

EFFECT OF SEX RATIOS AND HARVESTING STAGES ON YIELD ATTRIBUTES OF POINTED GOURD

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Abstract

Two field experiments were conducted during the cropping seasons of 2010-11 and 2011-12 to find out the suitable sex ratio (male : female) and fruit harvesting stage that result in higher yield of pointed gourd (*Trichosanthes dioica* Roxb.). The treatments consisted of three sex ratios, such as 1:15, 1:10, and 1:5, and three fruit harvesting stages, such as fruit harvesting at 8 days, 12 days, and 16 days after flower anthesis. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Both treatments and their combinations had significant influence on yield and yield attributes of pointed gourd. The sex ratio 1:15 and fruit harvest at 12 days after female flower anthesis singly as well as in combination gave the maximum number of fruits, weight of fruits per plant, and pulp weight per fruit, and finally produced the highest fruit yield of pointed gourd.

Keywords: Sex ratio, harvesting stage, yield, *Trichosanthes dioica* Roxb.

Introduction

Pointed gourd (*Trichosanthes dioica* Roxb.), locally known as patal belonging to the family Cucurbitaceae, is a very popular vegetable in Bangladesh. At present, it is expensive and demandable vegetable in Bangladesh. The Bengal and Asam region of India are the primary centers of its origin (Singh *et al.*, 1992). It is cultivated and consumed in every part of Bangladesh, particularly in the districts of Rajshahi, Bogra, Pabna, Jessore, and Kushtia (Rashid, 1999). It is a perennial crop and sold at the end of October when there is a shortage of other vegetables. The fruit is the edible part of the plant, which can be cooked alone or with other vegetables, fish or meat. It is called 'King of gourd' because of higher nutrient content than other cucurbits (Mandal *et al.*, 2014). Pointed gourd is rich in vitamins and minerals and contains 9.0 mg Mg, 2.6 mg Na, 83.0 mg K, 1.1 mg Cu, and 17.0 mg S per

100-gram edible portion (Singh and Prasad, 1989). Pointed gourd possesses the medicinal property of lowering total cholesterol, blood sugar and keeps the heart healthy; it prevents constipation and acts as blood purifier and also fights against ageing (Chandrasekar *et al.*, 1988; Sharma and Pant, 1988; Sharma *et al.*, 1988).

In Bangladesh, the area under pointed gourd cultivation is 10,024 hectares with its total production 86,133 metric tons (Anon., 2012). The average yield of pointed gourd is very low (8.59 t/ha) compared to its potential yield. Several factors are considered responsible for this low yield, but the main reason is not maintaining male: female sex ratio in the field of pointed gourd. Due to inadequate number of pollen plants, pollination as well as fertilization is hampered seriously and fruits are dropped before attaining edible stage. So, for its successful pollination and production,

appropriate ratio of male and female plants is required. Bharathi *et al.* (2013) reported that one male plant for every 10 female plants should be planted for proper pollination and fruit set. Maurya *et al.* (1985) reported that a female: male ratio of 9:1 is optimum for ensuring maximum fruit set. Therefore, sex ratio is a very important criterion for fruit setting and achieving higher yield in pointed gourd. Fruit harvesting stage is also an important factor influencing quality of fruit. It is desirable to harvest pointed gourd at proper maturity stage for cooking and also for transportation and maximum storage life. Delayed fruit harvesting makes larger and heavier fruits, which cause hard seeds and rendering them less desirable to the customers (Singh and Whitehead, 1999). The appropriate harvesting stage of pointed gourd fruit is 7 - 15 days after flowering (Maity *et al.*, 1995). In a survey about pointed gourd cultivation in Jessore region, Bhuiyan (2006), reported that farmers harvested fruits about 7 to 15 days of fruit setting. Kumar and Singh (2012) reported that fruits should be harvested about 15-18 days after pollination before physiological maturity. So far, no work has been done in determining suitable sex ratio of male: female plants and optimum time of fruit harvest for better fruit set and higher yield of pointed gourd. The investigation was, therefore, undertaken to find out the suitable sex ratio (male : female) and fruit harvesting stage for higher yield of pointed gourd.

