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Research Article

Standardization of Pre-Harvest Chemicals Suitable for Bitter Gourd (*Momordica Charantia* L.) Growth and Yield

Rajasekar Manivelu*[1] and Swaminathan Venkatesan[2]

[1]Precision Farming Development Centre, Agricultural Engineering College and Research Institute, TNAU, Coimbatore- 641 003
[2]Horticultural College and Research Institute, TNAU, Periyakulam – 625 604

Abstract

The field experiment was to standardize the pre- harvest chemicals suitable for growth and yield of Bitter gourd cv., CO1, MAHY 101, US 6214, Palee and Roma. There were nine treatments with four chemicals, viz., GA_3(250ppm), GA_3(500ppm), BA(50ppm), BA (100ppm), $CaCl_2$ (0.25 %), $CaCl_2$ (0.50 %), Ca $(NO_3)_2$ (0.50 %), Ca $(NO_3)_2$ (1.0 %),Control (No spray) were sprayed two times starting at the time of flowering and after fruit set, replicated three times in a Factorial Randomized block design. Results revealed that, application of Gibberellic acid (500 ppm) shows significantly early flowering and $CaCl_2$ - 0.50 per cent increased fruit length, fruit girth, fruit weight, number of fruits and yield per vine.

Keywords: Bitter gourd, Hybrids, Cultivars, Pre harvest Chemicals, Yield

***Correspondence**
Author: Rajasekar Manivelu
Email: rajahorts@gmail.com

Introduction

Bitter gourd (*Momordica charantia* L.) is cultivated throughout India as a vegetable crop during the warm seasons of the year. Among the cucurbitaceous vegetables, bitter gourd fruits are highly nutritive and are relatively high in proteins, minerals and vitamins. The fruits are borne on monoecious climbers with slender stem having pubescent or sub-glabrous leaves. The tender fruits contain, 83.2 per cent water, 2.9 per cent protein, 1.0 per cent fat, 1.4 per cent mineral matter, 1.7 per cent fiber, 9.8 per cent carbohydrates, 0.05 per cent calcium, 0.14 per cent phosphorus, 9.4 per cent iron and traces of Mg [1]

The fruit has immense medicinal properties due to the presence of beneficial phytochemicals which are known to have antibiotic, antimutagenic, antioxidant, antiviral, antidiabetic and immunity enhancing properties [2]. A compound known as momordicin and charantin present in the bitter gourd is used in the treatment of diabetes in reducing blood sugar level [3]. The perishable nature of bitter gourd is a definite risk to the traders. Pre-harvest sprays of plant growth regulators and other chemicals are known to be effective in enhancing the growth, yield, quality and shelf-life of vegetables [4]. Hence, the experiments were conducted to standardize the pre- harvest chemicals suitable for bitter gourd growth and yield.

Materials and Methods

The experiment was conducted during 2013 at college orchard in the Department of Horticulture, Agricultural College and Research Institute, TNAU, Madurai, to standardize the Pre-harvest chemicals and their doses suitable for the growth and yield of Bitter gourd cv. C_1 - Roma, C_2 - CO_1, C_3 - MAHY 101, C_4 – US 6214 and C_5 - Palee at a spacing of 2x1.5m. The experiment was laid out in a Factorial Randomized Block Design with four chemicals, viz., T_1 - Gibberellic acid (250 ppm), T_2 - Gibberellic acid (500 ppm), T_3 - Benzyl adenine (50 ppm), T_4 - Benzyl adenine (100 ppm), T_5 - $CaCl_2$ (0.25 %),T_6 –- $CaCl_2$ (0.50 %), T_7 - Ca $(NO_3)_2$ (0.50 %), T_8 - Ca $(NO_3)_2$ (1.0 %), T_9 - Control (No spray) were sprayed two times starting at the time of flower initiation and after fruit set. There were nine treatments replicated thrice. Ten plants were tagged in each treatment for biometric observation. Standard package of practices were followed. The data were statistically analyzed and interpreted.

Result and Discussion

The primary goal of any production system is to achieve maximum yield per unit area without affecting the quality. In bitter gourd, the yield is mainly judged by early flowering, increased fruit length, fruit girth, fruit weight, number of fruits and yield per plant. Spraying of chemical substances has made a remarkable effect on fruit yield. The

data regarding the effect of pre harvest chemicals spraying on days taken for first flowering of fresh bitter gourd is presented in **Table 1**.

