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Evidence confirms the occurrence of stenospermocarpic seedless fruit development in pointed gourd (*Trichosanthes dioica* Roxb.)

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Abstract

Pointed gourd (*Trichosanthes dioica*) is a perennial and vegetatively propagated cucurbitaceous vegetable grown for its tender fruits, and the occurrence of harder seeds reduces consumers' preference. The present study was undertaken to understand the mechanism of seedless fruit development in pointed gourd. The period of rapid fruit growth and development in pointed gourd took place generally 3-7 days after pollination due to faster cell division and cell enlargement. Significantly higher fruit growth recorded in seeded clone as compare to seedless clones (49.1% for fruit length, 16.7% for fruit diameter and 55.2% for fruit weight) at harvestable fruit maturity but at the same time no significant differences found at initial stage of fruit development. The occurrence of various mechanisms of seedless fruit development such as vegetative parthenocarpy, stimulative parthenocarpy and stenospermocarpy have been studied in details through different pollination treatments in both seeded and seedless clones. In seedless clone, the growth/development of seed was normal for first 3-4 days after pollination and become abnormal (aborted and degenerated embryo, shriveled and disintegrated cotyledons, traces of aborted seeds yellowish-white in colour and zero per cent seed germination) indicate the existence of fertilization and subsequent abortion of fertilized embryo which confirms the occurrence of stenospermocarpic seedlessness and absence of stimulative parthenocarpy in pointed gourd.

Keywords: Pointed gourd (*Trichosanthes dioica*); Seedlessness; Stenospermocarpy; Parthenocarpy

Introduction

Pointed gourd (*Trichosanthes dioica* Roxb., 2n=2x=22) is a perennial and vegetatively propagated (vine cutting and root sucker) cucurbitaceous vegetable grown in sub-tropical and tropical regions for its immature tender fruits. It is native to India and South East Asia, being the primary center of origin, there is wide range of variability present in this crop. The genus *Trichosanthes* is distributed in Indo-Malayan regions, possesses about 44 species, of which 22 are found in India (Chakravarty 1982). DeCandolle (1882) concluded that the species of *Trichosanthes*, especially *T. dioica* originated in the Old World, most probably in India. It is known by the various vernacular names such as parwal, parora, palwal, parmal, patol and potala in different parts of India. Both traditionally and commercially, it is grown in North and Eastern parts of India, particularly Tarai belts of Uttarakhand and Uttar Pradesh, Eastern parts of Uttar Pradesh, West Bengal, Odisha, Assam and Jharkhand, and also in Bangladesh. Pointed gourd has higher nutrient content than other cucurbits (Pandit and Hazra 2008). Its fruits are rich in vitamin-A (153 µg/100 g), and protein levels are 10 times higher than that of bottle gourd and 4 times that of snake gourd, ridge gourd and ash gourd (Kumar and Singh 2012). Pointed gourd is reported for its antioxidant activity, antidiabetic, cholesterol lowering and hepato-protective property. Its tender fruits are also used for confectionary preparations where seeds are removed by giving longitudinal cut on one side and stuffing with Khoa, a milk product, in Eastern India. Generally, pointed gourd produces seeded fruits and seedlessness is a rare phenomenon. Maturity in seeded pointed gourd hastens due to seed growth which eventually reduces the consumers' preference as well as marketability.

Anthesis, pollination and fertilization; and fruit and seed development in the flowering plants usually occur in a coordinated manner. The development of seeds is important for fruit growth and development because they are a source of the phytohormones that are required continuously throughout seed and fruit formation (Ozga et al. 2002; Vardi et al. 2008). A plant is considered to be seedless, if it is able to produce fruit without seed or

