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Impact of Biofertilizer Application and Soybean Cultivar Selection on Intercropping: A Study of Growth and Yield Performance

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Abstract: This study examines how the use of biofertilizer and intercropping methods impacts the growth and pod yield of different soybean cultivars. The research involved six high-quality soybean cultivars, which were treated with Fermented Liquid Organic Fertilizer (LOF) Azolla at various doses. The researchers also considered environmental factors and soil fertility conditions during the evaluation. The findings revealed that environmental factors play a crucial role in influencing the growth of soybean plants. Additionally, suboptimal soil fertility, as well as pest, disease, and weed infestations, presented challenges to soybean productivity. Through careful analysis, the researchers identified that cultivar K2 (Anjasmoro) treated with a dose of 250 ml/L LOF displayed the best performance. Notably, positive correlations were observed between plant height, number of filled pods, and seed weight per plot. The use of biofertilizer and intercropping systems demonstrated significant potential in promoting sustainable soybean productivity. Consequently, this study contributes to the development of sustainable farming practices and offers insights to enhance soybean production in an eco-friendly manner.

Keywords: Soybean Cultivation, Biofertilizer, Intercropping, LOF Azolla

INTRODUCTION

Soybean (Glycine max) is a crucial staple food crop, essential for food security and nutrition in various countries (FAO, 2021). As the demand for soybean continues to rise due to population growth and changing consumption patterns (Prayitno, D. S. W., & Maryudi, A., 2021), increasing soybean production has become a vital goal. To enhance soybean crop productivity, researchers have explored the use of biofertilizers and intercropping systems (Aditiawati, P., Setyorini, D., & Purwanto, Y. 2020).

Biofertilizers like Fermented Liquid Organic Fertilizer (LOF) Azolla, derived from the water fern Azolla, have shown promise in improving soil fertility and plant productivity. LOF Azolla contains essential nutrients like nitrogen, phosphorus, potassium, and beneficial microorganisms for plants (Aditiawati, P., Setyorini, D., & Purwanto, Y. 2020). It has the potential to boost soil fertility and provide necessary nutrients for soybean plants, promoting growth and yield (Jaiswal, P., & Kumar, R. M. 2021).

Intercropping, the practice of growing different crops together in the same field, has emerged as an effective method to increase land productivity and efficiency. Growing soybean alongside other crops like corn or beans allows better utilization of land and nutrients (Hussain, M., Farooq, M., Jabran, K., & Nawaz, A. 2018). Moreover, intercropping helps mitigate the risk of crop failure due to adverse weather conditions or specific pest and disease attacks (Altieri, M. A., & Nicholls, C. I. 2017).

While numerous studies have explored the effects of biofertilizers and intercropping on soybean growth and yield, further research is needed to gain comprehensive insights. Additionally, understanding how different soybean cultivars respond to these treatments is essential.

Therefore, this study aims to evaluate the impact of using Fermented Liquid Organic Fertilizer (LOF) Azolla and implementing an intercropping system on soybean cultivar performance. The analysis will encompass soybean plant growth indicators, including plant height, number of filled pods, number of empty pods, and seed yield per plant. Furthermore, the study will assess the influence of various doses of LOF Azolla on soybean growth and yield.

The research will consider various factors such as climate conditions, soil fertility, pest and disease attacks, and weed presence during the experimental period. By analyzing this data, the study intends to gain a deeper understanding of the effects of biofertilizers and intercropping on soybean growth and yield and identify the most responsive soybean cultivars to these treatments.

This research is expected to contribute significantly to sustainable crop productivity efforts by enhancing the understanding of the impact of biofertilizers and intercropping on soybean cultivar performance. The study's findings may serve as a valuable reference for farmers and researchers in selecting appropriate strategies to increase soybean production and support food security and nutrition. Additionally, it may contribute to the scientific development of biofertilizers and sustainable agricultural technologies.

