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YIELD IMPROVEMENT OF SPINE GOURD THROUGH GYNOMONOECIOUS HYBRID (*Momordica subangulata sub* spp.*renigera x Momordica dioica* roxb. ex)

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ABSTRACT

***Momordica dioica* roxb. ex. Wild and *Momordica subangulata* sub sp. *renigera* are dioecious plants under natural conditions. Dioecious nature of the plants is an obstacle to the yield improvement of the crops. Sex expression of inter-specific hybrid between tetraploid *Momordica subangulata* sub sp. *renigera* with diploid *Momordica dioica* roxb.ex. Wild was gynomonoecious under natural environmental conditions. To investigate the function of hermaphrodite flowers in gynomonoecious hybrid and yield improvement of gynomonoecious hybrid, the functions of pistil and stamen were analyzed by selfing and crossing of hermaphrodite flowers. At the flowering stage, total number of flowers of different sex types, i.e., male, female and hermaphrodite per vine were counted. Percentage of fruit set on the basis of number of crosses made, number of fruits per vine, fruits yield per vine and number of seeds per fruits and germination percentage were calculated in 2016 *Yala* and 2016/17 *Maha* seasons. Hermaphrodite flowers were yellow in colour and larger in size than the others. Ovary lengths of the hermaphrodite flowers were higher than the normal hybrid and local female flowers. Whereas self-pollination within the flower was not succeeded, within the vine was succeeded. Crosses with other vines in both directions were succeeded. Number of fruits per vine showed significant differences in both seasons such as highest number of fruits per vine was showed by local line in *Yala* season and hybrid female in *Maha* season. Fruits yield per vine did not show significant difference in *Yala* season and hybrid female got the highest yield in *Maha* season. Results suggest that inter-specific hybrid has the ability to produce functional hermaphrodite and it can be used for yield improvement of hybrid as the pollen source and the fruit source.**

Key words: Gynomonoecious, Hermaphrodite, Momordica, Yield

INTRODUCTION

Spine gourd (*Momordica dioica* roxb.ex. Wild) is an underutilized perennial dioecious cucurbit in Sri Lanka. It is known as 'Thumbakarawila' which is a seasonal bearing vegetable under rainfed condition. Bitterless taste, nutritional and medicinal qualities give a high demand among the consumers in Sri Lanka. Natural bearing of spine gourd occurs during *Maha* seasons. With the beginning of *Yala* season, Dry zone suffers from the drought and availability of spine gourd supply is highly limited in the market thus, fetches a high price. Among the cucurbitaceous vegetable grown in Sri Lanka, spine gourd has become a super earning vegetable of farmers. The dioecious nature, unavailability of new improved varieties, uncertainty of seeds propagation due to dormancy and unpredictable sex ratio in seed based populations are major constraints for improving the yield potential in spine gourd. Fruits setting under dioecious nature are mainly dependent on the presence of female and male plants in the population. In dioecious plants, assessment of yield performance of a female line using male plants is difficult, since male plants do not produce fruits and their utility ends with supply of pollen for fruit set on female plants.

This reduces the chance of making a cross with yield advantage of the hybrid over its female parent (Sanwal *et al*., 2011). Flower development is a critical factor influencing plant reproduction and crop yield (Papadopoulou and Grumet. 2005). Self-fertilization in female plants of dioecious species has been made possible by inducing hermaphrodite flowers (Ali *et al*., 1991; Hossain *et al*., 1996; Sanwal *et al*., 2011). Sex determination of individual flower buds is regulated by a combination of genetic, environmental and hormonal factors (Papadopoulou and Grumet.2005) thus sex modification in plants can often be achieved by application of plant growth regulators (Das and Mukherjee, 1986; Marchetti *et al*., 1992; Sanwal *et al*., 2011). A majority of higher plants are hermaphrodite (bi-sexual) species, and approximately 6% of flowering plants are dioecious species having separate male and female individuals (Matsumura *et al*., 2014). In dioecious *M. dioica*, is diploid. *Momordica subangulata* sub sp. *renigera* was identified as tetraploid as

compared to *M. dioica* (Roy *et al*., 1966; Sen and Datta, 1975; Ali *et al*., 1991; Hossain *et al*., 1996; Bharathi *et al*., 2011).