Materials and Methods

The experiment was conducted at the Regional Agricultural Research Station (RARS), BARI, Ishurdi, Pabna, Bangladesh during two consecutive growing seasons of 2010-11 and

2011-12. The soil was clay loam in texture having pH 7.24, 0.87% organic matter, 0.56% total N, 11 μ g/g available P, 0.12 meq/100g soil available K, 13 μ g/g S, 0.20 μ g/g B and 2.0 μ g/g Zn. The experimental material consisted of three different sex ratios (male : female) ($S_1 = 1: 15$, $S_2 = 1:10$, and $S_3 = 1:5$) and three fruit harvesting stages ($H_1 =$ fruit harvesting at 8 days, $H_2 =$ fruit harvesting at 12 days, and $H_3 =$ fruit harvesting at 16 days after female flower anthesis). The experiment was laid out in a randomized complete block design with three replications. The unit plot was of two sizes i.e., 3.0 m \times 1.5 m and 5.0 m \times 1.5 m and, plant spacing both for male and female plant was 1.5 m \times 1.0 m. So, each unit plot of 3.0 m \times 1.5 m and 5.0 m \times 1.5 m accommodated three and five plants, respectively. The treatment S_1 had two unit plots of 3.0 m \times 1.5 m and one plot received one male plant between two female plants. The treatment S_2 had two unit plots of 3.0 m \times 1.5 m and one unit plot of 5.0 m \times 1.5 m between the former two plots; the male plant was planted in the bigger plot in between four female plants. The treatment S_3 consisted of four unit plots of 3.0 m \times 1.5 m and one unit plot of 5.0 m \times 1.5 m between the former four plots, and the male plant was planted in the bigger plot in between four female plants. The block to block distance was 2.5 m and plot to plot distance was 0.50 m, but the distance from one treatment to other treatment within the block was 1.0 m.

Fresh pointed gourd (var. BARI Patal-1) vines (coiled) of 1.5 m length were used as planting material. The female flowers were tagged in the morning (about at 10 am). On the scheduled date, the fruits were harvested. Three pits of 50 cm \times 50 cm \times 30 cm size were prepared in

each bed. The vine (coiled) of female plants was planted in the pits on 15 October 2010 and 10 October 2011. At first, the vines were supported by the branches of bamboo to trail on the trellis. The trellis made of bamboo slices were provided to the crops for better growth. Manures and fertilizers were applied @ 10 tons of well decomposed cow dung, 500 kg oil cake, 70 kg N, 25 kg P, 50 kg K, and 20 kg S/ ha (Khan *et al.*, 2007a). The sources of N, P, K, and S were Urea, TSP, MoP, and Gypsum. The entire amount of cow dung, oil cake, P, and S were applied as basal dose in pit. The N and K were top dressed in three equal installments at 20, 60, and 90 days after vine establishment. Irrigations and other intercultural operations were done as and when required.

Data on days to first female flower anthesis, vine length at 1st female flowering (cm), fruit diameter (cm), number of fruits per plant, weight of fruits per plant (kg), pulp weight (kg), and yield (t/ha) were recorded. For pulp weight, at first the fruit was peeled and cut longitudinally, and the seeds were then removed. Then the weight of pulp per fruit was taken by electric balance. Data were

analyzed using MSTAT-C software (Freed, 1985) (Version 2.0.0.). Mean separation was done by Duncan's Multiple Range Test (DMRT) at 5% level of probability.

Results and Discussion

As, both years had more or less the similar results, pooled analyses were done and discussed accordingly.

Effect of sex ratio (male: female plants)

All the parameters except days to first female flower anthesis and vine length at 1st female flowering were significantly influenced by sex ratio of male : female plant (Table 1). The longest fruit was obtained from the sex ratio 1:15 (8.74 cm) and the shortest fruit from 1:5 sex ratio (6.94 cm). This is in agreement with the reports of Khan *et al.* (2007b). The maximum diameter of fruit was produced from the sex ratio of 1:15 (3.56 cm) closely followed by 1:10 sex ratio (3.53 cm), and the minimum diameter from 1:5 sex ratio (2.98 cm). This corroborates the results of Singh and Prasad (1989). The sex ratio 1:15 gave highest number of fruits per plant (161.45) and the 1.5 sex ratio produced lowest number

