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THE INFLUENCE OF MULCH APPLICATION AND POTASSIUM FERTILIZER DOSAGES ON THE YIELD OF WHITE WAXY CORN (*Zea mays* ceratina)

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ABSTRACT:

This study aims to examine the effects of using different types of mulch and potassium fertilizer dosages on the growth and yield of white waxy corn (Zea mays ceratina). The research was conducted in the experimental garden area of Robyong Hamlet, Wonomulyo Village, Poncokusumo District, Malang Regency, from December 2023 to April 2024. The method used was the Split Plot Design (SPD) with the main plot being the type of mulch (no mulch, rice straw mulch, and black silver plastic mulch) and the sub-plot being the dosage of K2O fertilizer (80, 120, 160, and 200 kg K2O ha^{-1}). Each treatment was repeated 3 times. The results showed that the use of black silver plastic mulch (MP) significantly increased plant height, leaf area, total dry weight, and leaf area index compared to no mulch (TM) and rice straw mulch (MJ). A K2O fertilizer dosage of 200 kg ha^{-1} gave the most optimal results for all growth and yield parameters of corn. The interaction between the use of plastic mulch and higher potassium fertilizer doses (K200) resulted in the highest average yield of 18.90 t ha^{-1}. In conclusion, the use of plastic mulch and the appropriate dosage of potassium fertilizer are essential to support optimal growth and high yields of white waxy corn. The combination of plastic mulch and higher K2O fertilizer dosage enhances water and nutrient use efficiency, supporting optimal conditions for plant growth.

Keywords: mulch, potassium fertilizer, nutrient use efficiency, Zea mays ceratina.

1. INTRODUCTION

Sweet corn is a commodity with high economic value, and its demand increases every year. The use of sweet corn as a food source is due to its good nutritional content, being rich in carbohydrates, fiber, vitamins (such as vitamins A and C), and minerals. One of the hybrid varieties of sweet corn widely cultivated in Indonesia is the Talenta Pertiwi variety, with a sugar content ranging from 12-14º Brix (Pertiwi 2021). The demand for sweet corn in Indonesia is substantial, and this crop plays an essential role in the agricultural industry and food supply in Indonesia. Sweet corn is used for household consumption, local market commodities, food processing industries, and feed.

Efforts to meet the demand for sweet corn in Indonesia consider several aspects, including increasing agricultural production, developing superior varieties, sustainable natural resource management, and efficient distribution and processing. To increase sweet corn production both in quantity and quality, cultivation management such as water supply regulation, temperature, light supply, and nutrient efficiency must be considered, as these factors often limit plant growth and development (Canatoy 2018). Potassium fertilizer management is one approach frequently used in sweet corn cultivation (Pradipta et al. 2014). However, some considerations in potassium fertilizer use include applying fertilizer according to plant needs and the efficiency of fertilizer application.

In sweet corn cultivation, potassium fertilizer application is often inefficient due to over-application, improper application techniques, and environmental conditions. Mulch use is an alternative to enhance potassium fertilizer efficiency. Pulok et al. (2016) stated that mulch and potassium fertilizer have a good relationship, with K2O being an essential nutrient for plants, and mulch helping to increase K2O fertilizer efficiency. Covering the soil with mulch helps plants better absorb and utilize potassium from K2O fertilizer by maintaining soil moisture and preventing potassium loss through leaching (Fan et al. 2022). Therefore, it is crucial to study the effects of mulch use and potassium fertilizer dosages to achieve good sweet corn yield both in quantity and quality.

2. MATERIALS AND METHODS

The research was conducted from December 2023 to April 2024 in the area of Robyong, Wonomulyo Village, Poncokusumo District, Malang Regency. This study used the Split Plot Design (SPD) with the main plot being mulch and the sub-plot being K2O dosage, repeated 3 times.The main plot of mulch consisted of 3 levels: TM = No Mulch MJ = Rice Straw Mulch MP = Black Silver Plastic Mulch, The sub-plot was the difference in K2O fertilizer application with 4 levels: K80: K2O (80 kg ha ha^{-1}) K120: K2O (120 kg ha^{-1}) K160: K2O (160 kg ha^{-1}) K200: K2O (200 kg ha^{-1})

Based on the above description, 12 treatments were obtained. Each treatment was repeated 3 times, resulting in 36 experimental units. Each treatment combination consisted of 72 plants, so a total of 2592 plants were planted.

