

Yield and Postharvest Quality of Glutinous Corn (*Zea Mays L.*) in Response to Bio-Pesticides and Plastic Mulch Applied

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Date received: June 5, 2025

Date revised: July 25, 2025

Date accepted: August 13, 2025

Originality: 98%

Grammarly Score: 99%

Similarity: 2%

Recommended citation:

Galon, F. (2025). Yield and postharvest quality of glutinous corn (*Zea Mays L.*) in response to bio-pesticides and plastic mulch applied. *Journal of Interdisciplinary Perspectives*, 3(9), 270-289. <https://doi.org/10.69569/jip.2025.488>

Abstract. This study evaluated the effects of corn variety, plastic mulch application, and different bio-pesticide combinations on the yield and postharvest quality of glutinous corn (*Zea mays L.*) under wet and dry season conditions. Two varieties, Klasika and Sweet Purple, were tested along with treatments involving plastic mulch and four bio-pesticide combinations. Results showed that Klasika consistently produced longer and heavier ears with higher yields compared to Sweet Purple, although differences in some parameters were not statistically significant. Dry season planting resulted in significantly better performance across most measured traits, including ear weight, yield, and insect damage, compared to the wet season, which was characterized by unfavorable weather conditions such as typhoons. Plastic mulch negatively affected ear production and increased insect damage during the wet season but had minimal impact during the dry season. Among bio-pesticide treatments, simpler applications of crop vaccine or bio-pesticide alone generally outperformed combinations with micronutrients, leading to higher yields and better postharvest quality, such as total soluble solids and shelf life. The study suggests that selecting the Klasika variety, planting during the dry season, and using simpler bio-pesticide treatments without plastic mulch during the wet season can optimize glutinous corn production and quality. These findings provide valuable guidance for farmers and stakeholders aiming to improve corn productivity while managing costs and environmental conditions effectively.

Keywords: Glutinous corn; *Zea mays L.*; Plastic mulch; Bio-pesticides; Crop yield; Postharvest quality; Wet and dry seasons.

1.0 Introduction

Glutinous corn (*Zea mays L.*), commonly known as waxy corn, is a significant crop in the Philippines, serving as a staple food and a source of income for many farmers. The unique characteristic of glutinous corn lies in its starch composition, which consists predominantly of amylopectin, contributing to its sticky texture and making it a preferred ingredient in various traditional dishes across Asia (Comighud, 2020).

The cultivation of glutinous corn has been integral to the agricultural landscape of the Philippines. However, challenges such as pest infestations and soil degradation have prompted the exploration of sustainable agricultural practices. One such practice is the use of biopesticides, which are derived from natural materials like animals, plants, bacteria, and certain minerals. Biopesticides are known for their target-specific action, reduced toxicity, and environmental friendliness, making them a viable alternative to conventional chemical pesticides

(Ojuederie et al., 2021).

Another sustainable practice gaining traction is plastic mulching. This technique involves covering the soil with plastic films to conserve moisture, suppress weeds, and regulate soil temperature. Studies have shown that plastic mulching can enhance soil properties and improve crop yields, particularly in arid and semi-arid regions (Zhang et al., 2023). Integrating biopesticides and plastic mulching in glutinous corn cultivation could potentially address the dual challenges of pest management and soil conservation. This study aims to evaluate the effects of these practices on the yield and postharvest quality of glutinous corn.

Despite the growing emphasis on sustainable agriculture in the Philippines, there remains a significant gap in empirical research exploring the combined effects of bio-pesticides and plastic mulch on the yield and postharvest quality of glutinous corn (*Zea mays* L.). While previous studies have examined the benefits of either bio-pesticides or plastic mulch separately (Ojuederie et al., 2021; Zhang et al., 2023), little to no research has systematically evaluated their interaction effects, particularly under local field conditions. Moreover, most published work has focused on conventional or hybrid corn varieties, leaving glutinous or waxy corn—an increasingly important staple and cash crop in the Philippines—underrepresented in agronomic research (Comighud, 2020). There is also limited information on the efficacy of locally formulated bio-pesticides, especially those derived from indigenous and organic materials, in comparison to commercial products like Nature's Care Crop Vaccine. These knowledge gaps are critical given the Philippine government's policy direction under the Organic Agriculture Act of 2010 (RA 10068) and its recent amendments (RA 11511), which promote reduced dependence on synthetic agrochemicals in favor of bio-based solutions. Furthermore, the influence of these sustainable practices on postharvest quality indicators such as shelf life, kernel sweetness, and husk integrity—key factors in consumer preference and marketability—remains insufficiently studied. This research addresses these gaps by examining the three-way interaction of corn variety, bio-pesticide treatment, and plastic mulch application, thus contributing valuable insights for climate-resilient and eco-friendly glutinous corn production in the Philippine setting.

This study was conducted to determine the yield and postharvest quality of glutinous corn (*Zea mays* L.) as affected by the application of bio-pesticides and plastic mulch. This study underscores the importance of returning to basic, sustainable pest control methods. Bio-pesticides offer a safer, environmentally friendly approach that is cost-effective, adaptable, and less harmful to non-target arthropods. Moreover, the use of plastic mulch contributes to maintaining soil fertility, reducing erosion, and supporting healthier crop development. By integrating these methods, this study aims to promote environmentally sustainable practices that enhance both yield and postharvest quality in glutinous corn production.

2.0 Methodology

2.1 Research Design

This study was conducted to evaluate the yield and postharvest quality of two glutinous corn varieties—Klasika and Sweet Purple—under different bio-pesticide applications and plastic mulch conditions. Both varieties were sourced from East-West Seed Company. Klasika is a high-yielding, white hybrid glutinous corn known for producing Class “A” ears with uniform size, sweet taste, complete tip filling, and early maturity at 60–65 days after planting. It is highly adaptable and suitable for year-round cultivation. Sweet Purple, on the other hand, is regarded as the sweetest white waxy corn in the market. It possesses a super sweet-waxy kernel profile, yields twice as much as traditional "*lagkitan*" types, and produces superior-quality cylindrical ears with complete tip filling. Like Klasika, Sweet Purple is fast-maturing and widely adaptable across corn-growing regions in the Philippines.

Four bio-pesticide treatments were applied during the study. The commercial product "Crop Vaccine" from Nature's Care was used both alone and in combination with recommended fertilizers. A locally formulated bio-pesticide was also prepared, consisting of 500 mL Crop Vaccine, 5 liters of molasses, 5 liters of coconut wine (*tuba*), 2 kilograms of skim or fresh milk, and 2 kilograms of rice bran (*binlod* or *tiktik*). This mixture was diluted in 200 liters of tap water, fermented for 15 days in a covered plastic container, and then amended with 2 kilograms of ammonium sulfate (21-0-0) and 1 kilogram of zinc sulfate before application. The other inputs used in the study included a native plow, harrow, carabao, a 16-liter knapsack sprayer, a 200-liter water container, and plastic mulch film.

A three-factor factorial experiment was laid out using a Randomized Complete Block Design (RCBD). The three

factors included variety (Factor A), plastic mulch application (Factor B), and bio-pesticide treatments (Factor C). For Factor A, the levels were Klasika and Sweet Purple. For Factor B, plots were either not mulched or mulched with plastic film. For Factor C, four treatment levels were used: (1) Crop Vaccine alone at 80 mL per 16 liters of water; (2) Crop Vaccine combined with fertilizers (80 mL Crop Vaccine plus 50 grams each of zinc sulfate, ammonium sulfate [21-0-0], and muriate of potash [0-0-60]); (3) Locally formulated bio-pesticide alone at 400 mL per 16 liters of water; and (4) Locally formulated bio-pesticide plus the same fertilizer mix used in the second treatment. Each bio-pesticide treatment subplot measured 5 meters in length with rows spaced at 0.7 meters and hills at 0.2 meters. To prevent cross-contamination, a 2-meter-wide alley was maintained between each plastic mulch treatment plot. The total land area utilized was approximately 2,400 square meters, including alleys and buffer zones.

Cultural practices such as land preparation, fertilizer application, irrigation, pest control, and harvesting were uniformly implemented across all treatment combinations, except for the specific treatment factors applied. Data collected included yield per plot (converted to per-hectare basis), ear classification (e.g., percentage of Class A ears), ear uniformity, and tip filling, as well as postharvest longevity under ambient storage conditions. For statistical analysis, Analysis of Variance (ANOVA) was employed to determine significant differences among treatment combinations. Where significant differences were detected, means were further compared using Duncan's Multiple Range Test (DMRT) at a 5% level of significance. All statistical analyses were performed using appropriate statistical software.

