

## Seed Yield and Quality as Influenced by Plant Growth Regulators and Stages of Spray in Bitter Gourd cv. Coimbatore Long

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**ABSTRACT** An experiment was conducted to find out the effect of growth regulators and stages of spray on seed yield and quality in bitter gourd variety Coimbatore Long during *rabi* 2002-03 and 2003-04. The NAA @ 50 ppm sprayed at two to four leaf stage recorded maximum seed yield  $\text{ha}^{-1}$  (840.0kg) which, was on par with ethrel 250 ppm sprayed at two to four leaf stage (805.50kg/ha). The maximum germination percentage (87.95%), root length (19.43 cm), shoot length (12.28 cm), seedling dry weight (131.70 mg) and vigour index (2769) were recorded with NAA @ 100 ppm. Spray of growth regulators at 15 days after flower initiation recorded higher germination percentage (83.70%), shoot length (11.63 cm) and vigour index (2462) in bitter gourd.

Key words: NAA,  $\text{GA}_3$ , ethrel, stages of spray, germination, vigour index

Bitter gourd is one of the important cucurbitaceous vegetable crop widely cultivated in Karnataka. Growth regulators enhance the number of female flowers and fruits that lead to increase in seed yield and quality in bitter gourd [1]. Though a number of improved varieties are available in India, an efficient seed production package is lacking especially aimed at manipulating the sex ratio for enhanced seed yield and quality. Considering all these, the present investigations were undertaken to increase the seed yield and quality in Coimbatore Long (green) variety of bitter gourd during *rabi* 2002-03 and 2003-04.

### MATERIALS AND METHODS

A field trial was conducted at KRC College of Horticulture, Arabhavi, Karnataka, India during *rabi* 2002-03 and 2003-04 with three replications in factorial randomized block design. The seeds were dibbled at 90 cm apart per hill and 120 cm apart in rows. After germination, only one seedling per hill was maintained. The gross size of plot was 7.00 x 6.00 m and net plot was 5.00

m x 4.00 m. The plant protection measures were adopted as and when required. Five plants from each plot were selected randomly for recording observations. Three growth regulators viz., gibberillic acid (25 and 50 ppm), naphthalene acetic acid (50 and 100 ppm) and ethrel (250 and 500 ppm) were used for foliar application at two concentrations with control (spray of water). Three sprays were given at two to four leaf stages ( $S_1$ ), flower initiation stage ( $S_2$ ) and 15 days after flower initiation stage ( $S_3$ ). Precaution was taken to prevent drifting of spray solutions from one treatment plot to the other. Fruits were harvested as and when they turn orange red colour and seeds were extracted manually. The observations on the seed yield  $\text{ha}^{-1}$ , germination percentage, root length, shoot length, seedling dry weight and vigour index were recorded. The germination test was conducted as per ISTA procedure [2] by adopting rolled towel method. Seedling dry weight was calculated based upon the ten normal seedlings which were selected at random and dried in hot air oven at 75°C for 24 hours. The vigour index was calculated by adopting the methods suggested

by Abdul-Baki and Anderson[3] and expressed in whole numbers for each treatment by using the following formula:

$$\text{Vigour index} = \text{Germination (\%)} \times \text{seedling length (cm)}$$

## RESULTS AND DISCUSSION

The pooled data of 2002-03 and 2003-04 on influence of spray of growth regulators at different stages of plant growth on seed yield and quality are presented in Tables 1-6.

### Effect of growth regulators

Growth regulators exhibited significant influence on seed yield ha<sup>-1</sup> (Table 1). The highest seed yield ha<sup>-1</sup> (704.40 kg) was obtained in NAA @ 50 ppm, which was on par with, ethrel @ 250 ppm (686.40

kg), while control recorded the lowest seed yield (554.60 kg). Increase in seed yield may be due to the maximum number of female flowers and fruits per vine and growth regulators brings certain changes in metabolism during fruit and seed development due to which there would be a greater accumulation of food reserves which resulted in higher seed yield. The beneficial effects of growth regulators were also reported in bitter gourd [4] and bottle gourd [5].

