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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(4): 504-507

www.thepharmajournal.com
Received: 08-02-2023
Accepted: 12-03-2023

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Study on effect of micronutrients and plant growth regulator on production of quality seed in cucumber (*Cucumis sativus* L.)

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Abstract
The present investigation was carried out to evaluate the effects of micronutrients (iron, zinc) and PGR on quality seed production of cucumber *cv* Pusa Barkha. The seed lot was undergone different seed treatment with micronutrient ($FeSO_4$ and $ZnSO_4$) solution with four concentration (100, 125 and 50, 75 ppm) for 12 hours followed by foliar spray of Ethrel with three concentrations (100, 200, 300 ppm) at 2-4 true leaf stage.Seed treatment with Fe (125 ppm) showed higher 1000 seed weight, root length, seedling dry weight, seedling vigour index-I &II. Further, treatment with Fe (100 ppm) showed higher shoot length and with Fe (125 ppm) and foliar spray of Ethrel (200 ppm) showed higher seed germination. The foliar spray with Ethrel (200 ppm) resulted in lowest electrical conductivity and highest dehydrogenase activity as compared to control. Seed treatment with micronutrients Fe (100,125 ppm) and Zn (50, 75 ppm) improved seed quality parameters but Fe (125 ppm) was more effective.

Keywords: Cucumber, micronutrients, PGR, quality, seed treatment, foliar spray

Introduction
Cucumber (*Cucumis sativus* L.) an annual vine vegetable crop belonging to Cucurbitaceae family, is the most widely grown after watermelon. The demand and supply for cucumber has been expeditiously increased in the last few years and now it is grown throughout the world using field or greenhouse culture. The seeds are extremely enriched with nutritive compounds; protein (33.8%), fat (45.2%), carbohydrates (10.3%), and crude fibers (2.0%) and the seed oil consist of four chief fatty acids; linoleic acid (61.6%), oleic acid (15.7%), stearic acid (11.1%), and palmitic acid (10.7%) as described by Mariod *et al*., 2017 [7].
The plant growth regulators (PGR) have positive role on growth, flowering, fruiting, and the fruit yield of cucumber and also on certain seed quality parameters. Among micronutrients, zinc occupies a significant place due to its capability to positively affect plant development and growth. Zinc activates the synthesis of tryptophan, the precursor of IAA, and it is responsible to increasing the photosynthesis and biomass production thus stimulates growth and yield of plant (Singh and Verma 1991) [12]. Iron is necessary for the biosynthesis of chlorophyll and cytochrome resulting significant increases the growth and yield (Agarwala *et al.*, 1985) [1]. Iron is necessary for the biosynthesis of chlorophyll and cytochrome resulting significant increases the growth and yield.
Nowadays, availability of quality seed in any crop, whether it is field or vegetable, is very much important. Seed production used to face both biotic and abiotic stress during seed development and maturation. If we treat the seed with several chemicals before sowing and/or foliar spray with plant growth regulators, this may effect the seed quality of progeny seed after harvest. To assess the effect of micronutrients and PGR on quality seed production in cucumber the present investigation was formulated.

Material and Methods
The Research was carried out a vegetable seed production area of Department of Horticulture (Vegetable & Floriculture), Bihar Agricultural College, Sabour, Bhagalpur during summer season of 2021. Geographically, Sabour is situated under humid sub-tropical climate and located in between 82.12^0 and 83.98^0 E longitude and 24.47^0 and 26.56^0N latitude at an altitude of 75 m above the mean sea level in the Indo -Gangetic Plains of North Eastern India. The soil of the experimental plot was sandy loam. Climatically Sabour falls under subtropical to

slightly arid region, receiving an annual mean annual rainfall about 1200 mm. The experiment was carried out in randomized block design having three replications. Seeds were sown in pits with spacing of 2.5 m between the rows and 0.40 m between the plants. Each treatment was accommodated in plot size of 2.50 X 2.0 m. The single seed lot of cucumber *cv* 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 was done to assess their effect on quality seed production. 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 intial 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 1000 seed weight (20.75-27.95 g), seed germination (75.0-92.0%), root length (10.25-17.83 cm), shoot length (0.65-18.13 cm), seedling dry weight (56.50-87.50 cm), seedling vigour index-I (1792-3144), seedling vigour index-II (3952-7876), electrical conductivity (98.05-143.81), dehydrogenase activity (0.785-1.484) in the cucumber seed lot after treatment of seed with micronutrient (Fe and Zn) followed by foliar spray of plant growth regulator (Ethrel) (table1).