Figure 1 Cultivars used for the study

Table 1 Effect of Pre-harvest chemical spray on days (No's) taken to first flowering in Bitter gourd cultivars

Treatments	Cultivars					
	C_1	C_2	C_3	C_4	C_5	Mean
T_1	35.89	44.67	35.57	36.91	38.00	38.21
T_2	34.04	44.33	35.33	35.09	37.01	37.16
T_3	38.41	46.00	38.00	38.16	39.42	40.00
T_4	37.53	45.96	37.90	38.07	39.13	39.72
T_5	36.73	45.15	36.18	37.67	38.54	38.85
T_6	36.17	44.98	36.00	37.43	38.32	38.58
T_7	37.30	46.20	37.67	37.97	39.00	39.63
T_8	37.01	45.83	36.42	37.90	38.67	39.17
T_9	39.72	46.23	38.16	39.97	39.99	40.81
Mean	36.98	45.48	36.80	37.69	38.68	
	T		C		C x T	
SEd	0.94		0.97		1.91	
CD @ 5%	1.85		1.91		3.76	

The days taken for first flowering were significantly different in various pre harvest chemical treatment and cultivars and their interactions. The results revealed that, the minimum days taken for first flowering was recorded with Pre-harvest spray of gibberellic acid T_2 - GA_3 (500ppm) (37.16). The maximum days taken for first flowering were recorded with T_9 - Control (40.81). For various cultivar treatments the minimum days taken for first flowering was C_3 - MAHY101 (36.80) and the maximum days taken for first flowering is C_2 - Co1 (45.48). The interaction between different chemical treatments and cultivar treatments revealed that the minimum days taken for first flowering was recorded in T_2 C_1 (T_2- GA_3 (500ppm), C_1- Roma) (34.04) and the maximum value was recorded in T_9 C_2 (T_9 Control, C_2- Co1) (46.23). This might be ascribed to more efficient utilization of food for reproductive growth (flowering and fruit set), higher photosynthetic efficiency and enhanced source to sink relationship of the plant, reduced respiration, enhanced translocation and accumulation of sugars and other metabolites. The findings are in concurrence with the melon fruits responses to various growth regulators [5].

Fruit length was significantly influenced by different chemical sprays and cultivar treatments and their interactions. For the chemical treatments the highest fruit length was recorded with T_6 - $CaCl_2$ (0.50 %) (24.68cm**)** and the lowest fruit length was recorded in T_9 - control (20.18 cm). While different cultivar treatments the highest fruit length was recorded in C_2 - Co1 **(**24.56 cm**)** and the lowest was recorded in C_4 - US 6214 (19.27 cm). Regarding interaction between different chemical sprays and cultivars, the highest fruit length was recorded in T_6 C_2 (T_6 - $CaCl_2$ (0.50 %), C_2 - Co1) (26.57 cm) and the cultivar treatment T_6 C_5 - Palee (25.85 cm) on par with T_6 C_2 and the lowest value was recorded in T_9 C_4 (T_9 - control, C_4 - US 6214) (17.06 cm). Spraying of calcium chloride might have increased the fruit length Vijayaraghavan [6] (**Table 2**)


Figure 2 Field view of the experiment

Table 2 Effect of Pre-harvest chemical spray on fruit length (cm) of Bitter gourd cultivars

Treatments	Cultivars					
	C_1	C_2	C_3	C_4	C_5	Mean
T_1	23.01	24.18	20.23	19.04	23.53	22.00
T_2	23.21	24.31	20.79	19.11	23.94	22.27
T_3	22.45	23.97	20.00	18.56	22.27	21.45
T_4	22.73	24.12	20.05	18.97	22.63	21.70
T_5	24.40	25.00	22.12	20.12	24.30	23.18
T_6	25.63	26.57	23.75	21.60	25.85	24.68
T_7	23.86	24.53	21.54	19.23	24.03	22.63
T_8	24.02	24.96	21.83	19.75	24.17	22.94
T_9	21.32	22.50	19.24	17.06	20.76	20.18
Mean	23.40	24.56	21.06	19.27	23.50	
	T		C		C x T	
SEd	0.43		0.41		0.83	
CD @ 5%	0.84		0.80		1.65	

The fruit girth data revealed that the various chemical sprays, cultivar treatments and their interactions had a significant effect. Among the different pre harvest chemicals T_6 - $CaCl_2$ (0.50 %) (16.10 cm) recorded highest fruit girth and the lowest was recorded in T_9 - Control (12.52 cm). Considering the different cultivars the highest fruit girth was recorded in C_5 - Palee (16.48 cm) and the lowest value was recorded in C_2- Co1 (12.79 cm). Regarding interaction of different chemical sprays and cultivars the maximum fruit girth was recorded in T_6 C_5 (T_6 - $CaCl_2$ (0.50 %), C_5 - Palee) (18.50 cm) and the lowest value was recorded in T_9 C_2 (T_9 - Control, C_2- Co1) (11.14 cm). Spraying of calcium in the form of $CaCl_2$ 0.05 per cent was found to improve the flesh thickness. This suggests that flesh thickness and increased chelate soluble pectate fractions in the cell walls are both important in enhancing firmness [7] retention. This may be due to the complex effect Ca has on the tissues. Other factors such as Ca effects on cell membrane function or integrity were observed in Ca treated fruits. These results derive support from the earlier works of Subbiah and Rani Perumal [8] in tomato and Toivonen and Bowen [9] in bell pepper (**Table 3**).

