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Influence of Naphthalene Acetic Acid (PGR) on the Growth, Yield and Susceptibility to Specific Chili Paper Disease in Different Chilies Cultivars (*Capsicum annuum)* in the Upland of Baluchistan

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Capsicum annuum, commonly known as chili pepper, is a significant spice crop worldwide, and its yield and fruit quality are important factors affecting economic returns for growers. However, these can be impacted by various abiotic and biotic stresses, including environmental conditions, nutrient deficiencies, pests, and diseases. Utilizing growth regulators for plants, such NAA, has emerged as a viable strategy to enhance growth, improve yield, and mitigate stress effects in chili production. To ascertain the impact of the plant growth regulator (NAA) on the development and yield of chilies, a field experiment was carried out. Plant pathogens pose a significant threat to agricultural productivity worldwide. The main challenge in this scenario is that the plant pathogens are dynamic organisms that adapt to changing environmental conditions and agricultural methods. Examples of this kind of evolution include the appearance and spread of novel diseases or more aggressive pathogens that are resistant to fungicides. Using three replications and seven treatments, randomized complete block design (RCBD) was used to perform the experiment. Control (applying no naphthalene acetic acid), 25 ppm, 50 ppm, 75 ppm, 100 ppm, 125 ppm, and 150 ppm applications of naphthalene acetic acid. The result shows that chili crop treated with application of NAA @ 125 ppm exhibited significantly maximum resulted with 80.95 cm plant height, 15.13 quantity of branches plant-1, 84.24 days to flowering, 100.02 days to fruit set, 8.65 cm fruit length, 42.89 g fruit weight, 36.72 quantity of fruits plant-1 and 0.43 kg yield plant-1. In contrast, chili treated under control exhibited the lowest performance, 53.98 cm plant height, 10.49 quantity of branches plant-1, 82.46 days to flowering, 90.77 days to fruit set, 5.66 cm fruit length, 22.54 g fruit weight, 20.39 quantity of fruits plant-1 and 0.02 kg yield plant-1. Among the chili variety, Hot chilies yielded the best results, with 69.31 cm plant height, 13.15 quantity of branches plant-1, 83.52 days to flowering, 96.05 days to fruit set, 7.39 cm fruit length, 34.07 g fruit weight, 29.71 quantity of fruits plant-1 and 0.25 kg yield plant-1. On the other hand, the variety SKY Cross showed the lowest performance, with 65.41 cm plant height, 12.49 quantity of branches plant-1, 83.24 days to flowering, 94.73 days to fruit set, 6.96 cm fruit length, 31.17 g fruit weight, 27.36 quantity of fruits plant-1 and 0.19 kg yield plant-1. After going through the findings of the present research, it was concluded that the application of NAA at 125 ppm showed superior results in terms of plant height, quantity of branches, days to flowering and fruit set, fruit length, fruit weight, quantity of fruits per plant, and overall yield per plant compared to other concentrations of NAA and the control group. The research findings show that that NAA at 125 ppm can be an effective growth regulator for chili crops, leading to improved growth and increased yields.
Keywords: Naphthalene acetic acid (PGR), Growth, Yield, Chili cultivars, Capsicum annuum.

INTRODUCTION

Capsicum annuum, commonly known as chili pepper, is a significant spice crop worldwide, and its yield and fruit quality are important factors affecting economic returns for growers. However, these can be impacted by various abiotic and biotic stresses, including environmental conditions,

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nutrient deficiencies, pests, and diseases. Utilizing growth regulators for plants, such NAA, has emerged as a viable strategy to enhance growth, improve yield, and mitigate stress effects in chili production (Etesami *et al*., 2018; Hernández-Pérez *et al*., 2020; Khalid *et al*., 2023).

Chilies are a popular spice across the world because of its strong flavor, aroma, and medicinal properties. Almost every cuisine in the world uses chili, one of the oldest spices known to civilization (Xiang *et al*., 2021). The genus Capsicum, which includes chilies, is a member of the Solanaceae family. A fiery fruit called chili is utilized in culinary dishes. It is primarily used to add spiciness to dishes.

