JAPSI (Journal of Agriprecision and Social Impact)
Volume 3 Issue 1 March 2026
e-ISSN: 3032-7849; p-ISSN: 3046-5397, Page 101-117
DOI: https://doi.org/10.62793/japsi.v3i1.95
Available online at: https://journal.kdp.co.id/index.php/japsi

Response of Microclimate Formation, Growth, and Yield of Cucumber (*Cucumis sativus* L.) to Mulch Application and Planting Spacing Variation under Dryland Conditions

Angelika Pasaribu
Department of Agronomy, Faculty of Agriculture, Brawijaya University

Didik Hariyono
Department of Agronomy, Faculty of Agriculture, Brawijaya University

Sisca Fajriani
Department of Agronomy, Faculty of Agriculture, Brawijaya University

Address: Jl. Veteran, Ketawanggede, Lowokwaru District, Malang City, East Java
Corresponding author: sisca.fp@ub.ac.id

Abstract. *Cucumber (Cucumis sativus* L.*) is a high-value horticultural commodity, but its production has declined due to drought stress affecting plant physiology and female flower formation. To address this issue, the use of mulch and planting spacing can modify the microclimate and reduce inter-plant competition. This study aimed to evaluate the effects of rice straw mulch and planting spacing on the growth, yield, and environmental conditions of cucumber. A factorial randomized block design was employed with two factors: mulch (no mulch and rice straw mulch) and planting spacing (40 × 60 cm, 50 × 50 cm, and 60 × 40 cm), replicated four times. Observed variables included vegetative growth, number of male and female flower, yield, soil temperature, and soil moisture. The study was conducted from June to August 2025 at the Agrotechnopark, Brawijaya University. The results showed a significant interaction between rice straw mulch and 50 × 50 cm planting spacing on fruit diameter, fruit length, fruit weight per fruit, fruit weight per plant, and plant productivity. This combination also created a more stable soil environment. It is concluded that the application of rice straw mulch with a 50 × 50 cm planting spacing is the optimal combination for enhancing cucumber growth and yield through improved microclimate conditions, however, these research are limited to a single growing season and a single experimental location.*

Keywords: *Cucumber, Drought management, Planting spacing, Rice straw mulch, Soil microclimate*

Received: February 18, 2026; Accepted: March 1, 2026; Published: March 17, 2026
*Corresponding author, e-mail address sisca.fp@ub.ac.id

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a high-value horticultural commodity in Indonesia, serving as a fresh food ingredient, processed food, and in the cosmetics and health industries due to its rich nutritional content. Data from Irjayanti et al. (2025) shows cucumber productivity declined from 10,73 tons ha-1 in 2022 to 10,25 tons ha-1 in 2023, and further dropped to 5,86 tons ha-1 in 2024. Land drought disrupts plant physiology, such as stomata closure, reduced photosynthesis, and dominance of male over female flowers, suppressing fruit yield potential.

This issue requires innovative cultivation strategies to manipulate soil microclimate, reducing evaporation, stabilizing temperature and humidity, and minimizing plant competition. Control efforts include applying organic mulch like rice straw, which suppresses water evaporation, inhibits weeds, regulates soil temperature, and enhances fertility through decomposition, proven to increase plant length, fruit diameter, and fruit weight in previous studies. Besides mulch application, optimal planting spacing like 40 cm x 60 cm or 50 cm x 50 cm maximizes light, water, and nutrient absorption while reducing competition, with optimal results on cucumber fruit length and weight. Combining mulch application and planting spacing variations has shown potential for cucumber plants.

This research aims to study the interaction of rice straw mulch application and planting spacing variations on growth, yield, and microclimate formation of Romansa cucumber variety, providing adaptive cultivation recommendations for drought conditions in East Java. The use of rice straw mulch combined with a planting spacing of 50 cm × 50 cm was able to improve the growth and yield of cucumber plants through reduced soil temperature and increased soil moisture.

LITERATURE REVIEW

Cucumber is a seasonal fruit vegetable from the Cucurbitaceae family that grows creeping and requires support for optimal growth. The required environmental conditions are temperatures of 20–30°C, 12–14 hours of sunlight per day, and rainfall of around 200–400 mm per month (Karki et al., 2020). Suitable soil is fertile, loose, rich in organic matter, not waterlogged, and has a pH of 6–7, as nutrient availability greatly determines growth and yield. Macronutrients like N, P, and K, and C-organic content play an important role in supporting cucumber productivity (Tampinongkol et al., 2021).