The number of fruits and fruit weight were positively correlated with yield per plant. The number of fruits was highest in the chemical treatment T_6 - $CaCl_2$ (0.50 %) (32.02) and the lowest value were recorded in T_9 - Control (26.56). While in case of different cultivar treatments the highest value was recorded in C_4- US 6214 (33.80) and the lowest value was recorded in C_2 - Co1 (19.75). Regarding the interaction between different chemical treatments and cultivars the highest fruit numbers was recorded in T_6 C_4 (T_6 - $CaCl_2$ (0.50 %), C_4 - US 6214 (36.57) and the lowest fruit numbers was recorded in T_9 C_2 (T_9 - Control, C_2- Co1) (17.50). The greater Ca content of unripe fruit might be explained by solute influx via the phloem, where Ca is known to be relatively immobile [10]. This influx increases with fruit development. Because of a lesser rate of cell division as the fruit mature, less binding sites for Ca are formed. Additionally, the volume: area ratio increases, which results in less transpiration per weight unit. These results are in line with the findings of Ferguson [11] (**Table 4**).

Table 3 Effect of Pre-harvest chemical spray on fruit girth (cm) of Bitter gourd cultivars

Treatments	Cultivars					
	C_1	C_2	C_3	C_4	C_5	Mean
T_1	13.07	12.23	13.51	14.43	16.24	13.90
T_2	13.75	12.79	13.79	14.92	16.79	14.41
T_3	12.96	12.03	13.09	13.86	15.31	13.45
T_4	13.00	12.10	13.23	14.12	15.65	13.62
T_5	14.59	13.87	14.89	15.33	17.21	15.18
T_6	15.76	14.60	15.49	16.13	18.50	16.10
T_7	14.09	13.03	14.12	15.07	17.11	14.68
T_8	14.23	13.30	14.43	15.21	17.03	14.84
T_9	12.29	11.14	12.51	12.13	14.51	12.52
Mean	13.75	12.79	13.90	14.58	16.48	
	T		C		C x T	
SEd	0.31		0.34		0.63	
CD @ 5%	0.62		0.66		1.26	

Table 4 Effect of Pre-harvest chemical spray on number of fruits/ vine of Bitter gourd cultivars

Treatments	Cultivars					
	C_1	C_2	C_3	C_4	C_5	Mean
T_1	30.46	18.53	29.87	33.51	30.02	28.47
T_2	31.56	19.60	29.08	33.93	30.86	29.00
T_3	29.92	18.03	28.14	31.95	29.12	27.43
T_4	29.23	18.11	28.67	33.02	29.68	27.74
T_5	32.45	21.62	31.53	35.21	32.86	30.73
T_6	34.20	23.20	32.71	36.57	33.46	32.02
T_7	31.80	20.21	30.06	34.16	31.23	29.49
T_8	32.04	20.94	30.92	34.76	31.91	30.11
T_9	28.62	17.50	27.35	31.12	28.21	26.56
Mean	31.14	19.75	29.81	33.80	30.82	
	T		C		C x T	
SEd	0.43		0.32		0.75	
CD @ 5%	0.84		0.63		1.49	

Highest fruit weight among the chemical treatments was recorded in T_6 - $CaCl_2$ (0.50 %) (189.95 g) and the lowest value were recorded in the T_9 - Control (151.37 g). Among the different cultivar treatments the highest fruit weight was recorded in C_5 - Palee (234.22 g) and the lowest value was recorded in C_1- Roma (149.61 g). Considering interaction effects the highest fruit weight was recorded in $T_6 C_5$ (T_6 - $CaCl_2$ (0.50 %), C_5 – Palee) (256.51 g) and the lowest fruit numbers was recorded in $T_9 C_1$ (T_9 - Control, C_1 - Roma) (130.20 g). The presence of calcium in the form of calcium pectate in middle lamella of cell wall would have increased the individual fruit weight, which prevent loss of moisture from the fruits and ultimately yields better quality fruit. This phenomenon has been well studied by Subbiah [12] in tomato. Calcium content of the fruit is associated with firmness of the fruit as a result of maintenance of turgidity of the fruit and fruit firmness and overall yield has increased due to the pre harvest foliar spray of 0.5 per cent $CaCl_2$ in okra Balasubramanian [13] (**Table 5**).