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contains traces of aborted seeds or a much-reduced number of seeds (Varoquaux et al. 2000). In plants, the seedlessness is due to either of two ways (i) parthenocarpy i.e. development of fruits with pollination (stimulative/facultative parthenocarpy) or without pollination (vegetative parthenocarpy) but without fertilization or (ii) stenosparmocarpy where pollination required for fruit development, but the fertilized ovules or embryos abort without developing in to mature seeds. Seedless fruit development reported in many vegetables/ fruits such as cucumber, banana, pineapple, sycamore fig, breadfruit and persimmon due to vegetative parthenocarpy; tomato, brinjal, sweet pepper, summer squash, lemon, orange, grapefruit and custard apple because of stimulative parthenocarpy; and watermelon, litchi, grape, avocado and mango owing to stenosparmocarpy (Stout 1936; Denna 1973; Rudich et al. 1977; Yen 1980; Tomer et al. 1980; Whiley et al. 1988; Qrtiz and Vuylsteke 1995; Kikuchi et al. 2008; Tiwari et al. 2011; Yamada et al. 2012; Durner EF 2013; Dhatt and Kaur 2016; Santos et al. 2016).

It is a dioecious (with distinct male and female plants) vine plant having cordate leaves (heart-shaped) and tuberous taproot system. The fruits are usually spindle or may be globose/round/oval in shape; light to dark green in colour with or without white stripes; and each fruit contains 20-30 seeds. Usually, flowering and fruiting starts in March and continued by November in humid sub-tropic climatic conditions. Usually, the consumption of seedless fruits is easier, more convenient and palatable, hence they are considered commercially more valuable and fetches higher price of products. In pointed gourd, the unique advantage of the seedlessness includes a sharp increase in recovery of edible portion as seeds and their cavities are replaced with edible tissues, and also extend the period of harvesting as compare to seeded genotype/variety. Additionally, the shelf-life of seedless fruits is assumed to be longer than seeded fruits because seeds produce hormones that stimulate senescence (Varoquaux et al. 2000). In pointed gourd, the seeds become harder towards maturity and eventually turn very hard and black in colour at ripe fruit stage. The hard seeds create uneasiness while consumption, have lesser preferences by consumers and also non-desirable for confectionary preparations. Unlike to other vegetables, the seeds of pointed gourd are recalcitrant in nature i.e. loose their viability very fast after extraction from ripe fruits. Although the seedless fruit development has been reported in a clone 'IIVRPG-105 (IC296492)' at ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh (Ram et al. 2003); yet the cause(s) of seedlessness has not been studied till date. Therefore, the present study was undertaken to understand the mechanism of seedless fruit development in pointed gourd.

Materials and Methods

The field experiments were conducted at ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh consecutively for three years i.e. 2012, 2013 and 2014. The experimental site is located at 25°10'55'' N latitude and 82°52'36'' E longitude with an altitude of 85 m above the mean sea level, receives an annual rainfall of 1050-1100 mm, and possesses humid sub-tropical climate with temperatures varying widely between summer and winter. The experimental materials comprised of a seedless clone 'IIVRPG-105' and a seeded clone 'Kashi Alankar (VRPG-1)', both developed and maintained at ICAR-IIVR, Varanasi which are genetically and morphologically diverse clones.

A set of two experiments was designed to find the cause of seedless fruit development in pointed gourd clones i.e. (i) confirmation of vegetative or stimulative parthenocarpy and (ii) confirmation of stenospermocarpy. In the investigation of vegetative parthenocarpy which doesn't require pollination for fruit set, the pollination was restricted by covering the flower buds of female plants as well as isolation of female plants from pollinizer (male clone) in insect proof net. In the absence of vegetative parthenocarpy, another experiment was carried out to confirm stimulative parthenocarpy by providing 15 different pollination/stimulation mechanisms (PSM) which includes pollination with the pollen of various gourd crops such as pointed gourd, snake gourd, bitter gourd, bottle gourd, ridge gourd, sponge gourd, spine gourd and ivy gourd; pollination with mix pollen including pointed gourd pollen; pollination with mix pollen excluding pointed gourd pollen; distilled water drops were used as stimulus agent and stimulation through plant growth regulators namely IAA (100 ppm), GA_3 (100 ppm) and combination of both (50 ppm). After the stimulation treatments, growth of developing seed observed in set fruits of seedless clone. In stenosparmocarpic seedlessness, pollination and fertilization required for fruit development, but embryos/ endosperm degenerate without developing in to mature seed; hence ovule/embryo/seed growth pattern was studied in developing fruits at different stages to confirm the presence/absence of fertilization. Fruit setting (%) in different pollination mechanisms were calculated based on 60 flowers for three years continuously. Fruit growth pattern pertaining to fruit length, fruit diameter and fruit weight at harvestable/edible maturity in seeded and seedless clone were observed.