Growth regulators showed significant influence on germination percentage (Table 2), shoot length (Table 4), seedling dry weight (Table 5) and vigour index (Table 6). Application of NAA @ 100 ppm recorded the highest germination (87.95%), root length (19.43 cm), shoot length (12.28 cm), seedling

**Table 1. Effect of growth regulators and stages of spray on seed yield (kg) per hectare in bitter gourd**

Growth regulator (G)	Seed yield (kg) per hectare											
	2002-03				2003-04				Pooled			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
G <sub>1</sub> -GA <sub>3</sub> 25ppm	600.00	561.70	507.40	556.37	603.70	540.73	525.90	556.78	601.80	551.20	516.70	556.60
G <sub>2</sub> -GA <sub>3</sub> 50ppm	677.77	656.80	653.07	662.54	666.63	685.17	633.30	661.70	672.20	671.00	643.20	662.10
G <sub>3</sub> -Ethrel 250ppm	779.90	640.75	608.63	676.43	812.30	618.50	640.70	690.50	805.50	629.00	624.70	686.40
G <sub>4</sub> -Ethrel 500ppm	733.34	442.60	558.03	577.99	777.77	503.70	511.10	597.92	755.50	473.10	534.60	587.70
G <sub>5</sub> -NAA 50ppm	810.73	687.63	646.90	715.08	870.37	592.57	618.47	693.80	840.00	690.10	632.70	704.40
G <sub>6</sub> -NAA 100ppm	769.10	629.60	596.30	665.00	774.07	662.97	588.83	675.29	771.60	646.30	592.60	670.10
G <sub>7</sub> -Control (Water spray)	537.00	549.38	570.36	552.24	537.03	574.07	533.30	548.13	537.20	545.00	551.80	544.60
<b>Mean</b>	<b>701.10</b>	<b>595.49</b>	<b>591.52</b>	<b>629.00</b>	<b>720.27</b>	<b>596.81</b>	<b>578.80</b>	<b>631.96</b>	<b>712.00</b>	<b>600.80</b>	<b>585.20</b>	<b>628.40</b>
	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
G	16.23		46.35		23.02		65.77		11.60		35.75	
S	10.62		30.35		15.07		43.06		7.59		23.39	
GxS	28.11		80.27		39.88		113.92		20.09		61.91	

Stages of spray (S): S<sub>1</sub> - Two to four leaf stage; S<sub>2</sub> - Flower initiation stage; S<sub>3</sub> - 15 days after flower initiation NS = Non-significant

Table 2. Effect of growth regulators and stages of spray on seed germination (%) in bitter gourd

Growth regulator (G)	Growth regulator (G)											
	2002-03				2003-04				Pooled			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
G <sub>1</sub> -GA <sub>3</sub> 25ppm	80.80 (64.03)*	78.90 (62.73)	84.80 (64.76)	<b>80.50</b> <b>(63.84)</b>	82.50 (65.30)	83.60 (66.12)	84.90 (67.41)	<b>83.67</b> <b>(66.28)</b>	81.65 (64.57)	81.25 (64.43)	83.35 (66.09)	<b>82.08</b> <b>(65.03)</b>
G <sub>2</sub> -GA <sub>3</sub> 50ppm	83.20 (65.81)	83.80 (66.03)	84.06 (66.45)	<b>83.69</b> <b>(66.20)</b>	83.80 (66.30)	84.90 (67.16)	85.60 (67.58)	<b>84.77</b> <b>(67.01)</b>	83.50 (66.06)	84.35 (66.74)	84.80 (67.30)	<b>84.22</b> <b>(66.61)</b>
G <sub>3</sub> -Ethrel 250ppm	82.60 (65.36)	83.50 (66.11)	82.90 (66.62)	<b>83.00</b> <b>(65.70)</b>	81.30 (64.38)	82.30 (65.13)	82.80 (65.52)	<b>82.13</b> <b>(65.01)</b>	81.95 (64.87)	82.90 (65.62)	82.85 (65.57)	<b>82.57</b> <b>(65.35)</b>
G <sub>4</sub> -Ethrel 500ppm	79.50 (63.13)	80.40 (63.72)	80.10 (63.53)	<b>80.00</b> <b>(63.46)</b>	78.50 (62.38)	78.80 (62.59)	78.00 (62.06)	<b>78.43</b> <b>(62.34)</b>	79.00 (62.75)	79.60 (63.16)	79.05 (62.76)	<b>79.22</b> <b>(62.89)</b>
G <sub>5</sub> -NAA 50ppm	85.90 (67.81)	86.70 (68.62)	88.80 (70.45)	<b>87.13</b> <b>(68.96)</b>	85.70 (67.78)	86.10 (68.18)	88.80 (70.47)	<b>86.87</b> <b>(68.81)</b>	85.80 (67.38)	86.40 (68.40)	88.80 (70.54)	<b>87.00</b> <b>(68.77)</b>
G <sub>6</sub> -NAA 100ppm	87.00 (68.88)	88.40 (70.10)	90.00 (71.58)	<b>88.46</b> <b>(70.19)</b>	85.30 (67.53)	87.90 (69.60)	89.10 (70.75)	<b>87.43</b> <b>(69.20)</b>	86.15 (71.53)	88.15 (69.84)	89.55 (72.00)	<b>87.95</b> <b>(71.13)</b>
G <sub>7</sub> - Control (Water spray)	78.90 (62.66)	77.40 (61.64)	78.10 (62.11)	<b>77.13</b> <b>(62.14)</b>	77.27 (61.57)	76.90 (61.28)	76.30 (66.75)	<b>76.82</b> <b>(63.20)</b>	78.08 (62.12)	77.15 (61.46)	77.20 (64.77)	<b>77.50</b> <b>(62.78)</b>
<b>Mean</b>	<b>82.55</b> <b>(65.38)</b>	<b>82.73</b> <b>(65.60)</b>	<b>83.68</b> <b>(66.36)</b>	<b>82.99</b> <b>(65.78)</b>	<b>82.05</b> <b>(65.03)</b>	<b>82.93</b> <b>(65.72)</b>	<b>83.64</b> <b>(67.22)</b>	<b>82.88</b> <b>(65.99)</b>	<b>82.31</b> <b>(65.61)</b>	<b>82.83</b> <b>(65.66)</b>	<b>83.70</b> <b>(66.97)</b>	<b>82.93</b> <b>(66.08)</b>
	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
G	0.71		2.03		0.68		1.93		0.49		1.51	
S	0.47		NS		0.44		1.26		0.32		0.99	
GxS	1.23		NS		1.17		NS		0.85		NS	

