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Optimizing Sweet Corn Yield and Profitability Through NPK Compound Fertilizer Application

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***Abstract**. Sweet corn (Zea mays L. saccharata) is a high-value horticultural crop whose productivity is closely linked to effective nutrient management, particularly the balanced application of macronutrients—nitrogen (N), phosphorus (P), and potassium (K). This study evaluates the agronomic and economic impacts of applying NPK compound fertilizer at varying doses (0.5×, 0.75×, 1.0×, 1.25×, and 1.5× the recommended rate) on sweet corn growth and yield performance. Field experiments demonstrated that NPK application significantly enhanced vegetative growth parameters, including plant height, leaf number, and stem diameter, with improvements ranging from 15.8% to 37.3% over the unfertilized control. Yield components such as ear length, husked ear weight, and dehusked ear weight also showed marked increases, resulting in higher total yields per plot and per hectare. Among the treatments, the 1.25× dose achieved the highest relative agronomic effectiveness (RAE) at 147%, indicating superior nutrient utilization and biomass conversion. However, the 1.0× dose yielded the most favorable economic outcome, generating a net profit of Rp. 10,780,200 and an R/C ratio of 1.47, suggesting optimal cost-efficiency. These findings underscore the dual benefits of NPK compound fertilizer in sweet corn cultivation, highlighting that precise dosage not only maximizes agronomic performance but also enhances economic viability. The study recommends adopting the 1.0× dose for balanced productivity and profitability, while the 1.25× dose may be considered in contexts prioritizing yield maximization.*

***Keywords**: Dose Optimization; Farm Profitability; Relative Effectiveness; Vegetative Growth; Yield Components*

1. INTRODUCTION

Sweet corn (*Zea mays* L. saccharata) is a widely cultivated crop valued for its sweet flavor, nutritional content, and economic potential (Feng et al., 2020). As consumer demand for high-quality produce continues to rise, optimizing agronomic practices to enhance sweet corn productivity has become increasingly important. Among the key factors influencing crop performance, fertilization plays a central role in determining both vegetative growth and yield outcomes (Pangaribuan et al., 2020; Agussalim et al., 2022).

Nitrogen (N), phosphorus (P), and potassium (K) are essential macronutrients required for plant development. NPK compound fertilizers, which combine these nutrients in balanced proportions, are commonly used to support crop growth and improve yield (Ruanjaichon et al., 2021; Revilla et al., 2021; Feng et al., 2020). Nitrogen is crucial for vegetative growth and chlorophyll synthesis (Rao et al., 2021; Schlichting et al., 2015), phosphorus supports root development and energy transfer (Mfilinge et al., 2014; Suliman et al., 2020), while potassium enhances water regulation, enzyme activation, and overall plant resilience (Taha et al., 2020; Lu et al., 2015; Nurliawati & Faqih, 2024). The synergistic effect of these nutrients can

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significantly influence the physiological and reproductive processes of crops, including sweet corn.

Despite the known benefits of NPK fertilization, determining the optimal dosage for maximum agronomic and economic efficiency remains a challenge, particularly under varying environmental and soil conditions (Samudin et al., 2025). Over-application may lead to nutrient imbalances and environmental concerns, while under-application can limit crop potential (Xie et al., 2022; Qin et al., 2015). Therefore, evaluating the effectiveness of different NPK compound fertilizer doses is essential to guide sustainable and profitable sweet corn cultivation.

Previous studies have demonstrated that NPK fertilization can improve growth parameters such as plant height, leaf number, and stem diameter, which are closely linked to yield components like ear length, ear weight, and total yield (Adiaha & Agba, 2016; Alley et al., 2009; Brown et al., 2010; Kaiser et al., 2016). However, the agronomic effectiveness must also be complemented by economic feasibility to ensure that fertilizer application translates into tangible benefits for farmers. Metrics such as Relative Agronomic Effectiveness (RAE), profit margins, and the R/C ratio are valuable tools for assessing both the biological and financial impacts of fertilization strategies.

