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Effect of seed soaking treatments on growth, yield and quality of baby corn (*Zea mays* L.)

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Abstract

There was an investigation regarding, Effect of seed soaking treatments on growth, yield and quality of baby corn (*Zea mays* L.) at farm of the Horticulture Polytechnic, ACH, Navsari Agricultural University, Navsari, Gujarat, India during the summer of 2023 on var. GAYMH-1. The experiment had a randomized block design (RBD) and included seven different treatments, including, T_1: 6-Benzyl adenine (Cytokinin) 50 ppm; T_2: GA3100 ppm; T_3: PBZ 50 ppm; T_4: Mepiquat Chloride 100 ppm; T_5: CCC 100 ppm; T_6: NAA 50 ppm and T_7: control (Water soaked).

On the one day before sowing, seeds were soaked with all the treatments for 24 hours and kept in the shade for 3 hours. Among treatments, seeds soaked in GA3 100 ppm (T_2) reached 50% germination one day earlier than the control with the highest germination percentage (93.03%). The highest plant height (77.17 cm, 211.20 cm, and 220.13 cm at 30, 60DAS, and at last picking, respectively), was recorded with NAA 50 ppm (T_6) and it attained 50% silking in 57.67 days which was 0.33 days earlier than control. Effect of seed soaking treatments of NAA 50 ppm (T_6) was detected in getting a higher number of cobs plant^{-1} (2.40), length of cob (13.50 cm), cob girth (4.84 cm), the diameter of cob (14.51 mm), average weight of cob (84.980 g with husk and 20.213 g without husk), yield of cob plant^{-1} (150.545 g with husk and 41.567 g without husk), cob yield ha^{-1} (12.144 t with husk and 2.716 t without husk) and green fodder yield (36.111 t ha^{-1}). The fresh weight basis were used to analyze the qualitative parameters of the cobs and obtained the highest protein (26.71 mg g^{-1}) and reducing sugar (1.82%) content with GA3 100 ppm (T_2). However, higher total sugar (3.93%) and (2.04%) content was obtained with NAA 50 ppm (T_6).

Keywords baby corn, gibberellins, plant growth regulators, randomized block design

Introduction

The unfertilized small corn (maize) harvested at the silking stage, very well-known as “baby corn”, is a new member of vegetables. It is in place of *Zea mays* L., commonly referred to as candle corn, little corn, or baby corn, is a type of corn ear that belongs to the family Poaceae. It is a tasty, attractive, and nutritious vegetable that is also cholesterol-free. It is almost free of diseases and insect pests. It is likely the only vegetable with no or minimal pesticide residues. Its nutritional value is on par with that of a number of expensive vegetables. Baby corn has almost the same mineral and nutritional content as an "egg." Per 100 g of edible portion, baby corn has these nutrition values like 86.00 mg phosphorus, 28.00 mg calcium, 75.00 mg ascorbic acid (Vitamin C), 8.20 g carbohydrates, 1.90 g protein, 0.20 g fat, 0.50 g thiamine (Vitamin B1), 0.08 g riboflavin (Vitamin B2) and 0.10 mg iron. Because of its high levels of succulence, palatability, and digestibility as well as its lactogenic properties, it is regarded as an excellent fodder crop for milch cattle [1].

In different countries such as Burma, Taiwan, Thailand, and Sri Lanka, baby corn is successfully grown for vegetable purposes. In India, the practice of producing baby corn is still relatively new. It is now only being grown seriously in Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Gujarat, Karnataka, and Andhra Pradesh. Adopting or expanding the use of this crop because of its short growing season and low water requirements. [2]. Seed soaking is a technique to improve the germination characteristics of seeds, such as a more rapid and consistent rate of germination across the environment and the breaking of dormancies in the seeds. This techniques also improves the growth, yield as well as quality of crops. Plant growth regulators (PGRs) are chemicals that at extremely low concentrations, affect the physiological functions of plants. Seeds treated with plant growth regulators gain more germination and have improved stress tolerance in the crucial early growth phases.

