Int.J.Curr.Microbiol.App.Sci (2019) *8*(1): 3216-3223

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 9 Number 01 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.802.376

Studies on the Effect of Plant Growth Regulators and Micronutrients on Okra (*Abelmoschus esculentus L*) cv. Parbhani Kranti

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Keywords
Randomized Block Design, Growth regulators, Micronutrients, Treatments etc.

Article Info

Accepted:
22 January 2019
Available Online:
10 February 2019

A B S T R A C T

The experiment detail for the present investigation was comprised of 13 treatments in Randomized Block Design with three replication, to record morphological, phonological, yield attributes and economics. The growth regulators and micronutrient significantly improved the plant height of okra. The maximum plant height was recorded when sprayed NAA @ 20 ppm. The higher number of leaves and length of internodes were recorded at NAA @ 40 ppm. Higher numbers of branches, higher length of internodes were recorded in foliar spray of cycocel@1000ppm. The foliar spray of growth regulators and micronutrient was recorded in significant improvement in leaf area on okra. The days taken to first flowering differed significantly the different treatment. The number of flower bud, the fruit length, fruit width, fruit per plant, fruit yield per plot, benefit cost ratio and fruit weight differed significantly in different treatment combination.

Introduction

Okra popularly Known as 'Bhindi' Okra [*Abelmoschus esculentus* (L.) Moench] belongs to the family Malvaceae having chromosome no. 2n=130 has captured a prominent position among vegetables. Okra one of the important summer and rainy season vegetable crops cultivated in various states in India. It is widely cultivated in plains of the India with acreage 5.07 Million ha and production 58.5 million tones and11.5 tones productivity. In Madhya Pradesh Okra is grown in 2.8 million ha area with production of 32.8 million tones and 11.7 tones productivity (Anonymous, 2016). It requires long and warm growing season and is susceptible to frost. The optimum day temperature for its well growth is between 25˚C to 40˚C and that of night is over 22˚C. Okra seed do not germinate when temperature is below 29˚C. It is a source of protein, vitamins C and A, iron and calcium and dietary fiber. Okra mucilage is suitable for medicinal and industrial applications. It has medically found application as a plasma

replacement or blood volume expander. The presence of traces of iodine in the pod of okra makes it a good remedy for goitre. After fruiting, the stalks are generally allowed to go waste or used as fuel. Sometimes, processing of okra involves blanching, which is a heat treatment, given to vegetables to limit. Its fruit are rich in vitamin-A (88 µ/100g), vitamin-C (13 mg/100g), calcium (66 mg/100g), potassium (103 mg/100g) and other minerals (Aykroyd, 1963). It is a tropical to sub-tropical crop and is sensitive to frost, low temperature, water logging and drought conditions, and the cultivars from different countries have adapted certain distinguishing characteristics specific to the country to which they belong Siemonsma, (1982).

Material and Methods

The land topography of the experimental site was almost uniform with an adequate surface drainage. The internal drainage of the experimental site is medium. In order to get good tilth of the soil for sowing, one cross cultivation was done by tractor drawn cultivator followed by two harrowing before sowing of seed. The first irrigation was given immediately after sowing to ensure proper germination. There after there was no need of irrigation due to time to time rains which provided sufficient moisture for proper growth and development of standing crop. A dose of 150kg N, 100kg P_2O_5 and 100kg K_2O/ha along with 20 tones FYM/ha was applied. One third nitrogen and entire quantity of P, K and FYM was applied prior to sowing as basal dose. Remaining dose of nitrogen was applied in two splits at 30 and 60 days after sowing. The crop was sprayed with Imidacloprid 0.5% to control insect-pest and drenching of Dithane M-45 0.2% to control diseases. The data recorded on various parameters such as morphological parameters like Plant height, Leaf area, Number of branches per plant, Number of internodes and length, Number of leaves per plant. Phonological parameters like Number of flower bud and fruits, Days taken to first picking Days to first flowering are recorded. Yield parameters like Fruit length, Fruit diameter, Fruit weight, Fruit yield per plant, Fruit yield per plot and Benefit cost ratio.

