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Research ArticleResponse of Growth Regulators and Micronutrients on Seed Quality of Okra [*Abelmoschus esculentus* (L.) Moench]

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ABSTRACT

Seed is the key input on which final yield of the crop depends. Plant growth regulators and micronutrients are well known agriculture inputs used for improving crop growth, yield and quality. To improve the seed quality of okra a two year field experiment was carried out in the vegetable research farm, College of Horticulture and Forestry, Pasighat in the rainy season of the year 2018 and 2019 to evaluate the effect of growth regulators (Auxin & Gibberellins) in two different concentration of 50 ppm and 100 ppm and micronutrients like zinc and boron which were used in three different concentration (0.5, 1.0 and 1.5%) sole and in combinations. Pooled data showed that among the different treatments of growth regulators application of GA_3 @ 100 ppm recorded significantly highest test weight, germination percentage, protein content, seedling length, fresh and dry seedling weight, Vigour index-I and Vigour index-II. In case of applications of different concentration of micronutrients, the significantly highest test weight, germination percentage, seedling length, fresh and dry seedling weight, Vigour index-I and Vigour index-II were recorded with borax application @ 1.0 % whereas, in case of protein content of seed zinc @ 1.0 % recorded the highest value. Interaction between growth regulators and micronutrient showed non-significant difference.

Keywords: *Growth regulators, Micronutrients, Okra, Seed quality, Foliar spray, Vigour index, Test weight*

Introduction

Okra is a warm-season vegetable crops belonging to the family Malvaceae popularly known as lady fingers. It is grown for its immature pod in tropical and sub-tropical parts of the world. Okra pods are considered nutritious, providing some important human supplementary vitamins such as vitamin C, A, B complex, potassium, calcium, iron and other minerals [1,2]. Okra pod have many nutritional compositions which are considered important for human health. One hundred gram of fresh pod has around moisture (89.6 %), K (103 mg), Ca (90 mg), Mg (43 mg), P (56 mg), vitamin C (18 mg) and some important metals such as iron and aluminium [3].

Growth and yield of okra depend upon several factors including seed quality, nutrition, climatic, cultural practice and plant growth regulators are one of them [4]. Growth regulators are substances which promote, inhibit or modify the physiological processes of plant. It increases the yield and improves the quality of the vegetables by altering the behaviour of plant and various physiological processes in plant system.

Micronutrients are essential for plant life cycle but are required in relatively smaller quantities by the crop. Micronutrients are usually required in minute quantities, nevertheless, are vital to the growth of plants.

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Vegetable crops suffer extensively by zinc deficiency followed by boron, copper, manganese, iron and molybdenum [5]. They improve general condition of plants and are known to act as catalysts in promoting organic reactions taking place in plant. Foliar application of micronutrients to crop plants is gaining popularity in increasing crop yield and quality with improved shelf life of the produce. Spraying of minor elements corrects the nutritional disorders.

Seed is very key input on which the final yield of the crops depends. Currently, quality seeds are met to the extent of 20 per cent only. Okra seed production is a profitable enterprise. Judicious application of NPK, growth regulators and micronutrients like zinc and boron plays a vital role in the seed production of okra.

Material and Methods

The experiment was conducted at Vegetable Research Farm, College of Horticulture and Forestry, Central Agricultural University, Pasighat, East Siang, Arunachal Pradesh. The experiment was laid in a randomized block design (RBD) with three replications in which the treatments comprised of two levels each of NAA (50 and 100 ppm), GA_3 (50 and 100 ppm) and three levels of micronutrients *i.e.* Zinc sulphate (0.5. 1.0 and 1.5%) and Borax (0.5. 1.0 and 1.5%) respectively and compared with control.

Standard agronomical practices followed throughout the crop duration. The growth regulators and micro-nutrients were sprayed on foliage in aqueous form by using fresh solution at each spray. Spraying was done with a knapsack sprayer and the leaves were wetted thoroughly with fine mist.

First foliar spray was applied at 30 days after sowing and the second sprays at 60 days after sowing. For better absorption of spray solution by okra leaves, a pinch of sticker (Tipol) was added to the spray solution before spraying. The spraying was done during evening hours.

