GENE ACTION AND HETEROSIS IN POINTED GOURD (*Trichosanthes dioica* Roxb.)

BY

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CERTIFICATE

*This is to certify that the thesis entitled, "**Gene action and heterosis in 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 in GENETICS AND PLANT BREEDING**, embodies the result of a piece of bona fide research work carried out by Md. Anwar Sadat, Registration No. 00372 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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(*Trichosanthes dioica* Roxb.)

ABSTRACT

An experiment was conducted with 17 F_1 hybrids of pointed gourd obtained by crossing a male parent to 17 female parents at the experimental farm of Regional Agricultural Research Station, Ishurdi of Bangladesh Agricultural Research Institute. Significant differences were observed among the parents and hybrids for most of the 34 characters studied except fruit width. A top cross analysis was performed to evaluate the F_1s. The average performances of the top crosses were lower than that of the parents for length of internode at first harvest, days to first flowering, fruit development period and harvest interval. Different parents showed superiority in respect of different characters. The parent PG009 was superior female parent giving higher fruit yield per harvest (g). The parent PG006 had the highest breeding value in respect of yield per harvest (g) followed by PG009. PG006 was also the best parent for number of fruits per plant, number of fruits per harvest, harvest length and pulp: seed ratio. Both positive and negative heterosis was found for different characters in different hybrids. Highly significant and positive heterosis was found in hybrid PG021XM2 for fruit weight, pulp weight, dry matter content and yield per harvest. While, significant and negative heterosis for early first flowering was observed in PG020XM2, for first flower bearing node number in PG007XM2. These hybrids might be used in future breeding program to exploit heterosis for better yield in pointed gourd.

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LIST OF ABBREVIATIONS AND SYMBOLS USED

Acronyms	Abbreviations/ Symbols
Agro Ecological Zone	AEZ
Analysis of Variance	ANOVA
Bangladesh Agricultural Research Institute	BARI
Bangabandhu Sheikh Mujibur Rahman Agricultural University	BSMRAU
Breeding value	*Ai*
Bangladesh Agricultural University	BAU
Centimeter	cm
Covariance	COV
Crosses mean	Ci
Degree of freedom	df
Figure	Fig.
First fillial generation	F_1
and others (at elli)	*et al.*
General Combining Ability	GCA
Gram	g
Hectare	ha
Mean sum square	*Mss*
Nitrogen	N
Parental mean	Pi
Parent offspring correlation	*rOP*
Parent offspring regression	*bOP*
Perts per million	ppm
Phosphorus	p
Potassium	K
Pulses Research Centre	PRC
Regression of breeding value on phenotypic value	bAP
Regional Agricultural Research Station	RARS
Specific Combining Ability	SCA
Sulphur	S
Sum	$\sum$
Sum square	*ss*
Ton per hectare	t/ha
Total sum square	*Tss*
Variance	Var.
Wheat Research Centre	WRC
Zinc	Zn

Chapter I
INTRODUCTION

Pointed gourd (*Trichosanthes dioica* Roxb.) is originated in India. Bengal-Assam is the primary centre of origin (Choudhury, 1990). The center of origin of *Trichosanthes* is not precisely known but most of the authors agree that India or Indo- Malayan region as its original home. Pointed gourd belongs to the family Cucurbitaceae having chromosome number, 2n= 22 (Varghese, 1971; 1972), sub family cucurbitoideae, tribe Trichosanthae. *Trichosanthes* is a large genus principally of Indo-Malayan distribution with about 44 species of which 22 occur in India (Chakravarty, 1982). Wide variations are found among the existing 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). Pointed gourd (*Trichosanthes dioica*) is one of the popular cucurbitaceous vegetables, it is grown almost in all districts of Bangladesh , but widely cultivated in summer and rainy season in the districts of Rajshahi, Bogra, Pabna, Jessore and Kustia (Rashid,1993).

Pointed gourd is an important summer vegetable in this country. Acreage and production of winter vegetables are scarce during summer season. Winter vegetables are usually grown in 62.03 % of the total vegetable land area while, 37.95 % of the area is covered by summer vegetables (Anonymous, 2003). In Bangladesh pointed gourd is produced in about 51895 hectares of land with a total production of 60665 tons, the average yield being 7.13 tons per hectare (Anonymous, 2004). There are lean periods at the end of winter and summer seasons when there are always scarcity of vegetables. During the period of May to October only few vegetables are available in the market and the amount is very low against our demand. Pointed gourd is usually harvested during this period. Thus it is a very important vegetable during vegetables scarcity in our country.

Keeping quality of fruits of the crop is considerably high. It has some medicinal value also. It is easily digestible, diuretic and laxative invigorates the heart and brain and is useful in recovery of the disorder of the blood circulatory system (Rice, *et al.*, 1992; Yawalker, 1985). The fruits are nutritionally rich containing 5.4 g protein, 0.5 g minerals, 153 µg carotene and 29 mg vitamin-C per 100 g fresh weight (Gopalan *et al.*, 1982).

Farmers of Bangladesh are cultivating the local cultivars of pointed gourd, which are low yielding. Average yield of pointed gourd in our country is low compared to other pointed gourd producing countries of the world like India. Several factors are considered responsible for low yield of pointed gourd in Bangladesh. These are lack of high yielding varieties, appropriate propagation techniques and improved production technologies. Production of hard seeds in the fruits within a few days after anthesis also deteriorates its palatability.

A large number of pointed gourd cultivars are grown in different names at different places. Rashid (1993) stated that several cultivars are available in different parts of Bangladesh. At present there is no hybrid variety of pointed gourd in the country. Pointed gourd is a dioecious and vegetatively propagated crop, so development and maintenance of hybrid is easy than other crops. As a dioecious crop, pointed gourd has high cross-pollination mechanism. Due to its high out crossing behavior, variability is always generating in this crop but maintenance of variability is very easy because of its vegetatively propagating nature. A few research works on variability but no research work in respect of heterosis and gene action have been done for the improvement of the crop in Bangladesh.

However, before development of hybrid variety, it is essential to study the breeding value and heterosis of yield and different yield attributes of the crop by crossing of two genetically dissimilar parents. Hays and Jones (1961) first observed heterosis in cucurbits. At present in most advanced and developing countries of the world almost all common varieties of vegetable crops are being replaced by F_1 hybrids. Considering this idea the present study of top cross was carried out with the following objectives:

i) To estimate breeding value of yield and yield contributing characters.

ii) To find out high heterotic parental combination(s) in order to develop hybrid variety with good quality fruits.

iii) To identify best topcross (s) to be used as hybrid variety.

Chapter II

REVIEW OF LITERATURE

Information related to gene action and heterosis of pointed gourd rarely reported. However, presently available literature pertinent to botany, plant character, fruit characters, seed characters, yield and yield contributing characters in respect of gene action and heterosis in *Trichosanthes dioica* Roxb. or related crops have been presented below.

2.1 Botany

Pointed gourd is generally propagated by stem cutting with two methods namely, straight vine and ring vine (Nath *et al.*, 1976). Mukhopadhyay and Chattapadhyay (1976) studied the propagation of pointed gourd by using seeds. They found differences among varieties and chemical treatments for seed germination.

Singh and Whitehead (1999) reported that pointed gourd is usually propagated through vine cutting, root sucker and tuberous root. Both pre-rooted and fresh vine cuttings are used for propagation. Seeds are not used in planting because of poor germination and difficult to determine the sex of plants before flowering. As a result, crop establishment from seed may contain 50% non-fruiting male plants.

Islam (1993) observed that male flowering was earlier than female flowering in several genotypes of bottle gourd.

Chauhan (1989) observed that male flowers of pointed gourd is bigger than female flowers and has a long base, while female flowers ended with a swollen ovary covered with fine white pubescence. He also observed that the stigma of pointed gourd remain receptive from seven hours before opening to 51 hours after opening of flower.

Bose and Som (1986) stated that flowering in cucurbits normally starts within 40-50 days after sowing depending upon weather condition. In all the species of cucurbits, the production of staminate (male) flower was found much more in number than the pistillate (female) ones. Again Bose and Som (1986) stated that the sex ratio in cucurbits varies from 5:1 to 25030:1. The ratio of male: female flower was changed by the climate and environmental factors (Sharma and Nath, 1971).

The first flower bearing node is an important character that determines the earliness of flowering. Haque (1971) observed that node for first male flower in bottle gourd, sweet gourd, white gourd and melon were 19^{th}, 25^{th}, 14^{th} and 14^{th} respectively. Node for first female flower in bottle gourd, sweet gourd, white gourd and watermelon were 28^{th}, 34^{th}, 21^{th} and 19^{th}, respectively. Hussain and Rashid (1974) reported that in teasle gourd the numbers of node at which the first male and female flower appeared were 8^{th} and 8^{th} to 26th, respectively. On the other hand, Sarkar *et al.* (1989) observed that the emergence of first female flower was from the node number of 37.4 in pointed gourd. Prasad and Singh (1990) reported that in pointed gourd the first female flower comes from 5th to 18th node depending on varieties.

On the other hand, Rahman *et al.* (1991) reported that male flower was earlier than female flower in several genotypes of bitter gourd, bottle gourd, ribbed gourd and sweet gourd. They reported significant variations for this character among the genotypes of bitter gourd, sweet gourd, ribbed gourd and bottle gourd. According to Pathak and Singh (1950) female flowers of pointed gourd opened within 8 to 12 days and male within 13 to 16 days from their bud appearance. Yawalkar (1985) stated that, in pointed gourd flowering started from 70-80 days after planting and harvesting of fruits commenced within 80-90 days of planting. Shamnugavelue (1989) reported that, pointed gourd took 136 to 158 days for first flowering after planting.

Hussain and Rashid (1974) studied floral biology of teasle gourd and reported that both male and female flowers bloom 6 and 7 a.m. They also noticed the dehiscence anthers at the time of opening of the flowers and the release of pollen grains continued for several hours. On the other hand Pathak and Singh (1950) observed that in pointed gourd that both male and female flowers opened in the early hours of the night and stigma remained receptive from 7 hours before opening and continues upto 51 hours after opening of flower. He also found that the pollen of pointed gourd become mature one hour before anther dehiscence and remains viable up to 22 hours after anthesis.

Seshardi (1986) stated that in pointed gourd as dioecious plants. Rashid (1976) noted that the flower of pointed gourd is white in colour, 1.5 to 2.0 inches in diameter, each comprised of 5 sepals and 5 petals. Staminate flower comprises of 3 stamens. Sarkar *et al.* (1989) reported that in pointed gourd total number of flowers per plant was 30.

Sachan *et al.* (1989) studied the floral biology of pointed gourd in Gujarat, India. They 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 becomes receptive 6 hours before anthesis. Pathak and Singh (1950) observed that in pointed gourd the stigma remained receptive from seven hours before opening to 51 hours after opening of flower. The pollen of pointed gourd became mature one hour before anther dehiscence and remains viable upto 22 hours after anthesis. The floral biology of pointed gourd was also studied by Singh *et al.* (1989) and similar findings were reported by Sachan *et al.* (1989)

In pointed gourd, 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 (Seshadri, 1986). As a cross pollinated crop, the fruit set of pointed gourd depends on the availability of pollinating agents particularly insects.

Hand pollination resulted in successful fruit set (about 100%) and should be done within 12 hours after anthesis (Alam, 1997). According to Pathak and Singh (1950), hand pollination in pointed gourd is expensive but preferable as it has given more fruits than natural pollination which takes place mainly through the agency of small beetles (*Carpophilus dimidiatus*) and small ants (*Componotus compressus*).

Ayyengar *et al.*, (1976) reported distinct difference in the size of pollen grains of *T. dioica* inferring the two distinctive categories of pollen grains may be male determining and female determining.

Kumar *et al.*, (1995) observed that the pointed cultivar, Santokhwa had the vine length from 11.06 to 10.14 m. While Polyandskaya (1985) reported that the length of main vine, the length and number of branches and number of internodes increased with the increase of plant density in bitter gourd. On the other hand in a study of 9 local germplasm of ash gourd, Hamid *et al.* (1989) found wide range of variation among the lines in respect of their vine growth.

Rahman (1988) observed that pointed gourd take two to three weeks for sprouting and three months for flowering and fruiting after planting of vine or roots.

In pointed gourd, anthesis takes place during night, and night temperature favors anthesis and fruit set in the early hours of the morning, when the insects visit them (Seshadri, 1986). As a cross pollinated crop, the fruit set of pointed gourd depends on the availability of pollinating agents particularly insects.

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.

Shamnugavelue (1989) observed four types of pointed gourd grown mostly in Bihar, Bengal and eastern Uttar Pradesh. These are (i) 10 to 13 cm long, dark green with white stripes (ii) 10 to 16 cm long, thick, dark green with very faint stripes and pale green in colour (iii) 5 to 10 cm long, small, roundish, dark green and striped and (iv) small, tapering at the end, green and striped.

Prasad and Singh (1990) studied agronomic and morphological characters in pointed gourd. They found a positive correlation between yield and late flowering. The fruit weight (34.6 g) and the seed number (19.9) were the highest in CHES-14. Thy also observed that the number of seeds per fruit had direct correlation with fruit weight. The genotypes CHES-12 (3.9 kg) performed the best yield followed by CHES-7 (2.6 kg), CHES-14 (2.5 kg).

Kumar *et al.*, (1995) studied four cultivars of pointed gourd in two growing seasons, in India. Among them Santokhwa had the longest fruits, Dandali and Santokhwa had the heaviest fruits. Hilly had the highest fruits per plant and highest yield (175.50 and 156.75 t/ha) and Nimia had the lowest yield (140.25 and 125.20 t/ha), respectively.

Singh *et al.*, (1985) evaluated 20 accessions of pointed gourd and found that the cultivar 'Dandali' produced the highest yield (5.53 kg) per plant. The lowest yield per plant was recorded in the cultivar Lalpur (2.70 kg). 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.

The length of pointed gourd varies depending upon the genotypes. Singh and Prasad (1989) reported that fruit length, width and weight of pointed gourd were in the range of 4.95-9.81 cm, 2.98-3.56 cm and 15.48-57.66 g, respectively depending on various genotypes. Singh and Singh (1988) conducted an experiment to study the performance of 18 lines of pointed gourd for yield per plant and 10 related characters and observed significant differences for all the characters among the accessions. Kumar *et al.* (1995) found wide variation among different cultivars of pointed gourd while evaluating 4 cultivars in Bihar, India.

Saha *et al.* (1989) reported that the yield of the line ranged from 8.20 to 14.50 t per ha. However, the lines TG002 and TG001 were found to be the most promising in respect of yield, number of fruits per plant and earliness in comparison to the others.

2.2 Variance and gene action

The variance is the measure of the variability and it is defined as the average of the squared deviation from the mean. The basic idea in the study of variation is its partitioning into components attribute to different causes.
Gene action involved in the expression of various quantitative characters, thus it helps to predict performance of parent in cross combination and thus, helps in identifying the desirable parents and hybrids as well the crosses for a crop improvement program. It gives an idea about fixable nature of gene action for a particular character.

Mishra et *al.* (1994) reported that both additive and non additive gene actions were involved in the expression of number of fruits per plant and yield per plant in bitter gourd (Momordica *charantia L.*).

Islam (1993) found significant variation for first flower bearing node number among the genotypes and suggested that the inheritance of this trait was predominantly under the additive genetic control of bottle gourd. He suggested that the character was predominantly controlled by the additive gene action.

Latif (1993) found high and significant variances in number of nodes per vine due to gca and sca, which indicated that this character was controlled by both additive and non additive genes. The gca:sca ratio was less than one suggesting the predominance of non additive gene action in ribbed gourd.

Rahman *et al.* (1991) studied different characters of 19 ribbed gourd genotypes, the genotypes showed significant differences among themselves for number of vines per plant. Minimum number of nodes per vine was recorded 32 for RG 006 genotypes while the maximum was 75 for genotype RG 017.

In a study Rahman *et al.* (1990) observed significant variation for days to first flowering and number of fruits per plant among the genotypes of ribbed gourd, bitter gourd and sweet gourd. They also observed that day to male flowering was earlier than days to female flowering in several genotypes of ribbed gourd, bitter gourd, bottle gourd and sweet gourd.

Significant variations among the cultivars for number of fruits per plant were also found in ribbed gourd and sweet gourd (Rahman *et al*, 1990).

Saha *et al.* (1989) reported significant differences among the teasle gourd lines for all the characters studied. The line TG 001 produced longest fruit over the others. The highest fruit weight (80.16g) was observed in TG006. Maximum number of fruits per plant was produced in TG002 and the lowest in TG004.

Hormuzdi and More (1989) reported that fruit length in cucumber was controlled by additive gene action. They also reported that variance due to gca was greater than that of sca indicating the predominance of additive gene actions for this character.

Sahni *et al.* (1987) mentioned that days to first flowering were controlled by non additive gene action and fruit weight by the additive genes in a diallel set of 10 lines of long-fruited bottle gourd.

From genetic analysis in long fruited bottle gourd, Sirohi *et al.* (1986) reported the presence of additive and non additive gene actions in the expression of fruit length.

Sirohi and Chowdhury (1983) reported additive gene action with partial dominance in an eight parent half diallel cross for fruit length of bitter gourd. They also reported that fruit weight was controlled by additive type of genes with partial dominance.

Singh and Joshi (1980) observed that the number of fruits per plant in bitter gourd was predominantly controlled by additive genes.

2.3 Heterosis

The term heterosis was first coined by Shull in 1984. It refers to the phenomenon of hybrid vigor. From the genetic point of view, the term heterosis refers to the superiority of the F_1 hybrid over the mean performance of its parents for various morphological, physiological and biochemical characters. In plant breeding, the main concern of heterosis is primarily with economic yield potential. Expression of heterosis is confined only to the first filial generation (F_1). Heterosis may be positive or negative. However, in common usage, it is important only when F_1 is superior to the best parent (Poehlman, 1979). In cucurbits, heterosis was first noted by Hays and Jones in 1961. Some of the reports on heterosis for different traits in cucurbits are given below.

Rahman (2004) observed significant heterotic effect over better parent in snake gourd. He estimated 22.34% heterosis for fruit length by the cross SG-001 X SG-006, 27.88% for number of fruits per plant by Jumlong X SG-001 followed by SG-018 X SG-004 (54.71%), –45.35% for less seeded fruit by the cross SG-004 X SG-001 and –36.99% for early fruit maturity by the cross Jumlong X SG-004. He also mentioned that significant highest negative heterosis for male and female flowering by the cross SG-

006 X SG-004 (−13.34% and −14.90%) followed by SG-001 X SG-004 (−12.69% and 9.79%).

Banik (2003) studied heterosis in Snakegourd through 6 X 6 full diallel cross and observed both positive and negative heterosis for 15 different characters of F_1 hybrids and the reciprocals. She also observed that the F_1 hybrid, SG-001 X SG-004 showed the highest heterosis over better parent for fruit weight per plant (69.54%) but the hybrid, SG-018 X SG-001 manifested the highest heterosis over better parent for total fruits per plant (46.15%). However, the highest negative heterosis over better parent for days to first male flower opening (-60.33%) and first female flower node number (-50.34%) were found in the cross combinations SG-004 X SG-001. She also noticed that both positive and negative heterosis over better parent for fruit weight.

Karim *et al.* (2001) reported desirable better parent heterosis for weight and diameter of green fruits and fruit yield per plant in F_1 hybrids, HFX Local and MK X Local.

Mohanty and Mishra (1999) derived information in heterosis for yield components in pumpkin from an 8 x 8 half diallel cross. The cross Baidyabati X Pusa Vishwars showed the highest heterosis for vine length (917.8%); but the hybrid Ambili X BBS-10 manifested the highest better parent heterosis for average fruit weight (968.7%); highest heterosis of 9150.0% and 181.55% over better parent for fruit number and yield per plant were expressed by cross Guamal local X Cuttack local respectively.

Ahmed (1998) reported both positive and negative heterosis over better parent for yield contributing characters in Snakegourd. He stated that among the F_1 hybrids, "Green long X White long", was the earliest in first flowering with the longest fruit. He also observed that all hybrids exhibited negative non significant heterosis over better and mid parental value for fruit length except "Green long X Green short", which gave positive non significant heterosis over mid parent. The F_1 hybrid "Green long X Green short" produced the highest yield per plant.

Mishra *et al.* (1994) stated that there was a high level of heterosis. High SCA effect was observed in bitter gourd.

Sirohi (1994) studied heterosis in pumpkin through 9 X 9 diallel cross and observed that the hybrids Pusa Vishwas X S. 122, Pusa Vishwas X S.93 and S. 93 X S.122 exhibited 30.9%, 25.8% and 24.6% increased yield, respectively over top parents S.122 and S.53; 41.1% and 39.8 % increased yield over Pusa Vishwas a commercial check, respectively.

Latif (1993) reported that two F_1 hybrids showed highly significant positive heterosis over their respective mid parental values and one showed significant negative heterosis over its mid parental value for fruit weight in a five parental half diallel cross of ribbed gourd. He also observed highest positive and negative heterosis over their better parent value.

Highly significant and positive heterosis over better parent in the hybrid BOG 004 X BOG 008 and highly significant and negative heterosis over mid parent in BOG 008 X BOG 012 for fruit length in bottle gourd were observed by Islam (1993).

Rahman (1992) studied the extent of heterosis in sweet gourd, bitter gourd and ribbed gourd and observed significant positive and negative heterosis for fruit weight.

Varghese (1991) studied the heterosis in Snakegourd and obtained both positive and negative heterosis in the cross. In his study the crosses, P_{11} X P_2 showed significant and positive heterosis for fruits per plant (111.11%), P_5 X P_3 showed negative heterosis (-18.87%) for days to first harvest and the cross P_{10} X P_4 showed negative effect for days to first female flower opening (-16.28%).

Janakiram and Sirohi (1989) reported that F_1 hybrids exhibited up to 84.5% heterosis for yield over the best parental line in round fruited bottle gourd. They also concluded that high yield was attributed in number of fruits per plant in those crosses.

Pal *et al.* (1983) examined the performance of hybrid vigor and its feasibility of exploitation in bitter gourd in a line X tester analysis with five lines and two testers. In all the combinations like Monsoon Miracle X Holly green, the largest X Indian Prime and China X Indian prime, the values were negative and high, indicating the possibility of exploitation for earliness. He found heterosis was marked by earliness of flowering (11 days over better parent).

Singh and Joshi (1979) obtained information on heterosis form a five parental diallel cross of bitter gourd and their F_1 hybrids. The crosses showed heterobeltiosis ranged from 2.1 to 22.30% for plant height and 7.8 to 37.1% for primary branches per plant. They reported that the cross BMM 1 X Co. long showed 29.9% heterobeltiosis for fruit length while the crosses BWM 1 X BWL 1 and BWL 1 X BS 1 had significantly more fruits per plant with 13.7% and 34.4% heterobeltiosis, respectively.

Srivastava and Nath (1983) studied the heterosis in bitter gourd and they observed negative heterosis (-16.7%) for days to first female flowering. Out of 90 hybrids, heterobeltiosis was observed in 35 for vine length (0.4-27.11 %) and 40 for fruits per plant (0.2-47.2%). They also observed as much as 64% increased yield in the hybrids over their parents.

Sirohi and Chaudhary (1978) developed 28 F_1 hybrid using eight diverse lines of bitter gourd and they observed among the 28 hybrids, crosses between Pusa Do. Mausumi X S-144, Pusa Do Mausumi X S-63 and Pusa Do. Mausumi X S-54 appeared the best performance for total yield per plant and its component characters and they showed 84.10%, 72.00% and 45.46% higher yield respectively, than the top parent, Pusa Do Mausumi.

Chapter III
MATERIALS AND METHODS

The experiment was carried out during the period from December 2004 to October 2005. 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 appendix 1.

3.4. 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. The land was then 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 1.2 5 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.

3.5. Hybridization and collection of seeds

Pollination to 27 female parents was done by the pollen from the male parent M2 at Horticulture Research Center of the Regional Agricultural Research Station, Ishurdi to obtain F_1 seeds. In the next season these 27 F_1 hybrids were planted along with the female parents to evaluate their hybrid performance.

In March, 2004 when female and male genotypes started flowering, bagging was done in the female flowers at 6 a.m. prior to pollination. In the next day pollination was made at 6 a.m. according to top cross method by the male flower till July, 2004. Pollination was made by hand every day after flowering. The pollen of male parent was dusting with each female parent carefully so that there was no chance of pollen contamination. In September top crossed ripened pointed gourd fruits were harvested and seeds were separated from fruits and dried and stored.

