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Original Research Article

PRIMING OF CHILLI SEEDS BY DIFFERENT PGRS FOR CHECKING ITS GERMINATION AND YIELD

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Abstract *This study investigates the effectiveness of seed priming with plant growth regulators (PGRs) such as gibberellins (GA) and naphthaleneacetic acid (NAA) in improving the germination and growth of different chilli genotypes. Four genotypes were evaluated for various seedling and yield-related traits. Seeds were primed with three levels of GA (GA0, GA250 and GA500) and NAA (NAA0, NAA50 and NAA100), and their effects on germination percentage, germination rate, radicle length, plumule length, seedling vigor index, plant height, root length, number of leaves, number of fruits per plant, and yield per plant were assessed. The results revealed significant improvements in germination percentage and rate with higher concentrations of GA, with GA500 showing the highest effectiveness. NAA priming notably enhanced radicle and plumule length, seedling vigor index, plant height, root length, and the number of leaves and fruits per plant. The study found that the optimal NAA concentration for most traits was 100 ppm. Overall, seed priming with GA and NAA significantly improved various germination and growth parameters in chilli plants, demonstrating its potential as a cost-effective strategy for enhancing crop performance, especially under adverse field conditions. These findings provide valuable insights for resource-limited producers seeking to improve chilli crop yields through effective seed priming techniques.*

Keywords*:* *Chilli; seed priming; PGRs; gibberellins; naphthaleneacetic acid; germination; yield*

Introduction

The chilli (*Capsicum annum* L.), a solanaceous vegetable crop, is extensively cultivated for its mature red and unripe green fruit (Hernández-Pérez et al., 2020). The fruit is a critical ingredient that enhances the flavor and color of numerous recipes, such as chutneys, condiments, and sauces, and also facilitates digestion, whether left whole or processed into a powder (García et al., 2016). The productivity of crops influenced by the percentage of emergence and the period between planting and emergence in terrestrial plant life cycles (Debbarma et al., 2018). The germination of seeds is a highly sensitive and critical phase in this process. Chilli seeds germinate slowly and unevenly when subjected to both conventional and abiotic conditions, such as moisture and cold. In general, seed priming enhances the vigor of seedlings, accelerates flowering and maturity, prolongs and accelerates emergence, and increases yields (Divya & Nirmaladevi, 2021). In a predictable and efficient manner, this method enhances the vigor of a seed to ensure uniform and timely emergence and germination under a variety of climatic conditions. For producers with limited resources and a low risk tolerance, seed priming is a cost-effective protection plan (Aloui et al., 2017; Ali et al., 2013).

By postponing the emergence of radicles and reducing pre-germination metabolic activity, this pre-sowing seed treatment strategy enhances the performance and germination rate of plants (Aloui et al., 2014). In order to restrict radicle protrusion and

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enhance pregerminative metabolic activity, seeds are rapidly soaked and subsequently desiccated to their original moisture content during priming (Ermis et al., 2016; Ali et al., 2014; Ali et al., 2016; Sarwar et al., 2021). The efficacy of this process is contingent upon the extent to which the crop and variety affect seed germination in response to priming. In relation to the concentration and duration of the chemicals employed for priming. A diverse array of priming strategies have been identified as effective pre-sowing seed treatments that enhance seed germination and seedling development, as well as the pre-metabolic processes necessary to withstand adverse field conditions, such as high temperatures or restricted water availability (Ozbay, 2018).

Gibberellins and other plant hormones effectively counteract ABA's ability to induce dormancy, which leads to accelerated seed germination. ABA catabolism enzymes are activated to decrease ABA levels, while ABA synthesis pathways are inhibited (Ali et al., 2022). Naphthaleneacetic acid (NAA), a synthetic auxin plant hormone, also significantly enhances seed germination. In addition to the conventional advantages of plant hormone seed priming, the germination rate, mean seedling emergence time, germination index, and mean germination time all increased when maize seeds were treated with 100 mg L-1 GA3 for 24 hours (Afzal et al., 2008).

The germination rate, root and shoot length, dry matter, and seedling vigor index of bell pepper seeds were considerably enhanced by priming them with GA3 (200 ppm) (Tombegavani et al., 2020). Seed priming with salicylic and acetylsalicylic acid enhances seedling establishment, homogeneity, and germination in high-salinity environments. The objective of this investigation was to determine the most effective GA to NAA ratio for the purpose of enhancing the germination and growth of various pepper cultivars. The germination and other characteristics of chilli plants were examined in relation to hormone priming with GA and NAA.

