AJAB

Original Article

The effect of rice straw mulch and cow urine on growth, yield, quality on sweet corn and pest population density

Darwin H. Pangaribuan[1*], Setyo Widagdo[1], Agus Muhammad Hariri[2], Safrianirmasari Siregar[1], Muhammad Iben Sardio[1]

[1]Department of Agrotechnology, Faculty of Agriculture, Universitas Lampung, Indonesia
[2]Department of Plant Protection, Faculty of Agriculture, Universitas Lampung, Indonesia

Received:
March 15, 2021

Accepted:
May 31, 2022

Published Online:
August 23, 2022

Abstract

Organic matter such as paddy straw mulch and cow urine could be used to improve the soil structure. The study aims to determine the effect of rice straw mulch and cow urine application on growth, yield, quality, and population of sweet corn pests. This study used a 2 x 4 factorial randomized block design with three replications. The first factor is rice straw mulch consisting of 2 levels, namely, with mulch and without mulch, and the second factor is the concentration of cattle urine composed of 4 levels, namely 2.5 ml L^{-1}, 5.0 ml L^{-1}, 7,5 ml L^{-1}, 10.0 ml L^{-1}. The results showed that rice straw mulch and cow urine increased sweet corn's growth, yield, and quality. The maximum yield of 17.87 t ha^{-1} was achieved in the treatment of straw mulch accompanied by cattle urine 10.0 ml L^{-1}. In comparison, the results of 15.33 t ha^{-1} were achieved in the treatment without rice straw mulch accompanied by 10.0 ml L^{-1} cow urine. The intensity of corn planthopper pests (Delphacidae family) ranged from 40-40.4% in 7 WAP and between 44.5 - 51.1% in 8 WAP and was not consistently affected by mulch treatment or the level of concentration of cattle urine.

Keywords: Liquid fertilizers, Nitrogen uptake, Organic farming, Postharvest, Soil structure

How to cite this:

Pangaribuan DH, Widagdo S, Hariri AM, Siregar S and Sardio MI. The effect of rice straw mulch and cow urine on growth, yield, quality on sweet corn and pest population density. Asian J. Agric. Biol. 2023(1): 202103123. DOI: https://doi.org/10.35495/ajab.2021.03.123

**Corresponding author email:*
darwin.pangaribuan@fp.unila.ac.id

Introduction

In Indonesia, sweet corn cultivation has not yet reached its optimum production. Maintaining soil fertility and enhancing nutrients to make sweet corn plants healthier and less susceptible to pests and diseases is one way of increasing sweet corn yield. Organic materials, such as paddy straw mulch and cow urine, keep the soil productive and good soil structure. Mulch covers the soil surface in the planting area using organic and inorganic materials (Iqbal et al., 2020).

Paddy straw can function as a mulch that maintains soil moisture and temperature and suppresses weed growth (Paul et al., 2021) so that plants grow better. According to Adnan et al. (2020), the use of straw mulch can help reduce pest attacks by reducing the growth of weeds that serve as hosts for pests and plant diseases, ensuring that the planting environment is kept clean. Some of the main pests in sweet corn plants include borer, corn stalks, caterpillars on cobs, aphids, and grasshoppers. The Pyralidae family found in sweet corn plantations is the corn stem borer. The corn stem borer (*Ostrinia furnacalis*) is one of the most important pests in maize. Corn stem borer larvae can damage leaves, stems, and male and female flowers (Nonci, 2004).

Sweet corn (*Zea mays* subs. mays) requires full nutrients for proper growth and development. Cow urine is a source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite, and sulphate (Pradhan et. al., 2018). It contains microorganisms that increase the efficiency of nutrient uptake for plants so that it reduces dependence on inorganic fertilizers and increases plant yields (Sofiana and Syaban, 2017). Many positive results have been shown on the application of urine. A study conducted by Oliveira et al. (2009) stated that the application of urine at a concentration of 1.25% and 1.00% for leaf and soil applications, respectively, could produce the highest height of lettuce. Puspita et al. (2015) research states that the treatment of 20 ml L^{-1} cow urine with 100% inorganic fertilizer (urea 220 kg ha^{-1}) has reached its optimum point compared to 10 ml L^{-1} and 30 ml L^{-1} treatments. Qibtiyah et al. (2015) reported that the application of urine 1500 and 2000 l ha^{-1} showed a significant effect on the growth parameters observed in rice. Result of Pradhan et al. (2017), the highest absorption of N, P, K was from the combined application of the recommended dose of 100% fertilizer with 1200 l ha^{-1} of cow urine as a basal application and 50% leaf spray cow urine. According to Santosa et al. (2015) urine combined with inorganic fertilizers had resulted in a higher yield of shallot than without urine. The urine fermentation process is needed before it is applied to plants. Research by Widjajanto et al. (2017) showed that the use of local microorganisms (LoM) from rotten fruits and vegetables in fermenting cow urine into liquid organic fertilizer was determined by the incubation period, especially at 18 days incubation. In general, cow urine has been used to improve the growth of food crops such as rice (Santosa et al., 2014), chickpeas (Patil et al., 2012), and used as biopesticides (Patel et al., 2019).