Chilies are tropical and subtropical plants that need a mix of warm, humid, and dry conditions. Warm, humid conditions is necessary for it to grow. Dry weather is ideal for fruit maturity, though. Crop growth is impacted by temperatures of 37°C or higher. Similar to this, a plant begins to decay when it rains a lot (Wei *et al*., 2020). During the fruiting stage, the bud does not develop correctly if the circumstances are low on moisture. Fruit and flowers may thus wither away. It implies that deflowering and small-sized fruits, if formed, would result from a high temperature and relatively low humidity level (Narayan *et al*., 2017).

***Problem Statement*:** Chili cultivars (*Capsicum annuum)* represent a significant agricultural resource in the upland regions of Baluchistan, contributing to both the economy and food security. Variable climate, poor soil quality, and other environmental factors frequently hamper the development and harvests of these crops. Naphthalene acetic acid, a plant growth regulator, has been found to improve crop growth and productivity in other plants. No research has been undertaken on the effect of NAA on chili cultivars in Baluchistan uplands. This problem is worth studying because increased yields of chili in these hilly areas can have significant economic and food security implications. NAA application may provide a strong approach to address this problem by identifying effective growth-promoting techniques. The research objective was to find out the impact of NAA on the growth and yield of different chili cultivars grown in the Baluchistan highlands. While the application of PGRs has been the subject of several research papers, the current study focuses on determining the ideal dose of naphthalene acetic acid for chili growing in Baluchistan. The following goals are included in the study. To assess the effect of naphthalene acetic acid on the growth of chilies. To determine the correct dose of naphthalene acetic acid for better production of chilies. The study was determine the perfect dose of naphthalene acetic acid for better growth and yield of chilies in upland of Baluchistan.

MATERIALS AND METHODS

To ascertain the impact of the plant growth regulator (NAA), plant disease on the development and yield of chills, a field experiment was carried out. A randomized complete block design (RCBD) with three replications was employed.

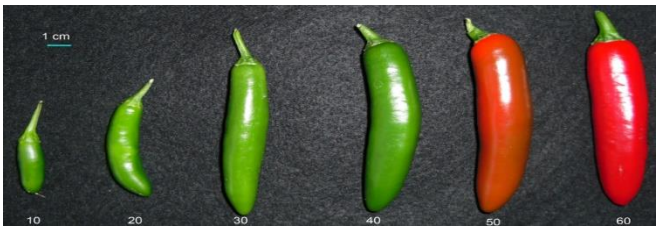

Figure 1. Growth and production of chilies

Treatments:

1. Control (no naphthalene acetic acid application)
2. Applying 25 parts per million of naphthalene acetic acid
3. Applying 50 parts per million of naphthalene acetic acid
4. Applying 75 parts per million of naphthalene acetic acid
5. Applying 100 parts per million of naphthalene acetic acid
6. Using naphthalene acetic acid at a concentration of 125 parts per million
7. 150 parts per million application of naphthalene acetic acid

Data Collection: The following data was collected for comparison among treatments.

Vegetative growth parameters:

1. Plant height (cm)
2. Quantity of Branches

Reproductive Growth Parameters:

1. Days to Flowering
2. Days to Fruits Set

Yield Parameters:

1. Fruit Length (cm)
2. Fruit Weight (g)
3. Quantity of fruits per plant
4. Yield per plant (kg)

Statistical analysis: The data was analyzed using Statistix version 8.1.

RESULTS

***Plant height (cm)*:** The plant height of chili varieties Roshni, SKY Cross, HP 2346, Golt hot, Bonus F_1, Orable and Hot chilies were treated with different naphthalene acetic acid levels. The result indicates that the effect of varieties by different sowing dates was significant at a level of ($P<0.05$). According to the results presented in Table 1, the maximum plant height (80.95 cm) was observed when the crop treated application of NAA @ 125 ppm, followed by application of NAA @ 100 ppm, application of NAA @ 150 ppm, application of NAA @ 75 ppm, application of NAA @ 50 ppm and application of NAA @ 25 ppm with an average plant height of 76.40 cm, 71.85 cm, 67.30 cm, 62.75 cm and 58.16 cm, respectively. The control group exhibited the lowest

Table 1. Plant height (cm) of chili varieties as influenced by different naphthalene acetic acid levels.

