# Enhancing Productivity and Quality of Parsley (*Petroselinum crispum* (Mill.) Nyman ex A. W. Hill) by Plant Growth Regulator Application

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## Abstract

Plant growth regulators enhanced the growth and yield parameter of the most herbaceous plant. It was unknown how different plant growth regulators affected parsley growth, yield, and quality. As a result, a study was carried out to assess the effects of several plant growth regulators and identify which treatment had the best influence on parley growth, yield, and quality. The treatment includes the following plant growth regulator (100 ppm Ethrel, 100 ppm GA3, 100 ppm PBZ and 100 ppm GA3 + 100 ppm PBZ) and a control treatment without plant growth regulator. A Completely Randomized Design (CRD) comprising five treatments with three replicates was used to collect growth, yield, and quality data. The plant growth regulator greatly influenced the growth parameter of the parsley plant. It also influenced all yield parameters as well as the quality but except for pH. Thus, the application of GA3 best enhances the maximum plant height, whereas PBZ application best in increasing the maximum number of leaves and stem diameter. In terms of yield and yield components, PBZ revealed best in increasing the maximum yield in terms of root length, root fresh weight, and fresh weight of the plant. Furthermore, a combination of PBZ and GA3 best enhances the total soluble solid but not in pH of the parsley plant.

**Keywords:** Ethrel, gibberellic acid, paclobutrazol, parsley, plant growth regulator.

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## INTRODUCTION

The plant *(Petroselinum crispum* (Mill.) Nyman ex A. W. Hill) belongs to the Apiaceae family. It's a short-lived biennial or perennial plant with a short life cycle. Parsley is grown for its leaves, used as a garnish or condiment, either fresh or dried. Due to its essential oil content of 0.3 percent in the leaf and 2-7 percent in the fruit, parsley possesses antispasmodic, carminative, and diuretic properties. Additionally, parsley is a good source of carotene (pro-vitamin A), vitamins B1, B2, and C, as well as iron and other minerals (Osman and Abd El-Wahab, 2009).

Due to its large foliage and root mass, parsley generally requires a tremendous amount of fertilizer to grow. The yield acquired from overwintering plants may rely upon the applied cover and fertilization (Rumpel et al., 1995; Biesiada and Kolota, 1996). The utilization of PGRs helps overcome the ever-increasing demand for medicinal plants through increase production as expected. It is well-recognized that growth regulators are the best agricultural strategies for encouraging and increasing plant development in various plants.

Growth regulators are required to determine physiological processes, growth, differentiation, and development (Davies, 2010). The hormone is just viable within a certain amount. Too high concentrations can repress plant growth, even lethal, while less optimum concentration may bring ineffectiveness. Synthetic growth hormone can enhance crop yields, both through vegetative propagation and embryogenesis (Gana, 2011). The influence of PGRs on parsley growth, yields, and quality is not well documented in some literature. Henceforth, this study aimed to determine the impact of different growth regulators on the growth, yield, and quality of parsley and determine which treatment gave the best result concerning growth, yield, and quality of parsley.

## MATERIAL and METHOD

### Seed Preparation and Seedling Establishment

The study was conducted at the nursery area of the Department of Horticulture, College of Agriculture and Food Sciences, Visayas State University. Visca, Baybay City, Leyte. The seeds were sown directly in seedling tray and transplanted after 15 days to a plastic pot of 8-inches in diameter. The newly planted seeds were watered immediately to avoid wilting. However, replanting was done one week after transplanting. Each pot contained a media of carbonized rice hull and garden soil (1:1) and was placed in the site where the field trial was finally conducted. All recommended cultural management practices were carried out during the growing seasons.

### Experimental Treatment and Design

A completely randomized design (CRD) with five treatments and three replications was used in this experiment. There were 75 pots used, with 15 pots for each treatment and 5 pots for each replication. To-control (no PGR), T1-100 ppm Ethrel, T2-100 ppm GA3, T3-100 ppm PBZ, and T4-100 ppm GA3 + 100 ppm PBZ are the treatments.

### Application of Treatment

Different plant growth regulators were used after fifteen days of transplanting. The following concentration (100 ppm Ethrel, 100 ppm GA3, 100 ppm PBZ and 100 ppm GA3 + 100 ppm PBZ) and a control treatment without using a plant growth regulator were used. The application of ethrel and GA3 was done through foliar, whereas PBZ was applied by drenching.