Materials and methods

In this experiment, four genotypes of chillis (G1: Ghotki, G2: Longi, G3: Talhar and G4: Sanam) were assessed on the basis of some seedling and yield related traits to study the impact of PGR priming. The seeds of the genotypes under study were air dried, washed with autoclaved water, then surface sterilized in a 2.5% sodium hypochlorite solution for 10 minutes. For seed priming, three levels of GA and three levels of NAA were used. To prepare 250 ppm and 500 ppm solution of GA, 0.25g and 0.5g hormone was added in separate conical flasks and volume was raised up to 1000 ml. Similarly, to prepare 50 ppm and 100 ppm solution of NAA, 0.05g and 0.1g hormone was added in separate conical flasks and volume was raised up to 1000 ml. After preparing solution, seeds were placed on perti dishes and primed with PGRS for 6h. After applying treatments, seed were dried and then planted in trays containing 1:1 sand and peat moss medium. Data of following important traits were measured during and end of the experiment:

- Gemination % (G%)
- Germination rate (GR)
- Radicle length (RL)
- Plumule length (PL)
- Seedling vigor index (SVI)
- Plant height (PH)
- Root length (RL)
- Number of leaves (NL)
- Number of fruits per plant (NF)
- Yield per plant (YP)

Results and Discussion

Germination %

The G% of all the genotypes was significantly impacted by seed priming. Increase in G% was observed as the concentration of PGRS increased as represented in figure 1. Highest G% was observed in GA500 among all the treatments under study. G1 showed highest G% at GA500 among all genotypes followed by G4 and G2 (figure 11). All genotypes under study showed lowest G% at GA0. The increase in G% is most likely due to gibberellin activity. Gibberellins facilitate the germination of seeds by increasing the activity of hydrolysis enzymes, particularly alpha-amylase. The quantity and quality of seeds that germinate can be enhanced by stimulating seeds, as numerous studies have demonstrated. The highest GR of pepper seeds (91.75%) is achieved with a 200 ppm gibberellic acid treatment in comparison to lower concentrations (Ali and Malik 2021; Yogananda et al., 2004).

Germination rate

The GR of all the genotypes was also significantly impacted by seed priming. Similar to G%, increase in GR was observed as the concentration of PGRS increased as represented in figure 2. Highest GR was observed in GA500 among all the treatments under study. G2 showed highest GR at GA500 among all genotypes followed by G4 (figure 11). G1 showed lowest GR at GA0 among all genotypes. Previous research has shown that pepper seedlings are stimulated with plant hormones to increase their germination rates. The germination rates of carrot seedlings are enhanced by priming them with gibberellic acid and salicylic acid (100 ppm), as per (Eisvand et al., 2015). The germination rates of wheat seeds were enhanced by the use of gibberellic acid

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and salicylic acid seed priming (Batool et al., 2023; Haider et al., 2023; Tabatabaei, 2013).