Treatments	Varieties							Mean
	Roshni	SKY Cross	HP 2346	Golt hot	Bonus F_1	Orable	Hot chilies	
Control	55.28	52.07	52.71	53.37	54.41	54.02	56.02	53.98G
Application of NAA @ 25 ppm	59.50	56.30	56.78	57.44	58.85	58.08	60.15	58.16F
Application of NAA @ 50 ppm	64.05	60.80	61.45	62.10	63.40	62.75	64.70	62.75E
Application of NAA @ 75 ppm	68.60	65.35	66.00	66.65	67.95	67.30	69.25	67.30D
Application of NAA @ 100 ppm	77.70	74.45	75.10	75.75	77.05	76.40	78.35	76.40B
Application of NAA @ 125 ppm	82.25	79.00	79.65	80.30	81.60	80.95	82.90	80.95A
Application of NAA @ 150 ppm	73.15	69.90	70.55	71.20	72.50	71.85	73.80	71.85C
Mean	68.65B	65.41G	66.03F	66.69E	67.97C	67.33D	69.31A	

	Treatments	Varieties	T x V
SE±	0.0741	0.0741	0.1959
LSD 0.05	0.1470	0.1470	0.3889

average plant height at 53.98 cm. The variety hot chilies showed the maximum plant height (69.31 cm), followed by Roshni (68.65 cm), Bonus F_1 (68.65 cm), Orable (68.65 cm), Golt hot (66.69 cm), HP 2346 (66.03 cm), while the minimum plant height (65.41 cm) was observed in the SKY Cross. The interactive effect of treatments and varieties, the treatment application of NAA @ 125 ppm and variety hot chilies resulted in the maximum plant height (82.90 cm), whereas the interaction control and the variety Orable resulted in the minimum plant height (54.02 cm). The LSD test indicated that the differences in plant height between treatments and varieties were significant at a level of ($P<0.05$).

***Days to fruits set*:** The days to fruits set of chili varieties Roshni, SKY Cross, HP 2346, Golt hot, Bonus F_1, Orable and hot chillies were treated with different naphthalene acetic acid levels. The result indicates that the effect of varieties by different sowing dates was significant at a level of ($P<0.05$). According to the results presented in Table 4, the maximum days to fruits set (100.02) was observed when the crop treated application of NAA @ 125 ppm, followed by application of NAA @ 100 ppm, application of NAA @ 150 ppm, application of NAA @ 75 ppm, application of NAA @ 50 ppm and application of NAA @ 25 ppm with an average days to fruits set of 98.48, 96.94, 95.40, 93.86 and 92.32, respectively. The minimum days to fruits set with an average 90.77 was observed under control. The hot chili variety exhibited the longest duration until fruit set, which was measured as (96.05) days, followed by Roshni (95.83), Bonus F_1 (95.61), Orable (95.39), Golt hot (95.17), HP 2346 (94.95), while the minimum days to fruits set (94.73) was observed in the SKY Cross. The interactive effect of treatments and varieties, the treatment application of NAA @ 125 ppm and variety hot chilies resulted in the maximum days to fruits set (100.68), whereas the interaction control and the variety SKY Cross resulted in the minimum days to fruits set (90.12). The LSD test indicated that the differences in days to fruits set between treatments and varieties were significant at a level of ($P<0.05$).

Table 2. Days to fruits set of chili varieties as influenced by different naphthalene acetic acid levels.

Treatments	Varieties							Mean
	Roshni	SKY Cross	HP 2346	Golt hot	Bonus F_1	Orable	Hot chilies	
Control	91.20	90.12	90.34	90.54	90.98	90.76	91.42	90.77G
Application of NAA @ 25 ppm	92.76	91.65	91.88	92.10	92.54	92.32	92.98	92.32F
Application of NAA @ 50 ppm	94.30	93.20	93.42	93.64	94.08	93.86	94.52	93.86E
Application of NAA @ 75 ppm	95.84	94.74	94.96	95.18	95.62	95.40	96.06	95.40D
Application of NAA @ 100 ppm	98.92	97.82	98.04	98.26	98.70	98.48	99.14	98.48B
Application of NAA @ 125 ppm	100.46	99.36	99.58	99.80	100.24	100.02	100.68	100.02A
Application of NAA @ 150 ppm	97.38	96.28	96.50	96.72	97.16	96.94	97.60	96.94C
Mean	95.83B	94.73G	94.95F	95.17E	95.61C	95.39D	96.05A	

