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Evaluating the Impact of Plant Growth Hormones on Growth and Yield of Summer Squash

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ABSTRACT

The field experiment was conducted at the Directorate of Agricultural Research, Tarahara, Sunsari, during the summer months of March to May 2023 to study the effect of plant growth hormone on the growth and yield of squash (Cucurbita pepo L.). It was a randomized complete block design (RCBD) experiment with six treatments and four replications. The treatments included T1 (NAA - 50 PPM), T2 (NAA - 100PPM), T3 (NAA - 150PPM), T4 (control), T5 (GA3 - 100PPM), and T6 (GA3 - 150PPM). Observations showed that plants treated with GA3 at 150 PPM (T6) exhibited maximum height and an increased number of branches at 45 DAS. Additionally, the highest fruit yield per plant (884.95 g) was obtained from plants receiving the recommended NPK concentration (200:180:80 kg/ha) (T6). The greatest fruit length and diameter were recorded in T1 and T6, measuring 22 cm and 77.4 mm, respectively. Growth and yield parameters were considerably lower in the control plot. Therefore, it can be concluded that treatment T6 (GA3 at GA3-150 ppm) showed a superior effect on the growth and yield of summer squash compared to other treatments, and its application in the field could help increase production and productivity.

Keywords: GA3, plant height, production, summer squash, yield

INTRODUCTION

Zucchini or summer squash (Cucurbita pepo) is one of the most significant crops of the Cucurbitaceous family among other types of squash. Zucchini is very polymorphic, which implies that it is very genetically diverse and differs in characteristics broadly. One of the squashes which are favored most during summer in the United States of America and in Europe is this squash (Usman, 2007). All the types of zucchini are plant species (Cucurbita pepo L) (Agyarko and Adomako, 2007). Zucchini was a product of America, but it is currently a crop grown across markets. The total coverage land area of summer squash in Nepal is 1922 ha, with a production of 24,509 Mt and a yield of 12.75 Mt/ha (MoALD, 2022). Zucchini is a healthy vegetable that contains vitamins, minerals, as well as dietary fiber (Paris, 1996).

This is a relatively new crop in Nepal, which is progressively assuming high economic value. Zucchini farming is practiced on drip irrigated soils during spring-summer to summer-fall seasons so as to meet the huge demand of this fresh vegetable in the country and abroad markets (Contreras et al., 2017). Cucurbitaceous crops such as zucchini are very important in terms of the global economy, and they are important in the provision of important nutrients and dietary fiber to individuals worldwide. These are crops; they have different squashes, pumpkins, melon, and cucumbers, and they are used not only as vegetables but also as a fruit.) As young fruits can be consumed as cooked vegetables and curries, zucchini can also be termed as medicinal plants because of its various medicinal values(Kaur and Rattan, 2021). A short-season crop that is easy to grow, summer squash is adapted to growth in temperate and subtropical climes and is produced in most areas. The global output of summer squash was more than 6,300,000 metric tons per year in the back quarter of the eighties (FAO statistics or Fruit and Vegetable Markets, 1992).(Paris, 1996). One of the most significant treatment beliefs is the growth regulators, which are nowadays being applied in the agricultural sector and which, in most cases, alter the plant growth and the following fruiting. Growth regulators are dignified as one of the biggest treatments, used in modern days in agriculture, which in the maximum state help improve plant growth as well as the subsequent fruiting. They are used to promote seed germination, vegetative growth, flowering, and fruiting in a variety of vegetable crops as gibberellins and Auxin. One of the vitamins is vitamin C, also called growth-regulating factor, and it controls numerous processes in the cell. Gibberellic acid is one of such plant growth regulators, which has become capable of manipulating numerous growth and development phenomena in numerous crops. GA3 is another substance that promotes growth processes in plants, enhancing stem cell elongation (Akter et al., 2007). NAA (Naphthaleneacetic acid) is an artificial plant hormone, which is widely utilized in the farming industry as a means of plant development stimulation. NAA can trigger root growth on summer squash plants, and thus it is useful during transplanting or plant establishment in general, as roots are important in providing nutrients to the plants accordingly. (Dalai et al., 2015).