### Weeding and Cultivation

Cultivation was done using a hand trowel to loosen the soil and provide aeration in pots. During cultivation, the weeds were removed from the experimental pots to prevent competition for nutrients and sunlight. Weeding was done twice a week in the experimental pots.

**Pest and Disease Control**

The plant was closely monitored for possible infestation. Physical and mechanical measures were undertaken by picking and crushing the insects infecting parsley plants.

**Harvesting**

The plant was harvested after one month and two weeks after transplanting. Growth parameters were evaluated every week, and the yield was measured during the termination of the study.

**Data Gathered**

The data collection was done every week and during the termination of the study. The following parameters were gathered:

**Plant height (cm) –** was measured using a meter stake from the plant base up to the apical meristem weekly.

**The number of leaves**- was determined by counting the leaves per plant at weekly intervals.

**Stalk diameter (cm)** –was determined using a digital Vernier caliper per plant per replication, and the means were calculated.

**Stem diameter (cm)** –was measured using a digital Vernier caliper from the base of the plant up to 1 inch of the stem.

**Stem length (cm) –**was done by measuring the base of the stem up to the top using a ruler.

**Root length (cm)** –was determined by measuring the base of the root up to the tip of the root using a ruler.

**Fresh weight of the roots (g)** - The average weight of the individual roots was measured using a digital weighing scale in grams by weighting five randomly taken parley roots from each replication, and the means were calculated.

**Fresh weight of the plant (g) -** The average weight of the individual leaves was determined in grams using a digital weighing scale by weighing five randomly selected parsley stalks with leaves from each replication and calculating the means.

**pH** – 10 grams of parsley stalk with leaves from each replication were randomly taken and juice was extracted using a blender with the addition of 50 ml water. The pH was taken using the Hanna pH meter and was recorded.

**Total Soluble Solid ($^{0}$Brix) –** Total soluble solids (TSS) were measured using 10 g of parley stalk with leaves per replication in all treatments. This was extracted using a blender with 50 ml water and strain using a clean cloth to separate the juice. TSS in Brix% was measured by a hand refractometer standardized with distilled water by placing 3 drops of juice on the instrument's lens to take the reading.

## Climatic Data

Climatic data such as temperature (maximum and minimum), relative humidity, day length, sunshine duration, and rainfall were gathered at the Philippine Atmospheric, Geophysical and Astronomical Services Administration, Visayas State University, Visca, Baybay City, Leyte.

## Data Analysis

The data were analysed by Analysis of Variance (ANOVA) using Statistical Tool for Agricultural Research (STAR) software and treatment means were separated by the Least Significant Difference (LSD) test at a 0.05% level of significance.

# RESULTS and DISCUSSION

## Plant height

The plant height of parsley was significantly influenced by the application of the plant growth regulator at a weekly interval (Figure 1). There was a linear increase during the growth stages of the plant. The application of GA3 markedly increased the plant height of the plant from week one up to the harvesting. However, ethrel retard the growth during the first up to harvesting. The PBZ application followed this. The increase in plant height might be because of the effect of GA3 on cell division and cell enlargement, and GA3 stimulated the growth and expansion of cells by expanding the wall plasticity of cells (Saleh, 1990; Matlub et al., 1964). The promotive effect of gibberellins on growth possibly increases the auxin level of tissue or improves the conversion of tryptophan to IAA, which causes cell division and cell elongation (Kuraishi and Muir, 1964).

According to Kumar et al. (2010) that ethrel had dwarfing effect on plants. He further stated that a lower concentration of ethrel was less effective in reducing height, but a higher concentration (400 ppm) significantly reduced plant height (66.12 cm). The same result was also observed by Gautam et al. (2006) in chrysanthemum in the use of ethrel.

The plants with the paclobutrazol application were likely to have lower average height growth than the controlled plants. This was due to the effect that was caused by paclobutrazol, which delayed the production of gibberellin. The plant height was the result of apical meristem cells division and extension stimulated by (growth regulator) gibberellin, so the absence of gibberellin in plants might cause dwarf-plant growth. Gibberellin activities, stimulating meristematic cell division and growth, were prevented by paclobutrazol (Runtunuwu et al., 2011). This will reduce cell division and extension speed so that the growth of plant height was delayed (Nasrullah et al., 2012).