Results and Discussion

The higher plant height was observed in the treatment T_1NAA @20 ppm followed by Feso4 (0.25%) while minimum plant height was recorded in T_{13} control (water spray). The variation of plant height was due to different concentration of PGR and Micronutrients. The significant result found that the application of growth promotive substances increased the plant height this might be due to rapid increase in cell division and cell elongation in the shoot apex. These results are in accordance with the findings of Maharaj *et al.*, (2015). The maximum number of leaves was recorded in the treatment T_4 NAA @ 40 ppm followed by Znso4 (0.25%), The increased number of leaves in these treatments might be due to rapid increase in cell division and cell elongation. This result is in agreement with the result found by Kokare *et al.*, (2013). The maximum number of branches was recorded in the treatment T_8 (Cycocel @1000 ppm) followed by $FeSO_4$ (0.25%) while minimum was recorded in the treatment T_{13} Control (water spray). The growth retardant chemical cycocel was effective in suppressing apical dominance, thereby promoting the growth of axillary buds into new shoots. The results are in agreement with the result found by Bhagure *et al*., (2013). Similarly, the micronutrients have been found to increase number of branches significantly. The higher number of internodes was recorded in the treatment T_8 (Cycocel @1000 ppm) followed by $FeSO_4$ (0.25%) while minimum was recorded in the treatment T_{13} Control. Cycocel reduced intermodal length by restricting the cell division hence, it increased the number of internodes Bhagure *et al*., (2013) reported that the significant result received by application of (Cycocel @750 ppm and 1000ppm) (Table 1–5).

Table.1 Effect of different treatments on Plant height (cm) and number of branches at various intervals of the crop stages

	Plant height (cm)						Number of branches		
Treatment	**15 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**Mean**	**60 DAS**	**75 DAS**	**Mean**
T1	13.20	25.83	32.50	35.00	36.83	28.67	1.20	1.33	1.27
T2	9.97	20.60	24.90	28.97	31.27	23.14	1.27	1.40	1.33
T3	10.63	20.23	25.80	29.67	30.03	23.27	1.10	1.27	1.18
T4	12.30	22.53	28.37	31.37	33.57	25.63	1.07	1.17	1.12
T5	10.80	20.57	25.40	29.60	30.83	23.44	1.20	1.53	1.37
T6	11.30	21.87	26.43	30.80	32.73	24.63	1.07	1.33	1.20
T7	10.73	19.90	25.07	29.00	30.70	23.08	1.27	1.5	1.43
T8	10.77	20.73	25.50	28.63	30.93	23.31	1.47	2.2	1.83
T9	10.33	19.60	25.63	28.93	31.07	23.11	1.27	1.47	1.37
T10	10.73	20.83	25.43	28.70	30.70	23.28	1.43	1.7	1.56
T11	10.87	20.33	25.23	28.73	30.63S	23.16	1.43	1.63	1.53
T12	10.83	20.20	24.97	28.37	30.17	22.91	1.43	1.60	1.51
T13	8.93	19.33	23.00	28.63	31.23	22.23	0.33	0.40	0.37
SE±m	**0.30**	**0.82**	**0.96**	**0.86**	**0.64**	**0.28**	**0.10**	**0.14**	**0.11**
CD (5%)	**1.12**	**3.05**	**3.58**	**3.20**	**2.41**	**1.06**	**0.55**	**0.52**	**0.39**

Table.2 Effect of different treatments combination on Number of leaves per plants and number of internodes at various intervals of growth stages

	Number of leaves						Number of internodes				
Treatment	**15 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**Mean**	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**Mean**
T1	2.33	3.73	7.87	8.90	7.43	6.05	3.2	6.7	8.0	9.1	6.80
T2	2.77	3.90	8.83	10.63	8.83	6.99	2.7	6.5	8.4	9.4	6.77
T3	1.87	3.70	8.93	9.60	7.73	6.37	3.2	6.5	8.3	9.8	7.05
T4	3.97	6.57	11.50	15.30	11.80	9.83	3.2	7.1	8.4	9.4	7.07
T5	2.00	4.77	8.37	9.20	7.30	6.33	3.2	6.3	8.2	9.6	6.84
T6	3.07	4.97	9.97	12.83	9.67	8.10	3.2	6.6	8.6	9.6	6.98
T7	2.23	3.17	8.27	9.33	7.33	6.07	3.2	6.3	8.2	9.7	7.00
T8	2.20	3.63	8.70	8.80	7.60	6.19	3.8	6.9	9.5	10.5	7.6
T9	2.05	3.50	8.43	8.77	7.63	6.08	3.2	6.6	8.3	9.8	7.01
T10	2.30	3.53	7.93	9.83	7.67	6.25	3.6	6.8	8.9	10.0	7.28
T11	2.03	3.50	8.20	9.83	7.60	6.23	2.8	6.0	8.1	9.8	6.52
T12	2.00	5.20	8.57	9.60	7.60	6.59	3.4	6.3	9.1	9.4	6.97
T13	1.50	3.53	6.4	7.7	7.03	5.89	2.9	5.6	6.0	6.3	5.08
SE±m	**0.21**	**0.42**	**0.87**	**0.89**	**0.29**	**0.21**	**0.18**	**0.19**	**0.35**	**0.25**	**0.14**
CD (5%)	**0.78**	**1.58**	**2.32**	**3.34**	**1.09**	**0.77**	**0.64**	**0.71**	**1.33**	**0.95**	**0.50**