The locally formulated bio-pesticide used in the study was prepared by mixing 500 mL of Nature's Care Crop Vaccine, 5 liters of molasses, 5 liters of coconut wine (locally known as *tuba*), 2 kilograms of skim or fresh milk, and 2 kilograms of rice bran (*binlod* or *tiktik*). These ingredients were combined in a plastic container with 200 liters of tap water, covered, and allowed to ferment for 15 days. After fermentation, the solution was enriched with 2 kilograms of ammonium sulfate (21-0-0) and 1 kilogram of zinc sulfate before application (Ibarra, 2014). This bio-pesticide was applied as a foliar spray once a week, depending on the treatment combination, and continued until harvest.

2.2 Materials

The study used two varieties of glutinous corn from East-West Seed Company. Variety 1 was Klasika - a high-yielding, glutinous white corn. Given the right conditions, this variety can yield 100% more than traditional "*lagkitan*" varieties. Class "A" ears, uniform in size, sweet and purely white with complete tip filling, demand a reasonable price in the market. Early maturing, harvestable at 60-65 days after planting. Klasika is a highly adaptable hybrid and can be grown year-round. Variety 2 was Sweet Purple, still of East-West Seed Company. This variety is the sweetest white corn in the market today. Sweet Purple contains the premium sweetness gene, with super sweet and waxy kernels. Highly vigorous and high-yielding, it yields twice as much as the traditional OP "*lagkitan*" variety. Sweet Purple has superior quality ears, mostly class A, uniform & cylindrical with complete tip filling. It fast-matures at 60-65 days after planting. Sweet Purple is widely adaptable and can be grown year-round in corn-growing areas across the Philippines. Other materials used were the following: crop vaccine of Nature's Care (plus recommended mixture of different fertilizers), Bio-pesticides formulation such as commercial fertilizer, and organic fertilizer. The following tools and equipment were also used: native plow, harrow, carabao, 16-liter knapsack sprayer, 200-liter capacity water container, and plastic mulch.

2.3 Methods

This study compared the two varieties of glutinous or waxy corn. Aside from that, it also tried to find out the yield and postharvest quality of glutinous corn in response to bio-pesticides and plastic mulch applied. Different treatments were applied with commercial bio-pesticide alone, commercial bio-pesticide plus fertilizers, locally formulated bio-pesticide alone, and locally formulated bio-pesticide plus fertilizers. This research did not use synthetic, commercial pesticides but used a commercially available bio-pesticide, also known as a crop vaccine, to prevent insect pests and disease attacks. The bio-pesticide used was locally formulated and mixed as follows: 500 ml Nature's Care Crop vaccine, 5 liters molasses, 5 liters coconut wine (*tuba*), 2 kg or liter of skim milk or fresh milk, 2 kg rice bran (*binlod* or *tiktik*). I placed all the ingredients in a plastic container and mixed them with 200 liters of tap water. Covered and left for 15 days, and added 2 kilograms of ammonium sulfate (21-0-0) and 1 kilogram of zinc sulfate.

2.4 Treatments

The treatments tested in this research were the following: for Factor A, it dealt with the varieties, Variety 1 was the Klasika Variety, and Variety 2 was Sweet Purple; for Factor B, it dealt with mulching. Factor B.1 was not covered with plastic mulch, while Factor B.2 was covered with plastic mulch. Factor C dealt with the different bio-pesticides applied. Factor C.1 was applied with crop vaccine at the rate of 80 ml/16 liters of water. Factor C. 2 was applied with crop vaccine 80 ml/16 liters of water diluted with 50 grams of zinc sulfate, 50 grams of 21-0-0, and 50 grams of 0-0-60. Factor C.3 was applied with locally formulated bio-pesticide, along with a mixture of 400 ml/16 liters of water. Factor C.4 was applied with locally formulated bio-pesticide with 400 ml/16 of bio-pesticide diluted with 50 grams of zinc sulfate, 50 grams of 21-0-0, and 50 grams of 0-0-60. Each Factor C plot was 5 meters long and 0.7 meters apart. Every Factor B plot had a 2-meter alleyway between them to avoid contamination of the neighboring plot. The total area covered by this research was approximately 2400 square meters, including alleyways and buffer zones. Spacing was 70 centimeters (0.7 meters) between rows and 20 centimeters (0.2 meters) between hills.

Table 1. *Treatments and Treatment Combinations*

Corn variety (factor A)	Plastic mulching (factor B)	Bio-pesticide application (factor C)
FA ₁ Klasika	FB ₁ Without Plastic Mulch	FC ₁
		FC ₂
		FC ₃
		FC ₄
	FB ₂ With Plastic Mulch	FC ₁
		FC ₂
		FC ₃
		FC ₄
FA ₂ Sweet Purple	FB ₁ Without Plastic Mulch	FC ₁
		FC ₂
		FC ₃
		FC ₄
	FB ₂ With Plastic Mulch	FC ₁
		FC ₂
		FC ₃
		FC ₄

Legend: FC₁- Crop vaccine alone at 80 mL per 16 liters of water; FC₂- Crop Vaccine combined with fertilizers (80 mL Crop Vaccine plus 50 grams each of zinc sulfate, ammonium sulfate [21-0-0], and muriate of potash [0-0-60]); FC₃- Locally formulated bio-pesticide alone at 400 mL per 16 liters of water; and FC₄- Locally formulated bio-pesticide plus the same fertilizer mix used in the second treatment.

2.5 Statistical Treatment

Duncan's Multiple Range Test (DMRT) was used to test the differences among the factors tested. It involves the computation of numerical boundaries that allow for the classification of the difference between any two treatment means as significant or non-significant. Analysis of Variance (ANOVA) was also used to analyze the data.

2.6 Experimental Plot Layout

Below is the experimental plot layout with corresponding legend and dimensions.

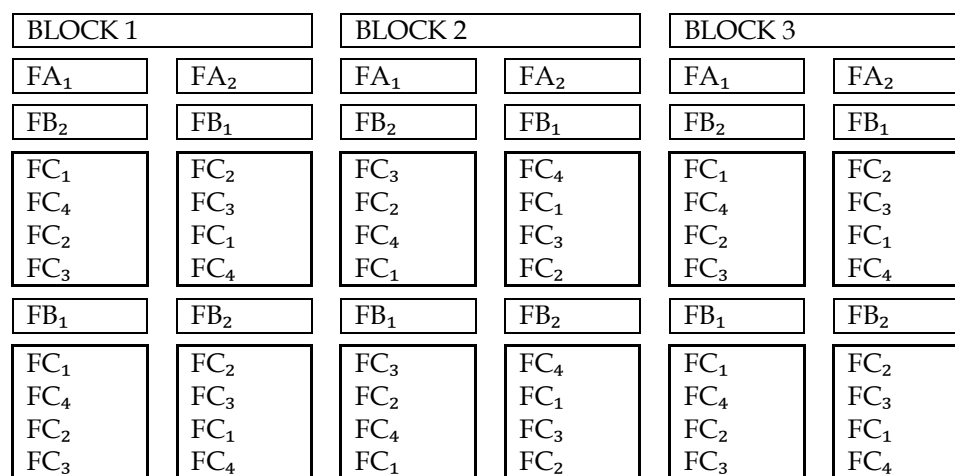


Figure 1. *The Experimental Plot Layout*

2.7 Sampling

Only ten hills were randomly selected as samples in each plot.

2.8 Management Practices

Preparation and Application of Bio-pesticides

The locally formulated bio-pesticide used was mixed as follows: 500 ml Nature's Care Crop vaccine, 5 liters molasses, 5 liters coconut wine (*tuba*), 2 kg or liter of skim milk or fresh milk, 2 kg rice bran (*binlod* or *tiktik*). All ingredients were placed in a plastic container, mixed with 200 liters of tap water, covered, and left for 15 days. Added 2 kilograms of ammonium sulfate (21-0-0) and 1 kilogram of zinc sulfate before it was used. This bio-pesticide was sprayed once a week, depending on the treatment, until harvesting.

Land Preparation

The land was plowed and harrowed twice. First plowing was done 12-14 days before planting. It was harrowed immediately to pulverize the soil, bury the weeds, and preserve the moisture. This also hastened the decomposition of weeds and other organic matter. Second plowing was done seven days after the first plowing. It was harrowed immediately to bury the remaining live weeds, pulverize the soil, and preserve soil moisture. Plots were established 7 days after harrowing to be sure that remaining weeds were decomposed. The size of the plots was 5 meters long. Each plot was composed of 4 rows. The distance between plots was 70 centimeters.