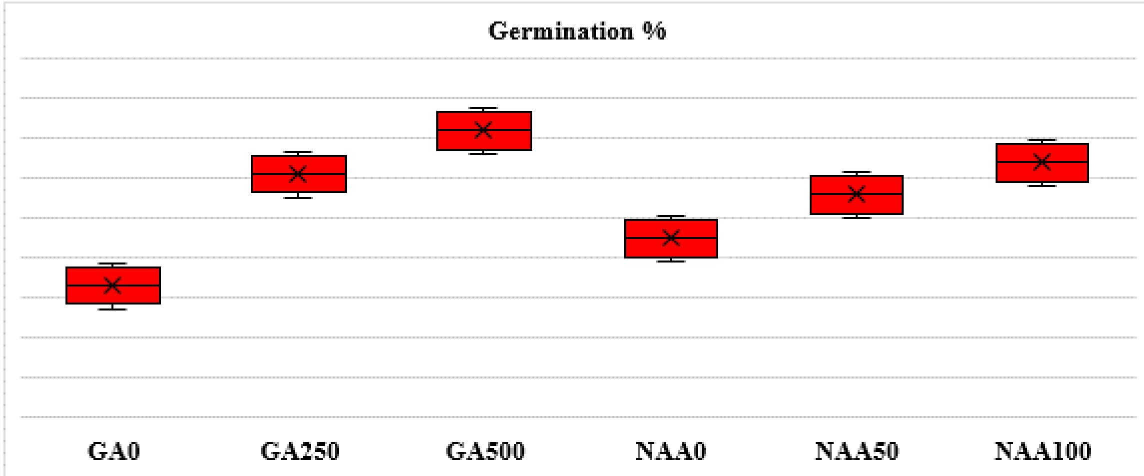

Figure 1: Impact of GA and NAA seed priming on germination % of chilli

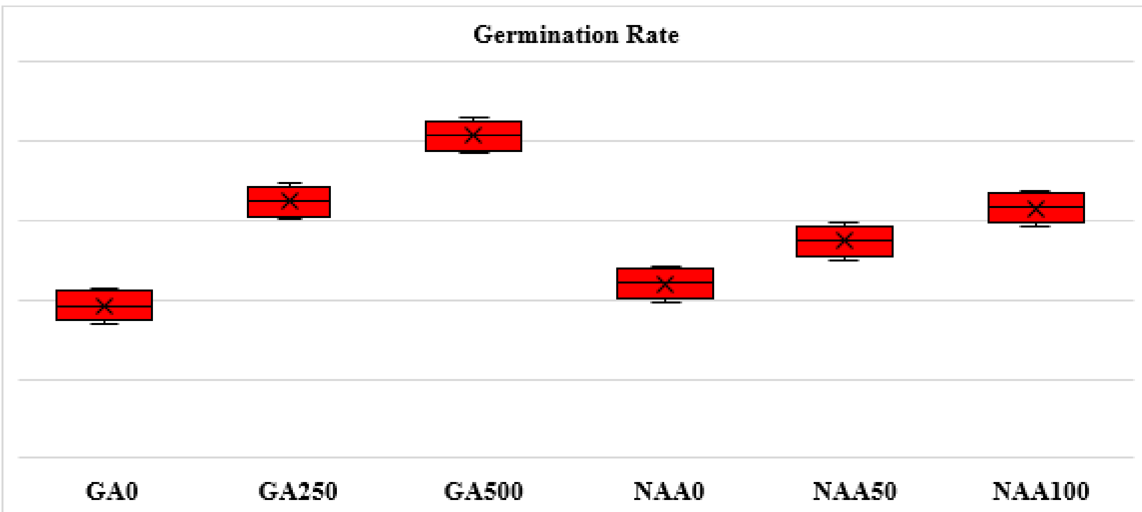

Figure 2: Impact of GA and NAA seed priming on germination rate of chilli

Radicle length

The RL of all the genotypes was increased by seed priming but maximum increase was observed by NAA priming treatment. Increase in RL was observed as the concentration of PGRS increased as represented in figure 3. Highest RL was observed in NAA100 among all the treatments under study. G2 and G4 showed highest RL at NAA100 among all genotypes as represented in figure 11. All genotypes showed lowest RL at GA0 among all genotypes. Similar results were also observed by (Eisvand et al., 2015; Ermis et al., 2016; Tombegavani et al., 2020).

Plumule length

As observed in RL, the PL of all the genotypes was also increased by seed priming but maximum increase was observed by NAA priming treatment. Increase in PL was observed as the concentration of PGRS increased as represented in figure 4. Highest PL was observed in NAA100 among all the treatments under study. G2 and G4 showed highest PL at NAA100 among all genotypes as represented in figure 11. All genotypes showed lowest PL at GA0 among all genotypes. Similar results were also

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reported by (Aloui et al., 2017; Aloui et al., 2014; Ozbay, 2018).

Seedling vigor index

The SVL can be improved by seed priming, which increases the rate and uniformity of germination. Increase in SVL was observed as the concentration of PGRS increased as represented in figure 5. Highest SVL was observed in NAA100 among all the treatments under study. G2 and G4 showed highest SVL at NAA100 among all genotypes as represented in figure 11. Our results are in agreement with prior research that has shown the ability of seed stimulation to elevate the vigor index of plant seeds. The vigor index of chickpea seedlings has been demonstrated to be enhanced by gibberellic acid (100 ppm)(Eisvand et al., 2015).

Plant height

The PH is presumed to be the result of longer internodes. The PH is increased by priming lentil seeds with salicylic acid and hydropriming (Mohammadi & Shekari, 2015). The results of present study indicated that PH of all the genotypes was increased by NAA seed priming but decrease due to GA priming. Increase in PH was observed as the concentration of NAA increased as represented in figure 6. Highest PH was observed in NAA100 among all the treatments under study. G4 showed highest PH at NAA100 among all genotypes as represented in figure 11.