	Treatments	Varieties	T x V
SE±	2.1123	2.1123	5.5893
LSD 0.05	4.1933	4.1933	0.0111

Table 3. Quantity of fruits plant^{-1} of chili varieties as influenced by different naphthalene acetic acid levels.

Treatments	Varieties							Mean
	Roshni	SKY Cross	HP 2346	Golt hot	Bonus F_1	Orable	Hot chilies	
Control	21.18	19.17	19.58	20.01	20.89	20.34	21.57	20.39G
Application of NAA @ 25 ppm	23.85	21.91	22.29	22.68	23.46	23.07	24.24	23.07F
Application of NAA @ 50 ppm	26.58	24.63	25.02	25.41	26.19	25.80	26.97	25.80E
Application of NAA @ 75 ppm	29.31	27.36	27.75	28.14	28.92	28.53	29.70	28.53D
Application of NAA @ 100 ppm	34.77	32.82	33.21	33.60	34.38	33.99	35.16	33.99B
Application of NAA @ 125 ppm	37.50	35.55	35.94	36.33	37.11	36.72	37.89	36.72A
Application of NAA @ 150 ppm	32.04	30.09	30.48	30.87	31.65	31.26	32.43	31.26C
Mean	29.32B	27.36G	27.75F	28.15E	28.95C	28.53D	29.71A	

	Treatments	Varieties	T x V
SE±	5.9013	5.9013	0.0156
LSD 0.05	0.0117	0.0117	0.0310

***Quantity of fruits plant^{-1}*:** The quantity of fruits plant^{-1} of chili varieties Roshni, SKY Cross, HP 2346, Golt hot, Bonus F_1, Orable and Hot chilies were treated with different naphthalene acetic acid levels. The result indicates that the effect of varieties by different sowing dates was significant at a level of ($P<0.05$). According to the results presented in Table 7, the maximum quantity of fruits plant^{-1} (36.72) was observed when the crop treated application of NAA @ 125 ppm, followed by application of NAA @ 100 ppm, application of NAA @ 150 ppm, application of NAA @ 75 ppm, application of NAA @ 50 ppm and application of NAA @ 25 ppm with an average quantity of fruits plant^{-1} of 33.99, 31.26, 28.53, 25.80 and 23.07, respectively. The minimum quantity of fruits plant^{-1} with an average 20.39 was observed under control. The variety hot chilies showed the maximum quantity of fruits plant^{-1} (29.71), followed by Roshni (29.32), Bonus F_1 (28.95), Orable (28.53), Golt hot (28.15), HP 2346 (27.75), while the minimum quantity of fruits plant^{-1} (27.36) was observed in the SKY Cross. The interactive effect of treatments and varieties, the treatment application of NAA @ 125 ppm and variety hot chilies resulted in the maximum quantity of fruits plant^{-1} (37.89), whereas the interaction control and the variety SKY Cross resulted in the minimum quantity of fruits plant^{-1} (19.17). The LSD test indicated that the differences in quantity of fruits plant^{-1} between treatments and varieties were significant at a level of ($P<0.05$).

***Yield plant^{-1} (kg)*:** The yield plant^{-1} of chili varieties Roshni, SKY Cross, HP 2346, Golt hot, Bonus F_1, Orable and Hot chilies were treated with different naphthalene acetic acid levels. The result indicates that the effect of varieties by different sowing dates was significant at a level of ($P<0.05$). According to the results presented in Table 8, the maximum yield plant^{-1} (0.43 kg) was observed when the crop treated application of NAA @ 125 ppm, followed by application of NAA @ 100 ppm, application of NAA @ 150 ppm, application of NAA @ 75 ppm, application of NAA @ 50 ppm and application of NAA @ 25 ppm with an average yield

Table 4. Yield plant^{-1} (kg) of chili varieties as influenced by different naphthalene acetic acid levels.