3.6. Sowing of seeds and transplantating of seedlings

F_1 seeds were sown on 15th October 2004 in polybag. Seedlings of 35 days old were planted on 5th December 2004 along with parents. Every morning watering was done after transplanting. The ratio of male and female population kept was 1:10. After flower initiation it was observed that among the 27 crosses all the plants of 6 crosses produced completely male flower *viz.* PG11XM2, PG13XM2, PG14XM2, PG15XM2, PG22XM2 and PG23XM2 on the other hand the plants of 4 crosses *viz.* PG1XM2, PG4XM2, PG24XM2 and PG25XM2 produced huge vegetative growth with negligible number (2-3) of female flower but there were no male flower. Plants from rest of the 17 crosses produced both male and female flowers but the ratio of male and female flowers producing plant was varied from 25-50% from one cross to another.

3.7. Treatments and experimental design

The treatment comprised 34 genotypes including 17 female parent and 17 top crosses made with 17 female pointed gourd genotypes with a male (Table 1). The experiment was laid out in a Randomized Block Design (RBD) with three replications. The size of a unit plot was 1.25m x 4.0m, which accommodated 4 plants at a spacing of 1m x 1.25 m.

Table 1. Thirty four genotypes (Parental inbreds and Top crosses) used as experimental materials

Sl. No.	Parental inbreds	Sl. No.	Top crosses
1.	PG002	18.	PG002X M2
2.	PG003	19.	PG003 X M2
3.	PG005	20.	PG005 X M2
4.	PG006	21.	PG006 X M2
5.	PG007	22.	PG007 X M2
6.	PG008	23.	PG008 X M2
7.	PG009	24.	PG009 X M2
8.	PG010	25.	PG010 X M2
9.	PG012	26.	PG012 X M2
10.	PG016	27.	PG016 X M2
11.	PG017	28.	PG017 X M2
12.	PG018	29.	PG018 X M2
13.	PG019	30.	PG-19 X M2
14.	PG020	31.	PG020 X M2
15.	PG021	32.	PG021 X M2
16.	PG026	33.	PG026 X M2
17.	PG027	34.	PG027 X M2

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.

3.9.1. 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.

3.9.2. Pruning of lateral vines

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

3.9.3. Irrigation

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

3.9.4. 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 each irrigation at appropriate time to break the soil crust and to make the soil loose.

3.10. 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.

3.11. Harvesting

Fruits were harvested regularly when they attained horticultural maturity, i e. immediately before hardness of seeds. Harvesting was started from the first week of March and continued up to second week of November 2004.

3.12. Data collection

Data on the twenty four yield and yield components *viz.* (i) Number of vines per plant, (ii) Vine length at first harvest, (iii) Number of nodes at first harvest, (iv) Length of internode, (v) Days to first flowering, (vi) First flower bearing node number, (vii) Fruit development period, (viii) Fruit length, (ix) Fruit width, (x) Fruit weight, (xi) Pulp weight, (xii) Pulp: Seed ratio, (xiii) Dry matter content, (xiv) Number of fruits per vine, (xv) Number of fruits per plant, (xvi) Weight of fruit per plant, (xvii) Harvest length, (xviii) Number of harvest within the harvest length, (xix) Harvest interval , (xx) Number of fruits per harvest, (xxi) Yield per harvest, (xxii) Yield of fruit, (xxiii) Number of seeds per fruit and (xxiv) Weight of seeds per fruit were recorded from two randomly selected plants of each accession.

The parameters estimated were variances, breeding value, parent-offspring correlation, parent-offspring regression and regression of parent on phenotypic value. Depending upon the results of the experiment the superior hybrid(s) were find out. The methods of data collection are described briefly below:

i. Number of vines per plant

The number of vines at first harvest was recorded and the average was calculated.

ii. Vine length at first harvest

Vine length was measured from the length of the vine at first harvest recorded from the collar region to the tip of the main vine in cm.

iii. Number of node at first harvest

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

iv. Length of internode

Total length of the main vine was measured in cm by a measuring scale at first harvesting stage and the average length of internode was calculated by dividing the length of main vine with the number of internodes was expressed in cm.

v. Days to first flowering

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

vi. First flower bearing node number

The number of node from ground level at which the first flower appeared was recorded.

vii. Number of fruits per vine

Total number of fruits produced in the vines of a plant was counted and the average number of fruits produced in each vine was recorded.

viii. Number of fruits per plant

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

ix. Weight of fruit per plant

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

x. Fruit development period

The number of days required from flowering to harvest was recorded from pollination to edible maturity of 10 fruits of each accession.

xi. Harvest length

Total days required from first harvest to last harvest were recorded.

xii. Number of harvest within the harvest length

The number of harvest from first to last was recorded dividing the harvest length by the days required for each harvest.

xiii. Harvest interval

It was days required from one harvest to another and was recorded dividing the harvest length by total number of harvest.

xiv. Number of fruits per harvest

Number of fruits per harvest was recorded from the average number of fruits of five harvests for each genotype.

xv. Fruit length

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.

xvi. Fruit width

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

xvii. Fruit weight

Weight of ten edible fruits of each genotype was weighted just after harvest and the average was worked out in (g).

xviii. Pulp weight

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

xix. Number of seeds per fruit

The number of seeds per fruit was counted from 10 fruits randomly harvested from every

plant and the average was worked out.

xx. Weight of seeds per fruit

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

xxi. Pulp: Seed ratio

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

xxii. Dry matter content

One hundred g flesh of edible fruit of each genotype was dried in oven and dry matter percentage was calculated as follows:

$$\text{Dry matter content} = \frac{\text{Oven dried weight of flesh}}{\text{Fresh weight of flesh}} \times 100$$

xxiii. Yield per harvest

Yield per harvest was recorded from the average weight of fruits of five harvests for each of the genotypes.

xxiv. Yield of fruit per hectare

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

3. 13. Statistical analysis

The collected data on various parameters were statistically analyzed to find out the statistical significance of the experimental results.

3.13. A. Analysis of Variance (ANOVA)

The mean values of all the characters for all the genotypes calculated were subjected to ANOVA and significance test among the means was performed by F- variance test according to Sharma, 1995. The skeleton of ANOVA was as follows.

Source of variation	df	SS	MSS
Replication(r)	r-1	rSS	rMS
Genotypes(g)	g-1	gSS	gMS
Parents(p)	p-1	pSS	pMS
Top crosses(c)	c-1	cSS	cMS
Parent vs Crosses (p vs c)	1	pcSS	pcMS
Error(e)	(g-1) (r-1)	eSS	eMS
Total	gr-1	TSS	

(i) $rSS = \sum_{j}^{r} Tr_j^2 / g - CF$

$rMS = rSS/ (r-1)$

Where,

rSS	=	Replication sum square
rMS	=	Replication mean sum square
Tr^2	=	Square of replication total
j	=	1....3
g	=	Genotype
CF	=	Correction factor
r	=	Replication

(ii) $gSS = \sum_{i}^{g} T_{gi}^2 / r - CF$

$gMS = gSS/ (g-1)$

Where,

gSS	=	Genotype sum square
gMS	=	Genotype mean sum square
Tgi^2	=	Square of genotype total
i	=	1,2,....34

(iii) $pSS = \sum_{i}^{p} T_{gi}^{2}/r - T_{p}^{2}/pr$

Where,

pSS	=	Parent sum square
T_{p}^{2}	=	Square of the total of parents

(iv) $cSS = \sum_{i}^{c} T_{gi}^{2}/r - T_{c}^{2}/cr$

Where,

cSS	=	Cross sum square
T_{c}^{2}	=	Square of the total of parents cross

(v) $pcSS = Tp^2/pr + Tc^2/cr - CF$

Where,

*pc*SS	=	Parent vs. Cross sum square
p	=	Parent
r	=	Replication
c	=	Crosses

(vi) $TSS = \sum_{i}^{g} \sum_{j}^{r} x_{ij}^{2} - CF$

Where,

TSS	=	Total sum square
x_{ij}^{2}	=	Square of observations

(vii) eSS = TSS – gSS – rSS

eMS = eSS/ (g-1) (r-1)

Where,

eSS	=	Error sum square
eMS	=	Error mean sum square

3.13. B. Top crosses analysis

The characters which showed significant variations among the genotypes were subjected to top cross analysis and the following parameters were calculated according to Sharma, 1995.

(a) Breeding Value (A)

The breeding value is the standardized deviation of progeny-means from the general mean of all progenies developed in a cross-breeding program. The breeding value of parents, off- spring and parents *vs* off-spring were calculated according to Sharma, 1995. The breeding value of parents represents gca (general combining ability) effects. This is the fixable component of gene action. The gca effect is judged according to the size of A. Larger the size of A, greater is the gca effects (fixable component of gene action).

Breeding value (A):

$Ai = A'i \div SD(A'i) = (\overline{Ci} - \overline{C}) / \mathrm{SD}(A')$

$A'i = \overline{Ci} - \overline{C}$

Where,

A	=	Breeding value
$\overline{Ci}$	=	Mean value of a cross
$\overline{C}$	=	Grand mean of crosses

Variance $(A'i) = \sum_i^p A'i^2 \div (\text{p-1})$

Standard deviation SD $(A'i) = \sqrt{VarA'i}$

Variance $= \sum A'i^2$

(b) Parent offspring correlation (r_{op})

$$r_{op} = \frac{COV.(OP)}{\sqrt{Var.(p).Var.(o)}} = \frac{COV.(OP)}{\sqrt{pSSxcSS}} \text{ (at } p-2)$$

Where,

r_{op}	=	Parent offspring correlation
COV.(OP)	=	Covariance of offspring parent
Var.(p) = pSS	=	Sum square of parents
Var.(o) = cSS	=	Sum square of crosses

(c) Parent offspring regression (b_{op})

$$b_{op} = \frac{COV.(OP)}{Var.(p)} = \frac{COV.(OP)}{pSS}$$

Where,

b_{op} = Parent offspring regression

(d) Regression of A (breeding value) on phenotypic value (b_{AP})

$$b_{AP} = \frac{Cov.(AP)}{Var.(P)}$$

$$Cov.(AP) = \sum_i^P Ai.\ \overline{Pi}$$

$$Var.(P) = \sum_i^P \overline{Pi^2} - [(\sum \overline{Pi})^2 \div P]$$

Where,

$\overline{Pi}$ = Mean value of parents

3.13. C. Estimation of heterosis

Percent of female parent heterosis (FP) for each character was calculated as follows and was expressed in percentage.

$$\text{Heterosis over female parent} = \frac{\overline{F_1} - \overline{FP}}{\overline{FP}} \text{ X } 100$$

Here, $(\overline{FP})$ = is the mean value (over replications) of the female parents of a particular cross. The significance test for heterosis was done by using slandered error of the value of female parent.

Chapter IV
RESULTS AND DISCUSSION

4. 1. Variance

The analyses of variance (ANOVA) for the 23 characters studied are given in Table 2. High significant mean sum of squares were observed for most of the character except fruit width due to genotypes indicated that there were substantial variations among the parents (inbreds) and top crosses. Significant mean sum of squares due to parents for most of the characters except fruit width also indicated the existence of significant difference among the parents (inbreds). Similar results were also observed among the top crosses ($P<0.01$). Significance ($P<0.01$) of single degree of comparison variance (parent vs. cross) for most of the characters except days required from flowering to harvest and fruit width indicated substantial difference between parents as a group and their hybrid progenies (top crosses) as another group for most of the traits except the two ones. Non-significant mean sum of squares due to replication for all the trait studied stated that the mean observations taken over replications were statistically similar.

Rahman *et al.* (1991) mentioned significant differences among the genotypes for number of vines per plant of ribbed gourd genotypes. Minimum number of vines per plant was recorded 32 for RG 006 genotypes while the maximum was 75 for genotype RG 017. Islam (1993) found significant variation for first flower bearing node number among the genotypes of bottle gourd. Latif (1993) found high and significant variances in number of nodes per vine due in ribbed gourd. In a study Rahman *et al.* (1990) observed significant variation for days to first flowering and number of fruits per plant among the genotypes of ribbed gourd, bitter gourd and sweet gourd. Significant variations among the cultivars for number of fruits per plant were also found in ribbed gourd and sweet gourd (Rahman *et al*, 1990). Saha *et al.* (1989) reported significant differences among the teasle gourd lines for all the characters studied.

Table 2. Mean sum squares of different characters of pointed gourd

Source of Variation	Number of vines per plant	Vine length at first harvest (cm)	Number of node at first harvest	Length (cm) of internode at first harvest	Days to first flower
Replication	0.559	363.451	3.245	0.170	7.775
Genotypes	3.813**	48294.405**	553.672**	5.027**	1193.644**
Parents	2.461**	6909.311**	114.328**	2.457**	305.995**
Top crosses	4.814**	76154.752**	820.782**	7.357**	311.395**
Parent *vs* crosses	9.422**	264690.353**	3309.422**	8.882**	29512.010**
Error	0.458	196.077	4.619	0.201	6.057

Table 2. (Continued.)

Source of Variation	First flower bearing node number	Number of fruits per vine	Number of fruits per plant	Weight of fruits per plant (g)	Days required for flowering to harvest
Replication	3.539	1.507	1.463	325353.441	3.422
Genotypes	227.712**	558.651**	16714.595**	19990605.96**	17.935**
Parents	21.375**	154.366**	3557.303**	1912178.935**	8.343**
Top crosses	226.956**	948.187**	2686.787**	37691146.14**	28.544**
Parent *vs* crosses	3541.186**	794.648**	2686.787**	26036795.64**	1.657
Error	2.913	16.518	161.680	331073.083	1.634

Table 2. (Continued.)

Source of Variation	Harvest length (days)	Number of harvest within the length	Interval per harvest (days)	Number of fruits per harvest	Fruit length(cm)
Replication	38.36	2.775	0.348	8.590	0.826
Genotypes	1445.0**	17.736**	37.818**	130.362**	2.951**
Parents	787.13**	2.199**	3.847**	86.087**	2.211**
Top crosses	1895.51**	26.968**	61.518**	112.70**	3.858**
Parent *vs* crosses	4762.13**	118.627**	202.166**	1121.365**	0.275**
Error	10.85	0.593	2.132	2.621	0.080

Table 2. (Continued.)

Source of Variation	Fruit width (cm)	Fruit weight (g)	Pulp weight (g)	Number of seeds per fruit	Weight of seeds per fruit (g)
Replication	0.075	0.959	0.431	1.708	0.074
Genotypes	0.205	142.254**	118.007**	39.859**	2.134**
Parents	0.247	122.939**	119.406**	48.405**	1.580**
Top crosses	0.078	139.550**	104.394**	33.791**	2.023**
Parent *vs* crosses	1.556	494.560**	313.426**	0.207**	12.777**
Error	0.012	0.709	1.829	3.206	0.142

Table 2. (Continued.)

Source of Variation	Pulp: seed ratio (by weight)	Dry matter content (%)	Yield per harvest (g)	Fruit Yield (t/ha)
Replication	0.062	2.066	10002.262	4.749
Genotypes	12.955**	6.146**	127701.065**	125.760**
Parents	17.840**	3.096**	72439.801**	59.236**
Top crosses	6.992**	7.917**	153320.282**	154.810**
Parent vs crosses	30.199**	26.612**	601973.812**	725.333**
Error	1.701	1.165	2316.494	1.656

4.2. Gene action

Breeding value (A) estimated through top cross analysis represents the general combining ability (gca) effect of individual test inbreds. Larger the size of A greater is the gca effects. The gca effect is the fixable components of gene action. Thus higher breeding value of a trait indicates higher scope of fixation of the trait in particular test genotypes. The parameter bAP is analogous to heritability. Higher the value of bAP, the parental potential is seemingly quite authentic and reliable. The breeding value and allied parameters in respect of the characters studied are described below:

4.2.1 Number of Vines per plant

The average performance of top crosses was lower than that of the parents ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis of the character. The parent PG007 was superior female parent in respect of producing higher number of vines per plant (*per se* mean = 6.7) (Table 3). On the other hand top cross of PG009 with M2 was superior in this character. The poorest among the female parents was PG021 for both the statistics (3.3 and 2.7). In the present study bAP for the character is -0.230$\pm$0.229

which is very low indicated low heritability of the trait. The breeding value of the parental inbred PG009 was 2.17, which was highest among the parents. The order of breeding value of parental inbreds was:

PG009>PG010>PG005>PG006>PG018>PG002>PG019>PG003>PG008>PG026>PG027>PG016>PG007>PG012>PG017>PG020>PG021

However table 2 indicated that the mean value of the parental top cross (PG009XM2) was higher than the mean value of the parental inbred (Ci=70>Pi=47). The breeding value of the parent was also highest (2.17) indicated that there was scope of significant and higher heterosis for the paretal inbred PG009 followed by PG010 for the parameter when crossed with the male M2. The parental inbreds PG002, PG003, PG005, PG006, PG007, PG018 and PG019 had low breeding value. On the other hand the parental inbreds PG008, PG010, PG012, PG016, PG017, PG026, PG027 and PG021 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

The regression line of crosses over parents revealed a positive and linear relationship between parents and crosses (Fig.1). For every one unit increase in the mean value of the parents there is an increase of crosses by 29.1 units for the trait. The regression of crosses of pointed gourd on parents was obtained as y = 0.29 + 2.84 (R^2 = 0.04). The coefficient of determination was 0 .04 meaning that 4% of total variation for the character in crosses of pointed gourd is explained by parents implying that within the range of parent tested, the estimated linear relationship of crosses on parents for the character was quite adequate and female parental mean appeared to be the least limiting factor in respect of getting higher number of vines per plant.

Table 3. Breeding value and allied parameters of number of vines per plant in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent – off spring correlation (rOP)	Parent - off spring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.33	4.3	4.7	0.208	0.291	0.230 ± 0.229
PG003	0.06	6.0	4.3			
PG005	0.85	5.7	5.3			
PG006	0.85	4.7	5.3			
PG007	0.06	**6.7**	4.3			
PG008	-0.73	3.7	3.3			
PG009	**2.17**	4.7	**7.0**			
PG010	1.90	5.0	6.7			
PG012	-0.99	5.7	3.0			
PG016	-0.73	3.7	3.3			
PG017	-0.99	4.7	3.0			
PG018	0.33	4.3	4.7			
PG019	0.06	5.0	4.3			
PG020	-0.99	4.7	3.0			
PG021	-1.25	3.3	2.7			
PG026	-0.46	4.7	3.7			
PG027	-0.46	6.0	3.7			
	$\Sigma Ai = 0.00$	$\overline{Pi} = 4.86$	$\overline{Ci} = 4.25$			

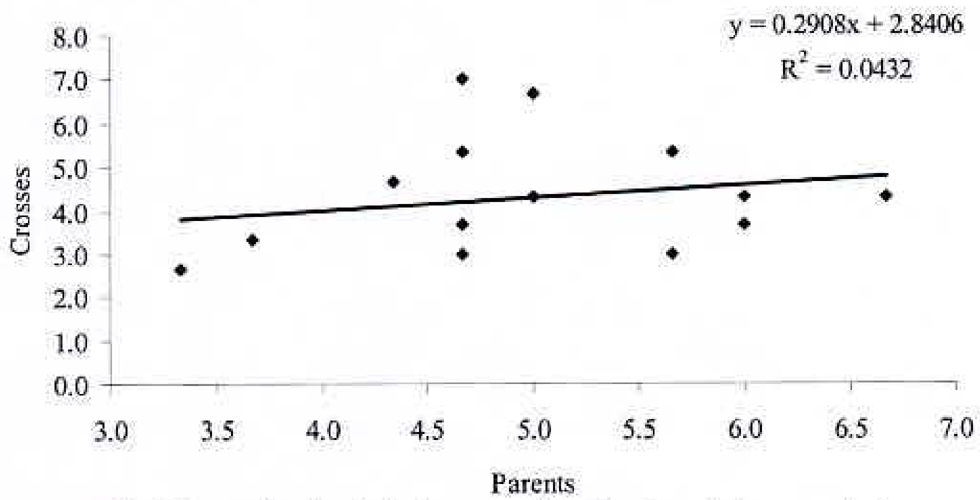


Fig.1. Regression line depicting regression of numberof vines per plant of parents on crosses in pointed gourd

4.2.2 Vine length (cm) at first harvest

The average performance of top crosses for this trait was higher than that of the parent $(\overline{Ci}>\overline{Pi})$ indicated significant average heterosis of the character. From Table 4 it was observed that the parent PG008 was superior female parent in respect of producing longer vine length at first harvest (*per se* mean = 348.3). On the other hand, top cross PG020 X M2 was superior for the trait. The poorest among the parent was PG007 for parent mean (Pi=143.00), while the poorest top cross was PG010 X M2 (Ci=177.7). In the present study bAP for the character is -0.005±12.022 which is very low indicated low heritability for the trait. The order of breeding value of parental inbreds was:

PG020>PG027>PG008>PG019>PG005>PG007>PG026>PG018>PG016>PG012>P G021>PG017>PG006>PG002>>PG009>PG003>PG010.

The mean value of the top cross (PG020xM2) was higher than the mean value of the parental inbred (Ci=841.7>Pi=190.0). The breeding value of the parent was also highest (3.25) indicated that there is scope of significant and higher heterosis for the parental inbred PG020 followed by PG027 for the parameter when crossed with the male M2.

The parental inbreds PG005, PG007, PG008 and PG019 had low breeding value. On the other hand the parental inbred PG002, PG003, PG006, PG009, PG010, PG012, PG016, PG017, PG 018, PG021and PG026 manifested negative breeding value, hence undesirable for further exploitation in respect of this character. Sirohi and Chowdhury (1983) observed additive gene action with partial dominance for the trait in bitter gourd.

The relationship between parents and crosses was linear in respect of this trait as indicated from the regression line of crosses against parents. A negative correlation found between the parents and crosses. The results are presented in Fig.2. For every one unit increase in the mean value of the female parents there is a decrease in crosses by 80.4 units for the character. The regression of crosses of pointed gourd on parents was obtained as $y = -0.80 + 502.3$ ($R^2 = 0.05$). The coefficient of determination was 0.05 meaning that 5% of total variation for the trait in crosses of pointed gourd is explained by parents implying that within the range of parent tested, the estimated linear relationship of crosses on for the trait parents was not quite adequate and that appeared to be the limiting factor getting longer vine length at first harvest.

Table 4. Breeding value and allied parameters of vine length (cm) at first harvest in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - off spring correlation (rOP)	Parent - offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.58	199.0	231.3	-0.242	-0.804	-0.005 ± 12.022
PG003	-0.72	194.7	209.0			
PG005	0.21	228.3	357.0			
PG006	-0.57	232.7	233.0			
PG007	0.61	143.0	421.3			
PG008	0.16	**348.3**	350.0			
PG009	-0.60	190.3	227.7			
PG010	-0.92	280.0	177.7			
PG012	-0.44	170.0	253.7			
PG016	-0.40	233.7	260.0			
PG017	-0.52	238.3	241.0			
PG018	-0.39	273.0	261.0			
PG-19	0.45	238.7	395.0			
PG020	**3.25**	190.0	**841.7**			
PG021	-0.50	217.0	244.7			
PG026	-0.19	217.0	293.3			
PG027	1.16	179.7	508.3			
	$\sum Ai = 0.00$	$\overline{Pi} = 221.98$	$\overline{Ci} = 323.86$			

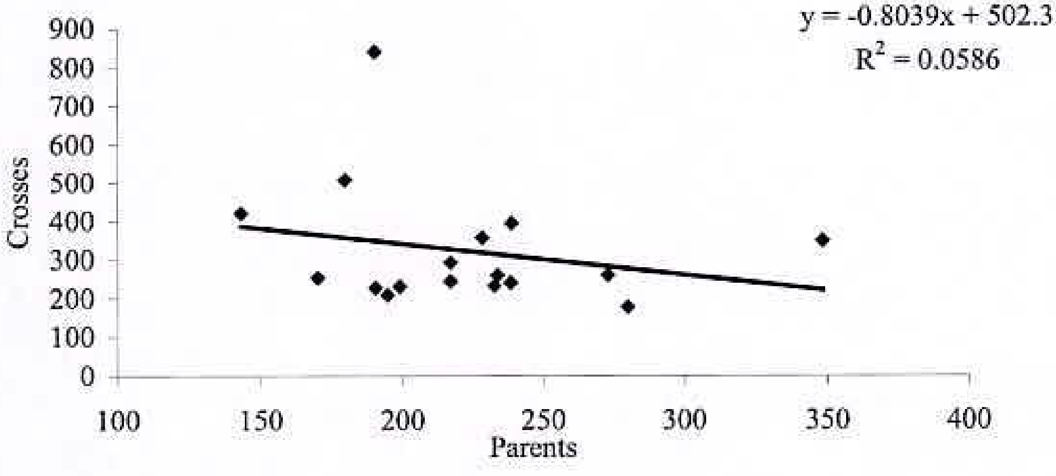


Fig. 2. Regression line depecting regression of vine length (cm) at first harvest of parents on crosses in pointed gourd

4.2.3. Number of node at first harvest

The average performance of top crosses was lower than that of the parent ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis of the character. From the Table 5 it was observed that the parent PG027 was superior female parent in respect of producing higher number first fruit bearing node number (*per se* mean = 24.0). On the other hand top cross of PG021 with M2 was superior in this character. The poorest among the female parents was PG007 (Pi=47.3), while the poorest top cross was PG010 (Ci=78.0). In the present study bAP for the character is -0.063±1.467 which is very low indicated low heritability for the trait. The breeding value of the parental inbred PG021 was -1.26 which was highest among the parents. The order of breeding value of parental inbred was:

PG020>PG027>PG019>PG005>PG007>PG002>PG008>PG018>PG012>PG026>PG016>PG017>PG009>PG006>PG003>PG010>PG021. However Table 5 indicated that the mean value of the top cross (PG021XM2) was lower than the mean value of the parental inbred (Ci=25.3<Pi=35.0). The breeding value of the parent was also highest (-1.26) indicated that there was scope of significant and higher heterosis for the parental inbred PG021 fallowed by PG010 when crossed with the male M2.