Table 1. Main effect of sex ratio on flowering, yield attributes and yield of pointed gourd (Pooled of 2010-2011 and 2011-2012)

| Treatment | Days to first female flower anthesis | Vine length at 1 st female flowering (cm) | Fruit length (cm) | Fruit diameter (cm) | No. of fruits/plant | Wt of fruits/plant (kg) | Pulp wt/ fruit (g) | Yield (t/ha) |
|----------------|--------------------------------------|--|-------------------|---------------------|---------------------|-------------------------|--------------------|--------------|
| S ₁ | 119 | 140.28 | 8.74 a | 3.56 a | 161.45 a | 4.93 a | 40.40 a | 32.58 a |
| S ₂ | 114 | 139.56 | 7.44 b | 3.53 a | 158.22 b | 4.57 b | 38.69 b | 30.06 b |
| S ₃ | 118 | 141.95 | 6.94 c | 2.98 b | 152.56 c | 3.45 c | 18.79 c | 23.00 c |
| CV(%) | 7.84 | 8.74 | 9.01 | 8.77 | 7.40 | 10.17 | 6.02 | 10.32 |

Means with uncommon letters in a column are significantly different at 5% level of probability by DMRT. S₁ = Sex ratio 1:15 (male:female), S₂ = 1:10 sex ratio (male:female), S₃ = 1:5 sex ratio (male:female)

of fruits per plant (152.26). This result is in consonance with the result of Singh and Whitehead (1999). The maximum weight of fruits per plant was recorded from the sex ratio 1:15 (4.93 kg) followed by sex ratio 1:10 and the minimum weight of fruits per plant was obtained from the sex ratio of 1:5 (3.45 kg). The sex ratio 1:15 gave maximum pulp weight/fruit (40.40 g) whereas; 1:5 sex ratio gave the minimum pulp weight per fruit (18.79 g). This is in agreement with the findings of Khan *et al.* (2007a) who reported that pulp weight had direct effect on fruit weight. The highest yield was obtained from the sex ratio 1:15 (32.38 t/ha) and the lowest yield from 1:5 sex ratio (23.58 t/ha). Similar results have also been reported by Khan *et al.* (2007b) and Dash *et al.* (1999). Decreasing the female plant population below 15 around one male plant resulted in significant reduction in the yield per hectare because of increasing male population per unit area.

Effect of fruit harvesting stage

Harvesting stage showed significant variation in case of all parameters studied (Table 2). Fruit harvest at eight days after female flower anthesis required maximum days to first female flowering (128.0), and minimum days to first female flowering (113.0) were required by fruit harvest at 16 days after female flower anthesis. Wide range of variability in vine length was found at 1st female flower anthesis (Table 2). The longest vine was recorded from fruit harvest at 16 days (182.17 cm) after female flower anthesis and the shortest vine from fruit harvest at eight days after female flower anthesis. The variation in vine length of pointed gourd at different harvesting stage was also observed by Kumar *et al.* (1995). The longest fruit was recorded from fruit harvested at 16 days (8.05 cm) after female flower anthesis and the shortest fruit from harvesting of fruit at eight days after female flower anthesis. However, there was no significant difference between fruit harvest at eight days and 12 days after female flower anthesis in respect of fruit length.

Table 2. Main effect of fruit harvesting stage on flowering, yield attributes and yield of pointed gourd (Pooled of 2010-2011 and 2011-2012)

| Treatments | Days to first female flower anthesis | Vine length at 1 st female flowering (cm) | Fruit length (cm) | Fruit diameter (cm) | No. of fruits/plant | Wt of fruits/plant (kg) | Pulp wt/fruit (g) | Yield (t/ha) |
|----------------|--------------------------------------|--|-------------------|---------------------|---------------------|-------------------------|-------------------|--------------|
| H ₁ | 128 a | 117.34 c | 7.46 b | 3.24 b | 156.28 b | 3.73 c | 31.85 b | 24.72 c |
| H ₂ | 113 b | 122.28 b | 7.61 b | 3.30 b | 179.39 a | 4.90 a | 32.23 b | 32.06 a |
| H ₃ | 113 b | 182.17 a | 8.05 a | 3.40 a | 136.56 c | 4.32 b | 33.80 a | 28.86 b |
| CV(%) | 7.84 | 8.74 | 9.01 | 8.77 | 7.40 | 10.17 | 6.02 | 10.32 |

Means with uncommon letters in a column are significantly different at 5% level of probability by DMRT. H₁ = Harvesting of fruit at 8 days after female flower anthesis; H₂ = Harvesting of fruit at 12 days after female flower anthesis, H₃ = Harvesting of fruit at 16 days after female flower anthesis

Maximum fruit diameter was obtained from fruit harvested at 16 days (3.40 cm) after female flower anthesis, which was identical with fruits harvested at 12 days after female flower anthesis, and minimum diameter was obtained from fruit harvested at eight days after female flower anthesis (Table 1). Similar fruit length and diameter in pointed gourd was reported by Akhter *et al.* (1994). Singh and Prasad (1989) also reported significant variation for fruit diameter in pointed gourd.