Data regarding fruit set, fruit length, fruit diameter and fruit weight of seedless and seeded genotypes were statistically analysed and compared using standard error bars with probability of less than 5% ($p<0.05$). Further, in the statistical analyses, arc sine transformation was followed as the fruit set (%) based on count data and were ranged between 0 to 100%. The distribution of percentage data followed binomial pattern and arc sine transformation converts the distribution in to normal distribution. In this transformation, the value of 0% is replaced by (1/4n) and 100% by (100 – 1/4n), where 'n' is the number of units based on which percentage data calculated.

Results

Verification of vegetative parthenocarpy: To verify seedless fruit development due to vegetative parthenocarpy in pointed gourd, firstly 60 flower buds each of seeded (Kashi Alankar) and seedless (IIVRPG-105) clones had been covered with butter paper envelop and also three vines of both type of clones was caged with insect proof net to isolate from pollinizer plants for avoiding any chance of artificial or natural pollination. Data on fruit set observed consecutively for three years (2012-2014) revealed that none of the flowers of both Kashi Alankar and IIVRPG-105 set fruits which covered/ caged with butter paper and insect proof net.

Confirmation of stimulative parthenocarpy: Moreover, to confirm stimulative parthenocarpy type of seedlessness, 60 flower buds each of seeded (Kashi Alankar) and seedless (IIVRPG-105) clones stimulated with 15 types of stimuli i.e. pollination with the pollen of various gourd crops such as pointed gourd, snake gourd, bitter gourd, bottle gourd, ridge gourd, sponge gourd, spine gourd and ivy gourd; pollination with mix pollen including pointed gourd pollen; pollination with mix pollen excluding pointed gourd pollen; distilled water drops; IAA; $GA_{3;}$ and combination of IAA+GA_3. Among 15 stimulation treatments, fruit set was recorded only in three type of pollination/stimulation mechanism i.e. flower kept open with pollinizer (male clone), hand pollination with the pollen of pointed gourd and hand pollination with mixed pollen of different gourds including pointed gourd (Table 1 and Figure 1). In seeded clone, mean fruit set was highest (97.78%) in hand pollination with the pollen of pointed gourd followed by mixed pollen of different gourds including pointed gourd (95.00%) and flower kept open with pollinizer (87.78%); while in seedless clone, it was maximum (92.78%) in hand pollination with the pollen of pointed gourd followed by mixed pollen of different gourds including pointed gourd (90.00%) and flower kept open with pollinizer (73.89%).

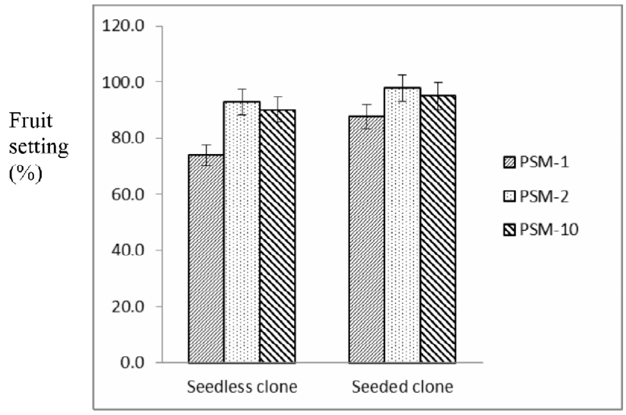


Figure 1: Fruit setting (%) in seedless and seeded clones (IIVRPG-105 and Kashi Alankar) under different pollination/ stimulation mechanisms (PSM-1: Flower kept open with pollinizer, PSM-2: Hand pollination with pollen of pointed gourd and PSM-10: Hand pollination with mixed pollen of all including pointed gourd)