The parental inbreds PG002, PG003, PG007, PG008, PG009, PG0016, PG017, PG018, and PG0026 had low breeding value. On the other hand the parental inbred PG005, PG019, PG020, and PG027 manifested negative breeding value, hence undesirable for further exploitation in respect of this character. Latif (1993) indicated that this character was controlled by both additive and non additive gene action in ribbed gourd.

The regression line of crosses and parents revealed a negative and linear relationship between the parent and crosses (Fig.3). This indicated that one unit increase in the mean value of the parents there is a decrease by 10.48 units in crosses for this attribute. The regression of crosses of pointed gourd on parents was obtained as y = -1.04 + 82.4 (R^2 = 0.15). The coefficient of determination was 0 .15 meaning that 15% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the character was not quite adequate female parent mean to be the most limiting factor for getting higher number of node at first harvest.

Table 5. Breeding value and allied parameters of number of node at first harvest in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.07	35.7	45.0	-0.391	-1.048	-0.063 ± 1.467
PG003	-0.89	39.7	31.3			
PG005	0.92	38.3	61.3			
PG006	-0.71	38.7	34.3			
PG007	-0.11	26.3	44.3			
PG008	-0.03	47.3	45.7			
PG009	-0.57	28.0	36.7			
PG010	-0.95	42.0	30.3			
PG012	-0.29	36.7	41.3			
PG016	-0.35	33.3	40.3			
PG017	-0.55	31.0	37.0			
PG018	-0.23	40.7	42.3			
PG019	1.14	34.7	65.0			
PG020	2.31	29.0	84.3			
PG021	**-1.26**	35.0	**25.3**			
PG026	-0.31	29.7	41.0			
PG027	1.93	**24.0**	78.0			
	$\sum Ai=0.00$	$\overline{Pi}=34.71$	$\overline{Ci}=46.10$			

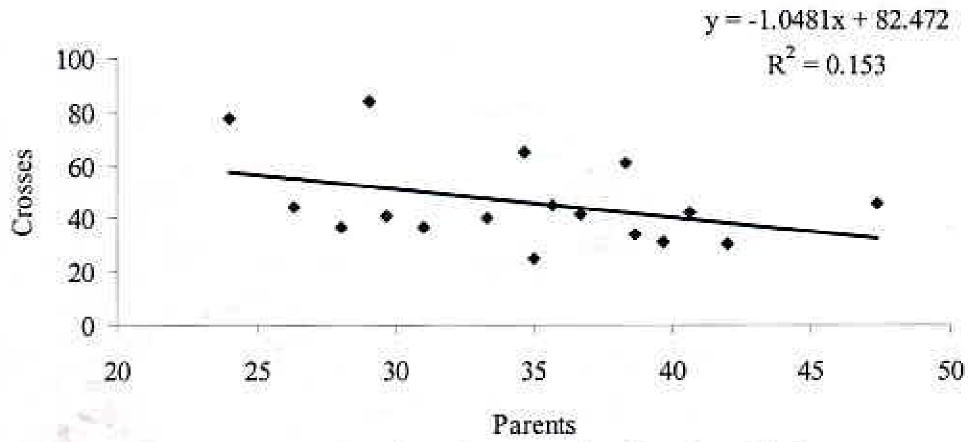


Fig.3. Regression line depecting regression of number of node at first harvest of parents on crosses in pointed gourd

4.2.4. Length (cm) of internodes at first harvest

In this character the mean values of top crosses has lower than that of the parent ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis for the trait. From Table 6 it was revealed that the parent PG003 was superior female parent in respect of producing lower length of tnternode at first harvest. On the other hand top cross PG010 X M2 was superior in this character. The poorest among female parent and top cross were PG027 (Pi=7.9) and PG020 (Ci=10.6) respectively. bAP for the character was very low indicated low (-0.005 ± 0.234) heritability for The breeding value of the parental inbred PG010 was -1.29 which was highest among the parents. The order of breeding value of parental inbred was:

PG010>PG002>PG012>PG017>PG005>PG009>PG006>PG018>PG019>PG027>PG016>PG026>PG003>PG007>PG008>PG021>PG020.

Table 6 revealed that the mean value of the parental top cross (PG010XM2) was lower than the mean value of the parental inbred ($Ci=5.1<Pi=6.7$). The breeding value of the parent PG010 was also highest (-1.29) indicated that there was scope of significant and higher heterosis for the parent.

The parental inbreds PG002, PG003, PG005, PG006, PG009, PG012 PG016, PG017, PG018, PG019 and PG026 had low breeding value. On the other hand the parental inbred PG007, PG008, PG020, and PG021 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

In respect of length of internodes at first harvest the relationship between parent and crosses was linear and revealed a negative correlation between the parents over crosses (Fig.4). It was observed that every one unit increase in the mean value of parents there is a decrease in crosses by 0.8 units for the character. The regression of crosses of pointed gourd on parents was obtained as $y = -0.0076 + 7.16$ ($R^2 = 0.00002$). The coefficient of determination was 0.00002 meaning that 0.002% of total variation in crosses of pointed gourd is explained by parents implying that within the range of parent tested, the estimated linear relationship of crosses on parents for the trait was not quite sufficient and female parental mean observed to be the limiting factor in getting higher length of internodes at first harvest (cm).

Table 6. Breeding value and allied parameters of length (cm) of internodes at first harvest of pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-off spring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.90	5.7	5.7	-0.004	-0.008	-0.005± 0.234
PG003	-0.05	4.6	7.0			
PG005	-0.48	6.7	6.4			
PG006	-0.43	6.2	6.4			
PG007	1.57	5.7	9.6			
PG008	0.61	7.2	8.1			
PG009	-0.46	7.2	6.4			
PG010	**-1.29**	6.7	**5.1**			
PG012	-0.71	**4.8**	6.0			
PG016	-0.26	6.3	6.7			
PG017	-0.58	7.5	6.2			
PG018	-0.39	7.0	6.5			
PG019	-0.37	6.9	6.5			
PG020	2.23	7.1	10.6			
PG021	1.95	6.2	10.2			
PG026	-0.09	7.3	7.0			
PG027	-0.33	7.9	6.6			
	$\sum Ai = 0.00$	$\overline{Pi} = 6.52$	$\overline{Ci} = 7.11$			

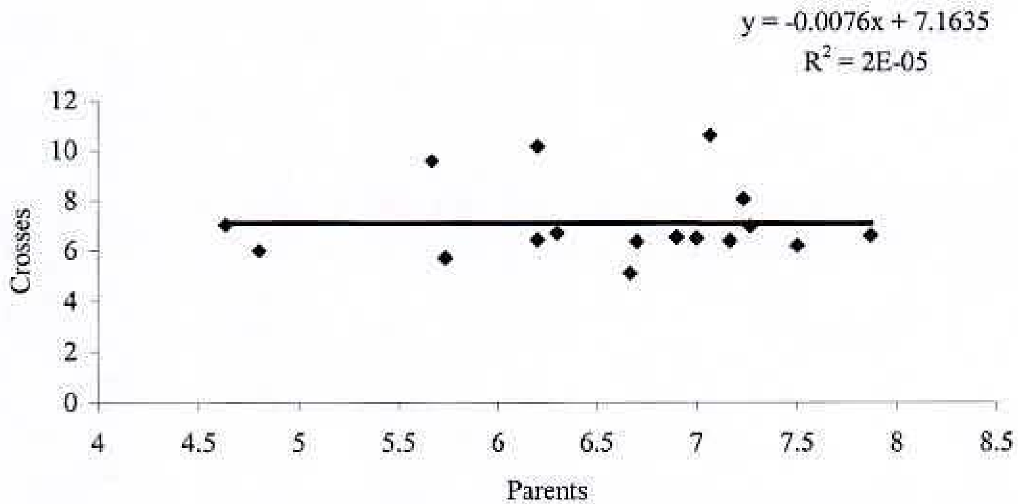


Fig. 4. Regression line depecting regression of length of internodes at first harvest (cm) of parents on crosses in pointed gourd

4.2.5. Days to first flower

The average performance of top cross was lower than that of the parent $(\overline{Ci}<\overline{Pi})$ indicated non significant average heterosis of the character. From Table 7 it was revealed that the parent PG021 was superior female parent in respect of producing first flower earlier (*per se* mean = 118.0). On the other hand top cross of PG020 with male M2 was superior in this character. The poorest among the female parents was PG007 (Pi=153.00), where as the poorest top cross was PG019 (Ci=177.7). In the present study bAP for the character was -0.019±2.561, which was very low indicated low heritability for the trait. The breeding value of the parental inbred PG020 was -1.25, which was highest among the parents. The order of breeding value of parental inbred was:

PG020>PG021>PG018>PG007>PG016>PG003>PG009>PG005>PG006>PG017>PG010>PG002>PG026>PG012>PG008>PG027>PG019.

However form the Table 7 it was observed that the mean value of the parental top cross (PG020xM2) was lower than the mean value of the parental inbred (Ci=80.7<Pi=148.3). The breeding value of the parent was also highest (-1.25) indicated that there was scope of significant and higher negative heterosis for the parental in breed PG020 for early flowering when crossed with M2. The parental inbreds PG003, PG005, PG008, PG016and PG018 had low breeding value. On the other hand the parental inbred PG002, PG006, PG007, PG010, PG012, PG017, PG019, PG026, and PG027 manifested positive breeding value, hence undesirable for further exploitation in respect of this character. Sahni *et al.* (1987) mentioned that days to first flowering were controlled by non additive gene action. The relationship between parents and crosses was linear in respect of this character. A linear regression of crosses over parents was estimated and a positive correlation found between the parents against and the result was presented in Fig. 5. It is revealed that every one unit increase in the mean value of parents there is an increase in crosses by 18.9 units for this attribute. The regression of crosses of pointed gourd on parents was obtained as y = 0.18 + 69.2 (R^2 = 0.03). The coefficient of determination was 0.03 meaning that 3% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents was quite adequate and that appeared to be the least limiting factor getting earlier flowering.

Table 7. Breeding value and allied parameters of days to first flower in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.23	124.7	95.7	0.188	0.189	0.019± 2.561
PG003	-0.53	120.3	88.0			
PG005	-0.07	120.7	92.7			
PG006	0.03	120.7	93.7			
PG007	0.85	153.0	102.0			
PG008	-0.79	123.3	85.3			
PG009	-0.46	123.7	88.7			
PG010	0.13	118.3	94.7			
PG012	0.49	126.3	98.3			
PG016	-0.79	134.0	85.3			
PG017	0.10	129.3	94.3			
PG018	-1.05	121.0	82.7			
PG019	2.84	135.3	122.3			
PG020	**-1.25**	148.3	**80.7**			
PG021	-1.11	**118.0**	82.0			
PG026	0.29	127.0	96.3			
PG027	1.08	121.3	104.3			
	$\sum$ Ai =0.00	$\overline{Pi}$ = 127.37	$\overline{Ci}$ =93.35			

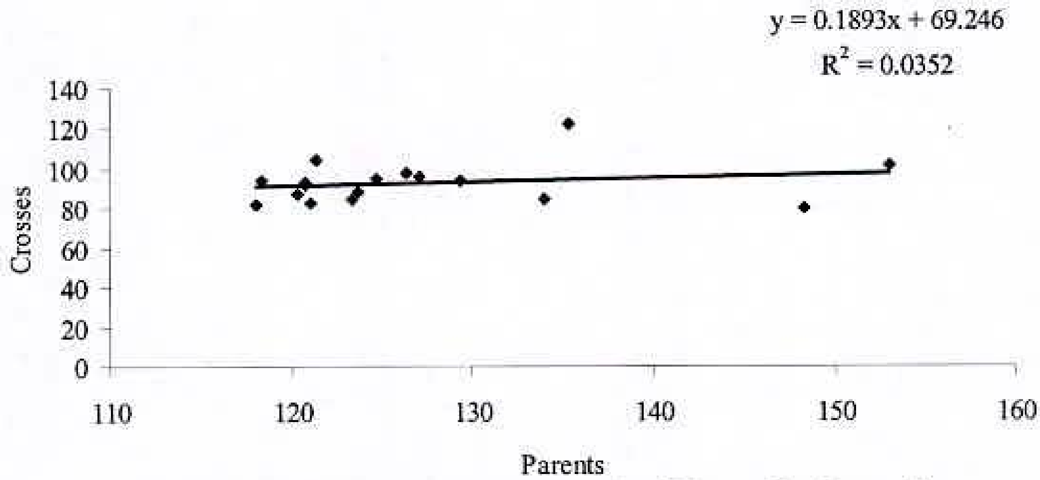


Fig. 5. Regression line depecting regression of days to first flower of parents on crosses in pointed gourd

4.2.6. First flower bearing node number

The heterosis exists for this character was non significant because the average mean values of top crosses were higher than that of parental inbred ($\overline{Ci}>\overline{Pi}$). It was observed that the parent PG012 and PG021 were superior female parent in respect of producing lower number of first flower bearing node number (*per se* mean for both were = 7.7). The top cross PG008 X M2 was superior in this character (A= - 1.66). The poorest among the female parents was PG010 (Pi=17.3), while the poorest top cross was PG020 (Ci=43.7). The value of bAP for the character is -0.032±0.687 indicated low heritability. The breeding value of the parental inbred PG008 was -1.66 which was highest among the parents hence there was fixable genes in this parent for the trait. The order of breeding value of parental inbreds was:

PG007>PG009>PG006>PG008>PG003>PG018>PG002>PG021>PG012>PG017>PG010>PG016>PG005>PG026>PG019>PG027>PG020.

However Table 8 revealed that the mean value of the parental top cross (PG008XM2) was lower than the mean value of PG008 (Ci=9.7<Pi=13.3). The breeding value of the parent was also highest (-1.66) indicated that there was scope of exploiting -ve higher heterosis for the trait.

The parental inbreds PG002, PG003, PG006, PG007, PG009, PG010, PG012, PG017, PG018 and PG021 had low breeding value. On the other hand the parental inbred PG005, PG016, PG018, PG019, PG026and PG027 manifested positive breeding value, hence undesirable for further exploitation of heterosis for reducing first flower bearing node number. Islam (1993) suggested that the inheritance of this character was predominantly control by the additive gene action.

The regression line of crosses against parents for first flower bearing node number clearly indicated that the relationship between parents and crosses was linear. A negative correlation found between the parents and crosses (Fig.6). For every one unit increase in the mean value of the parents there is an increase in crosses by 28.1 units for the trait. The regression of crosses of pointed gourd on parents was obtained as y = -0.28 + 27.5 (R^2 = 0.007). The coefficient of determination was 0 .007 meaning that 0.7% of total variation for the character in crosses of pointed gourd is explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was quite adequate and that appeared to be the least limiting factor getting first flower bearing node number.

Table 8. Breeding value and allied parameters of first flower bearing node number in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.40	13.0	20.7	-0.086	-0.281	-0.032 ± 0.687
PG003	-0.55	13.0	19.3			
PG005	0.41	12.0	27.7			
PG006	-0.93	15.7	16.0			
PG007	-0.78	12.0	17.3			
PG008	**-1.66**	13.3	**9.7**			
PG009	-1.01	12.0	15.3			
PG010	-0.01	17.3	24.0			
PG012	-0.21	**7.7**	22.3			
PG016	0.22	9.0	26.0			
PG017	-0.09	11.0	23.3			
PG018	-0.44	14.0	20.3			
PG019	1.02	16.0	33.0			
PG020	2.25	11.3	43.7			
PG021	-0.28	7.7	21.7			
PG026	0.68	13.3	30.0			
PG027	1.79	11.3	39.7			
	$\sum$ Ai= 0.00	$\overline{Pi}$ =12.33	$\overline{Ci}$ = 24.12			

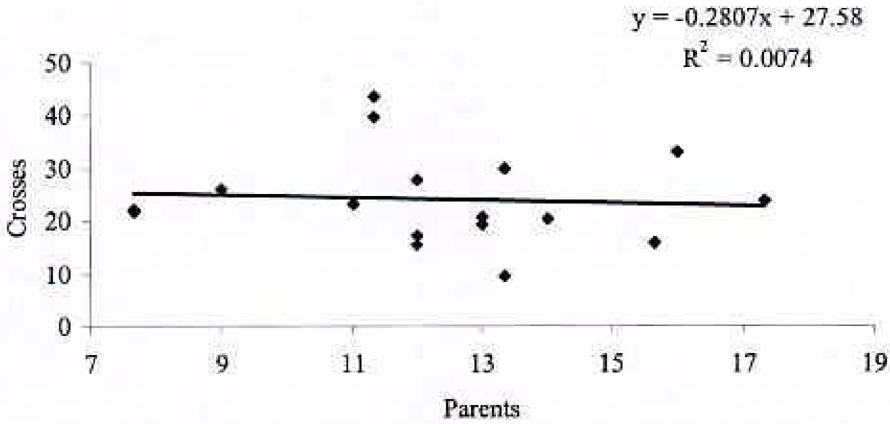


Fig. 6. Regression line depecting regression of first flower bearing node number of parents on crosses in pointed gourd

4.2.7. Number of fruits per vine

The average performance of the mean values of top crosses was higher than that of the parents ($\overline{Ci}>\overline{Pi}$) indicated significant heterosis of the character. From the Table 9 it was observed that the parent PG016 was superior female parent in respect of producing highest number of fruits per vine (*per se* mean = 39.6). On the other hand top cross PG006 X M2 was superior for this character. The poorest among the female parents was PG012 (Pi=12.6), PG019 was poorest top cross (Ci=9.7). In the present study bAP for the character was -0.007±1.850, which was very low indicated low heritability for the trait. In this study the breeding value of the parental inbred PG006 was 2.39 which was highest among the parents. The order of breeding value of parental inbreds was:

PG006>PG016>PG007>PG009>PG017>PG021>PG010>PG008>PG002>PG0012>PG027>PG005>PG003>PG018>PG020>PG026>PG019.

However Table 9 revealed that the mean value of the parental top cross (PG006xM2) was higher than the mean value of the parental inbred (Ci=75.9>Pi=24.3). The breeding value of the parent was also highest (2.39) indicated that there was scope of significant and higher heterosis for the parental inbred PG006 followed by PG016 for producing higher number of fruits per vine when crossed with M2.

The parental inbreds PG002, PG007, PG008 PG009, PG010, PG017 and PG021 had low breeding value. On the other hand the parental inbred PG003, PG005, PG012, PG018, PG019, PG020, PG026 and PG027 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

The relationship between parents and crosses was linear for the character as indicated from the regression line of parents and crosses. A negative correlation was found between the parents and crosses (Fig.7). It was observed that for every one unit increase in the mean value of the parents there is a decrease in crosses by 12.8 units for this trait. The regression of crosses of pointed gourd on parents was obtained as y = -0.127 + 36.9(R^2 = 0.002). The coefficient of determination was 0.002 meaning that 0.2% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the character was not quite adequate and that appeared to be the limiting factor getting number of fruits per vine.

Table 9. Breeding value and allied parameters of number of fruits per vine in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.15	26.0	36.1	-0.052	-0.128	-0.007 ± 1.850
PG003	-1.04	34.4	14.9			
PG005	-0.25	23.0	28.9			
PG006	**2.39**	24.3	**75.9**			
PG007	0.19	23.9	36.8			
PG008	0.63	26.2	44.7			
PG009	0.57	27.0	43.6			
PG010	0.19	23.7	36.8			
PG012	-0.02	12.6	33.1			
PG016	1.52	**39.6**	60.5			
PG017	0.34	32.3	39.5			
PG018	-1.09	30.4	14.1			
PG019	-1.34	36.8	9.7			
PG020	-1.12	34.2	13.5			
PG021	0.28	37.2	38.4			
PG026	-1.26	19.9	11.1			
PG027	-0.16	21.9	30.6			
	$\sum Ai=0.00$	$\overline{Pi}=27.84$	$\overline{Ci}=33.42$			

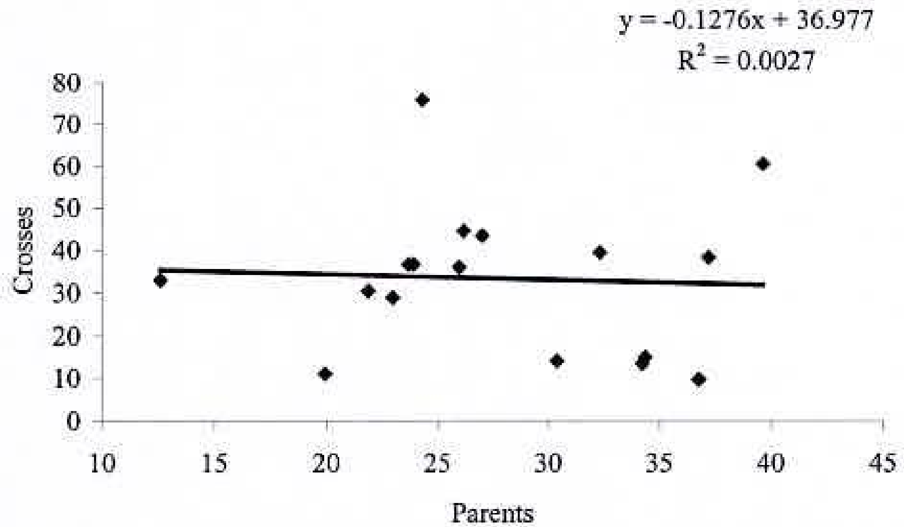


Fig. 7. Regression line depecting regression of number of fruits per vine of parents on crosses in pointed gourd

4.2.8. Number of fruits per plant

In this character the average performance of top crosses was higher than that of the parent ($\overline{Ci}>\overline{Pi}$) indicated significant average heterosis for producing higher number of fruits per plant. The parent PG003 was superior female parent in respect of the character (*per se* mean = 228.3) (Table 10). The top cross PG006 X M2 was superior for this trait. The poorest female parent and top crosses were PG012 (Pi=80.0) and PG026 (Ci=99.0) respectively. In the present study bAP for the character was -0.007±8.640 which was very low indicated low heritability for the parameter. The breeding value of the parental inbred PG006 was 2.39 which was highest among the parents. The order of breeding value of parental inbred was: PG006>PG009>PG010>PG016>PG002>PG005>PG008>PG007>PG027>PG021>PG017>PG012>PG018>PG003>PG020>PG026>PG019. Form the Table 10 it was found that the mean value of the parental top cross (PG006xM2) was higher than the mean value of the parental inbred (Ci=387.3>Pi=121.7). The breeding value of the parent was also highest (2.39) indicated that there is scope of significant and higher positive heterosis for the parental inbred PG006 followed by PG009 when crossed with the male M2. The parental inbreds PG007 had lowest breeding value where as PG002, PG005, and PG010 had low breeding value. On the other hand the parental inbred PG003, PG008, PG012, PG017, PG018, PG019, PG020, PG017, PG 021, PG026and PG027 manifested negative breeding value, hence undesirable for further exploitation in respect of this character. Mishra et *al.* (1994) found both additive and non additive gene actions involved in the expression of number of fruits per plant in bitter gourd (*Momordica charantia L.*). Singh and Joshi (1980) observed that this character was predominantly controlled by additive genes.