## Number of leaves

The number of leaves was significantly affected by the application of different growth hormones (Figure 2). Plant treated with PBZ obtained the maximum number of leaves per replication as compared to other treatments. However, a minimum number of leaves were observed in the control treatment and the application of ethrel, the combination of PBZ and GA3 from the first week until harvesting. A linear increase in the number of leaves was observed on a weekly interval.

The result coincided with the study of Lolaei et al. (2012); their study demonstrated that the utilization of 60 and 90 mg L-1 of PBZ enhanced the number and area of the leaf yet reduced petiole length.

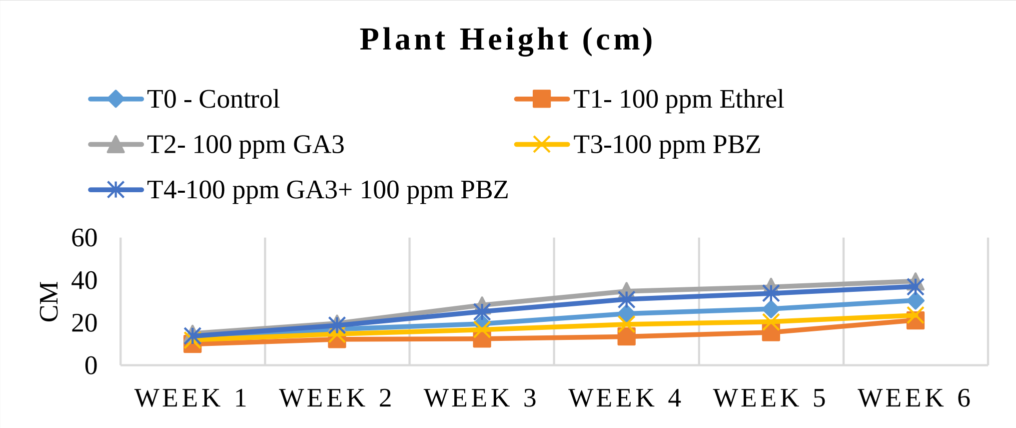


**Figure 1.** Plant height of parsley as affected by different plant growth regulators.

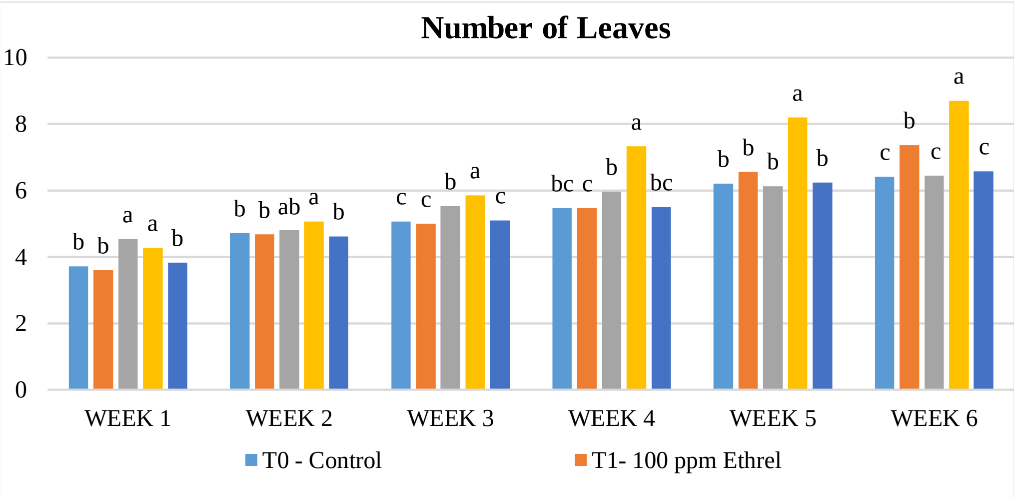


**Figure 2.** The number of leaves of parsley is affected by different plant growth regulators.

**Stem Diameter**

The stem diameter of parsley was significantly affected by applying different plant growth regulators from the first week up to the sixth week (Figure 3). Paclobutrazol consistently increased the stem diameter throughout the study as compared to control. Paclobutrazol treatment remarkably increases the thickness of the cortex, vascular bundles, and pith diameter resulting in thicker stems (Tsegaw et al., 2005). This modification might be attributed to the radial expansion of cells because of decreased endogenous activities in response to the treatment. On the other hand, GA limits the extent of radial expansion of plant organs, thereby increasing the stem diameter (Wenzel et al., 2000).

