotypic coefficient of variation was higher than genotypic coefficient of variation. The highest genotypic and phenotypic coefficient of variation was observed in number of fruits/plant and yield/plant.

In case of days to first flowering, PG001 took the lowest day (77 days) to first flowering and the highest day to first flowering (97 days) was taken by PG014 and PG015. Days to first flowering was positive association with fruit breadth, number of fruits per plant, weight of fruit per plant and yield of fruit (t/ha) .On the other hand days to first flower had negative correlation with number of node at first harvest, single fruit weight, pulp seed ratio and fruit length.

The maximum number of node at first harvest was recorded (45) in the plant of accession PG010 and the minimum (19) was recorded in PG019. Number of node at first harvest was positively correlated with single fruit weight, pulp seed ratio, number of fruits per plant and yield of fruit (t/ha).

The plant of accession PG013 had maximum length of inter node (17.38cm) at first harvest and minimum length of inter node was found in the plant of accession (6.15cm). In respect of vine length at first harvest, accession PG010 was tallest (4.70m) and accession PG019 was smallest (0.95m).

The accession of the plant PG001 and PG020 required the minimum days to first harvest (93 day) while PG0015 took the maximum days to first harvest (115 day).

In respect of single fruit weight, the highest weight was observed in the accession PG020 (56.33g) and lowest weight was found in PG016 (24.33g). Single fruit weight was significantly and positively correlated with pulp seed ratio, number of fruits per plant, weight of fruit per plant and yield of fruit.

In respect of pulp weight per fruit accession PG022 gave highest pulp weight (52.83g) and accession PG003 was lowest pulp weight (22.60g). In respect of pulp; seed ratio, accession PG017 was highest (20.37) which was statistically similar with PG018, PG022, PG001 but PG003 had the lowest pulp seed ratio (7.76). Pulp seed ratio was negatively correlated number of fruits per plant, weight of fruit per plant and yield of fruit.

In case of fruit length, longest fruit was recorded in PG002 (11.94cm). On the other hand PG003 had the shortest fruit length (8.06cm). Fruit length was negatively correlated with fruit breadth. The maximum (4.46cm) and minimum (3.26cm) fruit breadth was recorded in PG023 and PG015 respectively. Fruit breadth was significantly negatively correlated with pulp seed ratio.

In respect of number of fruits per plant, it was observed that PG019 had the lowest (41) number and PG007 had the highest (406) number of fruits per plant and was significant positively correlated with weight of fruit per plant and yield of fruit. In case of weight of fruit per plant, it was found that PG019 had the lowest (1.03kg)

weight of fruit per plant and the highest weight of fruit (13.56 kg) in PG020. Weight of fruits per plant was significantly positively correlated with yield of fruit.

It was observed that plat of accession PG012 produced the highest number of seeds per fruit (32) and the lowest (14) number of seed was found in PG015. In respect of weight of seed per fruit, accession PG020 was highest in weight (4.66g) and accession PG016 was lowest in weight (1.60g).

From path coefficient analysis it was observed that number of fruits per plant had maximum direct and positive effects on yield of fruit. The correlation of number of fruits per plant, fruit weight per plant was also found high and such high correlation was fruit yield was mainly due to the high positive direct effect on number of fruits per plant and considerable indirect effect via single fruit weight. Single fruit weight also highly positive and direct effect on yield per plant. This character contributes indirectly to yield per plant via days to first flower, number of node at first harvest, fruit length, pulp seed ratio and weight of fruit per plant.

As per D^2 and cluster analysis, the 9 morphological characters, 24 accessions of pointed gourd were grouped into five different clusters. The clusters I and III contained the highest number of accessions (6) followed by cluster V (5), cluster II (4) and cluster IV having 3 accessions, respectively. The clustering pattern of the accessions revealed that the accessions collected from the same location were grouped into different clusters.

The inter-cluster distance was maximum between clusters IV and II (41.56) followed by the distance between V and II (27.41), IV and III (41.56), V and IV (41.56), III and II (27.41). The minimum inter-cluster divergence was observed between cluster III and II (6.84) indicating genetically similar background of the genotypes of these clusters. The highest intra cluster distance was computed for cluster IV (35.80) composed of three accessions followed by cluster I (28.12), cluster V (26.63), cluster II (23.53) and cluster III (18.87). The minimum intra-cluster distance was found in cluster III (18.87). Cluster I indicate the importance of fruit breadth (4.27cm) and cluster II indicate the importance of fruit yield (35.28 ton /ha), number of fruits per plant (391) and fruit weight per plant (11.72). Cluster III showed the importance of days to first flowering (89.0) and single fruit weight (47.69g). The characters, fruit

length (10.40cm) and pulp seed ratio (14.48) were found to be important as indicated in cluster IV. Cluster V indicate the importance of number of node at first harvest (39.40). Geographic diversity was not associated with genetic diversity.

