Pertanika J. Trop. Agric. Sci. 49 (3): 1231 - 1246 (2026)

TROPICAL AGRICULTURAL SCIENCE

Journal homepage: http://www.pertanika.upm.edu.my/

# Field Performance of Hybrid Corn Varieties (*Zea mays*) Applied with Gibberellic Acid 3 (GA 3) at Cabagan, Isabela, Philippines

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## ABSTRACT

Corn (*Zea mays*) world's most productive crop, serving multiple uses in livestock feed, biofuel, and ethanol production industries. The study aimed to evaluate the performance of hybrid corn varieties applied with Gibberellic Acid 3 (GA 3). It was employed in Randomised Complete Block Design (RCBD) with a 4 × 2 factorial arrangement at eight treatment combinations. Factor A consisted of four different GA3 concentrations: Without GA 3 (WOG), 175 ml of GA 3 per hectare (175GA3), 200 ml of GA 3 per hectare (200GA3), and 225 ml of GA3 per hectare (225GA3). Factor B included two corn varieties: NK8840 (NK8) and NK6410 (NK6). Data collection focused on growth and yield parameters for each treatment combination, analysed using two-way ANOVA to assess the interaction of GA3 concentration and corn variety. Treatment differences were determined by Tukey's HSD test, with P-values ($P < 0.05$) obtained for plant height (PH), leaf count (LC), ear length (LE), ear diameter (ED), biomass yield (BY), weight of kernels (WK), and computed yield (CY). Results indicated that GA3 significantly affected BY and CY, with the 200 ml GA3 treatment yielding better results than other concentrations. While specific parameters did not show statistical significance, NK6 outperformed NK8 in terms of BY and CY.

ARTICLE INFO

*Article history:*
Received: 12 June 2025
Accepted: 19 April 2026
Published: 12 June 2026

DOI: https://doi.org/10.47836/pjtas.49.3.12

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e-ISSN: 2231-8542

The application of 200 ml GA3 resulted in the highest recorded yield and enhanced crop performance, suggesting it as a viable strategy for optimising corn production and improving farmers' economic returns.

*Keywords:* Ear, gibberellic acid 3, growth, hybrid corn, performance, tassel

## INTRODUCTION

Hybrid corn (*Zea mays*) is recognised as one of the most important staple food crops globally, particularly in the Philippines. It serves as a primary source of food, feed, and industrial raw materials (Rustia et al., 2022; Solaimalai et al., 2020; Shiferaw et al., 2011). Despite its significance, low productivity remains a persistent challenge for farmers and the agricultural sector (Giller et al., 2021; Shiferaw et al., 2011). According to the Department of Agriculture Regional Field Office III, approximately 600,000 farm households depend on corn as their main source of income. Isabela and Bukidnon are the leading producers of corn in the Philippines, contributing 1.8 million metric tons to the national output (Philippine Competition Commission [PCC], 2021). Gibberellic acid (GA3) is a plant growth regulator that presents a promising solution to overcoming productivity challenges and improving corn yields. Camara et al. (2018) reported that GA3 significantly enhances plant growth and development while being economically viable for production. Isabela has been recognised as the top corn-producing province, contributing between 9% and 16% of the country's overall corn output (Ocampo et al., 2015; Reyes et al., 2009). However, recent projections indicate a substantial decline in corn production. The Philippine Statistics Authority (PSA) (2024) reports that standing crop estimates from April to June 2024 have decreased by 19.1% compared to 2023, dropping from 1.47 million metric tons to 1.19 million metric tons. This decline is attributed to adverse weather conditions, including dry spells early in the year and severe flooding in September and December, both of which significantly impacted crop yields. As a result, Isabela has fallen to the second position nationally in corn production.

To address these challenges and enhance corn productivity, there is growing interest in plant growth regulators (PGRs), particularly gibberellic acid (GA3). GA3 is an essential plant hormone known for stimulating stem elongation, leaf expansion, and overall plant vigour (Al-Shaheen et al., 2018; Gao et al., 2020). Numerous studies confirm that applying GA3 enhances the growth and yield of corn across various environmental conditions. However, its effectiveness depends on several factors, such as planting density. Optimising plant spacing is crucial for improving light interception, nutrient availability, and creating a favourable microclimate, ensuring that each plant has access to the necessary resources to benefit fully from GA3 (Anjum et al., 2017; Camara et al., 2018; Majender et al., 2015). Overcrowding can intensify competition among plants, hindering their ability to utilise

GA3 effectively. Conversely, appropriate spacing can substantially enhance productivity (Noda-Leyva & Martín-Martín, 2017).

