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Studies on effect of seed treatment with micronutrients and plant growth regulator on vegetative and reproductive growth in cucumber (*Cucumis sativus* L.)

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Abstract
Seed treatment is one of the key techniques for improvement of crop performance in several crops. In the present study, seed treatment with $ZnSO_4$ and $FeSO_4$ and foliar spray of Ethrel was explored for improving vegetative and reproductive parameters in cucumber crop. The seed material comprised of single seed lot of cucumber *var*. Pusa Barkha, which was treated with $ZnSO_4$ (50, 75ppm) and $FeSO_4$ (100, 125 ppm) and foliar spray of Ethrel (100, 200, 300 ppm), at 2-4 true leaf stage. All the treatments have improved the vegetative and reproductive parameters in cucumber; however highest improvement was observed for Zn (75 ppm) followed by Ethrel (200 ppm).

Keywords: Seed treatment, vegetative, reproductive parameters

Introduction
The good harvest in almost all crops depends on several factors; one among them is quality seed and also performance of other inputs depend on this factor. Good seed in good soil realize good yield. The role of seed in agriculture is very much significant, particularly in developing countries like India where the population and GDP considerably depend upon agriculture (Tyagi, 2012) [18]. A good vigorous seed utilizes all the resources and realized a reasonable output to the grower.

Cucumber (*Cucumis sativus* L.) had been cultivated over 3000 years in India. Cucumber is also known as' Khira' in India which is extensively grown in tropics, subtropics and milder temperate zones. It is most widely cultivated cucurbits after watermelon and seed oil is also used as antipyretic. Nutrient content- protein (0.4%), carbohydrate(1.5mg), iron (2mg) and also contain Vitamin C. The immature fruit of cucumber is used as salad and for pickling. The fruits are also used as raw. The total area under cultivation of cucumber covers in India is 105.0 lakh hectare with annual production of 163.0 lakh million tonne (National Horticulture Board, 2019-20).

Micronutrients are involved in key physiological processes in crop plant *viz*., photosynthesis, respiration (Marschner,1995) [11] and their deficiency can inhibit this vital physiological process thus limiting yield gain. Application of micronutrients at early stage of reproduction phase in plant makes significant improvement in pollen fertility, pollen stigma interaction and seed setting (Pandey, 2010) [12].

Seventeen micronutrients play crucial role in growth and development of any crop vis a vis cucumber plant. Seed treatment with micronutrients potentially provides a simple and inexpensive method for improving micronutrient in plant nutrition (Farooq *et al.*, 2012) [6]. It also helps in membrane stabilization, free radical detoxification and several other activities in plant. There is a scanty of study available to assess the effect of micronutrient either individual or in combination with plant growth regulator (PGR) for improvement in vegetative as well as reproductive growth in vegetable crops especially, cucumber. Keeping in view the above fact regarding role of micronutrients and PGR on vegetative and reproductive growth in cucumber, the present investigation has formulated with the objective to assess the effect of micronutrient and PGR on vegetative and reproductive growth in cucumber.

The single seed lot of cucumber *var*. Pusa Barkha was treated with micronutrient solution *viz*., $FeSO_4$ (100, 125 ppm) and $ZnSO_4$ (50, 75 ppm) and foliar spray of Ethrel (100, 200, 300 ppm) and their different combinations to assess their effect on vegetative and reproductive growth. The seed was soaked in $FeSO_4$ (100, 125 ppm) and $ZnSO_4$ (50, 75 ppm) solution for 12 hour and

afterwards, the same was dried at room temperature to maintain the initial seed moisture content. Further, foliar spray with Ethrel (100, 200, 300 ppm) was done at 2-4 true leaf stage.