Morphologically, cucumber has a taproot and shallow fibrous root system, requiring soil that easily absorbs water and is rich in nutrients. Its stem is soft, watery, and segmented, supporting leaf growth and transporting water and nutrients (Padmiarso, 2019). Leaves are crucial for photosynthesis and regulating plant physiology, while male and female flowers are separate, so successful pollination affects fruit formation. Cucumber fruit is harvested when young, with bright green color and straight shape (Saparinto & Susiana, 2024).

Mulch modifies soil microclimate, available as organic or inorganic types (Kader et al., 2017). Mulch suppresses evaporation, stabilizes soil temperature, and reduces weed growth, increasing water efficiency and maintenance costs (Kartika & Kurniasih, 2021). Rice straw mulch is easily obtained and effective in maintaining soil moisture and temperature, improving soil structure and adding organic matter, positively impacting cucumber growth and yield (Li et al., 2023).

Planting spacing determines plant population and competition for light, water, and nutrients. Proper spacing provides optimal growth space and eases maintenance (Nurbaiti et al., 2017). Environmental conditions like temperature and humidity are also influenced by suitable spacing. 40 cm × 60 cm spacing gives best results for cucumber yield components like fruit length and weight (Abdurrazak et al., 2013).

Although mulch application and planting spacing have been extensively studied individually, fewer studies have examined their interactive effects on both crop performance and soil microclimate dynamics. Nugroho et al. (2020) observed that combined treatments produced stronger growth responses than single-factor applications, yet mechanistic explanations linking soil temperature, soil moisture, and reproductive outcomes remain limited. Similarly, Agustiyanti et al. (2021) and Yadav & Singh (2025) demonstrated improved vegetative growth and fruit yield under combined mulch–spacing treatments; however, these studies primarily focused on yield parameters without comprehensively integrating microclimate indicators. Therefore, despite the growing body of research on mulching and planting density, there remains a gap in understanding how rice straw mulch and planting spacing interact to regulate soil microclimate and subsequently influence cucumber growth and reproductive performance under drought-prone tropical conditions. A more integrative evaluation that simultaneously considers plant physiological responses, yield components, and soil environmental parameters is needed to clarify the mechanisms underlying productivity enhancement.

RESEARCH METHODS

The research was conducted from June to August 2025 at the Agrotechnopark, Brawijaya University, Jatikerto, Kromengan District, Malang Regency, East Java. The land is located at an altitude of 400 meters above sea level with an average daily temperature of 27ºC. The average rainfall in the Jatikerto area is 150-500 mm/year (Saputri, 2025). The tools used in the research include digital scales, calipers, measuring tapes, soil moisture testers, stem thermometers, stationery, and cameras. The material used is Romansa cucumber seeds. The environmental design uses a Randomized Block Design arranged factorially with 2 factors, namely mulch application and planting spacing variation. The first factor consists of 2 levels, namely without mulch and rice straw mulch. The second factor consists of 3 levels, namely planting spacing of 40 cm × 60 cm, 50 cm × 50 cm, and 60 cm × 40 cm. The design consists of 6 treatment combinations repeated 4 times, resulting in 24 experimental plots. The total plant population is 497 plants.

Cucumber plant care includes routine watering every afternoon, replanting at 7–14 days after planting to replace seedlings that do not grow or are not uniform, and installing stakes 2–3 days after planting to support vertical plant growth. Fertilization is carried out twice at 14 and 21 days after planting using NPK Phonska fertilizer at a dose of 300 kg ha^{-1} with the tugal method, accompanied by pruning at 18 days after planting to stimulate growth and increase fruit production. Pest and disease control is carried out through daily monitoring mechanically and chemically according to the level of attack, including manual control of armyworms (hand picking) in mild attacks.

The variables observed in this study include the number of leaves per plant, plant length, number of male and female flowers, fruitset percentage, minimum and maximum soil temperature, soil moisture, number of fruits per plant, fruit diameter, fruit length, fruit weight per fruit, fruit weight per plant, plant productivity, minimum soil temperature, maximum soil temperature, and soil moisture. The observation results will be analyzed using analysis of variance (ANOVA) at a 5% level. Then, it will be followed by a Honestly Significant Difference test at a 5% level if there is a significant difference between treatments at a 5% level.