Little information exists on the combination effect of mulch and urine. The research objective was to determine the effect of rice straw mulch and the fermented cow urine on growth, N nutrient uptake, yield, postharvest quality of sweet corn, and pest population density

Material and Methods

This research was conducted at Kebun Lapang experimental site located at 5°22'23"S 105°15'49"E, 374 m above sea level, Bandar Lampung, Indonesia, from March to June 2017. The soil type experimental plot was sandy clay loam in texture, neutral in reaction, medium in available nitrogen, phosphorous, potassium. It belonged to the order Ultisol of shallow to medium depth.

The study was conducted with a factorial Randomized Block Design 2 x 4. The first factor is straw mulch (m) which consists of two levels, namely without mulch (m0) and with mulch (m1). The second factor is the application of cow urine (b) which consists of 4 levels of urine with a concentration of 2.5 ml L^{-1} (b_1), 5.0 ml L^{-1} (b_2), 7.5 ml L^{-1} (b_3), and 10.0 ml L^{-1} (b_4).

The research was carried out starting from the fermentation of cow urine. The materials used were: 3 liters of cow urine, 3 kg mojo fruit (*Aegle marmelos*), 2 kg of starfruit (*Averrhora bilimbi*), 2 kg pineapples (*Ananas comosus*), 1 kg of curcuma (*Curcuma heyneana*), 1 kg of white turmeric (*Curcuma manga* Val.) and 1 kg of banana corm (*Musa paradisiaca*) with a ratio of 3: 3: 2: 2: 1: 1: 1. Then all the ingredients are mashed and put in a jerrycan, and blended. Then the jerrycan is closed tightly and given a plastic hole connected to a 1500 ml bottle filled with 500 ml water. After that, it is fermented for 21 days, the cow urine is filtered and ready to use.

Land preparation includes soil tillage by clearing the soil from growing weeds by pulling weeds to the roots. The second soil tillage was loosening the soil with a depth of 15-20 cm, then plotting the size of 3 m x 3 m = 9 m^2 with a distance between plots of 50 cm. The application of rice straw mulch is to cover the soil surface with a thickness of 5 cm with rice straw. Sweet corn is planted at a spacing of 20 cm x 70 cm. Recommended inorganic fertilizers are applied at a rate of 150 kg N ha^{-1}, 100 kg SP-36 ha^{-1}, and 100 kg KCL ha^{-1}. The fermented cow urine is applied every two weeks by watering the cow urine solution into the soil around the sweet corn rooting zone (soil drench). Weeds were controlled manually. Pest and diseases were relatively free from the experimental site. Harvesting is done at 11 WAP.

The variables observed in this experiment were (1) plant height, (2) number of leaves, (3) leaf greenness using a chlorophyll meter (SPAD value), (4) N uptake of leaves when maximum vegetative, (5) oven-dry stover weight, (6) yield, (7) ear diameter, (8) weight of 10 cobs from the tagged plants with husk and (9) without husk, (10) postharvest weight loss of cobs at room temperature (loss during storage) is measured through the difference in ear weight after the 1st, 2nd, 3rd, and 4th day of storage from the weight cobs early harvest, (11) soluble solids content (°Brix) day of harvest at 1st & 2nd after harvest measured by Refractometer, (12) intensity of pest attacks at 7 and 8 WAP, and (13) insect populations at 7 and 8 WAP.

Results and Discussion

Before planting, soil analysis revealed that the pH was 6.16, which is slightly acidic, available phosphorus was 2.38 ppm, which is very low, and the organic carbon content was 1.04%; total nitrogen was 0.10%; K-dd was 0.20 me 100 g^{-1}; CEC was 7.31 me 100 g^{-1}; alkaline saturation was 32.15%, all of which met the low criteria. In the initial soil analysis, the experiment shows that the available nutrients are still low so that fertilization is needed to add nutrients needed by the plant and add soil amendments such as rice straw mulch to improve the physical condition of the soil.

Table-1. Effect of rice straw mulch and cow urine on the vegetative phase of sweet corn plants.

Treatment	Variable Observations				
	Plant height (cm)	Number of Leaves (blades)	SPAD Level (%)	Nitrogen uptake of leaves (g/ml)	Dry weight per plant (g)
Straw Mulch (m)	**F-count followed by the difference value (%)**				
p_1 : m_0 vs m_1	86.23*	24.90*	35.59*	73.38*	42.33*
	5.05%	7.18%	6.16%	16.57%	12.06%
Urine Cow (b)					
p_2 : b-linear	72.21*	43.13*	55.56*	293.90*	12.54*
p_3 : b-quadratic	0.66^{ns}	0.00^{ns}	0.32^{ns}	11.55*	0.23^{ns}
m xb Interactions					
p_4 : p_1x p_2	7.13*	12.30*	8.35*	7.10*	0.37^{ns}
p_5 : p_1x p_3	3.14^{ns}	0.18^{ns}	2.17^{ns}	0.00^{ns}	0.14^{ns}

Notes: m= Straw Mulch; b= cow urine; m x b= Interaction straw mulch and cow urine, *= differs markedly of α 5%; ns=not significantly different at 5 % of α level.

The results showed that the application of rice straw mulch was able to increase plant height, leaf number, SPAD value, N nutrient uptake, and dry weight of sweet corn plants by 5.05%, 7.18%, 6.16%, 16.57%, and 12.06% higher than without rice straw mulch (Table 1).