The highest number of fruits per plant was obtained from fruit harvested at 12 days (179.39) after female flower anthesis, while the lowest number of fruits per plant was obtained from fruit harvest at 16 days (136.56) after female flower anthesis. Prasad and Singh (1990) observed similar results on number of fruits per plant in pointed gourd. The maximum weight of fruits per plant was also obtained

from fruit harvest at 12 days (4.90 kg) after female flower anthesis and the lowest fruit weight per plant from harvest eight days (3.73 kg) after female flower anthesis. Harvesting of fruit at 16 days after female flower anthesis gave maximum pulp weight (33.80 g) and lowest weight from fruit harvest at eight days (31.85 g) after female flower anthesis. The highest yield was recorded from fruit harvest at 12 days after first female flower anthesis and the lowest yield from fruit harvest at eight days after first female flower anthesis. This result is almost similar to that of Khan *et al.* (2007b).

Combined effect of sex ratio (male: female) and harvesting stage

Combined effect of sex ratio and fruit harvesting stage showed significant effect on flowering, yield, and contributing characters (Table 3). The earliest female flower anthesis

Table 3. Combined effects of sex ratios and fruit harvesting stages on flowering, yield attributes and yield of pointed gourd (Pooled of 2010-2011 and 2011-2012)

| Sex ratio × Harvesting stage | Days to first female flower anthesis | Vine length at 1 st female flowering(cm) | Fruit length (cm) | Fruit diameter (cm) | No. of fruits/ plant | Individual fruit wt (g) | Wt of fruits per plant (kg) | Pulp wt (g) | Yield (t/ha) |
|---------------------------------------|--|---|-------------------------|---------------------------|----------------------------|----------------------------|---|----------------|-----------------|
| S ₁ H ₁ | 128 a | 112.50 b | 8.46 b | 3.46 bcd | 161.50 c | 44.48 ab | 4.34 d | 38.77 bcd | 28.15 d |
| S ₁ H ₂ | 113 b | 124.34 d | 8.63 b | 3.55 ab | 184.00 a | 47.44 ab | 5.46 a | 40.33 b | 36.33 a |
| S ₁ H ₃ | 114 b | 184.00 a | 9.13 a | 3.65 a | 138.50 e | 49.80 a | 4.98 b | 42.10 a | 33.27 b |
| S ₂ H ₁ | 128 a | 121.67 cd | 7.17 d | 3.33 d | 158.17 c | 42.38 b | 4.09 e | 38.23 cd | 27.72 d |
| S ₂ H ₂ | 111 b | 117.84 bc | 7.44 d | 3.39 cd | 176.34 b | 42.11 b | 5.04 b | 38.07 d | 31.76 bc |
| S ₂ H ₃ | 112 b | 179.17 a | 7.72 c | 3.50 bc | 140.17 e | 43.85 b | 4.61 c | 39.77bc | 30.70 c |
| S ₃ H ₁ | 128 a | 117.84 b | 6.76 e | 2.93 e | 149.17 d | 24.05 e | 2.76 g | 18.05 e | 18.32 f |
| S ₃ H ₂ | 113 b | 124.67 cd | 6.77 e | 2.97 e | 177.83 b | 24.32 e | 4.21 de | 18.28 e | 28.07 d |
| S ₃ H ₃ | 112 b | 183.34 a | 7.29 d | 3.06 e | 130.67 f | 25.62 e | 3.38 f | 19.53 e | 22.61 e |
| CV(%) | 7.84 | 8.74 | 9.01 | 8.77 | 7.40 | 8.20 | 10.17 | 6.02 | 10.32 |

Means showing uncommon letters in a column are significantly different at 5% level of probability by DMRT, S₁ = Sex ratio at 1:15 (male: female), S₂ = Sex ratio at 1:10 (male : female) and S₃ = Sex ratio at 1:5 (male : female) H₁ = Harvesting of fruit at 8 days after female flower anthesis, H₂ = Harvesting of fruit at 12 days after female flower anthesis, H₃ = Harvesting of fruit at 16 days after female flower anthesis

