GROWTH AND YIELD PERFORMANCE OF SELECTED SOYBEAN (GLYCINE MAX) VARIETIES WITH DIFFERENT TILLAGE SYSTEMS UNDER OCCIDENTAL MINDORO CONDITION

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ABSTRACT

This study evaluated the growth and yield performance of soybean (*Glycine max L.*) under different tillage systems and varieties in the agroclimatic conditions of Occidental Mindoro. The research was conducted from January to May 2025 at the Vegetable Production Project of the Occidental Mindoro State College, Murtha Campus, San Jose, Occidental Mindoro. The study employed a 3 x 3 split-plot design within a randomized complete block design (RCBD). The two factors were: Factor A (Tillage System: A1-Conventional, A2-Minimum, and A3-No-tillage) and Factor B (Variety: Tiwala 6, Tiwala 14, and Manchuria). Results showed that the tillage system had no significant effect ($p>0.05$) on growth parameters such as plant height, number of leaves, and branches. However, soybean variety had a significant effect ($p<0.05$) on the number of leaves and branches, with Tiwala 14 performing the best. Similarly, tillage had no significant effect on yield attributes, whereas variety significantly influenced the number of pods, seeds per plant, and yield per hectare. Tiwala 14 recorded the highest yield (4.23 t/ha^{-1}). These results indicate that minimum and no-tillage systems are viable alternatives to conventional tillage when using a high-performing variety like Tiwala 14 under the agroclimatic conditions of San Jose, Occidental Mindoro.

Keywords: *conventional tillage, minimum tillage, no-tillage, Manchuria, growth and yield performance of soybean*

SDG: *SDG 2 - Zero Hunger; SDG 12 - Responsible Consumption and Production*

INTRODUCTION

Soybean (*Glycine* max) locally known as "*utaw*" in the Philippines is recognized as the "golden bean" or the "miracle bean" and a wonder crop (Wang & Komatsu, 2017) because of its versatility and exceptional health benefits. Soybean is among the major agricultural commodities imported in the Philippines. The Philippines' domestic production of soybean is very low. According to the US-International Trade Administration (2024), the Philippines is one of the top importing countries of soybeans and other agricultural and food products from the United States. Moreover, Agflow (2023), cited that the Philippines imports nearly 99% of soybean needs for food and feed from the United States, while only 1% is produced locally.

The low domestic production of soybeans in the country is due to stiff competition among the major crops, such as rice, corn, and vegetables (Panaynews, 2019). Moreover, Agcopra and Piadozo (2018), cited that soybean has low comparative advantages as a Philippines agricultural commodity due to high costs of production. The researchers added that the high cost of production is attributed to current soybean production systems which use conventional or maximum tillage systems. Furthermore, in the study of Swanson et. al (2020), Maximum tillage systems require higher labor and fuel costs for land preparation. According to the Department of Agriculture (2011), land preparation using conventional tillage in soybeans accounts to 16-20% of total production cost per hectare. Moreover, conventional tillage farming not only requires higher production, it also increases CO_2 emissions by destroying aggregates and accelerating the loss of soil organic carbon (SOC) (Liu et al., 2020). Meanwhile, conservation tillage such as no-tillage and ridge tillage positively influences soil aggregation processes, leading to improved soil structure. Conversion to no-till (NT) has been suggested to decrease the SOC mineralization (He et al., 2023) and enhance the accumulation of SOC owing to the minimal disturbance of soil (Wuaden et al., 2020), and reduce production cost.

Although soybeans are an economically important crop in the country, there are limited local studies on soybean production under Philippine conditions. Thus, the potential of this crop is not fully studied under local conditions. Hence, study explored the growth and yield of three soybean varieties under three tillage systems.

MATERIALS AND METHODS

Research Design and Experimental Site

The study employed a split-plot design arranged in a randomized complete block design (RCBD) with three replications. Tillage systems were assigned to main plots, while soybean varieties were allocated to sub-plots. Factor A consisted of Conventional Tillage (A1), Minimum Tillage (A2), and Zero Tillage (A3), while Factor B included Tiwala 6 (B1), Tiwala 14 (B2), and Manchuria (B3).