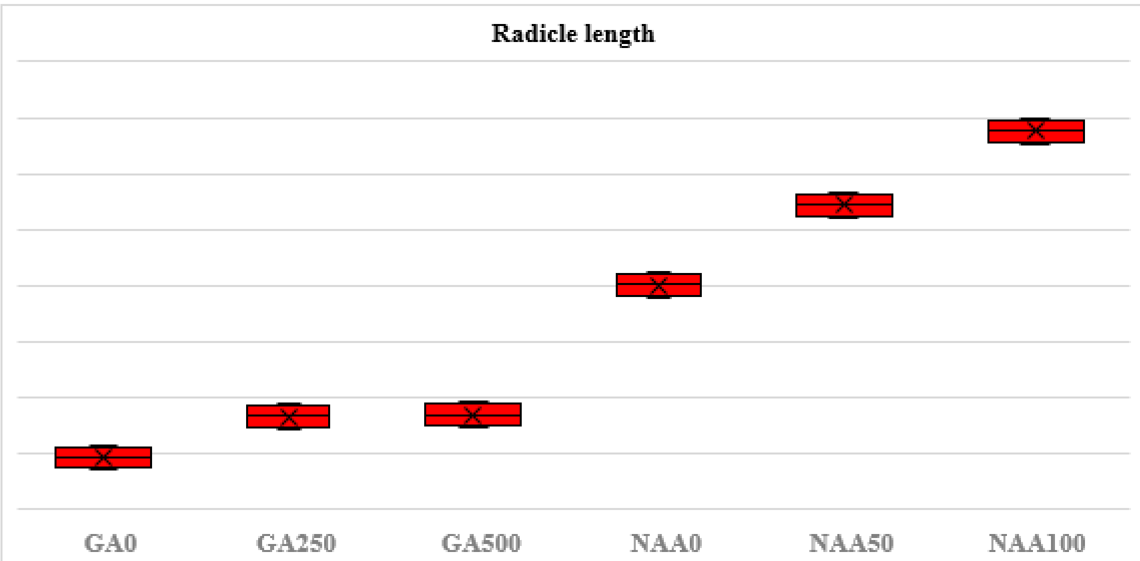

Figure 3: Impact of GA and NAA seed priming on radicle length of chilli

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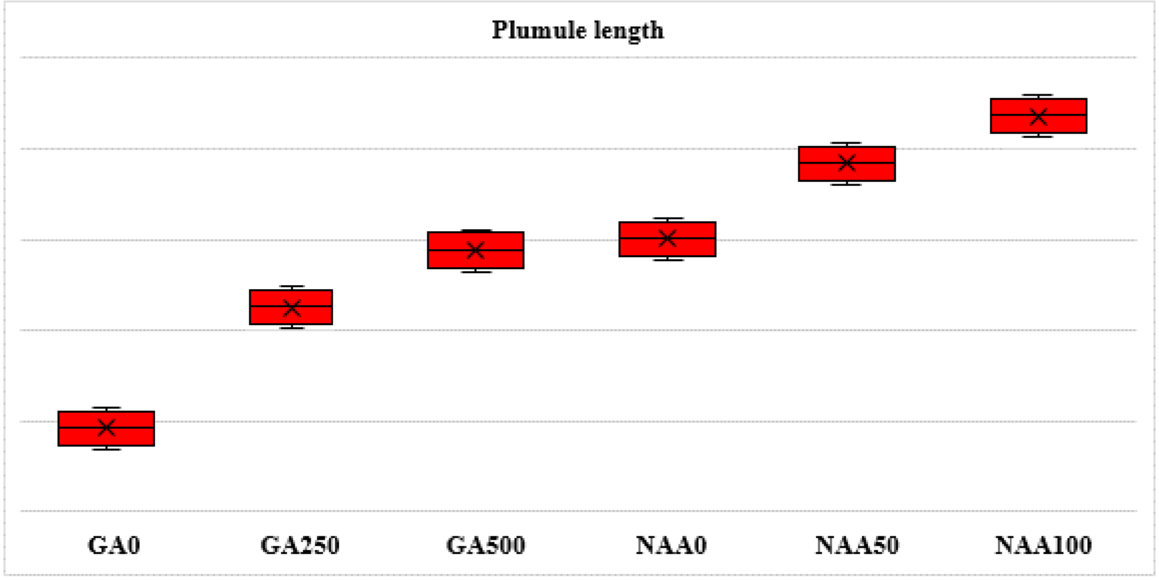