This study aims to evaluate the agronomic and economic effectiveness of various NPK compound fertilizer doses on sweet corn growth and yield. Specifically, it investigates the impact of fertilizer application on vegetative growth, yield components, total yield per plot and per hectare, RAE values, and farm profitability. The findings are expected to provide practical recommendations for optimizing fertilizer use in sweet corn production, contributing to improved crop performance and farmer income.

2. RESEARCH METHODS

Materials and Equipment

The materials used in this experiment included sweet corn hybrid seeds and a compound NPK fertilizer whose effectiveness was being tested, along with Urea, SP-36, and KCl fertilizers. The tested compound NPK fertilizer contained 16.8% total nitrogen (N), 16.2% phosphorus pentoxide (P_2O_5), and 16.1% potassium oxide (K_2O). The equipment used included cultivation tools (hoe, hand cultivator, sprayer), sample stakes, measuring tape, and a digital scale. Data processing was conducted using a computer and the SAS statistical analysis software.

Experiment Method

The experimental design used was a randomized complete block design (RCBD). The treatments consisted of seven fertilization levels: no inorganic fertilizer (P0), reference inorganic fertilization (P1), 0.5 dose of compound NPK fertilizer (P2), 0.75 dose of compound NPK fertilizer (P3), 1 dose of compound NPK fertilizer (P4), 1.25 dose of compound NPK fertilizer (P5), and 1.5 dose of compound NPK fertilizer (P6). The experiment was conducted with four replications, resulting in 28 experimental units. Each unit was a plot of land measuring 25 m². Detailed information on the treatments tested in this fertilizer effectiveness trial is presented in Table 1.

Table 1. Details of Compound NPK Fertilizer Treatments.

Treatment	Fertilizer Dose (kg/ha)			
	NPK	Urea	SP-36	KCl
Control	-	-	-	-
Reference	-	300	150	150
0.5 dose of compound NPK fertilizer	166	88	-	30
0.75 dose of compound NPK fertilizer	249	132	-	46
1.0 dose of compound NPK fertilizer	333	176	-	61
1.25 dose of compound NPK fertilizer	416	220	-	76
1.5 dose of compound NPK fertilizer	499	263	-	91

Experimental Procedure

Plots of land measuring 5 m × 5 m were prepared and thoroughly tilled with two rounds of plowing. The soil was then leveled to prepare it for planting. Seeds were sown at a spacing of 75 cm × 25 cm, with one seed per planting hole. At planting, Furadan was applied at a rate of 20 kg/ha directly into the planting holes.

Urea and compound NPK fertilizers were applied in two stages: 50% of the dose at planting, and the remaining 50% at four weeks after planting (WAP), placed in furrows approximately 7 cm from the planting holes. SP-36 and KCl fertilizers were applied entirely at planting, also in furrows about 7 cm from the planting holes. After fertilization, the furrows were covered again.

Pest and disease control was carried out selectively using pesticides, depending on the type and severity of infestation. Weeding was performed prior to the second fertilization.

Observations

Growth parameters observed included plant height and leaf number, measured on five randomly selected sample plants. Plant growth was monitored weekly. Yield and yield components were recorded at harvest, including ear length, ear diameter, ear weight with husk, ear weight without husk, yield per plot, and yield per hectare.

Data Analysis

Data were statistically analyzed using analysis of variance (ANOVA). If significant differences were found, the Duncan Multiple Range Test (DMRT) at the 5% significance level was used for further comparison. The effectiveness of the compound NPK fertilizer was considered superior to the control and reference treatments if the EAR value exceeded 100.