The experiment was conducted at the Vegetable Production Project Area of Occidental Mindoro State College–Murtha Campus, San Jose, Occidental Mindoro, Philippines, from January to April 2025. The site has a Type I climate characterized by a wet season (June–November) and dry season (December–May), with clay loam soil. The total experimental area was 210 m², with 4 m² plots.

Experimental Materials and Sampling

Three soybean varieties—Tiwala 6, Tiwala 14, and Manchuria—were obtained from the Institute of Plant Breeding, University of the Philippines Los Baños. These varieties have been previously evaluated in several locations in the Philippines, including Isabela, Nueva Ecija, and CARAGA. Data were collected from 27 experimental units, with 26 randomly selected plants per plot using simple random sampling.

Cultural Management Practices

Field preparation involved removal of previous crop residues with minimal soil disturbance, followed by irrigation to soften the soil. Conventional and minimum (strip) tillage was prepared at a depth of 1.75 inches, while zero tillage plots were prepared by clearing weeds and making planting holes (2 inches wide, 1 inch deep) based on a spacing of 15 cm between hills and 40 cm between rows. Direct seeding was done using the hill method at 1-inch depth, with two seeds per hill. Thinning was conducted 14 days after sowing. Drip irrigation was installed prior to planting and scheduled according to crop growth stage and soil moisture conditions. Fertilizer was applied once at 28 DAS using complete fertilizer (14-14-14) at a rate of 100 kg ha^{-1}. Manual weeding was conducted twice weekly, while pest and disease management included monitoring, manual removal, and pesticide application when necessary. Harvesting was done manually based on varietal maturity (90–105 DAS), followed by sun-drying and seed moisture reduction to 10–12% prior to storage (Department of Agriculture, 2011).

Data Collection Procedures

Growth parameters measured at 60 DAS included plant height, leaf number, and branch number from 26 sampled plants per plot. Pod count was recorded at 86 DAS, while seed number and seed weight were determined after harvest. Yield per hectare (mt ha^{-1}) was computed from seed weight per plot using standard conversion procedures.

Data Analysis

Data were encoded in Microsoft Excel and exported in CSV format for analysis using the Statistical Tool for Agricultural Research (STAR). Analysis of variance (ANOVA) for split-plot design was used to determine treatment effects. Treatment means were compared using Tukey's Honestly Significant Difference (HSD) test at a 5% level of significance.

RESULTS

Growth and Yield Performance of Selected Soybean (Glycine Max) Varieties

Table 1. Growth and Yield Performance of Selected Soybean (Glycine Max) Varieties

Parameter	A1	A2	A3	B1	B2	B3	A×B
Plant height (cm)	97.67	94.12	92.02	94.42	93.89	95.50	ns
Leaf number	57.10	50.64	55.57	54.72 b	67.54 a	41.05 c	ns
Branches	4.89	4.44	4.99	4.70 b	5.41 a	4.20 b	ns
Pods per plant	150.03	144.15	153.00	153.79 b	166.04 a	127.35 b	*
Seeds per plant	289.37	277.54	291.58	300.64 b	336.52 a	221.32 c	ns
Seed weight (g)	42.90	39.35	42.86	38.26 a	41.70 a	31.81 b	ns
Yield (mt/ha)	4.19	3.80	3.92	3.94 a b	4.23 a	3.73 b	ns

*Means with the same letter(s) are not significantly different at 5% level of significance.

Soybean plant height varied across treatments, with Conventional Tillage (A1) producing the tallest plants (97.67 cm) and Zero Tillage (A3) the shortest (92.02 cm). Among varieties, Manchuria (B3) recorded the tallest plants (95.50 cm), while Tiwala 14 (B2) had the lowest (93.89 cm). For leaf count, A1 had the highest production (57.10) and A2 the lowest (50.64), while Tiwala 14 (B2) showed the highest leaf count (67.54) and Manchuria (B3) the lowest (41.05). For number of branches, Zero Tillage (A3) recorded the highest mean (4.99), followed by A1 (4.89), while A2 had the lowest (4.44). Varietal differences were significant, where Tiwala 6 (B1) and Manchuria (B3) were statistically similar but both differed from Tiwala 14 (B2). In terms of pods, A3 produced the highest mean (153.00) and A2 the lowest (144.15), while B2 significantly differed from B1 and B3. For number of seeds per plant, A3 had the highest mean (291.58) and A2 the lowest (277.54), while B2 recorded the highest varietal mean (336.52) and B3 the lowest (221.32). Seed weight was highest under A1 (42.90 g), closely followed by A3 (42.86 g), while A2 had the lowest (39.35 g). Among varieties, B1 and B2 showed the highest seed weight (41.70 g), while Manchuria recorded the lowest (31.81 g). For yield per hectare, A1 produced the highest yield (4.19 mt/ha), closely followed by A3 (3.92 mt/ha), while A2 had the lowest (3.80 mt/ha). In terms of varieties, B2 recorded the highest yield (4.23 mt/ha), followed by B1 (3.94 mt/ha), and B3 the lowest (3.83 mt/ha).