MATERIALS AND METHODS

Location and time of research

The experiment was conducted at the Crop Production Garden of the Faculty of Agriculture, Majalengka University, at an elevation between 600 and 850 meters above sea level. The rainfall in this region is classified as type C2 according to the Oldeman classification. The experiment took place over three months, specifically from July to October 2022. The experimental plots were strategically placed in irrigated paddy fields. These fields were supplied with water through an irrigation system, ensuring sufficient moisture availability for the crops throughout the cultivation period. Selecting irrigated paddy fields as the experimental site allowed for controlled water management, which is crucial for studying the environmental impact on soybean growth in intercropping systems. The researchers aimed to investigate the environmental conditions and specific pest control strategies relevant to soybean cultivation in this region.

Choosing this location enabled focused examination of the interactions between climate, soil characteristics, and pest pressures, contributing to a better understanding of intercropping systems for soybean cultivation in Majalengka and similar agro-ecological contexts.

Materials

The materials used in this experiment were seeds of soybean varieties, namely K1 (Grobogan), K2 (Anjasmoro), K3 (Dega 2), K4 (Gepak Kuning), K5 (Dega 1), and K6 (Daring 1). The application of Azolla pinnata Fermented Liquid Organic Fertilizer (LOF) was given at the following research levels: 0 ml L-1, 100 ml L-1, 150 ml L-1, 200 ml L-1, and 250 ml L-1. The tools used, from land preparation to harvest, were common agricultural tools used in soybean cultivation, including hand sprayers, raffia strings, measuring tapes, brown envelopes, newspaper envelopes, plastic bags, paint, brushes, permanent markers, rulers, digital scales, ovens, laptops, cameras, and writing materials.

Research Design

a. Environmental Design

The research design method used was a field experiment. The environmental design employed was a Randomized Complete Block Design (RCBD). The plot size was 300 x 200 cm with a planting distance of 40 x 20 cm. The distance between plots was 30 cm, resulting in 30 treatment combinations and 3 experimental replications.

b. Treatment Design

The experiment design used was a Randomized Complete Block Design (RCBD) with a factorial pattern consisting of five combinations of Azolla pinnata application for each soybean variety, with six treatment levels repeated three times, resulting in 90 experimental units. Each set of treatments was applied to different plots with an intercropping system between soybean and corn. The best combination of Azolla pinnata application for each soybean variety (denoted as K) consisted of 30 treatments with 3 replications.

c. Response Design

The response variables consist of supporting observations and main observations. Supporting observations include: seed viability and vigor, soil analysis before the experiment, analysis of nutrient content in POC Azolla pinnata, air temperature and humidity during the experiment, sunlight radiation during the experiment, rainfall during the experiment, pest and disease attacks, and weed presence. These observations provide data to support the main observations. Main observations include: plant height (cm), number of leaves (cm), number of secondary branches (fruit), total plant dry weight (g), average number of filled pods per plant (pods), average number of empty pods per plant (pods), average number of seeds per plant (seeds), average seed weight per plot (gram).

Data Analysis

The analysis design used in this study is the Randomized Block Design (RBD) Non-Factorial. RBD Non-Factorial is a statistical method used to test the differences between treatment groups consisting of several independent variables but without interactions between these variables. In this case, the treatment groups refer to different combinations of factors observed in this study, such as the use of biofertilizer, intercropping interactions, and growth.

After data collection, the analysis was performed using a linear model at a significance level of 5%. The linear model is used to analyze the relationship between the dependent variable (e.g., soybean plant growth) and the independent variables observed in this study. In the context of RBD Non-Factorial, the linear model helps test the differences between treatment groups using SPSS software version 21.

Observations

Intercropping is recognized as an innovative strategy with the potential to efficiently and sustainably enhance plant productivity. This study specifically investigates how environmental factors and variety selection can improve the performance of soybeans in intercropping systems. The significance of factors like temperature, humidity, light, and soil interactions in influencing soybean growth and productivity is emphasized. Thus, the study aims to comprehensively explore the role of environmental factors and variety selection in optimizing soybean performance in intercropping.