Crosses and parents regression line revealed a negative correlation and linear relationship between crosses against parents (Fig.8). This revealed that one unit increase in the mean value of the parents there is decrease in crosses by 69.4 units for this character. The regression of crosses of pointed gourd on parents was obtained as $y = -0.69 + 238.4$ ($R^2 = 0.05$). The coefficient of determination was 0.05 meaning that 5% of total variation for the trait in crosses of pointed gourd is explained by parents implying that within the range of parent tested, the estimated linear relationship of crosses on parents for the character was not quite adequate female parental mean appeared to be the limiting factor getting number of fruits per plant.

Table 10. Breeding value and allied parameters of number of fruits per plant in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.19	111.8	164.0	-0.236	-0.694	-0.007±8.640
PG003	-0.81	**228.3**	63.3			
PG005	0.05	129.5	149.7			
PG006	**2.39**	121.7	**387.3**			
PG007	0.00	158.3	144.7			
PG008	-0.12	106.7	132.7			
PG009	1.94	142.8	341.0			
PG010	1.16	112.8	262.0			
PG012	-0.37	80.0	107.7			
PG016	0.39	113.5	184.3			
PG017	-0.34	149.5	110.3			
PG018	-0.79	144.8	65.0			
PG019	-1.09	144.5	34.7			
PG020	-1.03	170.7	40.7			
PG021	-0.29	114.3	116.0			
PG026	-1.03	99.0	40.3			
PG027	-0.23	162.2	121.3			
	$\sum$ Ai= 0.00	$\overline{Pi}$ =134.74	$\overline{Ci}$ =145.0			

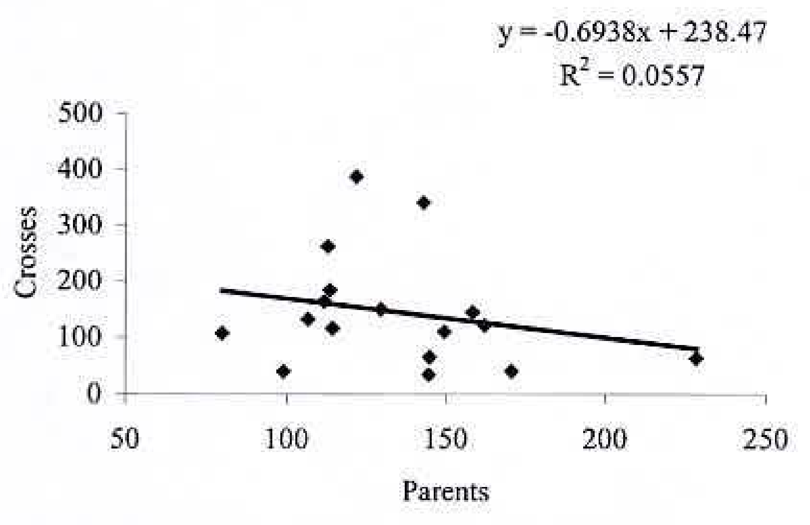


Fig. 8. Rgression line depecting regression of number of fruits per plant of parents on crosses in pointed gourd

4.2.9. Weight of fruits per plant

The average performance of top crosses was higher than that of the parents ($\overline{Ci}>\overline{Pi}$) indicated significant average heterosis of the character. From the Table 11 it was observed that the parent PG005 was superior female parent in respect of increasing weight of fruits per plant (*per se* mean = 4939.2). On the other hand top cross of PG006 with M2 was superior for the trait. The poorest among the female parent was PG021 while the poorest top cross was PG026. The value of bAP for the character was -0.000±201.754 which indicated low heritability for the trait. The breeding value of the parental inbred PG006 was 2.17 which was highest among the parents on positive value basis. The order of breeding value of parental inbred was: PG006>PG009>PG010>PG016>PG008>PG002>PG005>PG021>PG017>PG027>PG012>PG007>PG020>PG018>PG003>PG026>PG019.

However Table 11 showed that the mean value of the parental top cross (PG006xM2) was higher than the mean value of the parental inbred (Ci=12856.7>Pi=49.392). The breeding value of the parent was also highest (2.17) indicated that there was scope of significant and higher heterosis for the parental inbred PG009 followed by PG010 for increasing weight of fruits per plant. The parental inbreds PG002, PG007 and PG016 had low breeding value. On the other hand the parental inbred PG003, PG005, PG008, PG0012, PG017, PG018, PG019, PG020, PG 021, PG026and PG027 manifested negative breeding value, hence undesirable for further exploitation in respect of producing fruits with higher weight. Sahni *et al.* (1987) mentioned that fruit weight controlled by the additive genes in long-fruited bottle gourd.

The regression line of crosses against parents for weight of fruits per plant clearly indicated that the relationship between parents and crosses was linear. A negative correlation was found between the parents and crosses and the result was presented in Fig.9. This showed every one unit increase in the mean value of the parents there is decrease in crosses by 91.1 units for the attribute. The regression of crosses of pointed gourd on parents was obtained as y = -0.91 + 8976.8(R^2 = 0.04). The coefficient of determination was 0.04 meaning that 0.4% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the character was not quite adequate female parental mean appeared to be the limiting factor getting weight of fruits per plant.

Table 11. Breeding value and allied parameters of weight of fruits per plant in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offs pring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.13	3619.7	5636.7	-0.205	-0.911	0.000 ± 201.754
PG003	-0.97	4857.3	1731.3			
PG005	-0.07	**4939.2**	4941.7			
PG006	**2.17**	3637.2	**12856.7**			
PG007	0.30	4467.8	6231.7			
PG008	-0.35	3342.5	3940.0			
PG009	2.09	4301.7	12571.7			
PG010	1.11	4398.0	9125.0			
PG012	-0.34	2846.7	3966.7			
PG016	0.57	4376.7	7203.3			
PG017	-0.24	4793.3	4326.7			
PG018	-0.92	4573.3	1906.7			
PG019	-1.12	5295.0	1200.0			
PG020	-0.92	5310.0	1930.0			
PG021	-0.17	2626.7	4576.7			
PG026	-1.00	3905.0	1650.0			
PG027	-0.26	3585.0	4258.3			
	$\sum$ Ai= 0.00	$\overline{Pi}$ =4169.1	$\overline{Ci}$ =5179.5			

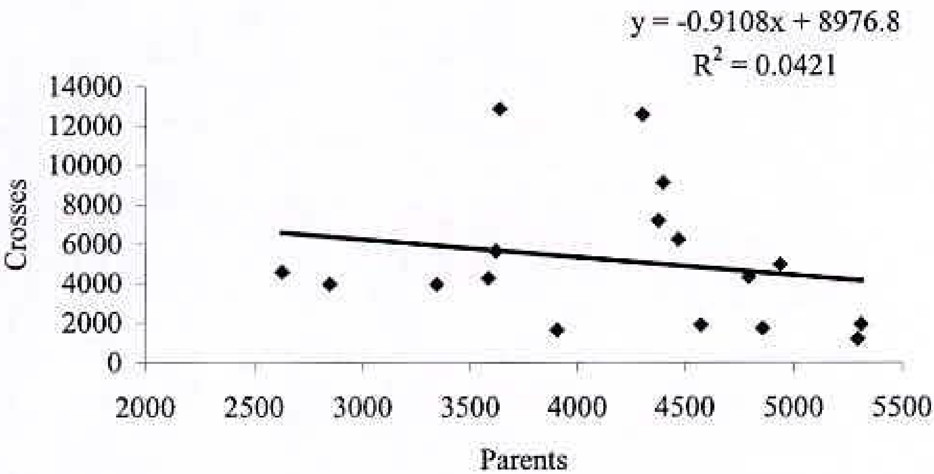


Fig. 9. Regression line depecting regression of weight of fruits per plant of parents on crosses in pointed gourd

4.2.10. Fruit development period

In this character the mean values of top crosses was lower than that of the parent ($\bar{C}i<\bar{P}i$) indicated significant negative heterosis for this trait Table 12 revealed that the female parent PG007 was superior female parent in respect of minimum days required for fruit development period (*per se* mean = 9.0). On the other hand top cross PG020 X M2 was superior in this character. bAP for the character was -0.155±0.416 which was very low indicated low heritability for the trait. The breeding value of the parental inbred PG020 was -1.45 which was highest among the parents. The order of breeding value of parental inbreds was:

PG020>PG021>PG002>PG008>PG016>PG026>PG027>PG003>PG009>PG018>PG019>PG006>PG007>PG017>PG005>PG012>PG010.

However Table 12 was represented that the mean value of the parental top cross (PG020xM2) was higher than the mean value of the parental inbreds (Ci=7.0<Pi=12.3). The breeding value of the parent was also highest (-1.45) indicated that there is scope of significant and higher negative heterosis for the parental inbred PG020 followed by PG021when crossed with M2.

The parental inbreds PG002, PG003, PG007 PG009, PG016, PG018, PG026 and PG027 had low breeding value. On the other hand the parental inbred PG005, PG006, PG008, PG010, PG012, PG017 and PG019 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

The relationship between parents and crosses was linear in respect of this trait as indicated from the regression line of crosses against parents therefore a linear regression of crosses on parents was estimated and a negative correlation found between the parents and crosses (Fig.10). Every one unit increase in the mean value of parents there is a decrease in crosses by 47.8 units for this character. The regression of crosses of pointed gourd on parents was obtained as $y = -0.47 + 17.0(R^2 = 0.06)$. The coefficient of determination was 0.06 meaning that 6% of total variation for the character in crosses of pointed gourd is explained by parents implying that within the range of parent tested, the estimated linear relationship of crosses on parents for the trait was not quite adequate and that appeared to be the limiting factor getting minimum days for fruit development.

Table 12. Breeding value and allied parameters of fruit development period in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-off spring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-1.02	13.7	8.3	-0.258	-0.478	-0.155 ± 0.416
PG003	-0.58	9.7	9.7			
PG005	1.14	11.7	15.0			
PG006	0.93	9.7	14.3			
PG007	-0.69	**9.0**	9.3			
PG008	1.04	10.7	14.7			
PG009	-0.58	11.7	9.7			
PG010	1.68	11.7	16.7			
PG012	1.14	11.3	15.0			
PG016	-0.69	11.7	9.3			
PG017	1.04	10.0	14.7			
PG018	-0.15	12.3	11.0			
PG019	0.71	14.0	13.7			
PG020	**-1.45**	12.3	**7.0**			
PG021	-1.13	11.7	8.0			
PG026	-0.69	13.0	9.3			
PG027	-0.69	15.3	9.3			
	$\sum Ai$= 0.00	$\overline{Pi}$ =11.73	$\overline{Ci}$ =11.47			

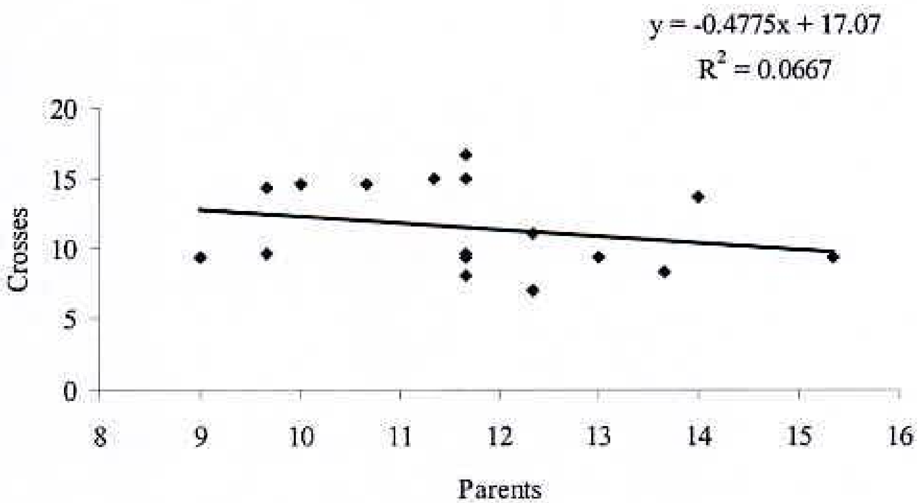


Fig. 10. Regression line depecting regression days required for fruit development period of parents on crosses in pointed gourd

4.2.11. Harvest length (days)

The average performance of top crosses for this trait was lower than that of the parent ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis of the character. From the Table13 it was observed that the parent PG020 was superior female parent in respect of increased harvest length (*per se* mean = 218.7). The top cross PG006 X M2 was also superior for the character. The poorest among the female parent was PG019 for both the statistics (155.0 and 120.0 respectively). The present study bAP for the character was 0.024±64.772, which was very low indicated low heritability for the trait. The breeding value of the parental inbred PG006 was 1.05 which was highest among the parents hence there was fixable genes in this parent and for the trait. The order of breeding value of parental inbred was:

PG006>PG005>PG017>PG010>PG003>PG002>PG021>PG012>PG008>PG016>PG018>PG-009>PG007>PG020>PG027>PG026>PG019.

However Table 13 revealed that the mean value of the parental top cross (PG006xM2) was higher than the mean value of the parental inbred PG006 (Ci=208.3>Pi=194.3). The breeding value of the parent was also highest (1.05) indicated that therewas scope of exploiting of higher positive heterosis for the trait.

The parental inbreds PG002, PG003, PG005, PG007, PG010, PG012, PG016 and PG021 had low breeding value. On the other hand the parental inbred PG002, PG008, PG009, PG018, PG019, PG020, PG016, PG026 and PG027 manifested negative breeding value, hence undesirable for further exploitation of heterosis for increasing harvest length.

The regression line of crosses against parents presented a positive and linear relationship between parents and crosses presented in Fig. 11. This is indicated that every one unit increase in the mean value of the parents there is an increase in crosses by 66.7 units for the character. The regression of crosses of pointed gourd on parents was obtained as $y = 0.61 + 62.6(R^2 = 0.15)$. The coefficient of determination was 0.15 meaning that 15% of total variation for the character in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the character was quite adequate and that appeared to be the least limiting factor getting longer harvest length.

Table 13. Breeding value and allied parameters of harvest length (days) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.61	176.0	197.3	0.992	0.610	0.024 ± 64.772
PG003	0.84	212.0	203.0			
PG005	1.00	216.7	207.0			
PG006	**1.05**	194.3	**208.3**			
PG007	0.33	192.7	190.3			
PG008	-0.21	213.7	176.7			
PG009	-0.17	211.7	177.7			
PG010	0.86	196.7	203.7			
PG012	0.41	190.0	192.3			
PG016	0.03	199.0	182.7			
PG017	0.92	184.0	205.0			
PG018	-0.09	194.0	179.7			
PG019	-2.46	155.0	120.0			
PG020	-0.70	**218.7**	164.3			
PG021	0.44	192.7	193.0			
PG026	-1.55	194.3	143.0			
PG027	-1.31	184.0	149.0			
	$\sum Ai = 0.00$	$\overline{Pi} = 197.57$	$\overline{Ci} = 181.94$			

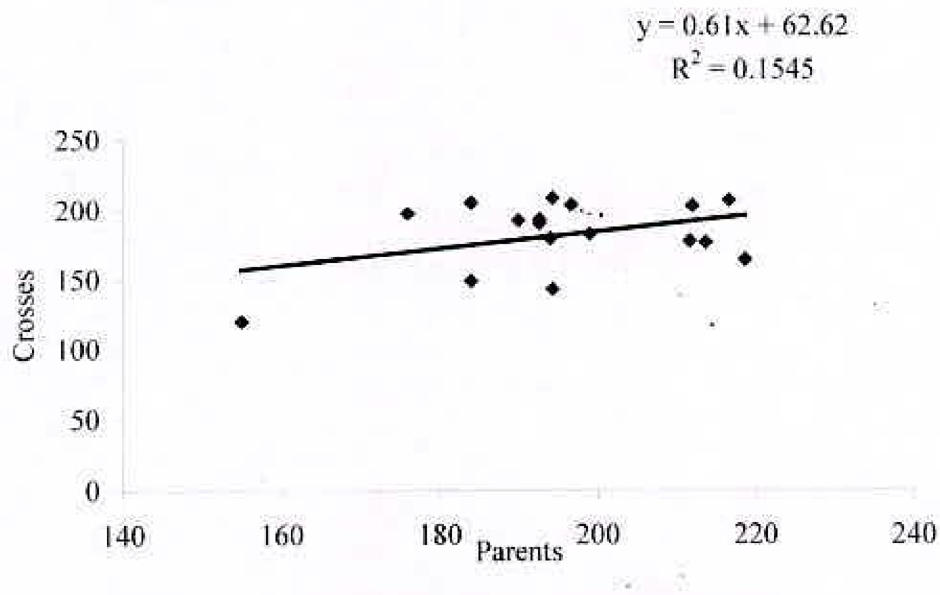


Fig. 11. Regression line depecting regression of harvest length (days)of parents on crosses in pointed gourd

4.2.12. Total number of harvest within the length of time

In this character the average performance of top crosses has lower than that of the parent ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis for the trait. The parent PG016 was superior female parent in respect of increasing total number of harvest within the length of time (*per se* mean = 14.7) (Table14). On the other hand top cross PG002 X M2 was also superior in this character. bAP for the character was very low indicated low (0.240 ± 0.216) heritability for the trait. The breeding value of the parental inbred PG002 was 1.46 which was highest among the parents. The order of breeding value of parental inbred was:

PG002>PG006>PG010>PG005>PG009>PG016>PG008>PG012>PG003>PG007>PG021>PG027>PG017>PG018>PG020>PG-019>PG026.

However Table 14 indicated that the mean value of the parental top cross (PG002xM2) was higher than the mean value of the parental inbred PG002 (Ci=15.3>Pi=12.0). The breeding value of the parent was also highest (1.46) indicated that there was scope of significant and higher positive heterosis for the parental inbred PG002.

The parental inbreds PG003, PG005, PG007, PG008, PG009, PG010, PG012 and PG016 had low breeding value. On the other hand the parental inbred PG017, PG018, PG019, PG020, PG021, PG026 and PG027 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

For this character the relationship between parents and crosses was linear and showed a positive correlation between the parents and crosses (Fig.12). For every one unit increase in the mean value of the parents there is an increase in crosses by 71.9 units for the character. The regression of crosses of pointed gourd on parents was obtained as $y = 0.71 + 1.52(R^2 = 0.04)$. The coefficient of determination was 0.04 meaning that 4% of total variation for the character in crosses of pointed gourd was explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was quite adequate and that appeared to be the least limiting factor getting higher number of harvest within the length of time.

Table 14. Breeding value and allied parameters of total number of harvest within the length of time in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	**1.46**	12.0	**15.3**	0.205	0.719	0.240 ± 0.216
PG003	0.13	13.3	11.3			
PG005	0.91	13.7	13.7			
PG006	1.35	13.3	15.0			
PG007	0.46	13.7	12.3			
PG008	0.02	13.7	11.0			
PG009	0.69	13.7	13.0			
PG010	1.35	13.7	15.0			
PG012	0.35	11.7	12.0			
PG016	0.58	**14.7**	12.7			
PG017	-1.09	13.0	7.7			
PG018	-1.09	13.7	7.7			
PG019	-1.31	12.7	7.0			
PG020	-1.09	13.7	7.7			
PG021	-0.54	12.0	9.3			
PG026	-1.43	12.7	6.7			
PG027	-0.76	11.7	8.7			
	$\sum Ai = 0.00$	$\overline{Pi} = 13.10$	$\overline{Ci} = 10.94$			

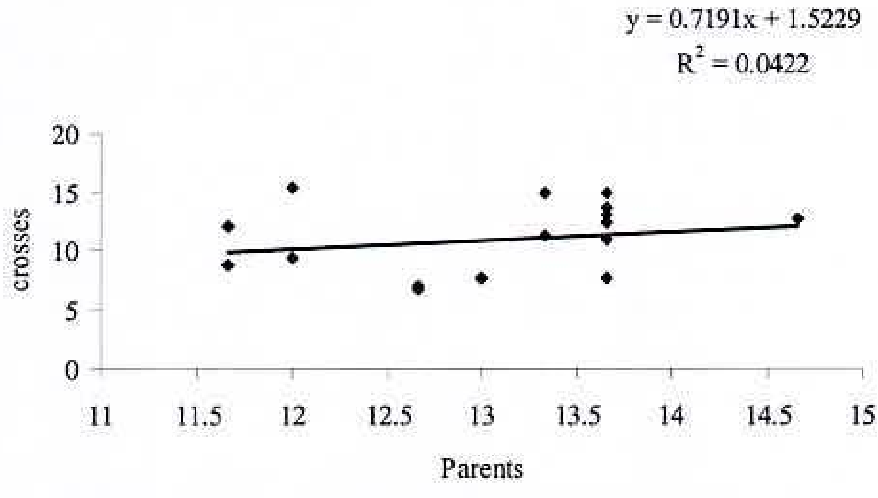


Fig. 12. Regression line depecting regression of number of harvest within the length of time of parents on crosses in pointed gourd

4.2.13. Interval per harvest (days)

The average performance of the top crosses was higher than that of the parent ($\overline{Ci}>\overline{Pi}$) indicated non significant average heterosis on negative value basis for this trait. From the Table15 it was reported that the parent PG019 was superior female parent in respect of reducing interval per harvest (days). On the other hand top cross PG002 X M2 was superior for the character. The poorest female parent and top crosses were PG012 (Pi = 17.8) and PG017 (30.9) respectively. The present study bAP for the character was -0.015$\pm$0.292 which was very low indicated low heritability for the trait. The breeding value of the parental inbred PG002 was -1.17which was highest among the parents. The order of breeding value of parental inbred was:

PG002>PG010>PG009>PG006>PG016>PG005>PG008>PG012>PG007>PG003>PG027>PG019>PG018>PG021>PG020>PG026>PG017.

The mean value of the parental top cross (PG002xM2) was lower than the mean value of the parental inbred (Ci=13.8<Pi=16.1). The breeding value of the parent was also highest (-1.17) indicated that there was scope of significant and higher negative heterosis for the parental inbred PG002 for increasing average interval per harvest (Table 15).

The parental inbreds PG003, PG005, PG006, PG007, PG008, PG009, PG010, PG012 and PG016 had low breeding value. On the other hand the parental inbred PG017, PG018, PG019, PG017, PG020, PG021and PG026 manifested positive breeding value, hence undesirable for further exploitation in respect of this character.

The relationship between parents and crosses was linear as indicated from the regression line of crosses over parents. Therefore a linear regression of crosses on parents was estimated and a positive correlation found between the parents and crosses and the result was presented in Fig.13. It is revealed that every one unit increase in the mean value of the parents there is an in increase by 6.7 units. The regression of crosses of pointed gourd on parents was obtained as y = 0.06 + 17.9 (R^2 = 0.0003). The coefficient of determination was 0.0003 meaning that 0.03% of total variation for the character in crosses of pointed gourd was explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was quite adequate and that appeared to be the least limiting factor in the test of site getting higher number of interval per harvest.