Analysis of Variance

The results revealed that different tillage systems had no significant effect ($p>0.05$) on the plant height, number of leaves, number of branches, number of pods, number of seeds, seed weight, and yield per hectare of soybeans. Likewise, no significant interaction effect was observed between tillage systems and soybean varieties across all parameters evaluated. However, soybean varieties significantly influenced several growth and yield characteristics. Highly significant differences ($p<0.01$) among varieties were observed in the number of leaves, branches, pods, seeds, and seed weight, while yield per hectare differed significantly ($p<0.05$). These findings indicate that varietal differences had greater influence on soybean growth and productivity than the tillage systems used in the study.

Table 2. Analysis of Variance.

SOURCE	DF	SS	MS	F	P
Plant height					
Replication	2	43.56	21.78		
Tillage (A)	2	152.89	76.44	3.05	0.16
Error (a)	4	100.22	25.06		
Variety (B)	2	16.22	8.11	0.64	0.54
A x B	4	98.22	24.56	1.94	0.17
Error (b)	12	151.56	12.63		
Total	26	562.67			
Number of leaves					
Replication	2	480.96	240.48		
Tillage (A)	2	199.41	99.70	2.20	0.23
Error (a)	4	181.04	45.26		
Variety (B)	2	3148.07	1574.04	24.92	0.00**
A x B	4	109.26	27.31	0.43	0.78
Error (b)	12	758.00	63.17		
Total	26	4876.74			
Number of branches					
Replication	2	12.52	6.26		
Tillage (A)	2	0.96	0.48	3.25	0.15
Error (a)	4	0.59	0.15		
Variety (B)	2	9.41	4.70	13.37	0.00**
A x B	4	0.37	0.09	0.26	0.90
Error (b)	12	4.22	0.35		
Total	26	28.07			
Number of pods					
Replication	2	10050.90	5025.44		
Tillage (A)	2	360.20	180.11	0.35	0.72
Error (a)	4	2058.20	514.56		
Variety (B)	2	7074.90	3537.44	34.12	0.00**
A x B	4	2182.20	545.56	5.26	0.01*
Error (b)	12	1244.20	103.69		
Total	26	22970.70			
Number of seeds per plant					
Replication	2	13216.10	6608.00		
Tillage (A)	2	1053.60	526.80	0.27	0.78
Error (a)	4	7939.00	1984.80		
Variety (B)	2	62804.50	31402.30	45.96	0.00**
A x B	4	2742.60	685.60	1.00	0.44
Error (b)	12	8198.20	683.20		

Total	26	95954.10			
Seed weight per plant (g)					
Replication	2	395.63	197.82		
Tillage (A)	2	53.41	26.70	0.78	0.52
Error (a)	4	137.70	34.43		
Variety (B)	2	451.63	225.82	20.32	0.00**
A X B	4	26.37	6.59	0.59	0.67
Error (b)	12	133.33	11.11		
Total	26	1198.07			
Yield ha^{-1} (mt)					
Replication	2	2.81	1.40		
Tillage (A)	2	0.72	0.36	0.99	0.45
Error (a)	4	1.44	0.36		
Variety (B)	2	1.12	0.56	6.91	0.01
A x B	4	0.82	0.21	2.53	0.10
Error (b)	12	0.97	0.08		
Total	26	7.89			