RESULTS AND DISCUSSION

1. Number of Leaves

The results of the analysis of variance on the observation of the number of leaves showed no interaction between the mulch application treatment and planting spacing variation. The effect of mulch application treatment had significantly different results at each observation age except 7 DAP, and planting spacing variation had non-significant results at each observation age (Table 1). The research results showed that mulch application produced more leaves compared to plants without mulch, where vegetative growth tended to be slower and the number of leaves was fewer. According to Sharmila and Singh (2020), organic mulch increases the vegetative growth of cucumber plants through increased photosynthetic efficiency and nutrient uptake.

Planting spacing variation did not have a significant effect on plant length or number of leaves at 7, 14, and 21 DAP observations. This indicates that in the early phase of vegetative growth, the difference in distance between plants within the range of planting spacing variation has not created a significant enough difference to affect stem growth or leaf formation. This result is supported by Putri et al. (2023), where the non-significant result on the number of leaves is due to the available nutrient content in the soil that can meet the plant's needs, so the different planting spacing treatments did not significantly affect the observed variable.

Table 1. Average Number of Leaves with Mulch Application and Planting Spacing Variation

Treatment	Number of Leaves (leaf)				
	7 DAP	14 DAP	21 DAP	28 DAP	35 DAP
Mulch:					
Without Mulch	3,66	6,47 b	9,11 b	12,30 b	13,72 b
Rice Straw Mulch	3,80	8,52 a	13,13 a	17,25 a	18,86 a
HSD 5%	ns	1,29	1,51	1,83	1,87
Planting Spacing:					
40 cm × 60 cm	3,70	7,41	11,58	14,58	16,16
50 cm × 50 cm	3,79	8,08	11,25	15,62	17,20
60 cm × 40 cm	3,70	7	10,54	14,12	15,5
HSD 5%	ns	ns	ns	ns	ns
CC (%)	7,68	19,88	15,69	14,25	13,26

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

2. Plant Length

The results of the analysis of variance showed an interaction between mulch application and planting spacing variation on plant length observations at 28 and 35 DAP (Table 3 & Table 4). Mulch application treatment had significantly different results at 14 and 21 DAP observations, while planting spacing variation had significantly different results at 28 and 35 DAP (Table 2). The significant interaction between rice straw mulch and planting spacing at 28 DAP showed that the combination of both factors was able to provide a greater growth response compared to single treatment. The combination of rice straw mulch with 50 cm × 50 cm planting spacing produced the highest plant length, indicating that the moist and stable soil conditions from mulch supported plants in utilizing growth space regulated through planting spacing more efficiently. The research results showed that integrated management of soil microclimate and plant population is a cultivation strategy to increase cucumber growth (Nugroho et al., 2020).

Table 2. Average Plant Length with Mulch Application and Planting Spacing Variation

Treatment	Plant Length (cm)		
	7 DAP	14 DAP	21 DAP
Without Mulch	12,25	19,44 b	35,69 b
Rice Straw Mulch	12,83	25,05 a	50,5 a
HSD 5%	ns	3,07	6,49
Planting Spacing:			
40 cm × 60 cm	12,66	22,62	43,83
50 cm × 50 cm	13	23,95	47,37
60 cm × 40 cm	11,95	20,16	38,08
HSD 5%	ns	ns	ns
CC (%)	6,31	15,55	17,34

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

Table 3. Average Plant Length at 28 DAP Observation with Interaction of Mulch Application and Planting Spacing Variation

Plant Length (cm) on Observation Age 28 DAP			
Mulch	Planting Spacing		
	40 cm × 60 cm	50 cm × 50 cm	60 cm × 40 cm
Without Mulch	59,83 a A	54,16 a B	50,5 a A
Rice Straw Mulch	72,08 ab A	93,08 a A	68 b A
HSD 5%	21,36		
CC (%)	14,01		

Note: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column indicate no significant difference based on HSD at 0.05 level; HSD: Honest Significant Difference; CC: Coefficient of Variation.

Table 4. Average Plant Length at 35 DAP Observation with Interaction of Mulch Application and Planting Spacing Variation

Plant Length (cm) on Observation Age 35 DAP			
Mulch	Planting Spacing		
	40 cm × 60 cm	50 cm × 50 cm	60 cm × 40 cm
Without Mulch	71,41 a A	65,58 a B	58,58 a A
Rice Straw Mulch	83,58 ab A	104,5 a A	74,16 b A
HSD 5%	23,66		
CC (%)	13,48		

Note: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column indicate no significant difference based on HSD at 0.05 level; HSD: Honest Significant Difference; CC: Coefficient of Variation.