1000 Seed Weight (SW, g)

The seed treatment with Fe (100 ppm) +Ethrel (100 ppm), Fe (125 ppm)+Ethrel (200 ppm) and Zn (50 ppm)+Ethrel (200 ppm) have significantly enhanced the SW. This highest improvement in SW was observed in case of Fe (125 ppm), which enhanced the same by 4.02 g. The lowest improvement in SW was noticed in case of Fe (100 ppm) followed by Ethrel (100 ppm) by 2.24 g.

The application of seed treatment with $ZnSO_4$ applied in tomato produced significantly higher seed yield per plant (10.33 g) and 1000-seed weight (4.03 g) and recorded higher germination (91.60%), root length (8.27 cm), shoot length (10.50 cm), seedling vigour index (1720), field emergence (84.87%) and dry weight(1.94 mg) (Patel *et al*., 2017) [9].

Seed Germination (SG, %)

All the treatment enhanced SG (1.0-17.0%) over untreated (75.0%). The seed germination was recorded highest for Fe (125 ppm) followed by Ethrel (100 ppm) which was 17.0 per cent higher over untreated seed lot. The lowest improvement (7.0%) in SG was recorded in case of seed treatment with Zn (75 ppm).

The foliar application of $ZnSO_4$ (0.5%) was applied in onion resulted in higher root length (12.92, 12.74, 12.83 cm), shoot length (9.51, 9.59, 9.55 cm), seedling vigour index (2026, 2049, 2037), seedling dry weight (36.0, 36.8, 36.4 mg), dehydrogenase enzyme activity (2.612, 2.617, 2.615 OD value) (Ashok *et al*., 2019)

The foliar spray of NAA (50 ppm) at 2-4 true leaf stage in bitter gourd resulted in maximum seed germination (83.25%), seedling vigour index-I (1757), seedling vigour index-II (10626), seedling length (21.11 cm), seedling dry weight (127.65 mg) and minimum electrical conductivity (0.316 dS/cm) of seed leachates (Kumar *et al.*, 2020) [6].

Root length (RL, cm)

The treatment enhanced root length (0.12-5.0 cm) over untreated (12.83 cm). The root length was recorded highest with Fe (125 ppm) which was 5.0 cm higher over untreated seed lot. The lowest improvement (2.84 cm) in RL was found with Zn (75 ppm).

The foliar spray of GA_3 (50 ppm) and boron (1.02 gm/l) were applied at three different stages *viz.*, 2-3 leaf, peak flowering and fruit initiation stage in bottle gourd resulted in improved seed quality parameters like seed germination (92.0%), seedling vigour index (4012), seedling dry weight (615.0 mg), shoot length (21.9 cm), root length (21.7 cm) and increases number of seed per plant and seed weight (Ritti *et al.*, 2019).

Shoot length (SL, cm)

The treatment enhanced shoot length (0.12-2.03 cm) over untreated (16.10 cm). The shoot length was recorded highest with Zn (50 ppm) which was 2.03 cm higher over untreated seed lot. The lowest improvement (1.15 cm) in SL was recorded for Zn (50 ppm) followed by Ethrel (100 ppm).

The foliar application of zinc (15, 30, 50 mg/l) and iron (50, 100 mg/l) or combination of iron and zinc resulted in increased seedling length and better seed quality parameter like highest germination percent (84.0%), shoot and root length and higher seedling dry weight in cucumber (Kazemi, 2013) [5].