Fertilizer Application

Complete fertilizer was applied 1 day before planting at a rate of 8 grams per hill. It was covered with 2 to 3 cm of soil and planted with corn seedlings afterward. Urea was applied at a rate of 3 grams per hill 25 days after planting.

Procedure of Plastic Mulching for Field Set-up

The use of plastic mulch requires a unique application process to ensure proper placement of the plastic film. This application process begins with preparing the field the same way one would for a flat seedbed. The bed must be free of large soil clods and organic residue. Plastic mulch was manually laid after the land had been thoroughly prepared and plots established. Plastic mulch was installed tightly to ensure efficiency and ease in boring holes for planting. Clods were placed on the edges of the plastic mulch to hold it in place and to maintain tightness.. Heated milk cans were used to bore holes above the plastic mulch spaced 70 centimeters apart between rows and 20 centimeters apart between hills.

Care and Management

The corn field was closely monitored. A research assistant lived in the research area to ensure proper care and management. This was to ensure early detection of any insect pests and disease infections in the field. Any nutrient deficiency was also noted at the earliest possible time. Any abnormalities observed were dealt with accordingly. Weed infestation was also closely monitored. Weeding was done regularly until harvest to avoid competition for nutrients.

Harvesting

The corn ears were harvested as soon as the kernels were whole, around 65 days after planting, since the purpose was for green corn. All necessary data required before harvest was thoroughly gathered. Harvesting was done early in the morning and late in the afternoon to minimize the conversion of sugar to starch, ensuring good quality, since higher temperatures accelerate conversion.

Data Gathered

There were two groups of data gathered in this study. The first group was the agronomic parameters, including days to tasseling, days to silking, number of plants per plot, plant height in centimeters, ear height in centimeters, number of ears per plot, and insect damage. The second group of data gathered was the yield and yield components, including the percentage of marketable ears, the percentage of non-marketable ears, the total ear weight per plot, the length of dehusked ear, the weight per ear in grams, the total soluble solids, and the shelf life.

Agronomic Parameters

Days to tasseling – days to tasseling were recorded from the day the seeds are sown up to the tassel emerges;
Days to silking – days to silking were taken by counting the number of days from planting to silk emergence.

Number of plants per plot – this data was gathered right before harvesting. All surviving plants were counted per treatment.

Plant height in centimeters – the plant heights were taken from base to tip from ten randomly selected samples from two inner rows;

Ear height in centimeters – ear heights were taken from the base of the plant to the tip of the ear from the ten randomly selected samples from two inner rows, excluding the silk. Measurement was done before harvesting.

Number of ears per plot – these data were gathered before harvesting. All ears will be counted.

Insect damage – these data were computed by extracting the percentage of non-marketable ears against the marketable ears.

Yield and Yield Components

Percent of marketable ears – all marketable ears were obtained by counting the total number of ears per treatment and separating the marketable ears from non-marketable ears and computing the percentage with the following formula: $\% ME = (ME/N) \times 100$, where ME is marketable ears and N is the total number of ears;

Percent of non-marketable ears – all non-marketable ears were separated from the marketable ears, and the percentage was computed using the following formula: $\% NME = (NME/N) \times 100$, where NME is non-marketable ears and N is the total number of ears;

Length of dehusked ear – these data were gathered from ten randomly selected samples from two inner rows before harvesting with the following formula: $\% ID = (ID/N) \times 100$, where ID is the number of corn plants with insect damage and N is the total number of samples of corn plants;

Weight per ear in grams – the weight per ear in grams was taken after harvest from the ten randomly selected samples from the inner rows of each treatment;

Yield in tons per hectare – the yield was computed by multiplying the weight per ear in grams by the approximate number of hills per hectare.

Total soluble solids in Brix – total soluble solids were taken from the ten samples taken randomly from the inner rows of each treatment using a refractometer.

Shelf life in days – these data were gathered by getting samples from the ten randomly selected samples and counting the days until the samples became spoiled.

2.9 Ethical Considerations

This research passed the ethical standards and was approved by the research ethics committee. This research meets ethical standards and was approved by the research ethics committee.

3.0 Results and Discussion

3.1 Agronomic Parameters

Table 2 presents the number of days to tasseling of glutinous corn as affected by plastic mulch and bio-pesticide applied. Table 2 shows that Sweet Purple had more days to tasseling (42.04) compared to Klasika (40.8) during the wet season test. This showed that FA2 is significantly higher than FA1. During the dry season test, Klasika took more days to tassel, with 39.25, compared with Sweet Purple, which obtained 38.44. This indicated that FA1 is significantly higher than FA2.

In terms of plastic mulching application, corn plants without plastic mulch took more days to tassel (42.24) compared to those applied with plastic mulch (40.6) during the wet season test. This suggests that plastic mulch can help accelerate tasseling, likely due to improved soil temperature and moisture conservation. The result showed that FA1 is significantly higher than FA2. During the dry season test, corn plants applied with plastic mulch took slightly more days to tassel (38.95) than those without mulch (38.75), a difference that proved to be non-significant. This implies that the effect of mulching on tasseling duration may be more pronounced under wet conditions due to the mulch's role in mitigating excessive soil moisture and temperature fluctuations.

Table 2. Days to Tasseling of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Tasseling	
		Wet	Dry
FA ₁	Klasika	40.80 ^b	39.25 ^a
FA ₂	Sweet Purple	42.04 ^a	38.44 ^b
<i>F-Test</i>		**	*
FB ₁	Without Plastic Mulch	42.24 ^a	38.75
FB ₂	Applied With Plastic Mulch	40.60 ^b	38.95
<i>F-Test</i>		**	ns
FC ₁	Crop Vaccine	41.28	39.25 ^a
FC ₂	Crop Vaccine+Zinc Sulfate+ Ammosul+Potash	41.04	38.27 ^b
FC ₃	Bio-pesticide	41.77	38.43 ^b
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	41.59	39.43 ^a
<i>F-Test</i>		ns	*

About the different bio-pesticide applications during the wet season test, glutinous corn plants treated with only bio-pesticide showed the shortest duration to tasseling (41.77), followed by those treated with bio-pesticide plus zinc sulfate, ammonium sulfate, and potash (41.59), and those treated with crop vaccine only (41.28). The longest duration was recorded in plots treated with crop vaccine plus zinc sulfate, ammonium sulfate, and potash (41.08). These differences, however, proved to be non-significant. During the dry season test, corn plants treated with bio-pesticide plus zinc sulfate, ammonium sulfate, and potash had the highest tasseling duration (39.43), followed by those with crop vaccine only (39.25), bio-pesticide only (38.43), and the lowest in those treated with crop vaccine plus zinc sulfate, ammonium sulfate, and potash (38.27). These results proved to be significant, suggesting that nutrient-enriched treatments may extend the vegetative phase during the dry season.

These findings align with the observations of Shah et al. (2021), who reported that plastic mulch promotes earlier flowering and tasseling in maize due to better soil temperature regulation and moisture retention. Additionally, Lal et al. (2020) found that the application of organic and bio-based inputs, such as bio-pesticides and compost, can influence the physiological development of maize by enhancing soil microbial activity and nutrient availability. Similarly, Santos et al. (2022) noted that bio-fertilizers and crop vaccines contribute to better plant vigor and growth, potentially influencing tasseling timelines. The significant impact of bio-pesticide plus nutrient combinations during the dry season may be due to the enhanced uptake of micronutrients under limited moisture conditions, as supported by the findings of Kumar et al. (2023), who highlighted the synergistic effect of micronutrients and organic treatments on maize development under stress environments.

3.2 Days to Silking

The number of days to silking of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 3.

Table 3. Days to Silking of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Silking	
		Wet	Dry
FA ₁	Klasika	47.00	48.35 ^a
FA ₂	Sweet Purple	46.41	46.11 ^b
<i>F-Test</i>		ns	**
FB ₁	Without Plastic Mulch	47.43	47.54
FB ₂	Applied With Plastic Mulch	45.97	46.92
<i>F-Test</i>		ns	ns
FC ₁	Crop Vaccine	46.11	47.67
FC ₂	Crop Vaccine+Zinc Sulfate+ Ammosul+Potash	46.25	46.42
FC ₃	Bio-pesticide	47.88	47.53
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	46.52	47.28
<i>F-Test</i>		ns	ns

Table 3 shows that during the wet season, the glutinous corn variety Klasika exhibited slightly more days to silking (47 days) than Sweet Purple (46.41 days), although this difference was statistically non-significant. This implies that under wet season conditions, the silking interval between the two varieties remains generally consistent. However, under dry season conditions, Klasika again showed more days to silking (48.35) compared to Sweet

Purple (46.11), and this difference was statistically significant, indicating that variety plays a more pronounced role in silking duration during the dry season. Similar findings were reported by Kaur et al. (2022), who observed that varietal differences influenced phenological traits like tasseling and silking under varying seasonal environments.