3. Number of Male Flowers, Number of Female Flowers, and Percentage of *Fruitset*

The results of the analysis of variance on the number of male flowers, number of female flowers, and fruitset percentage showed no interaction between mulch application and planting spacing variation. Mulch application treatment had significantly different results on the number of female flowers and fruitset percentage, but not on the number of male flowers. Planting spacing variation had non-significant results on the number of male flowers, number of female flowers, and fruitset percentage. Environmental factors such as temperature and water availability are known to affect the ratio of male to female flowers, where dry conditions and high temperatures tend to increase male flowers, while moist conditions support flowering balance (Aparna et al., 2023).

The fruitset percentage in the without mulch treatment was relatively high, but the fewer number of female flowers resulted in lower total fruit and final yield compared to the combination of rice straw mulch and 50 cm × 50 cm planting spacing. High fruitset percentage does not always correlate with harvest yield if the number of female flowers is limited or there are resource allocation limitations for fruit development (Gao et al., 2021). Additionally, planting spacing variation did not significantly affect the formation of male flowers, female flowers, or fruitset percentage, indicating that the generative phase is more influenced by microenvironmental conditions than plant density. Sitorus and Sa’diyah (2024) research showed that planting spacing variation does not always have a consistent effect on cucumber generative variables when environmental factors are relatively stable.

Table 5. Average Number of Male Flowers, Number of Female Flowers, and Fruitset Percentage with Mulch Application and Planting Spacing Variation

Treatment	Generatif Growth Variables		
	Male Flowers	Female Flowers	Percentage of *Fruitset*
Mulch:			
Without Mulch	7,11	9,25 b	86,62 a
Rice Straw Mulch	6,86	12,30 a	74,61 b
HSD 5%	ns	0,98	6,55
Planting Spacing:			
40 cm × 60 cm	6,58	10,79	81,70
50 cm × 50 cm	8,33	11,16	77,58
60 cm × 40 cm	6,04	10,37	82,56
HSD 5%	ns	ns	ns
CC (%)	28,11	10,47	9,36

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

4. Number of Fruit per Plant

The results of the analysis of variance showed no interaction between mulch application and planting spacing variation on the number of fruits per plant. The effect of mulch application treatment had significantly different results on the number of fruits per plant. Planting spacing variation had non-significant results on the observation of the number of fruits per plant (Table 6).

The increase in the number of fruits in the mulch treatment is related to the role of mulch in maintaining soil moisture, suppressing temperature fluctuations, and increasing the efficiency of water and nutrient utilization. The more stable soil conditions support plant physiological activities, including the formation of female flowers and fruit development, resulting in higher production per plant (Kartika & Kurniasih, 2021).

Table 6. Average Number of Fruits per Plant with Mulch Application and Planting Spacing Application

Treatment	Number of Fruit per Plant
Mulch:	
Without Mulch	9,25 b
Rice Straw Mulch	12,30 a
HSD 5%	0,68
Planting Spacing:	
40 cm × 60 cm	10,79
50 cm × 50 cm	11,16
60 cm × 40 cm	10,37
HSD 5%	ns
CC (%)	2,69

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

5. Fruit Diameter

The results of the analysis of variance on fruit diameter observation showed an interaction between mulch application and planting spacing variation, with significantly different results. The interaction between mulch application and planting spacing variation had a significant effect on cucumber fruit diameter, indicating that fruit enlargement is influenced by the combination of soil conditions and plant growth space. Rice straw mulch helps maintain soil moisture and temperature stability, increasing water and nutrient absorption efficiency, and translocation of photosynthates to the fruit, supporting larger fruit size (Yang et al., 2025). Meanwhile, suitable planting spacing reduces competition for light and nutrients, maintaining optimal photosynthesis and allocating assimilates for fruit growth. The combination of soil microclimate improvement by mulch and plant population regulation is an important factor in improving fruit physical quality (Nurbaiti et al., 2017).