Application of CaCl2 0.05 per cent spray registered significantly highest yield of T_6 - $CaCl_2$ (0.50 %) (6.10 kg/ vine) and the lowest yield was recorded in T_9 - Control (4.05 kg / vine). In case of cultivar treatments registered the highest yield was C_5 - Palee (7.24 kg / vine) and the lowest yield was recorded in C_2 - Co1 (3.11 kg / vine). Regarding interaction effect the highest yield per vine was recorded in $T_6 C_5$ (T_6 - $CaCl_2$ (0.50 %), C_5 - Palee) (8.62 kg / vine) and the lowest yield per vine was recorded in $T_9 C_2$ (T_9 – Control, C_2- Co1) (2.39 kg / vine).there is some evidence that Ca can influence endogenous growth regulators [14] and effects such as increased cytokinin activity may result in thicker pericarp walls, since cytokinins have been associated with cell division and thickening in other plant organs [15]. The potential effects of the chloride ion in these responses have been ruled out since prior work has shown that ca ion is

the active component in $CaCl_2$ treatment [16]. The high level of calcium present in fruits sprayed with $CaCl_2$ 0. 5 per cent provides supporting evidence to confirm the role of calcium in increasing the fruit weight and yield. The earlier findings of Bharat Singh *et al.* [17] in okra, Rahman and Shormeen [18] in pumpkin, Vijay Kumar and Ray [19] in cauliflower and Vijayaraghavan [6] in bitter gourd lend credence to the present study (**Table 6**).

Table 5 Effect of Pre-harvest chemical spray on fruit weight (g) of Bitter gourd cultivars

Treatments	**Cultivars**					
	C_1	**C_2**	**C_3**	**C_4**	**C_5**	**Mean**
T_1	141.47	152.03	145.83	158.30	230.57	165.64
T_2	149.03	158.20	149.47	160.37	232.23	169.86
T_3	135.27	147.57	140.20	153.57	221.17	159.56
T_4	139.30	149.77	140.87	154.37	226.33	162.13
T_5	163.73	165.33	161.73	166.10	243.11	180.00
T_6	170.97	176.00	169.33	175.93	256.51	189.95
T_7	156.53	160.20	152.67	162.80	238.43	174.13
T_8	160.00	162.43	157.37	165.23	240.60	177.12
T_9	130.20	136.54	133.69	142.37	214.03	151.37
Mean	149.61	156.45	150.13	159.89	234.22	
	T		**C**		**C x T**	
SEd	3.08		3.05		6.12	
CD @ 5%	6.05		5.98		12.02	

Table 6 Effect of Pre-harvest chemical spray on yield / vine (Kg) of Bitter gourd cultivars

Treatments	**Cultivars**					
	C_1	**C_2**	**C_3**	**C_4**	**C_5**	**Mean**
T_1	4.31	2.82	4.36	5.30	6.92	4.74
T_2	4.70	3.10	4.35	5.44	7.17	4.95
T_3	4.05	2.66	3.95	4.91	6.44	4.40
T_4	4.07	2.71	4.04	5.10	6.72	4.53
T_5	5.31	3.57	5.10	5.85	8.09	5.58
T_6	5.85	4.08	5.54	6.43	8.62	6.10
T_7	4.98	3.24	4.59	5.56	7.45	5.16
T_8	5.13	3.40	4.87	5.74	7.71	5.37
T_9	3.73	2.39	3.66	4.43	6.04	4.05
Mean	4.68	3.11	4.50	5.42	7.24	
	T		**C**		**C x T**	
SEd	0.13		0.09		0.21	
CD @ 5%	0.25		0.19		0.42	

Conclusion

The preharvest Ca was sprayed as foliar in bitter gourd increased yield and yield attributes with increasing concentrations of preharvest sprays of $CaCl_2$ 0.5 per cent produced the highest fruit length, fruit girth, number of fruits, fruit weight and yield. Regarding cultivars C_5- Palee followed by C_4- US 6214 produced the highest fruit weight and fruit yield / vine. These responses were associated with improved firmness retention in all the cultivars of bitter gourd. Water loss characteristics and initial fruit weight were not affected by Ca application. It appears that Ca sprays act to improve quality in bitter gourds in two ways: first by increasing pericarp wall thickness and non-water soluble pectic fractions of the cell walls and these promote firmness retention, and second by reducing the severity of postharvest decay.

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