Observations included growth observations, yield observations, and plant growth analysis. The observational data were analyzed using variance analysis (F test) at the 5% level. If there was a significant effect in the analysis for each treatment, further tests were conducted using the Honest Significant Difference (HSD) test at the 5% level to determine the differences between treatments.

3. RESULTS AND DISCUSSION

Plant Height

Mulch application affected the height of white waxy corn at 45 and 60 days after planting (DAP), while potassium fertilizer dosages influenced height at 30, 45, and 60 DAP (Table 1).

Table 1. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Corn Plant Height at Various Observation Ages

Type of Mulch	Plant Height (cm) at Age (DAP)

	15	30	45	60
TM	26.76	62.44	100.5 a	117.9 a
MJ	24.25	60.24	112.1 b	131.6 b
MP	27.05	65.93	115.3 b	132.8 b
HSD	ns	ns	9.73	10.18
CV (%)	7.86	9.07	6.12	5.49
K_2O Fertilizer	Plant Height (cm) at Age (DAP)			
K80	24.67	58.32 a	101.3 a	106.4 a
K120	25.17	61.44 a	102.1 a	120.8 a
K160	27.07	64.27 a	114.6 b	140.5 b
K200	27.17	67.44 b	119.1 b	139.9 b
HSD	ns	6.69	11.43	11.96
CV (%)	8.61	7.99	7.85	7.04

Explanation: Numbers accompanied by the same letter in the same column indicate no significant difference, based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Leaf Area

Mulch and K2O fertilizer application affected the leaf area of white waxy corn at 30 and 60 DAP. The average leaf area due to these treatments can be seen in Table 2.

Table 2. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Corn Leaf Area at Various Observation Ages

Type of Mulch	Leaf Area (cm^{-2} $plant^{-1}$) at Age (DAP)	
	30	60
TM	143.9 a	1005 a
MJ	147.8 ab	1140 b
MP	166.4 b	1171 b
HSD	20.26	124.8
CV (%)	9.11	7.75
K2O Fertilizer	Leaf Area (cm^{-2} $plant^{-1}$) at Age (DAP)	
K80	141.9 a	1026 a
K120	149.5 ab	1078 ab
K160	158.2 b	1143 b
K200	161.4 b	1176 b
HSD	15.15	100.5
CV (%)	8.24	6.82

Explanation: Numbers accompanied by the same letter in the same column indicate no significant difference, based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Total Dry Weight

Table 3 shows that at 30 DAP, the treatment without mulch (TM) was not significantly different from rice straw mulch (MJ) but significantly different when compared to plastic mulch (MP). The highest average dry weight was obtained with plastic mulch (MP), 302.9 g $plant^{-1}$, while the lowest was obtained with no mulch, 267.8 g $plant^{-1}$. There was no significant difference in K2O fertilizer treatment, with an average total dry weight of 284.9 g $plant^{-1}$.

Table 3. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Total Dry Weight of Corn at Various Observation Ages

Type of Mulch	Total Dry Weight (g plant^{-1}) at Age (DAP)	
	30	60
TM	26.78 a	67.36 a
MJ	28.40 ab	78.38 b
MP	30.29 b	82.51 b
HSD	3.34	9.33
CV (%)	8.03	8.42
K2O Fertilizer	Total Dry Weight (g plant^{-1}) at Age (DAP)	
K80	27.39	69.93 a
K120	28.05	71.73 ab
K160	29.09	80.22 b
K200	29.43	82.46 b
HSD	tn	10.24
CV (%)	12.78	10.10

Explanation: Numbers accompanied by the same letter in the same column indicate no significant difference, based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Leaf Area Index

Mulch and K2O fertilizer application affected the leaf area index of white waxy corn at 30 and 60 DAP. The average leaf area index due to these treatments can be seen in Table 4.