Inter-specific hybridization is used to improve crops by transferring desirable agronomic characters and some specific traits such as pest and stress resistance from wild species to cultivated species (Bharathi *et al*., 2012). Crossing between *Momordica subangulata* sub sp. *renigera* and *M. dioica* make quality dioecious F1 hybrid with larger size male and female flowers. More number of female flowers with hermaphrodite flowers can be seen in hybrid female vine and hand pollination could increase number of fruits per vine. Functional hermaphrodites in spine gourd would increase the pollination efficiency and fruits number. Therefore this study was aimed to investigate the function of hermaphrodite flowers in gynomonoecious hybrid and yield improvement of gynomonoecious hybrid.

MATERIALS AND METHOD

Field experiment was conducted in Regional Agricultural Research and Development Centre, Aralaganwila located in Low country Dry zone 2b1. Field evaluation was done during 2016 *Yala* and 2016/17 *Maha*. Potted spine gourd hybrid female (*M. subangulata* sub sp. *renigera* x *M. dioica*) vines were established in the field with two local female genotypes (variety Golica and selected local line) and hybrid male genotype. Female to male ratio per plot was kept as 5: 1. This experiment was arranged in a Completely Randomized block Design (RCBD) with three replications. The plants were arranged in 1 x 9m plots at the spacing of 1 x 1.5m. All the other cultural practices were done according to the Department of Agriculture recommendations. At the flowering stage, total number of flowers of different sex types, i.e., male, female and hermaphrodite per vine were counted. 25 crosses (hermaphrodite x hybrid male and hybrid female x hermaphrodite male) were done to investigate the function of pistil and stamen in hermaphrodite flowers. Selfing of hermaphrodite within the flower and within the plant of the same clone was also done. Percentage of fruit set for number of crosses made, number of fruits per vine, fruits yield per vine and number of seeds per fruit was taken from average of five random fruits and germination percentage were calculated. No

of flowers per vine in different genotypes, number of fruits per vine and fruits yield per vine was analyzed by using SAS 9.1.computer software.

RESULTS AND DISCUSSION

Sex expression of hybrid female vines was gynoecious and gynomonoecious under natural conditions in both seasons (Figure 1). Local variety and cultivars were gynoecious under same conditions (Table 2.). Hermaphrodite flowers in gynomonoecious vines morphologically showed deep yellow colour and higher size than the hybrid female and local female flowers. Changing of sex expression in spine gourd hybrid under natural conditions was not recorded and literature indicated induced hermaphrodite in several species in cucurbits. Hossain *et al*. (1996) found that application of 200 – 800 mg/l Silver nitrate (AgNO3) to the female 'kakrol' or teasle gourd (*Momordica dioica* Roxb.) plant was effective for inducing hermaphrodite flowers. Yamasaki *et al*. (2011) in cucumber and Sanwal *et al*. (2011) in sweet gourd induced hermaphrodite flowers by spraying $AgNO_3$. Behera *et al*. (2011) used 6M Silver Thiosulfate to induce hermaphrodite flowers in *Momordica charantia*. In 1989 Jha *et al*., indicated F1 hybrid between a tetraploid female and diploid male produced only flowers while in the following season it also produced many flowers. Sex expression had changed from dioecious to monoecious and one branch of the hybrid produced hermaphrodite flowers. Therefore creation of gynomonoecious hybrid in this experiment from dioecious Momordica species may be due to crossing of tetraploid *Momordica subangulata* sub sp. *renigera* female with diploid *M. dioica* male.

a **b**

Note: a = Female flower; b = Hermaphrodite flower.

Fig 1. Sex conversion of gynoecious spine gourd hybrid from female to hermaphrodite.

Number of flowers per vine in different genotypes showed a significant difference *and* Golica female got the highest number of flowers per vine in *Yala* while hybrid male flowers showed significantly highest number of flowers in *Maha* season (Table 1). Success of fruit setting depends on the availability of viable pollens for pollinations hermaphrodite flowers with functional stamens are beneficial.

Table 1. Number of flowers in different treatments.