Treatments	Varieties							Mean
	Roshni	SKY Cross	HP 2346	Golt hot	Bonus F_1	Orable	Hot chilies	
Control	0.04	0.00	0.01	0.02	0.03	0.02	0.05	0.02G
Application of NAA @ 25 ppm	0.10	0.06	0.06	0.07	0.09	0.08	0.11	0.08F
Application of NAA @ 50 ppm	0.17	0.12	0.13	0.14	0.16	0.15	0.18	0.15E
Application of NAA @ 75 ppm	0.24	0.19	0.20	0.21	0.23	0.22	0.25	0.22D
Application of NAA @ 100 ppm	0.38	0.33	0.34	0.35	0.37	0.36	0.39	0.36B
Application of NAA @ 125 ppm	0.45	0.40	0.41	0.42	0.44	0.43	0.46	0.43A
Application of NAA @ 150 ppm	0.31	0.262	0.27	0.28	0.30	0.29	0.32	0.29C
Mean	0.24B	0.19G	0.20F	0.21E	0.23C	0.22D	0.25A	

	Treatments	Varieties	T x V
SE±	2.7154	2.7154	7.1824
LSD 0.05	5.3894	5.3894	1.4253

plant^{-1} of 0.36 kg, 0.29 kg, 0.22 kg, 0.15 kg and 0.08 kg, respectively. The minimum yield plant^{-1} with an average 0.02 was observed under control. The variety hot chilies showed the maximum yield plant^{-1} (0.25 kg), followed by Roshni (0.24 kg), Bonus F_1 (0.23 kg), Orable (0.22 kg), Golt hot (0.21 kg), HP 2346 (0.20 kg), while the minimum yield plant^{-1} (0.19 kg) was observed in the SKY Cross. The interactive effect of treatments and varieties, the treatment application of NAA @ 125 ppm and variety hot chilies resulted in the maximum yield plant^{-1} (0.46 kg), whereas the interaction control and the variety SKY Cross resulted in the minimum yield plant^{-1} (0.00 kg). The LSD test indicated that the differences in yield plant^{-1} between treatments and varieties were significant at a level of ($P<0.05$).

DISCUSSION

The influence of Naphthalene Acetic Acid (PGR) on the growth and yield of different chili cultivars (Capsicum annuum) in the upland region of Baluchistan has garnered significant attention among researchers and farmers alike. As one of the major agricultural regions in Pakistan, Baluchistan's upland areas present unique challenges for chili cultivation due to their arid and semi-arid climate. As a result, in modern years, scientists have considered the possibility of applying Plant Growth Regulators to boost productivity in such extremes. Finally, the output of this work, through examining the impacts of Naphthalene Acetic Acid on the growth parameters, duration of flowering, fruit formation through fruit set, and yield of different varieties can change the chili cultivation landscape. In the end, this research can support chili farmers to increase their productivity and consequently enhance food security.

The result shows that chili crop treated with application of NAA @ 125 ppm exhibited significantly maximum resulted with 80.95 cm plant height, 15.13. Also, the quantity of branches plant^{-1}, 84.24 days to flowering, 100.02 days to fruit set, 8.65 cm fruit length, 42.89 g fruit weight, 36.72 quantity of fruits plant^{-1} and 0.43 kg yield plant^{-1}. In contrast, chili treated under control exhibited the lowest performance, 53.98 cm plant height, 10.49 quantity of branches plant^{-1}, 82.46 days to flowering, 90.77 days to fruit set, 5.66 cm fruit length, 22.54 g fruit weight, 20.39 quantity of fruits plant^{-1} and 0.02 kg yield plant^{-1}. Among the chili variety, hot chilies yielded the best results, with 69.31 cm plant height, 13.15 quantity of branches plant^{-1}, 83.52 days to flowering, 96.05 days to fruit set, 7.39 cm fruit length, 34.07 g fruit weight, 29.71 quantity of fruits plant^{-1} and 0.25 kg yield plant^{-1}. In contrast, the SKY Cross variety displayed the least favorable performance, characterized by a plant height of 65.41 cm, 12.49 branches per plant, 83.24 days to flowering, 94.73 days to fruit set, 6.96 cm fruit length, 31.17 g fruit weight, 27.36 fruits per plant, and a yield of 0.19 kg per plant. Chili plants treated with NAA at 125 ppm in the experiment had the maximum yield per plant, 0.43 kg, according to a critical review of the research findings. Subsequently, NAA at 100 ppm produced a 0.36 kilogram yield per plant, and NAA at 150 ppm produced a 0.29 kg yield per plant.