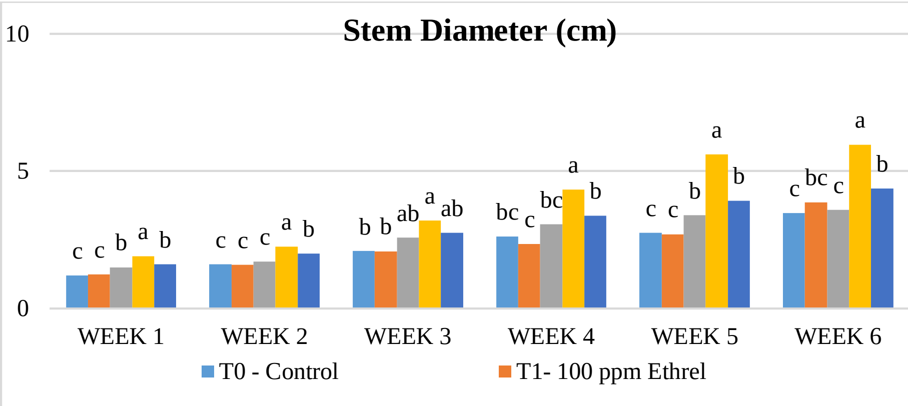


**Figure 3.** The stem diameter of parsley is affected by different plant growth regulators.

**Yield and Yield Components**

The yield and yield components parameter was significantly affected by applying different growth regulators (Figure 4-5). The application of PBZ and the combination of PBZ and GA3 significantly increased the diameter of the stalk compared to the control (Figure 4). Likewise, the application of ethrel, GA3, and control has a longer stem length while PBZ and combination treatment were obtained the shorter. The results are in agreement with the findings of Feucht and Watson (1958). They stated that the application of gibberellic acid increased the internode length of the seedlings and increased the number and size of cells. Cell elongation is predominantly responsible for the growth in internode length.

The reduction in stem length with the application of paclobutrazol may have been attributed to increases in stem diameter. Paclobutrazol contents of synthetic organic compounds could decrease the extension cell on sub-apical meristem and lessen the stem extension speed on responsive plants (Wattimena, 1989).

In the present study, the root diameter significantly increased by applying PBZ (Figure 6). PBZ increased the root diameter by inflating the cortex's width and enhancing the formation of more secondary xylem vessels (Tsegaw et al., 2005). According to Barnes et al. (1989), PBZ increased root diameter in soybean by increasing the size of cortical parenchyma cells.

PBZ also enhanced the root length of the study as compared to the control (Figure 8). Jaleel et al. (2007) reported that root growth might be connected to the increased partitioning of assimilates towards the roots because of decreased need on the shoot. On the other hand, increasing root growth by PBZ is additionally associated with the enhanced level of endogenous cytokinin (Fletcher and Arnold, 1986). In addition, inhibition of GA and increase of cytokinin and ABA might be the reason for the increased root length in the triadimefon treated plants. It might be related to larger parenchyma cells and the promotion of radial cell expansion (Jaleel et al., 2007).

The application of paclobutrazol enhanced the root's fresh weight, and the plant's weight also increased with PBZ alone and PBZ and GA3 combination (Figure 6). The highest increase was observed by paclobutrazol application. Paclobutrazol treatment improved the fresh weight in drought stress. A similar case of improvement in fresh weight was stated in Catharanthus plants in salt stress (Jaleel et al., 2007a).

The increase in yield characters caused by the use of PGRs could be attributed to the stimulatory effect of growth regulators. This induces many reproductive sinks, resulting in increased carboxylating enzymes and higher photosynthetic rates with greater translocation and accumulation of metabolites in the sink (Nehara et al., 2006).