NAA is also reported to increase fruit set in most of the crops by inducing the production of the fruiting bodies and by augmenting the ovarian development. It may be used to aid in producing more fruits in summer squash and in getting uniform growth of fruits. NAA sometimes produces increased fruit size in summer squash when applied. This is usually a result of more cell division and stretching in the fruit tissues.

MATERIALS AND METHODS

The current experiment, which has the title of Different Plant Growth Hormones on Growth and Yield of Summer Squash, was conducted in the summer months of March to May of 2024 in the Directorate of Agricultural Research, Koshi province, Tarahara, Sunsari, NARC. The research was done to determine the right way of plant hormonal practice that suits the growth and productivity of summer squash. The harvesting was done 4 times in total. Below is a discussion of the details of materials used and methods adopted in the course of the research.

The experiment was conducted at the Directorate of Agricultural Research, Province 1, Tarhara, Sunsari, NARC. The experimental site covered Tarhara, which is located in the eastern Terai of Nepal, and the field was at an elevation of 130 meters above sea level. It was situated at 26°47'45 " N latitude and 87°28'11 " E longitude. The region receives an average annual rainfall of 1435.3mm, with maximum and minimum air temperatures of 39.2 °C and 11.8 °C, respectively (DHM, 2022).

During the time that the last crop was harvested, the land was plowed well with the help of a 4-wheel tractor with a cultivator. A rotavator was used to break clods down and thoroughly till the soil. All the land was smoothed so that stubble and weeds were totally removed in the experiments. Plots were prepared in a pre-designed pattern, a bit higher to avoid flooding. A drainage trench was also cut around the trial plot area to allow water to flow effectively when it rains.

The summer squash requires a lot of irrigation during the initial stages of transplanting, and as the plants grow, they need less water. In particular, they require watering once every 20days after transplanting. It prefers the temperature of 18-35o °C. Whereas it can survive the dry conditions in its maturity, it also requires sufficient moisture in its vegetative and flowering phases. During the vegetative to flowering, the plants are maintained irrigated at least two or three times each week to guarantee optimum growth and development.

Under Randomized Complete Block Design (RCBD), there were six treatments repeated four times and used in the experiment. The experimental field was composed of 159.74 m 2. Top 24 experimental units were created, i.e., 1.2*2.5 m2 in size.

RESULTS AND DISCUSSION

The recorded values showed that the highest temperature was recorded as 40 °C on the 15th day of transplanting throughout the period of research in the months of March to June 2008. On the same note, the lowest temperature was observed on the 9th day of transplanting, i.e., 29th of March, with 12.5 oC. Based on the figures and graph, they have shown that the highest rainfall was registered as 84.1 mm on a total of 45 days during which the squash was transplanted, i.e., the 16th of May. This was the climatic condition as a whole throughout the research period, from transplanting to harvest.

Effect of hormones on the growth of plant height

The growth hormone was proven to increase the height of the squash plants, as shown in the experiments. The treatment T6, which consisted of GA3-150 ppm, produced the tallest plants in all the stages of growth. T6 plants had an average height of 48 cm at 30 DAS, and plant height gradually increased to 62 cm at 45 DAS, 62 cm, which means that they had the highest average plant height. The treatment was found to be highly superior with the greatest statistical significance at 45DAS, which implies that the treatment had a positive effect in enhancing the healthy growth of plants. Comparatively, Treatment T2 has shown equivalent results of significant plant height improvement, yet not good enough to be compared to T4. T3 attained an average height of 59 cm, which means efficient growth but not much compared to T4. The height of the plants that were subjected to treatments T1 and T2 was obtained. The T1 group averaged 56 cm, with the T2 group averaging 61.3 cm, and both recorded a huge improvement. The hormone-free control treatment, T4, was always of the shortest plant level, the average plant height was 24 cm in length, and it is clear that in order to achieve the best results in plant growth, it is important to apply the hormone. On the whole, the findings demonstrate the effectiveness of utilizing growth hormone management strategies, especially with, in appreciably growing squash and weight.