3. RESULTS AND DISCUSSION

Results

Effect of Compound NPK Fertilizer on Sweet Corn Growth

The application of compound NPK fertilizer had a significant effect on the height of sweet corn plants (Table 2). Fertilizer application promoted better plant growth. Plants treated with 0.5 to 1.5 doses of compound NPK fertilizer exhibited greater height compared to the control plants at 3, 5, and 6 weeks after planting (WAP). At 4 WAP, plant height was significantly influenced only by treatments with 0.5 to 1.0 doses of compound NPK fertilizer. Nevertheless, all levels of NPK fertilizer dosage resulted in better growth responses than the control by the end of the observation period.

Table 2. Sweet corn plant height across different compound NPK fertilizer application levels.

Treatment	Plant Height (cm)			
	3 WAP	4 WAP	5 WAP	6 WAP
Control	76.9b	107.3b	131.7b	157.1b
Reference	98.6a	130.9a	159.8a	187.0a
0.5 dose of compound NPK fertilizer	**104.9a**	**134.5a**	**157.7a**	**184.2a**
0.75 dose of compound NPK fertilizer	**104.3a**	**135.8a**	**151.4a**	**189.5a**
1.0 dose of compound NPK fertilizer	**106.3a**	**129.6a**	**159.1a**	**188.9a**
1.25 dose of compound NPK fertilizer	**100.4a**	124.5ab	**158.5a**	**188.8a**
1.5 dose of compound NPK fertilizer	**94.7a**	116.8ab	**151.6a**	**182.0a**

***Note**: Values in the same column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level.*

The application of compound NPK fertilizer significantly affected the number of leaves in sweet corn plants (Table 3). Observations showed that applying 0.5 to 1.5 doses of compound NPK fertilizer resulted in a higher leaf count compared to the control plants, starting from the initial observation through to the final observation (3–6 weeks after planting, WAP). At the end of the observation period, the number of leaves in fertilized plants ranged from 13.7 to 14.0.

Table 3. Number of leaves in sweet corn plants under various compound NPK fertilizer applications.

Treatment	Leaves Number			
	3 WAP	4 WAP	5 WAP	6 WAP
Control	5.7b	6.9b	8.9b	10.9b
Reference	8.0a	9.9a	11.9a	13.9a
0.5 dose of compound NPK fertilizer	**7.7a**	**9.7a**	**11.7a**	**13.7a**
0.75 dose of compound NPK fertilizer	**8.0a**	**10.0a**	**12.0a**	**14.0a**
1.0 dose of compound NPK fertilizer	**8.0a**	**10.0a**	**12.0a**	**14.0a**
1.25 dose of compound NPK fertilizer	**8.0a**	**10.0a**	**12.0a**	**14.0a**
1.5 dose of compound NPK fertilizer	**7.8a**	**9.7a**	**11.7a**	**13.7a**

***Note**: Values in the same column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level.*

Compound NPK fertilizer also had a significant effect on stem diameter (Table 4). The results indicated that different dosage levels of the fertilizer increased stem diameter. Treatments with 0.5 to 1.5 doses of compound NPK fertilizer produced thicker stems compared to the control plants, consistently from 3 to 6 WAP. The stem diameter of fertilized sweet corn plants ranged from 8.9 to 9.2 cm, while control plants had a stem diameter of only 6.7 cm.

Table 4. Stem diameter of sweet corn under compound NPK fertilizer treatments.

Treatment	Stem Diameter (cm)			
	3 WAP	4 WAP	5 WAP	6 WAP
Control	4.9b	5.2b	6.0b	6.7b
Reference	6.6a	7.7a	8.3a	8.6a
0.5 dose of compound NPK fertilizer	**6.9a**	**7.8a**	**8.3a**	**9.2a**
0.75 dose of compound NPK fertilizer	**6.9a**	**7.8a**	**8.2a**	**9.2a**
1.0 dose of compound NPK fertilizer	**6.9a**	**7.6a**	**8.2a**	**9.1a**
1.25 dose of compound NPK fertilizer	**6.8a**	**7.4a**	**8.3a**	**9.0a**
1.5 dose of compound NPK fertilizer	**6.6a**	**7.1a**	**7.9a**	**8.9a**