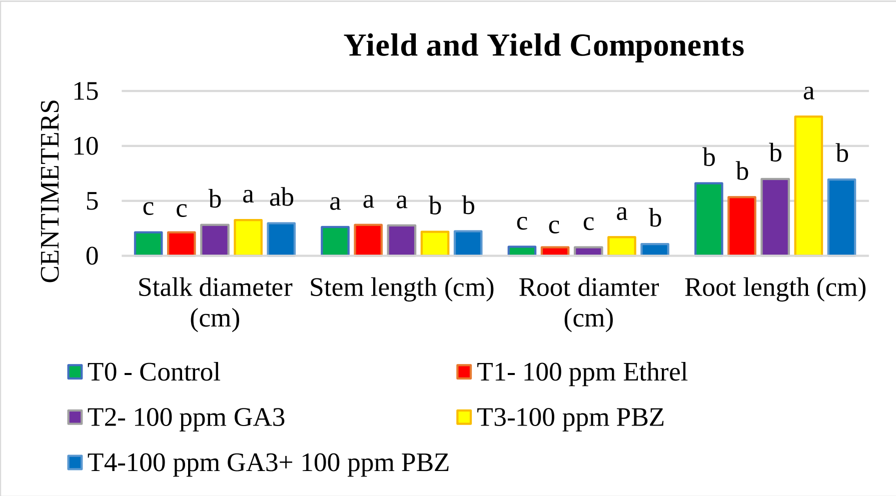


**Figure 4.** Yield and yield components of parsley as affected by different plant growth regulators.

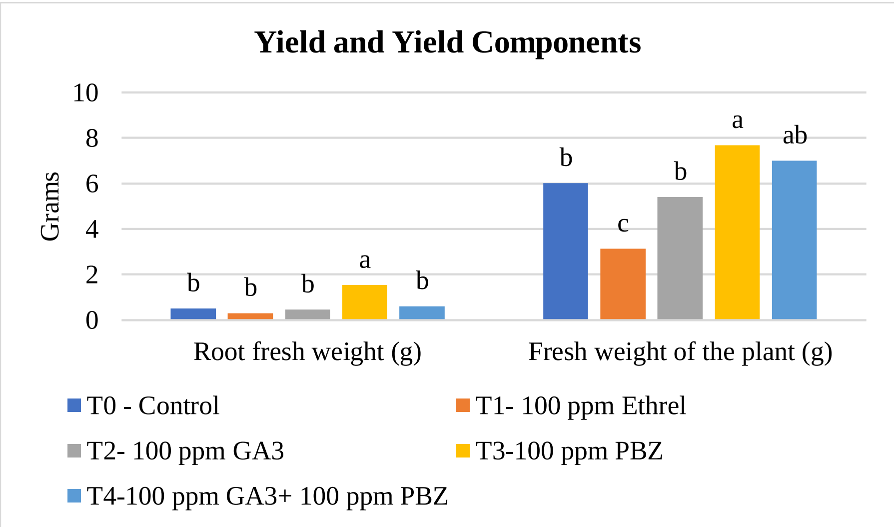


**Figure 5.** Yield and yield components of parsley as affected by different plant growth regulators.

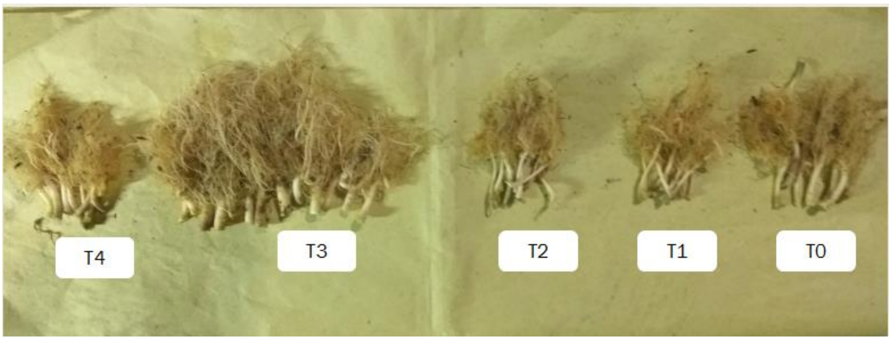


**Figure 6.** Roots of Parsley as affected by different plant growth regulators.

## pH and TSS

pH was not affected by the various plant growth regulator applications, but the TSS was influenced by the other treatments (Figure 7). All plants treated with PBZ increased the TSS of the plant as compared to control. Yeshitela et al. (2004) state that fruit quality improvements concerning TSS, TSS to acid ratio, total sugars, and reducing sugars in response to PBZ treatments can be related to assimilate partitioning of the plant. Assimilate demand is unidirectional to developing fruit. PBZ-treated trees had higher fruit quality attributes due to the significant suppression of vegetative growth. However, the result of this study was inconsistent with the result of Benjawan et al. (2007).