** = Highly significant (p<0.01)
ns = not significant (p>0.05)

DISCUSSION

Plant height is a crucial parameter to crop growth and productivity. Soybean growth is driven by the interaction of genetics, environment, and management factors (Yang et al., 2021). Intensive tillage fundamentally shifts the physical, chemical, and biological properties of the soil, directly modifying how the crop develops. In this current study, the effect of conventional tillage, minimum tillage, and zero tillage on plant height of soybeans is found insignificant. This finding suggests that conventional tillage, minimum and zero tillage systems do not significantly affect the plant height of soybeans. According to Wang et al. (2020), zero-tillage commonly increases soil organic carbon, reduces CO_2 flux from the soil, cuts fuel use and erosion, and improves soil structure and moisture retention. Likewise, plant height can be influenced by both genetic and environmental factors (Yang et al., 2021) and management such as irrigation and rate of fertilizer application particularly at early growth stage (El-Sherif, A. & Ali, M. M., 2015). Fattah et al. (2024) cited that soybean varieties have different physical characteristics, with plant height ranging from 52-68 cm. These differences are due to the variations between the varieties themselves. Elias and Orpilla (2024) noted an insignificant difference on the plant height of six NSIC soybeans varieties.

The number of leaves of soybeans is the same as the number of nodes in other studies because the trifoliate leaves of soybeans are developed from the nodal parts of plants (University of Minnesota Extension (n.d.). In this study, the number of leaves of the three soybean varieties tested under tillage systems were found insignificant (p>0.05). This finding is supported by the study of Kihara et al. (2011.) citing that the performance of soybean plants was equally well in different tillage systems. Moreover, Ghani et al. (2023) cited that the effect of a tillage system (like no-till or conventional) on leaf number is not uniform but depends on the variety's inherent growth rate and adaptation to that environment. On the other hand, the different soybean varieties showed a highly significant difference in terms of number of leaves (p<0.01). This finding is supported by the study of Magsino et al. (2016) citing that the number of nodes of Tiwala 6, Tiwala 8, and Manchuria is significantly different. Meanwhile, Ohashi et al. (2020) cited that the number of leaves of soybeans varies among varieties due to differences of varieties' genetic make-up. The result also indicates that Tiwala 6, Tiwala 14, and Manchuria is suitable under Occidental Mindoro conditions. It can also be planted under conservation tillage, such as zero tillage and minimum tillage that can be contributed to the soil property and microbial activities in the soil.

Management practices such as tillage systems as in the case of conventional tillage has a significant effect on the number of branches per plant by improving soil moisture and nutrient availability through a prolific root system (Chorey et al., 2019). However, the results of this study highlighted that tillage systems have no significant effect on the number of branches of soybeans. This finding confirmed the results of the study of Jug et al. (2010) and Ozturk & Sogut (2016) citing that no significant differences in the number of branches of soybeans. Meanwhile, the variety of soybeans showed a highly significant difference on the number of branches. The number of branches of Tiwala 14 variety significantly outnumbered Tiwala 6 and Manchuria (p<0.01). This confirmed the study of Xu et al. (2021), that the number and growth of branches are also influenced by factors such as varieties, agricultural management, and climate. Generally, the number of branches of soybeans is a genetically controlled trait in plants.

Soybean varieties with indeterminate growth habits have a higher number of branches compared to determinate ones. The locally developed soybeans varieties in the country including Tiwala series and Manchuria are determinate types with branches ranging from 2-5 with maturity ranging from 95-100 days during wet season and 83-92 days during dry season (Tandang et al., 2020). Findings showed that soybean varieties, especially Tiwala 14 are suitable under Occidental Mindoro condition, and can also be planted under different tillage systems, especially zero tillage.