Evidence of stenospermocarpic seedless fruit development: Seed growth and development, cotyledon and embryo development, and seed coat colour were observed at different stages after pollination in both seeded and seedless clones to find the evidence of stenospermocarpic seedlessness in pointed gourd. Seed growth and development was normal for 3-4 days after pollination in both type of clones; nevertheless, it was retarded after 5 days of pollination, become rudimentary after 9-10 days of pollination, and traces of seeds were observed in fully-ripe fruits in seedless clone as compare to fully developed seeds in ripe-fruits of seeded clone (Table 2, Figure 2). Likewise, cotyledon development in growing seeds was also observed normal for 4-5 days after pollination in both seeded and seedless clones; while it started shriveling after 6 days of pollination, and degenerated in the seed traces of fully-ripe fruits of seedless clone, but well-developed cotyledons were present in fully-developed seeds in ripe-fruits of seeded clone (Table 2). Embryo development too followed the pattern of seed and cotyledon development in both type of clones; while embryo development was observed normal by 3-4 days followed by abnormal growth for 5-8 days of pollination, and eventually thereafter it aborted and degenerated in seedless clone. However, well-developed plumpy embryos of off-white colour were visualized in the matured seeds of ripe fruits of seeded clone. In seeded clone of Kashi Alankar, seed coat colour of developing seeds was observed white by 10-11 days of pollination followed by cream-white at harvestable fruit maturity, and ultimately turned to black colour at ripe fruit stage or seed harvestable maturity; on the other hand, white seed coat colour was observed in seedless clone 'IIVRPG-105' by 4-5 days, turned cram-white at

Table 1: Fruit setting (%) in seedless and seeded clones of pointed gourd under various pollination/stimulation mechanisms

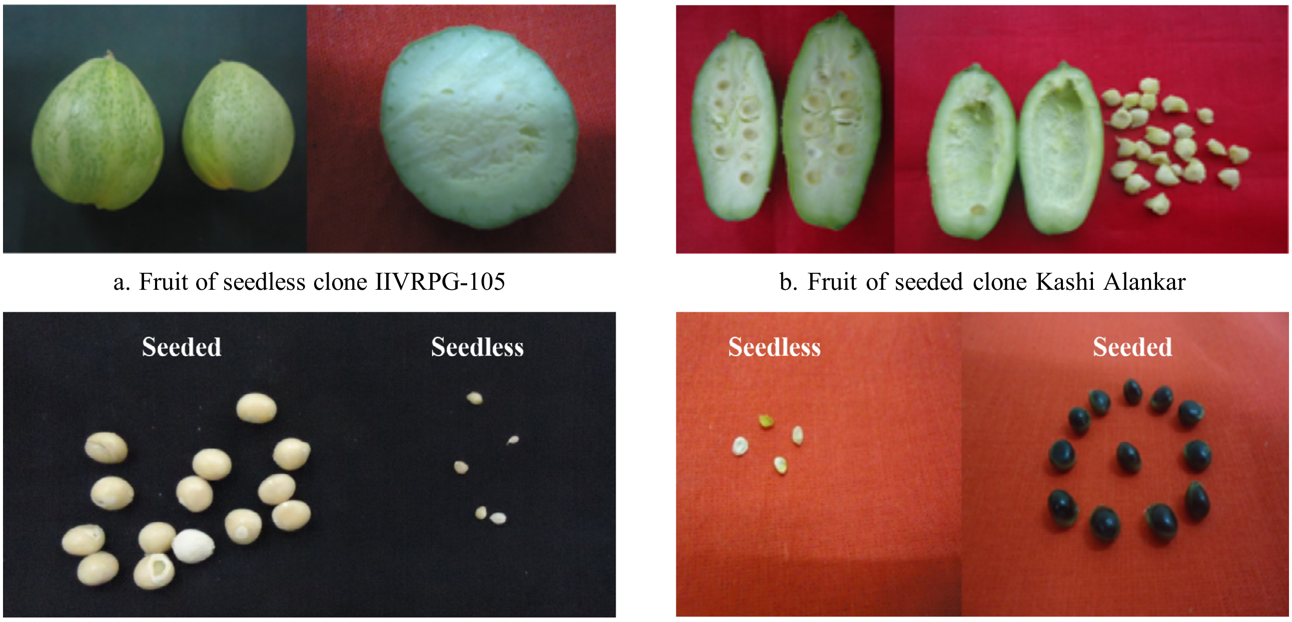
S. No.	Pollination/stimulation mechanism (PSM)	Seedless clone (IIVRPG-105)				Seeded clone (Kashi Alankar)			
		2012	2013	2014	Mean	2012	2013	2014	Mean
1	Flower kept open with pollinizer (Male clone)	76.67 (61.12)	71.67 (57.84)	73.33 (58.91)	73.89 (59.27)	93.33 (75.04)	88.33 (70.03)	81.67 (64.65)	87.78 (69.54)
2	Hand pollination with pollen of pointed gourd	96.67 (79.48)	93.33 (75.04)	78.33 (70.03)	92.78 (74.41)	98.33 (82.58)	95.00 (77.08)	100.00 (90.00)	97.78 (81.43)
3	Hand pollination with pollen of snake gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
4	Hand pollination with pollen of bitter gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
5	Hand pollination with pollen of bottle gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
6	Hand pollination with pollen of ridge gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
7	Hand pollination with pollen of sponge gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
8	Hand pollination with pollen of spine gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
9	Hand pollination with pollen of ivy gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
10	Hand pollination with mixed pollen of all including pointed gourd	91.67 (73.22)	88.33 (70.03)	90.00 (71.57)	90.00 (71.57)	95.00 (77.08)	96.67 (79.48)	93.33 (75.04)	95.00 (77.08)
11	Hand pollination with mixed pollen of all excluding pointed gourd	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
12	Drop of distilled water on stigma as stimulant	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
13	Drop of IAA (100 ppm) on stigma as stimulant	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
14	Drop of GA_3 (100 ppm) on stigma as stimulant	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)
15	Drop of IAA (50 ppm) + GA_3 (50 ppm) on stigma as stimulant	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)	0 (0.37)