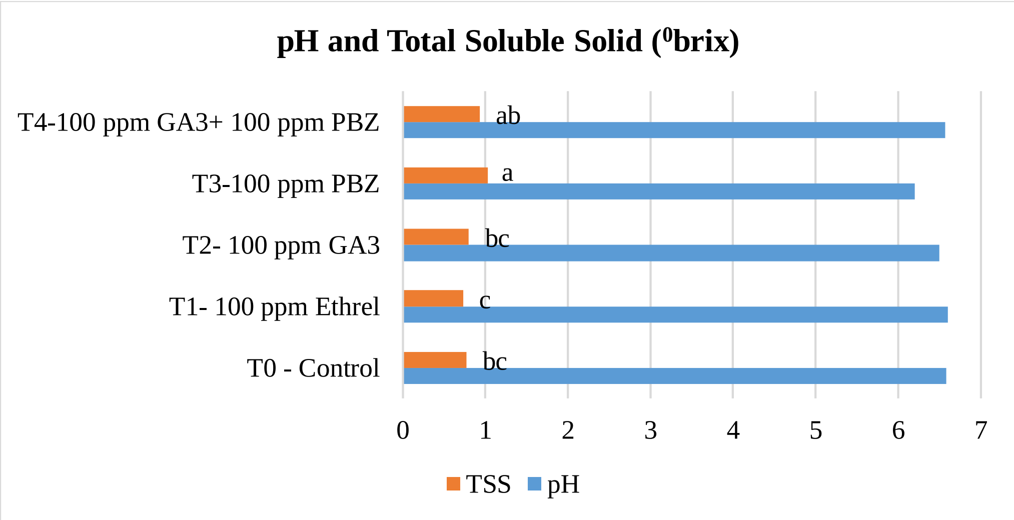


**Figure 7.** pH and total soluble solid of parsley as affected by different plant growth regulators.

## Climatic Data

During the conduct of the study, there were fluctuating trends of temperature, sunshine duration, and relative humidity (Figure 8-9). On the other hand, there was a decreasing trend in rainfall (Figure 10). However, in terms of day length, there was an increasing linear growth observed throughout the growing period of the plant (Figure 11).