These results are also in agreement with the studies conducted by (Rana and Singh *et al*., 2012) on the height of capsicum, (Singh *et al*., 2017) on the quantity of branches in capsicum, and (Kannan *et al*., 2009) on paprika's quantity of days taken to reach initial blooming. Moreover, these findings also coincide with those found by Shetty and (Hemanta *et al*., 2012); the quantity of blossoms per plant, in (Dhotre and Mantur *et al*., 2018) on the quantity of chili paparka fruits per plant, and in (Balraj and Kurdikeri *et al*., 2002), on fructification of yield of fruit per plant in chili severally.

To achieve the developed plant parameters; plant height 109.38 cm; plant spread 87.10 cm; branches per plant 13.56; flowers per plant 10.10; fruit weight, 168.26 g, fruit per plant 8.41, seeds per fruit 105.26, fruit yield per plant 1.41 kg; and fruit yield per plot 12.72 kg; I treated T1 to T6 on post treatment T7 with treatment T5 under NAA 30 ppm.

While another intervention was brought about a spectacular event is a reduction of plant coverage (72.60 cm), the total of harvest (6.44kg) and elongation of duration of period of appearance of first flower (leading to T8 (NAA 100 ppm)). The points of our study added up to the results of (Singh *et al*., 2012) regarding the budget of Hybric Capsicum, as well as (Kannan *et al*., 2009) and who were the first to bloom in pepper. Besides, (Rana and Singh *et al*., 2012) determined the height of Hybric Capsicum's plants. (Sridhar *et al*., 2009, Tirakannavar *et al*., 2009), and (Balraj *et al*., 2002) also enumerate characteristics of chili types whose fruits baring habit and the bearer among chili fruits per plant are comprehensively entrenched (Balraj *et al*., 2002).

In a study by (Singh *et al*., 2017), T7 exhibited the highest fruit yield per plant (1.67 kg), fruit yield per plot (15.07 kg), and fruit production per hectare (69.76 t). To achieve superior plant characteristics, including a plant height of 109.38 cm, plant spread of 87.10 cm, 13.56 branches per plant, 10.10 flowers per plant, 168.26 g fruit weight, 8.41 fruits per plant, 105.26 seeds per fruit, a fruit yield of 1.41 kg per plant, fruit yield per plot of 12.72 kg, and a fruit yield per hectare of 58.96 t, treatment T5 (NAA 30 ppm) was administered after T7. Concurrently, T1 (GA3 30 ppm) exhibited the shortest quantity of days to first flowering after T7. In contrast, treatment T8, which involved the application of 100 ppm of NAA, exhibited the smallest plant spread but demonstrated notable outcomes, including the highest quantity of fruits per plant (6.36), the greatest fruit weight (144.65 g), and the highest quantity of seeds per fruit (92.36). Conversely, the control treatment (T0) displayed distinct characteristics, such as the lowest plant height (85.28 cm), the most branches per plant (9.85), and the highest quantity of fruits per plant (4.51). Additionally, T0 yielded the greatest fruit yield per plant (0.70 kg), the highest fruit yield per plot (6.44 kg), and required the

lengthiest quantity of days to first flowering, as reported by (Aashish *et al*., 2022; Ullah *et al*., 2021) found that the application of PGRs (GA3 and NAA, either alone or in combination) did not significantly influence sweet pepper yield in non-temperature-controlled conditions. The study highlighted that elevated temperatures (45 °C) in uncontrolled tunnels during 2012–13 led to a notable decrease in yields, potentially contributing to the lack of discernible PGR impacts. High temperatures have been reported to reduce tomato (Maboko *et al*., 2015) and pepper (Erickson and Markhart *et al*., 2002) fruit set and yield. Notably, four distinct PGR treatments applied to pepper plants in 2013–14 did not result in increased pepper production.