Gibberellins (GAs), which contain tetracyclic, and diterpenoid substances, are naturally occurring plant growth regulators. The seed treatment with GA_3 helps improve seed germination and stimulates stem elongation, flowering, and fruiting in plants [3]. Chlormequat Chloride (CCC), also known as cycocel, is a colorless, hygroscopic, crystalline growth retardant chemical that could serve to increase crop yield under environmental stress [4]. Mepiquat Chloride is an anti-gibberellin chemical that behaves as a plant growth regulator, inhibiting vegetative growth and boosting off the development of reproductive organs. Various kinds of cytokinin have been found to regulate by controlling cell proliferation and differentiation, plant growth, and developmental processes are regulated, which ultimately leads to the beginning of the germination of seed and the breaking of seed dormancy. The plant growth regulator naphthaleneacetic acid (NAA), a white, amorphous synthetic substance that belongs to the auxin family of hormones, plays an essential role for rooting as well as for promoting vegetative growth through active cells expanding and division, which enhances growth characteristics and stimulates the reproductive phase [5]. As a member of the triazole family, paclobutrazol (PBZ) has growth-regulating qualities that are mediated by changes in the concentrations of important plant hormones such cytokinins (CK), gibberellins (GAs) and abscisic acid (ABA). Pre-treating crops with PBZ effectively reduces plant height, inhibits lodging, increases fruit production and weight per tree, improves fruit quality by increasing fruit content in carbs, and strengthens crop resistance to drought.

Thus, this investigation was conducted to assess the effects of seed soaking on baby corn production, quality, plant performance, and seed germination.

Methodology

At the Horticulture Polytechnic Farm, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India, a field experiment on baby corn var. GAYMH 1 was carried out in the summer of 2023. The experiment was laid out in randomized block design (RBD) with seven treatments *viz.*, T_1: 6-Benzyl adenine (Cytokinin) 50 ppm; T_2: GA3 100 ppm; T_3: PBZ 50 ppm; T_4: Mepiquat Chloride 100 ppm; T_5: CCC 100 ppm; T_6: NAA 50 ppm and T_7: control (Water soaked), replicated thrice. One day before sowing seeds were treated with all the treatments and allowed to soak for 24 hours then in place of and they were kept in the shade for 3 hours. The soil at the experimental site had a medium water-holding capacity was well-draining and was generally favorable for growing baby corn. The required volumes of inorganic fertilizers (60 kg P_2O_5, 0 kg K_2O, and 120 kg N) and well-decomposed FYM (10 t ha^{-1}) were applied. The fertilizers were applied as single super phosphate (SSP) and urea. Each plot received a full application of FYM, which was well blended into the soil.

During the time of sowing, 100% of the phosphorus and 50% of the nitrogen were applied together. The remaining 50% of the nitrogen was applied at 30 DAS. Planting was done at a spacing of 60 cm x 25 cm, with a gross plot size of 3 m × 2.5 m and a net plot size of 1.8 m x 2.0 m. Panse and Sukhatme [6] methods for statistical analysis was used.

Results and Discussion

Growth parameters

Days to 50% germination and germination percentage at 10 DAS

The data on days to 50% seed germination and percentage of germination at 10 DAS are presented in Table 1. Seeds treated with GA_3 100 ppm (T_2) forced a positive effect on days to 50% seed germination with (93.03%) percentage and germinated one day earlier than control. This could be the result of GA_3 inducing the release of seed store reserves and promoting the development of embryos by weakening the endosperm or seed coat through the stimulation of hydrolytic enzymes (-amylase). Similar findings were observed by Tapfumaneyi et al., [7] in amaranthus.

Table 1. Effect of seed soaking treatments on growth parameters of baby corn var. GAYMH 1

Treatments	Days to 50% germination	Germination percentage at 10 DAS	Plant stand (%) at 20 DAS	Days to 50% silking	Plant height (cm)		
					30 DAS	60 DAS	At Final picking
T_1: 6 Benzyl adenine (Cytokinin) 50 ppm	6.00	60.77	69.44	60.00	53.63	182.47	190.47
T_2: GA3 100 ppm	5.00	93.03	91.67	58.00	73.40	206.33	208.67
T_3: PBZ 50 ppm	6.00	86.65	84.72	57.67	74.38	201.80	208.33
T_4: Meoiquat chloride 100 ppm	5.67	76.10	84.72	57.67	70.00	197.40	203.93
T_5: CCC 100 ppm	5.67	81.92	86.11	58.00	75.83	199.67	202.53
T_6: NAA 50 ppm	5.00	88.89	91.66	57.67	77.17	211.20	220.13
T_7: Control (Water soaked)	6.00	83.32	84.72	58.00	73.27	196.93	206.60
SEm±	**0.19**	**4.85**	**5.19**	**0.39**	**3.06**	**5.14**	**5.10**
CD at 5%	**0.57**	**14.93**	**NS**	**1.20**	**9.41**	**15.83**	**15.70**
CV%	**5.72**	**10.29**	**10.61**	**1.16**	**7.44**	**4.46**	**4.29**