Table 7. Average Fruit Diameter with Interaction of Mulch Application and Planting Spacing Variation

Fruit Diameter (mm)			
Mulch	Planting Spacing		
	40 cm × 60 cm	50 cm × 50 cm	60 cm × 40 cm
Without Mulch	47,78 a B	47,89 a B	48,55 a A
Rice Straw Mulch	50,90 a A	50,95 a A	49,33 a A
HSD 5%	2,02		
CC (%)	2,78		

Note: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column indicate no significant difference based on HSD at 0.05 level; HSD: Honest Significant Difference; CC: Coefficient of Variation.

6. Fruit Length

The results of the analysis of variance on fruit length observation showed an interaction between mulch application and planting spacing variation, with significantly different results. The interaction between mulch application and planting spacing variation had a significant effect on cucumber fruit length, indicating that fruit growth response is influenced by physiological and environmental interactions between soil microclimate and plant growth space. In the rice straw mulch treatment, fruit length tended to be higher, especially at 50 cm × 50 cm planting spacing, showing that stable soil moisture and better nutrient availability support fruit enlargement (Kader et al., 2017).

Mulch helps suppress water stress and maintain plant physiological activity, allocating assimilates more optimally to fruit organs. Meanwhile, suitable planting spacing reduces competition between plants for light and nutrients, maintaining effective photosynthesis and supporting maximum fruit growth. Additionally, more even light capture efficiency in the plant canopy helps increase fruit biomass formation, improving fruit yield and quality (Abdurrazak et al., 2013).

Table 8. Average Fruit Length with Interaction of Mulch Application and Planting Spacing Variation

Fruit Lenght (cm)			
Mulch	Planting Spacing		
	40 cm × 60 cm	50 cm × 50 cm	60 cm × 40 cm
Without Mulch	16,16 a B	15,97 ab B	15,61 b B
Rice Straw Mulch	17,35 ab A	17,71 a A	16,54 b A
HSD 5%	0,42		
CC (%)	2,12		

Note: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column indicate no significant difference based on HSD at 0.05 level; HSD: Honest Significant Difference; CC: Coefficient of Variation.

7. Fruit Weight per Plant

The analysis of variance for fruit weight per plant shows a significant interaction between mulch application and planting spacing. The straw mulch treatment at 50 cm × 50 cm spacing resulted in higher fruit weight per plant compared to no mulch, likely due to improved soil moisture and stable soil temperature, enhancing water and nutrient uptake, and increasing assimilate translocation to fruits (Lusiana, 2019). Straw mulch also protects the soil from environmental stress, optimizing fruit growth. The interaction between mulch and spacing affects horticultural crop growth and yield through improved soil conditions and optimal space utilization (Yadav & Singh, 2025).

Table 9. Average Fruit Weight per Plant with Interaction of Mulch Application and Planting Spacing Variation

Fruit Weight per Plant (g)			
Mulch	Jarak Tanam		
	40 cm × 60 cm	50 cm × 50 cm	60 cm × 40 cm
Without Mulch	1347,91 a B	1293 a B	1246,66 a B
Rice Straw Mulch	1851,91 b A	1962,33 a A	1587,25 c A
HSD 5%	182,74		
CC (%)	5,3		

Note: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column indicate no significant difference based on HSD at 0.05 level; HSD: Honest Significant Difference; CC: Coefficient of Variation.

8. Plant Productivity

The results of the analysis of variance on plant productivity observation showed an interaction between mulch application and planting spacing variation, with significantly different results. The application of rice straw mulch combined with 50 × 50 cm planting spacing gave the highest fruit weight per plant and productivity per hectare, around 58.8 tons ha-1. This result is within the range of cucumber variety productivity according to literature. The increase in productivity in this treatment is supported by better plant growth, more balanced flowering between male and female flowers, and a higher number of fruit set. The positive effect of mulch application on plant productivity is also in line with research by Uwah & Iwo (2019), which found that organic mulch can increase horticultural productivity by 25-40% compared to without mulch.

Table 10. Average Plant Productivity with Mulch Application and Planting Spacing Variation

Plant Productivity (ton.ha^{-1})			
Mulch	Planting Spacing		
	40 cm × 60 cm	50 cm × 50 cm	60 cm × 40 cm
Without Mulch	33,67 b B	38,79 ab B	41,55 a B
Rice Straw Mulch	46,29 c A	58,87 a A	52,90 b A
HSD 5%	55,35		
CC (%)	5,31		

Note: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column indicate no significant difference based on HSD at 0.05 level; HSD: Honest Significant Difference; CC: Coefficient of Variation.