Additionally, the administration of 4-CPA, 15 mg/L of GA3, and 15 mg/L of NAA decreased the total yield. Fruit deformity was elevated by foliar 4-CPA spray at a dose of 30 mg/L. The tomato juice's TSS, pH, EC, and blossom-end rot were not significantly impacted by PGRs. PGR application elicited varying responses in terms of plant production and growth. In contrast to our sweet pepper study, an application of 4-CPA was found to boost tomato output. Additionally, it was discovered in earlier research by (Maboko *et al*, 2015) that NAA and GA3 were employed to enhance fruit setting and yield in tomatoes; nevertheless, they were ineffective in increasing the output of sweet pepper in our investigation. When gibberellic acid was applied, plant height rose. Using GA3 had a beneficial impact on the various combinations. Gibberellins' ability to promote cell elongation and division was thought to be the cause of the GA3-induced increase in plant height (Emongor *et al*., 2007). The promotion of cell division and cellular extensibility may be the cause of GA3's stimulation of sweet pepper plant height (Emongor *et al*., 2007). Plant height rose at 10 $mg.L^{-1}$. This concentration of GA3 was used. This is consistent with the findings of (Gelmesa *et al*., 2010), who reported that tomato plants treated with 10 $mg.L^{-1}$ (10 ppm) GA3 exhibited a 17% increase in stem length.

***Conclusion*:** Following the processing of the study finding, it was established that the concentration of NAA at 125 ppm resulted in the highest success in the parameters for plant height, quantity of branches, days to the flowering, fruit set, fruit length, fruit weight, quantity of fruits per plant, and finally overall for plant yield compared to other NAA concentrations and the control group. The expression of genes is 1.2 fold increase in chili, which shows that the NAA applied at 125 ppm could be a useful growth regulator in pepper crop and might lead to enhanced growth and higher yields.

***Authors contributions statement*:** M. B. Khan, B.M. Shah, M. Rafee designed, completed the experiments; Kaleemullah supervised whole research; S. S. Shah prepared and finalized the draft.

***Conflict of interest*:** The authors declare no conflict of interest.

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***Ethical statement*:** This article does not contain any studies regarding human or Animal.

***Availability of data and material*:** We declare that the submitted manuscript is our work, which has not been published before and is not currently being considered for publication elsewhere?

***Code availability*:** Not applicable.

***Consent to participate*:** All participants involved in this study provided informed consent prior to their participation.

REFERENCES

Narayan, S., M. I. Makhdoomi, A. Malik, A. Nabi, K. Hussain and F. A. Khan. 2017. Influence of Plastic and organic mulching on productivity, growth and weed density in chilli (Capsicum annuum L.). Journal of Pharmacognosy and Phytochemistry 6:1733-1735.

Xiang, Q., W. Guo, X. Tang, S. Cui, F. Zhang, X. Liu and W. Chen. 2021. Capsaicin—the spicy ingredient of chili peppers: A review of the gastrointestinal effects and mechanisms. Trends in Food Science & Technology 116:755-765.

Wei, L. L., W. C. Chen, W. C. Zhao, J. Wang, B. R. Wang, F. J. Li and K. Wang. 2020. Mutations and overexpression of CYP51 associated with DMI-resistance in Colletotrichum gloeosporioides from chili. Plant disease 104:668-676.

Sridhar, G., R. V. Koti, M. B. Chetti and S. M. Hiremath. 2009. Effect of naphthalene acetic acid and mepiquat chloride on physiological components of yield in bell pepper (Capsicumannuum L.). Journal of Agricultural Research 47:53-62.

Rana, D. K., and R. N. Singh. 2012. Influence of bio regulators on quantitative and qualitative parameters of sweet pepper under controlled condition. Progressive Horticulture 44:96-100.