Transformed values in parentheses

Table 2: Seed morphology in developing fruits of seedless and seeded genotypes of pointed gourd

Days after pollination	Seed growth and development		Cotyledon development		Embryo development		Seed-coat colour	
	Seedless clone	Seeded clone	Seedless clone	Seeded clone	Seedless clone	Seeded clone	Seedless clone	Seeded clone
3-4	Normal	Normal	Normal	Normal	Normal	Normal	White	White
5	Reduced	Normal	Normal	Normal	Abnormal	Normal		
6	Stopped	Normal	Shriveled	Normal	Abnormal	Normal	Cream-white	
7	Stopped	Normal	Shriveled	Normal	Abnormal	Normal		
8	Stopped	Normal	Shriveled	Normal	Abnormal	Normal		
9	Stopped	Normal	Shriveled	Normal	Aborted	Normal		
10	Rudimentary	Normal	Shriveled	Normal	Aborted	Normal		
11#	Rudimentary	Normal	Shriveled	Normal	Aborted	Normal		
12#	Rudimentary	Developed	Shriveled	Developed	Aborted	Developed		Cream-white
13#	Rudimentary	Developed	Shriveled	Developed	Aborted	Developed		
24-30*	Rudimentary	Fully developed	Degenerated	Well-developed	Aborted	Well-developed plumpy embryo	Yellowish-white	Black

Harvestable maturity of fruits; *Ripe fruits (Harvestable maturity of seeds)



a. Fruit of seedless clone IIVRPG-105

b. Fruit of seeded clone Kashi Alankar

c. Seed at harvesting maturity stage

d. Seed from ripe fruits

Figure 2: Fruits and seed morphology of seedless (IIVRPG-105) and Seeded (Kashi Alankar)

6-13 days of pollination, and finally became yellowish-white in seed traces at ripe fruit stage (Table 2, Figure 2). Further, 63.7% and 0% seed germination was recorded, respectively in the freshly harvested seeds of seeded and seed-traces of seedless clone.