For recording test weight 1000 seeds of each replication and treatments were counted and weighted in electronic balance and observation was recorded as test weight. For germination percent, 100 seeds of each treatment were kept in three replications subjected to between paper method as suggested by ISTA [6]. Seeds were kept for incubation at 25±2°C. Germination seeds were counted at final count day. Finally, average germination (%) was worked out for each treatment. In case of protein content of seed one random sample of mature fruits from each replication for each treatment was taken and seeds were removed, dried, grinded and two samples of this powder were used for nitrogen estimation and conversion factor 6.25 was used to calculate the amount of protein in various samples. To record the length of the seedling ten normal seedlings in each treatment were randomly selected from the germination test for measuring the seedling length on final count day of germination. The seedling length was measured from the top of the shoot region to the bottom of the root. Average seedling length was computed and expressed in centimetres. For calculating the fresh seedling weight, the fresh seedlings were removed on final count day from blotting paper and randomly selected ten seedling weight was recorded and mean of fresh seedling weight was calculated. The seedling which was used for recording the fresh weight, were packed in a butter paper bag and dried for 24 hours in hot air oven maintained at 60 ºC. Then the seedlings were taken out from the oven and cooled in desiccators for 30 minutes. Then the weight of each sample was recorded for calculating dry seedling weight. The vigour index values were calculated as per the method prescribed by Abdul-Baki and Anderson[7] and expressed in whole numbers.

1. Vigour index-I = Germination (%) × mean seedling length (cm)

2. Vigour index-II = Germination (%) × mean seedling dry weight (g)

Results and Discussion

Effect of growth regulators

The pooled data of seed quality parameters presented in the tables (Table 1, 2 & 3) showed that the application of growth regulators significantly influenced the seed quality of okra seeds. Amongst the different treatments the highest 1000 seed weight (71.51 g), germination percentage (92.02%), seedling length (21.06 cm), fresh seedling weight (4.65 g), dry seedling weight (0.2441 g), vigour index- I (1937.46) and vigour index- II (22.459) were found highest when plant received gibberellins treatment (GA_3- 100 ppm). The other treatments also significantly improved the quality characters of the seed as compared to the control. The increase in 1000 seed weight of okra seed might be due to the result of better diversion of photosynthates to the fruit and better accumulation of fruit reserves into the seed. Similar findings were also reported by Patil *et al*. [8], Ravat and Makani [9], Maity *et al*. [10] and Sanodiya *et al*. [11] in okra, Panda *et al*. [12] in coriander, Gour *et al*. [13]in fenugreek, Priya *et al*. [14] in chilli. Increase in germination percentage might be due to application of gibberellins which increases the amino acid content of the embryo which helps in release of hydrolytic enzyme responsible of digestion of starch during seed germination [15].

Many researchers also reported that gibberellin is involved in cell division, cell elongation and increases cell wall extensibility thus, increasing the length and weight of seedlings. The results were in accordance to the findings of Sanodiya *et al*. [11] in okra and Jadhav *et al*. [15] in black gram. The vigour and viability of seeds depends upon proper growth and development of embryo. Propionate use of growth regulators might have increased the vigour of the seed. Similar result was recorded by Sanodiya *et al*. [11] in okra, Singh *et al*. [16] in coriander and Jadhav *et al*. [15] in black gram.

The data regarding seed protein content of okra seed influenced by different growth regulators presented in the table (Table 3) ranged from 21.65% to 22.63%. From the data it is clear that application of different growth regulators significantly influenced the protein content of okra seed. Increase in the protein content of seed might be due to fact that application of growth hormones increased the amino acid content of seed which are the pre requisite for protein synthesis [17]. The results were in agreement with the findings of Jadhav *et al*. [15] in black gram.

Effect of micronutrients

It was clear from the data presented in table (Table 1, 2 & 3) that micronutrients at different concentration showed significant differences among different quality characters of seed. The highest increase in seed quality character like 1000 seed weight (68.28 g), germination percentage (89.27%), seedling length (20.40 cm), fresh seedling weight (4.47 g), dry seedling weight (0.2368 g), vigour index- I (1821.87) and vigour index- II (21.158) were recorded with application of boron (borax-1.0%). It was observed that the application of micronutrients (boron and zinc) in the form of borax and zinc sulphate from 0.5% to 1.0% concentration showed an increasing trend in respect to quality parameters of plant but showed negative trends when concentration increased from 1.0% to 1.5%. This might be due to toxic effect of micronutrients (zinc and boron). Similar findings were also reported by Sharma [18] in tomato, Bhat and Jandial [19] in potato. Application of boron might have helped in efficient translocation of food material from source to sink thus resulting in increasing the 1000 seed weight by increasing the number of bold seed as reported byHamsaveni *et al.* [20] in tomato and Rahman *et al.* [21] in okra. The increase in germination percentage of seed by application of boron might be due to the fact that boron play an important role in many catalytic reactions which in turn helped in the release of complex substances like starch to simpler substances like sugars, and amino acids which are prerequisite for seed germination [22]. Improvement of other quality parameters of seed like seedling length, fresh seedling weight, dry seedling weight, vigour index- I and vigour index- II due to application of boron might be due to the fact that boron is associated with the development of cell wall and cell differentiation. Boron is also involved in tissue expansion of root and shoot region thus helping in increasing the vigour of the seed [23]. The results were in close conformity with the findings of Rahman *et al.* [21] in okra, Hamsaveni *et al.* [20] in tomato, Deepika and Pitagi [24] in radish.