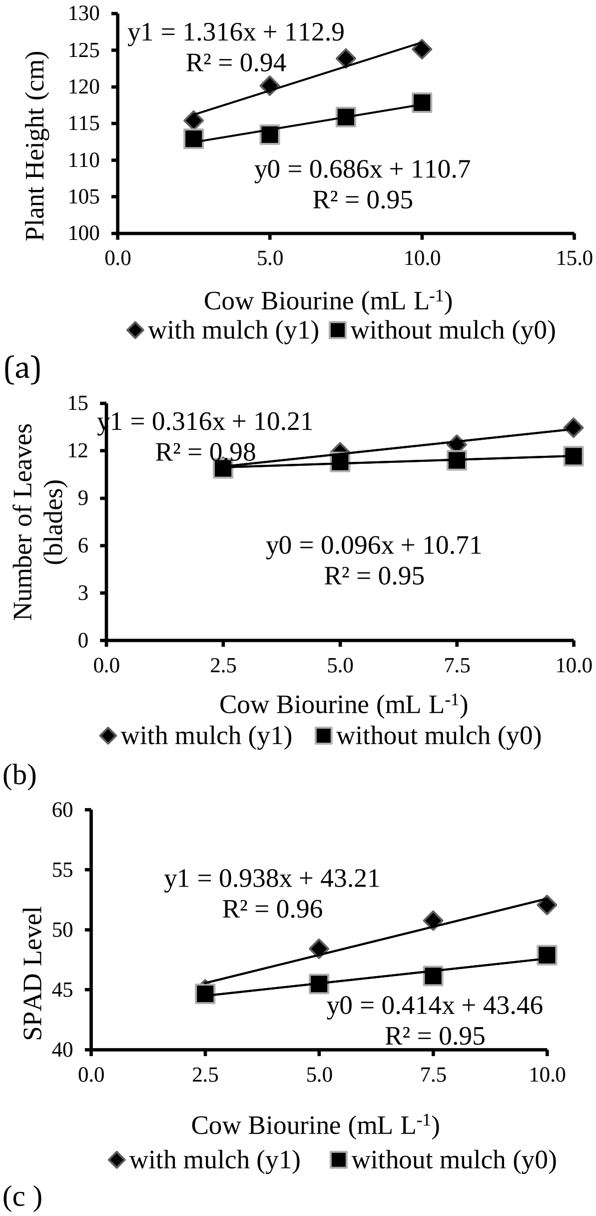
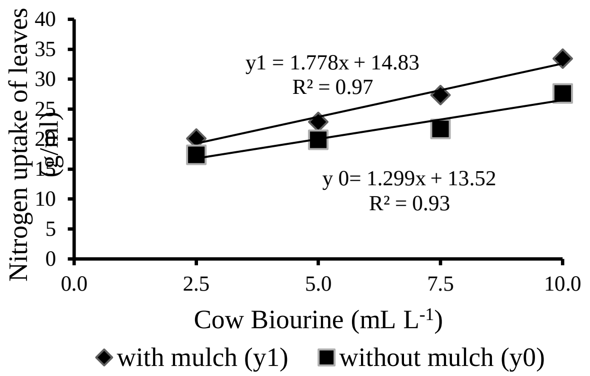
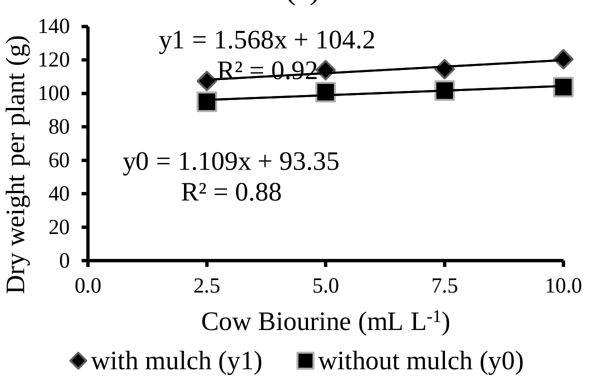


Figure-1. Effect of the interaction of rice straw mulch and cow urine (a) plant height, (b) the number of leaves, (c) level of leaf greenness.

Figure 1 showes that every increase in urine concentration by 1 ml L^{-1} with rice straw mulch increased plant height, the number of leaves, SPAD value, of sweet corn plants, respectively 1.32 kg, 0.32 leaves, 0.94 unit. Then, each 1 ml L^{-1} increase in urine concentration without rice straw mulch increased plant height, leaf number, and leaf greenness of sweet corn plants respectively by 0, 69 kg, 0.10 leaves, and 0.41 unit. Leaves with a darker green color have a higher chlorophyll concentration, allowing plants to maximize their photosynthesis process (Shah et al., 2017; Reis et al., 2009).



(a)



(b)

Figure 2. The effect of the interaction of rice straw mulch and cow urine on (a) N nutrient uptake and (b) dry weight

Figure 2 (a) showes that every 1 ml L^{-1} increase in urine concentration accompanied by rice straw mulch increased N nutrient uptake in sweet corn by 1.78. In contrast, each increase in urine concentration 1 ml L^{-1} without mulch rice straw increased the N nutrient uptake of sweet corn by 1.30. Urine act as a source of energy and food for microbes. The application of urine enhances nitrogen uptake, leading to an increase in protoplasm, which increases plant cell wall thickness (Pradhan et al., 2018; Muratore et al. 2021). Figure 2 (b) shows that increasing the concentration of urine by 1 mL L^{-1} with or without the addition of rice straw mulch increased the dry stover weight of sweet corn by 1.34 g.

Table-2. Effect of rice straw mulch and cow urine on yield and production components of sweet corn.