Result and discussion

The mean values of different parameters ranged as number of branches per pant (2.56-4.84), internodal length (6.50-7.36 cm), vine length (152.78-219.78cm), days to 50 percent flowering (38.33-45.33), number of fruits per vine (3.89-7.33), fruit length (20.95-30.74 cm), fruit diameter (0.32-1.54 cm), fruit weight (469.33-574.50 gram) in the cucumber seed lot after treatment of seed with micronutrient (Fe and Zn) followed by foliar spray of plant growth regulator (Ethrel) (table1).

a. Number of branches per plant

All the treatment enhanced the number of branches (0.20-2.28) over untreated seed lot (2.56). The Treatment with Zn (75 ppm), Ethrel (100, 200, 300 ppm) resulted in improvement in number of branches by 0.66 to 1.37. Among combination of micronutrient and plant growth regulator at different concentration, the highest number of branches was recorded in case of seed treatment with Zn (75ppm) and foliar spray of Ethrel (200ppm) at 2-4 true leaf stage i.e., 2.28 over untreated seed lot which was also highest among all the treatments. The lowest improvement (0.2) in number of branches was observed in case of Fe (125 ppm).

Rafeekher *et al*., 2001 observed that the foliar application of Ethrel (200 ppm) at 2 and 4 true leaf stage increased number of branches per plant in cucumber. Also, the Ethrel (250 ppm) sprayed at 2 and 4 true leaf stages increased the number of branches per plant in sponge gourd *var*. Pusa chikani (Girde *et al*., 2006) [7].

The foliar application of other plant growth regulators like Ethrel(100, 200ppm), MH(100, 200ppm), NAA(50, 100ppm) in cucumber at 2-4 true leaf stage increased higher number of branches per vine (Thappa *et al*., 2011) [17]

b. Internodal length

All the treatment combination has enhanced the internodal length over untreated (6.50) but, it was comparable with untreated seed lot. The highest improvement was observed in seed treatment with Zn (50 ppm) followed by Ethrel (200 ppm).

c. Vine length (VL, cm)

The effect on vine length was at par with the untreated seed lot. Among combination of micronutrient and plant growth regulator at different concentration, the highest vine length was recorded in case of Zn (50 ppm) and foliar spray of Ethrel (200ppm) at 2-4 true leaf stage which was 0.86 cm over untreated seed lot. This improvement in vine length was also found highest among all treatment and its combination. The lowest vine length was observed in untreated seed lot i.e., 0.08 cm.

Rai *et al.*,2003 [16] found that the foliar application of 100 mg/l paclobutrazol at two (2) true leaf stage as soil drenching around the plant were recorded maximum improvement in vine length in bitter gourd *cv.* Meghalaya local.

The foliar application of other growth hormone like GA_3 (50ppm), which was applied at three times at 2 and 4- leaf stage in bitter gourd resulted in highest number of vine length(396.11cm).

Further, Ethrel (300ppm) sprayed at 2-4 true leaf stage in cucumber resulted in higher vine length (131.88cm) and number of branches per plant (9.87) (Ajay *et al*., 2018) [1].

d. Days to 50% Flowering (DF, days)

The seed treatment with Zn (50 ppm) alone significantly reduced DF by 14.79 %. However, effect of Ethrel (100, 200, 300 ppm) alone was at par with untreated. Among combination of treatment, the lowest DF was recorded in case of Fe (100ppm) and Ethrel (300ppm) which was 6.82 per cent lower. The highest DF was observed with Fe (100ppm) and Ethrel (200ppm) i.e., 45.33 days.

e. Number of fruits per vine

All the treatment enhanced the number of fruits per vine (1.37-2.45) over untreated (3.89). The Zn (75 ppm) and Ethrel (300 ppm) alone significantly enhanced the number of fruits per vine by 1.67 and 2.0, respectively. Among combination, the highest number of fruits was recorded in case of Zn (75ppm) and foliar spray of Ethrel (200ppm) at 2-4 true leaf stage which was 3.44 over control; this improvement was also found highest among all treatment and its combination. The lowest number of fruits per vine was observed in control i.e., 3.89.