The number of pods is a key factor in determining yield and is strongly linked to overall crop productivity. In this study, zero tillage resulted in the highest number of pods (153.00), closely followed by conventional tillage (150.03). However, analysis showed no significant difference (p>0.05) in pod production between these two tillage methods. This finding supports the study of Sharifi et al. (2016) citing that the number of pods of soybeans is not influenced by tillage systems. Similar results were reported by Księżak and Bojarszczuk (2024). This finding provides significant insights on the effect of conservation tillage systems on the number of pods which is statistically the same with conventional tillage. Moreover, in terms of the effect of different varieties on the number of pods, results showed a highly significant difference. The Tiwala 14 produced a highly significant number of pods compared to Manchuria and Tiwala 6 varieties. The study of Elias and Orpilla (2024) provided substantial support to the finding of this study. The researchers cited that there is no significant difference on the number of pods per plant of six NSIC soybeans varieties which include the Tiwala 6, Tiwala 14, and Manchuria. Li et al. (2024) cited that soybean varieties vary significantly in number of pods due to genetic differences. The study found that Tiwala 14 produced the most pods compared to the other varieties tested. The results suggest that these varieties, especially Tiwala 14, can be successfully grown using different tillage systems, including zero-tillage. There was a significant interaction between the tillage system used and the variety planted, and Tiwala 14 appears to be particularly well-suited to zero-tillage systems. According to Da Silva et al. (2023), zero-tillage farming does not negatively impact soil water infiltration and can lead to a 6.5% increase in soybean grain yield. A long-term (33-year) no-tillage system helps to prevent water stress in soybean plants, resulting in higher grain production compared to conventional tillage methods.

Ali et al. (2013) cited that the number of seeds has a very strong correlation to yield of soybeans under the same environmental conditions and production management practices. In this study, the effect of tillage systems on the number of seeds of soybeans is found statistically the same (p>0.05). The number of soybean seeds is not significantly affected by the tillage system. Meanwhile, the soybean varieties have a highly significant effect on the number of seeds of soybean (p<0.01). Tiwala 14 produced a significantly higher number of seeds compared to Tiwala 6 and Manchuria. This suggests that the number of seeds of soybeans is highly influenced by variety. Ali et al. (2013) and Wang et al. (2025) reported that the number of seeds of soybeans significantly varies due to genotypic differences. The researchers further cited that the varieties with the number of seeds have higher yield. The number of seeds per plant is a good criterion for selection of high yielding varieties. In this parameter, zero tillage and Tiwala 14 exhibited excellent results compared to other varieties and tillage practices.

The effect of tillage systems on seed weight differs insignificantly (p>0.05). This means that the seed weight of soybeans produced from different tillage systems is statistically the same. This is similar to the findings of Hosseini et al. (2016). This suggests that there is enough evidence that the study failed to reject the null hypothesis. In terms of selected soybean varieties, the result revealed a highly significant difference (P-value <0.0) of seed weight of soybeans. In the study of Krisnawati and Adie (2015), the Analysis of variance of yield and yield components revealed that soybean varieties significantly affect the flowering time, days to maturity, 100 seed weight, and seed yield. This means that there is enough evidence to reject the null hypothesis. The result indicates that the conventional and zero tillage performed well. However, in the soybean variety Tiwala 14 exhibited the highest result among the three varieties. The genetic make-up of the different varieties also has an effect on the yield of soybeans. Soybean pests and diseases can reduce seed weight and yield. According to Murithi et al. (2019), Soybean pests can infest crops at any point in its development, from emergence through harvest and their impact is often greatest between flowering and maturity. They further explain that these pests lower both yield and grain quality. They cause harm through direct feeding, which weakens plant tissues and increases vulnerability to other pathogens, and indirectly by transmitting viruses and additional disease-causing organisms.

The effect of tillage system in yield ha^{-1} (mt) of soybean is not significant (p>0.05). This finding suggests that the yield ha^{-1} of soybean is not affected by the tillage system. This finding is supported by Adamič, S. & Leskovšek, R. (2021). The researchers cited that soybean yield is not significantly affected by the tillage system. This finding highlights that soybeans can be planted using zero tillage and minimum tillage instead of conventional tillage. The findings of this study provide very viable insights on the use of zero tillage or minimum tillage in soybean production. In terms of variety however, the study found significant differences on yield ha^{-1}. B2 (Tiwala 14) produced the highest yield ha^{-1} with 4.23 mt. This finding suggests that B2 (Tiwala 14) is one of the most promising varieties of soybeans for zero tillage. B2 (Tiwala 14) is one of the latest high yield soybean cultivars developed and released by the Institute of Plant Breeding (IPB) under Tiwala lines. Even though conventional tillage produced higher yield than zero tillage, zero tillage is recommended for planting soybean because of its environmental benefits, such as protecting soil microorganism, causing less soil disturbance, and improving the soil's capacity to retain water and it requires low inputs in production. However, in the study of Dlugosz et al. (2024), soybean is commonly grown under conventional tillage (CT), but this method involves numerous field operations that greatly raise production costs. It also leads to soil compaction and reduces soil organic matter, which results in poorer soil quality over time.