Treatments	Number of flowers /vine 2016 *Yala*	Number of flowers/vine 2016/17 *Maha*
Hybrid female + Hermaphrodite	202.3 b	200.8 b
Local (Accession) female	189.5 b	132.3 b
Golica female	618.1 a	152.2 b
Hybrid male	417.6 ab	1125.4 a
CV%	47.4	87

Note: Means with the same letters are not significantly different at 0.05% probability level

Hermaphrodite flowers initiated later than the hybrid female. From a population of hybrid 72% vines can produce hermaphrodite flowers and 43 hermaphrodite flowers per vine were produced during the cropping period. Hermaphrodite to female ratio within the vine was 0.6 (Table 2). This indicates a sign for extra pollen source in the population. Ovary length of hermaphrodite was higher than the hybrid females (Table 2).

Table 2. Different morphological traits of treatments during the cropping period.

Morphological Traits	Hybrid female	Local female	Golica female
Days for induction of female flowers	31	31	32
Days for induction of hermaphrodite flowers	33	-	-
Hermaphrodite flowering vines%	72	0	0
No of Hermaphrodite flowers /vine	43	0	0
Hermaphrodite flowers: female flowers/ vine	0.6	0	0
Average ovary length (cm) of female flower	1.7	1.5	1.4
Average ovary length (cm) of Hermaphrodite flower	2.9	-	-

All the crosses except selfing within the flower set fruits and seeds (Table 3). The heterosexual crossing in both ways succeeded the fruits set. Poor seeds germination percentages were observed in all the crosses (Table 3). It may be due to poor embryogenesis of the seeds.

Table 3. Analysis of pistil and stamen function in morphologically bisexual flowers in F1 spine gourd plants.

Nature of cross	Fruit set (%)	Fruit weight (g)	No of seeds/ fruit	Seed germination (%)
Selfing within flower (Hermaphrodite x Hermaphrodite)	0	0	0	0
Selfing within vine (Female x Hermaphrodite)	100	33.9	15	13
Out crossing of flower in other vine (hybrid Female x Hermaphrodite)	100	32.6	17	5
Out crossing of hermaphrodite flowers (Hermaphrodite x Hybrid male)	100	30.7	32	3

A flower with a functional ovary and pollen was defined as afunctional bisexual flower. Genetically, a bisexual flower possesses a functional ovary and pollen (Papadopoulou and Grumet, 2005). Results of Table 3 indicate the functional pollens and pistil in hermaphrodite flowers. Number of fruits per vine showed significant difference in both seasons and highest number of fruits per vine was showed by local line in *Yala* season and hybrid female in *Maha* season. Fruits yield per vine did not show a significant difference in *Yala* season and hybrid female got the highest yield in *Maha* season (Table 4). A yield improvement of hybrid could be seen with the increasing fruits number. Variety Golica and local line did not show significant difference in yield improvement with the increasing of fruits number. Therefore yield improvement is significantly higher in hybrid female in 2016/17 *Maha* season (Table 4).

Table 4. Yield contributing characters of treatments.

Line	No of fruits/vine		Yield(g) / vine	
	2016 *Yala*	**2016/17 *Maha***	**2016 *Yala***	**2016/17 *Maha***
Hybrid	15.6 b	120 a	316.3 a	1793.9 a
Golica	29.3 b	37.6 c	312.2 a	285.0 b
Local line	48.7 a	84.6 b	422.1 a	581.3 b
CV%	21.6	18.9	30.9	43.6

Note: Means with the same letters are not significantly different at 0.05% probability level

CONCLUSION

Bisexual flowers of spine gourd hybrid are with the functional ovary and pollen. Therefore, production of hermaphrodite flowers in spine gourd hybrid is a genetic character. Pollens of the hermaphrodite flowers can be used for the fruits development of the spine gourd hybrid. Hermaphrodite flowers can be used as a pollens source as well as female flowers for setting fruits. Yield of spine gourd can be significantly improved by using gynomonocious hybrid (*M. subangulata* sub sp. *renigera* x *M. dioica*). Further confirmations for functions of hermaphrodite flower are needed to future improvements of hybrid. Cultivation of hybrid more benefitial than the local variety or cultivars.

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