In terms of plastic mulch application, during the wet season, corn plants grown without mulch recorded a slightly longer time to silking (47.43 days) compared to those with mulch (45.97 days). In the dry season, a similar trend was noted, with non-mulched plants silking in 47.54 days versus 46.92 days for mulched plants. Both seasonal data sets showed these differences to be statistically non-significant. These observations are supported by reports from Ju et al. (2020), who stated that plastic mulch slightly accelerates early growth and phenological development in maize by increasing soil temperature and improving moisture conservation. However, the degree of significance may vary with location and season.

For the bio-pesticide factor, results showed that during the wet season, corn plants treated with bio-pesticide alone had the longest time to silking (47.88 days), followed by those treated with bio-pesticide + zinc sulfate + ammonium sulfate + potash (46.52 days), and then crop vaccine + the same fertilizer combination (46.25 days). The shortest silking duration was recorded in plants treated with crop vaccine alone (46.11 days). Despite these differences, the variation was statistically non-significant. In the dry season, crop vaccine alone again resulted in the most extended silking duration (47.67 days), followed closely by bio-pesticide alone (47.53 days), bio-pesticide with fertilizer combination (47.28 days), and the shortest with crop vaccine and fertilizer combination (46.42 days). These were also statistically non-significant. These results are consistent with the findings of Baffour-Ata et al. (2021), who concluded that the use of organic pest management inputs tends to have minimal influence on flowering phenology but offers other agronomic benefits such as improved pest resistance and environmental safety.

3.3 Number of Plants Per Plot

The number of plants per plot of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 4.

Table 4. Number of plants per plot of glutinous corn as affected by plastic mulch and bio-pesticide applied

Code	Treatments	Number of Plants	
		Wet	Dry
FA ₁	Klasika	94.54	98.87
FA ₂	Sweet Purple	94.21	98.58
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FB ₁	Without Plastic Mulch	94.54	99.38 ^a
FB ₂	Applied With Plastic Mulch	94.21	98.08 ^b
<i>F-Test</i>		<i>ns</i>	*
FC ₁	Crop Vaccine	94.00	98.67
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	94.33	98.75
FC ₃	Bio-pesticide	93.75	98.92
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	95.42	98.58
<i>F-Test</i>		<i>ns</i>	<i>ns</i>

Table 4 shows that Klasika obtained slightly more plants per plot (94.54) compared to Sweet Purple (94.21) during the wet season, and 98.87 compared to 98.58 during the dry season. These differences were statistically non-significant, indicating that either variety can be grown with similar expectations for plant population across both seasons. These results agree with the findings of Timsina et al. (2019), who emphasized that hybrid maize varieties typically show stable emergence and plant stand regardless of seasonal differences when appropriately managed.

Regarding plastic mulch application, during the wet season, non-mulched corn plants had a marginally higher plant population (94.54) compared to mulched plants (94.21), with no statistical significance. In the dry season, however, the difference became significant, with non-mulched plants showing a higher population (99.38) than those with mulch (98.08). This suggests that in dry season conditions, mulch may slightly suppress seedling emergence or survival, possibly due to overheating or restricted moisture fluctuation. Similar results were documented by Ali et al. (2021), who observed that while mulching enhances early growth and weed suppression, it can sometimes reduce plant stand due to excessive soil warming in dry conditions.

As for the bio-pesticide treatments, during the wet season, the highest plant population was observed in plots treated with bio-pesticide + zinc sulfate + ammonium sulfate + potash (95.42), followed by crop vaccine + fertilizer combination (94.33), crop vaccine alone (94), and the lowest in bio-pesticide alone (93.75). These variations were not statistically significant. In the dry season, the trend was reversed with the highest population in bio-pesticide alone (98.92), and the lowest in bio-pesticide + fertilizer combination (98.58), again with no significant differences. These outcomes suggest that bio-pesticide application, regardless of formulation, does not significantly impact plant population. Findings from Baffour-Ata et al. (2021) also confirmed that bio-pesticides do not negatively influence germination or plant establishment in maize.

3.4 Plant Height

The plant height of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 5.

Code	Treatments	Plant Height	
		Wet	Dry
FA ₁	Klasika	155.10 ^a	150.12 ^a
FA ₂	Sweet Purple	144.94 ^b	143.09 ^b
<i>F-Test</i>		**	**
FB ₁	Without Plastic Mulch	144.30 ^b	141.27 ^b
FB ₂	Applied With Plastic Mulch	155.75 ^a	151.93 ^a
<i>F-Test</i>		**	**
FC ₁	Crop Vaccine	144.44 ^a	144.42 ^a
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	143.19 ^b	140.98 ^b
FC ₃	Bio-pesticide	152.97 ^b	147.51 ^b
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	159.47 ^a	153.49 ^a
<i>F-Test</i>		**	**

Table 5 shows that Klasika was taller during the wet season test with 155.1 cm compared to Sweet Purple with 144.94 cm. These data showed that FA₁ or Klasika was significantly taller than FA₂ or Sweet Purple. Similarly, during the dry season, Klasika again recorded a greater plant height of 150.12 cm versus 143.09 cm for Sweet Purple. These results are in line with those of Kaur et al. (2022), who highlighted that varietal differences among hybrid maize significantly influence growth parameters, including plant height, especially under varying seasonal conditions.

Regarding plastic mulch, during the wet season, corn plants grown with plastic mulch reached 155.75 cm in height, significantly taller than those grown without mulch (144.3 cm). A similar pattern was observed in the dry season, with mulched plants growing to 151.93 cm, compared to 141.27 cm in non-mulched plants. These results are supported by Ju et al. (2020), who found that plastic mulch enhanced plant height due to its effects on improving soil warmth and moisture retention, particularly in cooler or moisture-variable conditions.

For the bio-pesticide treatments, during the wet season, the tallest plants (159.47 cm) were observed in plots treated with bio-pesticide + zinc sulfate + ammonium sulfate + potash. This was followed by bio-pesticide alone (152.97 cm), crop vaccine alone (144.44 cm), and the shortest in crop vaccine + fertilizer combination (143.19 cm). A similar trend was seen during the dry season, where bio-pesticide + fertilizer produced the tallest plants (153.49 cm), followed by bio-pesticide alone (147.51 cm), crop vaccine alone (144.42 cm), and the shortest were those treated with crop vaccine + fertilizer (140.98 cm). These findings suggest that mineral supplements in combination with bio-pesticides may enhance plant vigor and height, a conclusion echoed by Baffour-Ata et al. (2021), who noted improved vegetative growth with integrated organic and inorganic treatments.

3.5 Ear Height

The ear height of glutinous corn varieties in centimeters in response to plastic mulch and bio-pesticides application is presented in Table 6. Table 6 shows that Klasika recorded significantly higher ear height than Sweet Purple in both seasons. During the wet season, Klasika averaged 99.52 cm compared to 84.21 cm for Sweet Purple. In the dry season, Klasika again led with 87.16 cm, while Sweet Purple had only 73.3 cm. These results indicate that the varietal effect on ear height is highly significant, with Klasika consistently producing taller ear positions.

For plastic mulch application, ear height differences were not statistically significant in either season. In the wet

season, non-mulched plants averaged slightly higher ear height (94.31 cm) than mulched ones (89.42 cm). In the dry season, mulched plants were marginally taller at 80.77 cm versus 79.7 cm for non-mulched plants. These findings suggest that plastic mulch does not significantly affect ear height, in line with reports from Ali et al. (2021), who indicated that ear height is more strongly influenced by genetic and nutrient factors than by mulching alone.