On the other hand, despite the rising popularity of GA3, further research is needed to understand its interaction with various planting distances, particularly in soil conditions like those found in clay-dominated fields. Additionally, GA3 has the potential to enhance crop performance under abiotic stress. For example, the external application of GA3 has been shown to improve corn growth under salinity stress by increasing chlorophyll content, reducing sodium uptake, and enhancing potassium uptake, ultimately leading to improved photosynthetic activity and greater resilience (Mukkarram et al., 2021; Shadzad et al., 2021). Further investigation into the combined effects of GA3 and foliar fertiliser applications revealed elevated antioxidant enzyme activities, reduced oxidative damage, and improved nutrient uptake, highlighting its potential as a protective agent in adverse conditions (El-Nwehy & Afify, 2023). Similarly, a study on GA3 and mepiquat chloride (MC) found that a foliar fertiliser with 100 ppm GA3 resulted in approximately a 33% increase in corn yield compared to the control, demonstrating its role in reducing stress-induced yield losses.

GA3 promotes and encourages cell elongation and division, which ultimately boosts overall yield (Ayyub et al., 2013; Zaman et al., 2015). Findings indicate that the application of GA3 can positively influence crop productivity under various irrigation conditions. Significantly, when applied during optimal irrigation periods, GA3 has shown the potential to yield the highest crop output. Importantly, even under drought stress, the application of GA3 has proven effective in enhancing crop resilience and achieving higher yields under ideal irrigation situations (Sawar et al., 2017). This capability underscores GA3's significant role as an important agricultural strategy, enhancing productivity under typical conditions and strengthening corn’s ability to withstand drought. Furthermore, it has been demonstrated that GA3 improves seed germination and growth of corn in saline conditions, indicating its ability to help crops endure environmental stresses (Ge et al., 2023; Rauf et al., 2022).

Hybrid corn varieties have become the preferred choice for farmers due to their remarkable qualities, such as resistance to insect pests and diseases, and their adaptability to environmental conditions. While hybrid corn has played a leading role in advancing agricultural technology, its development and widespread adoption have also inadvertently contributed to current challenges within the corn farming sector (Ramey, 2010).

Current research advances provide field-based, site-specific evidence on how GA3 concentrations influence the productivity of hybrid corn varieties under real agricultural conditions. In contrast to previous studies that focused on single varieties, controlled environments, or stress simulations, this research aims to identify variety characteristics and optimal GA3 applications that improve performance amidst climate disruptions. This study aims to make the GA3 application more practical, cost-effective, and applicable for farmers, improving our understanding of its role in corn growth. The anticipated outcomes will offer valuable insights into GA3 as a plant growth regulator, helping farmers determine the optimal concentration for their specific hybrid corn varieties.

## METHODOLOGY

### Study Area

The study was conducted at the Experimental area of Isabela State University, Cabagan Campus, located in Cabagan, Isabela, Philippines. This location, found at a torrid zone with a 17.4144° N latitude and 121.7670° E longitude, experiences high temperatures, which is characteristic of the Philippines. The experiment was carried out over the dry season from March 2023 to July 2023. This month, prolonged heat, low humidity, or limited rainfall could have amplified or suppressed GA 3 effects, so the observed growth and yield may differ under wet or cooler seasons.

### Treatments, Experimental Design, and Soil Sampling

The field trials covered 341 square meters, divided into three blocks, each subdivided into 8 equal plots measuring 3 m × 3 m with 1.0 m alleyways between blocks and plots. Soil samples were collected at a depth of 6-8 inches, with composite samples representing the entire area. Following debris, weed, and topsoil removal, samples were collected using a shovel, bolo, and post hole digger, then transported in pails. The samples were pulverised and air-dried for 7 days. Uniform 1-kilogram samples were obtained using a quartering technique and sent to the Department of Agriculture-Soil Laboratory-Cagayan Valley Research Centre (DA-SL-CVRC) in San Felipe, Ilagan, Isabela, for analysis. Based on the soil analysis recommendations, detailed in Table 1, both inorganic and organic fertilisers were applied. Organic fertilisers, specifically carbonised rice hull and vermicompost, were administered at 450 grams per plot.

Table 1
*Mode of application, type and rate of fertiliser applied in the study*

| Mode of Application | Type of Fertiliser | Rate of Application |
|---|---|---|
| Basal | Organic Fertiliser (Carbonised Rice Hull and Vermicompost) | 450 g per plot |
| | 14-14-14 (Complete Fertiliser) | 256.95 g per plot |
| Side Dressing | 46-0-0 (Urea) | 58.5 g per plot |
| | 0-0-60 (Muriate of Potash) | 31.5 g per plot |

*Note.* This table is the result of soil analysis of the Department of Agriculture-Soil Laboratory-Cagayan Valley Research Centre (DA-SL-CVRC) in San Felipe, Ilagan, Isabela

Inorganic fertilisers, including Urea (46-0-0), Muriate of Potash (0-0-60), and Complete Fertiliser (14-14-14), were applied at rates of 58.5 grams, 31.5 grams, and 256.95 grams, respectively.