Table 4. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Corn Leaf Area Index at Various Observation Ages

Type of Mulch	Leaf Area Index at Age (DAP)	
	30	60
TM	0.070 a	0.479 a
MJ	0.080 b	0.543 b
MP	0.082 b	0.558 b
HSD	0.0085	0.0594
CV (%)	7.56	7.75
K2O Fertilizer	Leaf Area Index at Age (DAP)	
K80	0.071 a	0.488 a
K120	0.074 ab	0.509 ab
K160	0.079 b	0.544 b
K200	0.084 b	0.560 b
HSD	0.0078	0.0479
CV (%)	7.60	6.82

Explanation: Numbers accompanied by the same letter in the same column indicate no significant difference, based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Crop Growth Rate

Mulch application affected the growth rate of white waxy corn at 30 and 60 DAP, while K2O fertilizer affected the growth rate at 30 and 60 DAP. The average growth rate due to these treatments can be seen in Table 5.

Table 5. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Corn Growth Rate at Various Observation Ages

Type of Mulch	Growth Rate (g cm^{-2} day^{1}) at Agr (DAP)	
	0-30	30-60
TM	0.383 a	0.555 a
MJ	0.392 a	0.666 ab
MP	0.441 b	0.716 b
HSD	0.048	0.098
CV (%)	8.07	10.39
K2O Fertilizer		
K80	0.391	0.539 a
K120	0.394	0.646 ab
K160	0.404	0.674 b
K200	0.431	0.746 b
HSD	ns	0.123
CV (%)	13.01	14.17

Explanation: Numbers accompanied by the same letter in the same column indicate no significant difference, based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Fresh Cob Weight

Table 6 shows that treatments without mulch (TM) and rice straw mulch (MJ) did not show a significant difference in fresh cob weight at each potassium fertilizer dosage, while treatments with plastic mulch (MP) and K80 showed the lowest average fresh cob weight at 283.1 g $plant^{-1}$ compared to other treatments. There was no significant difference in fresh cob weight for K80 and K200 treatments across mulch types, while K120 and K160 treatments showed a significant difference between treatments without mulch (TM) and plastic mulch (MP).

Table 6. Effect of Interaction of Various Types of Mulch and Potassium Fertilizer Dosages on Fresh Cob Weight

Treatment	Fresh Cob Weight (g plant-1)			
	K80	K120	K160	K200
TM	259.1 a	255.3 a	285.2 a	318.9 a
	A	A	A	A
MJ	289.9 a	305.4 a	315.4 a	302.7 a
	A	AB	AB	A
MP	283.1 a	353.4 b	362.0 b	361.1 b
	A	B	B	A
HSD	69.06			
CV Mulch (%)	14.79			
CV Potassium (%)	7.38			

Explanation: Numbers accompanied by the same uppercase letter in the same column and the same lowercase letter in the same row indicate no significant difference based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Brix

Mulch application did not affect the sweetness of white waxy corn, while K2O fertilizer did affect the sweetness (Table 7).

Table 7. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Corn Sweetness

Type of Mulch	Brix (%)
TM	11.25
MJ	12.08
MP	12.67
HSD	Ns
CV (%)	8.67
K2O Fertilizer	Brix (%)
K80	10.56 a
K120	11.67 ab
K160	12.33 b
K200	13.44 b
HSD	1.42
CV (%)	8.86

Explanation: Numbers accompanied by the same letter in the same column indicate no significant difference, based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

Yield

Table 8 shows that treatment without mulch (TM) and K80 did not show a significant difference from K120 but did show a significant difference from K160 and K200. Treatments with rice straw mulch (MJ) and K80 did not show a significant difference from K120 and K200 but did show a significant difference from K160. Treatments with plastic mulch (MP) and K80 did not show a significant difference from K120 and K160 but did show a significant difference from K200. K80, K120, and K160 treatments did not show a significant difference across mulch types, while K200 treatment showed the highest average yield with plastic mulch (MP) at 18.90 t ha^{-1} compared to other treatments.