Treatment	Variable Observations			
	Yield ($t\ ha^{-1}$)	**Cob Diameter (cm)**	**The weight 10 cob with ear (kg)**	**The weight 10 cob without ear (kg)**
Mulch of Straw (m)	**F-count followed by the difference value (%)**			
$p_1 : m_0$ vs m_1	13.68*	30.46*	13.68*	28.93*
	7.14%	12.21%	6.76%	10.87%
Urine Cow (b)				
p_2 : b-linear	66.31*	16.81*	66.31*	153.94*
p_3 : b-quadratic	0.46^{ns}	0.33^{ns}	0.46^{ns}	0.44^{ns}
m xb Interactions				
$p_4 : p_1 x\ p_2$	9.45*	8.45*	9.45*	8.71*
$p_5 : p_1 x\ p_3$	0.46^{ns}	0.33^{ns}	0.67^{ns}	1.59^{ns}

Notes: m= Straw Mulch; b= cow urine; m x b= Interaction straw mulch and cow urine, *= differs markedly of α 5%; ns=not significantly different at 5 % of α level.

The results revealed that using rice straw mulch increased yield, ear diameter, the weight of 10 cobs with husks, and weight of 10 cobs without husks by 7.14 %, 12.21 %, 6.76 %, and 10.87 %, respectively, compared to not using rice straw mulch (Table 2).

Figure 3 shows that increasing urine concentration by 1 mL L^{-1} and applying rice straw mulch increased yield, cob diameter, the weight of 10 cobs with husks, and weight of 10 cobs without husks, respectively, to 0.61 t, 0.13 cm, 0.11 kg, and 0.13 kg. The use of rice straw mulch increased the yield of sweet corn. Rice straw mulch enhances soil conditions and creates favorable environmental conditions (Kavian et al., 2020) for sweet corn plant nutrient uptake. Straw mulch improves the soil's physical and chemical features, such as water content, thermal energy, and nutritional content (Paul et al., 2021). As a result, indirect increases in chlorophyll content, photosynthetic activity, crop yields, and plant growth and development would follow (Zhang et al., 2015). Soil moisture is a limiting issue for cultivation. According to Sekhon et al. (2008) straw mulch could lower soil temperature, retain soil moisture, and promote plant growth and yield. Increased crop production due to the application of straw mulch was also found in research on rice (Devasinghe et al., 2013) and chillies (Rani et al., 2020).

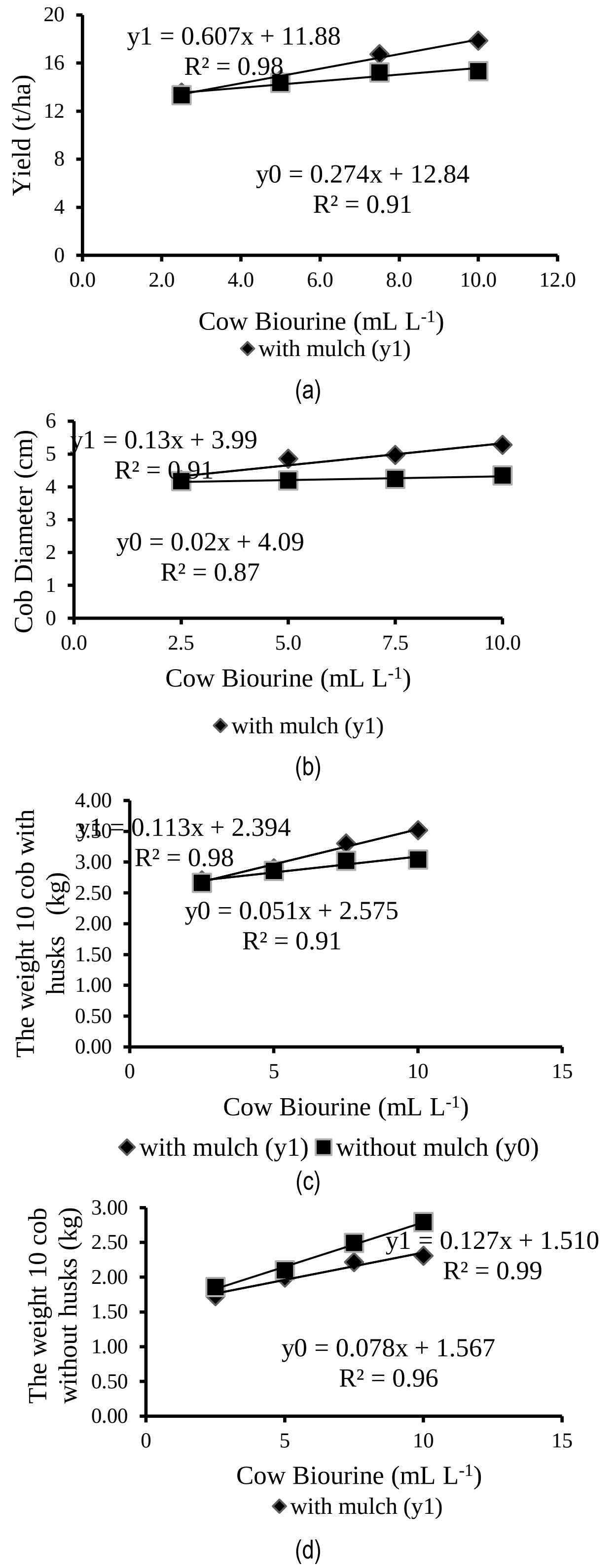


Figure-3. Effect of the interaction of rice straw mulch and cow urine on (a) production, (b) ear diameter, (c) weight of 10 cobs with husks, and (d) weight of 10 cobs without husks.