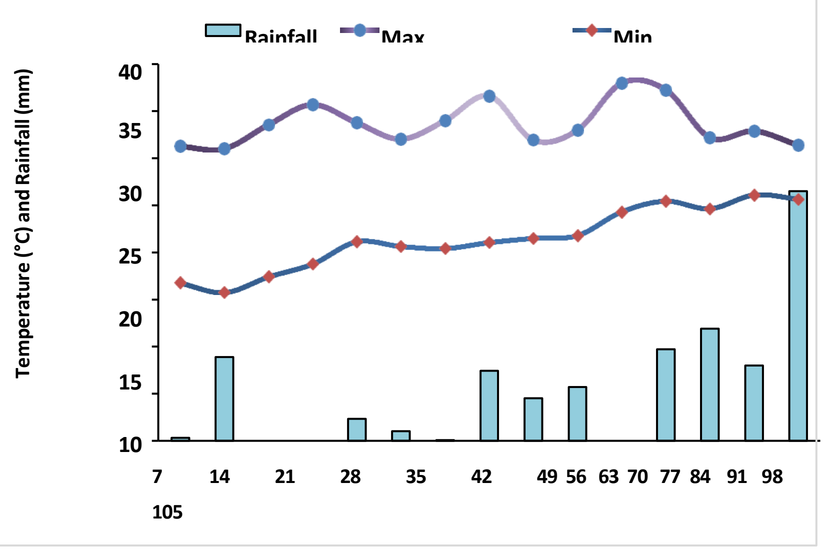

Figure 1. Climatic conditions (temperature and rainfall) during the crop period in days after sowing

Table 1. Effect of hormones on the growth of plant height

Treatment	15DAS(Average)	30DAS(Average)	45DAS(Average)
T1	29.065^{b}	39.70^{abc}	52.625^{bc}
T2	31.1^{ab}	40.95^{ab}	55.450^{ab}
T3	31.1^{ab}	40.35^{ab}	53.775^{abc}
T4	25.3^{c}	36.50^{c}	47.750^{d}
T5	29.15^{b}	37.50^{bc}	50.025^{cd}
T6	33.1^{a}	42.55^{a}	57.250^{a}
Grand Mean	29.80	39.59	52.81
CV%	7.55	5.87	5.37
SEM	0.46	0.47	0.58

Effect of hormones on the growth of branches

The experimental outcomes used to understand the influence of various doses of hormonal treatments on the development of squash primary branches were clear. T6 was the highest in all, with an average of 15.6 cm in all the stages of growth. This amounted to a total average T6 of 20.87cm of primary branches, which was much larger compared to other treatments to enhance branch development. It has been treated with T4 but was not as effective as T3. It averagely 15.6 cm primary

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branches, whereby at 15, 30, and 45 DAS, there were significant differences (F-value: ***), showing that though T3 enhanced branch growth as compared to the control level, it could not attain the level realized by T6. The intermediate levels of the branch counts were obtained with treatments T1 and T5, made up of NAA-50PPM and GA3-100 PPM. Means of T1 and T5 were 19.2 and 18cm, respectively, of the primary branches. There were considerable differences between both treatments, and the Treatment T2 and the Treatment T6, which were applied using the average counts of branch numbers of 20.875, respectively. Although such treatments were found to be superior to the control, their performance was weaker than T4. This was the case of treatment T4, where there was no hormone present, and the mean number of primary branches was 15.6. This outlines the importance of hormonal treatment in stimulating the growth of branches. In general, the findings reveal the usefulness of employing hormonal control measures, particularly when they are integrated with organic manures such as vermicompost, in enhancing a healthier extension/growth of perennial branches and general growth of fruits and plants.