Figure 4: Impact of GA and NAA seed priming on plumule length of chilli

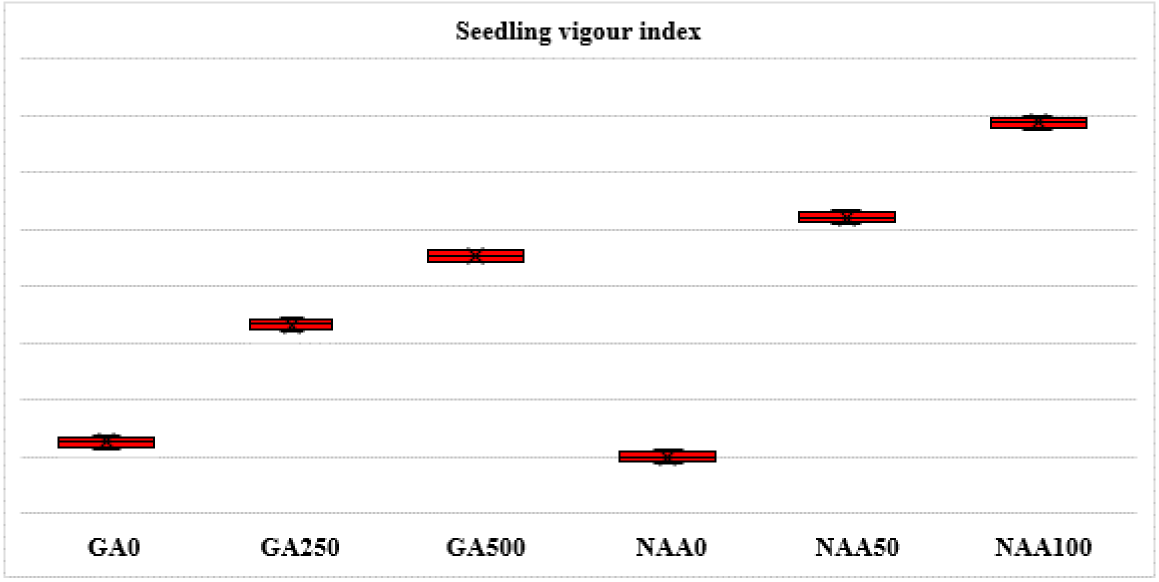

Figure 5: Impact of GA and NAA seed priming on seedling vigour index of chilli

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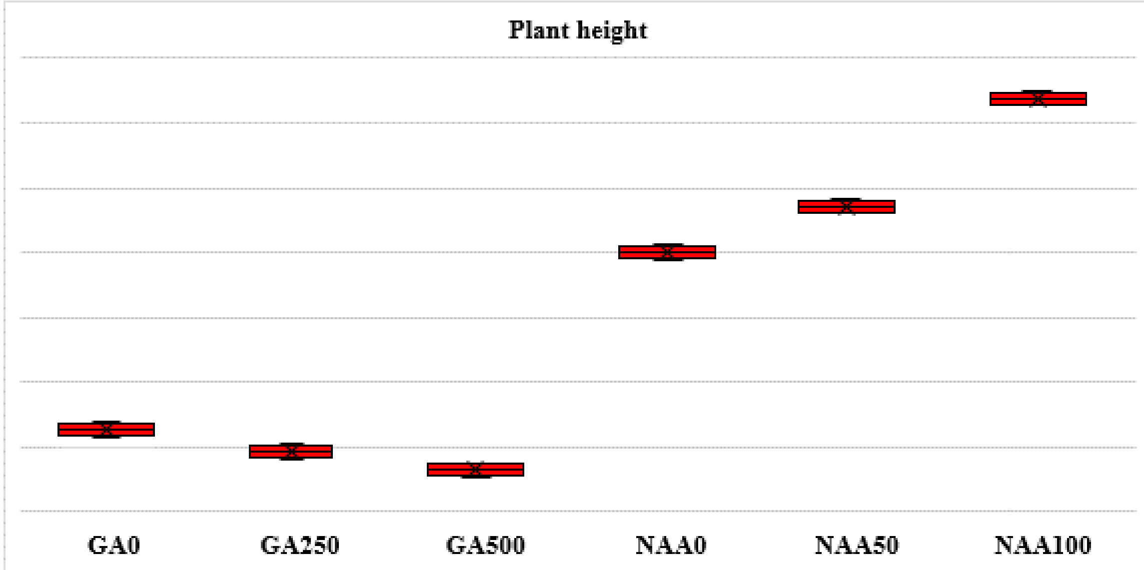

Figure 6: Impact of GA and NAA seed priming on plant height of chilli

Root length

The substantial increase in shoot and root length observed in primed seeds may be attributed to its involvement in meristematic growth and cell elongation or division (Debbarma et al., 2018). Additionally, (de Castro et al., 2000) found that the administration of plant hormones, including IAA, IBA, and NAA, to seedlings enhances root development. The results of present study indicated that RL of all the genotypes was increased by NAA seed priming but decrease due to GA priming. Increase in RL was observed as the concentration of NAA increased as represented in figure 7. Highest RL was observed in NAA100 among all the treatments under study (figure 11).

Number of leaves

The NL of all the genotypes was increased by seed priming but maximum increase was observed by NAA priming treatment. Increase in RL was observed as the concentration of PGRS increased as represented in figure 8. Highest NL was observed in NAA100 among all the treatments under study. G4 and G2 showed highest NL at NAA100 among all genotypes as represented in figure 11. All genotypes showed lowest NL at NAA0 among all genotypes. Previous research demonstrated that eggplants treated with 200 ppm gibberellic acid produced a greater number of leaves than the control group (Gavaskar & Anburani, 2004). The growth of two pepper cultivars, Jwala and Suryamukhi, was substantially influenced by plant growth regulators (Chaudhary et al., 2006). The cultivars with the maximum leaf area index contained 40 ppm NAA. (Rana & Singh, 2012) conducted research on the influence of plant growth regulators on the quality, quantity, and size of pepper fruit. They found that the number of leaves was substantially increased when 50 ppm NAA was used as a stimulant.

Number of fruits per plant

The significant increase in NF in primed seeds was also observed in previous investigations on various crops (de Castro et al., 2000; Divya & Nirmaladevi, 2021; Eisvand et al., 2015). The results of present study indicated that NF of all the genotypes was increased by NAA seed priming but decrease due to GA priming. Increase in NF was observed as the concentration of NAA increased as represented in figure 7. Highest RL was observed in NAA100 among all the treatments under study (figure 11).