***Note**: Values in the same column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level.*

Effect of NPK Compound Fertilizer on Yield Components and Yield of Sweet Corn Plants

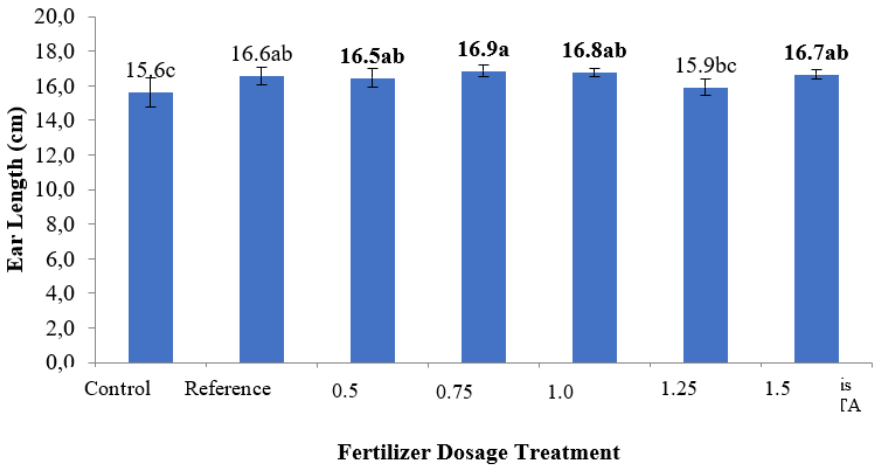

Figure 1. Ear length of sweet corn under NPK compound fertilizer treatments.

The application of NPK compound fertilizer significantly influenced the ear length of sweet corn (Figure 1). Based on observations, applying 0.5, 1.0, and 1.5 doses of NPK compound fertilizer resulted in the longest ears compared to the control plants. In contrast, the application of 1.25 doses did not show a statistically significant difference from the control. Plants treated with NPK compound fertilizer produced ear lengths ranging from 16.5 to 16.9 cm, whereas control plants only reached 15.6 cm.

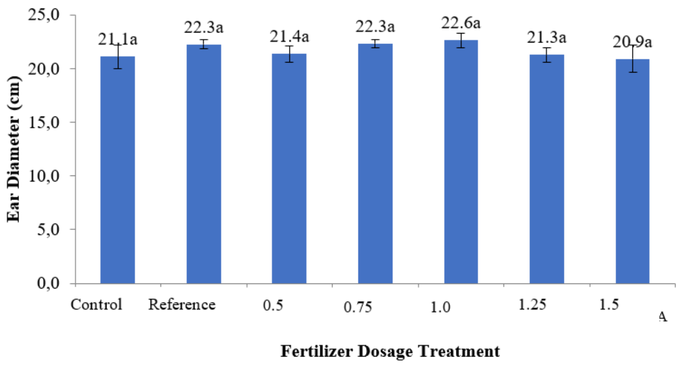

Figure 2. Ear diameter of sweet corn under NPK compound fertilizer treatment.

The application of NPK compound fertilizer did not show a significant response in the ear diameter of sweet corn plants (Figure 2). Neither the different fertilizer doses nor the comparison fertilizer treatments resulted in ear diameters that differed from the control plants. The ear diameter of sweet corn in this experiment ranged from 20.9 to 22.6 cm.

However, the application of NPK compound fertilizer showed a significant response in the husked and dehusked ear weights of sweet corn (Table 5). Fertilizer doses ranging from 0.5 to 1.5 times the standard NPK compound fertilizer resulted in better husked ear weights compared to the control plants, which ranged from 280.9 to 326.5 g, while the control plants only produced husked ear weights of 221.7 g. A slightly different trend was observed in the dehusked ear weight variable. The 1.25-dose NPK compound fertilizer treatment did not differ significantly from the control, but the other NPK fertilizer dose treatments showed better results than the control.

Table 5. Ear weight of sweet corn under NPK compound fertilizer treatment.