Table 2. Effect of hormones on the growth of branches

Treatments	Average branches
T1	19.200[ab]
T2	18.000[abc]
T3	16.500[bc]
T4	15.600[c]
T5	18.300[abc]
T6	20.875[a]
Grand mean	18.08
CV%	11.325
SEM	0.42

Effect of the hormone on the number of fruits per plot

- The research on the impact of hormonal treatments on the quantity of fruits per plot showed that there were great differences in the number of fruits per plot at different growing stages (15, 30, and 45 days since planting, DAS).
- T6(GA3- 150 PPM) had the highest number of Fruits per plant (29), which was much higher as compared to other treatments.
- T6 has the largest number of fruits, and this value is 29 after T3 was achieved with 27.25. T4 gave a marginal average of 14 fruits in a single plot, whereas all the treatments gave the highest average.

- These were followed by T3(NAA-150PPM) and T1 (NAA-50PPM), which averagely 27.25 and 24 pods respectively over stages.
- The relationship between the number of fruits and the control treatment (T4) was similar, with the lowest fruits registered at every stage and an average of 14 fruits per plot.
- The advantage of such treatments in terms of the number of fruits per plot emphasizes the significance of the fruit development subject.

Effect of hormones on the growth of fruit length

The research conducted based on the comparison between the effects of different treatments on different growth stages of fertilizers on the length of fruit (cm) indicated a significant difference, especially at 30 DAS. The pod length did not vary much in most of the treatments at 45 DAS, except in the control treatment (T4), which had significantly the shortest length (14.53 cm) as compared to T6 GA3-150ppm, which recorded the longest length of fruit at 23.6 cm, which was closely followed by other treatments. Greater differences were also detected once the plants grew. T6 remained the leader in the highest length of fruits at 23.6 cm, quite above all other treatments. This was continued until T6 recorded the highest length of fruits, which averagely at 23.6 cm, respectively.

Table 3. Effect of hormone on the growth of the Average no. of fruit/ plot

Treatment	Average no. of fruit/ plot
T1	24.00^{ab}
T2	19.50^{b}
T3	27.25^{a}
T4	14.00^{c}
T5	20.50^{b}
T6	29.00^{a}
Grand Mean	22.375
CV%	15.42277
SEM	0.70

Average fruit length at all developmental stages of T6 was recorded at 23.6 cm, which was the highest amongst all treatments. Comparatively, treatments T3, T1, T2, T3, T5 were also rated relatively high in pod, similar to mitra, and the mean length of fruit in each of them was 23.6 cm, which was very not from those of treatment T6. On the contrary, the control treatment (T4) recorded the shortest fruits in every stage, with an average length of 14.53 cm. This evidence reveals the high potential of the treatment using hormones and especially vermicompost-enriched treatment (T6) on improving the length of the fruits during the growth period of the crop. It brings out the need to use hormonal approaches in ensuring maximum crop growth and productivity.

Table 4. Effect of hormones on growth of fruit length

Treatment	Average fruit length
T1	22.000[a]
T2	16.550[de]
T3	19.10[bc]
T4	14.525[e]
T5	18.050[cd]
T6	21.450[ab]
Grand mean	18.6125
CV%	8.547685
SEM	0.32

Effect of hormones on the growth of fruit diameter

The research analyzing the outcome of the influence of the various hormonal treatments on the pod diameter (cm) at different stages of growth (15, 30, and 45days after sowing, DAS) displayed the severity of the differences among the treatments. T6 (GA3-150PPM) generated the highest fruit diameter (7.74 cm) compared to the control (T4), which had a 3.78 cm diameter; this was greatly significant. TL maintained the lead in fruit diameter in all stages as the crop grew and recorded 6.27 cm fruit diameter, which made it to give average fruit diameter of 7.74 cm, the largest among all treatments.