Table 15. Breeding value and allied parameters of interval per harvest (days) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	**-1.17**	16.1	**13.8**	0.017	0.067	0.015 ± 0.292
PG003	-0.20	17.2	18.2			
PG005	-0.59	16.8	16.4			
PG006	-0.92	16.3	14.9			
PG007	-0.46	15.2	17.0			
PG008	-0.28	17.1	17.8			
PG009	-0.93	16.4	14.8			
PG010	-0.99	15.6	14.6			
PG012	-0.34	17.8	17.5			
PG016	-0.76	14.8	15.6			
PG017	2.62	15.3	30.9			
PG018	0.67	16.0	22.1			
PG019	0.21	**13.3**	20.0			
PG020	1.03	16.7	23.7			
PG021	0.76	17.0	22.5			
PG026	1.26	17.4	24.8			
PG027	0.10	16.9	19.5			
	$\sum Ai = 0.00$	$\overline{Pi} = 16.24$	$\overline{Ci} = 19.05$			

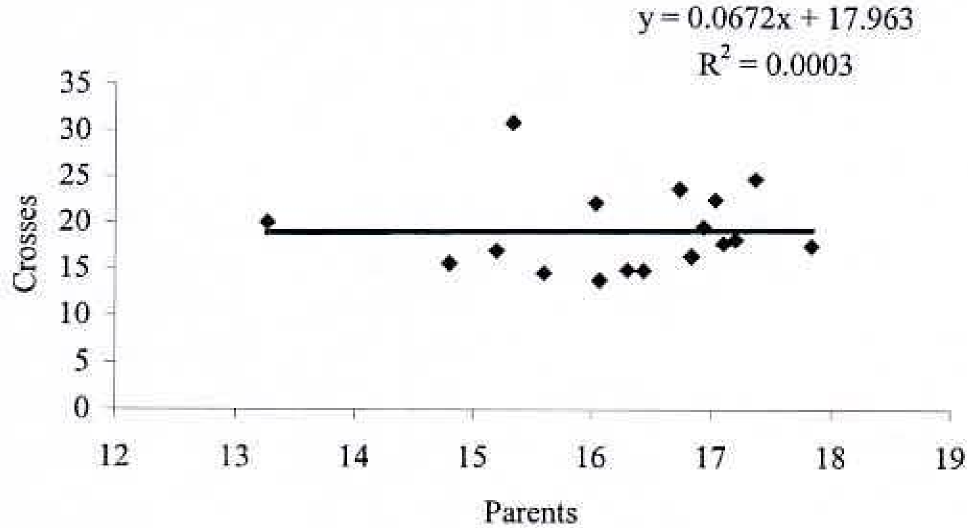


Fig. 13. Regression line depecting regression of average interval per harvest (days) of parents on crosses in pointed gourd

4.2.14. Number of fruits per harvest

In this charater the mean values of top crosses was lower than that of the parent ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis for the trait. Table16 revealed that the parent PG003 was superior female parent in respect of producing higher number of fruits per harvest (*per se* mean = 30.7). On the other hand top cross PG006 X M2 was superior in this character. The poorest among the female parent was PG021, while the poorest top cross was PG020XM2. The value of bAP for the character was very low (-0.032 ± 1.363) indicated low heritability for the trait. The breeding value of the parental inbred PG006 was 2.17which was highest among the parents. The order of breeding value of parental inbred was:

PG006>PG009>PG010>PG016>PG017>PG027>PG007>PG021>PG008>PG005>PG00 2>PG012>PG018>PG026>PG019>PG020>PG003.

Form the Table 16 it was found that the mean values of the parental top cross (PG006xM2) was higher than the mean value of the parental inbred PG006 (Ci=25.6>Pi=19.0). The breeding value of the parent was also highest (3.25) indicated that there was scope of significant and higher positive heterosis for the parent.

The parental inbreds PG008, PG007, PG010, PG016, PG017and PG027 had low breeding value. On the other hand the parental inbred PG002, PG003, PG005, PG007, PG012, PG018, PG019, PG020, PG021and PG026 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

The regression line of crosses against parents for average number of fruits per harvest clearly indicated that the relationship between parents and crosses was linear and hence a linear regression of crosses over parents. A negative correlation found between the parents and crosses (Fig.14). It was revealed that every one unit increase in the mean value of the parents there is a decrease in crosses by 19.6 units. The regression of crosses of pointed gourd on parents was obtained as $y = -0.19 + 16.0$ ($R^2 = 0.02$). The coefficient of determination was 0.02 meaning that 2% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parent tested, the estimated linear relationship of crosses on parents for the trait was not quite adequate female parental mean appeared to be the limiting factor getting higher number of fruits per harvest.

Table 16. Breeding value and allied parameters of number of fruits per harvest in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOp)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.23	12.1	10.9	-0.171	-0.196	-0.032 ± 1.363
PG003	-1.17	**30.7**	5.2			
PG005	-0.21	19.0	11.0			
PG006	**2.17**	19.0	**25.6**			
PG007	-0.13	23.2	11.5			
PG008	0.01	15.6	12.4			
PG009	2.10	20.4	25.2			
PG010	0.88	16.8	17.7			
PG012	-0.47	13.7	9.4			
PG016	0.41	14.1	14.8			
PG017	0.34	23.0	14.4			
PG018	-0.62	21.0	8.5			
PG019	-1.13	23.3	5.4			
PG020	-1.14	23.5	5.3			
PG021	-0.09	9.2	11.7			
PG026	-1.02	14.7	6.0			
PG027	0.28	22.7	14.0			
	$\sum Ai = 0.00$	$\overline{Pi} = 18.94$	$\overline{Ci} = 12.31$			

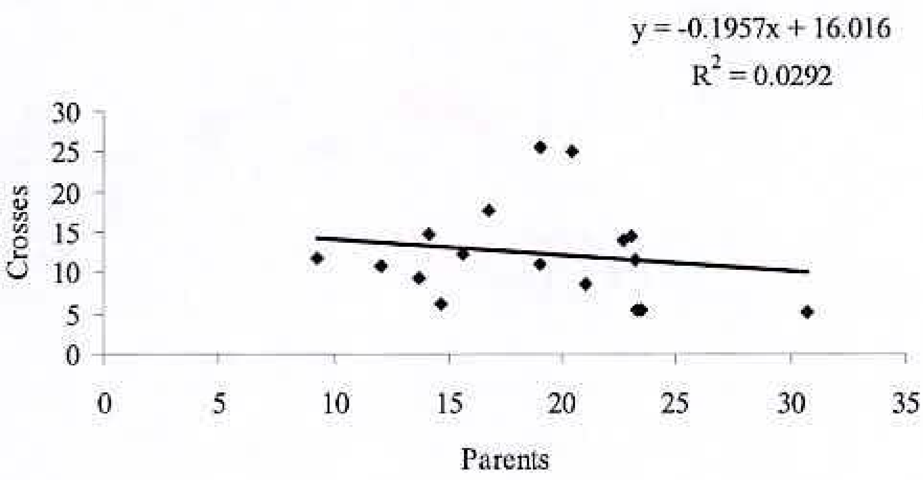


Fig. 14. Regression line depecting regression of number of fruits per harvest of parents on crosses in pointed gourd

4.2.15. Fruits length (cm)

The average performance of the top crosses for this trait was lower than that of the parent ($\overline{Ci}<\overline{Pi}$) indicated non significant average heterosis for the character. The parent PG026 was superior female parent in respect of producing longer fruit length (*per se* mean = 10.0). On the other hand top cross PG020 X M2 was superior in this character. The poorest among the female parents was PG003 for both the statistics (7.1 and 6.5). The present study bAP for the character was very low (0.240±0.217) indicated low heritability for the trait (Table15). The breeding value of the parental inbred PG020 was 2.00, which was highest among the parents. The order of breeding value of parental inbred was: PG020>PG008>PG021>PG006>PG009>PG017>PG027>PG010>PG026>PG002>PG012>PG005>PG016>PG007>PG019>PG018>PG003. Table17 revealed that the mean value of the parental top cross (PG020xM2) was higher than the mean value of the parental inbred (Ci=11.2>Pi=9.3). The breeding value of the parent was also highest (2.00) indicated that there was scope of significant and higher positive heterosis for the parental inbred PG020 for the parameter when crossed with the male M2. The parental inbreds PG006, PG009, PG010, PG017 and PG027 had low breeding value. On the other hand the parental inbred PG002, PG003, PG005, PG008, PG012, PG016, PG018, PG019 and PG026 manifested negative breeding value, hence undesirable for further exploitation in respect of this character. Hormuzdi and More (1989) reported that fruit length in cucumber is controlled by additive gene action. From genetic analysis in long fruited bottle gourd, Sirohi *et al* (1986) reported the presence of additive and non additive gene actions in the expression of fruit length. A linear relationship was observed between parents and crosses were in respect of this character. A positive correlation found between the parents and crosses and the result was presented in Fig.15. This indicated that every one unit increase in the mean value of the parents there is an increase in crosses by 27.3 units for the character. The regression of crosses of pointed gourd on parents was obtained as $y = 0.27 + 6.5$ ($R^2 = 0.04$). The coefficient of determination was 0.04 meaning that 4% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was quite adequate and that appeared to be the least limiting factor in getting longer fruit length (cm).

Table 17. Breeding value and allied parameters of fruits length (cm) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.12	9.6	8.8	0.206	0.273	0.240 ± 0.217
PG003	-2.09	7.1	6.5			
PG005	-0.18	9.7	8.7			
PG006	0.68	9.2	9.7			
PG007	1.44	8.9	10.5			
PG008	-0.68	9.0	8.1			
PG009	0.47	8.7	9.4			
PG010	0.06	9.1	9.0			
PG012	-0.15	9.5	8.7			
PG016	-0.21	7.5	8.7			
PG017	0.24	7.9	9.2			
PG018	-1.35	8.5	7.4			
PG019	-1.21	9.4	7.5			
PG020	**2.00**	9.3	**11.2**			
PG021	0.97	7.4	10.0			
PG026	-0.09	**10.0**	8.8			
PG027	0.21	8.7	9.1			
	$\sum Ai = 0.00$	$\overline{Pi} = 8.80$	$\overline{Ci} = 8.90$			

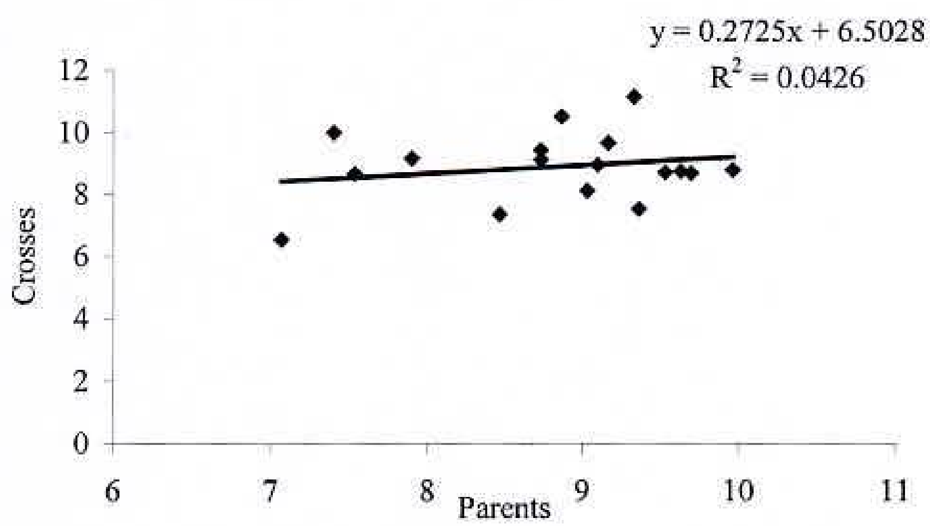


Fig. 15. Regression line depecting regression of fruit length (cm) of parents on crosses in pointed gourd

4.2.16. Fruit weight (g)

There exist significant heterosis for the character because the average values of top crosses were higher than those inbreds ($\overline{Ci}>\overline{Pi}$). It was also observed that the parent PG020 was superior female parent in respect of increasing fruit weight (*per se* mean for both were 45.6). The top cross PG020 X M2 was superior in this character. The value of bAP for the character was 0.018$\pm$1.642 indicated low heritability for the trait. The breeding value of the parental inbred PG007 was 2.18 which was highest among the parents hence there was fixable genes in this parent and for the trait. The order of breeding value of parental inbred was:

PG008>PG020>PG009>PG006>PG021>PG016>PG010>PG002>PG026>PG017>PG005>PG027>PG007>PG012>PG018>PG019>PG003.

However Table18 represented that the mean value of the parental top cross (PG007xM2) was higher than the mean value of the parental inbred PG007 (Ci=56.4>Pi=35.6). The breeding value of the parent was also highest (2.18) indicated that there was scope of exploiting of higher positive heterosis for the trait.

The parental inbreds PG002, PG006, PG009, PG010, PG016, PG021 and PG026 had low breeding value. On the other hand the parental inbred PG003, PG005, PG008, PG012, PG018, PG019 and PG027 manifested negative breeding value, hence undesirable for further exploitation of heterosis for increasing average fruit weight(g). Sahnai *et al.* (1987) reported that fruit weight controlled by the additive genes in long-fruited bottle gourd. Sirohi and Chowdhury (1983) reported that fruit weight was controlled by additive type of genes with partial dominance in bitter gourd.

The regression line of crosses over parents revealed a positive and linear between the parents and crosses (Fig.16). For every one unit increase in the mean value of the parents there is an increase in crosses by 12.1 units. The regression of crosses of pointed gourd on parents was obtained as $y = 0.12 + 37.04$ ($R^2 = 0.01$). The coefficient of determination was 0.01 meaning that 1% of total variation for the character in crosses of pointed gourd was explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was quite adequate and that appeared to be the least limiting factor getting higher fruit weight (gm).

Table 18. Breeding value and allied parameters of fruit weight (g) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent-off spring correlation (rOP)	Parent-off spring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.25	32.5	43.2	0.114	0.121	0.018 ± 1.642
PG003	-1.69	23.9	30.0			
PG005	-0.23	44.9	40.0			
PG006	0.59	41.5	45.6			
PG007	**2.18**	35.6	**56.4**			
PG008	-0.50	36.2	38.1			
PG009	0.87	37.1	47.5			
PG010	0.29	38.4	43.5			
PG012	-0.69	35.9	36.8			
PG016	0.36	38.2	44.0			
PG017	-0.05	36.0	41.2			
PG018	-1.30	39.5	32.7			
PG019	-1.54	45.5	31.0			
PG020	1.36	**45.6**	50.8			
PG021	0.45	23.9	44.6			
PG026	0.00	43.0	41.5			
PG027	-0.35	33.5	39.2			
	$\sum Ai = 0.00$	$\overline{Pi} = 37.14$	$\overline{Ci} = 41.54$			

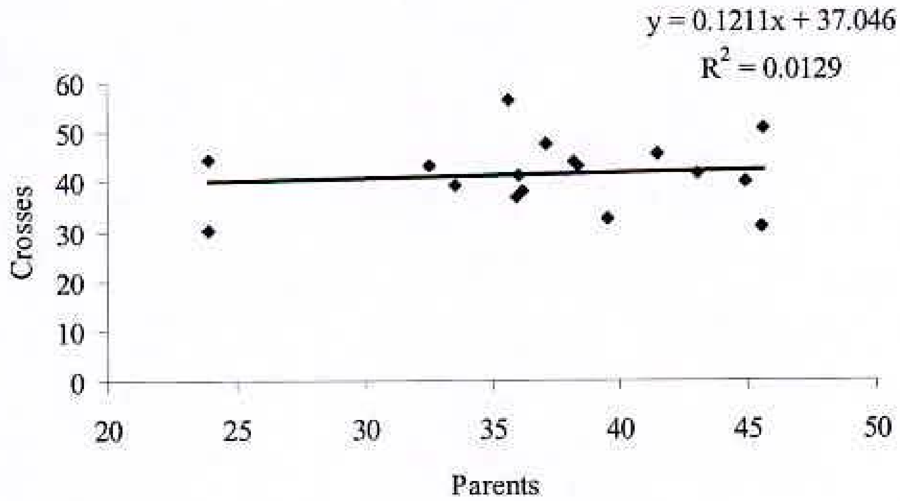


Fig. 16. Regression line depecting regression of fruit weight (g)of parents on crosses in pointed gourd

4.2.17. Pulp weight (g)

In this character the mean values of top crosses was higher than that of the parent ($\overline{Ci}>\overline{Pi}$) indicated significant average heterosis for the trait. Table17 revealed that the parent PG005 was also superior female parent in respect of increasing pulp weight (*per se* mean = 41.7). On the other hand top cross PG007 X M2 was superior for the trait. The poorest among the female parent was PG021 (Pi=18.6), while the poorest top cross was PG010 X M2 (Ci=27.2). In the present study bAP for the character was 0.17±1.620 which was very low indicated low heritability for the trait. The breeding value of the parental inbred PG007 was 2.10 which was highest among the parents hence there was fixable genes in this parent and for the character. The order of breeding value of parental inbred was:

PG008>PG020>PG009>PG006>PG016>PG021>PG010>PG005>PG026>PG002>PG01 7>PG007>PG027>PG-012>PG018>PG019>PG003

The mean value of the parental top cross (PG007xM2) was higher than the mean value of the parental inbred (Ci=48.5>Pi=31.0). The breeding value of the parent was also highest (3.25) indicated that there was scope of exploiting of higher positive heterosis for the trait (Table 19).

The parental inbreds PG005, PG006, PG009, PG010, PG016, PG021 and PG026 had low breeding value. On the other hand the parental inbred PG002, PG003, PG008, PG012, PG017, PG018, PG019 and PG027 manifested negative breeding value, hence undesirable for further exploitation in respect of this character.

In respect of pulp weight (gm) the relationship between parents and crosses was linear and revealed a positive correlation between the parents and crosses (Fig.17). Every one unit increase in the mean value of the parents there is an increase in crosses by 9.8 units. The regression of crosses of pointed gourd on parents was obtained as y = 0.09 + 32.9 (R^2 = 0.01). The coefficient of determination was 0.01 meaning that 1% of total variation in crosses of pointed gourd was explained by parents for the trait implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the character was quite adequate and that appeared to be the least limiting factor getting increasing pulp weight(g).

Table 19. Breeding value and allied parameters of pulp weight (g) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - offspring correlation (rOP)	Parent-off spring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.10	28.3	35.6	0.105	0.098	0.017 ± 1.620
PG003	-1.51	20.4	27.2			
PG005	0.02	**41.7**	36.2			
PG006	0.54	38.2	39.3			
PG007	**2.10**	31.0	**48.5**			
PG008	-0.35	32.9	34.1			
PG009	0.73	32.0	40.4			
PG010	0.17	32.3	37.1			
PG012	-0.79	32.5	31.5			
PG016	0.44	33.0	38.7			
PG017	-0.17	30.7	35.1			
PG018	-1.32	34.6	28.3			
PG019	-1.50	39.2	27.3			
PG020	1.77	37.6	46.6			
PG021	0.38	18.6	38.4			
PG026	0.02	41.4	36.2			
PG027	-0.42	30.3	33.7			
	$\sum Ai = 0.00$	$\overline{Pi} = 32.64$	$\overline{Ci} = 36.14$			

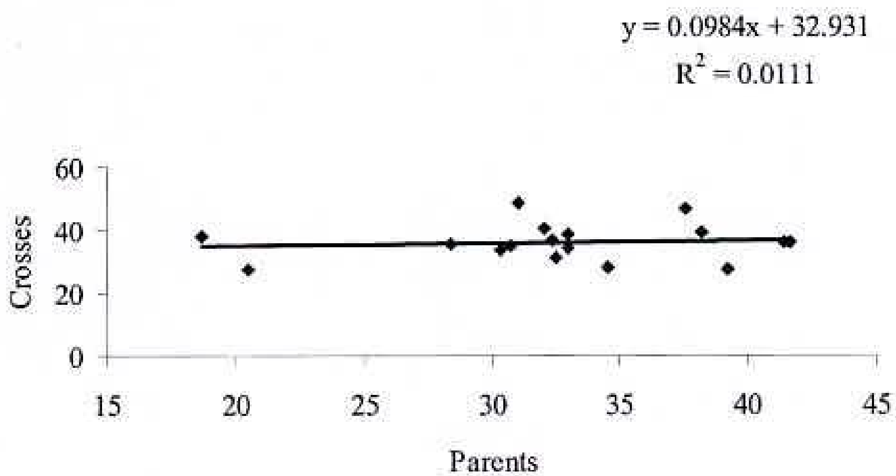


Fig. 17. Regression line depecting regression of pulp weight (gm) of parents on crosses in poited gourd

4.2.19. Number of seeds per fruit

The average performance of the top crosses was higher than that of the parent ($\overline{Ci}>\overline{Pi}$) indicated non significant heterosis of the character negative value basis. It was also found that the parent PG026 was superior female parent in respect of lower number of seeds per fruit. On the other hand, top cross PG018 X M2 was superior in respect of lower number of seeds per fruit. The value of bAP for the character was -0.002±1.037 which was very low in case of reduced number of seeds per fruit. Breeding value of the parental inbred PG018 was -1.63 which was highest among the parents in respect of lower number of seeds per fruit hence there was fixable genes in the parent and for the character. The order of breeding value of parental inbred was:

PG018>PG019>PG027>PG016>PG007>PG005>PG026>PG003>PG010>PG006>PG009>PG008>PG002>PG012>PG020>PG017>PG021.

The mean value of the parental top cross (PG018 X M2) was higher than the mean value of the parental inbred PG018. The breeding value of the parent was also highest (-1.63) indicated that there was scope of significant and higher negative heterosis for the parental inbred PG018 in respect of lower number of seeds per fruit (Table 20). The parental inbreds PG002, PG007, PG009, PG012, PG017, PG020, and PG021 manifested positive breeding value, hence undesirable for further exploitation in respect of this character.

The relationship between parents and crosses was linear in respect of this character as indicated from the regression line of crosses over parents. Therefore a positive correlation was found between the parents and crosses (Fig.18). Every one unit increase in the mean value of the parents there is an increase by 0.8 units in crosses for the trait. The regression of crosses of pointed gourd on parents was obtained as y = 0.0081 + 16.9 (R^2 = 0.00009). The coefficient of determination was 0.00009 meaning that 0.009% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was quite adequate female parental mean appeared to be the least limiting factor for number of seeds per fruit.

Table 20. Breeding value and allied parameters of number of seeds per fruit in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - offspring correlation (rOP)	Parent-offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.91	18.5	20.1	0.010	0.008	0.002 ± 1.037
PG003	-0.30	19.9	16.1			
PG005	-0.34	22.0	15.9			
PG006	-0.20	20.9	16.4			
PG007	0.88	16.9	20.0			
PG008	-0.42	16.1	15.7			
PG009	0.04	14.7	17.2			
PG010	-0.26	14.3	16.2			
PG012	1.02	21.0	20.5			
PG016	-0.73	12.2	14.6			
PG017	1.47	11.9	22.0			
PG018	**-1.63**	12.7	**11.6**			
PG019	-1.46	21.0	12.2			
PG020	1.17	23.1	21.0			
PG021	1.47	13.1	22.0			
PG026	-0.34	**10.9**	15.9			
PG027	-1.31	19.3	12.7			
	$\sum Ai = 0.00$	$\overline{Pi} = 16.97$	$\overline{Ci} = 17.06$			

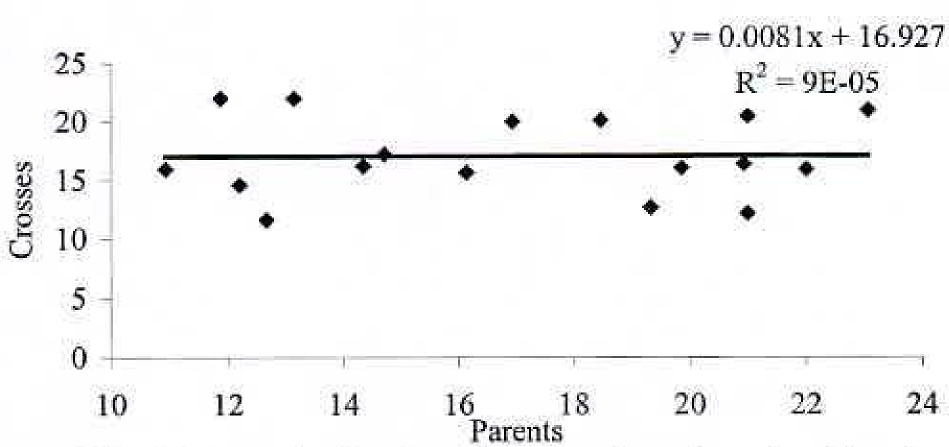


Fig. 18. Regression line depecting regression of number of seeds per fruit of parents on crosses in pointed gourd

4.2.20. Weight of seeds per fruit (g)

In this character the average performance of the top crosses was higher than that of the parent ($\overline{Ci}>\overline{Pi}$) indicated non significant average heterosis for the character. From the Table 21 it was reported that the parent PG021 was superior female parent in respect of reduced weight of seeds per fruit (*per se* mean = 2.1). Top cross PG019 X M2 was superior in respect of reduced weight of seeds per fruit. In the present study bAP for the character was very low (-0.681$\pm$0.163) indicated low heritability for the trait. The breeding value of the female parental inbred PG019 was -1.45 which was highest among the parents in respect of reduced weight of seeds per fruit. The order of breeding value of parental inbred was:

PG019>PG006>PG018>PG002>PG027>PG007>PG005>PG010>PG003>PG026>PG01 2>PG009>PG020>PG016>PG021>PG00-8>PG017.