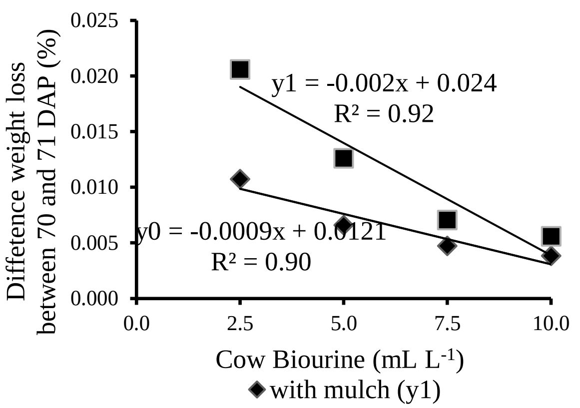
The application of urine to sweet corn plants boosted yield by 0.61 t ha^{-1} for every 1 ml L^{-1} rise in urine concentration with rice straw mulch in this study. The population of soil microorganisms rises when urine is applied, and these bacteria create enzymes that may be absorbed by plants, increasing crop yields (Pradhan et al., 2017). Urine in this study had a high level of N nutrient, with a concentration of 6657.08 ppm. Cow urine contains nitrogen, which can supply additional nutrients to sweet corn plants. In addition to uric acid, urine contains IAA, a growth-regulating hormone that can speed up the growth and development of sweet corn plants. According to Pradhan et al. (2018), cow urine includes 95% water, 2.5% urea, and the remaining 2.5% contains mineral salts, hormones, and enzymes. According to Puspadewi et al. (Puspadewi et al., 2016) and Adu et al. (2018), the element N has a significant impact since it is essential for cell division, which promotes plant growth in terms of both size and volume. Similar results were also found by Nuraini and Asgianingrum (2017), who stated that the application of 600 ml L^{-1} of cow urine fertilizer per plant gives the best results on pak choi plants when compared to controls. The treatment of rice straw mulch and cow urine 10 ml L^{-1} yielded the highest yield of 17.87 t ha^{-1}. Urine includes nutrients and growth hormones, causing a quick photosynthetic process. Gibsona et al. (2011) found that increasing photosynthetic efficiency led to greater yield.

The rice straw mulch and urine application showed an interaction with the vegetative phase of sweet corn plants, such as plant height, leaf number, and SPAD value (Table 1). Sweet corn plants would absorb urine optimally under optimum environmental conditions. Plant height, leaf number, leaf greenness, and N nutritional uptake were all significantly affected by rice straw mulch and cow urine 10.0 ml L^{-1}. According to Zhang et al. (2015), the application of rice straw mulch resulted in the maximum chlorophyll content of corn. Sweet corn plants with good vegetative growth will support plants generative growth.

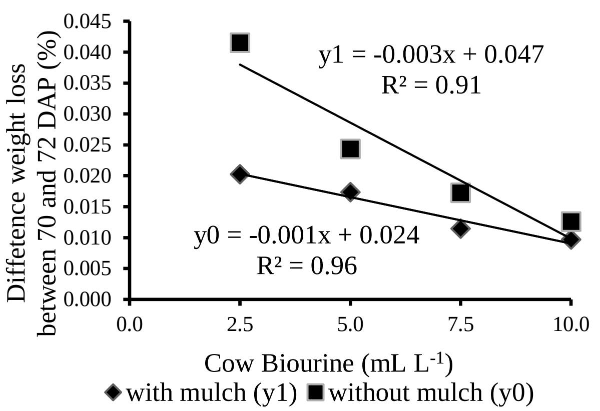
Table-3. The interaction of rice straw mulch and cow urine application on weight loss of cob without husk and sweetness level of corn after harvest.

Treatment	Variable Observations			
	Diffetence weight loss between 70 and 71 DAP (%)	Diffetence weight loss between 70 and 72 DAP (%)	Sucrose level 71 DAP	Sucrose level 72 DAP
Mulch of Straw (m)	F-count followed by the difference value (%)			
$p_1 : m_0$ vs m_1	14.77*	13.44*	35.57*	38.94*
	43.50%	38.62%	6.12%	6.68%
Urine Cow (b)				
p_2 : b-linear	39.73*	34.04*	116.42*	127.46*
p_3 : b-quadratic	3.55^{ns}	1.85^{ns}	1.84^{ns}	2.01^{ns}
m xb Interactions				
$p_4 : p_1 x\ p_2$	5.77*	6.24*	2.12^{ns}	2.32^{ns}
$p_5 : p_1 x\ p_3$	0.39^{ns}	1.28^{ns}	1.18^{ns}	1.29^{ns}

Notes: m= Mulch of Straw; b= cow urine; m x b= Interaction mulch of straw and cow urine, *= differs markedly of α 5%; ns=not significantly different at 5 % of α level.



(a)



(b)

Figure-4. The effect of the interaction of rice straw mulch and cow urine on weight loss of sweet corn cobs without husks on (a) day 1, (b) day 2 after harvest.

The results showed that using rice straw mulch reduced weight loss of sweet corn cobs without husks by 43.50% and 38.62% on the first and second days after harvest, respectively, compared to not using rice straw mulch. The use of rice straw mulch increased the sweetness of sweet corn by 6.12% and 6.68% at 71 and 72 days, respectively, compared to not using rice straw mulch (Table 3).