The application of NAA 100 ppm through foliar spray at 2 and 4 leaf stages increased the number of fruits per plant in *cv.* Patiwalli of bottle gourd (Patel *et al*.,1992) [13]. The application of Ethrel (150 ppm) sprayed at 4 leaf stage increased number of fruits per plant in pumpkin (Das and Maurya, 1993) [5].

The application of GA_3(50 ppm) was applied at 2 and 4 leaf stage in bitter gourd exhibited significantly increased number of fruits per vine (8.85) (Hirpara *et al*., 2014) [8].

Chaurasiya *et al*., 2016 [4] found that the Ethrel(100ppm) which was applied at 2 and 4-leaf stage in muskmelon resulted in increasing the number of days to first female flower (43.58), enhanced number of pistillate flower per plant 17.05), least sex ratio (7.19), maximum number of fruits per plant (4.52) and yield per hectare (350.90).

f. Fruit length (cm)

Almost all the treatment enhanced the fruit length (5.05-9.79cm) over control (20.95cm). The Fe (100, 125 ppm), Zn (50, 75 ppm) and Ethrel (100, 200, 300 ppm) enhanced the fruit length which was at par with control. Among combination, the highest fruit length was recorded for Zn (75ppm) and foliar spray of Ethrel (200ppm) which was 9.79 cm over control; this improvement was also found highest among all selected treatment. The lowest enhancement (5.05 cm) was observed for Fe (125 ppm) followed by Ethrel (300 ppm).

The foliar application of 100ppm Ethrel at 2 and 4-leaf stage along with seed soaking by boron (0.05%) for 12 hours in bitter gourd, resulted in increased number of fruits per vine, fruit length and ultimately yield per hectare (Ansari *et al*., 2018) [3].

g. Fruit diameter (cm)

Each and every treatment in present study improved the fruit diameter (0.32-1.54 cm) over untreated (5.63 cm). The treatment with Fe (100, 125 ppm), Zn (50, 75 ppm) and Ethrel (100, 200, 300 ppm) enhanced the fruit diameter which was at par with untreated seed lot. Among combination, the highest fruit diameter was recorded with Zn (75ppm) and foliar spray

of Ethrel (200ppm) which was 1.54 cm over control; this improvement was also found highest among all treatment under study. The lowest improvement (0.86 cm) in fruit diameter was observed in case of Zn (50 ppm) followed by Ethrel (200 ppm).

h. Fruit weight (gram)

Seed treatment with Fe (100 ppm) and Zn (75 ppm) enhanced the fruit weight which was at par with untreated seed lot. Further, Ethrel (100 ppm) resulted in highest improvement in fruit weight which was 115.67 gram higher in comparison with control. Among combination, the highest fruit weight was recorded in case of Zn (75ppm) and Ethrel (200ppm) which was 105.17 gram over control. The lowest improvement (81.78 gram) in fruit diameter was observed in case of Zn (50 ppm) followed by Ethrel (200 ppm).

These finding was also reported by several other researchers in cucurbitaceous crop. The Ethrel (150 ppm) was applied at 2 and 4 leaf stage through foliar spray in muskmelon exhibited the one best treatment in decreasing the number of days to first female flower (43.58), enhanced number of pistillate flower per plant 17.05), least sex ratio (7.19), maximum number of fruits per plant (4.52) and yield per hectare (350.90) (Chaurasiya *et al.*,2016) [4]. The application of Ethephon and Maleic hydrazide were applied at 2-leaf and 4-leaf stage in cucumber and observed that foliar application of 200ppm Ethephon decreased the vine length but increased primary number of branches, fruit yield per vine (Kaur *et al.*,2016) [9].

The Ethrel (600 ppm) was applied in bottle gourd influenced the morphological attributes such as vine length, number of nodes and internodal length and also observed maximum number of female flowers, minimum number of male flower and ultimately maximum number of fruit (Patel *et al.*,2017).

