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To cite this article: N Gofar *et al* 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1162** 012001

Application of Liquid Organic Pusri Fertilizer (LOPF) and Inorganic Fertilizer on Ultisols Planted With Red Chili (*Capsicum annuum* L.)

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Abstract. Red chili is a strategic horticultural commodity that is currently experiencing an increase in demand, especially in the food industry. Chili productivity itself tends to be unstable and often decreases. The things that can be done to increase the plant growth and production are fertilization. Liquid Organic Pusri Fertilizer (LOPF) is a biological fertilizer product developed by Pupuk Sriwidjaja Ltd. As the growth promoter, LOPF contains nitrogen fixing bacteria, P and K solubillizing bacteria with a biostimulant carrier made from seaweed extract. This study was designed in a randomized block design with 9 treatment levels and 3 replications. The treatment levels are P0 (100% inorganic fertilizer); P1 (LOPF application to soil); P2 (LOPF application to soil + 50% inorganic fertilizer); P3 (LOPF application to soil + 75% inorganic fertilizer); P4 (LOPF application to soil + 100% inorganic fertilizer); P5 (LOPF application to seeds and soil); P6 (LOPF application to seeds and soil + 50% inorganic fertilizer); P7 (LOPF application to seeds and soil + 75% inorganic fertilizer); and P8 (LOPF application to seeds and soil + 100% inorganic fertilizer). The recommendation dose of 100% inorganic fertilizer for NPK 16-16-16 is 300 kg ha^{-1} and urea fertilizer 200 kg ha^{-1}. LOPF applied to seeds with a concentration of 100 ppm and in soil was 12 L ha^{-1}. Application of LOPF on seeds and soil combined with 100% recommendation dose of inorganic fertilizer gave the best results in increasing the production of red chili plants with a production of 9.70 tons ha^{-1}.

1. Introduction

Red chili is a strategic horticultural commodity that is currently experiencing an increase in demand, especially in the food industry. The trend of spicy food is getting popular in Indonesians. However, the high consumer demand has not been fully met by domestic chili production [1]. It has various impacts such as high chili prices and increased opportunities for Indonesia to import chilies, although the Food Agriculture Organization (FAO) stated that in 2018 Indonesia was the fourth largest chili producing country in the world. Curly red chili is a woody seasonal plant, growing in areas with tropical climates. This plant can grow and develop both in the highlands and lowlands. To obtain high yield quantity and quality of curly red chili, it should be planted in fertile land, loose soil, organic material-rich, and not flooded, with a soil pH range of 5.5 – 6.8 [2].

The problem faced by farmers that causes the low production of chili is the cultivation area. Ultisols is often used in horticultural cultivation [3]. Ultisols is one of soil types that are categorized as sub-optimal land because of its characteristics that does not support for plant growth. The problems faced in Ultisols are the high levels of exchangeable Al and Fe, low soil pH (which is < 5), very low organic matter content, low availability of macro nutrients, and low base saturation and CEC [4]. The effort that can be done to overcome the Ultisols problem is by adding organic matter and lime to the soil, where these two materials will indirectly affect the aggregation process, the distribution of soil pores and increase soil pH [5]. Another way that can be used to increase the yield of chili plants and increase soil fertility is fertilization using organic fertilizer or environmentally friendly biological fertilizer [6].

Bio fertilizer is a kind of fertilizer contains live microorganisms that can promote growth by increasing the nutritional needs of plants [7] . Liquid Organic Pusri Fertilizer (LOPF) is a biological fertilizer produced by PT Pupuk Sriwidjaja Palembang which is made from seaweed extract, and enriched with several functional microorganisms, it has a role in the effective use of chemical fertilizers and to improve soil conditions. The benefits of biological fertilizers are evaluated based on the positive response of plants to the increasing fertilization effectiveness and efficiency so that it can save fertilizer and labour costs [8].