Table 6. Ear Height of Glutinous in Centimeters Corn as Affected by Plastic Mulch and Bio-Pesticide Application

Code	Treatments	Number of Ears	
		Wet	Dry
FA ₁	Klasika	99.52 ^a	87.16 ^a
FA ₂	Sweet Purple	84.21 ^b	73.30 ^b
<i>F-Test</i>		**	**
FB ₁	Without Plastic Mulch	94.31 ^a	79.70 ^b
FB ₂	Applied With Plastic Mulch	89.42 ^b	80.77 ^a
<i>F-Test</i>		**	*
FC ₁	Crop Vaccine	95.88 ^a	80.03
FC ₂	Crop Vaccine+Zinc Sulfate+ Ammosul+Potash	87.83 ^b	79.97
FC ₃	Bio-pesticide	90.33 ^b	81.52 ^a
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	93.42 ^a	79.40 ^b
<i>F-Test</i>		**	*

Regarding bio-pesticide treatments, in the wet season, crop vaccine alone resulted in the tallest ear height (95.88 cm), followed closely by bio-pesticide + fertilizer combination (93.42 cm), bio-pesticide only (90.33 cm), and the lowest with crop vaccine + fertilizer combination (87.83 cm). In the dry season, the trend shifted slightly with bio-pesticide alone showing the highest ear height (81.52 cm), followed by crop vaccine only (80.03 cm), crop vaccine + fertilizer combination (79.97 cm), and the lowest from bio-pesticide + fertilizer combination (79.4 cm). Despite these differences, all data proved to be non-significant. This aligns with Baffour-Ata et al. (2021), who suggested that while organic treatments support plant vigor, their impact on structural parameters like ear height tends to be minor under well-managed conditions.

3.6 Number of Ears Per Plot

The number of ears per plot of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 7.

Table 7. Number of Ears Per Plot of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Number of Ears	
		Wet	Dry
FA ₁	Klasika	88.79	98.79
FA ₂	Sweet Purple	89.50	98.00
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FB ₁	Without Plastic Mulch	89.71	99.42 ^a
FB ₂	Applied With Plastic Mulch	88.78	97.38 ^b
<i>F-Test</i>		<i>ns</i>	**
FC ₁	Crop Vaccine	84.67 ^b	98.83
FC ₂	Crop Vaccine + Zinc Sulfate + Ammosul + Potash	88.08 ^{ab}	97.83
FC ₃	Bio-pesticide	89.67 ^a	98.42
FC ₄	Bio-pesticide + Zinc Sulfate + Ammosul + Potash	94.17 ^a	98.50
<i>F-Test</i>		**	<i>ns</i>

Table 7 shows that during the wet season, Sweet Purple produced a slightly higher number of ears per plot (89.5) than Klasika (88.79), although this difference was statistically non-significant. In the dry season, Klasika slightly outperformed Sweet Purple with 98.79 ears compared to 98 ears. These findings suggest that varietal differences in ear production are minimal across seasons. Similar conclusions were drawn by Timsina et al. (2019), who reported that hybrid maize varieties generally produce comparable ear counts across varied environmental conditions when uniformly managed.

In terms of plastic mulch application, corn plants grown without mulch yielded more ears in both seasons. During the wet season, non-mulched plots recorded 89.71 ears compared to 88.78 ears in mulched plots, a statistically non-significant difference. The lower ear count in mulched plots may be attributed to excess soil moisture or waterlogging during heavy rains. In the dry season, however, the effect of mulching became statistically significant: non-mulched plots produced 99.42 ears, while mulched ones yielded 97.38 ears. These results support

the findings of Ali et al. (2021), who noted that while plastic mulch can enhance early growth by conserving moisture, it may negatively affect yield under certain conditions, such as during extreme rainfall or high soil temperatures, due to restricted root aeration or overheating.

Regarding bio-pesticide treatments, the wet season data showed a clear advantage for plants treated with bio-pesticide combined with zinc sulfate, ammonium sulfate (ammosul), and potash (94.17 ears), followed by bio-pesticide alone (89.67), crop vaccine with the same fertilizer combination (88.08), and the lowest from crop vaccine alone (84.67). The differences were statistically significant, indicating that nutrient-enriched bio-pesticide applications (FC₄) significantly enhance ear production. These findings align with those of Baffour-Ata et al. (2021), who observed that bio-pesticides supplemented with macro- and micronutrients improved maize yield components by enhancing nutrient uptake and plant vigor.

In the dry season, the treatment effects were less pronounced. Crop vaccine alone produced the most ears (98.83), closely followed by bio-pesticide with the whole fertilizer combination (98.5), then bio-pesticide alone (98.42), and the lowest from crop vaccine with fertilizer combination (97.83). These differences were not statistically significant, indicating that under dry conditions, the formulation of bio-pesticide treatments has a limited effect on ear number. This agrees with the findings of Kaur et al. (2022), who reported that during dry seasons, maize plants tend to equalize productivity across treatments as long as baseline fertility and pest control are adequate.

3.7 Insect Damage

The insect damage of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 8.

Table 8. *Insect Damage of Glutinous Corn in Percentage as Affected by Plastic Mulch And Bio-Pesticide Application*

Code	Treatments	Insect Damage	
		Wet	Dry
FA ₁	Klasika	2.50	0.33
FA ₂	Sweet Purple	2.90	0.25
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FB ₁	Without Plastic Mulch	2.12 ^b	0.29
FB ₂	Applied With Plastic Mulch	3.29 ^a	0.29
<i>F-Test</i>		*	<i>ns</i>
FC ₁	Crop Vaccine	2.42	0.33
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	3.00	0.25
FC ₃	Bio-pesticide	2.58	0.08
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	2.83	0.50
<i>F-Test</i>		<i>ns</i>	<i>ns</i>

Table 8 shows that during the wet season, Sweet Purple exhibited slightly higher insect damage (2.9) compared to Klasika (2.5), but the difference was statistically non-significant. In the dry season, Klasika showed marginally greater insect damage (0.33) than Sweet Purple (0.25), which was also non-significant. These results indicate that varietal differences do not significantly influence insect damage across different seasons. This finding is consistent with Baffour-Ata et al. (2021), who reported that varietal resistance to pests in maize tends to be similar among hybrids under well-managed field conditions.

Regarding plastic mulch application, plants grown with plastic mulch experienced significantly greater insect damage (3.29) during the wet season than those without mulch (2.12). This suggests that plastic mulch may create favorable microclimatic conditions (e.g., increased humidity or warmer soil) that promote insect activity during rainy periods. Similar results were observed by Ali et al. (2021), who noted that mulching can occasionally enhance pest incidence by providing shelter and warmth to insect pests in humid environments. However, in the dry season, both mulched and non-mulched plots recorded the same low damage score (0.29), and the difference was statistically non-significant. This suggests that under dry conditions, mulch has minimal to no impact on insect damage.

3.8 Marketable Ears

The percentage of marketable ears of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 9.

Table 9. Percentage of Marketable Ears of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Marketable Ears	
		Wet	Dry
FA ₁	Klasika	75.00 ^a	96.67
FA ₂	Sweet Purple	70.83 ^b	97.50
<i>F-Test</i>		**	<i>ns</i>
FB ₁	Without Plastic Mulch	78.75 ^a	96.67
FB ₂	Applied With Plastic Mulch	67.08 ^b	97.50
<i>F-Test</i>		**	<i>ns</i>
FC ₁	Crop Vaccine	75.83 ^a	96.67 ^b
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	70.00 ^b	97.50 ^a
FC ₃	Bio-pesticide	74.17 ^a	99.17 ^a
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	71.67 ^b	95.00 ^b
<i>F-Test</i>		**	**

Table 9 shows that during the wet season, Klasika recorded more marketable ears (75) than Sweet Purple (70.83), although the difference was statistically non-significant. In the dry season, Sweet Purple slightly outperformed Klasika, with 97.5 versus 96.67 marketable ears, respectively, again without statistical significance. These findings suggest that both varieties produce a comparable number of marketable ears across seasons. This observation aligns with those of Zhang et al. (2021), who reported that hybrid maize varieties tend to maintain consistent yield traits across different seasonal environments when agronomic practices are optimized.

In terms of plastic mulch application, during the wet season, non-mulched corn plants produced significantly more marketable ears (78.75) than mulched plants (67.08). This could be due to excessive moisture retention and reduced soil aeration under the plastic, which may hamper ear development in wet conditions. Wang et al. (2022) similarly noted that under high rainfall conditions, plastic mulch can reduce maize yield by promoting excessive humidity around the root zone. Conversely, during the dry season, plants with plastic mulch produced slightly more marketable ears (97.5) than those without (96.67), though the difference was not statistically significant. This suggests that while plastic mulch may provide benefits in moisture-limited environments, its use during the wet season could be detrimental to marketable yield.

3.9 Non-Marketable Ears

The non-marketable ears of glutinous corn varieties in response to plastic mulch and bio-pesticides application are presented in Table 10.