Stages of spray (S): S<sub>1</sub>-Two to four leaf stage; S<sub>2</sub>-Flower initiation stage; S<sub>3</sub>-15 days after flower initiation NS = Non-significant; \*Figures in the parenthesis indicate angular transformed values.

dry weight (131.70 mg) and vigour index (2769) compared to all other growth regulator treatments. The control recorded the lowest germination (77.50%), seedling dry weight (111.70 mg) and the ethrel 500 ppm recorded the lowest root length (14.77 cm) and vigour index (1972). The increase in germination per cent in NAA @ 100 ppm is due to adequate supply of food reserves to resume embryo growth and in addition to release enzymes responsible for degradation of macromolecules into micro molecules to be utilized in growth promoting process. The increase in seed quality attributes in NAA treatment may be due certain changes in

metabolism, which helps, in better seed development, greater accumulation of food reserves. Similar results were reported in bitter gourd [6], onion [7] and bottle gourd [5].

#### Effect of stages of spray

Stages of spray showed significant influence on seed yield. Among the stages of spray, the growth regulators sprayed at two to four leaf stage (S<sub>1</sub>) recorded the maximum seed yield ha<sup>-1</sup> (712.0 kg) compared to flower initiation (600.8 kg) and 15 days after second spray stage (585.2 kg). The

Table 3. Effect of growth regulators and stages of spray on root length (cm) in bitter gourd

Growth regulator (G)	Root length (cm)											
	2002-03				2003-04				Pooled			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
G <sub>1</sub> -GA <sub>3</sub> 25ppm	18.17	18.33	17.87	<b>18.12</b>	18.21	18.45	19.00	<b>18.55</b>	18.41	18.73	19.15	<b>18.76</b>
G <sub>2</sub> -GA <sub>3</sub> 50ppm	15.82	17.33	16.37	<b>16.50</b>	16.80	17.50	17.50	<b>17.27</b>	16.90	17.75	17.95	<b>17.53</b>
G <sub>3</sub> -Ethrel 250ppm	16.50	15.53	16.05	<b>16.02</b>	16.40	16.05	16.16	<b>16.20</b>	16.25	16.53	16.51	<b>16.43</b>
G <sub>4</sub> -Ethrel 500ppm	16.90	17.13	16.68	<b>16.90</b>	15.05	14.40	14.84	<b>14.76</b>	15.28	14.60	14.44	<b>14.77</b>
G <sub>5</sub> -NAA 50ppm	20.93	18.77	20.20	<b>19.96</b>	18.60	18.00	18.05	<b>18.22</b>	18.75	18.15	18.73	<b>18.54</b>
G <sub>6</sub> -NAA 100ppm	17.96	17.47	19.23	<b>17.89</b>	19.00	20.10	18.87	<b>19.32</b>	19.50	19.60	19.25	<b>19.43</b>
G <sub>7</sub> -Control (Water spray)	17.77	19.00	11.76	<b>16.17</b>	16.15	16.28	18.77	<b>17.07</b>	16.60	16.48	17.94	<b>17.00</b>
Mean	17.72	17.65	16.73	<b>17.37</b>	17.17	<b>17.25</b>	<b>17.60</b>	<b>17.34</b>	<b>17.38</b>	<b>18.00</b>	<b>17.71</b>	<b>17.50</b>
	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
G	0.94		NS		0.39		1.12		0.30		0.92	
S	0.61		NS		0.25		NS		0.20		NS	
GxS	1.62		NS		0.67		NS		0.52		NS	