Treatment	Husked Ear Weight (g)	Dehusked Ear Weight (g)
Control	221.7b	191.7b
Reference	288.8a	256.3a
0.5 dose of compound NPK fertilizer	**304.4a**	**245.9a**
0.75 dose of compound NPK fertilizer	**326.5a**	**258.9a**
1.0 dose of compound NPK fertilizer	**302.5a**	**264.6a**
1.25 dose of compound NPK fertilizer	**280.9a**	227.9ab
1.5 dose of compound NPK fertilizer	**298.4a**	**245.9a**

Note: *Values in the same column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level.*

The application of NPK compound fertilizer showed a significant response to the yield of sweet corn (Table 6). Observations indicated that applying 0.5 to 1.25 doses of NPK compound fertilizer increased both yield per plot and yield per hectare compared to the control treatment. These doses produced yields per plot ranging from 19.0 to 21.0 kg, whereas the control treatment only yielded 11.9 kg. Higher plot yields also positively correlated with sweet corn yield per hectare. Sweet corn plants treated with 0.5 to 1.25 doses of NPK compound fertilizer yielded between 7.6 and 8.4 tons/ha, while untreated plants only produced 4.8 tons/ha.

Table 6. Sweet corn yield under NPK compound fertilizer treatment.

Treatment	Yield per Plot (kg)	Yield per Hectare (kg/ha)
Control	11.9c	4760c
Reference	18.1ab	7240ab
0.5 dose of compound NPK fertilizer	**19.0ab**	**7590ab**
0.75 dose of compound NPK fertilizer	**19.7ab**	**7860ab**
1.0 dose of compound NPK fertilizer	**21.0a**	**8380a**
1.25 dose of compound NPK fertilizer	**21.0a**	**8402a**
1.5 dose of compound NPK fertilizer	16.2bc	6460bc

Note*: Values in the same column followed by the same letter are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level.*

Relative Agronomic Effectiveness (RAE)

Relative agronomic effectiveness (RAE) is one measure of a fertilizer's effectiveness. A fertilizer is considered agronomically effective if it has a relative agronomic effectiveness value greater than 100. An RAE value above 100 indicates that the fertilizer increases yield more than the yield increase from the comparison fertilizer relative to the control. The analysis results of the relative agronomic effectiveness of NPK compound fertilizer are presented in Table 7.

Table 7. Relative agronomic effectiveness values under NPK compound fertilizer treatment.

Treatment	RAE (%)
Control	-
Reference	-
0.5 dose of compound NPK fertilizer	114
0.75 dose of compound NPK fertilizer	125
1.0 dose of compound NPK fertilizer	146
1.25 dose of compound NPK fertilizer	147
1.5 dose of compound NPK fertilizer	69

The relative agronomic effectiveness (RAE) values indicated that treatments with 0.5 to 1.25 doses of NPK compound fertilizer were agronomically effective, as they had RAE values greater than 100. This means that the yield increase caused by the NPK compound fertilizer was higher than the increase caused by the comparison fertilizer relative to the control. In this experiment, the 1.25-dose NPK compound fertilizer treatment was the most agronomically effective, with an RAE value of 147%.

Farm Business Analysis

The economic effectiveness of NPK compound fertilizer was evaluated using profit and R/C ratio variables. These two variables are used to assess the economic feasibility of farming. The results of the farm business analysis for several treatments in the NPK fertilizer effectiveness test are presented in Table 8.

Table 8. Farm business analysis results for various treatments in the NPK compound fertilizer effectiveness test.