Plant stand at 20 DAS

Result pertaining to the plant stand at 20 DAS is given in Table 1 and it was found non-significant. However, treatment T_2 (GA3 100 ppm) showed maximum plant stand (91.67%) and treatment T_1 (Cytokinin 50 ppm) showed minimum plant stand (69.44%).

Plant height (cm)

The various seed soaking treatments' effects on the height of the plant (Table 1) at 30 DAS, 60 DAS, and at final picking were found significant. Though the seeds treated with NAA 50 ppm (T_6) achieved maximum plant height (77.17 cm and 211.20 cm at 30 and 60 DAS, respectively) did not exert any special effect and statistically remained similar to all the research treatments., except T_1 (Cytokinin 50 ppm). The same treatment (T_6) recorded the highest plant height (220.13 cm) at final picking which was statistically remained at par with T_2 (GA3 100 ppm), T_3 (PBZ 50 ppm), and control also. This may be because NAA, an auxin, encouraged vegetative development by promoting active cell division and cell elongation, which served to improve growth characteristics. It may also have increased reproductive growth. For enhanced plant growth, NAA also boosts nutrient and water osmotic absorption [8]. The current results match with Maurya et al., [9] in maize. Similar outcomes were witnessed by Singh et al., [10] and Pargi et al., [11] in tomato.

Days to 50% silking

The analysis of data (Table 1) demonstrates that the impact of various treatments on days to 50% silking proved effective and significant. Treatment T_3 (PBZ 50 ppm), T_4 (Mepiquat Chloride 100 ppm) and T_6 (NAA 50 ppm) required minimum days (57.67 days) for 50% silking which was 0.33 days earlier than the control but these treatments statistically remain same with all the treatments except T_1 (Cytokinin 50 ppm). The plants in treatment T_1 (Cytokinin 50 ppm) required a maximum days (60) to reach 50% silking.

Yield parameters

Number of cobs plant^{-1}

The data reveals that the number of cobs plant^{-1} (Table 2) was significantly affected by the various treatments and gave the range of production in between maximum (2.40 cobs plant^{-1}) in treatment T_6 (NAA 50 ppm) to minimum (2.00 cobs plant^{-1}) in treatment T_2 (GA_3 100 ppm) but treatment T_6 has statistically remained at par with treatment T_2 (GA_3 100 ppm) having 2.20 cobs plant^{-1}.

Length of cob (cm), girth of cob (cm) and diameter of cob (mm)

Table 2 presents the data pertaining to the length, girth, and diameters of the cobs influenced by various treatments. The results indicate that all of these parameters were significantly influenced by the various treatments that were the subject of the study. Treatment T_6 (NAA 50 ppm) produced the maximum cob length of 13.50 cm, which was statistically equivalent to treatment T_2, T_3, and T_7 and that of minimum (10.65 cm) was obtained with T_1 (Cytokinin 50 ppm) treatment. Same treatment T_6 (NAA 50 ppm) recorded maximum cob girth (4.84 cm) and cob diameter (14.51 mm) but statistically remained similar with T_2 (GA3 100 ppm) and T_7 (Control) treatments for cob girth (4.67 cm) while it was at par with T_2 (GA3 100 ppm), T_4 (Mepiquat Chloride 100 ppm) and T_7 (Control) treatments for cob diameter 14.35 mm, 13.39 mm and 13.12 mm, respectively). This could be the outcome of applying naphthalene acetic acid (NAA), which significantly affects the enzymatic activity, biosynthesis and growth and development of plants. These effects may have an impact on physiological processes, particularly respiration and photosynthesis, which eventually cause the buildup of dry matter, minerals, and carbohydrates in the final product. A similar result was witnessed by Vishwakarma et al., [12] in broccoli.