Fruit growth pattern in seedless and seeded clone: The values of fruit growth parameters were higher in seeded clone (Kashi Alankar) as compare to seedless clone (IIVRPG-105) at harvestable maturity (12 days after pollination) i.e. 8.2 and 5.5 cm in fruit length, 4.2 and 3.6 cm in fruit diameter, and 30.1 and 19.4 g fruit weight, respectively (Figure 3, Figure 4 and Figure 5). Moreover, there were no significant differences for the length, diameter and weight of ovary just after pollination in both types of clones i.e. 1.2 and 1.2 cm in fruit length, 0.7 and 0.7 cm in fruit diameter, and 0.5 and 0.6 g fruit weight, respectively; but the differential fruit growth in seeded and seedless clones were observed 2-3 days after pollination.

Discussion

Seedlessness is a trait of economic importance in many commercially grown fruit and vegetable crops if devoid of undesirable changes to shape, texture, quality or flavour. In pointed gourd, the absence of seeds is very much valued by producers as well as consumers because it enhances harvestable period (longer field stay), consumers' preference, palatability and fruit shelf-life. Vegetative parthenocarpy is a mechanism in which seedless fruits develop without pollination and

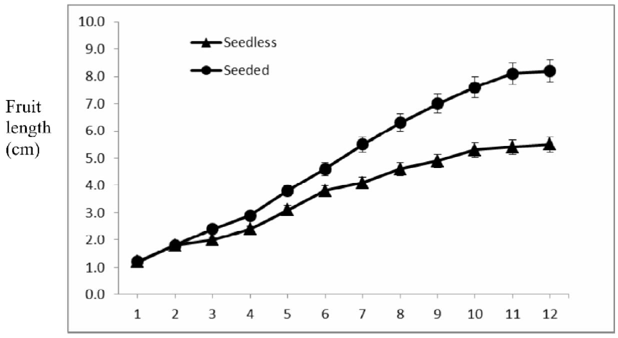


Figure 3: Pattern of fruit growth in relation to fruit length of seedless (IIVRPG-105) and seeded clone (Kashi Alankar)

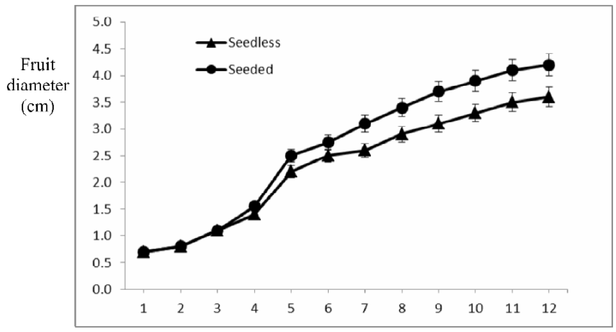


Figure 4: Pattern of fruit growth in term of fruit diameter of seedless (IIVRPG-105) and seeded clone (Kashi Alankar)

fertilization. In this experimentation, consecutively from 2012-2014, no fruit setting was recorded in both types of clones (seedless and seeded) whose flowers were either bagged with butter paper or plants were caged with insect-proof net to restrict pollination which indicate

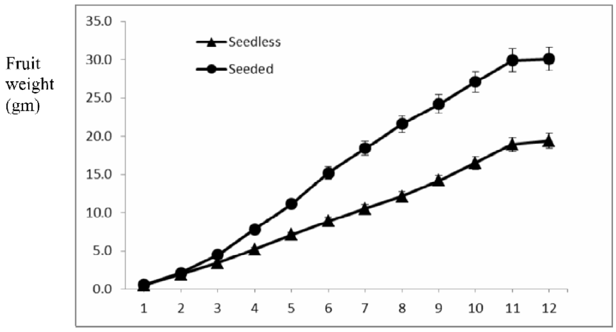


Figure 5: Pattern of fruit growth in relation to fruit weight of seedless (IIVRPG-105) and seeded clone (Kashi Alankar)

that vegetative parthenocarpy is not responsible for seedlessness in pointed gourd. Moreover, seedlessness due to vegetative parthenocarpy has been reported in banana, persimmon, cucumber, pineapple etc (Yamada et al. 2012; Qrtiz and Vuylsteke 1995; Rudich et al. 1977; Durner EF 2013)