9. Minimum Soil Temperature

The results of the analysis of variance on minimum soil temperature observation showed no interaction between mulch application and planting spacing variation. Mulch application treatment had significantly different results at 5, 10, 15, 20, 25, 30, and 35 DAP observations, while planting spacing variation had non-significant results at each observation age (Table 11). Mulch covers the soil surface, reducing heat loss at night and making soil temperature more stable. Stable soil temperature helps roots and soil microorganisms work better in absorbing and providing nutrients for plants (Kader et al., 2017). This shows that soil microclimate conditions are more influenced by mulch application than planting spacing variation.

Table 11. Average Minimum Soil Temperature with Mulch Application and Planting Spacing Variation

Treatment	Minimum Soil Temperature (°C)						
	5 DAP	10DAP	15DAP	20 DAP	25 DAP	30 DAP	35 DAP
Mulch:							
Without Mulch	21,75a	21,77a	20,94 a	21,80 a	21,11	21,72 a	21,66 a
Rice Straw Mulch	21,00 b	21,19b	20,13b	21,00 b	21,08	21,00 b	21,05 b
HSD 5%	0,19	0,24	0,4	0,29	ns	0,21	0,25
Planting Spacing:							
40 cm × 60 cm	21,33	21,41	20,58	21,37	21,04 b	21,33	21,29 b
50 cm × 50 cm	21,37	21,5	20,45	21,37	21,04 b	21,33	21,29 b
60 cm × 40 cm	21,41	21,54	20,58	21,45	21,2 a	21,41	21,5 a
HSD 5%	ns	ns	ns	ns	0,17	ns	0,18
CC (%)	0,6	0,76	1,3	0,91	0,69	0,67	0,8

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

10. Maximum Soil Temperature

The results of the analysis of variance on maximum soil temperature observation showed no interaction between mulch application and planting spacing variation. The research results showed that rice straw mulch application was able to lower maximum soil temperature, especially during the day when solar radiation intensity was at its peak. This decrease was more pronounced compared to the without mulch treatment, where soil temperature tended to increase sharply and experience larger daily fluctuations. Mulch application acts as a covering layer that inhibits heat flow to the soil surface, so solar radiation is not directly received by the soil (Li et al., 2016).

Table 12. Average Maximum Soil Temperature with Mulch Application and Planting Spacing Variation

Treatment	Maximum Soil Temperature (°C)						
	5 DAP	10DAP	15DAP	20 DAP	25 DAP	30 DAP	35 DAP
Mulch:							
Without Mulch	27,94a	27,02a	25,61 a	27,91 a	27,77 a	27,8 a	27,27 a
Rice Straw Mulch	26,97b	26,05b	25,08b	27,13 b	27,08 b	27,16 b	26,22 b
HSD 5%	0,48	0,28	0,24	0,28	0,34	0,32	0,48
Planting Spacing:							
40 cm × 60 cm	27,41	26,58	25,29	27,45	27,37	27,45	26,62 b
50 cm × 50 cm	27,41	26,5	25,29	27,45	27,37	27,41	26,54 b
60 cm × 40 cm	27,54	26,54	25,45	27,66	27,54	27,58	27,08 a
HSD 5%	ns	ns	ns	ns	ns	ns	0,34
CC (%)	1.18	0.7	0.63	0.68	0.83	0.79	1.2

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

11. Soil Moisture

The results of the analysis of variance showed no interaction between mulch application and planting spacing on soil moisture. Mulch application had significantly different results at every observation age. Planting spacing variation had non-significant results at every observation age (Table 13). The results showed that rice straw mulch application significantly increased soil moisture at all observation times, while planting spacing variation did not have a consistent effect. Mulch covers the soil surface, reducing water evaporation and helping maintain water reserves in the root zone. More stable soil moisture supports plant physiological processes like nutrient absorption and photosynthesis, allowing growth to proceed more optimally (Zhang et al., 2023).