Seedling dry weight (SDW, mg)

The treatment enhanced SDW (0.5-24 mg) over untreated (16.10 cm). The SDW was recorded highest for Fe (125 ppm) which was 24.0 mg higher over untreated seed lot. The lowest improvement (6.50 mg) in SDW was recorded with Fe (125 ppm) followed by Ethrel (100 ppm).

The foliar application of Ethrel (250 ppm) at 2-4 true leaf stage resulted in maximum germination percentage while NAA (50 ppm) improved the seedling length, seedling dry weight and vigour index in cucumber (Jyoti and Mehta, 2014) [3].

Seedling vigour index-I(SVI-I)

The treatment improved the SVI-I (28-974) over control (2170). The SVI-I was recorded highest in case of seed treatment with Fe (125 ppm) which was 974.0 higher over untreated seed lot. The lowest improvement (301) in SVI-I was recorded with Fe (100 ppm).

The foliar application of Ethrel (200 ppm) at two four, six leaf stage in bitter gourd gave maximum germination percentage (84.0%) and vigour index (Rafeeker *et al.*, 2001) [10].

Seedling vigour index-II(SVI-II)

The treatment enhanced SVI-II (491-3121) over control (4755). The SVI-II was recorded highest with Fe (125 ppm) which was 3121 higher over untreated seed lot. The lowest improvement (657.5) in SVI-II was recorded for Fe (100 ppm).

The foliar spray of NAA (50 ppm) at two to four leaf stage in bitter gourd resulted in maximum seed germination (83.25%), seedling vigour index-I (1757), seedling vigour index-II (10626), seedling length (21.11 cm), seedling dry weight (127.65 mg) and minimum electrical conductivity (0.316 dS/cm) of seed leachates (Kumar *et al.*, 2020) [6].

Electrical conductivity (EC, dS/cm/50Seed)

The treatment improved the EC (2.69- 45.76) over untreated (143.81) seed lot. The seed treatment with Fe (100 ppm) and combination of treatment i.e., Fe (100 ppm) + Ethrel (200 ppm), Fe (125 ppm) + Ethrel (100 ppm), Zn (50 ppm) + Ethrel (100, 200, 300 ppm) improved the membrane permeability as it reduces seed leachates in solution, hence low value of EC recorded which was at par with untreated seed lot.

The seed treatment with Fe (125 ppm), Zn (75 ppm), foliar spray of Ethrel (100, 200, 300 ppm) and combination of treatment i.e., Fe (100 ppm) followed by Ethrel (100, 300 ppm), Fe (125 ppm) followed by Ethrel (200 ppm) and Zn (50 ppm) followed by Ethrel (100, 200 ppm) significantly reduced seed leachates in solution, hence low EC was recorded. The highest reduction in EC value was recorded in case of seed treatment with Fe (125 ppm) which was 45.76 lower over untreated seed lot. The next higher reduction in EC was observed after foliar spray of Ethrel (300 ppm) by 43.79.

The foliar spray of NAA (50 ppm) at two to four leaf stage in bitter gourd resulted in minimum electrical conductivity (0.316 dS/cm) of seed leachates (Kumar *et al*., 2020) [6].

Dehydrogenase activity (DHA, OD)

The treatment improved the DHA (0.237-0.672) over untreated (0.812) seed lot. The highest improvement in DHA was observed with Fe (125 ppm) which was 0.672 OD higher than untreated seed lot. The lowest improvement in DHA was observed in case of seed treatment with Fe (100 ppm) followed by foliar spray of Ethrel (300 ppm) by 0.237 OD.

Overall, seed treatment with micronutrient (iron and zinc) along with foliar spray of plant growth regulator (Ethrel) improved the seed quality in cucumber *cv* Pusa Barkha. It may be concluded from present investigation that seed treatment with Fe (125 ppm) improve highest for almost all seed quality parameters in cucumber.