The experiment was structured as a 4 × 2 randomised complete block design (RCBD) using a factorial approach. Factor A evaluated the effects of different durations of drought and flood stress, consisting of the following treatments: A1 - Without GA3 (WOG), A2 - 175 ml of GA3 per hectare (175GA3), A3 - 200 ml of GA3 per hectare (200GA3), and A4 - 225 ml of GA3 per hectare (225GA3). The selected GA3 concentrations were chosen because they are within agronomically proven, safe, and cost-effective ranges that enhance corn growth without causing abnormal elongation or yield reduction. These concentrations were intended to capture the most practical and effective GA3 response under field conditions, ensuring both biological effectiveness and applicability for farmers. The control group, designated as A1 in the experiment, served as a baseline reference point against which the other treatment groups were compared. A1 - Control refers to the plants that were not treated with GA3. The purpose of the control group was to provide a standard for comparison, enabling an accurate assessment of the effects of the applied treatments.

On the other hand, Factor B represented the different hybrid varieties of corn used in the study. The first variety, NK8840 (NK8), matures in 115-120 days after planting (DAP) and has a yield potential of 12 metric tons per hectare (MT/ha). This variety is well adapted to the Isabela, Cagayan Valley Region, particularly in Upper Vega, Ilocos Region, and Central Luzon. It is noted for its better drought resistance and ease of dehusking and harvesting. The second variety, NK6410 (NK6), matures in 100-105 DAP and also has a potential yield of 12 MT/ha. NK6410 is suitable for a wider range of regions, including Lower Vega in the Cagayan Valley, Ilocos Region, Central Luzon, South Luzon, Bicol Region, and Mindanao Low Elevation. This variety is recognised for producing high-quality grain and its desirable field performance, making it easy to shuck and harvest. To maintain control of the experiment and enable a thorough study, the selection focused exclusively on these two hybrid varieties.

### Planting, Planting Materials, and Crop Management

The materials needed to implement the study were procured from an Agricultural Supply store in Ugad, Cabagan, Isabela, such as hybrid corn seeds, fertilisers like Complete, Urea, and Muriate of Potash and insecticide, while GA 3 was obtained in authorized online retailer. Other items, including vermicast, wheelbarrow, hand tractor, placards, gardening tools, pegs, meter stick, and sprayer, were borrowed from the school nursery.

The land preparation operation started with ploughing at a double-pass using a four-wheeled tractor, followed by harrowing one week prior to planting. Any foreign materials and weeds were removed. The research areas were then divided into three columns and eight rows, measuring 3 × 3 meters per plot. The soil surface was flattened using a rake before planting started.

In furrows, Hybrid corn seeds were sown at a depth of 2 to 5 cm, a total of 130 seeds per plot accommodating 10 rows, with 13 hills per row each subplot, To assure the high germination two seeds per hill was planted while it maintained the spacing of 20 cm between hills and 25 cm between rows, However during the conduct of study, poor germination was observed, particularly in NK6410 variety, replanting at 7 and 15 days after sowing (DAS) was conducted. This was performed by filling any vacant hills to ensure the uniform density across all the plots, an important factor for reliably evaluating the effects of the GA 3 treatments. Patchy plant stands can lead to uneven competition for the resources such as light, water and nutrients. By resolving this problem early in the growth cycle, it should maintain the plant populations, ensuring that any evident differences in productivity could be credited to the treatments rather than variations in plant establishment.

The GA 3 was diluted in 115.2 ml of water and applied in a fine foliar spray using a knapsack sprayer, maintaining constant spray volume and pressure, to ensure equal absorption of GA 3 across all plots. This was carried out at 15, 30, and 45 days after sowing (DAS). Applications sustained until the leaves were uniformly wet. All plots obtained corresponding concentrations, volume of spray, and application interval to lessen variability in absorption. High temperature was considered in the potential for GA 3 degradation and applications, it was sprayed during early morning hours when temperatures are lower, and its evaporation rates are minimal.

A submersible pump was used in irrigation management and was operated every 5 days. Weed management was performed through manual removal using a hand trowel. Initial management of fall armyworm infestations involved hand-picking the pests. Harvesting of mature corn cobs was manually collected, followed by manual threshing by removing the husks and separation of kernels. Lastly, kernels were sun-dried until they reached 12-14% of moisture content.