The use of biological fertilizers is certainly not enough to provide nutrients for plants, so it is necessary to add inorganic fertilizers to meet the nutrients need. Inorganic fertilizer is a type of fertilizer that is widely used by the community, although its excessive use can cause environmental damage, but inorganic fertilizers are easier to obtain even though the price is relatively expensive [9]. Application of inorganic fertilizers can stimulate the plant growth. Nutrients given to plants through inorganic fertilizers are relatively quickly available in the soil and more quickly absorbed by plant roots [10]. Inorganic fertilizers that commonly used are NPK and urea. NPK fertilizer is a compound fertilizer consisting of various types of nutrients such as N, P, and K. While urea is a single fertilizer containing 46% nitrogen [11]. The application of 2.5 g NPK fertilizer/plant had the best response in increasing the number of branches, flowers, and fruits, while the dose of 2 g/plant had a significant effect on the weight of chili [12]. Based on research a combination of biological fertilizers and 100% NPK fertilizer is the best treatment in producing the number of fruits and fruit weight [13]. The use of biological fertilizers combined with a dose of 100% NPK fertilizer can increase plant height, fruit length, and chili yields and can reduce the percentage of plant mortality in acid dry land [14].

The experimental field area of Sriwijaya University is classified as Ultisol. Based on the description above, the problem of chili cultivation in Ultisols were caused by the characteristics of Ultisol that does not support the growth of chili plant. Therefore, this study aims to determine the effectiveness of LOPF application on red chili seeds and into the soil to increase the growth and production of red chili plants in the experimental field of Sriwijaya University with soil type of Ultisols. LOPF is considered capable to improve the physical, chemical, and biological properties of Ultisols and can help to provide nutrients when it is combined with inorganic fertilizers. The combination of LOPF and inorganic fertilizer is expected to increase the growth and production of red chili plants.

2. Materials and Methods

This research was carried out in the experimental field of Agriculture Faculty, Sriwijaya University from July 2021 to January 2022. The experiment was designed in a randomized block design with 9 treatment levels. Each treatment was replicated 3 times, so there were 27 experimental units. The treatment levels consisted of: P0 (100% inorganic fertilizer), P1 (LOPF application to soil), P2 (LOPF application to soil + 50% inorganic fertilizer), P3 (LOPF application to soil + 75% inorganic fertilizer), P4 (LOPF application to soil + 100% inorganic fertilizer), P5 (LOPF application to seeds and soil), P6 (LOPF application to seeds and soil + 50% inorganic fertilizer), P7 (LOPF application to seeds and soil + 75% inorganic fertilizer), and P8 (LOPF application to seeds and soil + 100% inorganic fertilizer). The doses of LOPF applied to seeds with a concentration of 100 ppm and in soil was 12 L ha^{-1}.

Land preparation was done by land clearing to remove the remnants of plant from the previous planting or even weeds, tilling or loosening the soil with a hand tractor. Soil samples were taken in a composite manner before tillage. The soil pH was less than 5.6, so the soil was limed at a dose of 1 ×

Al-ex (exchangeable Al) as well as the addition of 20 tons ha^{-1} organic matter in the form of animal manure as a basic treatment. Plots were made with a size of 1.2 m × 4 m. The soil was watered to the field capacity condition and incubated for 2 weeks.

Seed preparation was done by seed treatment and non-seed treatment. Firstly, the seeds were soaked in warm water for 1 hour at a temperature of 50°C to break the seed dormancy period. Seed treatment was carried out by soaking the seeds using LOPF for 15 minutes. The planting media used in sowing procces was a mixture of animal manure and soil 50:50 (v/v). After the seedlings were 4 weeks old and had 5-6 leaves, the seedlings are transplanted to the plots with a spacing of 60 × 70 cm.