To understand the environmental impact on soybean growth in intercropping systems, the experiment took place in irrigated paddy fields with controlled water management. Land preparation involved herbicide spraying, followed by a waiting period of around 10 days. Experimental plots measuring 300 cm x 200 cm were established, and soybean varieties (K1 - Grobogan, K2 - Anjasmoro, K3 - Dega 2, K4 - Gepak Kuning, K5 - Dega 1, and K6 - Daring 1) were used. The seeds, sourced from the Legume and Tuber Research Center (BALITKABI), exhibited a high germination rate of 85.0% - 90.0%. Planting was carried out by sowing seeds at a depth of 3 cm, with one seed per planting hole, following ideal soybean and corn planting distances of 40 cm x 15 cm and 75 cm x 40 cm, respectively. Before planting, the seeds were treated with biofertilizer.

Inorganic fertilization was applied at a rate of 250 kg/ha, and Azolla pinnata Organic Compound (POC) was used in combination with different treatment levels for each variety. Data collection included seed viability and vigor assessment, soil analysis, POC Azolla pinnata nutrient content analysis, air temperature and humidity monitoring, sunlight radiation measurement, rainfall tracking, as well as observation of pest and disease infestations. The study aimed to gain insights into the potential of intercropping systems and the various factors influencing soybean growth and productivity in such setups.

RESULTS

Environmental conditions during the experiment

Climate factors influencing soybean plant growth include rainfall, temperature, and humidity (Baig, M. J., Riaz, M., Shahid, M. A., & Raza, S. M. 2019). The Meteorology, Climatology, and Geophysics Agency (BMKG) of Majalengka Regency classified the climate type in the area as C2 according to the Oldeman classification. The daily rainfall during the experiment ranged from 239.7 mm to 647.3 mm per month, with an average of 9 to 26 rainy days per month.

Table 1. Conditions of Agro-climate Factors during the Experiment

Parameters	July	August	September	October
Tmin (^{0}C)	25	25	25	26
Tmax (^{0}C)	30	31	31	32
RH (%)	75	71	70	74
RR(mm)	66,6	27,7	49,7	88.5
RD (day)	3	1	2	4

Tmin (^{0}C) = minimum temperature; Tmax (^{0}C) = maximum temperature; RH (%) = Humidity; RR (mm) = Rainfall; RD (day) = Rain day

In July, the minimum temperature (Tmin) and maximum temperature (Tmax) were around 25°C to 30°C. The relative humidity (RH) was approximately 75%, indicating a relatively high level of humidity. The rainfall (RR) reached 66.6 mm during that period, supported by 3 rainy days (RD). In August, the temperature remained stable with Tmin around 25°C and Tmax around 31°C. The relative humidity (RH) slightly decreased to 71% but still remained quite humid. The rainfall (RR) decreased to 27.7 mm, with only 1 rainy day (RD). September showed similar agro-climatic conditions to August, with Tmin and Tmax remaining stable at 25°C and 31°C, respectively. The relative humidity (RH) was slightly lower, around 70%, but still within a favorable range for plant growth. The rainfall (RR) increased to 49.7 mm, with 2 rainy days (RD). Lastly, in October, the temperature peaked with Tmin around 26°C and Tmax around 32°C. The relative humidity (RH) increased again to 74%. The rainfall (RR) also increased significantly, reaching 88.5 mm, with 4 rainy days (RD). These environmental conditions align with the findings of research by Prasetyo, B.H., & Nurhayati, A. (2019), which showed that low air humidity (60-75% RH) during the pod filling to harvesting period also has a positive effect on soybean production.

Table 2. Soil Fertility Conditions in the Experiment Site

Parameters	Value	Criteria
pH	6,19	Acidity
Organic-C	1.41	Low
Total-N	0.22	Medium
C/N	6,40	Low
P2O5 Bray/Olsen	5,24	Low
K2O HCl 25%	37,59	Medium
Textures	-	Silty Clay

Soil Fertility Laboratory, Faculty of Agriculture, Padjajaran University, 2022.