## General Observation and Collection of Data

The several key growth and yield parameters in data collection focus on the following; first is the measuring of plant height (PH) using meter stick from the base of the stem to the tip of the tallest leaf, this was taken 45 DAS, which also coincided with the final GA 3 application, chosen to capture the peak response to the treatment and provide a practical yet reliable indicator of its effect. Leaf count (LC) was recorded following the GA 3 application.

For corn yield, the length of ears (LE) is measured from the base of the plant to the tip of the cob after dehusking. The calliper ear diameter (ED) was assessed, while the computed yield (CY) was calculated by weighing the harvested marketable dry kernels for each treatment. Its weight was converted into per-hectare yield to reflect the actual field performance, and the weight of 1,000 kernels (WK) was determined by drying its samples.

### Analysis of Data

To analyse the effect of different concentrations of GA3 and various corn varieties on productivity parameters, a statistical analysis called Analysis of Variance (ANOVA) was conducted. Prior to the analysis, several assumptions underlying the ANOVA model were carefully checked. These assumptions included the normality of the residuals, homogeneity of variances across groups, and independence of individual observations.

The Shapiro-Wilk test was used to assess the normality of the residuals, while Levene's test was employed to evaluate the consistency of variances. The appropriate data transformations were implemented to normalise the data and stabilise variances, thus ensuring the validity and reliability of the statistical assumptions drawn from the ANOVA, while Tukey's Honestly Significant Difference (HSD) test was utilised to determine the significance of the differences observed among the treatment means. The results were carried in terms of the mean values together with the standard deviation (SD), and lastly, the significance level of $P<0.05$ to ascertain the statistical significance of the findings was also established.

## RESULTS AND DISCUSSION

### Plant Height

The data on plant height under various concentrations of gibberellic acid (GA3) and different corn varieties (Table 2), despite not showing statistically significant differences in results, offers insightful observations with practical implications. The treatment with 200 ml of GA3 per hectare (200GA3) achieved the highest mean height of 147.67 ± 6.79 cm, suggesting a potential positive influence of GA3 at this concentration. This was followed by the treatment without GA3 (WOG), which had a mean height of 144.67 ± 3.79 cm, and the treatment with 175 ml of GA3 per hectare (175GA3), which had a mean height of 136.17 ± 4.71 cm. The lowest mean height was observed in the treatment with 225 ml of GA3 per hectare (225GA3), with a mean of 135.00 ± 5.88 cm. However, the results did not identify these differences as statistically significant.

As shown in Table 3, the corn variety NK6 (NK6410) had a mean plant height (PH) of 143.67 ± 2.79 cm, while NK8 (NK8840) had a mean PH of 138.08 ± 2.79 cm. Despite this numerical difference, it was not statistically significant, suggesting that the height variation between these two varieties is minimal and likely due to random variation rather than a true difference in growth characteristics. Both NK6410 and NK8840 are hybrid corn varieties developed by Syngenta Philippines, known for their high yield potentials and adaptability to various regions. NK6410 matures in 100-105 days and has a potential yield of 12 metric tons per hectare.

Table 2
*Effects of plant height, leaf count, ear length, ear diameter, biomass yield, weight of kernels and computed yield in different concentrations of GA3 in hybrid corn*

| Factor A | PH (cm) | LC | LE (cm) | ED (mm) | BY (g) | WK (g) | CY (kg) |
|---|---|---|---|---|---|---|---|
| WOG | 144.67 ± 3.79 | 9.00 ± 0.29 | 12.50 ± 0.08 | 37.17 ± 0.545 | 1748.33 ± 109.25[b] | 283.00 ± 6.21 | 1673.67 ± 466.13[c] |
| 175GA3 | 136.17 ± 4.71 | 8.17 ± 0.54 | 12.67 ± 0.08 | 35.83 ± 0.795 | 1735.00 ± 122.58[b] | 270.83 ± 5.97 | 1907.67 ± 232.13[c] |
| 200GA3 | 147.67 ± 6.79 | 9.17 ± 0.46 | 13.00 ± 0.42 | 37.17 ± 0.545 | 1986.67 ± 128.42[a] | 276.83 ± 0.04 | 2600.67 ± 460.88[a] |
| 225GA3 | 135.00 ± 5.88 | 8.50 ± 0.21 | 12.17 ± 0.42 | 36.33 ± 0.295 | 1961.00 ± 103.42[a] | 276.50 ± 0.29 | 2377.17 ± 237.38[b] |