Singh, P., D. Singh, D. K. Jaiswal, D. K. Singh, and V. Singh. 2017. Impact of Naphthalene Acetic Acid and Gibberellic Acid on Growth and Yield of Capsicum, Capsicum annuum (L.) cv. Indra under Shade Net Conditions. International Journal of Current Microbiology and Applied Sciences 6:2457-2462.

Tirakannanavar, Shantappa, Ahmed, M.S. Ao, P. M. Munikrishnappa, M. L. Chavan and A. B. MastikolL. 2009. Effect of plant growth regulators and method of application on growth, fruit, and seed yield in paprika chilli. Indian Seed Research 37:14-19.

Balraj R., M.B. Kurdikeri, Revanappa. 2002. Effect of growth regulators on growth and yield of chilli (Capsicum annuum) at different pickings. Indian Journal of Horticulture 59:84-88.

Aashish, K. C., J. Kumar, V. J. Silas, H. Giri, H. Khadka, and M. K. Yadav. 2022. Effect of foliar application of urea and naphthalene acetic acid (NAA) on growth and yield of chilli (Capsicum annuum L.) var Pusa Jwala. The Pharma Innovation 11:1187-1198.

Ullah, S., I. Afzal, S. Shumaila and W. Shah. 2021. Effect of naphthyl acetic acid foliar spray on the physiological mechanism of drought stress tolerance in chilli. Plant Stress 2:100035.

Maboko, M. M., and C. P. Du Plooy. 2015. Effect of plant growth regulators on growth, yield, and quality of sweet pepper plants grown hydroponically. HortScience 50:383-386.

Erickson, A. N., and A. H. Markhart. 2002. Flower developmental stage and organ sensitivity of bell pepper (Capsicum annuum L.) to elevated temperature. Plant, Cell & Environment 25:123-130.

Emongor, V. E. 2007. Effect of Accel on growth, yield and yield components of snap bean (Phaseolus vulgaris).

Gelmesa, D., B. Abebie and L. Desalegn. 2010. Effects of Gibberellic acid and 2, 4-dichlorophenoxyacetic acid spray on fruit yield and quality of tomato (Lycopersicon esculentum Mill.). Plant Breed. Crop science 2:316-324.

Singh, P., D. Singh, D. K. Jaiswal, D. K. Singh and V. Singh. 2017. Impact of naphthalene acetic acid and gibberellic acid on growth and yield of capsicum, Capsicum annum (L.) cv. Indra under shade net conditions. International Journal of Current Microbiology and Applied Sciences 6:2457-2462.

Kannan, K., M. Jawaharlal and M. Prabhu. 2009. Effect of plant growth regulators on paprik-A review. Agricultural Reviews 30:229-232.

Hemanta, L., K. V. Jayaprasad, D. P. Kumar, R. K. Manohar and G. Gopinath. 2012. Effect of levels of fertigation on yield and flower quality of different varieties of carnation (Dianthus caryophyllus L.) under naturally ventilated polyhouse.

Dhotre, M., and S. M. Mantur. 2018. Use of plant growth regulators to enhance productivity of hybrid capsicum grown under polyhouse. Journal of Farm Science 31:172-177.

Khajuria, A., T. Bhandari, A. Shayan, A. Asif, P. Mehta and V. K. Aswathy. 2022. Depression, Anxiety and Stress among the Undergraduate Students in Punjab. NeuroQuantology 20:1503.

Etesami, H., and D. K. Maheshwari. 2018. Use of plant growth promoting rhizobacteria (PGPRs) with multiple plant growth promoting traits in stress agriculture: Action mechanisms and future prospects. Ecotoxicology and environmental safety 156:225-246.

Hernández-Pérez, T., M. D. R. Gómez-García, M. E. Valverde and O. Paredes-López. 2020. Capsicum annuum (hot pepper): An ancient Latin-American crop with outstanding bioactive compounds and nutraceutical potential. A review. Comprehensive Reviews in Food Science and Food Safety 19:2972-2993.

Khalid, M. F., S. Huda, M. Yong, L. Li, L. Li, Z. H. Chen and T. Ahmed. 2023. Alleviation of drought and salt stress in vegetables: crop responses and mitigation strategies. Plant Growth Regulation 99:177-194.