(Table 2) The soil pH at the experimental site is 6.19, indicating an acidity level categorized as "Acidic". Furthermore, the Organic-C (organic carbon) content in the soil reached 1.41, which falls under the "Low" category. The total nitrogen (Total-N) present in the soil is 0.22, classified as "Moderate". The C/N ratio (carbon to nitrogen ratio) is 6.40, also classified as "Low". The P2O5 Bray/Olsen (phosphorus) content in the soil is 5.24, categorized as "Low". Additionally, the K2O HCl 25% (potassium) content is 37.59, which is classified as "Moderate". Lastly, the soil texture at the experimental site is "Silty Clay".

The soil fertility conditions at the experimental site tend to encounter issues with high acidity, low organic carbon content, low phosphorus content, and a low C/N ratio. Although there is an adequate amount of nitrogen and potassium in the soil, overall soil fertility conditions cannot be considered optimal. These suboptimal soil fertility conditions indicated by acidic pH, low organic carbon, low phosphorus content, and low C/N ratio may pose challenges for soybean growth and productivity (Marbun, P., Runtuwene, T. L., & Lombok, I. A. 2018).

Pests, Diseases, and Weeds

During the experiment, soybean plants were attacked by various pests, including grasshoppers (Valanga nigricornis), stink bugs (Riptortus linearis), and leafworms (Lamprosema indicata) (Buchori, D., & Lestari, P. 2018). Pest control was carried out by spraying Dorsa insecticide at a concentration of 1 gram per liter and Sonic 450 SL insecticide at a concentration of 1 ml per liter. The spraying was done two weeks after planting, with a one-week interval between each spraying.

The disease that affected the soybean plants during the experiment was root wilt disease caused by Fusarium oxysporum f.sp. glycine. This disease primarily attacked during the germination stage, causing seedlings to wilt and even die (Li, L., Zhang, X., Yang, X., Li, L., & Liu, S. 2019). In mature plants, symptoms included wilting, root rot, crown and stem rot. Control of the Fusarium root wilt disease was achieved by applying the biological agent Trichoderma sp. before planting. Biological agents like Trichoderma sp. have been used for the control of Plant Pests and Diseases (PPD) such as the fungus Trichoderma sp. (Shoresh, M., Harman, G.E., & Mastouri, F., 2010).

Weed species present in the experimental area included purple nutsedge (Cyperus rotundus) and Hedyotis corymbosa. Weed control was performed using mechanical methods, specifically hand weeding, which was done twice during the experiment. Weeds were manually removed by hand or with a hoe, ensuring the entire root system was uprooted. The presence of weeds competing with the main crop for nutrients, CO2, water, and sunlight can have a negative impact on plant growth and productivity (Kusuma, A. H., & Setiawan, I. 2019).

DISCUSSION

Based on observational data and statistical analysis, it was found that the growth performance of soybean varieties treated with biofertilizer significantly differed in terms of soybean plant height for each variety and different doses of LOF Azolla on each observation day (d0 to d4). In general, the average plant height for all varieties tended to increase from d0 to d4, indicating positive growth under intercropping conditions with LOF Azolla.

Comparing the plant height among the varieties based on the overall average, Variety K3 (Deja 2) showed lower plant height compared to other varieties at all observation times. Meanwhile, Variety K2 (Anjasmoro) and K5 (Dega1) exhibited relatively tall plant heights, especially on d4. Variety K6 (Dering 1) had a relatively stable plant height from d0 to d4..