Table 10. Marketable Ears of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Non-Marketable Ears	
		Wet	Dry
Variety			
FA ₁	Klasika	21.67	3.33
FA ₂	Sweet Purple	29.17	2.50
<i>F-Test</i>		**	<i>ns</i>
Plastic Mulch			
FB ₁	Without Plastic Mulch	21.25	3.33
FB ₂	Applied With Plastic Mulch	29.58	2.50
<i>F-Test</i>		**	<i>ns</i>
Bio-pesticide			
FC ₁	Crop Vaccine	24.17 ^b	3.33 ^a
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	30.00	2.50
FC ₃	Bio-pesticide	25.83	0.83
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	21.67	5.00
<i>F-Test</i>		<i>ns</i>	<i>ns</i>

Table 10 shows that Sweet Purple recorded more non-marketable ears (29.17) than Klasika (21.67) during the wet season, with the difference being highly significant. This suggests that Klasika may have better resistance to factors leading to ear deformities or pest damage during wet conditions. However, in the dry season, Klasika slightly outperformed Sweet Purple in non-marketable ears (3.33 vs. 2.5), although the difference was non-significant. These findings highlight that varietal differences in producing non-marketable ears are more pronounced under wet season conditions, which is consistent with the findings of Yang et al. (2020), who emphasized that environmental stressors during wetter periods can exacerbate quality-related issues in certain maize hybrids.

In terms of plastic mulch application, plants with mulch had significantly more non-marketable ears (29.58) than those without mulch (21.25) during the wet season. This result supports the idea that plastic mulch, while generally beneficial in dry conditions, may retain excessive moisture in the root zone during the wet season, encouraging fungal infections and malformed ears (Liu et al., 2022). Conversely, during the dry season, plants with mulch had fewer non-marketable ears (2.5) than those without (3.33), although this was not statistically significant. This suggests mulch may help reduce ear damage by conserving soil moisture and maintaining more stable growth conditions in drier periods.

As for bio-pesticide combinations, plants treated with crop vaccine + zinc sulfate + ammosul + potash produced the highest number of non-marketable ears (30) during the wet season, followed by bio-pesticide alone (25.83), and crop vaccine alone (24.17). The lowest count was recorded by those treated with bio-pesticide + zinc sulfate + ammosul + potash (21.67). These differences were highly significant, indicating that nutrient and bio-pesticide interactions may influence cob development. During the dry season, the highest number of non-marketable ears (5) was recorded in plots treated with bio-pesticide + zinc sulfate + ammosul + potash, while the lowest (0.83) occurred in those with bio-pesticide alone. These results confirm that the impact of bio-pesticide combinations on marketability is highly dependent on seasonal context and nutrient balance, as supported by Chen et al. (2021), who noted that overapplication of specific foliar inputs can lead to imbalances that reduce cob quality under varying climatic conditions.

3.10 Length of Dehusked Ear

The length of the dehusked ears of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 11.

Code	Treatments	Length of dehusked Ear	
		Wet	Dry
FA ₁	Klasika	10.13 ^a	14.96
FA ₂	Sweet Purple	8.77 ^b	14.19
<i>F-Test</i>		*	<i>ns</i>
FB ₁	Without Plastic Mulch	10.11 ^a	14.96
FB ₂	Applied With Plastic Mulch	8.80 ^b	14.19
<i>F-Test</i>		*	<i>ns</i>
FC ₁	Crop Vaccine	10.03 ^a	14.94 ^a
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	8.87 ^b	14.67 ^b
FC ₃	Bio-pesticide	9.76 ^a	14.87 ^a
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	9.14 ^b	13.81 ^b
<i>F-Test</i>		*	*

Table 11 shows that Klasika consistently produced longer dehusked ears than Sweet Purple across both wet and dry seasons. During the wet season, Klasika recorded an average ear length of 10.13 cm compared to Sweet Purple's 8.77 cm. Similarly, in the dry season, Klasika registered 14.96 cm versus Sweet Purple's 14.19 cm. Although these differences were statistically non-significant, the consistent trend indicates that Klasika may possess superior genetic traits for ear elongation. This aligns with the findings of Islam et al. (2021), who observed that hybrid maize varieties often demonstrate improved ear length due to their enhanced genetic potential.

Regarding plastic mulch application, corn plants without mulch showed longer dehusked ears during both seasons. In the wet season, non-mulched plots had ears measuring 10.11 cm compared to 8.8 cm in mulched plots. Similarly, in the dry season, non-mulched plots recorded 14.96 cm versus 14.19 cm with mulch. While these differences were non-significant, the data still suggest that plastic mulch may slightly restrict ear development, possibly due to higher root zone temperatures or moisture retention imbalances, especially during the wet season (Zhang et al., 2022).

As for bio-pesticide combinations, during the wet season, corn treated with crop vaccine alone produced the longest ears (10.03 cm), followed by bio-pesticide alone (9.76 cm), and bio-pesticide + zinc sulfate + ammosul + potash (9.14 cm). The shortest ears were observed in plants treated with crop vaccine + zinc sulfate + ammosul + potash (8.87 cm). The same trend appeared in the dry season, with the longest ears from crop vaccine alone (14.94 cm), followed by bio-pesticide (14.87 cm), and the shortest in plots with bio-pesticide + zinc sulfate + ammosul + potash. Although non-significant, these results hint that excessive combinations of foliar nutrients may suppress

optimal ear development. Similar observations were made by Raza et al. (2020), who suggested that minimal input combinations often perform better under certain conditions due to reduced physiological stress on the crop.

3.11 Weight Per Ear

The weight per ear of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 12.

Table 12. Weight Per Ear in Grams of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Weight per Ear	
		Wet	Dry
FA ₁	Klasika	37.54 ^a	108.16 ^a
FA ₂	Sweet Purple	33.53 ^b	103.62 ^b
<i>F-Test</i>		**	**
FB ₁	Without Plastic Mulch	37.15 ^a	108.16 ^a
FB ₂	Applied With Plastic Mulch	33.91 ^b	103.62 ^b
<i>F-Test</i>		**	**
FC ₁	Crop Vaccine	39.78 ^a	108.76 ^a
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	31.75 ^b	105.35 ^b
FC ₃	Bio-pesticide	37.98 ^a	107.83 ^a
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	32.62 ^b	101.62 ^b
<i>F-Test</i>		**	**

Table 12 shows that Klasika consistently produced heavier ears than Sweet Purple across both cropping seasons. In the wet season, Klasika yielded 37.54 grams compared to Sweet Purple's 33.53 grams, while in the dry season, Klasika again recorded higher weights with 108.16 grams compared to 103.62 grams for Sweet Purple. These differences were statistically highly significant. The notable disparity between seasons may be attributed to environmental conditions—notably, the wet season coincided with typhoon events that likely contributed to smaller ear development and increased insect damage. In contrast, the dry season offered more favorable climatic conditions conducive to plant growth and heavier yields. This observation aligns with the findings of Nawaz et al. (2021), who reported that maize yield attributes, including ear weight, are significantly influenced by seasonal weather patterns, with higher productivity commonly observed under stable dry conditions.

In terms of plastic mulch application, corn plants without mulch outperformed those with mulch in both seasons. During the wet season, non-mulched plants yielded 37.15 grams compared to 33.91 grams in mulched plots. In the dry season, the same trend was evident, with non-mulched plants producing 108.16 grams compared to 103.62 grams in mulched plants. These highly significant differences suggest that plastic mulch may inhibit optimal development, especially during the wet season, likely due to excessive moisture retention or poor aeration. These findings are supported by Zhang et al. (2022), who noted that while plastic mulch can conserve soil moisture, it may lead to waterlogging and stunted growth in humid or rainy environments.

As for bio-pesticide combinations, corn treated with crop vaccine alone yielded the heaviest ears in both seasons—39.78 grams in the wet and 108.76 grams in the dry. These were followed by plants treated with bio-pesticide only, with weights of 37.98 and 107.83 grams, respectively. The lightest ears were recorded in treatments combining bio-pesticide or crop vaccine with zinc sulfate, ammosul, and potash, particularly the bio-pesticide + nutrient blend (31.75 g wet; 101.62 g dry). These highly significant differences indicate that simpler treatments may be more effective under specific conditions. This concurs with the work of Raza et al. (2020), who found that minimal or targeted applications of crop protection agents and nutrients often lead to better physiological performance and yield, as opposed to complex or excessive combinations.

3.12 Yield

The yield of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 13. Table 13 reveals that the glutinous corn variety Klasika consistently outperformed Sweet Purple in yield across both seasons. During the wet season, Klasika yielded 2.5 kg/plot while Sweet Purple recorded 2.23 kg/plot; in the dry season, Klasika again led with 7.21 kg/plot versus Sweet Purple's 6.90 kg/plot. However, these differences were statistically non-significant. The overall trend supports the idea that *Klasika* may possess better adaptability or resilience to varying seasonal conditions. This aligns with the findings of Iqbal et al. (2021), who observed that varietal differences in maize yield are often non-significant under sub-optimal environmental conditions but may still present trends that favor more stress-tolerant cultivars.