Table 8. Effect of Various Types of Mulch and Potassium Fertilizer Dosages on Corn Yield

Treatment	Yield (t ha^{-1})			
	K80	K120	K160	K200
TM	9.187 a	11.95 ab	13.53 b	14.60 b
	A	A	A	A
MJ	11.65 a	13.25 ab	15.92 b	14,53 ab
	A	A	A	A
MP	11.91 a	12.67 a	15.21 ab	18.90 b
	A	A	A	B
HSD	3.82			
CV Mulch (%)	12.74			
CV Pottasium (%)	9.24			

Explanation: Numbers accompanied by the same uppercase letter in the same column and the same lowercase letter in the same row indicate no significant difference based on the HSD (Honestly Significant Difference) test at the 5% level; ns = not significant; CV = coefficient of variation.

The use of plastic mulch (MP) and rice straw mulch (MJ) showed significantly higher plant height at 45 and 60 DAP compared to no mulch (TM). A potassium dosage of K200 resulted in the highest plant height compared to other dosages, especially at 45 and 60 DAP. Plastic mulch (MP) resulted in larger leaf areas compared to no mulch (TM) and rice straw mulch (MJ). A potassium dosage of K200 showed the highest leaf area at 30 and 60 DAP.

Mulch is a soil cover material used for various agronomic purposes, including weed control, soil moisture management, and soil temperature enhancement. In this study, the mulch used was plastic mulch (MP) and rice straw mulch (MJ). The use of plastic mulch was proven to be effective and optimal for corn growth. This study's results are supported by research stating that plastic mulch can increase water and fertilizer use efficiency, thereby supporting better plant growth and yield (Li and Zhang 2022). Research by Fan et al. (2016) also stated that plastic mulch can increase soil temperature, accelerating plant growth. Agber et al. (2017) found that mulch significantly affected plant height, with the highest plant height under mulch (144.5 cm) compared to no mulch (136.0 cm), and mulch significantly increased corn leaf area, with the highest leaf area under mulch (4110 cm^2) compared to no mulch (3340 cm^2).

Plastic mulch (MP) resulted in the highest total dry weight compared to other treatments at 30 and 60 DAP. A potassium dosage of K200 also resulted in significantly higher dry weight compared to other dosages. The use of plastic mulch (MP) and a potassium dosage of K200 resulted in the highest chlorophyll index at 60 DAP. Plastic mulch (MP) and a potassium dosage of K200 resulted in the highest leaf area index at 30 and 60 DAP. Plastic mulch (MP) resulted in a higher growth rate compared to no mulch (TM) and rice straw mulch (MJ). A potassium dosage of K200 resulted in a significantly higher growth rate compared to other dosages.

Potassium (K) is one of the essential macro-nutrients for plant growth and development. Potassium plays a role in various physiological and biochemical processes in plants, including photosynthesis, nutrient transport, and protein formation (Canatoy 2018). Higher potassium fertilizer dosages (K160 and K200) resulted in better outcomes for various plant growth components. Potassium is an essential nutrient for photosynthesis, carbohydrate translocation, and protein synthesis, all contributing to optimal plant growth (Hafsi et al. 2014). Previous research by Fahrurrozi et al. (2018) showed that increased potassium dosages could enhance photosynthesis efficiency and overall plant growth.

Potassium added through fertilizer is more efficiently used by plants under good soil moisture conditions maintained by mulch, reducing potassium loss through leaching and increasing its availability to plants (Nurliawati and Faqih 2024). The combination of mulch and potassium increases plant tolerance to various environmental stresses (Rahmadiana 2013). Mulch helps reduce water and temperature stress, while potassium helps maintain cell turgor pressure and increases resistance to diseases and unfavorable environmental conditions. Mulch plays a crucial role in improving potassium availability for corn plants by enhancing soil physical properties, increasing water retention, and supporting microbial activity essential for organic matter decomposition (Tumbapo et al. 2024). Therefore, mulch can enhance potassium use efficiency by corn plants, contributing to better growth and yield.