Table 13. Average Soil Moisture with Mulch Application and Planting Spacing Variation

Treatment	Soil Moisture (%)						
	5 DAP	10DAP	15DAP	20 DAP	25 DAP	30 DAP	35 DAP
Mulch:							
Without Mulch	73,47 b	76,11b	81,11b	81,38 b	82,5 b	80,97 b	80,69 b
Rice Straw Mulch	75,97 a	79,02a	84,58a	84,30 a	84,72 a	84,58 a	84,16 a
HSD 5%	2,19	1,23	1,6	1,78	2,06	1,09	1,39
Planting Spacing:							
40 cm × 60 cm	74,58	77,91	82,7	83,12	83,95	83,33 a	83,12 a
50 cm × 50 cm	75	77,5	83,54	83,33	84,16	82,91 a	82,91 a
60 cm × 40 cm	74,58	77,29	82,29	82,08	82,7	82,08 b	81,25 b
HSD 5%	ns	ns	ns	ns	ns	0,76	0.98
CC (%)	1,95	1,05	1,28	1,43	1,64	0,87	1,12

Note: Numbers followed by the same letter in the same column and treatment are not significantly different at HSD 5 % ; ns = not significant; DAP = days after planting; HSD: Honest Significant Difference; CC: Coefficient of Variation.

CONCLUSION

The research results showed an interaction between rice straw mulch application and 50 cm × 50 cm planting spacing on variables such as fruit diameter, fruit length, fruit weight per fruit, fruit weight per plant, and plant productivity. The combination of rice straw mulch and 50 cm × 50 cm planting spacing increased fruit diameter by 6.38%, fruit length by 10.89%, fruit weight per fruit by 30.74%, fruit weight per plant by 51.76%, and plant productivity by 51.76% higher compared to the without mulch and 50 cm × 50 cm planting spacing treatment. The combination of rice straw mulch and 50 cm × 50 cm planting spacing was able to lower maximum soil temperature by 3.85% and increase soil moisture by 4.3% compared to the without mulch and 50 cm × 50 cm planting spacing treatment.

The result indicate that the integration of rice straw mulch with 50 cm × 50 cm planting spacing is an effective cultivation strategy to enhance cucumber growth, yield, and soil microclimatic conditions under the conditions of this study. However, the results are limited to a single location and planting season, so their applicability to different agroecological zones and seasonal conditions requires further research. Future research should therefore include multi-location and multi-season trials, as well as long-term assessments, to validate the consistency and sustainability of this cultivation practice across broader environmental conditions.

REFERENCES

Abdurrazak, A., Hatta, M., & Marliah, A. (2013). Pertumbuhan dan Hasil Tanaman Mentimun (*Cucumis sativus* L.) akibat Perbedaan Jarak Tanam dan Jumlah Benih Per Lubang Tanam. *Jurnal Agrista*, *17*(2), 55–59.

Agustiyanti, E., Fredickus, B., & Purnomo, J. (2021). Pengaruh Pemberian Mulsa Organik dan Jarak Tanam terhadap Pertumbuhan dan Hasil Kedelai Edamame Pada Tanah Ultisol. *Enviro Scienteae*, *17*(2), 71–77.

Aparna, Skarzyńska, A., Pląder, W., & Pawełkowicz, M. (2023). Impact of Climate Change on Regulation of Genes Involved in Sex Determination and Fruit Production in Cucumber. *Plants*, 12(14), 1 – 21. Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/plants12142651.

Gao, L., Yu, G., Hu, F., Li, Z., Li, W., & Peng, C. (2021). The Patterns of Male and Female Flowers in Flowering Stage May Not be Optimal Resource Allocation for Fruit and Seed Growth. *Plants*, *10*(12), 1–19. https://doi.org/10.3390/plants10122819.

Irjayanti, A. D., Khairunnisa, D. A., Stiyaningsih, H., Putri, I. M., Sumartini, N. P., & Areka, S. K. (2025). Statistik Holtikultura 2024. Badan Pusat Statistik.

Kader, M. A., Senge, M., Mojid, M. A., & Ito, K. (2017). Recent Advances in Mulching Materials and Methods For Modifying Soil Environment. *Soil and Tillage Research*, *168*, 155 – 166.

Karki, A., Sapkota, B., Bist, P., Bista, K., Dutta, J. P., Marahatta, S., & Shrestha, B. (2020). Mulching Materials Affect Growth and Yield Characters of Cucumber (*Cucumis sativus* cv. Malini) Under Drip Irrigation Condition in Chitwan, Nepal. *Journal of Agriculture and Forestry University*, 153–159.