Average cob weight (g)

The data on cob weight (Table 2) revealed that different seed soaking treatments elicited a significant influence on cob weight either with or without husk. The highest cob weight (84.980 g) with husk was obtained by treatment T_6 (NAA 50 ppm) and this weight was statistically comparable to that of treatments T_2 (75.573 g), T_3 (73.593 g) and T_5 (70.880 g). However, in the case of cob weight without husk, almost the same trend was observed and treatment T_6 (NAA 50 ppm) found the best and recorded maximum cob weight (20.213 g), which statistically remained at par with T_2 (18.173 g), T_7 (17.427 g) and T_3 (15.873 g) treatments.

Yield of cob plant^{-1} (g), yield of cob plot^{-1} (kg) and yield of cob ha^{-1} (t)

After examining Table 2 data, it became evident that the various seed soaking treatments significantly affected the yield of cob plants^{-1}, yield of cob plots^{-1} and ha^{-1} with husk and without husk. Treatment T_6 (NAA 50 ppm) found the best and recorded maximum cob yield with husk (150.545 g plant^{-1}) and without husk (41.567 g plant^{-1}) but it has statically remained at par with T_2, T_4, T_3 and T_5 treatments. In all the treatments, treatment T_6 (NAA 50 ppm) recorded the highest cob yield (4.372 kg plot^{-1}) with husk and (0.978 kg plot^{-1}) without husk but statistically remained at par with T_2, T_3, T_7, T_5 and T_4 treatments. Turning of these data on yield plot^{-1} into hectares resulted that maximum cob yield with husk, treatment T_6 (NAA 50 ppm) found the best and recorded the highest production of cobs of 12.144 t ha^{-1}, based on statistics analysis, stayed comparable to all of the treatments under investigation, except T_1. However, in the case of cob yield ha^{-1} without husk, the same treatment T_6 (NAA 50 ppm) found the best and recorded maximum cob yield (2.716 t ha^{-1}), and Statistics stayed comparable with all the treatments under study, except T_1 treatment.

This might occur because the use of NAA resulted in an increase in the mobilization of reserve food resources in developing sinks by increasing the activities of hydrolyzing and oxidizing enzymes [13].

Table 2. Effect of seed soaking treatments on yield parameters of baby corn var. GAYMH 1

Treatments	Cob no.	Cob length (cm)	Cob girth (cm)	Cob diame ter (mm)	Average cob weight (g)		Cob yield plant^{-1} (g)		Cob yield plot-^{1} (kg)		Cob yield ha^{-1} (t)		Green fodder yield	
					With husk	With out husk	With husk	With out husk	With husk	With out husk	With husk	With out husk	Plot^{-1} (kg)	ha^{-1} (t)
T_1: 6 Benzyl adenine Cytokinin) 50 ppm	2.00	10.65	4.03	12.78	57.013	11.107	118.363	30.655	2.970	0.531	8.250	1.475	8.333	23.14
T_2: GA3 100 ppm	2.20	11.96	4.67	14.35	75.573	18.173	147.769	40.797	4.122	0.973	11.451	2.702	12.333	34.25
T_3: PBZ 50 ppm	2.07	12.71	4.41	12.54	73.593	15.873	141.575	36.533	4.042	0.959	11.229	2.663	12.333	34.25
T_4:Mepiquat chloride 100 ppm	2.13	11.01	4.23	13.12	58.853	13.527	145.029	38.783	4.012	0.777	11.144	2.158	11.000	30.55
T_5: CCC 100 ppm	2.00	11.45	4.25	12.43	70.880	13.427	138.060	38.255	3.838	0.823	10.661	2.287	10.333	28.70
T_6: NAA 50 ppm	2.40	13.50	4.84	14.51	84.980	20.213	150.545	41.567	4.372	0.978	12.144	2.716	13.000	36.11
T_7:Control(Water soaked)	2.00	12.27	4.67	13.39	66.393	17.427	113.618	34.366	3.679	0.842	10.220	2.339	10.667	29.63
SEm±	**0.07**	**0.52**	**0.14**	**0.47**	**5.10**	**1.45**	**5.35**	**1.74**	**0.26**	**0.07**	**0.71**	**0.20**	**0.73**	**2.04**
CD at 5%	**0.21**	**1.61**	**0.42**	**1.45**	**15.72**	**4.47**	**16.48**	**5.37**	**0.79**	**0.23**	**2.18**	**0.63**	**2.26**	**6.27**
CV%	**5.68**	**7.59**	**5.36**	**6.13**	**12.69**	**16.02**	**6.79**	**8.10**	**11.44**	**15.06**	**11.44**	**15.06**	**11.39**	**11.39**