The fertilizers used are inorganic fertilizers, consisted of NPK 16-16-16 and urea (46% N). The recommended doses of 100% inorganic fertilizer were 300 kg ha^{-1} NPK 16-16-16 or 12.6 g/plant and 200 kg ha^{-1} urea or 8.4 g/plant for one period of planting. The recommended doses of 75% inorganic fertilizer were 9.45 g/plant of NPK and 6.3 g/plant of urea. For recommended dose of 50% inorganic fertilizer were 6.3 g NPK/plant and 4.2 g urea/plant. The application of NPK fertilizer was applied twice according to the treatment, in 14 and 42 days after transplanting to the plots. Urea fertilizer was applied 1 week after transplanting. Application of LOPF into the soil was carried out in 10 and 35 days after transplanting.

Plant care includes plant replanting, watering, maintenance, and pest control. Plant embroidery or replanting was done by replacing dead plants to new plants with the Pest and disease control was done by controlling manually, planting refugia, and controlling using biopesticides. Harvesting was carried out at the age of 11 to 19 weeks after transplanting with the criteria of 60% fruit showing a full red color on the fruit.

Data measurement consisted of soil pH, plant height, maximum number of branches, number of productive branches, flowering time, analysis of N, P, and K levels in plant tissue, analysis of N, P, and K soil nutrient, total population of N-fixing bacteria, P and K solubilizing bacteria. Although the observed production components included percentage of flower drops, number of fruit per plant, fruit weight per plant and per hectare in one period of planting. Observational data were analyzed statistically using excel to determine the effect of treatment on the observed variables. The best dose that produces optimal production was determined based on the $LSD_{0.05}$ test.

3. Results

3.1. Soil Reaction

Soil reaction during the study was indicated by soil pH values measured at 4, and 8 weeks after planting (WAP) red chili plants. The analysis of variance showed that LOPF and inorganic fertilizer treatments had no significant effect on soil pH at 4 and 8 weeks after planting. The average soil pH value for each observation period is presented in Table 1.

Table 1. The average soil pH values due to LOPF application and its combination with inorganic fertilizers

Treatment	Soil pH	
	4 weeks after planting (WAP)	8 weeks after planting (WAP)
P0 (100% inorganic fertilizer)	4.48	5.74
P1 (LOPF application to soil)	4.62	5.66
P2 (LOPF application to soil + 50% inorganic fertilizer)	4.49	5.84
P3 (LOPF application to soil + 75% inorganic fertilizer)	4.45	5.46
P4 (LOPF application to soil + 100% inorganic fertilizer)	4.28	5.69
P5 (LOPF application to seeds and soil)	4.47	5.65
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	4.72	5.84
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	4.34	5.77
P8(LOPF application to seeds and soil + 100% inorganic fertilizer)	4.63	5.88

3.2. Plant height

LOPF treatment and its combination with inorganic fertilizer had no significant effect on plant height of red chili plants that planted in Ultisols. The average of plant height due to LOPF application is presented in Figure 1. LOPF applied to soil and seeds showed the higher plant height than fertilized the plant with 100% urea and NPK at the beginning of plant growth, 14 days after planting (DAP). During the plant growth phase, the addition of 50% urea and NPK in chili plants cultivation that had been applied with LOPF showed the highest plants height. It seems that the microorganisms were contained in LOPF have a positive impact on increasing the height of red chili plants. The LOPF contained nitrogen-fixing bacteria (*Alcaligens* sp. and *Ocrobactrum* sp.) and P and K solubilizing bacteria (*Bacillus* sp.). These bacteria have a positive effect on the vegetative growth of red chili plants on Ultisol, presumably because of their role in increasing N and dissolving P and K as well as stimulating the plant growth. In line with the research from [15], biological fertilizer containing microorganisms tend to provide nutrient needs for plants so that plant growth could be more optimal.