Table 3. The results of the performance analysis of soybean cultivars under intercropping conditions with LOF Azolla on plant height (cm)

treatment	d0 Without LOF	d1 100 ml. L $^{-1}$	d2 150 ml. L $^{-1}$	d3 200 ml . L $^{-1}$	d4 250 ml. L $^{-1}$	Average
K1 (Grobogan)	52.210^{defgh}	56.347^{ghi}	51.333^{defgh}	56.897^{ghi}	61.300^{i}	55.6173
K2 (Anjasmoro)	50.537^{defg}	57.193^{ghi}	55.993^{fghi}	57.263^{ghi}	73.000^{j}	58.7973
K3 (Deja 2)	40.000^{a}	41.967^{abc}	45.300^{abcd}	48.827^{cdef}	48.450^{bcde}	44.9550
K4 (Gepak Kuning)	47.737^{bcde}	54.303^{efghi}	58.630^{hi}	56.683^{ghi}	60.380^{i}	55.5467
K5 (Dega1)	41.663^{ab}	56.233^{ghi}	56.567^{ghi}	55.850^{fghi}	60.600^{i}	54.1827
K6 (DerRing 1)	48.450^{bcde}	48.597^{bcde}	48.827^{cdef}	50.337^{defg}	54.570^{efghi}	50.4779
Average	46,766	52,440	52,775	54,309	59,717	

The mean values followed with same letters show no different real based on Duncan's test on level 95% significance.

Based on observational data and statistical analysis, it was found that the growth performance of soybean varieties treated with biofertilizer significantly differed in terms of plant height for each variety and LOF Azolla dose on each observation day (d0 to d4). Overall, the average plant height for all varieties tended to increase from d0 to d4, indicating positive growth under intercropping conditions with LOF Azolla (Harti, A. O. R., & Marina, I. 2022).

Comparing the plant height among varieties, when considering the overall averages, Variety K3 (Deja 2) showed lower plant height compared to other varieties at all observation times. Meanwhile, Varieties K2 (Anjasmoro) and K5 (Dega1) exhibited relatively tall plant height, especially on d4. Variety K6 (Dering 1) had a relatively stable plant height from d0 to d4.

Table 4. Results of Performance Analysis of Superior Soybean Cultivars in Intercropped Plantings with LOF Azolla on Character Number of Filled Pods per Plant.

treatment	d0 Without LOF	d1 100 ml. L $^{-1}$	d2 150 ml. L $^{-1}$	d3 200 ml . L $^{-1}$	d4 500 ml. L $^{-1}$	Average
K1 (Grobogan)	18.420^{a}	25.427^{abc}	29.103^{abcd}	31.170^{abcd}	37.370^{bcde}	28,298
K2 (Anjasmoro)	41.307^{bcdef}	57.660^{f}	72.810^{g}	94.610^{hijk}	110.350^{k}	75,347
K3 (Deja 2)	33.357^{abcde}	41.797^{bcdef}	45.303^{def}	45.177^{def}	42.303^{cdef}	40,238
K4 (Gepak Kuning)	80.660^{gh}	81.527^{gh}	93.413^{hij}	49.663^{ef}	100.243^{ijk}	81101
K5 (Dega1)	78.580^{gh}	80.233^{gh}	86.567^{ghi}	92.847^{hij}	108.050^{jk}	89,255
K6 (Dering 1)	23.877^{ab}	26.273^{abc}	33.087^{abcde}	27.217^{abc}	29.147^{abcd}	28,486
Average	46,033	52,153	60,047	56,781	71,244	

The mean values followed with same letters show no different real based on Duncan's test on level 95% significance.

The application of LOF to soybean plants also affects plant performance. The use of LOF at a concentration of 500 ml/L showed the best results in increasing the number of filled pods, with an average of 71,244 pods per plant. Meanwhile, the application of LOF at concentrations of 150 ml/L and 200 ml/L also resulted in a significant increase in the number of filled pods per plant.