Figure 4 shows that a 1 mL L^{-1} increase in urine concentration combined with the application of rice straw mulch reduced weight loss of sweet corn during storage by 0,0009% on the first day (Fig 4a) and 0.001% on the second day (Fig 4b).

Figure 5 shows that increasing the urine concentration by 1 mL L^{-1} and applying rice straw mulch raised the sweetness of sweet corn by 0.27 ^{0}Brix on the first day of storage at 71 DAP and 0.27 ^{0}Brix on the second day of storage at 72 DAP. The dynamic weight loss and sugar level of sweet corn could be used to assess postharvest quality. There was a weight loss reduction when rice straw mulch and cow urine were used together. Wills et al. (2007) found that weight loss in sweet corn is proportional to the amount of water that evaporates and the process of respiration that happens during storage. Sweet corn with rice straw mulch has a higher sugar level than sweet corn without rice straw mulch. Similarly, increasing the amount of cow urine resulted in a higher level of sucrose. Every day following harvest, the sucrose content of sweet corn (^{0}Brix) drops, as sweet corn is still respiring after being harvested. However, this study found that using straw mulch and urine maintains the quality of sweet corn during storage, as seen by the increased amount of sucrose after using straw mulch and urine.

Several insect pests were found in sweet corn plants during the 7 WAP and 8 WAP observations, including the Delphacidae, Noctuidae, and Pyralidae families. Insects from the families Mantidae, Coccinellidae, Oxyopidae, and Staphylinidae serve as natural enemies. Corn planthoppers were the most prevalent pest population in this study (Family Delphacidae).

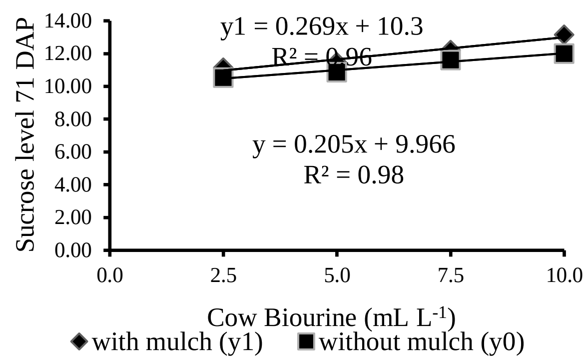
At 7 WAP, the intensity of pest infestations ranged from 40 to 44.4%. The treatment with no mulch and a concentration of urine 7.5 ml L^{-1}, i.e. 44.44%, caused the most damage. The intensity of pest attacks ranged from 44.50 to 51.10% on 8 WAP observations. The treatment without mulch and a concentration of urine 7.5 ml L^{-1} consistently resulted in the highest percentage of damage, 51.10%. The amount of plant damage differed little and did not reveal a significant difference between the various treatments of cow urine concentration and straw mulch.

The corncob borer was found among the insect pests of the Noctuidae family. The female insects of this insect lay their eggs on the corn silk, and the larvae will infiltrate the cob and consume the developing seeds immediately after hatching. The quality and quantity of corn cobs can be harmed by this insect invasion (Pabbage et al., 2007). Only the 7 WAP observation in the without mulch and 2.5 ml L^{-1} treatment and the 8 WAP observation in the with mulch and 10 ml L^{-1} treatment had this pest. This insect isn't affecting sweet corn plant yield because its appearance coincides with harvest season, and the pest's attack isn't severe because it hasn't reached the inner part of the cob.

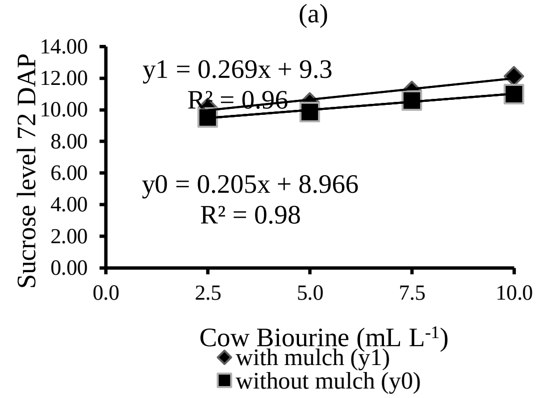
Stenocranus pacificus, a Delphacidae family insect, was discovered. Among other insect pests, the presence of *S. pacificus* is the most common. On the ventral part of the abdomen, female insects have a white waxy coating. Following the development of *S. pacificus* on sweet corn plants, white wax appeared on the lower surface along the leaf bones. *S. pacificus* lays its eggs on the white candle. Hopperburn can occur when these insects strike in high numbers (Susilo et al., 2017). This observation shows no consistent influence on the population of *S. pacificus* between mulch treatment and no mulch, and cow urine concentrations treatment did not have a consistent effect on the population of *S. pacificus* (Family Delphacidae).

Corn stem borer belongs to the Pyralidae family, found in sweet corn plantations. One of the most common maize pests is the corn stem borer (*Ostrinia furnacalis*). Corn stem borer larvae can cause problems on leaves, stems, and male and female flowers, according to Nonci (2004). Corn stem borer populations are most common at 7 WAP and 8 WAP, but their numbers are small. Mulch and no mulch treatments and cow urine concentrations had no consistent effect on the maize stem borer population in the observed population. In addition to insect pests, certain natural enemy insects can be found in the fields. Animals or insects that consume other animals or insects are known as natural enemies (predators). The Coccinellidae, Oxyopidae, Staphylinidae, Mantidae, and Anisolabidae families of insects were discovered. Natural enemies were found in low numbers at the 7 WAP and 8 WAP observations, and had little effect on the pest population.