Foliar applications of micronutrients also seemed to increase the protein content of seed as compared to the control. Among the different treatments the highest protein content of seed (22.67%) was found with the zinc sulphate @ 1.0% which was found to be statistically at par with zinc sulphate @ 0.5 %) having protein content of 22.51%.

Zinc is one of the important micronutrient which is associated with a number of dehydrogenase and proteinase enzymes involved in protein synthesis. A similar finding was reported by Zaver [25] in okra. Hajiboland and Amirazad [26] suggested that deficiency of zinc caused stress to the plant which might reduce or inhibit the number of antioxidant enzymatic activities, resulting in oxidative damage of protein and nucleic acid. Similar results were also reported by Zaver [25], Alrawi and Aljumail [27] in okra Sachdev *et al*. [28] in chickpea and Sonune *et al*. [29] in soybean.

Interaction effect of growth regulators and micronutrients

The perusal of data presented in the table (Table 1, 2 & 3) revealed that the combine application of growth regulators and micronutrients was found to be non-significant regarding seed quality parameters of okra seed.

Conclusion and future line of work

From the abhove result it may be concluded that application of growth regulators and micronutrients significantly influenced the seed quality parameters of okra.

Among the different growth regulators, increasing concentration of gibberellic acid improves the seed quality of okra as compared with auxin. Similarly, increasing concentration of micronutrients improves the seed quality. Application of boron improves seed quality more efficiently as compared with zinc. It has also been observed that continuous increase in concentration of micronutrients impact negatively on the seed quality.

In future different combination of growth regulators and micronutrients can be tried by the researchers for better result. A comparative study of seed treatment, soil and foliar application can also be done.

Conflict of interest

The authors declare that they have no conlict of interest.

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Table 1: Effect of different level of growth regulators and micronutrient on sees quality parameters of okra

Treatments	Test weight (g)			Germination percentage			Seedling length (cm)		
	2018	2019	Pooled Mean	2018	2019	Pooled Mean	2018	2019	Pooled Mean
Growth Regulators									
P_0: Control	63.10	62.30	62.70	85.86	85.52	85.69	19.22	19.61	19.41
P_1: NAA- 50 ppm	65.77	65.39	65.58	87.90	86.57	87.24	19.79	20.33	20.06
P_2: NAA- 100 ppm	68.80	68.10	68.45	89.14	88.76	88.95	20.02	20.68	20.35
P_3: GA_3- 50 ppm	68.53	67.94	68.25	91.00	89.62	90.24	20.08	20.74	20.40
P_4: GA_3- 100 ppm	71.91	71.11	71.51	92.33	91.71	92.02	20.68	21.43	21.06
SE (m) ±	**0.28**	**0.41**	**0.25**	**0.15**	**0.11**	**0.09**	**0.06**	**0.05**	**0.04**
CD at 5%	**0.79**	**1.16**	**0.70**	**0.43**	**0.31**	**0.26**	**0.16**	**0.15**	**0.11**
Micronutrients									
M_0: Control	66.48	65.44	65.96	88.93	88.07	88.50	19.72	20.32	20.02
M_1: Zinc Sulphate- 0.5%	67.22	66.46	66.84	89.27	88.13	88.70	19.94	20.54	20.24
M_2: Zinc Sulphate- 1.0%	67.72	67.06	67.39	89.40	88.53	88.97	20.04	20.64	20.34
M_3: Zinc Sulphate- 1.5%	67.42	66.66	67.04	89.00	88.27	88.63	19.88	20.48	20.18
M_4: Borax- 0.5%	67.76	67.34	67.55	89.47	88.60	89.03	19.99	20.59	20.29
M_5: Borax- 1.0%	68.50	68.06	68.28	89.67	88.87	89.27	20.10	20.70	20.40
M_6: Borax- 1.5%	68.26	67.76	68.01	89.00	88.60	88.80	20.03	20.63	20.33
SE (m) ±	**0.33**	**0.49**	**0.30**	**0.18**	**0.13**	**0.11**	**0.07**	**0.06**	**0.04**
CD at 5%	**0.93**	**1.37**	**0.83**	**0.51**	**0.37**	**0.31**	**0.19**	**0.17**	**0.12**
Interaction (Growth Regulators× Micronutrients)									
SE (m) ±	**0.74**	**1.09**	**0.42**	**0.40**	**0.29**	**0.16**	**0.15**	**0.14**	**0.06**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS= Non-significant

Table 2: Effect of different level of growth regulators and micronutrient on sees quality parameters of okra