In another type of parthenocarpic seedlessness i.e. stimulative parthenocarpy, the development of fruits require pollination but not fertilization. The occurrence of this types of seedlessness and need of pollination for fruit setting in both seedless and seeded clones were verified by applying 15 various kinds of stimuli [PSM-1: natural pollination with pointed gourd; PSM-2 to PSM-9: hand pollination with the pollen of various gourd crops (pointed gourd, snake gourd, bitter gourd, bottle gourd, ridge gourd, sponge gourd, spine gourd and ivy gourd); PSM-10: hand pollination with mix pollen containing pointed gourd pollen; PSM-11: hand pollination with mix pollen without pointed gourd pollen; PSM-12: drops of distilled water; and PSM-13 to PSM-15: application of plant growth hormones i.e. IAA, GA_3 alone and in combination]. Among these 15 stimuli, fruit settings were noted only in three pollination and stimulation mechanism (PSM) namely natural pollination with pointed gourd (flower kept open with pollinizer), hand pollination with pointed gourd and hand pollination with mix pollen having pointed gourd pollen i.e. 73.89% (71.67-76.67%), 92.78% (78.33-96.67%) and 90.00% (88.33-91.67%) in seedless clone, and 87.78% (81.67-93.33%), 97.78% (95.00-100.00%) and 95.00% (93.33-96.67%) in seeded clone, respectively (Table 1, Figure 1). The fruit setting in both types of clones was observed only in three combinations having pollens of pointed gourd (PSM-1, PSM-2 and PSM-10) indicate that pollination is required for fruit setting in both seeded and seedless clones. Therefore, seedless fruit development in pointed gourd may or may not be due to the stimulative parthenocarpy. In tomato, brinjal, sweet pepper, summer squash, lemon, orange, grapefruit and custard apple for the development of seedless fruit, stimulation through pollination or growth regulator is required (Kikuchi et al. 2008; Tiwari et al. 2011; Durner EF 2013; Dhatt and Kaur 2016; Santos et al. 2016).

To confirm the absence or presence of fertilization i.e. stimulative parthenocarpy or stenospermocarpy; seed growth and development pattern, cotyledon and embryo development, and seed coat colour were observed at different stages after pollination in both seeded and seedless clones. In seeded clone, normal seed growth and development was observed from pollination to fruit ripening stage having fully-grown plumpy embryos of off-white colour, well-developed cotyledons, normal seed coat (cream-white in colour at fruit harvestable fruit maturity and black at ripened fruit stage), fully developed almost round seed with 63.7% seed germination indicating the presence of fertilization and absence of embryo abortion which leads to development of seeded fruit. Moreover, in seedless clone, the growth and development of seed was normal for first 3-4 days after pollination, but during course of fruit development the it become abnormal i.e. aborted and degenerated embryo, shriveled and disintegrated cotyledons, traces of aborted seeds yellowish-white in colour and zero per cent seed germinability authenticating the existence of fertilization and subsequent abortion of fertilized embryo which confirms the occurrence of stenospermocarpic seedlessness and absence of stimulative parthenocarpy in pointed gourd. In most of the grape varieties seedlessness is due to stenospermocarpy except "Black Corianth" which produced parthenocarpic seedless fruit (Stout 1936; Berrit 1970; Emershad and Ramming 1984; Christensen et al. 1983). Stenospermocarpic seedless fruit development is also reported in litchi, avocado and mango (Yen 1980; Tomer et al. 1980; Whiley et al. 1988).

Ovule fertilization usually hastens the development of fruits from ovary. In pointed gourd, the period of rapid fruit growth and development happens after 3-7 days of pollination because of faster cell division and cell enlargement. The values of fruit growth parameters like fruit length, fruit diameter and fruit weight were higher in seeded clone as compare to seedless clone at harvestable maturity (Figure 3, Figure 4 and Figure 5). Non-significant differences for the length, diameter and weight of ovary at the time or just after pollination in both types of clones and the differential growth responses of fertilized ovary observed after 2-4 days of pollination; and distinctly higher fruit growth recorded in seeded clone as compare to seedless clones (49.1% for fruit length, 16.7% for fruit diameter and 55.2% for fruit weight) at harvestable fruit maturity. In avocado seed also controls rate of growth and development and seeded fruits are generally 8-10 times larger than seedless fruits (Blumenfeld and Gazit 1974). Slower rate of fruit growth and lesser fruit weight in seedless fruits as compare to seed one was reported in "Sah Keng" variety of Litchi (Yen 1980).