Furthermore, the appropriate development of the plants, management of the abscission layer during the full bloom stage, which hastens the fruit setting, and an increase in the number of ears may all contribute to improved NAA performance and eventually, higher yield. The current results correspond with Kalariya et al., [14] in okra and Hoque et al., [15] in brinjal.

Green fodder yield (kg plot^{-1} and t ha^{-1})

Table 2 showed a significant variation in the amount of green fodder produced when various seed soaking treatments were used. Maximum green fodder yields of 13,000 kg plot^{-1} and 36.111 t ha^{-1} were reported in treatment T_6 (NAA 50 ppm), which statistically remained at par with treatments T_2, T_3 and T_4. Muthukumar et al., [16] revealed that NAA increased fodder yield, because encouraged
the growth, elongation, and division of cells, increasing plant height, the leaf area index and total biomass.

All the growth and yield characteristics of baby corn were negatively responded to Cytokinin 50 ppm (T_1) treatment. This could be as a result of the long-lasting rooted inhibitory activity, gradual degradation, and relative stability of BAP conjugates. Another adverse side effect of supraoptimal BAP levels is hyperhydration of the shoot tissue, which is worsened by calcium shortage. High BAP levels result in little leaves and shoots, even though the rooting capacity is positively connected with shoot length and quality [17].

Quality parameters

Table 3 displays the impact of various seed soaking treatments on the protein, total sugar, reducing sugar, and non-reducing sugar content of fresh baby corn. Fresh baby corn with a maximum protein content of 26.71 mg g^{-1} was obtained from treatment T_2 (GA_3 50 ppm), which was statistically equivalent to treatments T_6 and T_5. Treatment T_6 (NAA 50 ppm) recorded maximum total sugar (3.93%) content and remained at par with T2 treatment while non reducing sugar (2.04%) content was significantly the highest in the same T_6 treatment. However, the greatest level of reducing sugar (1.82%) from samples of fresh baby corn was recorded by the GA_3 50 ppm (T_2) treatment, which was statistically equivalent to the T_6, T_3, and T_5 treatments. It may be because NAA acts as an amino acid stimulant and seems to be beneficial for photosynthesis and the buildup of carbohydrates, both of which contribute to the movement of additional sugar into the fruits. It has been reported, that the presence of these plant bio-regulators increases the conversion of starch into sugar (source to sink). Similar kinds of outcomes were found in baby corn by Vani and Kumar [18].

Table 3. Effect of seed soaking treatments on quality parameters of baby corn var. GAYMH 1

Treatments	Protein content (mg g^{-1})	Total sugar (%)	Reducing sugar (%)	Reducing sugar (%)
T_1:6 Benyl adenine (Cytokinin) 50 ppm	22.22	2.76	1.56	1.13
T_2: GA3 100 pppm	26.71	3.77	1.82	1.83
T_3: PBZ 50 ppm	23.37	3.36	1.71	1.56
T_4: Mepiquat Chloride 100 ppm	24.02	2.95	1.63	1.25
T_5: CCC 100 ppm	24.85	3.46	1.70	1.48
T_6: NAA 50 ppm	26.55	3.93	1.77	2.04
T_7: Control (Water soaked)	23.94	3.10	1.68	1.29
SEm±	**0.83**	**0.10**	**0.04**	**0.06**
CD at 5%	**2.56**	**0.31**	**0.13**	**0.18**
CV%	**5.88**	**5.18**	**4.34**	**6.82**

Conclusion

The results of the current experiment showed that the application of T_6 (NAA 50 ppm) boosted growth and yield characteristics and the quality of the baby corn.

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