Treatments	Fresh seeding weight (g)			Dry seeding weight (g)			Vigour Index-I		
	2018	2019	Pooled Mean	2018	2019	Pooled Mean	2018	2019	Pooled Mean
Growth Regulators									
P_0: Control	3.74	3.83	3.79	0.2067	0.2106	0.2087	1650.09	1677.26	1663.68
P_1: NAA- 50 ppm	4.40	4.54	4.47	0.2341	0.2358	0.2371	1739.64	1759.88	1749.76
P_2: NAA- 100 ppm	4.43	4.58	4.51	0.2345	0.2424	0.2384	1784.30	1835.22	1809.76
P_3: GA_3- 50 ppm	4.45	4.63	4.53	0.2367	0.2443	0.2401	1827.31	1858.73	1840.84
P_4: GA_3- 100 ppm	4.55	4.75	4.65	0.2398	0.2484	0.2441	1909.45	1965.47	1937.46
SE (m) ±	**0.02**	**0.02**	**0.02**	**0.0004**	**0.0008**	**0.0004**	**5.67**	**5.56**	**3.95**
CD at 5%	**0.07**	**0.06**	**0.05**	**0.0011**	**0.0022**	**0.0012**	**15.99**	**15.70**	**11.05**
Micronutrients									
M_0: Control	4.25	4.41	4.33	0.2281	0.2348	0.2315	1755.67	1791.84	1773.76
M_1: Zinc Sulphate- 0.5%	4.31	4.46	4.38	0.2302	0.2376	0.2339	1780.62	1811.08	1795.85
M_2: Zinc Sulphate- 1.0%	4.32	4.48	4.40	0.2304	0.2371	0.2338	1792.21	1828.17	1810.19
M_3: Zinc Sulphate- 1.5%	4.28	4.43	4.35	0.2287	0.2354	0.2321	1770.20	1808.64	1789.42
M_4: Borax- 0.5%	4.34	4.49	4.41	0.2313	0.2380	0.2347	1789.68	1825.72	1807.70
M_5: Borax- 1.0%	4.39	4.55	4.47	0.2333	0.2402	0.2368	1803.10	1840.65	1821.87
M_6: Borax- 1.5%	4.31	4.45	4.38	0.2303	0.2370	0.2337	1783.64	1829.06	1806.35
SE (m) ±	**0.03**	**0.03**	**0.02**	**0.0005**	**0.0009**	**0.0005**	**6.70**	**6.58**	**4.68**
CD at 5%	**0.08**	**0.07**	**0.05**	**0.0013**	**0.0026**	**0.0014**	**18.92**	**18.58**	**13.07**
Interaction (Growth Regulators ×micronutrients)									
SE (m) ±	**0.06**	**0.06**	**0.03**	**0.0010**	**0.0019**	**0.0009**	**14.99**	**14.72**	**6.61**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS= Non-significant

Table 3: Effect of different level of growth regulators and micronutrient on seed quality parameters of okra

Treatments	Vigour Index-II			Protein content (%)		
	2018	2019	Pooled Mean	2018	2019	Pooled Mean
Growth Regulators						
P_0: Control	17.747	18.014	17.880	21.96	21.33	21.65
P_1: NAA- 50 ppm	20.575	20.787	20.681	22.74	22.29	22.51
P_2: NAA- 100 ppm	20.900	21.512	21.206	23.05	22.58	22.81
P_3: GA_3- 50 ppm	21.543	21.893	21.661	22.52	22.09	22.35
P_4: GA_3- 100 ppm	22.141	22.778	22.459	22.81	22.45	22.63
SE (m) ±	**0.047**	**0.069**	**0.042**	**0.06**	**0.06**	**0.04**
CD at 5%	**0.133**	**0.196**	**0.117**	**0.18**	**0.16**	**0.12**
Micronutrients						
M_0: Control	20.313	20.703	20.508	22.35	21.78	22.06
M_1: Zinc Sulphate- 0.5%	20.572	20.966	20.769	22.80	22.22	22.51
M_2: Zinc Sulphate- 1.0%	20.625	21.014	20.820	22.95	22.39	22.67
M_3: Zinc Sulphate- 1.5%	20.378	20.798	20.588	22.68	22.26	22.47
M_4: Borax- 0.5%	20.714	21.108	20.911	22.44	22.06	22.25
M_5: Borax- 1.0%	20.948	21.368	21.158	22.58	22.21	22.39
M_6: Borax- 1.5%	20.519	21.020	20.770	22.52	22.11	22.31
SE (m) ±	**0.056**	**0.082**	**0.049**	**0.08**	**0.07**	**0.05**
CD at 5%	**0.158**	**0.231**	**0.138**	**0.21**	**0.19**	**0.14**
Interaction (Growth Regulators × Micronutrients)						
SE (m) ±	**0.125**	**0.183**	**0.070**	**0.17**	**0.15**	**0.07**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS= Non-significant

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