Table 1: Mean values for different seed quality parameters of progeny seed

Treatment	1000 Seed Weight (g)	SG (%)	Root Length (cm)	Shoot Length (cm)	SDW (mg)	SVI-I	SVI-II	EC (dS/cm/50 seed)	DHA (OD)
Untreated	23.93	75	12.83	16.10	63.50	2170	4755.0	143.81	0.812
Fe (100 ppm)	22.15	80	12.95	17.88	67.50	2471	5412.5	141.12	1.389
Fe (125 ppm)	27.95	90	17.83	17.07	87.50	3144	7876.0	98.05	1.484
Zn (50 ppm)	21.31	84	13.90	18.13	80.50	2691	6752.0	144.67	1.086
Zn (75 ppm)	20.75	82	15.67	16.79	72.50	2662	5940.0	121.95	0.785
Ethrel (100 ppm)	25.36	73	12.59	17.53	61.00	2198	4441.0	124.71	1.211
Ethrel (200 ppm)	24.54	70	13.08	15.17	56.50	1975	3952.0	107.00	1.202
Ethrel (300 ppm)	16.80	72	13.33	15.00	59.00	2036	4260.0	100.02	1.167
Fe (100 ppm) + Ethrel (100 ppm)	26.17	76	11.16	12.44	74.50	1792	5658.5	128.87	1.049
Fe (100 ppm)+Ethrel (200 ppm)	25.62	78	13.26	12.51	73.50	2008	5740.0	141.45	1.389
Fe (100 ppm) + Ethrel (300 ppm)	21.18	70	10.82	15.25	66.50	1831	4647.5	127.38	1.328
Fe (125 ppm) + Ethrel (100 ppm)	24.34	92	10.25	16.94	70.00	2509	6432.0	138.84	1.063
Fe (125 ppm) + Ethrel (200 ppm)	27.67	75	10.83	15.14	63.50	1947	4755.0	110.75	1.099
Fe (125 ppm)+Ethrel (300 ppm)	21.92	77	12.95	14.88	60.00	2142	4635.0	153.50	1.266
Zn (50 ppm) + Ethrel (100 ppm)	18.90	80	13.92	17.25	50.00	2501	4025.0	105.82	0.82
Zn (50 ppm) + Ethrel (200 ppm)	26.73	78	13.22	16.75	72.50	2337	5640.0	117.01	1.055
Zn (50 ppm) + Ethrel (300 ppm)	20.99	82	10.67	15.75	64.00	2165	5246.0	160.87	1.331
Zn (75 ppm) +Ethrel (100 ppm)	21.36	80	12.48	15.50	76.00	2245	6110.0	133.88	1.405
Zn (75 ppm) +Ethrel (200 ppm)	24.08	84	13.73	16.00	69.50	2499	5856.0	127.67	1.272
Zn (75 ppm) + Ethrel (300 ppm)	19.09	75	12.55	13.45	62.50	1955	4675.0	129.54	0.964
CD (p=0.01)	2.042	6.086	1.024	1.118	6.178	268.599	657.211	17.470	0.094
CV (%)	5.349	4.672	4.794	4.279	5.524	7.163	7.430	8.251	4.901

SG-Standard germination; SDW-Seedling dry weight; SVI-Seedling vigour index; EC-Electrical conductivity; DHA-Dehydrogenase activity

Conclusion

it was observed that seed treatment with Fe (125 ppm) for 12 hour followed by shade drying showed higher 1000 seed weight, root length, seedling dry weight as compared to untreated seed lot. But the higher seed germination percentage was observed in case of seed treatment with Fe (125 ppm) along with foliar spray of Ethrel (100 ppm) as compared to untreated. The higher shoot length was recorded in seed treatment with Fe (100 ppm). As far vigour parameters are concerned the highest seedling vigour index-I and seedling vigour index-II was observed when seed treatment was done with Fe (125 ppm). Seed treatment with Fe (125 ppm) also showed lower electrical conductivity and higher dehydrogenase activity as compared to control which is also a line of confirmation that Fe (125 ppm) improved the vigour of the seed lot in cucumber.

Acknowledgement

The authors are very much thankful to Bihar Agricultural University, Sabour, Bhagalpur (Bihar) for providing all the facilities to conduct the present investigation.

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