Treatment	Cost (Rp)	Revenue (Rp)	Benefit (Rp)	R/C
Control	19,000,000	19,040,000	40,000	1.00
Reference	21,715,000	28,960,000	7,245,000	1.33
0.5 dose of compound NPK fertilizer	21,110,400	30,360,000	9,249,600	1.44
0.75 dose of compound NPK fertilizer	21,801,600	31,440,000	9,638,400	1.44
1.0 dose of compound NPK fertilizer	22,739,800	33,520,000	10,780,200	1.47
1.25 dose of compound NPK fertilizer	23,670,000	33,608,000	9,938,000	1.42
1.5 dose of compound NPK fertilizer	24,597,900	25,840,000	1,242,100	1.05

The application of NPK compound fertilizer showed profitable farm business analysis results, as indicated by an R/C ratio greater than 1. The 1.0-dose NPK compound fertilizer treatment provided the highest economic benefit, yielding a profit of Rp. 10,780,200 compared to other treatments. Additionally, this treatment also produced a higher R/C ratio of 1.47.

Discussion

The application of NPK compound fertilizer showed a positive response to the growth of sweet corn plants. Plants treated with the fertilizer exhibited better vegetative growth compared to those that did not receive NPK compound fertilizer. Treatments with 0.5 to 1.5 doses of NPK compound fertilizer resulted in plant height increases ranging from 15.8% to 20.6% compared to the control. Similarly, the number of leaves increased by 25.7% to 28.4%, and stem diameter improved by 32.8% to 37.3% compared to the control. These results indicate that NPK compound fertilizer enhances sweet corn plant growth. Adiaha and Agba (2016) reported that NPK fertilizer improves growth parameters such as plant height and leaf number. Moreover, the application of macronutrients supports better growth than untreated plants. Adequate macronutrient supply is essential for corn plant growth (Alley et al., 2009; Brown et al., 2010; Kaiser et al., 2016).

Good plant growth positively influences yield components and overall sweet corn yield. Measurements of ear length showed that treatments with 0.5, 1.0, and 1.5 doses of NPK compound fertilizer increased ear length by 5.8% to 8.3% compared to the control. However, ear diameter did not show significant differences among treatments. Observations of husked and dehusked ear weights revealed that treatments with 0.5 to 1.5 doses of NPK compound fertilizer increased these parameters by 26.7% to 47.3% and 28.3% to 38.0%, respectively, compared to the control. These improved yield components positively correlated with sweet corn yield per unit area. The experiment showed that treatments with 0.5 to 1.25 doses of NPK compound fertilizer increased plot and hectare yields by up to 76.5% compared to untreated sweet corn plants. This demonstrates that NPK compound fertilizer significantly enhances sweet corn yield. Tabri (2010) found that corn plants treated with NPK macronutrients produced the highest dry grain yield compared to other treatments. Shapiro et al. (2008) stated that primary macronutrient application can increase corn yield, provided that the dosage of each nutrient is carefully considered. Bundy (2004) also supported that the macronutrient content in corn kernels is relatively high, indicating the importance of these nutrients for kernel formation.

Economic analysis showed that the 1.0-dose NPK compound fertilizer treatment provided the highest profit in this experiment. This treatment yielded a profit of Rp. 10,780,200 with an R/C ratio of 1.47. The high yield aligns with good plant growth and improved yield components and overall sweet corn yield. Therefore, the application of 1.0 dose of NPK compound fertilizer is agronomically and economically effective and provides the highest benefit to farmers.

4. CONCLUSION

The application of NPK compound fertilizer significantly improved the growth and yield of sweet corn. Treatments with 0.5 to 1.5 doses of NPK fertilizer enhanced vegetative growth parameters such as plant height, leaf number, and stem diameter compared to the control. These improvements translated into better yield components, including ear length, husked and dehusked ear weights, and ultimately higher yields per plot and per hectare.

Agronomically, the fertilizer treatments—particularly the 1.25-dose—demonstrated high relative agronomic effectiveness (RAE > 100), indicating superior performance compared to the comparison fertilizer. Economically, the 1.0-dose treatment provided the highest profit and R/C ratio, making it the most feasible option for farmers.

Overall, the use of NPK compound fertilizer at appropriate doses is both agronomically and economically effective, offering a promising strategy to enhance sweet corn productivity and profitability.

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