Yield per plant

The YP of all the genotypes was also significantly impacted by seed priming. Increase in YP was observed as the concentration of PGRS increased as represented in figure 10. Highest YP was observed in NAA100 among all the treatments under study. G2 showed highest YP at NAA500 among all genotypes followed by G4 (figure 11). G1 showed lowest GR at NAA0 among all genotypes. Similar results were also observed in different crops (Debbarma et al., 2018; Rana & Singh, 2012).

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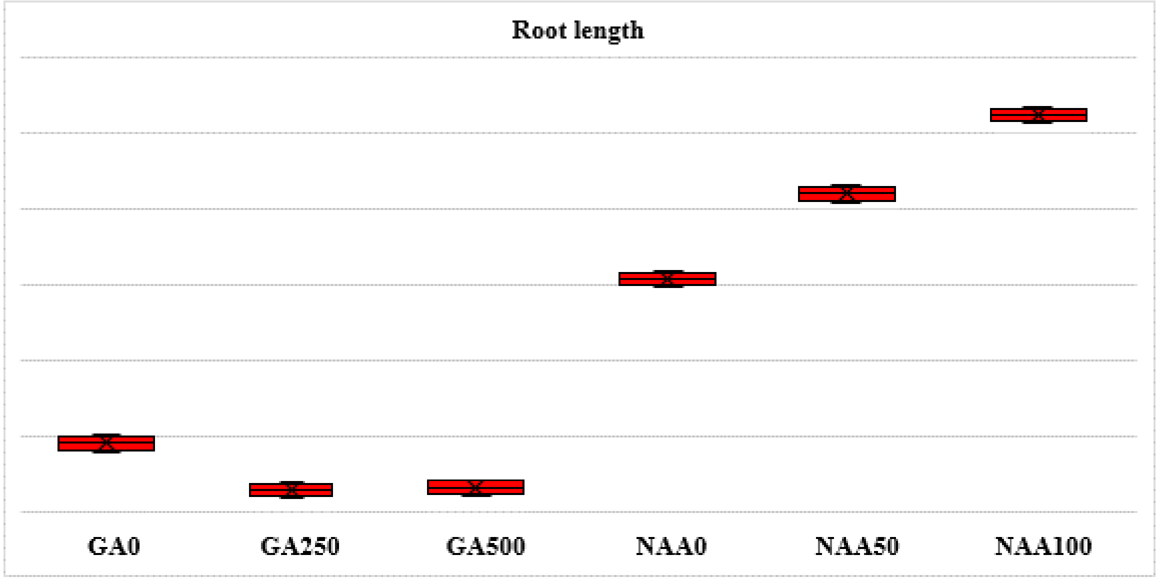