In general, it has been observed that the fruit growth and development in seedless clone is comparatively slower to seeded clone which might be due to the lack of activity of growth hormones produced in the seed. Development of fruits and seeds is closely associated, synchronized and governed by plant growth hormones (Pandolfini 2009). The phytohormones, particularly gibberellins, cytokinins and auxins are engaged in the signaling processes after pollination/fertilization and these plant growth regulators also facilitate further growth and development of fruits and seeds in the horticultural crops (Bohner et al. 1988; Pak 1993; Cano-Medrano and Darnell 1997; Fos et al. 2001; Chowdhury et al. 2007; Mohammad et al. 2008). Furthermore, the developing seeds are also source of phytohormones which invariably stimulate the various stages of fruit growth and development (Ozga et al. 2002).

Pointed gourd, commonly, produces seeded fruit and production of seedless fruit is a rare phenomenon. Findings of this study confirm that the seedless fruit development in VRPG-105 is solely due to the stenospermocarpy. With respect to market value for culinary as well as confectionary purpose, consumers generally prefer soft seeded/seedless/less seeded pointed gourd than hard seeded one. Seed growth in this crop correlated with the fruit growth. Maturity in seeded pointed hastened due to seed growth which reduces the marketability of this vegetable. The unique advantage of the seedless pointed gourd not only includes maximum recovery of edible portion but also extending period of harvesting time as compare to seeded counterpart. Fruits of seed less pointed gourd can be kept in the vine itself for 7-8 day more than seeded one. Thus this line could also provide the opportunity to the farmer to monitor the marketing time. Nevertheless, the development of yield potential seedless pointed gourd genotypes utilizing VRPG-105 will be helpful to accomplish the consumer's preference for culinary purpose and to revalorize its utilization in confectionary preparation.

सारांश

परवल (*ट्राइकोसैन्थस डाइओका*) एक बहुवर्षीय तथा वर्धीय प्रचारित कद्दूवर्गीय सब्जी है जिसकी खेती मुलायम फलों के लिये की जाती है। फलों में कठोर बीजों का होना उपभोक्ता के लिये उपयुक्त नहीं होता है। वर्तमान अध्ययन, परवल में बीज रहित फल विकास की प्रक्रिया को जानने हेतु किया गया है। परवल में तेजी से फल वृद्धि व विकास पुष्प परागण के 3–7 दिनों में होता है क्योंकि इसी समय तेज कोशिका वृद्धि व कोशिका विस्तार होता है। बीज धारित क्लोन की तुलना में बीज रहित क्लोन (49.5 प्रतिशत फल की लम्बाई, 16.7 प्रतिशत फल व्यास तथा 55.2 प्रतिशत फल भार) फल पकाव तुड़ाई के समय देखा गया लेकिन एक ही समय में फल विकास की प्रारम्भिक अवस्था से कोई सार्थक अन्तर नही पाया गया। बीज रहित फल विकास की विभिन्न प्रक्रियाओं जैसे–वर्धीय पार्थेनोकार्पिक, उत्तेजना पार्थोनोकार्पिक व स्टेनोस्पर्मोकार्पी के माध्यम से विस्तृत अध्ययन बीज धारित व बीज रहित क्लोनों में विभिन्न परागण उपचारों से किया गया। बीज रहित क्लोन में परागण के 3–4 दिनों तक बीज विकास की प्रक्रिया सामान्य रही और असमान्य (गर्भपात और पतित भ्रूण, सिकुड़ा हुआ और पतित बीज पत्र, गर्भपात बीज के पीले–सफेद पदार्थ व शून्य प्रतिशत जमाव) से व्यवहार से स्पष्ट हुआ कि निषेचित भ्रूण और बाद में गर्भपात की मौजूदगी से स्पष्ट होता है कि परवल में स्टेनोस्पर्मोकार्पिक बीज रहित तथा उत्तेजना पार्थेनोकार्पिक की अनुपस्थिति है।

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