The other treatments, which were T1(NAA-50ppm), T5(GA3-100ppm), exhibited fairly high fruit diameters as well, with the mean of 6.275 and 5.775, respectively. The control treatment (T4), on the other hand, reported smaller fruit diameters at every given time in the study period, and its concentration produced an average fruit diameter of 3.783 cm.

These results demonstrate that the application of fertilizers, particularly the enriched treatment (T6), significantly enhances fruit diameter at various growth stages. The findings highlight the importance of appropriate hormones in improving fruit quality and overall crop performance.

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Table 5. Effect of hormones on growth of fruit diameter

Treatment	Average fruit diameter
T1	6.275[b]
T2	4.725[bc]
T3	4.880[bc]
T4	3.783[c]
T5	5.775[b]
T6	7.740[a]
Grand mean	5.529667
CV%	21.84
SEM	0.25

Effect of hormone on fruit weight per plot (kg)

The research on the influence of various hormonal therapies on the fruit weight per plot(kg) at different stages of growth revealed that there was significant variation between the different treatments. T6 (GA3-150PPM) recorded the highest weight of fruits per plot of 8.52 kg, and this was highly significant over the control (T4), 4.90 kg. T3 remained a top average fruit weight per plot leader (7.69 kg) as the crop grew. This was followed by other treatments (T3(NAA-150ppm), T1(NAA-50ppm) which recorded relatively high averages of fruit weight per plot (7.69 kg and 7.65 kg, respectively).

Table 6.Effect of hormone on fruit weight per plot (kg)

Treatment	Average FWPPKG
T1	7.65000[a]
T2	5.59250[bc]
T3	7.68625[a]
T4	4.90250[c]
T5	6.23000[b]
T6	8.52250[a]
Grand mean	6.763958
CV%	10.19
SEM	0.14

On the contrary, control treatment (T4) recorded the minimum value of fruit weight per plot (kg) across the experiment, and the value produced an average fruit weight per plot (kg) of 4.9 kg. treatment (T6), which significantly improves fruit weight per plot (kg) at different growth stages. The results indicate the significance of proper hormones in enhancing the quality of fruits.

Effect of hormone on average fruit weight

The research on the influence of differing hormonal regimes on the weight per single fruit (grams) of different growth periods, 15 and 30 days after sowing and 45 days after DAS, found significant differences. The fruit produced by T 6 (GA3-150PPM) was heaviest an average fruit weight being 389.2 grams, which was much bigger than the rest of the treatments.

Table 7. Effect of hormone on average fruit weight

Treatments	Average fruit weight, g.
T1	312.325^{ab}
T2	291.000^{bc}
T3	320.025^{ab}
T4	254.500^{c}
T5	307.575^{b}
T6	346.550^{a}
Grand mean	305.33
CV%	8.31
SEM	5.17

Other treatments, though, like T3 (NAA-150 PPM) and T1(NAA-50 PPM), had significant fruit weights, but this was always lower compared to the results that were obtained in T6. The maximum, minimum, and average weights of fruits of the T3, T1 and T2, and T5 were 320.025 grams, 312.325 grams and 291 grams, and 307.575 respectively. Conversely, fruit yield was the least in the control treatment (T4) over the whole time.

CONCLUSION

The Plant growth hormonal practices also had a great influence on the growth, yield, yield attributes, and economic factors of the summer squash. One of the methods in which application of GA3-150ppm, the recommended dose, i.e., (280:180:80) N: P_2O_5: K_2O kg/ropani, applied plot amounted to significantly high fruit weight.. Moreover, growth and yield attributes also offered improved outcomes when NAA-100ppm and GA3 were used. There was also a high net return and benefit-cost ratio of the appropriate use of these hormones compared to other sources of fertilizer.

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