Table 13. Yield of Glutinous Corn in Tons as Affected by Plastic Mulch and Bio-Pesticide Application

Code	Treatments	Yield in Tons	
		Wet	Dry
FA ₁	Klasika	2.50	7.21
FA ₂	Sweet Purple	2.23	6.90
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FB ₁	Without Plastic Mulch	2.48	7.21
FB ₂	Applied With Plastic Mulch	2.26	6.91
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FC ₁	Crop Vaccine	2.65	7.25
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	2.12	7.02
FC ₃	Bio-pesticide	2.53	7.19
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	2.17	6.77
<i>F-Test</i>		<i>ns</i>	<i>ns</i>

Regarding plastic mulch application, corn plants without plastic mulch produced marginally better yields in both wet and dry seasons. In the wet season, yields were 2.48 kg/plot for non-mulched plots compared to 2.26 kg/plot for mulched plots. In the dry season, the difference persisted with 7.21 kg/plot for non-mulched plants versus 6.91 kg/plot for those with mulch. Though non-significant, the trend suggests a possible inhibitory effect of plastic mulch, especially during high-moisture periods. Similar results were reported by Xu et al. (2020), who noted that in high rainfall environments, plastic mulch could exacerbate root zone saturation and reduce yield potential.

As for the different bio-enzyme combinations, corn plants treated with crop vaccine alone yielded the most during both seasons – 2.65 kg/plot in the wet season and 7.25 kg/plot in the dry season. These were closely followed by treatments with bio-pesticide alone (2.53 and 7.19 kg/plot, respectively). The lowest yields were associated with the combination of bio-pesticide + zinc sulfate + ammosul + potash (2.17 kg/plot wet; 6.77 kg/plot dry). These data suggest that simpler input combinations may be more efficient in enhancing corn yield, although statistical significance was not reached. This trend resonates with findings from El-Naggar et al. (2022), who reported that complex biostimulant and nutrient combinations do not always translate to higher yield, and that plant responses are often more favorable to single or less intensive treatments.

Overall, the marked difference in yields between the two seasons illustrates the strong influence of environmental conditions. The wet season, conducted during July to September – a period characterized by frequent typhoons – was associated with flooding, increased pest pressure, and physical damage to crops. Conversely, the dry season provided optimal growing conditions with reduced pest incidence and more stable temperatures, contributing to longer, heavier ears and improved yield. This is consistent with recent climate-resilience studies in maize, such as those by Silva et al. (2023), which emphasized the importance of seasonality and climatic stability in optimizing corn productivity.

3.13 Total Soluble Solids

The total soluble solids of glutinous corn varieties in response to plastic mulch and bio-pesticides application are presented in Table 14.

Table 14. Total Soluble Solids in Brix of Glutinous Corn as Affected by Plastic Mulch and Bio-Pesticide Applied

Code	Treatments	Total Soluble Solids	
		Wet	Dry
FA ₁	Klasika	11.71	16.58
FA ₂	Sweet Purple	10.92	17.83
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FB ₁	Without Plastic Mulch	11.33	16.58
FB ₂	Applied With Plastic Mulch	11.29	17.83
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FC ₁	Crop Vaccine	12.83 ^a	17.33
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	11.00 ^a	17.17
FC ₃	Bio-pesticide	10.67 ^b	17.00
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	10.75 ^b	17.33
<i>F-Test</i>		**	<i>ns</i>

Table 14 presents the total soluble solids (TSS) in °Brix measured across treatments. During the wet season, the variety *Klasika* obtained slightly higher TSS (11.71 °Brix) than Sweet Purple (10.92 °Brix), though this difference

was statistically non-significant. In contrast, during the dry season, Sweet Purple recorded a higher TSS value (17.83 °Brix) compared to *Klasika* (16.58 °Brix), which was also non-significant. The observed fluctuations in TSS across varieties and seasons align with the findings of Bhattarai et al. (2021), who emphasized that environmental factors such as sunlight intensity and water availability significantly influence sugar accumulation in maize kernels, particularly under dry season conditions when evapotranspiration is higher.

As to the effect of plastic mulch, during the wet season, corn plants without mulch recorded slightly better TSS (11.33 °Brix) compared to those with mulch (11.29 °Brix). However, during the dry season, corn plants with plastic mulch showed a higher TSS (17.83 °Brix) than those without (16.58 °Brix). All differences were statistically non-significant. These trends suggest a possible season-dependent interaction, where mulch may retain soil moisture and support sugar accumulation under dry conditions but may hinder aeration and increase humidity-related stress during the wet season. This pattern corresponds with research by Zhou et al. (2021), who reported that mulching under dry environments could enhance sugar content in sweet corn due to improved soil temperature and moisture retention.

In terms of bio-pesticide combinations, corn plants treated with crop vaccine alone recorded the highest TSS value (12.83 °Brix) during the wet season, followed by those treated with crop vaccine + zinc sulfate + ammosul + potash (11.00 °Brix), then by bio-pesticide + zinc sulfate + ammosul + potash (10.75 °Brix), and lastly by bio-pesticide alone (10.67 °Brix). These results showed a statistically significant difference during the wet season, favoring the crop vaccine-only treatment (FC₁). In the dry season, both crop vaccine alone and bio-pesticide + zinc sulfate + ammosul + potash recorded the highest TSS (17.33 °Brix), followed by crop vaccine + zinc sulfate + ammosul + potash (17.17 °Brix), and the lowest was recorded in bio-pesticide alone (17.00 °Brix). However, the differences were not statistically significant. These results suggest that crop vaccine, either alone or in combination, may enhance sugar accumulation, particularly under wet conditions. This agrees with the findings of Nguyen et al. (2020), who observed that biostimulants like crop vaccines can improve carbohydrate metabolism and nutrient uptake, contributing to higher soluble solids in maize.

3.14 Shelf Life

The shelf life of glutinous corn varieties in response to plastic mulch and bio-pesticides application is presented in Table 15.

Table 15. Shelf Life of Glutinous Corn in Days as Affected by Plastic Mulch and Bio-Pesticide Application

Code	Treatments	Total Soluble Solids	
		Wet	Dry
FA ₁	Klasika	6.33	8.00
FA ₂	Sweet Purple	6.21	8.29
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FB ₁	Without Plastic Mulch	6.79	8.00
FB ₂	Applied With Plastic Mulch	5.75	8.29
<i>F-Test</i>		<i>ns</i>	<i>ns</i>
FC ₁	Crop Vaccine	6.25	8.17
FC ₂	CropVaccine+Zinc Sulfate+ Ammosul+Potash	6.17	8.00
FC ₃	Bio-pesticide	6.50	8.17
FC ₄	Bio-pesticide+Zinc Sulfate+ Ammosul+Potash	6.17	8.25
<i>F-Test</i>		<i>ns</i>	<i>ns</i>

Table 15 presents the shelf life of dehusked ears under varying treatments. During the wet season, the variety *Klasika* recorded a slightly longer shelf life (6.33 days) than *Sweet Purple* (6.21 days), though this difference was not statistically significant. In the dry season, *Sweet Purple* showed marginally longer shelf life (8.29 days) compared to *Klasika* (8.00 days), again with non-significant differences. These results suggest that varietal differences had minimal influence on shelf life, and postharvest longevity may be more closely linked to environmental and treatment factors than genetic background alone. Similar findings were reported by Zewdu et al. (2022), who noted that shelf life variability in sweet corn is often more affected by storage and cultivation conditions than by varietal traits.

In terms of plastic mulch application, corn plants grown without mulch had slightly longer shelf life during the wet season (6.79 days) compared to those with mulch (5.75 days). However, the trend reversed during the dry season, with mulched plants exhibiting longer shelf life (8.29 days) than those without mulch (8.00 days). These

differences were not statistically significant in either season. The reversal in shelf life performance may be explained by improved soil moisture and temperature regulation under mulch during drier periods, which contributes to better physiological maturity and cell wall integrity – factors influencing postharvest behavior (Ali et al., 2021).

Regarding bio-pesticide treatments, in the wet season, corn plants treated with bio-pesticide alone had the most extended shelf life (6.5 days), followed closely by those treated with crop vaccine (6.25 days), and lastly by both combined treatment groups (6.17 days each). During the dry season, the treatment with bio-pesticide + zinc sulfate + ammosul + potash resulted in the most extended shelf life (8.25 days), followed by crop vaccine alone and bio-pesticide alone (8.17 days each), and crop vaccine + micronutrients (8.00 days). All variations were statistically non-significant. The improved shelf life seen in treatments with either bio-pesticide or crop vaccine aligns with the study of Lamichhane et al. (2020), which highlighted that biological control agents and micronutrient boosters can influence the postharvest physiology of vegetables and grains by reducing microbial load and enhancing stress tolerance.