From the Table 21 it was reported that the mean value of the parental top cross (PG019XM2) was higher than the mean value of the parental inbred PG019. The breeding value of the parent was also highest (-1.45) indicated that there was scope of exploiting of significant and higher negative heterosis for the character.

The parental inbreds PG002, PG003, PG005, PG008, PG009, PG010, PG012, PG016, PG018, PG020, PG021, PG026 and PG027 had low breeding value. On the other hand parental inbreds PG007, PG009, PG012, PG016, PG017, PG020, and PG021 manifested positive breeding value, hence undesirable for further exploitation in respect of this character.

The regression line of crosses against parents revealed a negative correlation between parent and crosses in respect of this trait. The result was presented in Fig.19. This revealed that every one unit increase in the mean value of the parents there is a decrease in crosses by 55.9 units. The regression of crosses of pointed gourd on parents was obtained as $y = -0.559 + 5.4$ ($R^2 = 0.2$). The coefficient of determination was 0.2 meaning that 20% of total variation for the trait in crosses of pointed gourd was explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the character was not quite adequate female parental mean appeared to be the limiting factor in respect of getting lower weight of seeds per fruit.

Table 21. Breeding value and allied parameters of weight of seeds per fruit (g) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - off spring correlation (rOP)	Parent - off spring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.80	3.7	3.1	-0.496	-0.559	-0.681± 0.163
PG003	-0.27	3.4	3.5			
PG005	-0.35	3.2	3.5			
PG006	-1.00	3.5	2.9			
PG007	1.68	2.8	5.1			
PG008	-0.76	3.2	3.1			
PG009	0.21	2.5	3.9			
PG010	-0.35	2.0	3.5			
PG012	0.01	3.1	3.8			
PG016	0.95	2.3	4.5			
PG017	1.80	2.4	5.2			
PG018	-0.96	2.7	3.0			
PG019	**-1.45**	4.7	**2.6**			
PG020	0.62	4.2	4.3			
PG021	1.55	**2.1**	5.0			
PG026	-0.07	3.2	3.7			
PG027	-0.80	2.7	3.1			
	$\sum Ai = 0.00$	$\overline{Pi} = 3.05$	$\overline{Ci} = 3.76$			

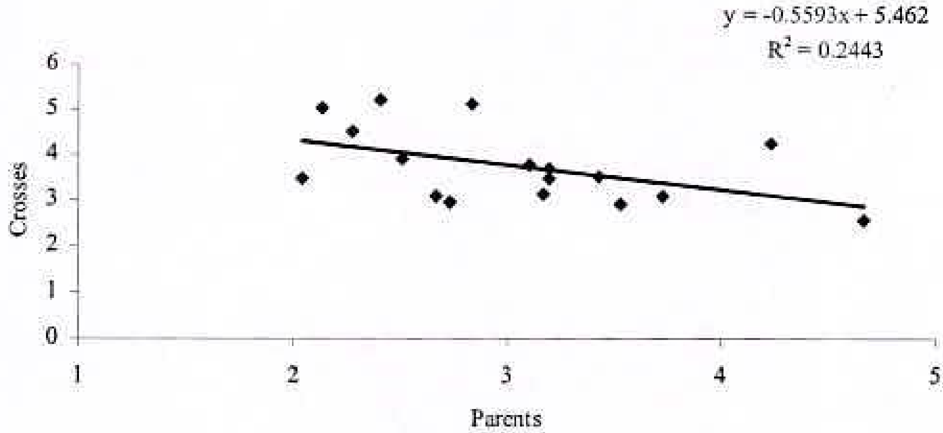


Fig. 19. Regression line depecting regression of weight of seeds per fruit (gm) of parents on crosses in poited gourd

4.2.21. Pulp: seed ratio (by weight)

There exist insignificance average heterosis for the character because the average performance of top crosses was lower than that of the parent $(\overline{Ci}<\overline{Pi})$. It was also found that the parent PG006 was superior female parent in respect of increasing pulp: seed ratio (by weight). On the other hand top cross PG003 X M2 was also superior for the character. The poorest among the female parent was PG019 (Pi=6.7), while the poorest top cross was PG012 (Ci=7.2). The value of bAP for the character was very low (0.051 ± 0.625) indicated low heritability for the trait (Table 22). Breeding value of the parental inbred PG003 was 15.9 which was highest among the parents hence there was fixable genes in this parent for the character. The order of breeding value of parental inbred was:

PG006>PG002>PG009>PG020>PG010>PG027>PG007>PG019>PG005>PG008>PG01 8>PG026>PG016>PG012>PG003>PG021>PG017.

However Table 22 indicated that the mean value of the parental top cross (PG006XM2) was higher than the mean value of the parental inbred PG006 (Ci=11.5>Pi=1.05). The breeding value of the parent was also highest (15.9) indicated that there was scope of exploiting of higher heterosis for the character.

The parental inbreds PG005, PG007, PG008 PG010, PG018, PG019, PG020and PG027 had low breeding value and the parental inbred PG003, PG012, PG016, PG017, PG012, PG016, PG017, PG021and PG026 manifested negative breeding value, hence undesirable for further exploitation of heterosis for increasing pulp: seed ratio.

Crosses against parents revealed a positive correlation from the regression line of crosses over parents (Fig.20). This showed that every one unit increase in the mean value of the parents there is an increase in crosses by 7.7 units. The regression of crosses of pointed gourd on parents was obtained as $y = 0.077 + 9.07$ ($R^2 = 0.01$). The coefficient of determination was 0.01 meaning that 1% of total variation for the trait in crosses of pointed gourd was explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents was quite adequate for the character and that appeared to be the limiting factor in respect of getting increasing pulp: seed ratio.

Table 22. Breeding value and allied parameters of pulp: seed ratio (by weight) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - offspring correlation (rOP)	Parent - offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	1.03	8.5	**11.5**	0.124	0.077	0.051 ± 0.625
PG003	-1.44	6.0	7.7			
PG005	0.44	13.1	10.6			
PG006	**1.05**	10.9	**11.5**			
PG007	0.28	10.9	10.4			
PG008	0.61	10.4	10.9			
PG009	1.03	12.9	**11.5**			
PG010	0.63	**15.9**	10.9			
PG012	-1.00	10.5	8.4			
PG016	-0.90	13.6	8.6			
PG017	-2.14	12.8	6.7			
PG018	0.11	11.9	10.1			
PG019	0.55	8.4	10.8			
PG020	0.66	8.9	10.9			
PG021	-1.46	8.7	7.7			
PG026	-0.07	13.1	9.8			
PG027	0.63	10.7	10.9			
	$\sum Ai = 0.00$	$\overline{Pi} = 11.02$	$\overline{Ci} = 9.93$			

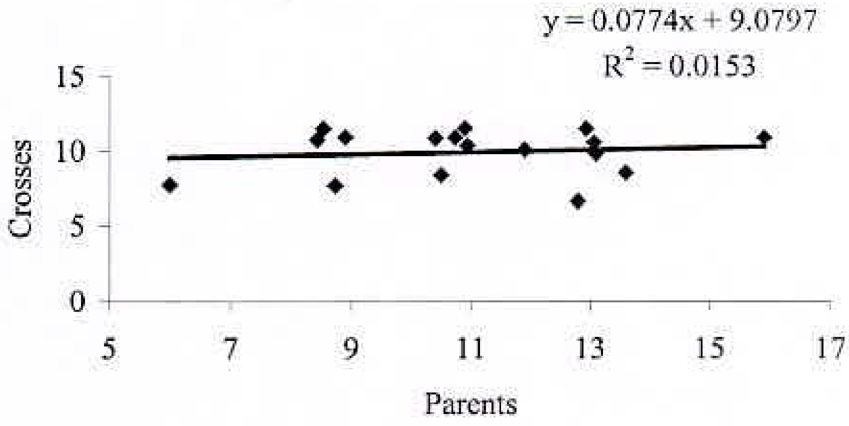


Fig. 20. Regression line depecting regression of pulp:seed ratio (by weight) of parents on crosses in pointed gourd

4.2.22. Dry matter (%)

The average performance of top crosses was higher than that of the parents ($\overline{Ci}>\overline{Pi}$) indicated significant heterosis for the trait. From the Table23 it was observed that the parent PG006 was superior female parent in respect of producing higher dry matter (%). On the other hand, top cross PG003 X M2 was also superior in this character. The value of bAP for the character was 0.063$\pm$0.262 indicated low heritability for the trait. The breeding value of the parental inbred PG003 was 2.79which was highest among the parents. The order of breeding value of parental inbred was:

PG003>PG021>PG019>PG018>PG010>PG007>PG017>PG006>PG009>PG016>PG026>PG005>PG008>PG020>PG002>PG027>PG012.

Table 23 presented that the mean value of the parental top cross (PG003xM2) was higher than the mean value of the parental inbred (Ci=13.9>Pi=9.5). The breeding value of the parent was also highest (2.79) indicated that there was scope of significant and higher positive heterosis for the parental in bread PG006 followed by PG021 for higher dry matter (%) when crossed with M2.

The parental inbreds PG008, PG010, PG018 and PG019 had low breeding value. On the other hand the parental inbred PG002, PG005, PG006, PG007, PG09, PG012, PG016, PG017, PG 020, PG026and PG027 manifested negative breeding value, hence undesirable for further exploitation of heterosis for increasing dry matter (%).

The regression line of crosses against parents for dry matter (%) indicated that the relationship between parents and crosses was linear and hence a linear. A positive correlation was found between the parents and crosses as showed in Fig.21. For every one unit increase in the mean value of the parents there is an increase in crosses by 10.2 units for this attribute. The regression of crosses of pointed gourd on parents was obtained as y = 0.10 + 8.5 (R^2 = 0.004). The coefficient of determination was 0.004 meaning that 0.4% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses over parents for the trait was quite adequate female parental mean appeared to be the least limiting factor in respect of getting increasing dry matter content (%).

Table 23. Breeding value and allied parameters of dry matter (%) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - offspring correlation (rOP)	Parent - offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-1.09	9.1	7.6	0.064	0.102	0.063 ± 0.262
PG003	**2.79**	9.5	**13.9**			
PG005	-0.31	9.6	8.9			
PG006	-0.04	**9.8**	9.3			
PG007	-0.51	7.6	8.6			
PG008	0.10	8.7	9.6			
PG009	-0.08	9.0	9.3			
PG010	0.12	9.1	9.6			
PG012	-1.33	7.9	7.2			
PG016	-0.10	8.9	9.2			
PG017	-0.02	7.3	9.4			
PG018	0.35	7.7	10.0			
PG019	0.88	6.7	10.8			
PG020	-0.62	7.7	8.4			
PG021	1.37	7.1	11.6			
PG026	-0.25	9.6	9.0			
PG027	-1.27	7.2	7.3			
	$\sum$ Ai = 0.00	$\overline{Pi}$ = 8.38	$\overline{Ci}$ = 9.40			

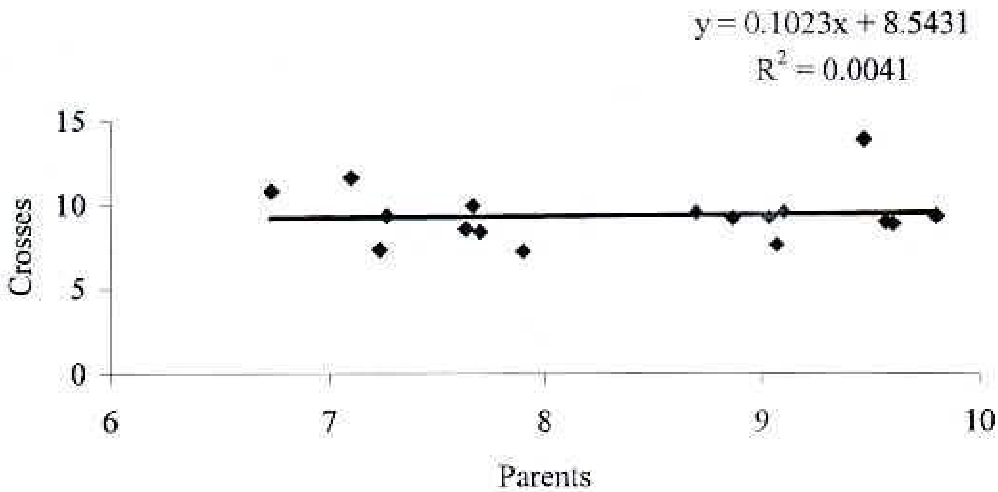


Fig. 21. Regression line depecting regression of dry matter (%) of parents on crosses in pointed gourd

4.2.23. Yield per harvest (g)

In this character the mean values of top crosses was lower than that of the parent $(\overline{Ci}<\overline{Pi})$ indicated non significant average heterosis for the character. The parent PG019 was superior female parent in respect of highest yield per harvest (*per se* mean = 835.6). On the other hand, top cross PG021 X M2 was superior for the character (Table 24). The poorest among the female parent was PG007 (Pi=218.9), while the poorest top cross was PG003 X M2 (Ci=151.6). In the present study bAP for the character was which was very low (-0.002 ± 38.998) indicated low heritability for the trait. The breeding value of the parental inbred PG009 was 2.32 which was highest among the parents. The order of breeding value of parental inbred was:

PG009>PG006>PG010>PG016>PG017>PG008>PG027>PG021>PG002>PG007>PG005>PG012>PG020>PG018>PG026>PG019>PG003.

The mean value of the top cross (PG009xM2) was higher than that of the parental inbreds (Ci=969.0>Pi=629.4). The breeding value of the parent was also highest (2.32) indicated that there was scope of significant and higher positive heterosis for the parental in bread PG009 followed by PG006 for higher average yield (g) when crossed with M2.

The parental inbreds PG007, PG010, PG016, PG017, PG021 and PG027 had low breeding value. On the other hand the parental inbred PG002, PG003, PG005, PG008, PG012, PG018, PG019, PG020and PG026 manifested negative breeding value, hence undesirable for further exploitation for the character.

Parent and crosses expressed linear relationship in respect of the trait as indicated from the regression line of crosses against parent. Therefore a linear regression of crosses on parents was estimated and a negative correlation was found between the parents and crosses (Fig.22). This indicated that every one unit increase in the mean value of the parents there is a decrease in crosses by 34.2 units. The regression of crosses of pointed gourd on parents was obtained as y = -0.34 + 646.2 (R^2 = 0.05). The coefficient of determination was 0.05 meaning that 0.5% of total variation in crosses of pointed gourd was explained by parents for the character implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the was not quite adequate female parental mean appeared to be the limiting factor getting increasing yield per harvest (g).

Table 24. Breeding value and allied parameters of yield per harvest (g) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - offspring correlation (rOP)	Parent - offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	-0.34	390.7	367.5	-0.235	-0.342	-0.002 ± 38.991
PG003	-1.29	724.1	151.6			
PG005	-0.38	723.5	357.5			
PG006	1.82	545.6	856.6			
PG007	0.28	653.4	508.2			
PG008	-0.37	489.5	359.5			
PG009	**2.32**	629.4	**969.0**			
PG010	0.73	643.9	608.4			
PG012	-0.50	488.0	330.6			
PG016	0.55	447.6	569.0			
PG017	0.54	737.4	565.6			
PG018	-0.86	665.8	249.0			
PG019	-1.21	**835.6**	171.4			
PG020	-0.84	776.1	254.1			
PG021	0.21	218.9	491.0			
PG026	-0.87	582.4	247.6			
PG027	0.21	609.4	492.6			
	$\sum Ai = 0.00$	$\overline{Pi} = 597.72$	$\overline{Ci} = 444.08$			

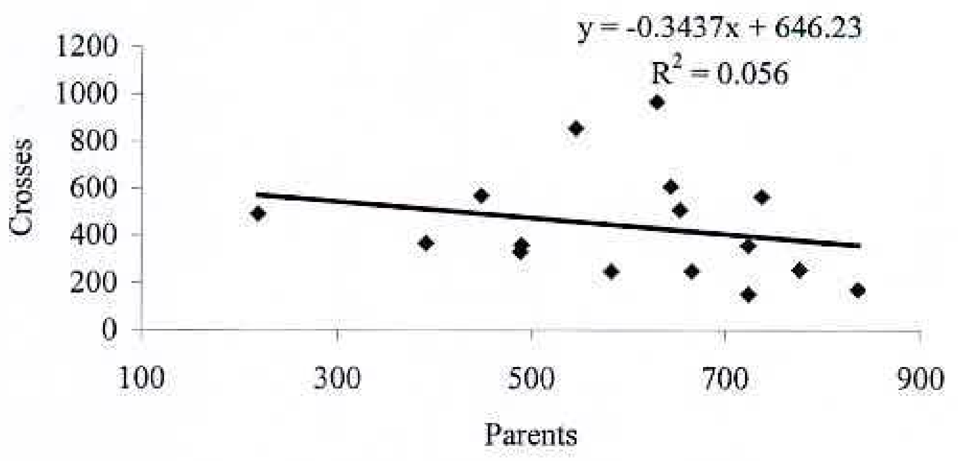


Fig. 22. Reression line depecting regression of yield per harvest(gm) of parents on crosses in pointed gourd

4.2.24. Yield (t/ha)

There exist non significant heterosis for the character because the mean values of top crosses was lower than that of parental inbreds ($\overline{Ci}<\overline{Pi}$). From the Table 25 it was found that the parent PG009 and PG020 were also superior female parent in respect of highest yield (*per se* mean for both were 21.2). The top cross with PG020 X M2 was superior for the character. The poorest among the female parent was PG006, while the poorest top cross was PG019 X M2. The value of bAP for the character was -0.027$\pm$1.139 indicated low heritability for the trait. The breeding value of the parental inbred PG006 was 2.16 which was highest among the parents. The order of breeding value was:
PG006>PG009>PG010>PG016>PG008>PG002>PG005>PG017>PG021>PG012>PG007>PG027>PG018>PG003>PG020>PG026>PG019. The mean value of the parental top cross (PG006xM2) was higher than the mean value of the parental inbred PG006 (Ci=25.7>Pi=14.6). The breeding value of the parent was also highest (2.16) indicated that there was scope of exploiting higher positive heterosis for the parental inbred PG006 which was followed by PG009 for the parameter when crossed with male M2 (Table 25). The parental inbreds PG002, PG007, PG010 and PG016 had low breeding value. On the other hand the parental inbred PG003, PG005, PG008, PG0012, PG017, PG018, PG019, PG020, PG021and PG026 manifested negative breeding value, hence undesirable for further exploitation for increased yield (t/ha). Mishra et *al.* (1994) observed both additive and non additive gene actions were involved in the expression yield per plant in bitter gourd (Momordica *charantia L.*). Hormuzdi and More (1989) also found similar result for this character in cucumber. The regression line of crosses against parents showed a negative and linear relationship between crosses against parents and the result was presented in Fig. 22. This indicated that every one unit increase in the mean value of the parents there is a decrease in crosses by 19.6 units. The regression of crosses of pointed gourd on parents was obtained as y = -0.195+ 13.21 (R^2 = 0.01). The coefficient of determination was 0.01 meaning that 0.1% of total variation for the character in crosses of pointed gourd was explained by parents implying that within the range of parents tested, the estimated linear relationship of crosses on parents for the trait was not quite adequate female parental mean appeared to be the limiting factor for getting highest yield (t/ha).

Table 25. Breeding value and allied parameters of yield (t/ha) in pointed gourd

Parents	Breeding value (Ai)	Parent mean (Pi)	Cross mean (Ci)	Parent - offspring correlation (rOP)	Parent - offspring regression (bOP)	Regression of breeding value(A) on phenotypic value(bAP)
PG002	0.15	7.5	11.3	-0.121	-0.196	-0.027 ± 1.139
PG003	-0.93	16.1	3.5			
PG005	-0.04	19.8	9.9			
PG006	**2.16**	14.6	**25.7**			
PG007	0.32	17.9	12.5			
PG008	-0.32	13.4	7.9			
PG009	2.08	17.2	25.1			
PG010	1.13	17.6	18.3			
PG012	-0.32	11.4	7.9			
PG016	0.59	13.1	14.4			
PG017	-0.21	19.2	8.6			
PG018	-0.89	18.3	3.8			
PG019	-1.12	**21.2**	2.1			
PG020	-0.93	**21.2**	3.5			
PG021	-0.28	5.3	8.2			
PG026	-1.01	15.6	2.9			
PG027	-0.36	14.3	7.6			
	$\sum$ Ai = 0.00	$\overline{Pi}$ = 15.51	$\overline{Ci}$ = 10.17			

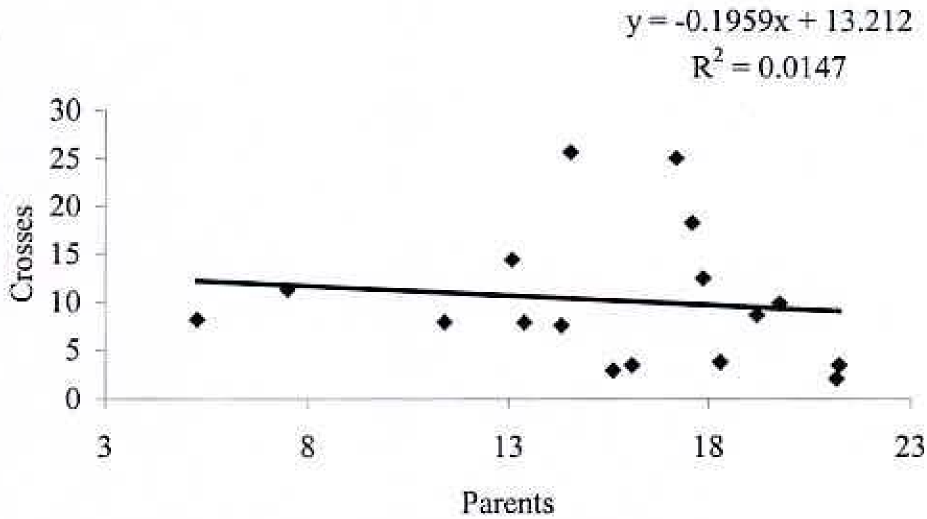


Fig. 23. Reression line depecting regression of yield (t/ha) of parents on crosses in pointed gourd

4.3. Heterosis

Percent heterosis over female parent of 17 hybrids of pointed gourd was presented in Table 26. Heterosis over female parent for first flowering node number, days to first female flower, vine length at first harvest, number of node at first harvest, length of internode at first harvest, number of vines per plant, number of fruits per vine, weight of fruit per plant, fruit length, fruit width, fruit weight, pulp weight, dry matter (%), days required for flowering to harvest, harvest length, total number of harvest within the harvest length, interval per harvest, number of fruits per harvest, yield per harvest, harvest length, weight of seeds per fruit, pulp: seed ratio, and yield were estimated. The results are discussed below.

4.3.1. Number of vines per plant

Among all crosses, both positive and negative heterosis over female parent was observed in this trait. Heterosis for number of vines per plant ranged from -38.89% to 50.00%. However, positive heterosis ranged from 7.09% to 50.00%. Positive female parent heterosis was showed by five cross combinations. The highest female parent heterosis of the cross was obtained from PG009XM2 (50.00%) followed by PG010XM2. Thus, the combination PG009XM2 can be used as a desirable combination for getting highest number of vines per plant.

4.3.2. Vine length at first harvest (cm)

Heterosis for vine length at first harvest ranged from -36.55% to 342.98%. Out of seventeen cross combination, two crosses showed negative heterotic effect for the trait. Again negative significant female parent heterosis was showed by fifteen cross combinations and the highest value for the parameter was showed by PG010XM2 (342.98%). Thus, the cross combination PG010XM2 can be used as a desirable combination for getting smallest vine length at first harvest. Mohanty and Mishra (1999) found similar result in the cross Baidyabati X Pusa Vishwars for vine length (917.8%) in pumpkin.

4.3.3. Number of node at first harvest

Among all crosses, both positive and negative heterosis over female parent was observed in this trait. Hrterosis for the trait ranged from -27.78% to 225.0%. The positive heterosis ranged from 4.10% to 225.00% and negative heterosis ranged form -11.21% to -27.78%. The most desirable combination for this trait was observed by the hybrid PG027XM2 followed by PG010XM2 on the basis of negative heterosis.