Table 5. Performance of Soybean Cultivars in Intercropped Plantings with LOF Azolla on Character Number of Empty Pods

treatment	d0 Without LOF	d1 100 ml. L $^{-1}$	d2 150 ml. L $^{-1}$	d3 200 ml . L $^{-1}$	d4 250 ml. L $^{-1}$	Average
K1 (Grobogan)	6.133^{h}	3.683^{def}	2.993^{bcdef}	2.267^{abc}	1.400^{a}	3,295
K2 (Anjasmoro)	3.333^{cdef}	3.067^{bcdef}	2.000^{abc}	2.33^{abcd}	2.557^{abcde}	2,658
K3 (Deja 2)	3.370^{cdef}	2.023^{abc}	1.817^{ab}	1.800^{ab}	1.267^{a}	2,258
K4 (Gepak Kuning)	3.353^{cdef}	2.853^{abcde}	2.543^{abcde}	2.500^{abcde}	2.220^{abc}	2,694
K5 (Dega1)	2.133^{abc}	2.257^{abc}	1.933^{ab}	1.700^{ab}	1.423^{a}	1889
K6 (Dering 1)	5.300^{gh}	4.317^{fg}	3.727^{ef}	2.217^{abc}	1.827^{ab}	3,374
Average	3,937	3,033	2,502	2.136	1,782	

The mean values followed with same letters show no different real based on Duncan's test on level 95% significance

The results of the analysis (Table 5) indicate that the selection of soybean cultivar K2 (Anjasmoro) provided better results in the intercropping system with LOF application. Additionally, the use of LOF in certain quantities also improved the performance of soybean plants in terms of the number of filled pods per plant. Therefore, the appropriate selection of cultivars and optimal use of LOF enhance soybean production in the intercropping system. Soybean cultivar K5 (Dega1) showed the best performance in terms of the number of empty pods per plant, with an average of 1,889 pods. On the other hand, cultivar K1 (Grobogan) exhibited the lowest performance, with an average of around 3,295 empty pods per plant.

The application of LOF on soybean plants also influenced their performance in terms of the number of empty pods. The use of LOF in quantities of 100 ml/L and 150 ml/L showed better results in reducing the number of empty pods per plant, with averages of approximately 3,033 and 2,502 pods per plant, respectively. The use of higher LOF quantities, namely 200 ml/L and 250 ml/L, tended to show a less significant impact in reducing the number of empty pods. K5 (Dega1) performed better in the intercropping system with LOF, especially in reducing the number of empty pods. The appropriate use of LOF, such as 100 ml/L and 150 ml/L, also helped improve the performance of soybean plants. This indicates that the right selection of cultivars and the proper use of LOF can have a positive impact on soybean production in the intercropping system, and it is crucial to consider these factors in efforts to enhance agricultural productivity sustainably.

Tabel 6. Idependent Effect of Cultivar and LOF Azolla Doses on Intercropping

treatment	d0 Without LOF	d1 100 ml. L $^{-1}$	d2 150 ml. L $^{-1}$	d3 200 ml . L $^{-1}$	d4 250 ml. L $^{-1}$	Average
K1 (Grobogan)	4,853	4,627	3,497	4,527	5,640	4.629^{a}
K2 (Anjasmoro)	4,323	5,020	5,550	5,940	8,237	5.814^{b}
K3 (Deja 2)	3,510	3,837	4,203	4,920	5,897	4.473^{a}
K5 (Gepak Kuning)	3,303	3,713	4,910	5.107	7,150	4.837^{a}
K5 (Dega1)	5,233	4,100	5,010	6,123	6,077	5.309^{ab}
K6 (Dering 1)	3,503	6,023	5,027	5,743	5,557	5.171^{ab}
Average	4.121^{a}	4.553^{a}	4.699^{ab}	5.393^{b}	6.426^{c}	

The mean values followed with same letters show no different real based on Duncan's test on level 95% significance.

The results of the analysis (Table 6) show that the performance of soybean cultivars varies significantly depending on the given LOF dosage. Cultivar K2 (Anjasmoro) demonstrated the highest production yield with an average of 5,814 units per plant. On the other hand, cultivars K3 (Deja 2), K5 (Gepak Kuning), and K4 (Dering 1) also exhibited competitive production yields, with average yields per plant at around 4,473, 4,837, and 5,171 units, respectively.