Stages of spray (S): S<sub>1</sub>-Two to four leaf stage; S<sub>2</sub>-Flower initiation stage; S<sub>3</sub>-15 days after flower initiation NS = Non-significant

Table 4. Effect of growth regulators and stages of spray on shoot length (cm) in bitter gourd

Growth regulator (G)	Shoot length (cm)											
	2002-03				2003-04				Pooled			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
G <sub>1</sub> -GA <sub>3</sub> 25ppm	10.40	13.00	14.10	<b>12.50</b>	11.19	12.00	11.76	<b>11.65</b>	10.80	12.50	12.85	<b>12.05</b>
G <sub>2</sub> -GA <sub>3</sub> 50ppm	11.20	12.80	13.60	<b>12.53</b>	10.85	11.30	12.30	<b>11.48</b>	11.03	12.05	12.45	<b>12.00</b>
G <sub>3</sub> -Ethrel 250ppm	10.16	9.39	9.56	<b>9.50</b>	11.10	10.74	10.57	<b>10.81</b>	11.30	10.07	10.07	<b>10.48</b>
G <sub>4</sub> -Ethrel 500ppm	9.80	9.50	10.10	<b>9.63</b>	10.50	10.50	10.85	<b>10.62</b>	9.90	10.00	10.48	<b>10.13</b>
G <sub>5</sub> -NAA 50ppm	11.20	12.70	11.90	<b>11.93</b>	10.55	10.80	11.05	<b>10.80</b>	10.88	11.75	11.48	<b>11.37</b>
G <sub>6</sub> -NAA 100ppm	11.00	12.80	12.73	<b>12.44</b>	11.15	11.77	13.26	<b>12.06</b>	11.48	12.28	13.08	<b>12.28</b>
G <sub>7</sub> -Control (Water spray)	10.80	11.20	10.30	<b>10.76</b>	10.73	10.90	10.71	<b>10.78</b>	10.76	11.02	10.51	<b>10.76</b>
Mean	<b>10.69</b>	<b>11.62</b>	<b>11.75</b>	11.36	<b>10.87</b>	<b>11.17</b>	<b>11.50</b>	<b>11.17</b>	<b>10.88</b>	<b>11.38</b>	<b>11.63</b>	<b>11.30</b>
	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
G	0.36		1.04		0.23		0.65		0.20		0.62	
S	0.24		0.68		0.15		0.42		0.13		0.40	
GxS	0.63		NS		0.39		NS		0.34		NS	

Stages of spray (S): S<sub>1</sub>-Two to four leaf stage; S<sub>2</sub>-Flower initiation stage; S<sub>3</sub>-15 days after flower initiation NS = Non-significant

Table 5. Effect of growth regulators and stages of spray on seedling dry weight (mg) in bitter gourd

Growth regulator (G)	Seedling dry weight (mg)											
	2002-03				2003-04				Pooled			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
G <sub>1</sub> -GA <sub>3</sub> 25 ppm	126.8	128.6	128.7	128.0	128.0	129.1	130.0	129.0	127.4	128.9	129.3	128.5
G <sub>2</sub> -GA <sub>3</sub> 50 ppm	126.1	127.0	129.6	127.6	126.6	127.1	128.1	127.3	126.4	127.1	128.9	127.4
G <sub>3</sub> -Ethrel 250 ppm	125.0	125.7	126.1	125.6	125.4	125.7	125.6	125.6	125.2	125.8	125.9	125.6
G <sub>4</sub> -Ethrel 500 ppm	120.8	121.1	122.0	121.3	121.2	121.1	121.1	121.1	121.0	121.0	121.6	121.2
G <sub>5</sub> -NAA 50 ppm	130.1	130.2	130.7	130.3	129.2	130.3	130.6	130.0	129.6	130.3	130.7	130.2
G <sub>6</sub> -NAA 100 ppm	132.0	128.3	132.1	130.8	131.1	131.8	132.0	131.6	131.6	131.4	132.0	131.7
G <sub>7</sub> -Control (Water spray)	110.3	117.0	110.6	112.6	110.3	111.4	110.9	110.9	110.3	114.2	110.8	111.7
<b>Mean</b>	<b>124.4</b>	<b>125.4</b>	<b>125.7</b>	<b>125.2</b>	<b>124.5</b>	<b>125.2</b>	<b>125.5</b>	<b>125.1</b>	<b>124.5</b>	<b>125.5</b>	<b>125.6</b>	<b>125.2</b>
	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
G	1.18		3.20		1.30		3.71		0.83		2.56	
S	0.73		NS		0.85		NS		0.54		NS	
GxS	1.94		NS		2.25		NS		1.43		NS	