*Note.* WOG = Without GA3; 175GA3 = 175 ml of GA3 per hectare; 200GA3 = 200 ml of GA3 per hectare; 225GA3= 225 ml of GA3 per hectare
*PH = plant height; LC = leaf count; LE = length of ears; ED = ear diameter; BY = biomass yield; WK = Weight of 1000 kernels; CY = computed yield; cm = centimetre; mm = millimetre; g = gram and kg = kilogram. The different factors are presented along with their respective standard deviations (SD) using the format mean ± standard deviation. Significant differences at a 5% probability level ($P < 0.05$) were tested

It is adaptable to regions like Cagayan Valley, Ilocos Region, Central Luzon, South Luzon, Bicol Region, and Mindanao's low elevations. NK8840 matures in 115-120 days, also with a potential yield of 12 metric tons per hectare, and is suitable for Cagayan Valley (Upper Vega), Ilocos Region, and Central Luzon. The slightly shorter heights of NK6410 and NK8840 could be attributed to their hybrid nature, potentially bred for specific traits like drought resistance or suitability for certain climates, which might result in shorter stature without compromising yield.

Furthermore, Table 4 illustrates the interaction between GA3 concentrations and corn varieties, showing that the combination of 200GA3 and NK6 resulted in the tallest plants at 148.90±8.03 cm. Despite the lack of statistical significance, these findings indicate a trend where 200GA3 could be considered optimal for enhancing corn plant height. Practical applications of this study suggest that using 200 ml/ha of GA3 could potentially maximise plant height, contributing to better canopy structure and potentially higher yield. However, challenges such as fall armyworm infestations, which hindered plant growth during the first 30 days after planting (DAP), adversely affecting plant growth, must be managed to realise the full benefits of GA3 treatments. This study underscores the importance of integrated pest management alongside growth regulator applications to optimise crop performance. Abrahams et al. (2017) observed that infestations of fall armyworm can cause growth distortion, reduced crop yield, and in severe cases, total crop failure.

### Leaves Count

The study investigated how different concentrations of GA3 and various corn varieties influence leaf count. Although the observed trends were interesting, the differences between the treatments were not statistically significant. Table 2 shows that the treatment with 200 ml/ha of GA3 (200GA3) had the highest average leaf count at 9.17 ± 0.46, while the treatment with 175 ml/ha of GA3 (175GA3) recorded the lowest average at 8.17 ± 0.54. Furthermore, neither the concentrations of GA3 nor the corn varieties significantly affected leaf count. A slight numerical difference was observed in leaf count between the NK6 and NK8 varieties, with means of 8.83 and 8.58, respectively, but this difference was not statistically significant. When examining the combination of both GA3 concentrations and corn varieties, no significant differences were found; however, leaf counts ranged from 7.63 to 9.27.

The combination of 200GA3 and NK6 produced the highest leaf count, followed by 225GA3 + NK6 with a mean of 8.77 ± 0.14 counts, and 200GA3 + NK8 with 8.87 ± 0.24 counts. Other combinations included WOG + NK8 (8.83 ± 0.20 counts), 175GA3 + NK8 (8.57 ± 0.06 counts), 175GA3 + NK6 (8.00 ± 0.63 counts), and 225GA3 + NK8 (7.63 ± 0.99 counts), with the latter being the lowest. Despite these differences, the results indicated that there were no significant differences among the treatments.

## Length of Ears

The effect of ear length in relation to varying concentrations of GA3 and different corn varieties yielded nuanced results; however, the findings did not show statistically significant differences. Among the GA3 concentrations, the application of 200 ml/ha (200GA3) resulted in the highest mean ear length of 13.00 ± 0.42 cm, while the shortest ear length was noted in the 225 ml/ha treatment (225GA3), with an overall mean of 12.17 ± 0.42 cm. Additionally, the NK6 variety produced a higher mean ear length of 13.17 ± 0.59 cm, compared to the NK8 variety, which had a mean of only 12.00 ± 0.59 cm. The analysis of the interaction between the concentrations and varieties, as shown in Table 4, revealed that the combination of 200GA3 and the NK6 variety yielded the longest mean ear length of 13.73 ± 1.15 cm. However, there were no significant differences in ear length among the evaluated treatments.

## Ear Diameter

In ear diameter (ED) showed in the study that while different concentrations GA 3 and various corn varieties did not produce statistically significant differences, intriguing insights emerged. Table 2 indicates that the 200 ml/ha GA 3 treatment and the control (WOG) group exhibited the highest ear diameters, with the 175 ml/ha GA 3 treatment showing slightly reduced values, suggesting that GA 3 application may not significantly impact ED but offers flexibility in maintaining it.