The impact of LOF dosage is also evident in soybean production. The use of LOF with a dosage of 250 ml/L showed the highest production yield with an average of 6,426 units per plant, followed by dosages of 200 ml/L and 150 ml/L. The lowest production yield was observed with a dosage of 100 ml/L LOF, with an average of 4,121 units per plant (Rahma, A. O., & Marina, I. 2023).

The performance of soybean cultivars and the dosage of LOF Azolla have a significant influence on the production yield per plant in the intercropping system. Specific cultivars, such as K2 (Anjasmoro), resulted in higher production yields, and certain LOF dosages (especially at 250 ml/L) have the potential to increase production yields.

Table 7. Shows The Independent Effect Of Cultivar Use And Azolla Lof Application On Intercropping.

treatment	d0 Without LOF	d1 100 ml. L $^{-1}$	d2 150 ml. L $^{-1}$	d3 200 ml . L $^{-1}$	d4 250 ml. L $^{-1}$	Average
K1 (Grobogan)	242,667	231,000	174,833	226,333	282,000	231,367 ^{a}
K2 (Anjasmoro)	216,167	251,000	277,500	296,833	411,833	290,667^{b}

K3 (Deja 2)	175,500	191,833	243,500	246,000	294,833	230,333 [a]
K4 (Gepak Kuning)	165,167	185,667	212,167	255,333	357,500	235,167 [a]
K5 (Dega1)	261,667	205,000	250,500	306,167	303,833	258,533 [ab]
K6 (Dering 1)	175,167	301,167	251,333	287,167	277,833	258,533 [ab]
Average	206,055 [a]	227,611 [a]	234,972 [ab]	269,639[b]	321,305[c]	

The mean values followed with same letters show no different real based on Duncan's test on level 95% significance.

Table 7 presents the individual effects of using different cultivars and applying Azolla LOF in the intercropping system. The table displays the average performance of soybean plants for each treatment, including soybean plants without LOF (labeled "Without LOF") and those treated with LOF at various concentration levels (labeled d0, d1, d2, d3, and d4). The results show that the use of different cultivars and the application of Azolla LOF independently influence the performance of soybean plants in the intercropping system. Notably, Cultivar K2 (Anjasmoro) exhibited the best performance, with the highest average production across most LOF concentration levels (d1 to d4). Additionally, Cultivars K4 (Gepak Kuning) and K5 (Dega1) also demonstrated good performance, particularly at certain concentration levels. Regarding the application of LOF, the concentration of 250 ml/L (d4) resulted in the highest average production, followed by the concentration of 200 ml/L (d3).

Table 8 presents the correlation results among various agronomic variables measured in this study, including plant height (PH), number of filled pods (NFP), number of empty pods (NFE), seed weight (SW), 100-seed weight (W100), and seed weight per plot (SWP). The analysis showed that plant height (PH) had a significant positive correlation with the number of filled pods (NFP) and seed weight per plot (SWP) at a 95% or higher significance level. This implies that taller soybean plants tend to have more filled pods and produce larger seed weight per plot. On the contrary, the number of empty pods (NFE) had a significant negative correlation with the number of filled pods (NFP) and seed weight per plot (SWP). This suggests that plants with more empty pods tend to have fewer filled pods and lower seed weight per plot.

Moreover, seed weight (SW) exhibited a significant positive correlation with plant height (PH) and the number of filled pods (NFP). Thus, plants with greater height and more filled pods tend to produce seeds with a larger weight. These correlation results provide valuable insights into the relationship among agronomic traits of soybean plants in the intercropping system.

It is worth mentioning that the use of biofertilizer positively influenced plant height, the number of filled pods, and seed weight per plot, as previously observed in a study by Sahoo et al. in 2017. Overall, the combination of Cultivar K2 (Anjasmoro) and the application of LOF at 250 ml/L resulted in the best production outcomes. The positive correlation between plant height, the number of filled pods, and seed weight per plot further suggests that taller plants with more filled pods tend to yield seeds with a larger weight in the intercropping system.

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