Figure 7: Impact of GA and NAA seed priming on root length of chilli

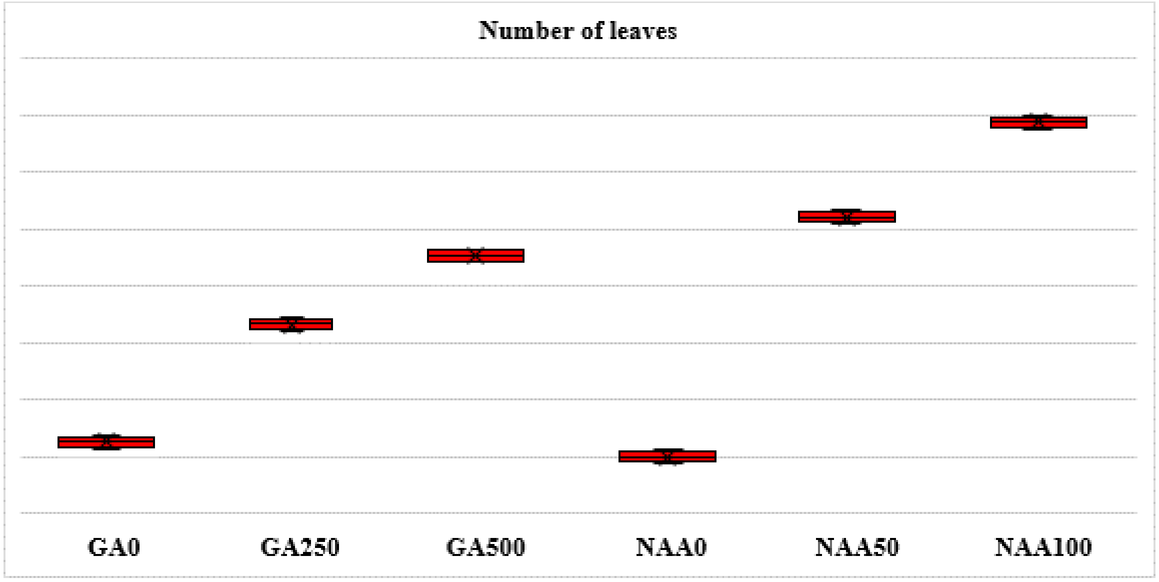

Figure 8: Impact of GA and NAA seed priming on number of leaves of chilli

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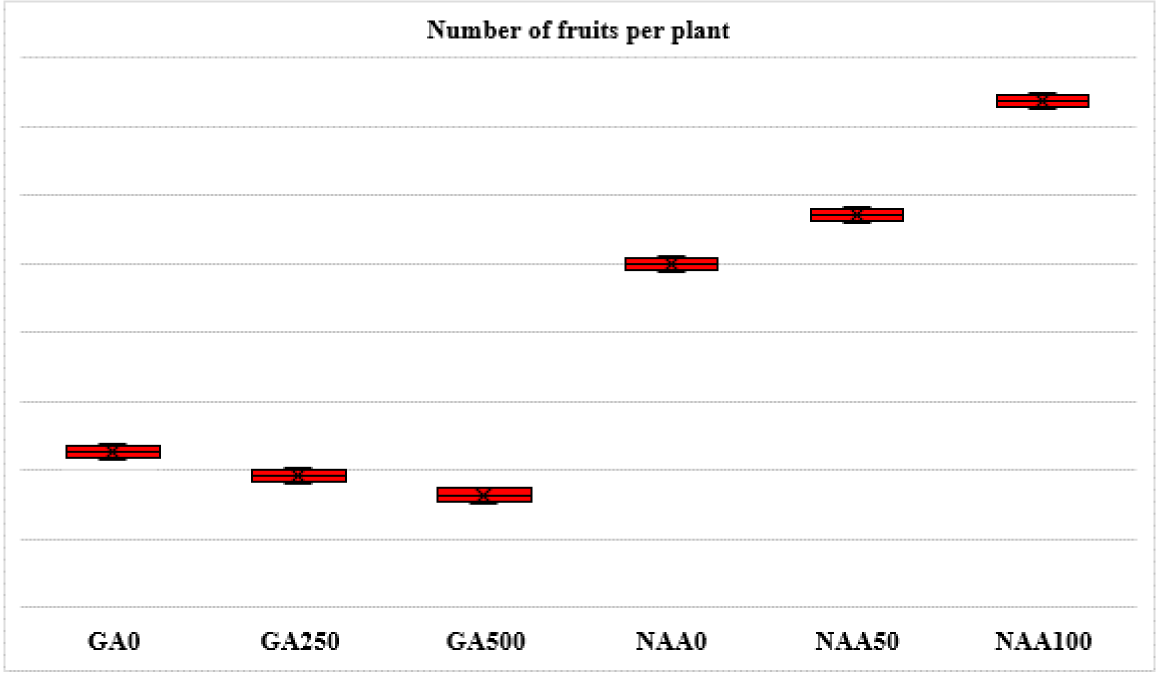

Figure 9: Impact of GA and NAA seed priming on number of fruits per plant of chilli