was recorded in S₂H₂ (111.0) and delayed female flower anthesis (128.0) in S₁H₁ and S₃H₁. The lowest vine length was recorded from S₁H₃ (184.0) closely followed by that of S₃H₃ (183.34) and S₂H₃ (179.17) and the shortest length was obtained from S₁H₁ (112.50). The longest fruit was recorded from S₁H₃ (9.13) and the shortest from S₃H₁ (6.76 cm) closely followed by that from S₃H₂. The widest diameter was also recorded in S₁H₃ closely followed by that of S₁H₂ (3.55 cm), while the lowest diameter was obtained from S₃H₁ closely followed by that of S₃H₂. The maximum number of fruits per plant was harvested from S₁H₂ combination (184.0) and the minimum number from S₃H₃ combination (130.67). The weight of fruits per plant was also found highest in S₁H₂ (5.46 kg) and lowest was in S₃H₁ combination (2.76 kg). The highest pulp weight was provided by S₁H₃ (42.10) followed by that of S₁H₂ (40.33 g) and the lowest weight was in S₃H₁. The combination S₁H₂ gave the maximum yield (36.33 t/ha), which was followed by S₁H₃

((33.27 t/ha) and the combination S₃H₁ gave minimum yield (18.32 t/ha)

Correlation among eight characters

Correlation coefficient values and level of significance among yield contributing characters and yield influenced by the combination of sex ratio and fruit harvesting stage are presented in Table 4. There was a weak negative correlation of days to 1st female flowering anthesis with vine length at 1st female flowering, length of fruit, diameter of fruit, number of fruits per plant, weight of fruits per plant, pulp weigh, and fruit yield per hectare.

Vine length at 1st female flowering showed weak and positive correlation with length of fruit, diameter of fruit, weight of fruits per plant, pulp weigh, and fruit yield per hectare but negative correlation with number of fruits per plant ($r = -0.780$). There was significant and moderate positive correlation of length of fruit with diameter of fruit ($r=0.875^{**}$), weight of fruits per plant ($r=0.682^*$), pulp weight ($r = 0.749^{**}$), and fruit yield per hectare ($r=0.697^*$).

Table 4. Correlation coefficient among fruit yield and yield attributes in pointed gourd as influenced by sex ratio and fruit harvesting stage

| Characters | VL | LF | DF | FP | WF | PW | FY |
|------------|--------|--------|---------|--------|---------|---------|---------|
| FA | -0.330 | -0.163 | -0.198 | -0.052 | -0.505 | -0.054 | -0.498 |
| VL | | 0.286 | 0.228 | -0.780 | 0.027 | 0.068 | 0.074 |
| LF | | | 0.875** | -0.040 | 0.682* | 0.749** | 0.697* |
| DF | | | | 0.042 | 0.823** | 0.967** | 0.829** |
| FP | | | | | 0.479 | 0.131 | 0.445 |
| WF | | | | | | 0.792** | 0.993** |
| PW | | | | | | | 0.791** |

*, ** indicates the level of significance at 5% and 1% level of significance, respectively. FA = Days to 1st female flower anthesis, VL= Vine length at 1st female flowering, LF = Length of fruit (cm), DF = diameter of Fruit (cm), FP=No. of fruits per plant, WF = Weight of fruits./plant (kg), WF = Pulp weight/fruit (g), FY = Fruit yield (t/ha)

Diameter of fruit had weak positive correlation with number of fruits per plant, but strong positive correlation with weight of fruits per plant ($r=0.823^{**}$), pulp weight ($r = 0.967^{**}$), and fruit yield per hectare ($r = 0.829^{**}$). Number of fruits per plant showed weak but positive correlation with weight of fruits per plant, pulp weight, and fruit yield. Weight of fruits per plant had high significant positive correlation with pulp weight ($r = 0.792^{**}$) and fruit yield per hectare ($r=0.993^{**}$). Pulp weight also had significant positive correlation with fruit yield per hectare ($r= 0.791^{**}$). Moderate and high positive correlation among different characters indicated that all these characters had significant contribution to fruit yield, and fruit yield can be increased by improving these yield attributes. It is seen that fruit size (length \times width), pulp weight, and weight of fruits per plant had direct contribution to fruit yield per hectare.

Conclusion

Based on the above discussion, it can be concluded that the sex ratio (male : female plant) of 1:15 produced the maximum fruit size, number of fruits per plant, and pulp weight, while fruit harvest at 12 days after flower anthesis gave the maximum number of fruits and weight of fruits per plant. Both sex ratio and harvesting of fruits at 12 days independently and combinedly gave the maximum yield of pointed gourd. Therefore, it can be suggested to the farmers that one male plant for every 15 female plants should be planted for proper pollination, fruit set, and higher fruit yield, and 12 day-old fruits should be harvested

for consumption as well as higher fruit yield in pointed gourd.

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