Kartika, M. N., & Kurniasih, B. (2021). Pengaruh Irigasi Tetes dan Mulsa terhadap Pertumbuhan Tajuk Tanaman Tomat (*Solanum lycopersicum* L.) di Lahan Kering Gunungkidul. *Vegetalika*, *10*(1), 31. https://doi.org/10.22146/veg.55590

Li, B., Liang, F., Wang, Y., Cao, W., Song, H., Chen, J., & Guo, J. (2023). Magnitude and Efficiency of Straw Return in Building Up Soil Organic Carbon: A Global Synthesis Integrating The Impacts of Agricultural Managements and Environmental Conditions. *Science of the Total Environment*, *875*, 2–9.

Li, N., Tian, F., Hu, H., Lu, H., & Ming, G. (2016). Effects of Plastic Mulch on Soil Heat Flux and Energy Balance in a Cotton Field in Northwest China. *Atmosphere, 7*(107), 1–16. https://doi.org/10.3390/atmos7080107

Lusiana. (2019). Pengaruh Mulsa Organik terhadap Pertumbuhan dan Hasil Tanaman Mentimun (*Cucumis sativus* L) Varietas Bandana. *Jurnal Agrorektan*, 6–1.

Nugroho, M. H., Dharma, I. P., & Trigunasih, N. M. (2020). Pengaruh Jarak Tanam dan Mulsa Jerami Padi terhadap Pertumbuhan dan Hasil Tanaman Jagung (*Zea mays* L.). *Jurnal Agroekoteknologi Tropika*, *9*(4), 248–257. https://ojs.unud.ac.id/index.php/JAT248

Nurbaiti, F., Haryono, G., & Suprapto, A. (2017). Pengaruh Pemberian Mulsa dan Jarak Tanam pada Hasil Tanaman Kedelai (*Glycine max* L. Merrill.) var. Grobogan. *Vigor: Jurnal Ilmu Pertanian Tropika Dan Subtropika*, *2*(2), 41–47.

Padmiarso, M. W. (2019). Budidaya Mentimun yang Lebih Menguntungkan. Pustaka Agro.

Putri, A. D., Sugiono, D., & Supriadi, D. R. (2023). Pengaruh Jarak Tanam dan Interval Waktu Pemberian Pupuk Anorganik Terhadap Pertumbuhan dan Hasil Tanaman Mentimun (*Cucumis sativus* L.) Ethana Variety. *Jurnal Pertanian Agros*, *25*(1), 498–506.

Saparinto, C., & Susiana, R. (2024). Grow Your Own Fruits, Panduan Praktis Menanam 28 Tanaman Buah Populer di Pekarangan. Penerbit Andi.

Saputri, R. E. (2025). Analisis Hujan 2025. Badan Meteorologi, Klimatologi, Dan Geofisika. https://www.bmkg.go.id/iklim/analisis-hujan

Sitorus, F. K., & Sa’diyah, H. (2024). Pengaruh Variasi Jarak Tanam terhadap Pertumbuhan dan Hasil Tiga Varietas Tanaman Mentimun (*Cucumis sativus* L.). *Journal of Applied Agricultural Sciences*, *6*(1), 11–18. https://doi.org/10.36423/agroscript.v6i1.1318

Tampinongkol, C. L., Tamod, Z., & Sumayku, B. (2021). Ketersediaan Unsur Hara sebagai Indikator Pertumbuhan Tanaman Mentimun (*Cucumis sativus* L.). *Jurnal Transdisiplin Pertanian*, *17*(2), 711–718.

Uwah, D. F., & Iwo, G. A. (2019). Effectiveness of Organic Mulch on the Productivity of Maize (*Zea mays* L.) and Weed Growth. *The Journal of Animal & Plant Sciences*, *21*(3), 525–530.

Yadav, S., & Singh, D. (2025). Varying Intra-Row Spacing and Mulching Effect on Growth and Yield of Parthenocarpic Cucumber (*Cucumis sativus* L.) under Protected Conditions. *Journal of Advances in Biology & Biotechnology*, *28*(8), 234–241. https://doi.org/10.9734/jabb/2025/v28i82700

Yang, C., Liu, H., Gong, P., Li, P., & Qiao, X. (2025). Optimizing Mulching Strategies in Cotton Fields: Balancing Soil Environmental Impact and Productivity. *Field Crops Research*, *333*, 1–15.

Zhang, P., Xiao, M., Zhang, Z., Dai, Y., Liu, G., & Senge, M. (2023). Hydrological Characteristics of Different Organic Materials Mulches. *Scientific Reports*, *13*(1), 1–9. https://doi.org/10.1038/s41598-023-28124-y