The result of the present experiment revealed that a wide variability existed among the collected pointed gourd accessions. Also there was correlation of different yield contributing characters with the yield of pointed gourd. Cluster analysis revealed that there is no relation between geographic distributions with genetic diversity. From the results of the experiment the following conclusion can be made

(i) Wide variability existed among the pointed gourd accessions used in this experiment. That variability's could be used for future breeding programme to develop a high yielding pointed gourd variety in our country.

(ii) To develop a high yielding variety of pointed gourd selection should be done on the basis of desired characters such as single fruit weight, number of fruits per plant and weight of fruits per plant etc.

Chapter VI

RECOMMENDATIONS

The following recommendations can be inferred from the present study-

(i) Collection of pointed gourd germplasm should be continued for getting more variability and desired traits.

(ii) Molecular techniques such as RAPD, RFLP should be used for proper identification of the germplasm at molecular level.

Chapter VII

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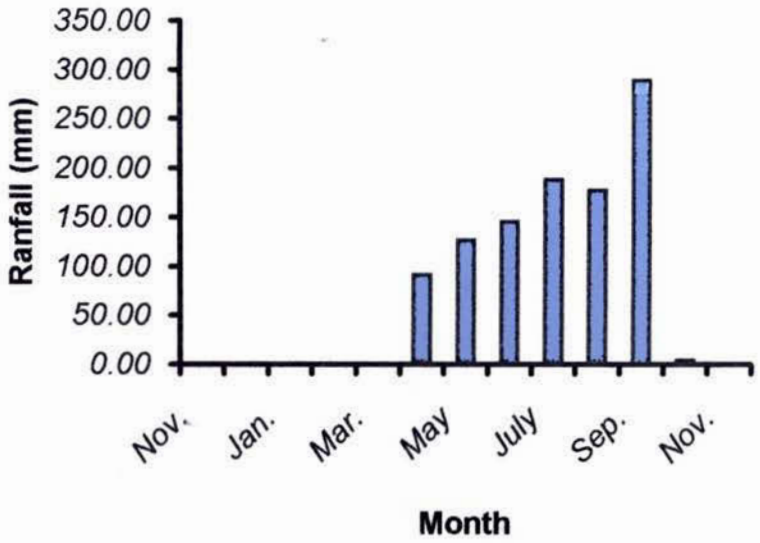
Chapter VIII

APPENDICES

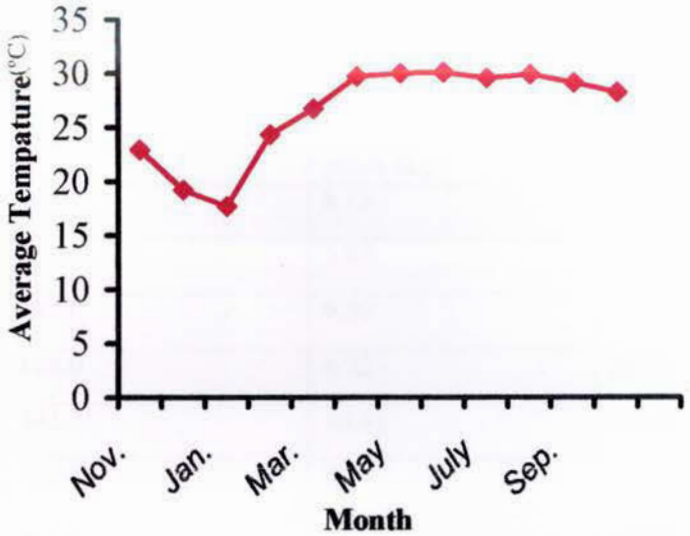
Appendix 1. Physical and chemical properties of soils at RARS, Ishurdi, Pabna

Land category	Textural class	pH	OC* (%)	Total N (%)	P (ppm)	K (me / 100 g)	S (ppm)	Zn (ppm)
High	Silt loam	8.5	0.58	0.06	12.20	0.25	25	0.70