The yield of white waxy corn is influenced by the interaction between mulch types and potassium fertilizer dosages. Plastic mulch (MP) and higher potassium dosages (K160 and K200) resulted in higher yields. Plastic mulch (MP) resulted in higher yields compared to no mulch (TM) and rice straw mulch (MJ). A potassium dosage of K200 resulted in the highest fresh cob weight with husk. A potassium dosage of K200 showed the highest sweetness. Plastic mulch (MP) with a K200 dosage showed the highest fresh cob weight without husk compared to other treatments. Plastic mulch (MP) with a K200 dosage showed optimal yields.

The use of plastic mulch in white waxy corn cultivation supports increased yields due to its ability to maintain soil moisture and control weeds, supporting optimal conditions for plant growth and development. This aligns with the theory stating that plastic mulch can increase water and fertilizer use efficiency and reduce plant stress due to drought (Fahrurrozi et al. 2018). Higher potassium fertilizer dosages (K200) resulted in higher yields because potassium plays a crucial role in plant physiological processes, including photosynthesis, carbohydrate formation and translocation, and increased disease resistance. Previous research showed that increased potassium dosages could enhance crop yield and quality (Alfian and Purnamawati 2019).

Higher potassium fertilizer dosages (K200) resulted in higher yields because potassium plays a crucial role in plant physiological processes, including photosynthesis, carbohydrate formation and translocation, and increased disease resistance. Research by Amanullah et al. (2016) showed that increased potassium dosages could enhance crop yield and fruit quality in corn plants. Research by Hussain et al. (2005) also showed that potassium plays a role in increasing yield quantity and quality, supporting the findings of this study.

The use of plastic mulch and appropriate potassium fertilizer dosages is essential in supporting optimal growth and high yields in white waxy corn. The use of mulch in sweet corn agriculture can affect the soil microclimate, including temperature and moisture, ultimately affecting crop yields (Chaerunnisa et al. 2016). Plastic mulch maintains optimal soil conditions, allowing plants to utilize potassium more efficiently. This study's results showed that different mulch types and potassium fertilizer dosages showed varying responses for each observed parameter. It can be seen that the higher the potassium fertilizer dosage applied and the use of plastic mulch, the better the results. This was evident from the 200 kg ha^{-1} potassium fertilizer dosage resulting in significantly higher yields compared to lower dosages, reaching 18.9 t ha^-1. Research by Amanullah et al. (2016) showed that optimal potassium dosage application in corn plants could increase ear weight in corn plants.

Plastic mulch (MP) gave the best results for corn plants compared to rice straw mulch (MJ) and no mulch (TM). The use of mulch, especially plastic mulch, significantly increased water and nutrient use efficiency, impacting increased growth and yield (Fan et al. 2016). Potassium fertilizer application based on plant growth stages also increased the effectiveness of potassium nutrient absorption by plants, contributing to increased corn crop yield (Alfian and Purnawati 2019). This is because the potassium requirement increases, especially before ear emergence, with about 75% of the total potassium absorbed by the time corn starts flowering (Fahrurrozi et al. 2018). Additionally, potassium can increase the sugar content in plants (Hafsi et al. 2014). Thus, potassium application is crucial in enhancing plant growth, but the interaction with mulch types determines the final yield.

4. CONCLUSIONS

The use of plastic mulch (MP) consistently resulted in better plant height growth compared to no mulch (TM) and rice straw mulch (MJ), especially at 45 and 60 DAP. Higher K2O fertilizer dosages (K160 and K200) positively influenced plant height, leaf area, total dry weight, and especially at 60 DAP. The use of plastic mulch (MP) and higher K2O fertilizer dosages (K160 and K200) consistently increased fresh cob weight without husk, sweetness, and yield. The treatment of plastic mulch (MP) and K200 dosage gave the highest yield of 18.9 t ha^{-1}.

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