The application of 300ppm Ethrel was applied at 2-leaf and 4-leaf stage in cucumber under polyhouse condition resulted in higher vine length (131.88cm), number of branches per plant (9.87), and internodal length (Ajay *et al*., 2018) [1].

The foliar application of micronutrient like iron (0.2%), boron (0.1%), applied in chilli at 60, 90 and 120 days after transplanting, significantly increased plant height (70.02cm), number of primary branches per plant (8.51), plant spread (36.13 cm), number of fruits per plant (47.80), dry fruit yield per ha (52.61 q ha^{-1}), average fruit weight (6.64 g), fruit length (10.52 cm) and fruit width (1.36 cm) (Malik *et al*., 2020) [10].

From present study, it was concluded that each and every seed treatment with micronutrient followed by foliar application of plant growth regulator given variable response of treatments, yet the treatment with Zn (75ppm) for 12 hours along with foliar spray of Ethrel (200ppm) at 2-4 leaf stage was found the most promising and effective for improving the crop performance i.e vegetative and reproductive growth in cucumber crop.

Table 1: Mean value of different vegetative and reproductive growth parameters

Treatment	Number of branches	Internodal length (cm)	Vine length (cm)	Days to 50 % flowering	Number of fruits per vine	Fruit Length (cm)	Fruit diameter (cm)	Fruit weight (g)
Untreated	2.56	6.50	152.78	44.00	3.89	20.95	5.63	469.33
Fe (100ppm)	2.93	6.58	162.66	40.00	5.27	20.42	5.55	493.60
Fe (125ppm)	2.76	6.12	162.11	40.33	5.26	21.41	5.95	568.67
Zn (50ppm)	3.00	5.99	170.22	38.33	5.35	20.50	5.79	555.23
Zn (75ppm)	3.22	6.46	172.00	39.00	5.56	21.83	5.84	499.90
Ethrel (100ppm)	3.33	6.32	170.44	43.67	5.67	22.32	6.00	585.00
Ethrel (200ppm)	3.81	6.56	177.67	43.33	5.71	23.20	6.19	553.33
Ethrel (300ppm)	3.93	6.49	181.56	43.33	5.89	22.83	6.11	395.33
Fe (100ppm) + Ethrel (100ppm)	3.75	6.39	178.00	44.00	5.78	23.16	5.91	570.00
Fe(100ppm)+ Ethrel (200ppm)	4.05	6.60	187.34	45.33	5.88	24.08	6.22	446.50
Fe(100ppm) + Ethrel (300ppm)	4.09	7.18	194.67	41.00	6.00	21.38	6.42	457.27
Fe(125ppm) + Ethrel (100ppm)	3.67	6.31	175.33	43.66	5.70	22.80	5.98	567.83
Fe (125ppm) + Ethrel (200ppm)	3.78	6.69	181.11	44.33	5.69	21.83	6.06	439.17
Fe (125ppm)+ Ethrel (300ppm)	3.89	6.59	181.78	42.33	5.79	26.00	6.39	459.00
Zn (50ppm) + Ethrel (100ppm)	4.00	7.19	190.89	43.66	5.98	23.66	6.33	457.56
Zn (50ppm) + Ethrel (200ppm)	4.22	7.36	200.66	43.00	5.99	23.73	6.49	551.11
Zn (50ppm) + Ethrel (300ppm)	4.41	7.33	207.44	42.00	6.11	24.00	6.55	520.23
Zn (75ppm) +Ethrel (100ppm)	4.44	7.07	211.67	42.33	6.33	28.03	6.68	530.00
Zn (75ppm) +Ethrel (200ppm)	4.84	6.89	219.78	43.00	7.33	30.74	7.17	574.50
Zn (75ppm) + Ethrel (300ppm)	4.33	6.97	207.45	44.33	6.24	28.33	6.93	511.67
CD (p=0.01)	0.476	NS	19.648	3.760	0.684	3.478	0.807	71.477

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