Although statistical significance was not observed, consistent trends suggest that specific bio-pesticide formulations may improve postharvest longevity, particularly when combined with proper environmental management during the dry season.

3.15 Summary

The study assessed the effects of bio-pesticides and plastic mulch on the yield and postharvest quality of glutinous corn (*Zea mays L.*) using two varieties – Klasika and Sweet Purple – across wet and dry seasons. Results showed that varietal differences were generally non-significant, although Klasika consistently produced better outcomes in several parameters. For insect damage, both varieties exhibited similar resistance, but plastic mulch significantly increased insect damage during the wet season, likely due to higher moisture levels attracting pests. In terms of marketable ears, Klasika slightly outperformed Sweet Purple in the wet season, whereas Sweet Purple yielded more in the dry season, though differences were statistically non-significant. Notably, the use of plastic mulch resulted in fewer marketable ears during the wet season, a significant finding that suggests mulch may negatively impact marketable yield under high humidity conditions.

Non-marketable ears were significantly higher in Sweet Purple during the wet season. Plastic mulch also significantly increased the number of non-marketable ears under wet conditions. Among bio-pesticide treatments, the combination of bio-pesticide with zinc sulfate, ammosul, and potash produced the highest number of non-marketable ears during the wet season, while bio-pesticide alone resulted in the fewest non-marketable ears during the dry season. Although differences in dehusked ear length were non-significant, Klasika consistently had longer ears than Sweet Purple. Corn plants grown without plastic mulch tended to have slightly longer ears, and the use of crop vaccine alone resulted in the longest ears, regardless of season.

All factors significantly influenced ear weight. Klasika consistently produced significantly heavier dehusked ears compared to Sweet Purple in both seasons. Corn without plastic mulch also had significantly heavier ears than those with mulch. Among treatments, crop vaccine alone and bio-pesticide alone led to the heaviest ears, while combinations with micronutrients tended to reduce ear weight. Yield followed a similar trend: Klasika and corn grown without mulch produced higher yields, although differences were non-significant. Again, crop vaccine alone produced the highest yield, followed closely by bio-pesticide alone.

Total soluble solids (TSS) were highest in Klasika during the wet season and in Sweet Purple during the dry season, with no significant varietal differences. Plastic mulch had minimal effect. However, crop vaccine alone significantly increased TSS in the wet season, suggesting a positive effect on sweetness. Shelf life did not significantly vary by variety, mulch use, or treatment, although corn grown without mulch tended to last longer in the wet season. In the dry season, plastic mulch slightly extended shelf life. Bio-pesticide alone and crop vaccine alone produced longer shelf life than the combined treatments.

Overall, the dry season provided better growing conditions, resulting in heavier and longer ears, higher yields, improved sweetness, and better postharvest quality due to reduced pest pressure and more favorable weather. Klasika showed greater consistency in performance across traits, while plastic mulch was generally unfavorable

during the wet season. Treatments using crop vaccine or bio-pesticide alone consistently yielded better results across agronomic and postharvest traits, suggesting these may be more effective and economical for glutinous corn production than more complex mixtures involving micronutrients.

4.0 Conclusion

The performance of glutinous corn (*Zea mays* L.), specifically the Klasika and Sweet Purple varieties, was influenced by the season, plastic mulch application, and bio-pesticide combinations. Klasika consistently outperformed Sweet Purple in most agronomic traits such as ear length, ear weight, and yield, although the differences were primarily non-significant. The dry season proved more favorable for glutinous corn production due to improved environmental conditions, leading to heavier ears, higher yields, better ear quality, and reduced insect damage compared to the wet season, which was negatively affected by typhoons, high winds, and pest pressure.

Plastic mulch had mixed effects. While it helped reduce non-marketable ears during the dry season, it significantly increased insect damage. It reduced marketable ears and ear weight during the wet season, indicating that its use may be more suitable during dry periods. Across all parameters, the use of plastic mulch was generally not advantageous, especially during the wet season. In terms of bio-pesticide combinations, simpler treatments such as crop vaccine alone or bio-pesticide alone consistently led to better results in terms of ear weight, yield, total soluble solids, and shelf life. Combinations with additional micronutrients like zinc sulfate, ammosul, and potash did not enhance, and in some cases negatively affected, the overall performance of glutinous corn. This suggests that simpler, less costly bio-pesticide treatments may be more effective and economical for growers. In conclusion, for optimal yield and postharvest quality of glutinous corn, the Klasika variety is recommended, particularly during the dry season. The application of crop vaccine or bio-pesticide alone is sufficient and preferable over more complex combinations. Additionally, the use of plastic mulch should be reconsidered, especially during the wet season, due to its tendency to.

4.1 Implications for Practice

For farmers and local agricultural practitioners, this study provides practical, evidence-based alternatives to synthetic pesticides. The use of a cost-effective, locally formulated bio-pesticide—composed of standard farm-based inputs—offers a feasible solution for smallholder farmers aiming to adopt organic or low-input farming systems. Likewise, plastic mulch not only improved soil moisture retention and weed suppression but also contributed to improved ear development and husk freshness postharvest. These practices can support higher marketability and income generation, particularly for green corn intended for fresh consumption.

4.2 Implications for Policy

The results support the goals of the Organic Agriculture Act of 2010 (RA 10068) and its amendment RA 11511, which promote the use of bio-based and environmentally safe agricultural inputs. Policymakers may consider using these findings to develop subsidy programs or training modules encouraging the adoption of biological pest control and mulching technologies. Additionally, local government units and agricultural extension offices could integrate these techniques into their sustainable agriculture initiatives, thereby contributing to national food security and environmental stewardship.

4.3 Implications for Education

Agricultural colleges and vocational training institutions should incorporate hands-on modules on the preparation and use of indigenous bio-pesticides, proper plastic mulch installation, and variety-specific management practices. This can enhance the capacity of future practitioners and agripreneurs in sustainable crop production, aligning agricultural education with global and national development goals. Integrating this knowledge into agricultural extension programs will further benefit local farming communities.

4.4 Implications for Research

This study opens avenues for more rigorous and long-term field trials across different agro-ecological zones, particularly in varying climatic conditions. Future research may focus on:

Comparative life-cycle analysis of biodegradable vs. polyethylene mulches.

Soil microbiota and biodiversity responses to repeated bio-pesticide and mulch application.

Economic feasibility studies assessing cost-benefit ratios of locally formulated vs. commercial bio-inputs. Postharvest physiology, including biochemical analysis of sugar-starch conversion and husk degradation rates under different treatment combinations.

Moreover, research could explore digital tools (e.g., remote sensing or soil moisture sensors) to optimize mulch placement and application timing of bio-pesticides, contributing to the precision agriculture movement in smallholder contexts.

5.0 Contribution of Authors

A sole researcher conducts this research.

6.0 Funding

The author and the Commission on Higher Education fund this research.

7.0 Conflict of Interest

The author declares no conflict of interest regarding the publication of this paper.

8.0 Acknowledgment

The author wishes to express sincere gratitude to all individuals and groups who, in one way or another, contributed to the successful completion of this dissertation. Heartfelt thanks go to the Third Year Bachelor of Agricultural Technology students for their assistance in preparing the research area through underbrushing and clearbrushing. Appreciation is also extended to the First Year Bachelor of Agricultural Technology students for their help in installing the plastic mulch, fertilizing, and planting the research area. The author is equally grateful to the Second and Third Year Bachelor of Science in Agriculture students, for their support in land preparation, mulch installation, fertilization, and planting. Special thanks are due to one of the Fourth Year BAT Student for plowing and harrowing the research area and for improving the access road. BSA 1 Student is also acknowledged for cleaning the research area and contributing to the road improvements. Gratitude is extended to the utility worker for managing all construction work within the research area, and to another utility worker for his invaluable assistance in land preparation, planting, data gathering, and encoding. The farm technician is appreciated for his efforts in area preparation, planting, and data collection. The author thanked the former Dean of the College of Agriculture of Central Philippines State University, for granting access to laboratory facilities of the Crop Science Department, and to the Dean of the Graduate School, for conducting the statistical treatment of data. Deep appreciation goes to the adviser for his unwavering support in the field layout and for reviewing and revising the manuscript. The author is also profoundly thankful to his sons, whose presence served as inspiration throughout the journey. Above all, the author offers utmost gratitude to the Almighty God for the divine guidance and strength bestowed during this academic endeavor.

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