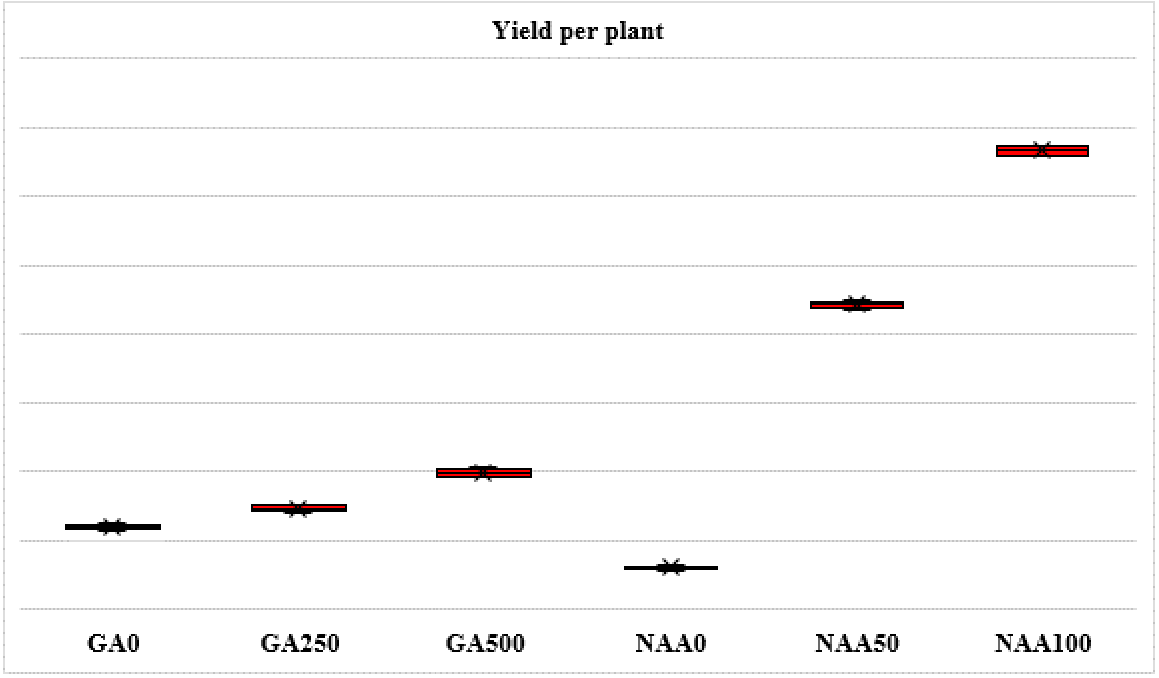

Figure 10: Impact of GA and NAA seed priming on yield per plant of chilli

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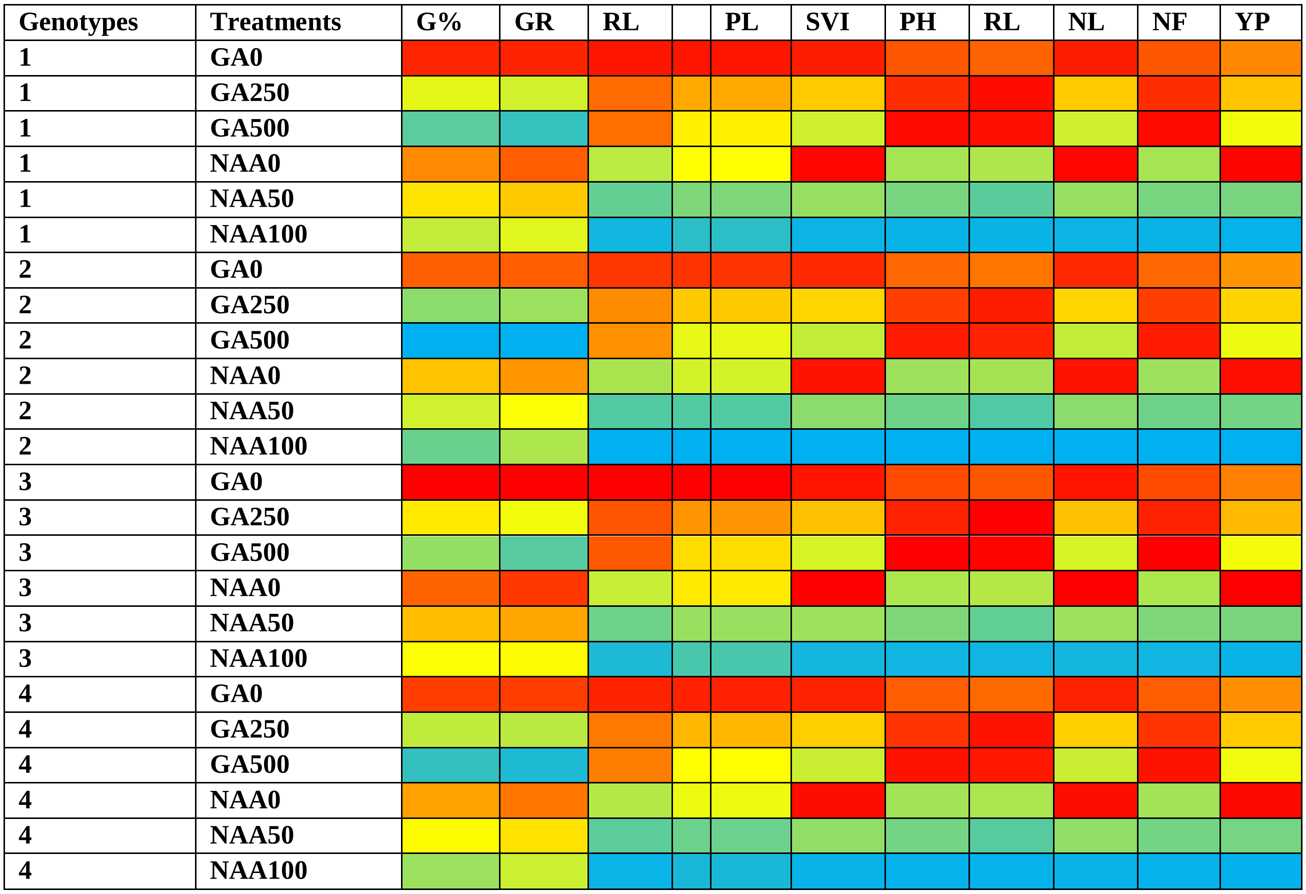

Figure 11: Heat map of four genotypes of chilli at 3 different levels of GA and NAA for different morphological traits under study

Conclusion

The findings suggest that adopting GA and NAA priming techniques can substantially improve chilli crop yields, providing a valuable strategy for producers, particularly those with limited resources and low risk tolerance. Further research is recommended to explore the long-term impacts and optimal conditions for seed priming in different crop species.

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Declaration

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

The study was approved by authors.

Funding Statement

Not applicable

Conflict of Interest

There is no conflict of interest among the authors regarding this case study.

Authors Contribution

All authors contributed equally.

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