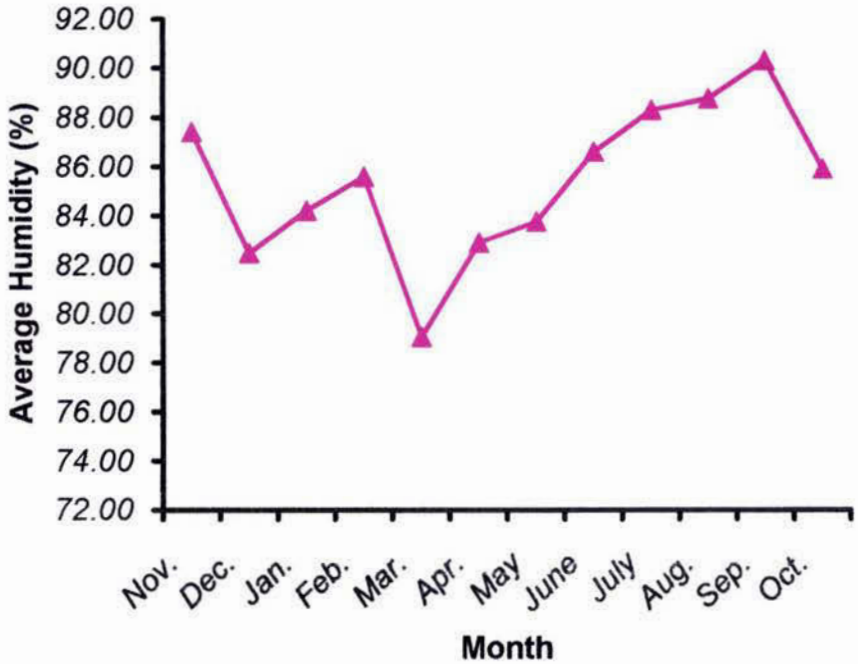
*Organic carbon



Appendix 2. Annual rainfall of the area during field research, 2005-2006



Appendix 3. Annual temperature of the area during field research, 2005-2006



Appendix 4. Average humidity (%) of the area during field research, 2005-2006

Appendix 5. Fruits and Seeds characteristics of different accessions of pointed gourd (*Trichosanthes dioica* Roxb.)

Treatment	Number of fruits per plant	Weight of fruits per plant (kg)	Yield of fruit (ton / ha.)
PG001	216.7	8.12	24.40
PG002	151.0	5.43	16.28
PG003	137.0	9.29	27.86
PG004	168.0	6.72	20.20
PG005	341.7	10.61	31.84
PG006	254.0	8.41	25.13
PG007	405.7	11.09	33.26
PG008	349.3	10.67	31.90
PG009	321.0	10.72	31.95
PG010	250.0	8.37	25.10
PG011	258.0	8.51	25.29
PG012	402.3	10.98	33.07
PG013	332.3	10.48	31.75
PG014	130.0	4.32	13.23
PG015	155.0	4.54	13.20
PG016	48.00	1.32	4.01
PG017	333.7	12.01	36.40
PG018	168.3	5.01	15.04
PG019	41.33	1.03	3.08
PG020	331.7	13.56	40.05
PG021	219.3	8.17	25.01
PG022	55.33	2.01	30.30
PG023	369.3	12.17	37.05
PG024	385.0	12.62	37.75
LSD 0.05	36.93	0.450	0.686
CV (%)	9.26	3.36	1.63

Appendix 6. Analysis of variance of data on yield and yield contributing characters of pointed gourd

Source of variation	Degree of freedom	Mean sum of square				
		Days required to first flowering	Number of node at first harvest	Inter node length at first harvest	Vine length at first harvest	Days to first harvest
Replication	2	3.014	6.722	12.189	0.011	1.167
Treatment	23	131.179	124.019	17.750	1.579	157.168
Error	46	2.202	7.679	12.509	0.044	2.775

Appendix 7. Analysis of variance of data on yield and yield contributing characters of pointed gourd

Source of variation	Degree of freedom	Mean sum of square									
		Fruit length (cm)	Fruit breadth (cm)	Single fruit weight	Pulp wt. per fruit (gm)	Pulp seed ratio	Number of fruits per plant	Weight of fruit per plant	Yield of fruit (ton / ha.	Number of seeds per fruit	Seed wt. per fruit
Replication	2	0.001	0.139	1.167	0.453	0.296	130.542	0.007	0.036	6.234	0.040
Treatment	23	2.243	2.791	220.670	208.723	20.495	39930.319	39.775	314.634	74.669	1.537
Error	46	0.003	0.122	0.432	14.360	0.149	505.034	0.075	0.174	2.222	0.052