Among other pests, the maize planthopper (Family Delphacidae) population dominates. Corn leafhoppers (Family Delphacidae) attack intensity on the leaf bone had symptoms like white wax ranging from 40-40.4% in sweet corn plants aged 7 WAP to 44.5-51.1% in sweet corn plants aged 8 WAP, and was not consistently influenced by mulch treatment or the level of fermented cow urine concentration. The liquid urine fertilizer contains fermented vegetable pesticides that operate as biopesticide, resulting in reduced insect attack in this study. Adajar and Taer (2021) have used fermented plant extract to increase corn yield. Kumar et al. (2021) suggest that plant extract could be used as a biopesticide. According to Tembo et al. (2018), using pesticide plant extracts to manage pests is as successful as using synthetic pesticides in terms of yield, while the tritrophic effect is decreased, and could save non-target anthropods that produce a balanced environment. Based on this study, using straw mulch with urine fertilizer increased sweet corn growth, yield, and postharvest quality parameters in acid soils. As a result, for organic farming practices in the tropics, using urine-organic fertilizer in combination with straw mulch is recommended.



(a)



(b)

Figure-5. The effect of the interaction of rice straw mulch and cow urine on the sweetness level of corn at (a) 71 days after planting(b) 72 days after planting.

Conclusion

Sweet corn vegetative growth, yield, and quality were enhanced when rice straw mulch and cow urine were applied. The application of straw mulch on sweetcorn farming improved productivity and quality. Urine at a concentration of 10 mL L^{-1} could be used as an alternative nitrogen fertilizer and hence could be recommended for organic sweet corn growth. Pests from the Delphacidae, Pyralidae, and Nocturdae families were detected in this study, with a low pest population.

Disclaimer: None.
Conflict of Interest: None.
Source of Funding: None.

References

Adajar RR and Taer EC, 2021. Application of foliar biofertilizers with and without NPK in cultivating white-glutinous corn. J. Agric. Appl. Biol. 2: 105-113.

Adnan M, Asif M, Khalid M, Abbas B, Hayyat MS, Raza A, Khan BA, Hassan M, Khan MAB and Hanif MS, 2020. Role of mulches in agriculture: A review. Int. J. Bot. Stud. 5: 309-314.

Adu GB, Alidu H, Amegbor IK, Abdulai MS, Nutsugah SK, Obeng-Antwi K, Kanton RAL, Buah SS, Kombiok MJ, Abudulai M and Etwire PM, 2018. Performance of maize populations under different nitrogen rates in northern Ghana. Annals Agric. Sci. 63: 145-152.

Devasinghe DAUD, Premaratne KP and Sangakkara UR, 2013. Impact of rice straw mulch on growth, yield components and yield of direct seeded lowland rice (*Oryza sativa* L.). Trop. Agric. Res. 24: 325-335.

Gibsona K, Park JS, Nagaia Y, Hwanga SK, Chod YC, Rohc KH, Leec SM, Kimc DH, Choie SB, Ito H, Edwardsa GE and Okita TW, 2011. Exploiting leaf starch synthesis as a transient sink to elevate photosynthesis, plant productivity and yields. Plant Sci. 181: 275-281.

Iqbal R, Raza MAS, Valipour M, Saleem MF, Zaheer MS, Ahmad S, Toleikiene M, Haider I, Aslam MU and Naza MA, 2020. Potential agricultural and environmental benefits of mulches - a review. Bull. Nat. Res. Cent. 44: 1-16.

Kavian A, Kalehhouei M, Gholami L, Jafarian Z, Mohammadi M and Rodrigo-Comino J, 2020. The use of straw mulches to mitigate soil erosion under different antecedent soil moistures. Water 12: 2518.

Kumar J, Ramlal A, Mallick D and Mishra V, 2021. An overview of some biopesticides and their importance in plant protection for commercial acceptance. Plants 10: 1185.

Muratore C, Espen L and Prinsi B, 2021. Nitrogen uptake in plants: The plasma membrane root transport systems from a physiological and proteomic perspective. Plants.10: 681.

Nonci N, 2004. Biologi dan musuh alami penggerek batang batang (*Ostrinia furnacalis* Guenee) (Lepidoptera: Pyralidae) pada tanaman jagung. Jurnal Litbang Pertanian 32: 8-14.

Nuraini Y and Asgianingrum RE, 2017. Peningkatan kualitas biourin sapi dengan penambahan pupuk hayati dan molase serta pengaruhnya terhadap pertumbuhan dan produktivitas pakchoy. Jurnal Hortikultura Indonesia 8: 183-191.

Oliveira NLCd, Puiatti M, Santos RHS, Cecon PR and Rodrigues PHR, 2009. Soil and leaf fertilization of lettuce crop with cow urine. Hort. Bras.27(4): 431-437.

Pabbage MS, Adnan AM and Nonci N, 2007. Pengelolaan hama prapanen jagung In Jagung: Teknik produksi dan pengembangan, pp. 274-304. Bogor: Pusat Penelitian dan Pengembangan Tanaman Pangan.