Stages of spray (S): S<sub>1</sub>-Two to four leaf stage; S<sub>2</sub>-Flower initiation stage; S<sub>3</sub>-15 days after flower initiation NS = Non-significant

Table 6. Effect of growth regulators and stages of spray on vigour index in bitter gourd

Growth regulator (G)	Vigour index											
	2002-03				2003-04				Pooled			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
G <sub>1</sub> -GA <sub>3</sub> 25 ppm	2342	2528	2686	<b>2519</b>	2468	2516	2717	<b>2567</b>	2389	2537	2726	<b>2549</b>
G <sub>2</sub> -GA <sub>3</sub> 50 ppm	2346	2582	2655	<b>2528</b>	2341	2442	2617	<b>2467</b>	2331	2513	2622	<b>2489</b>
G <sub>3</sub> -Ethrel 250 ppm	2311	2205	2254	<b>2257</b>	2213	2206	2269	<b>2229</b>	2258	2206	2201	<b>2222</b>
G <sub>4</sub> -Ethrel 500 ppm	1972	1954	1928	<b>1951</b>	2014	1970	2005	<b>1996</b>	1988	1959	1969	<b>1972</b>
G <sub>5</sub> -NAA 50 ppm	2579	2688	2815	<b>2694</b>	2520	2480	2584	<b>2528</b>	2540	2583	2683	<b>2602</b>
G <sub>6</sub> -NAA 100 ppm	2766	2811	2847	<b>2808</b>	2592	2655	2789	<b>2679</b>	2670	2804	2833	<b>2769</b>
G <sub>7</sub> -Control (Water spray)	2191	2161	2390	<b>2247</b>	2081	2161	2128	<b>2123</b>	2134	2121	2196	<b>2150</b>
<b>Mean</b>	<b>2357</b>	<b>2418</b>	<b>2510</b>	<b>2429</b>	<b>2318</b>	<b>2347</b>	<b>2444</b>	<b>2370</b>	<b>2329</b>	<b>2389</b>	<b>2462</b>	<b>2393</b>
	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
G	53		153		31		89		34		105	
S	35		100		20		58		22		69	
GxS	93		NS		54		NS		59		NS	

Stages of spray (S): S<sub>1</sub>-Two to four leaf stage; S<sub>2</sub>-Flower initiation stage; S<sub>3</sub>-15 days after flower initiation NS = Non-significant

highest seed yield  $\text{ha}^{-1}$  may be due to the highest fruit yield  $\text{ha}^{-1}$  as well as the highest seed yield per vine associated with  $S_1$  stage. These beneficial effects of exogenous application of growth regulators at two to four leaf stages was also reported in cucumber [8] and bottle gourd [5].

Stages of spray showed significant influence on germination percentages, shoot length and vigour index. It showed non-significant influence on root length and vigour index. The maximum germination per cent (83.70%), shoot length (11.63 cm) and vigour index (2462) were noticed in growth regulators sprayed at 15 days after flower initiation stages ( $S_3$ ) compared to  $S_2$  and  $S_1$  stage. The growth regulators sprayed at two to four leaf stage recorded minimum germination per cent (82.31%), shoot length (10.88 cm) and vigour index (2329). The increase in germinations at  $S_3$  stage may be due to greater accumulation of food reserves in seed because of additional supply of growth regulators especially at fruit development stage. The better seed quality in  $S_3$  stage may be due to certain changes in metabolism, which helps in better seed development and greater accumulation of food reserves. Similar results were also reported in bitter gourd [6], chilli [9], onion [7] and bottle gourd [5].

#### *Interaction effect of growth regulators and stages of spray*

Interaction effect of growth regulators and stages of spray showed significant influence on seed yield. The highest seed yield  $\text{ha}^{-1}$  (840.0 kg) was recorded with 50 ppm NAA sprayed at two to four leaf stage ( $G_4S_1$ ) and which was on par with 250 ppm ethrel sprayed at two to four leaf stages (805.5 kg). Similar results were reported in bottle gourd [10, 11].

From the present study, it is concluded that, NAA @ 50 ppm or ethrel @ 250 ppm sprayed at two to four leaf stages were effective for increasing seed yield. The NAA 100 ppm or 50 ppm was most effective in improving the seed quality parameters of bitter gourd cv. Coimbatore Long.

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