Table.3 Effect of different treatments combination on length of inter nodes per plants, Leaf area (cm^2) at various intervals of growth stages.

Table.4 Effect of different treatments combinations on the days taken to first flowering, Number of flowers bud and fruits and Days taken to first picking

length of internodes (cm)						**Leaf area (cm^2)**				
Treatment	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**Mean**	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**Mean**
T1	2.5	3.1	2.9	3.2	2.93	81.1	254.9	355.5	354.0	261.36
T2	3.6	3.6	3.5	3.7	3.63	87.4	256.2	352.8	355.7	263.00
T3	3.0	3.4	3.2	3.4	3.27	86.4	257.1	356.1	351.7	262.84
T4	2.3	3.0	3.0	3.0	2.86	89.0	262.3	367.4	361.1	269.96
T5	2.3	2.9	3.0	3.1	2.83	87.6	259.6	357.8	356.5	265.37
T6	2.9	3.3	3.1	3.3	3.14	84.3	256.5	356.3	352.0	262.28
T7	1.1	3.1	2.6	3.1	2.47	86.4	255.4	355.4	352.5	262.42
T8	2.7	2.7	2.9	3.0	2.82	87.4	252.0	352.3	349.3	260.25
T9	2.7	3.1	2.9	3.1	2.97	87.2	258.6	355.6	352.2	263.39
T10	2.7	3.2	3.0	3.0	2.98	88.1	260.1	359.8	357.7	266.43
T11	2.8	3.0	2.9	3.0	2.93	87.6	258.5	356.4	356.4	264.72
T12	2.7	3.2	2.9	3.2	3.00	86.6	256.1	355.6	351.2	262.38
T13	1.1	1.6	2.3	2.9	1.98	79.4	249.5	322.4	240.1	222.86
SE±m	**0.29**	**0.14**	**0.12**	**0.11**	**0.10**	**0.80**	**0.84**	**0.58**	**28.55**	
CD (5%)	**1.13**	**0.52**	**0.48**	**0.42**	**0.39**	**2.97**	**3.13**	**2.15**	**106.55**	

S. No.	Treatment	Days taken to first flowering (Mean)	No. of flowers bud (Mean)	No. of fruit (Mean)	Days taken to first picking (Mean)
1	T1	36.3	19.7	15.5	43.1
2	T2	36.8	26.8	22.1	46.3
3	T3	36.2	20.2	14.4	41.2
4	T4	37.1	18.2	14.8	47.6
5	T5	37.0	23.2	18.4	43.4
6	T6	38.4	19.2	13.4	45.9
7	T7	35.7	17.8	13.1	43.5
8	T8	42.5	18	13.4	44.1
9	T9	38.5	18	13	42.6
10	T10	39.4	18.3	13.5	44.9
11	T11	34.3	18.5	13.6	43.8
12	T12	39.7	18.1	13.5	43.4
13	T13	32.3	14.3	9.6	40.7
14	SE±m	**1.99**	**1.34**	**1.13**	**1.15**
15	CD (5%)	**7.46**	**5.01**	**4.23**	**4.31**

Table.5 Effect of different treatments combinations on the fruit length (cm), Fruit width (cm), Fruit weight (g), number of fruit per plant, fruit yield per plot (kg), yield (q/ha), gross return and B:C ratio.