Patel C, Singh D, Sridhar V, Choudhary A, Dindod A and Padaliya S, 2019. Bioefficacy of cow urine and different types of bio-pesticide against major sucking insect pests of Bt cotton. J. Entomol. Zool. Stud. 7: 1181-1184.

Patil SV, Halikatti SI, Hiremath SM, Babalad HB, Sreenivasa MN, Hebsur NS and Somanagouda G, 2012. Effect of organics on growth and yield of chickpea (*Cicer arietinum* L.) in vertisols. Karnataka J. Agric. Sci. 25: 326-331.

Paul PLC, Bell RW, Barrett-Lennard EG and Kabir E, 2021. Impact of rice straw mulch on soil physical properties, sunflower root distribution and yield in a salt-affected clay-textured soil. Agric. 2021: 264.

Pradhan SS, Bohra JS, Pradhan S and Verma S, 2017. Effect of fertility levels and cow urine application as basal and foliar spray on growth and nutrient uptake of Indian Mustard [*Brassica juncea* (L.) Czernj. & Cosson]. Ecol. Environ. Conserv. 23: 1549-1553.

Pradhan SS, Verma S, Kumari S and Singh Y, 2018. Bio-efficacy of cow urine on crop production: A review. Int. J. Chem. Stud. 6: 298-301.

Puspadewi S, Sutari W and Kusumiyati, 2016. Pengaruh konsentrasi pupuk organik cair (POC) dan dosis pupuk N, P, K terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* L. var Rugosa Bonaf) kultivar Talenta. Jurnal Kultivasi 15: 208-216.

Puspita PB, Sitawati and Santosa M, 2015. Pengaruh urine sapi dan berbagai dosis N terhadap tanaman kailan (*Brassica oleraceae* L.). Jurnal Produksi Tanaman 3: 1-8.

Qibtiyah M, Aini N and Soelistyono R, 2015. The effect of application time and dosage of urine on growth and production of rice (*Oryza Sativa* L.). IOSR J. Agric. Vet. Sci. 1: 26-30.

Rani KV, Umesh, Kumar A, Prakash S and Mandal BK, 2020. Effect of different types of mulching materials on growth and yield of chilli (*Capsicum annum* L. cv. Arka Harita). Int. J. Curr. Microbiol. Appl. Sci. 9: 2005-2012.

Reis AR, Favarin JL, Malavolta E, Júnior JL and Moraes MF, 2009. Photosynthesis, chlorophylls, and SPAD readings in coffee leaves in relation to nitrogen supply. Comm. Soil Sci. Plant Anal. 40:9-10: 1512-1518.

Santosa M, Maghfour MD and Fajriani S, 2014. The effect of solid fertilizers and urine application on plants rice cv Ciherang at Ngujung, Batu, East Java. Res. J. Life Sci. 1: 146-153.

Santosa M, Suryanto A and Maghfoer MD, 2015. Application of urine on growth and yield of shallot fertilized with inorganic and organic fertilizer in Batu, East Java. Agrivita 37: 290-295.

Sekhon NK, Singh CB, Sidhu AS, Thind SS, Hira GS and Khurana DS, 2008. Effect of straw mulching, irrigation and fertilizer nitrogen levels on soil hydrothermal regime, water use and yield of hybrid chilli. Arch. Agron. Soil Sci. 54: 163–174.

Shah SH, Houborg R and McCabe MF, 2017. Response of chlorophyll, carotenoid and SPAD-502 measurement to salinity and nutrient stress in wheat (*Triticum aestivum* L.). Agronomy 7(61):1-21.

Sofiana R and Syaban RA, 2017. Application of urine on the yield and seed quality of two peanut varieties (*Arachis hypogaea* L.). J. Appl. Agric. Sci. 1: 69-78.

Susilo FX, Swibawa IG, Indriyati, Hariri AM, Hasibuan R, Wibowo L, Suharjo R, Fitriana Y, Purnomo, Dirmawati SR, Solikhin S, Sumardiyono S, Rwandini RA, Sembodo DR and Suputa S, 2017. The white-bleed planthopper (Hemiptera: Delphacidae) infesting corn plants in South Lampung, Indonesia. Jurnal Hama Penyakit Tropika. 17: 96-103.

Tembo Y, Mkindi AG, Mkenda PA, Mpumi N, Mwanauta R, Stevenson PC, Ndakidemi PA and Belmain SR, 2018. Pesticidal plant extracts improve yield and reduce insect pests on legume crops without harming beneficial arthropods. Front. Plant Sci. 9: 1-10.

Widjajanto DW, Purbajanti ED, Sumarsono and Utama CS, 2017. The Role of Local Microorganisms Generated from Rotten Fruits and Vegetables in Producing Liquid Organic Fertilizer. J Appl. Chem. Sci 4: 325-329.

Wills RBH, McGlasson WB, Graham D and Joyce DC, 2007. Postharvest: An introduction to the physiology and handling of fruit, vegetables and ornamentals. NSW, Australia and Wallingford, UK: University of New South Wales and CABI. 227 pp.

Zhang X, Qian Y and Cao C, 2015. Effects of straw mulching on maize photosynthetic characteristics and rhizosphere soil micro-ecological environment. Chilean J. Agric. Res. 75: 481-487

Contribution of Authors

Pangaribuan DH: Data analysis, interpretation and manuscript write up
Widagdo S: Critical review and editing of manuscript and data interpretation
Hariri AM: Crop protection analysis, data collection and manuscript write up
Siregar S: Data collection and laboratory analyses
Sardio MI: Data collection and pest inspection