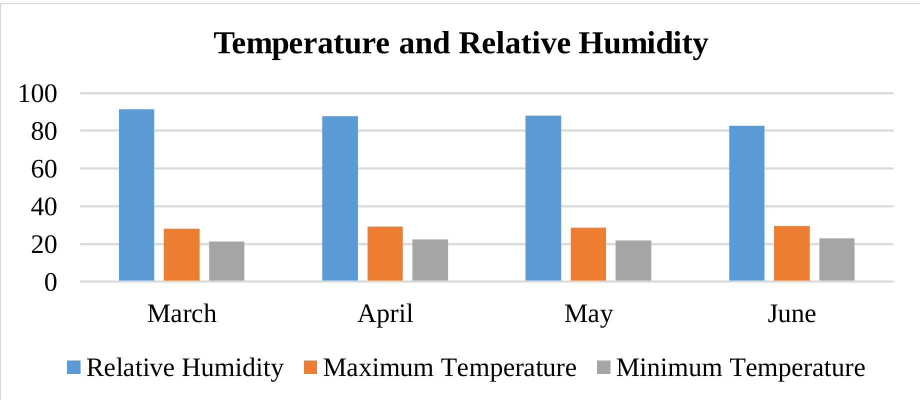


**Figure 8.** Data on maximum and minimum temperature and relative humidity during the conduct of the study.

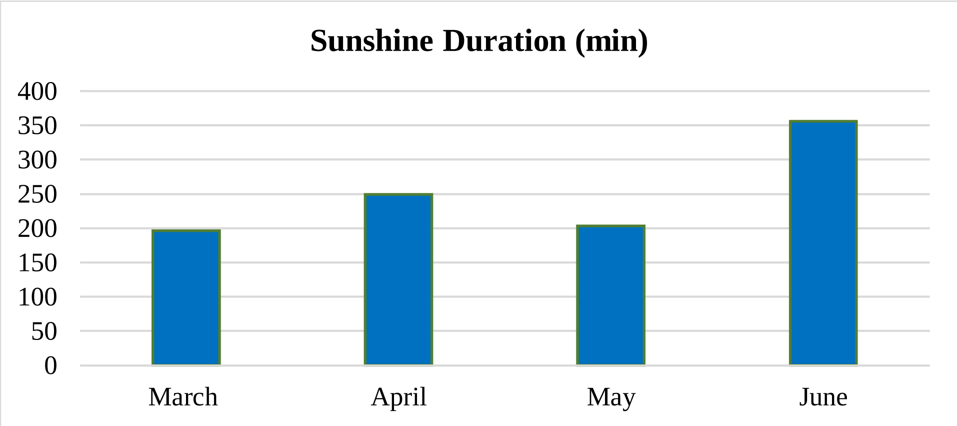


**Figure 9.** Data on sunshine duration during the conduct of the study.

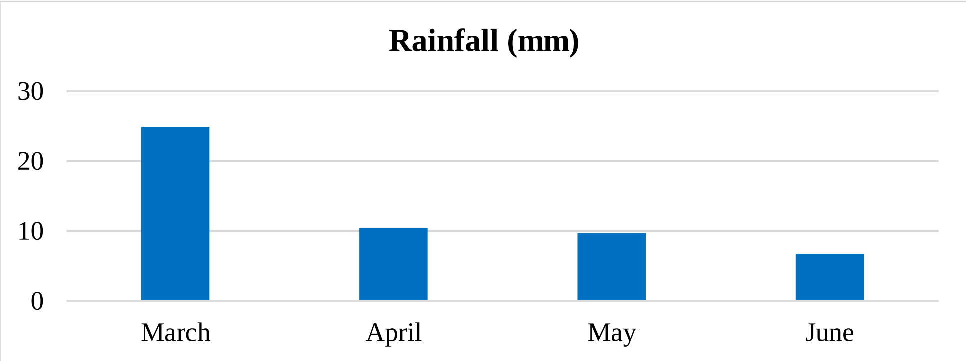


**Figure 10.** Data on rainfall during the conduct of the study.

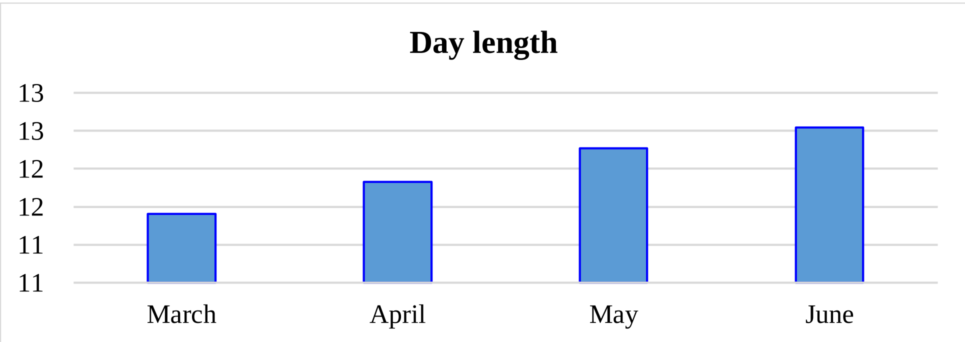


**Figure 11.** Data on day length during the conduct of the study.

## CONCLUSION

The growth regulator greatly influenced the growth parameter of the parsley plant. It also influenced all yield parameters as well as the quality but except pH. Application of GA3 is best in increasing the plant height of the parsley, plant but in terms of the number of leaves and stem diameter, PBZ is the best treatment. However, in terms of yield and yield components, PBZ yielded the best result in terms of root length, root fresh weight, and fresh weight of the plant. On the other hand, PBZ and a combination of PBZ and GA3 show the best result in enhancing the TSS but not the pH.

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