S. No.	Treatment	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	No. of fruit plant^{-1}	Fruit yield per plot (kg)	Yield (q.)/ hac	Gross return	B:C Ratio
1	T1	14.1	4.4	14.6	12.5	4.2	42	6300	2.85
2	T2	13.4	4.0	14.2	14.1	4.5	43.2	6480	3.66
3	T3	15.3	4.6	15.1	12.1	4.1	40.7	6105	3.08
4	T4	13.8	4.2	13.4	12.6	4.1	44.8	6720	3.46
5	T5	14.5	4.5	14.7	13	4.3	41.7	6255	3.24
6	T6	13.8	4.1	12.6	11.8	4.1	38.5	5775	3.34
7	T7	13.2	4.1	12.3	12	4.1	41.4	6210	3.29
8	T8	13.2	4.2	12.3	11.8	4.1	40.5	6075	3.18
9	T9	13.06	4.0	11.9	10.4	4	39.9	5985	3.19
10	T10	11.5	4.1	11.4	10.5	4	39.6	5940	3.07
11	T11	13.6	3.9	10.2	12.1	3.9	41.6	6240	3.02
12	T12	11.2	3.8	9.8	9.6	3.9	42.4	6360	3.28
13	T13	10.2	3.2	9.1	8.5	3.2	32	4800	2.69
14	SE±m	**0.35**	**0.13**	**0.41**	**0.48**	**0.2**			
15	CD (5%)	**1.31**	**0.50**	**1.5**	**1.8**	**0.74**			

The higher leaf area was recorded in the treatment T_4 (NAA 40 ppm) followed by Znso4 (0.25%), similarly due to, use of micronutrients significantly higher leaf area was recorded under soil application of ZnSo4 7.5 kg /ha. The cycocel might have induced synthesis of flowering hormone affecting early flowering. Similar result was reported by Rajputet *et al.*, (2011) in cycocel @ 100,200,300 ppm was sprayed. The days taken to first flowering was significantly increased in T_8 (Cycocel @1000 ppm) followed by Feso4 (0.25%) while minimum was recorded in the treatment T_{13} Control. The cycocel might have induced synthesis of flowering hormone affecting early flowering. Similar result was reported by Rajput *et al.*, (2011) in cycocel @ 100,200,300 ppm was sprayed. The data recorded on the days taken to first picking under the influence of plant growth regulators and micronutrients combinations. The increase in number of pickings might be due to early flowering and more number of nodes which might have accounted for more pods at less intervals of time. Similar result also found by Parsad and Srihari (2008) with Cycocel in Okra. The higher number of flower bud and pods was reported in T_2 (NAA @ 40 ppm) followed by FeSO4 0.25%. However, the minimum number of flower bud and pods was recorded in T_{13} (control). The increase number of flower bud and fruits application of growth regulators which are capable of redistribution of dry matter in the plant thereby bringing about an improvement in yield which depends not only on the accumulation of photosynthesis during crop growth and development but also on its partitioning in the number of flowers due to the acceleration of axillary buds into new shoots providing extra sites for more flower. Similar result was observed by Surendra *et a*l., (2006.The higher fruit length, fruit diameter and fruit weight). The increase in the size of fruit i.e. length and diameter were recorded in T_3 (NAA @ 20 ppm) followed by $MgSO_4$ 0.5% while lower was observed under T_{13} control (water spray) might be a result of cell enlargement and cell elongation, which is caused by the supply of growth regulators within the plants similar results were reported by Sanodiya *et al*. (2017). The higher fruit length, width, diameter associated with soil application of boric acid @6%on chili. The result has been disagreed found by Devi *et al*., (2013). The increase in fruit yield higher in the T_2 (NAA@ 40 ppm) followed by FeSO4 0.25% while the minimum fruit per plant and yield per plot was observed in T_{13} (control). The increase in fruit yield could be attributed to betterment in the growth parameters. The results obtained may be explained on the basis that the treated plants remained physiologically more active, resulting in more number of flowers and more number of pods. Similar use of micronutrients has been found significantly higher number of per plot has been found by Surendra *et al*., (2006) by the application of NAA @ 20 and 40 ppm among $FeSO_4$ 0.5%. The higher B: C ratio obtained in (T_2 NA A @ 40 ppm followed by $FeSO_4$0.25%). Similar results were observed by Surendra *et al*., (2005). From the point of economics, it is thus inferred that the use of PGR foliar spray at 20 and 40 days after sowing could be recommended for increasing both unit productivity and also net returns. Similar use of micronutrients has been found to have higher B: C ratio by the application of $FeSO_4$ 0.5% 60 DAS after sowing.

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.**How to cite this article:**

Ajay Kumawat, N.K. Gupta, Nimisha Raj Jain and Shambhu Nayama. 2019. Studies on the Effect of Plant Growth Regulators and Micronutrients on Okra (*Abelmoschus esculentus* L.) cv. Parbhani Kranti. *Int.J.Curr.Microbiol.App.Sci*. 8(01): 3216-3223.
doi: https://doi.org/10.20546/ijcmas.2019.802.376