CONCLUSION AND RECOMMENDATION

The study concludes that soybean growth and yield varied with tillage and variety. Conventional tillage produced the tallest plants and highest yield per hectare, while zero tillage yielded more pods and seeds per plant. Tiwala 14 generally outperformed the other varieties, having the most leaves, branches, pods, seeds, and overall yield. Tillage methods did not significantly affect height but influenced leaf and branch growth, with a notable interaction effect on pod production. Based on the findings of this study, it is recommended that future research evaluate the pest and disease resistance of these varieties under local conditions and expand the study to the wet season and sandy loam soils to assess environmental adaptability. Furthermore, the integration of soybeans, particularly the high-performing Tiwala 14 variety, into rice-based cropping rotations (e.g., rice-soybean-corn) and organic farming systems should be explored. Finally, it is suggested that zero-tillage be specifically tested for Tiwala 14 alongside a comprehensive economic analysis of cost and return across all tillage systems to determine the most profitable management practice for farmers.

REFERENCES

Adamič, S. & Leskovšek, R. (2021). Soybean (Glycine max (L.) Merr.) Growth, Yield, and Nodulation in the Early Transition Period from Conventional Tillage to Conservation and No-Tillage Systems. *Agronomy*. https://doi.org/10.3390/agronomy11122477

Agcopra, J.D.V. L. and Piadozo, M.E. S. (2018). Cost and Price Competitiveness of Soybean Production in Isabela, Philippines. *Economics, Management & Agricultural Development.* https://jemad.cem.uplb.edu.ph/articles/cost-and-price-competitiveness-of-soybean-production-in-isabela-philippines/

AgFlow. (2023). The Philippines: US supplies 99% of the total soybean demand. https://www.linkedin.com/posts/agflow_the-philippines-us-supplies-99-of-the-total-activity-7112393117319729152-1ayF

Ali, A., Iqbal, Z., Safdar, M. E., Ashraf, M., Aziz, M., Asif, M., Mubeen, M., Noorka, I. R. & Rehman, A. (2013). Comparison of yield performance of soybean varieties under semi-arid conditions. Journal of Animal and Plant Sciences. https://thejaps.org.pk/AbstractView.aspx?mid=2013-JAPS-324

Chorey, A. B., Sahu, A. S., & Gharde, Y. V. (2019). Effect of various tillage practices on soybean productivity and soil moisture dynamics under rainfed condition. International Journal of Current Microbiology and Applied Sciences. https://www.ijcmas.com/special/11/Anita%20B.%20Chorey,%20et%20al.pdf

Department of Agriculture. (2011). Soybean Production Technology and product utilization. https://cagayanvalley.da.gov.ph/wp-content/uploads/2018/02/soybean281111.pdf

Da Silva, G. F., Calonego, J. C., Luperini, B. C. O., Silveira, V. B., Chamma, L., Soratto, R. P., & Putti, F. F. (2023). No-Tillage system can improve soybean grain production more than conventional tillage system. Plants. https://doi.org/10.3390/plants12213762

Dlugosz, J., Dębska, B. & Dlugosz, A. P. (2024). The Effect of Soil Tillage System on the Soil Microbial and Enzymatic Properties Unter Soybean *(Glycine max* L. Merrill) Cultivation-Implication for Sustainable Soil Management. Sustainability. https://doi.org/10.3390/su162411140

Elias, K. E. (2024). Morpho-agronomic characteristics and yield of new promising Soybean (Glycine max L.) Lines for Bacnotan, La Union, Philippines. International Journal of Biosciences (IJB). https://doi.org/10.12692/ijb/24.3.133-140

El-Sherif, A. & Ali, M. M. (2015). Effect of deficit irrigation and soybean/maize intercropping on yield and water use efficiency. *International Journal of Current Microbiology and Applied Sciences.* https://www.ijcmas.com/vol-4-12/Ahmed%20M.A.El-Sherif%20and%20Mahmoud%20M.%20Ali.pdf