A more detailed analysis presented in Table 3 indicated that the NK6 variety had a marginally larger mean ear diameter of 37.33 ± 0.71 mm, compared to NK8, which had a mean ear diameter of only 35.92 ± 0.71 mm. This difference was not statistically significant, highlighting the overall consistency of ED across these varieties. The interaction effects shown in Table 4 further reinforced this consistency, revealing variations in mean values across combined treatments but no significant impact on ED. Ultimately, although no statistically significant differences were detected, the findings emphasise practical flexibility in managing crop yield and minimising variability by considering GA3 applications and the choice of corn varieties.

## Biomass Yield

The findings on biomass yield (BY) showed significant variations influenced by both GA 3 concentrations and corn varieties. As presented in Table 2, it was revealed that the 200GA3 treatment yielded the highest average BY with a mean of 1986.67 ± 128.42 g, and statistical analysis confirmed significant differences among GA 3 levels, particularly between the 175 ml/ha treatment and the control (WOG), underscoring the role of GA 3 in yield trends, the same with the research showing GA 3 can enhance biomass yield in crops (Singh & Singh, 2019).

Table 3
*Response of two varieties of hybrid corn in various parameters*

| Factor B | PH (cm) | LC | LE (cm) | ED (mm) | BY (g) | WK (g) | CY (kg) |
|---|---|---|---|---|---|---|---|
| NK8 | 138.08 ± 2.79 | 8.58 ± 0.14 | 12.00 ± 0.59 | 35.92 ± 0.71 | 1572.5 ± 217.92[b] | 272.50 ± 4.29 | 1840.00 ± 299.79[b] |
| NK6 | 143.67 ± 2.79 | 8.83 ± 0.14 | 13.17 ± 0.59 | 37.33 ± 0.71 | 2008.33 ± 217.92[a] | 281.08 ± 4.29 | 2439.58 ± 299.79[a] |

*Note.* NK8 = NK8840 corn variety; NK6 = NK6640 corn variety
*PH = plant height; LC = leaf count; LE = length of ears; ED = ear diameter; BY = biomass yield; WK = Weight of 1000 kernels; CY = computed yield; cm = centimetre; mm = millimetre; g = gram and kg = kilogram. The different factors are presented along with their respective standard deviations (SD) using the format mean ± standard deviation. Significant differences at a 5% probability level ($P < 0.05$) were tested

Table 4
*Interaction of effects of hybrid corn varieties applied with different concentrations of GA3*

| Treatments | PH (cm) | LC | LE (cm) | ED (mm) | WK (g) |
|---|---|---|---|---|---|
| WOG + NK8 | 142.50 ± 1.63 | 8.83 ± 0.20 | 11.63 ± 0.96 | 35.43 ± 0.38 | 286.00± 9.21 |
| 175GA3 + NK8 | 138.13 ± 2.74 | 8.57 ± 0.06 | 12.30 ± 0.29 | 35.69 ± 0.12 | 262.00 ± 14.79 |
| 200GA3 + NK8 | 146.70 ± 5.83 | 8.87 ± 0.24 | 12.40 ± 0.19 | 35.76 ± 0.05 | 266.00 ± 10.79 |
| 225GA3 + NK8 | 124.90 ± 15.97 | 7.63 ± 0.99 | 12.20 ± 0.39 | 35.53 ± 0.28 | 276.00 ± 0.79 |
| WOG + NK6 | 146.47 ± 5.60 | 9.07 ± 0.44 | 12.97 ± 0.39 | 34.52 ± 1.29 | 280.00 ± 3.21 |
| 175GA3 + NK6 | 134.47 ± 6.40 | 8.00 ± 0.63 | 13.42 ± 0.84 | 36.12 ± 0.31 | 279.67 ± 2.88 |
| 200GA3 + NK6 | 148.90 ± 8.03 | 9.27 ± 0.64 | 13.73 ± 1.15 | 38.77 ± 2.96 | 287.67 ± 10.88 |
| 225GA3 + NK6 | 144.90 ± 4.03 | 8.77 ± 0.14 | 12.03 ± 0.56 | 34.68 ± 1.13 | 277.00 ± 0.21 |

*Note.* WOG = Without GA3; 175GA3 = 175 ml of GA3 per hectare; 200GA3 = 200 ml of GA3 per hectare; 225GA3= 225 ml of GA3 per hectare; NK8= NK8840 corn variety; NK6 = NK6640 corn variety
PH = plant height; LC = leaf count; LE = length of ears; ED- ear diameter; BY = biomass yield; WK = Weight of 1000 kernels; cm = centimeter; mm = millimeter; g = gram and kg = kilogram. The different factors are presented along with their respective standard deviations (SD) using the format mean ± standard deviation. Significant differences at a 5% probability level ($P < 0.05$) were tested

Table 3 further highlighted the importance of genetic factors, revealing significant differences in BY among corn varieties, with NK6 producing a higher mean BY with a final mean of 2008.33 ± 217.9 g than NK8, a finding echoed in other studies where cultivar choice significantly impacted yield components. The interaction analysis in Table 4 presented a more complex picture: the combination of 200 ml/ha GA 3 with the NK6 variety resulted in the highest BY (2596.67 ± 806.25 g), while the NK8 variety showed lower yields, especially when treated with no GA 3 (WOG at 1376.67 ± 413.75 g), reinforcing that the 200 ml/ha GA 3 concentration was particularly effective across both varieties tested.