4.3.4. Length of internodes at first harvest (cm)

Out of seventeen cross combination, nine cross combination showed significant negative female parent heterosis for this trait. Heterosis foe length of internodes at first harvest (cm) ranged from -23.50% to 63.98%. The highest value of the parameter was observed in PG017XM2 (-23.50%) followed by PG010XM2.

4.3.5. Days to first flower

All the top crosses showed significant and negative heterosis. Hterosis for earliness in female flower ranged from -9.91% to -45.62%. The highest negative heterotic effect (-45.62%) was found for this character in hybrid PG020XM2 followed by PG016XM2. Thus, the cross combination can be used as a desirable combination for getting earlier flower. Ahmed (1998) reported both positive and negative heterosis over better parent for yield contributing characters in Snakegourd. He reported that among the F1 hybrids, "Green long X White long", was the earliest in first flowering with the longest fruit. Srivastova and Nath (1983) studied the heterosis in bitter gourd and they observed negative heterosis (-16.7%) for days to first female flowering.

4.3.6. First flower bearing node number

Among all crosses, both positive and negative heterosis over female parent was observed in this trait. Heterosis for first flower bearing node number ranged from -27.50% to 285.29%. Out of seventeen cross combination, only one showed significant negative heterosis which was -27.50%. The positive heterosis was ranged from 2.13% to 285.29%.

The most desirable combination for this trait was observed by the hybrid PG007XM2, can be used as a best combination.

4.3.7. Number of fruits per vine

Out of seventeen cross combination only five hybrids exhibited negative heterosis, but rest of cross combination showed significant positive heterosis for this trait. -60.47% to 212.21% heterosis was observed for number of fruits per vine. Positive hrterosis for female parent ranged from 3.23% to 212.21%, but positive highest significant female parent heterosis was showed by the cross combination PG006XM2 (212.21%), can be used as a hybrid variety.

4.3.8. Number of fruits per plant

Both positive and negative heterosis was observed in this trait. Among the 17 crosses, eight crosses were less than their parent. Other nine crosses showed higher than their parent. Heterosis for number of fruits per plant ranged from -76.17% to 218.36%. Positive heterosis range from 1.46 % to 218.36 % and negative heterosis ranged from -8.63 % to -76.17 %. The highest positive heterotic effect (218.36 %) was found for this character in hybrid PG006 X M2. Banik (2003) reported that SG-018 X SG-001 manifested the highest heterosis over better parent for total fruits per plant (46.15%). Varghese (1991) observed both positive and negative heterosis in for fruits per plant (111.11%), in the crosses, P_{11} X P_2 in Snakegourd.

4.3.9. Weight of fruits per plant

Among all the crosses only six crosses showed negative heterosis for this trait and other showed positive heterosis. Heterosis weight of fruits per plant ranged from -77.34 % to 253.48 %. The positive heterosis ranged from 0.05 % to 253.48 % and negative heterosis ranged from -9.71 % to -77.34 %. But positive significant female parent heterosis was shown by the cross combination PG006 x M2, can be used as a best combination if one want to get maximum higher weight fruits per plant. Banik (2003) observed similar result for the trait in snake groud.

4.3.10. Fruit development period

Range of heterosis for day's required for fruit development was -43.24 to 48.28%. Among all the crosses both positive and negative heterotic effect was found. The range of positive heterosis was 0.00% to 48.28% and the range of negative heterosis was -2.38% to -43.24% for this character. The F1 hybrid PG006XM2 showed highest negative significant heterosis over female parent, thus the combination can be used as a hybrid variety. Rahman (2004) observed significant heterotic effect over better parent and −36.99% heterosis for early fruit maturity by the cross Jumlong X SG-004 in snake gourd.

4.3.11. Harvest length

Heterosis range for harvest length was -26.42% to 12.12%. Both positive and negative heterosis was observed in this trait. The positive heterosis ranged from 0.17% to 12.12% and negative heterosis ranged from -1.21% to -26.42%. The most desirable combination for this trait was observed by the hybrid PG002X M2, can be used as a best combination.

4.3.12. Total number of harvest within the length

Four cross combination out of seventeen crosses showed positive heterosis, one cross combination showed no-heterotic effect and other showed negative heterosis. Heterosis for total range of number of harvest within the length was from -47.37% to 27.78%. The range of negative heterosis was -4.88% to -47.37% and the positive heterosis was 2.86% to 27.78%. Significant positive female parent heterosis was shown by the cross combination PG002XM2, can be used as a best combination for getting higher number of harvest within the length.

4.3.13. Interval per harvest

Out of seventeen cross combinations, only seven cross combinations showed positive significant heterosis and other showed non- significant positive or negative heterosis. Heterosis for interval per harvest ranged from -14.32% to 101.52%. The positive heterosis ranged from 3.90% to 101.5% and negative heterosis ranged from -1.87% to

14.32%. The highest significant heterosis for the trait was observed by the PG002XM2 followed by PG009XM2.

4.3.14. Number of fruits per harvest

Both positive and negative heterosis was observed in this trait. Among the 17 crosses, twelve crosses were less than their parent. Other five crosses showed higher than their parent. Positive heterosis range from 4.95 % to 34.91 % and negative heterosis ranged from -9.67% to -83.17 %. Range of heterosis for number of fruits per harvest was -83.17% to 34.91%. The highest positive heterotic effect (34.91 %) was found for this character in hybrid PG006 X M2. Rahman (2004) found significant heterotic effect over better parent in snake gourd for number of fruits per plant by Jumlong X SG-001 (27.88%) followed by SG-018 X SG-004 (54.71%).

4.3.15. Fruit length (cm)

Heterosis for fruit length ranged from -19.57% to 35.14%. Out of seventeen cross combinations, eight cross combinations showed positive female parent heterosis for this trait and other showed negative heterosis. The positive heterosis ranged from 4.58% to 35.14% and negative heterosis ranged from -1.47% to -19.57%. Highest positive heterosis was shown by the cross combination PG021XM2, can be used as a best combination, if one want to get larger fruit size. Hormuzdi and More (1989) observed similar result of fruit length in cucumber. On the other hand, Rahman (2004) estimated 22.34% heterosis for fruit length by the cross SG-001 X SG-006 of snake gourd.

4.3.16. Fruit width

Out of 17 cross combinations only two cross combinations exhibited negative female parent heterosis and other showed positive heterosis. Heterosis range for fruit width was from -9.35% to 33.33%. The highest significant positive heterosis was shown by the cross combination PG021 X M2 for this trait and the negative heterosis was shown by the cross combination PG005 X M2.

4.3.17. Fruit weight

Out of 17 cross combinations only one cross combination (PG012XM2) was non significant rest of the cross combination exhibited highly significant heterosis. The positive heterosis ranged from 2.60% to 86.61% and negative heterosis ranged from -3.49% to -31.84%. Highest significant better female parent heterosis was shown by the cross combination PG0021XM2 (86.61 %) can be used as a best combination, where the range of heterosis for average fruit weight was from -31.84% to 86.61%. Banik (2003) observed that the F_1 hybrid, SG-001 X SG-004 showed the higyhhest heterosis over better parent for fruit weight per plant (69.54%) in Snakegourd. Rahman (1992) found significant positive and negative heterosis for fruit weight in sweet gourd, bitter gourd and ribbed gourd.

4.3.18. Pulp weight

Among all crosses, both positive and negative heterosis over female parent was observed in this trait. Heterosis for pulp weight ranged from -30.50% to 106.08%. However, positive heterosis ranged from 3.06% to 106.08% and negative heterosis ranged from -2.98% to 30.50%. Positive female parent heterosis was showed by five cross combinations. The highest female parent heterosis of the cross was obtained from PG021XM2 (106.08%) followed by PG007XM2. Thus, the combination PG021XM2 can be used as best hybrids if one want to get maximum weight of pulp.

4.3.19. Number of seed per fruit

Out of seventeen crosses, five crosses showed significant positive heterosis and five crosses showed significant negative heterosis. Range of heterosis for number of seed per fruit was -42.06% to 85.39%. Positive heterosis ranged from 9.03% to 58.39% and negative heterosis ranged from -2.89% to -42.06%. Negative heterosis is the desirable for less seeded fruit type. The hybrid PG019XM2 produced the lowest number of seeds per fruit (-42.06%) followed by PG027X M2 (-34.48%). Rahman (2004) estimated –45.35% heterosis for less seeded fruit by the cross SG-004 X SG-001 in snake gourd.

4.3.20. Weight of seeds per fruit

Out of 17 cross combinations both positive and negative heterosis was obtained. The range of positive heterosis was 0.79 % to 135.94 % and the range of negative heterosis was -1.05 5 to - 45.00 %, where the range of heterosis was -45.00% to 135.94%. Significantly highest positive female parent heterosis was found by the cross combination PG021XM2and the significant lowest negative female parent heterotic effect was found by the cross combination PG019 X M2 was indicated desirable combination for low weight of seeds per fruit.

4.3.21. Pulp: seed ratio (by weight)

Nine cross combination out of seventeen, showed negative heterosis and other showed positive heterotic effect for this trait. The cross combination PG017XM2 (-47.92) showed highest negative heterotic effect of female parent and the cross combination PG002XM2 (34.77%) showed highest positive heterotic effect of female parent. The range of positive heterosis was 1.55% to 34.77% and the range of negative heterosis was -5.18% to -47.92%, where as the range of heterosis was -47.92% to 34.77% inrespect of pulp: seed ratio.

4.3.22. Dry matter (%)

Among all crosses, only six crosses showed non-significant positive and five crosses showed negative heterotic effect. Heterosis for dry matter ranged from-15.81% to 63.85%. Positive heterosis ranged from 1.38% to 63.85% and negative heterosis ranged from -4.76% to -15.81%. Highest heterotic effect for dry matter (%) was found in the cross combination PG021XM2. Thus, the combination PG021XM2 can be used as best hybrids if one want to get maximum dry matter (%).

4.3.23. Yield per harvest (g)

Heterosis for yield per harvest ranged from -79.06% to 124.34%. Both positive and negative heterosis was observed in this trait. The positive heterosis ranged from 27.14% to 124.34% and the negative heterosis ranged from -5.52% to -79.48%. The highest desirable heterotic effect (124.34%) was found in the cross combination PG021XM2, can be used as a best hybrid.

4.2.24. Yield (t/ha)

Among the entire cross combinations, both positive and negative heterotic effects were found for this trait. Negative significant female parent heterosis should not be used if we want to get more yields. The cross combination PG006 x M2 showed highest positive heterotic value (76.43 %). The range of negative heterosis was -30.22 % to -90.08 % and the range of positive heterosis was 3.79 % to 76.43 %.The range of heterosis for yield was -90.08% to 76.43%. Ahmed (1998) found similar result in Snakegourd. He also observed that the F_1 hybrid "Green long X Green short" produced the highest yield per plant. Karim *et al*. (2001) reported desirable better parent heterosis for fruit yield per plant in F_1 hybrids, HFX Local and MK X Local. Sirohi (1994) observed similar result in pumpkin through the hybrids Pusa Vishwas X S. 122, Pusa Vishwas X S.93 and S. 93 X S.122. Janakiram and Sirohi (1989) reported that the F_1 hybrids exhibited up to 84.5% heterosis for yield over the best parental line in round fruited bottle gourd.

Table 26. Percent heterosis over female parent of 17 hybrids of pointed gourd for yield and, yield contributing characters

F_1 Hybrids	Number of vines per plant	Vine length at first harvest (cm)	Number of node at first harvest	Length of inter-node at first harvest (cm)	Days to first flower	First flower bearing node no.
PG002X M2	7.69	16.25**	26.17**	-0.58	-23.26**	58.97**
PG003 X M2	-27.78**	7.36	-21.01**	51.80**	-26.87**	48.72**
PG005 X M2	-5.88	56.35**	60.00**	-4.98	-23.20**	130.56**
PG006 X M2	14.29	0.14	-11.21*	3.76	-22.38**	2.13
PG008 X M2	-35.00**	194.64**	68.35**	68.8**	-33.33**	44.44**
PG007 X M2	-9.09	0.48	-3.52	11.52*	-30.81**	-27.50**
PG009 X M2	50.0**	19.61**	30.95**	-10.70*	-28.30**	27.78**
PG010 X M2	33.33**	-36.55**	-27.78**	-23.50**	-20.00**	38.46**
PG012 X M2	-47.06**	49.22**	12.73*	25.00**	-22.16**	191.30**
PG016 X M2	-9.09	11.27*	21.00**	6.35	-36.32**	188.89**
PG017 X M2	-35.71**	1.12	19.35**	-17.33**	-27.06**	112.12**
PG018 X M2	7.69	-4.40	4.10	-7.14	-31.68**	45.24**
PG019 X M2	-13.33	65.50**	87.50**	-5.31	-9.61**	106.25**
PG020 X M2	-35.71**	342.98**	190.80**	50.00**	-45.62**	285.29**
PG021 X M2	-20.00	12.75*	-27.62**	63.98**	-30.51**	182.61**
PG026 X M2	-21.43	35.18**	38.20**	-4.13	-24.15**	125.00**
PG027 X M2	-38.89**	182.93**	225.00**	-16.10**	-14.01**	250.00**

*, ** indicated significant at the 5% and 1% level of probability, respectively

Table 26. (Continued.)

F_1 Hybrids	Number of fruits per vine	No. of fruits per plant	Weight of fruits per plant (g)	Fruit developme nt period	Harvest length (days)	Number of harvest within the length
PG002X M2	39.15**	46.65**	55.72**	-39.02**	12.12**	27.78**
PG003 X M2	-56.55**	-72.26**	-64.36**	0.00	-4.25	-15.00**
PG005 X M2	25.98	15.57	0.05	28.57**	-4.46	0.00
PG006 X M2	212.21**	218.36**	253.48**	48.28**	-8.49*	12.50**
PG008 X M2	53.84**	-8.63	39.48**	3.70	-1.21	-9.76*
PG007 X M2	70.83**	24.38*	17.88	37.50**	-17.32**	-19.51**
PG009 X M2	61.36**	138.74**	192.25**	-17.14	-16.06**	-4.88
PG010 X M2	55.35**	132.20**	107.48**	42.86**	3.56	9.76*
PG012 X M2	162.43**	34.58*	39.34*	32.35**	1.23	2.86
PG016 X M2	52.65**	62.41**	64.58**	-20.00*	-8.21*	-13.64**
PG017 X M2	22.27*	-26.20**	-9.74	46.67**	11.41*	-41.03**
PG018 X M2	-53.51**	-55.12**	-58.31**	-10.81	-7.39	-43.90**
PG019 X M2	-73.71**	-76.01**	-77.34**	-2.38	-22.58**	-44.74**
PG020 X M2	-60.47**	-76.17**	-63.65**	-43.24**	-24.85**	-43.90**
PG021 X M2	3.23	1.46	74.24**	-31.43**	0.17	-22.22**
PG026 X M2	-44.31*	-59.26**	-57.75**	-28.21**	-26.42**	-47.37**
PG027 X M2	39.94*	-25.18**	18.78	-39.13**	-19.02**	-25.71**

*,** indicated significant at the 5% and 1% level of probability, respectively

Table 26. (Continued.)

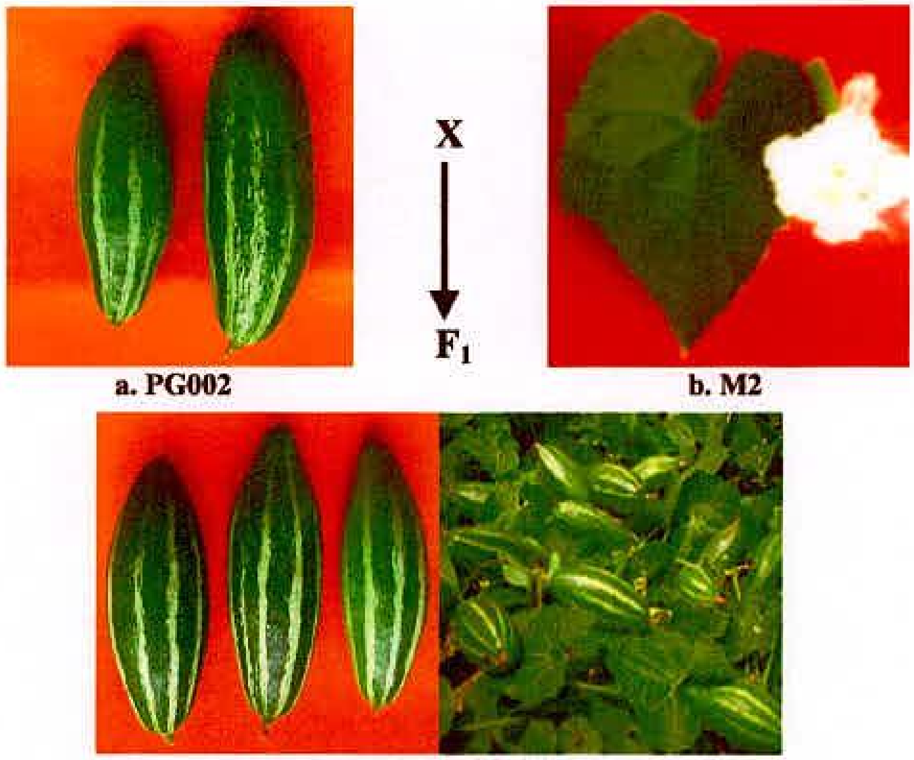
F_1 Hybrids	Interval per harvest (days)	Number of fruits per harvest	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Pulp weight (g)
PG002X M2	-14.32	-9.67**	-9.00**	16.33**	33.03**	25.53**
PG003 X M2	5.62	-83.17**	-7.55**	8.89**	25.66**	33.28**
PG005 X M2	-2.77	-42.11**	-10.31**	-9.35**	-10.98**	-13.04**
PG006 X M2	-8.59	34.91**	5.45*	13.98**	9.80**	3.06
PG008 X M2	3.90	-20.51*	-9.96**	11.58**	5.34**	3.44
PG007 X M2	11.62	-50.29**	18.80**	18.89**	58.28**	56.56**
PG009 X M2	-9.74	23.53**	8.02**	0.94	27.92**	26.35**
PG010 X M2	-6.62	5.77	-1.47	0.93	13.38**	14.85**
PG012 X M2	-1.87	-31.14**	-8.39**	20.45**	2.60	-2.98
PG016 X M2	5.63	4.95	15.04**	2.80*	15.20**	17.37**
PG017 X M2	101.52**	-37.39**	16.03**	13.68**	14.43**	14.32**
PG018 X M2	37.84**	-59.52**	-12.99**	4.00**	-17.30**	-18.03**
PG019 X M2	50.75**	-76.82**	-19.57**	0.96	-31.84**	-30.50**
PG020 X M2	41.63**	-77.30**	19.64**	2.80*	11.48**	23.94**
PG021 X M2	32.09**	27.08	35.14**	33.33**	86.61**	106.08**
PG026 X M2	42.61**	-58.96**	-11.71**	-0.94	-3.49**	-12.48**
PG027 X M2	15.16*	-38.18**	4.58	2.15*	16.80**	11.11**

*,** indicated significant at the 5% and 1% level of probability, respectively

Table 26. (Continued.)

F_1 Hybrids	Number of seeds per fruit	Weight of seeds per fruit (g)	Pulp:seed ratio (by weight)	Dry matter content (%)	Yield per harvest (g)	Yield (t/ha)
PG002X M2	9.03	-16.96*	34.77**	-15.81	-5.93	50.22**
PG003 X M2	-19.13*	2.91	28.89	47.18**	-79.06**	-78.47**
PG005 X M2	-27.58**	8.33	-18.88*	-7.29	-50.59**	-50.08**
PG006 X M2	-21.66**	-16.98*	5.81	-4.76	57.00**	76.43**
PG008 X M2	-2.89	-1.05	4.49	9.96	-26.55**	-41.29**
PG007 X M2	18.31*	81.18**	-5.18	12.23	-22.22**	-30.22**
PG009 X M2	17.01	57.33**	-11.08	2.58	53.96**	45.93**
PG010 X M2	13.02	70.49**	-31.45**	5.49	-5.52	3.79
PG012 X M2	-2.38	21.51*	-20.00*	-8.44	-32.27**	-30.70**
PG016 X M2	19.67*	100.00**	-37.01**	4.14	27.14**	9.92
PG017 X M2	85.39**	118.06**	-47.92**	28.90*	-23.30**	-55.03**
PG018 X M2	-8.42	8.54	-15.13	30.00*	-62.60**	-79.23**
PG019 X M2	-42.06**	-45.00**	27.67*	60.89**	-79.48**	-90.08**
PG020 X M2	-8.96	0.79	22.85	9.09	-67.26**	-83.67**
PG021 X M2	67.51**	135.94**	-11.83	63.85**	124.34**	55.06**
PG026 X M2	45.73**	15.63	-24,94**	-5.92	-57.49**	-81.24**
PG027 X M2	-34.48**	16.25	1.55	1.38	-19.17**	-47.21**

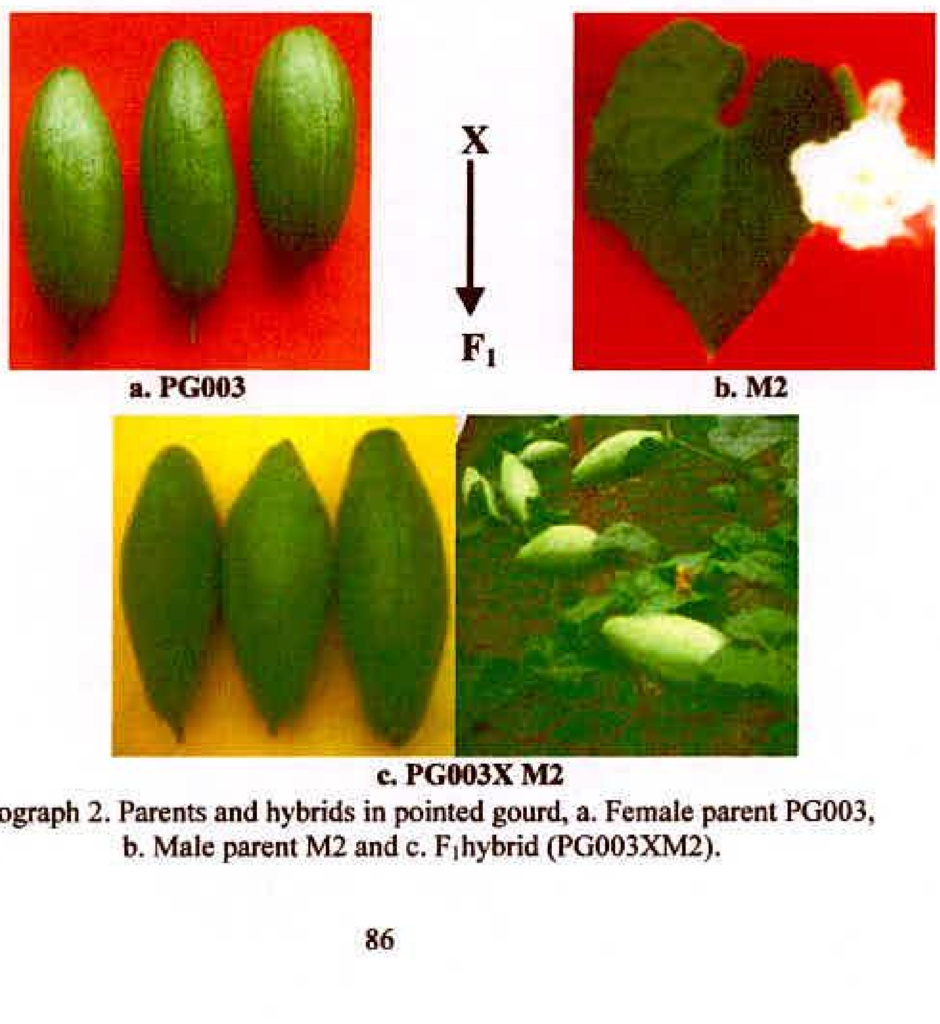
*,** indicated significant at the 5% and 1% level of probability, respectively



a. PG002 **b. M2**

c. PG002X M2

Photograph 1. Parents and hybrids in pointed gourd. a. Female parent PG002, b. Male parent M2, c. F_1 hybrid (PG002XM2).



a. PG003 **b. M2**

c. PG003X M2

Photograph 2. Parents and hybrids in pointed gourd, a. Female parent PG003, b. Male parent M2 and c. F_1hybrid (PG003XM2).