Fattah, A., Negara, A., Supriadi, K., Hannan, M. F. I., Ardjanhar, A., Beding, P. A., Najamuddin, E., Pustika, A. B., Susilawati, S., Nonci, N., Latifah, E., Arifin, Z., Istiqomah, N., Udiarto, B. K., & Dewayani, W. (2024). Characteristics of several soybean varieties (Glycine max L.) and weed management systems in an effort to increase productivity in low land rice. Frontiers in Sustainable Food Systems. https://doi.org/10.3389/fsufs.2024.1418759

Gawęda, D., Haliniarz, M., Bronowicka-Mielniczuk, U., & Łukasz, J. (2020). Weed infestation and health of the soybean crop depending on cropping system and tillage system. Agriculture, 10(6), 208. https://doi.org/10.3390/agriculture10060208

Ghani, R. A., Omar, S., Jolánkai, M., Tarnawa, A., Kende, Z., Khalid, N., Gyuricza, C. & Kassai, M. K. (2023). Interaction effect of variety and week number on number of leaves at early growth of soybean planted under soilless condition. Agriculture. https://www.mdpi.com/2077-0472/13/9/1713

He, C., Chen, Z., Qiu, K., Chen, J., Bohoussou, Y. N., Dang, Y. P., & Zhang, H. (2023). Effects of conservation agriculture on carbon mineralization: A global meta-analysis. Soil and Tillage Research, 229, 105685. https://doi.org/10.1016/j.still.2023.105685

Hosseini, S. Z., Firouzi, S., Aminpanah, H. & Sadegnehnejhad, H. R. (2016). Effect of tillage system on yield and weed populations of soybean (*Gylcin max* L.) https://www.scielo.br/j/aabc/a/dMmGHf4VZ8Y3YpFsmS55tCr/?lang=en

Jug, D., Sabo, M., Jug, I., Bojan, S. & Stošić, M. (2010). Effect of different tillage systems on the yield and yield components of soybean [Glycine max (L.) Merr.]. Acta Agronomica Hungarica.

https://www.researchgate.net/publication/240762893_Effect_of_different_tillage_systems_on_the_yield_and_yield_components_of_soybean_Glycine_max_L_Merr

Kihara, J., Bationo, A., Waswa, B., Kimetu, J. M., Vanlauwe, B., Okeyo, J., Mukalama, J., & Martius, C. (2011). EFFECT OF REDUCED TILLAGE AND MINERAL FERTILIZER APPLICATION ON MAIZE AND SOYBEAN PRODUCTIVITY. Experimental Agriculture, 48(2), 159–175. https://doi.org/10.1017/s0014479711000895

Krisnawati, A. & Adie, M. (2015). Selection of Soybean Genotypes by Seed Size and its Prospects for Industrial Raw Material in Indonesia. Procedia Food Science. https://www.sciencedirect.com/science/article/pii/S2211601X15000401

Księżak, J. & Bojarszczuk, J. (2024). The productivity of selected soybean cultivars grown using various cultivation methods. Journal Of Water and Land Development. https://www.jwld.pl/files/2024-03-JWLD-11.pdf

Liu, Q., Kan, Z., He, C., Zhang, H., (2020). Effects of Strategic Tillage on Soil Physiochemical Properties and Grain Yield in Northern China Plain. Agronomy. https://doi.org/10.3390/agronomy10081167

Li, W., Wang, L., Xue, H., Zhang, M., Song, H., Qin, M., & Dong, Q. (2024). Molecular and genetic basis of plant architecture in soybean. Frontiers in Plant Science. https://doi.org/10.3389/fpls.2024.1477616

Magsino, A. dM., Adan, A.J. R., Espinili, M.M. R. (2016). Soybean Production Under Conventional, Organic and Zero Fertilization Schemes. https://calabarzon.depdev.gov.ph/wp-content/uploads/2016/10/Magsino-Soybean-Production-Under-Conventional-Organic-and-Zero-Fertilization-Schemes.pdf

Murithi, H., Wosula, D., Lagos-Kutz, D., Wosula, E. & Hartman, G. (2019). The State of Soybean in the Africa: Soybean Pests. farmdoc DAILY. https:// doi.org/10.22004/ag.econ.302026