Figure 1 illustrates the interaction analysis, demonstrating that combinations such as 200 ml/ha GA3 with NK6 achieved the highest mean BY of 2596.67 ± 806.25 g, followed by 200 ml/ha GA3 with NK8 at a mean of 1910.00 ± 119.58 g. Conversely, the combination of no GA3 with NK8 produced the lowest BY with a mean of 1376.67 ± 413.75 g. These experimental results indicate statistically significant differences, highlighting that the 200 ml/ha GA3 treatment performed well across the tested varieties. The interaction between plant growth regulators, like GA3, and crop varieties has been shown to significantly affect both yield and quality. For instance, a study on the effect of GA3 on the flowering and yield of hybrid rice parental lines found that applying GA3 at specific growth stages significantly increased plant height, internode length, and total dry biomass.

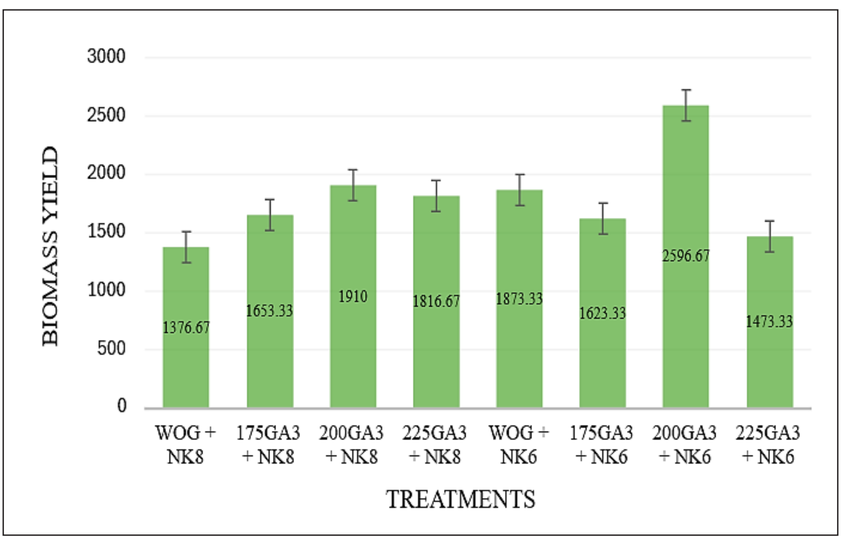


*Figure 1.* Interaction of effects of hybrid corn varieties applied with different concentrations of GA3 on biomass yield

*Note.* WOG = Without GA3; 175GA3 = 175 ml of GA3 per hectare; 200GA3 = 200 ml of GA3 per hectare; 225GA3 = 225 ml of GA3 per hectare; NK8 = NK8840; NK6 = NK6640

## Weight of 1000 kernels

As observed in Table 2, the weight of 1000 kernels (WK) was influenced by various concentrations of GA3. Notably, the treatment without GA3 (WOG) yielded the highest WK at 283.00 ± 6.21 g, while the treatment with 175 ml of GA3 per hectare (175GA3) produced the lowest weight at 270.83 ± 5.97 g. However, the results indicated that the weight of 1000 kernels was not significantly affected by the different concentrations of GA3. In Table 3, the WK response across different corn varieties ranged from 272.5 g to 281.08 g. NK6 exhibited the highest WK with a mean of 281.08 ± 4.29 g, while NK8 displayed the lowest weight with a mean of 272.50 ± 4.29 g. Similarly, the results demonstrated a non-significant effect of different corn varieties on WK. Table 4 illustrates the interaction effect of WK influenced by different concentrations of GA3 and various corn varieties. Among all the treatments, there were no significant effects on WK. However, the combination of 200 ml of GA3 per hectare with NK6 (200GA3 + NK6) achieved the highest WK with a mean of 287.67 ± 10.88 g, while the combination of 175 ml of GA3 per hectare with NK8 (175GA3 + NK8) resulted in the lowest WK with a mean of 262.00 ± 14.79 g.