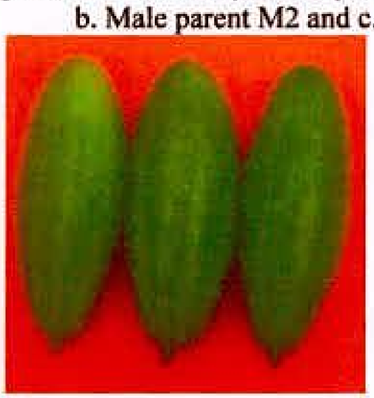
X

F_1

a. PG005 **b. M2**

c. PG005XM2

Photograph 3. Parents and hybrid in pointed gourd, a. Female parent PG005, b. Male parent M2 and c. F_1hybrid (PG005XM2).



X

a. PG006 **F_1** **b. M2**

c. PG006X M2

Photograph 4. Parents and hybrid in pointed gourd, a. Female parent PG006, b. Male parent M2 and c. F_1hybrid (PG006XM2).

X

↓

F_1

a. PG007 **b. M2**

c. PG007XM2

Photograph 5. Parents and hybrid in pointed gourd, a. Female parent PG007, b. Male parent M2 and c. F_1hybrid (PG007XM2).

X

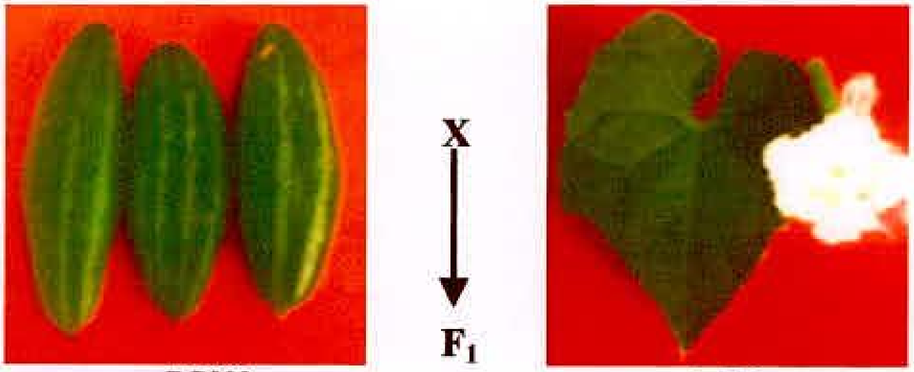
↓

F_1

a. PG008 **b. M2**

c. PG008X M2

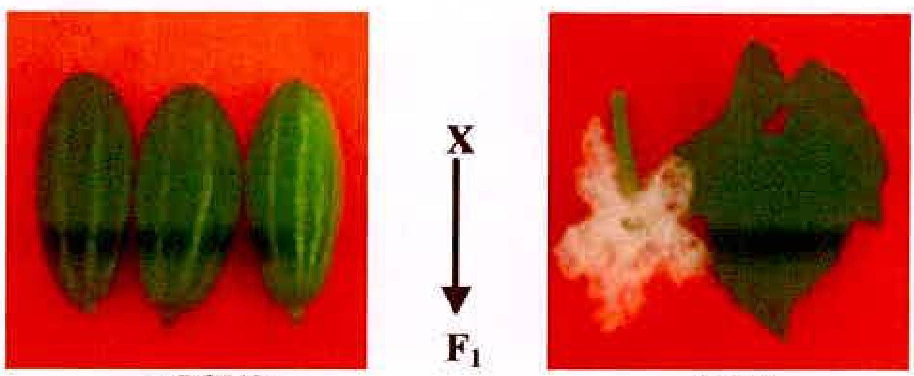
Photograph 6. Parents and hybrid in pointed gourd, a. Female parent PG008, b. Male parent M2 and c. F_1hybrid (PG008XM2).



a. PG009 **b. M2**

c. PG009X M2

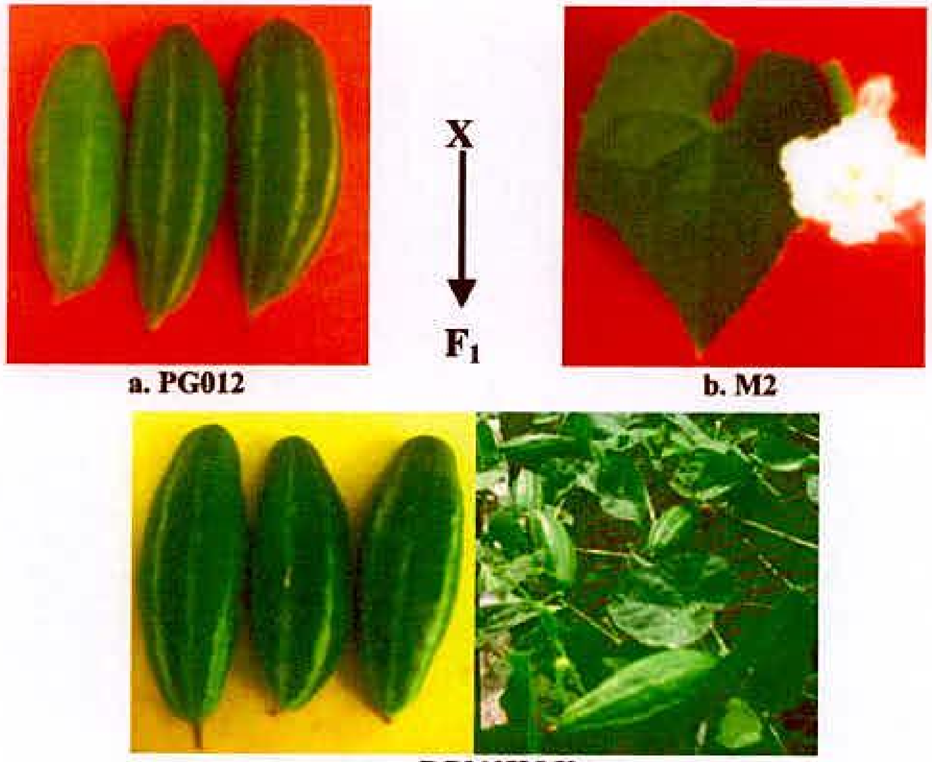
Photograph 7. Parents and hybrid in pointed gourd, a. Female parent PG009, b. Male parent M2 and c. F$_1$ hybrid (PG009XM2).



a. PG010 **b. M2**

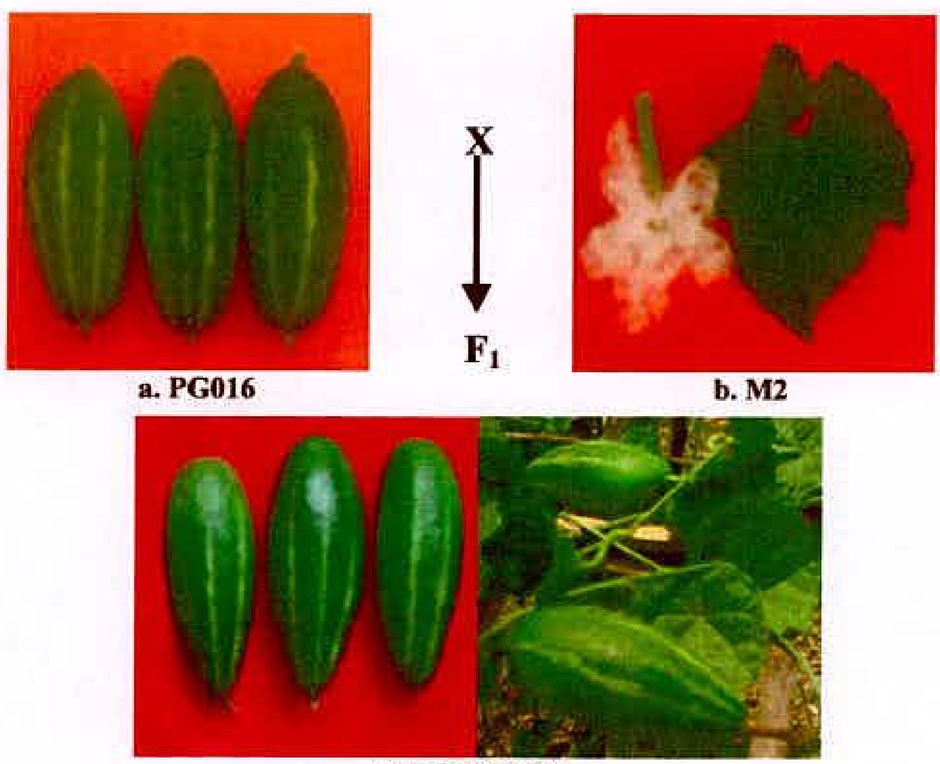
c. PG010X M2

Photograph 8. Parents and hybrid in pointed gourd, a. Female parent PG010, b. Male parent M2 and c. F$_1$ hybrid (PG010XM2).



c. PG012X M2

Photograph 9. Parents and hybrid in pointed gourd, a. Female parent PG012, b. Male parent M2 and c. F_1hybrid (PG012XM2).



c. PG016X M2

Photograph 10. Parents and hybrid in pointed gourd, a. Female parent PG016, b. Male parent M2 and c. F_1hybrid (PG016XM2).

X

F_1

a. PG017 b. M2

c. PG017X M2

Photograph 11. Parents and hybrid in pointed gourd, a. Female parent PG017, b. Male parent M2 and c. F_1 hybrid (PG017XM2).

X

F_1

a. PG018 b. M2

c. PG018X M2

Photograph 12. Parents and hybrid in pointed gourd, a. Female parent PG018, b. Male parent M2 and c. F_1hybrid (PG018XM2).

X

F$_1$

a. PG019 **b. M2**

c. PG019X M2

Photograph 13. Parents and hybrid in pointed gourd, a. Female parent PG019, b. Male parent M2 and c. F$_1$ hybrid (PG019XM2).

X

F$_1$

a. PG020 **b. M2**

c. PG020X M2

Photograph 14. Parents and hybrid in pointed gourd, a. Female parent PG020, b. Male parent M2 and c. F$_1$ hybrid (PG020XM2).

X

F_1

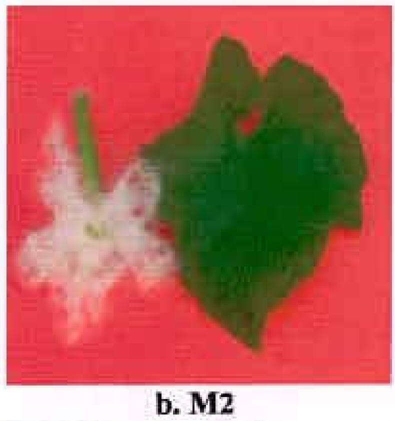
a. PG021 **b. M2**

c. PG021XM2

Photograph 15. Parents and hybrid in pointed gourd, a. Female parent PG021, b. Male parent M2 and c. F_1hybrid (PG021XM2).

X

F_1



a. PG026 **b. M2**

c. PG026X M2

Photograph 16. Parents and hybrid in pointed gourd, a. Female parent PG026, b. Male parent M2 and c. F_1hybrid (PG026XM2).

X

F_1

a. PG027 **b. M2**

c. PG027X M2

Photograph 17. Parents and hybrid in pointed gourd, a. Female parent PG027, b. Male parent M2 and c. F_1 hybrid (PG027XM2).

Chapter V
SUMMARY

The experiment was undertaken to perform analysis of variance and to estimate breeding value and female parent heterosis in pointed gourd using top cross. The experiment was conducted at the experimental field of Regional Agricultural Research Station, Ishurdi, Pabna, during April 2004 to March 2005. The parental genotypes used in the study were PG002, PG003, PG005, PG006, PG008, PG007, PG009, PG010, PG012, PG016, PG017, PG018, PG019, PG020, PG021, PG026, and PG027. Data were taken on number of vines per plant, vine length at first harvest, number of node at first harvest, length of internode, days to first flowering, first flower bearing node number, days required for flowering to harvest, fruit length, fruit width, fruit weight, pulp weight, pulp: seed ratio, dry matter content, number of fruits per vine, number of fruits per plant, weight of fruit per plant, harvest length, number of harvest within the length, interval per harvest, number of fruits per harvest, number of seeds per fruit, weight of seeds per fruit, yield per harvest, yield of fruit. Significant mean sum of squares were observed for most of the character except fruit width due to genotypes, parents and top crosses and for parent vs. cross for most of the characters except days required from flowering to harvest and fruit width.

The average performance of the top crosses was lower than the average performance of the parents for length of internodes at first harvest (cm), days to first flowering, fruit development period and average interval per harvest (days).

PG007 was superior female parent in respect of producing higher number of vine per plant and days required for flowering to harvest, PG008 was superior for producing longer vine at first harvest, PG027 was superior female parent for producing higher number of nodes at first harvest, PG003 was superior for lower length of internode at first harvest and higher number of fruits per harvest, PG020 was superior for earlier flowering, longer harvest length and higher fruit weight (g) , PG012 and PG021 were superior female parent for producing higher number of first flower bearing node number, where as PG016 was superior parent for producing increased number of fruits per vine and total number of harvest within the length of time, on the other hand

PG019 was superior female parent for average interval per harvest and average yield per harvest, PG005 was superior for increasing pulp weight, PG006 was superior for producing higher dry matter (%) and PG009 was superior female parent in respect of higher yield(t/ha).

Breeding value (A) of parental inbred PG009 was highest among the parents and the mean value of the parental top cross (PG009 X M2) was higher than the mean value of this parental inbred for number of node at first harvest (A = 2.17, Ci = 70 > Pi = 47), and average yield per harvest (A = 2.32, Ci = 969.0 > Pi = 629.4). The mean value of parental top cross (PG010 X M2) was lower than the mean value of this parental inbred (Ci = 5.1 < Pi = 6.7), the breeding value of the parent PG010 was also highest (-1.29) in respect of length (cm) of internode at first harvest. The mean values of the parental top cross(PG020 X M2) was lower than the mean value of this parental inbred and the breeding value of the parent PG020 was also highest for days to first flowering (A = -1.25, Ci = 80.7 < Pi = 148.3) and days required for flowering to harvest(A= -1.45, Ci = 7.0 < Pi = 12.3). The breeding value of parental inbred PG008 (3.25) was highest among the parents and the mean value of the parental top cross (PG008 X M2) was higher than the mean value of this parental inbred (Ci = 9.7 < Pi = 13.3) in respect of first flower bearing node number. The mean value of parental top cross (PG006 X M2) was higher than the mean value of this parental inbred, breeding value of the parent was also highest in respect of number of fruits per plant(A= 2.39, Ci = 387.3 > Pi = 121.7), higher number of fruits per vine (A = 2.39, Ci = 75.9 > Pi = 24.3), harvest length(A=1.05, Ci = 208.3 > Pi = 194.3), average number of fruit per harvest(A = 3.25, Ci = 25.6 > Pi = 19.0), Pulp: seed ratio(A = 15.9, ci = 11.5 > Pi = 1.05) and average yield per harvest(A = 2.32, Ci = 969.0 > Pi = 629.4). The breeding value of the parent PG002 was also highest in respect of total number of harvest within the harvest length (1.46) and harvest interval (-1.17). Mean value of parental top cross (PG007 X M2) was higher than the mean value of this parental inbred, the breeding value of the parent was also highest for the parameter average fruit weight (A = 2.18, Ci = 56.4 > Pi = 35.6) and pulp weight (A = 3.25, Ci = 48.5 > Pi = 31.0). The parental top cross (PG003 X M2) was higher than the mean value of this parental inbred (Ci = 13.9 > Pi = 9.5) and the breeding value of the parent was also highest which was 2.79 in respect of increasing dry matter (%).

The parent PG020 was the parent for vine length at first harvest, days to first flower, days required for flowering to harvest, fruit length, and average fruit weight in pointed gourd. Again PG007was the best parent for number of vines per plant, number of fruit per vine, number of fruit per plant, weight of fruit per plant and harvest length. But for average number of fruit per harvest, pulp: seed ratio, yield per harvest, PG006 and PG009 were considered the best parent. It also observed that the trait number of vines per plant PG009 can be selected. PG002 was the superior for average interval per harvest and total number of harvest within the length of time and PG008 was the superior for the trait average fruit weight and pulp weight. It was found that parent PG003 was the superior for dry matter content (%). The parent PG010 was desirable for the character length of internode at first harvest.

In this study female parent heterosis was estimated. Both positive and negative heterosis was obtained for different characters of hybrids of which few hybrids showed desirable and significant values. Significant highest negative heterosis for days to first flower was (45.62%) from the hybrid PG020 X M2, for first flower bearing node number highest significant negative heterosis ((-27.50%) was found by the cross combination PG007 X M2.Therefore, these hybrids might be used in future breeding program to exploit heterosis for earliness in flowering. Significant heterotic effect over female parent were found (50.0%) for number of node at first harvest (87.50%) by the cross combination (PG019 X M2) and for number of fruits per vine (212.21%), number of fruits per plant (218.36%), weight of fruits per plant (253.48%) by the cross combination (PG006 X M2), for average fruit weight (86.61%), pulp weight (106.08%), dry matter content (63.85%) and average yield per harvest (124.34%) by the cross combination PG021 X M2. These hybrids might be used in future breeding program to exploit heterosis for better yield in pointed gourd.

Chapter VI

COCLUSION AND RECOMMENDATION

The parents and F_1 hybrids studied were statistically different among themselves for most of the characters studied except for fruit width.

Based on stable response of earliness, higher number of fruits per plant, higher fruit yield and higher dry matter content, five female parental genotypes namely, PG020, PG007, PG006, PG009, and PG010 and one male genotype M2 were selected for effective use in breeding program.

Breeding value was predominant in most of the traits except fruit width.

The cross combination PG006 X M2 expressed highest significant female parent heterosis effect for number of fruits per vine, number of fruits per plant, weight of fruits per plant and yield. This hybrid could be used for exploitation of heterosis in pointed gourd.

The cross combination PG021 X M2 manifested highly significant female parent heterotic effect for average fruit weight, pulp weight, dry matter content and yield. This cross could be used for exploitation of heterosis in pointed gourd in respect of these characters.

Exploitation of heterosis at commercial level utilizing the selected combinations should be confirmed.

Chapter VII
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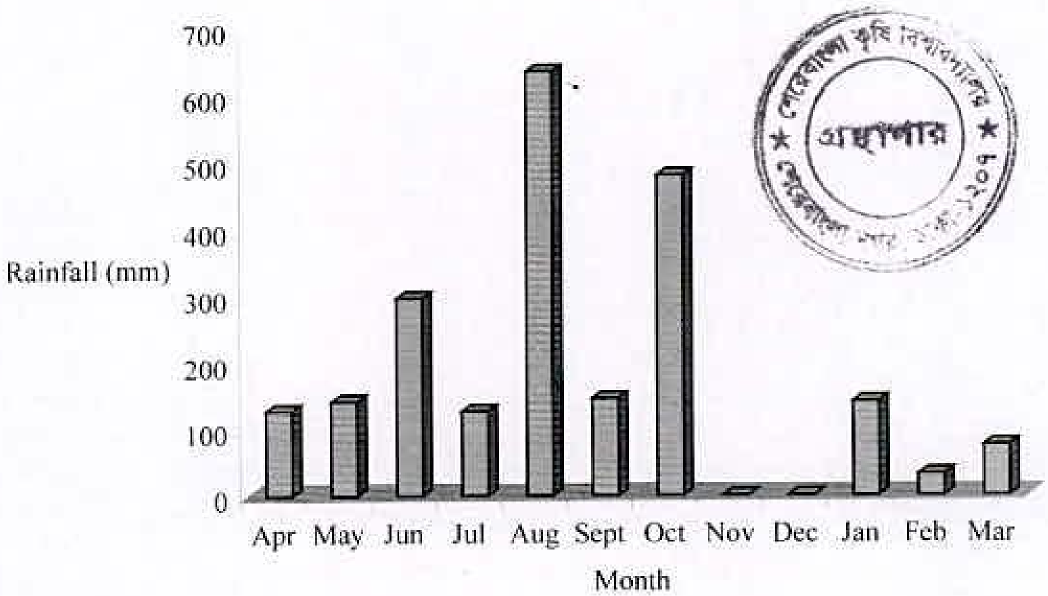
Chapter VIII
APPENDICES

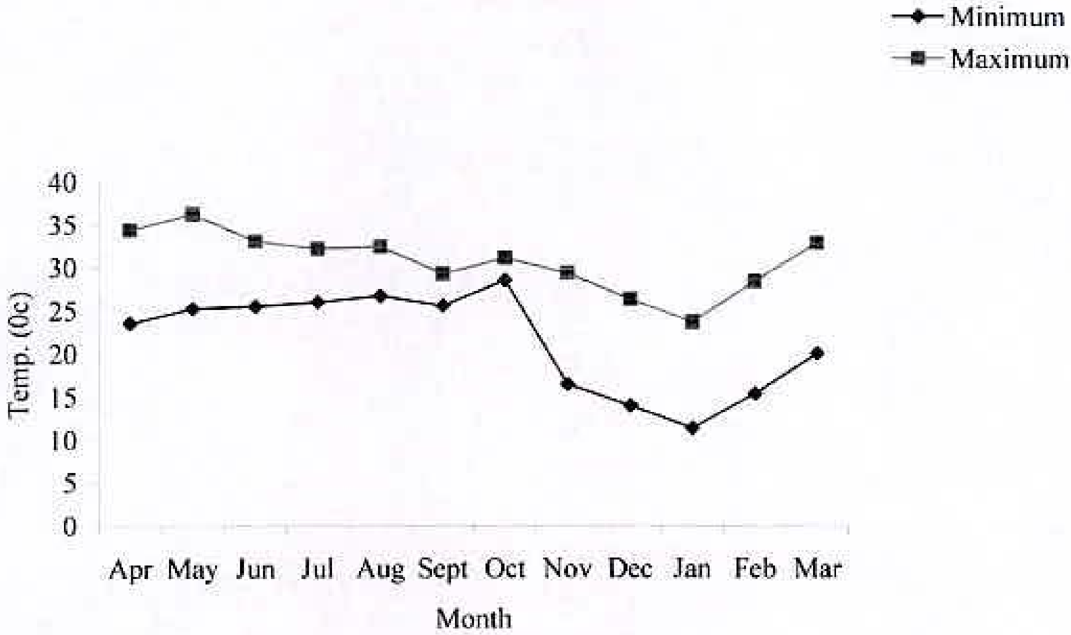
Appendix 1. Physical and chemical properties of soils at RARS, Ishurdi, Pabna

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

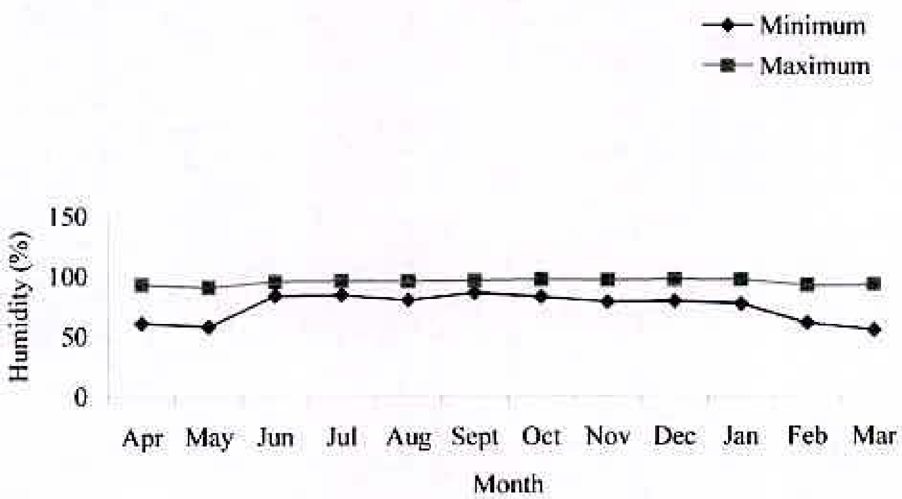
*Organic carbon



Appendix 2. Annual rainfall of the area during field research, 2004-2005



Appendix 3. Annual temperature of the area during field research, 2004-2005



Appendix 4. Humidity (%) of the area during field research, 2004-2005