Ohashi, S., Kurita, H., Takahashi, Y., Nagasuga, K., Nagaya, Y., & Umezaki, T. (2020). Varietal difference of soybean plant type focus on petiole. Plant Production Science. https://doi.org/10.1080/1343943x.2020.1801349

Ozturk, F. & Sogut, T. (2016). The effect of tillage and plant density on yield and yield components of soybean [*glycine max* (l.) Merrill] grown under main and double-cropping soybean (*glycine max* l. Merr.**)**. https://stumejournals.com/journals/am/2016/2/19.full.pdf

Panaynews. (2019). Improving soybean production in the Philippines. AgroPages. https://news.agropages.com/News/Detail-33438.htm?fbclid=IwY2xjawNpzZJleHRuA2FlbQIxMQABHmG2mGFGUJU5F9VqmOv-z98wh7BDxbWbULzQDvKx63rSCLcyNqvgGZZbzm3U_aem_7tgUI_1rdD0hx2dHSKPFIA

Sharifi, A., Sadeghnezha, H. R. & Faraji, A. (2016). Effect of conservation tillage systems on growth, yield and yield components of soybean. CIGR Journal. https://cigrjournal.org/index.php/Ejounral/article/view/3544

Swanson, K., Schnitkey, G., Paulson, N., Coppess, J. & Zulauf, C. (2020). Couse management: Tillage operations. Farmdocdaily. https://farmdocdaily.illinois.edu/2020/08/cost-management-tillage-operations.html

Tandang, L.L., Macyon, D.T.J., Epie, M.S. (2020). Agro-morphological characterization, evaluation, and cluster analysis of soybean (Glycine max (L.) Merrill) accessions grown under organic production system in La. Philippine Science and Technology Abstracts. https://www.stii.dost.gov.ph/images/jdownloads/pdf_files/psta/PSTA_2020_June.pdf

US-International Trade Administration. (2024). Philippines Country Commercial Guide. Official Website of the United States government. https://www.trade.gov/country-commercial-guides/philippines-agricultural-sectors

University of Minnesota Extension (n.d.). Soybean growth stages. https://extension.umn.edu/growing-soybean/soybean-growth-stages#vegetative-phase-%28table-1%29-539860

Wang, H., Wang, S., Yu, Q., Zhang, Y., Wang, R., Li, J., & Wang, X. (2020). No tillage increases soil organic carbon storage and decreases carbon dioxide emission in the crop residue-returned farming system. Journal of Environmental Management. https://doi.org/10.1016/j.jenvman.2020.110261

Wang, X. & Komatsu, S. (2017). Chapter Four - Improvement of Soybean Products Through the Response Mechanism Analysis Using Proteomic Technique.
https://doi.org/10.1016/bs.afnr.2016.12.006.

Wang, X., Zhang, M., Li, F., Liu, X., Zhang, Z., Zhang, F., Zhao, K., Yuan, R., Lamlom, S. F., Ren, H., Qui, H. & Zhang, B. (2025). Genome-Wide Association Study Reveals Key Genetic Loci Controlling Oil Content in Soybean Seeds. Agronomy. https://www.mdpi.com/2073-4395/15/8/1889n

Wuaden, C. R., Nicoloso, R. S., Barros, E. C., & Grave, R. A. (2020). Early adoption of no-till mitigates soil organic carbon and nitrogen losses due to land use change. Soil and Tillage Research, 204, 104728. https://doi.org/10.1016/j.still.2020.104728

Xu, C., Li, R., Song, W., Wu, T., Sun, S., Hu, S., Han, T., & Wu, C. (2021). Responses of branch number and yield component of soybean cultivars tested in different planting densities. *Agriculture*. https://doi.org/10.3390/agriculture11010069

Yang, Q., Lin, G., Lv, H., Wang, C., Yang, Y. & Liao, H. (2021). Environmental and genetic regulation of plant height in soybean. *BMC Plant Biology*. https://doi.org/10.1186/s12870-021-02836-7

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The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors utilized Dola and Gemini for sentence and grammar checking. The authors have carefully reviewed and validated all findings, accepting complete accountability for the final content of this work.

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