Overall, these findings suggest that the applied concentrations of GA3 and the different corn varieties did not significantly impact the weight of 1000 kernels. This indicates that neither the application of GA3 nor the variety of corn significantly affects WK, highlighting the potential stability of WK under the various agricultural conditions studied. Nevertheless, these outcomes emphasise the importance of considering broader environmental effects and farm management practices, which may play vital roles in determining WK results in corn production.

## Computed Yield

Table 2 reveals that GA3 has a highly significant positive impact on corn yield. The treatment with 200 ml/ha of GA3 achieved the highest mean yield of 2600.67 ± 460.88 kg, while the control group (WOG) yielded only 1673.67 ± 466.13 kg. This finding is consistent with Singh & Singh (2019), who stated that GA3 enhances crop productivity. Additionally, Table 3 presents significant varietal differences in computed yield (CY). The NK6 hybrid corn recorded the highest yield at 2439.58 ± 299.79 kg, whereas the NK8 variety produced the lowest mean yield of 1840.00 ± 299.79 kg.

Interestingly, the interaction effects illustrated in Figure 2 indicate that the combination of 200 ml/ha GA3 with either the NK6 or NK8 variety resulted in the highest mean yields of 2683.70 ± 543.89 kg and 2619.26 ± 479.45 kg, respectively. This implies that the application of GA3 in conjunction with appropriate varieties significantly boosts yield, supported by research on GA3's role in crop development (Rosales & Galinao, 2018). However, it is important to note that the experiment was notably affected by drought conditions during May and June, which impacted the development of corn ears and their maturity.

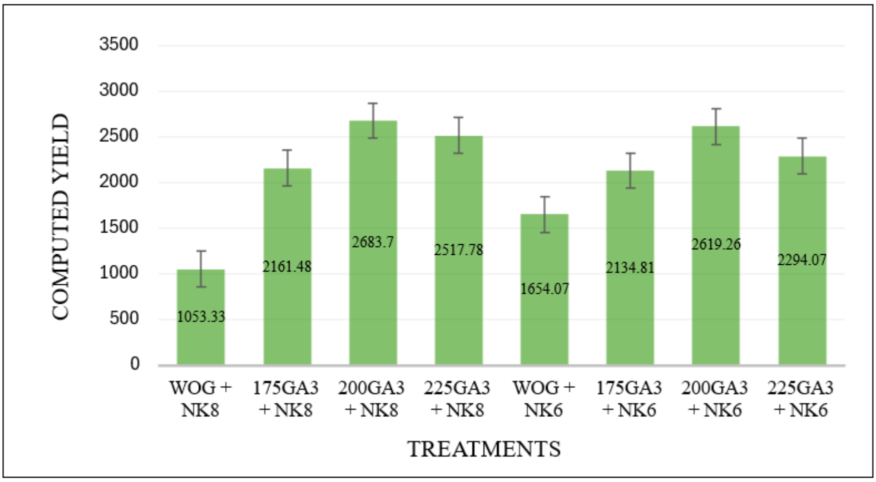


*Figure 2.* Interaction of effects of hybrid corn varieties applied with different concentrations of GA3 on computed yield
*Note.* WOG = Without GA3; 175GA3 = 175 ml of GA3 per hectare; 200GA3 = 200 ml of GA3 per hectare; 225GA3 = 225 ml of GA3 per hectare; NK8 = NK8840 Corn Variety; NK6 = NK6640 Corn Variety

This aligns with findings by Zhao et al. (2017) and Khalili et al. (2013), indicating that environmental stressors like drought significantly reduce corn yield, particularly during critical stages such as silking.

## CONCLUSION

The study found that GA3 significantly affects both the computed yield and biomass in hybrid corn varieties. A concentration of 200 ml of GA3 per hectare yielded the highest performance, indicating it as the optimal treatment, although other parameters did not show significant differences. The NK6410 variety exhibited superior agronomic characteristics. Notably, the combination of 200 ml/ha GA3 with the NK6 variety produced the highest overall yield, demonstrating a promising synergy for optimising productivity in corn. Therefore, it is advisable to implement this specific treatment strategy to enhance corn production in similar agroecological settings. For more conclusive results, future research should consider multi-season trials to assess the performance of GA3, conducting the same study during the wet season, and conducting multi-location trials with additional corn hybrids to evaluate their responses.

## ACKNOWLEDGEMENT

The authors would like to express their deep gratitude to the College of Agricultural Sciences and Technology at Isabela State University (ISU) for their support and guidance throughout this experiment. The contributions of Dr. Emerson V. Barcellano, the Cluster Executive Officer, and Dr. Velmor M. Abellera, the College Dean, were instrumental in the successful completion of this endeavour, and their leadership and support are greatly appreciated.

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