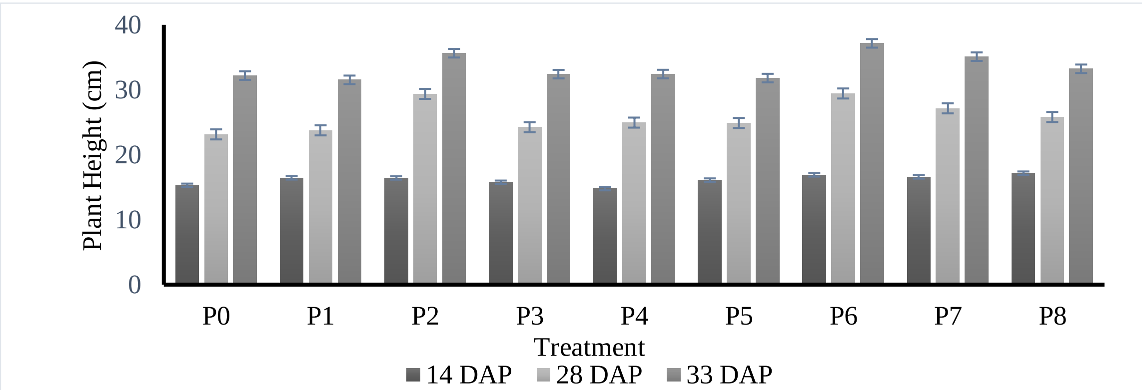

Figure 1. The height of red chili plants in each treatment at observation 14, 28 and 33 days after planting (DAP).

3.3. Number of Maximum and Productive Branches and Flower Appearance Time

LOPF application had no significant effect either on the number of maximum and productive branches or flower appearance time of red chili plants that planted in Ultisols. The average number of maximum and productive branches, also flower appearance time due to LOPF application are presented in Table 2.

The maximum number of branches and productive branches varied in each treatment. The highest number of branches was obtained in the P5 treatment (LOPF application to soil and seeds without inorganic fertilizers). The data in Table 2 proves that the application of LOPF could accelerate flower appearance compared to the application of urea and NPK fertilizers. It is in line with research, that the application of biological fertilizers with active *Pseudomonad fluorescent* bacteria can accelerate flower appearance. Increasing the dose of urea and NPK fertilizers could delay the flowering time [16].

Table 2. The average number of maximum and productive branches and flower appearance time due to LOPF application and its combination with inorganic fertilizer

Treatment	Maximum number of branches	Number of productive branches	Flowers appear (days)
P0 (100% inorganic fertilizer)	3.64	20.55	38.98
P1 (LOPF application to soil)	4.21	19.24	31.07
P2 (LOPF application to soil + 50% inorganic fertilizer)	3.50	14.62	33.26
P3 (LOPF application to soil + 75% inorganic fertilizer)	1.60	13.00	37.83
P4 (LOPF application to soil + 100% inorganic fertilizer)	4.00	17.02	36,10
P5 (LOPF application to seeds and soil)	5.71	23.00	31.45
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	1.19	5.52	33.40
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	1.95	15.02	36.90
P8(LOPF application to seeds and soil + 100% inorganic fertilizer)	4.26	16.93	36.76

3.4. Soil NPK Levels in the Primordial Phase of Red Chili Plants

Nutrient levels of N, P, and K in the soil due to LOPF application were analyzed after the red chili plants were 33 days old. LOPF application and its combination with inorganic fertilizer had no significant effect on the total N, available P, and exchangeable K in the soil that planted red chili plants. The average soil nutrient content (N, P, and K) due to LOPF application in red chili cultivation is presented in Table 3.

Table 3. Nutrient levels of soil NPK due to LOPF application its combination with inorganic fertilizer

Treatment	Soil Nutrient Level		
	N total (%)	P2O5 (mg kg^{-1})	K2O ($cmol_{(+)}$ kg^{-1})
P0 (100% inorganic fertilizer)	0.22	176.8	0.78
P1 (LOPF application to soil)	0.19	168.8	0.35
P2 (LOPF application to soil + 50% inorganic fertilizer)	0.21	169.9	0.53
P3 (LOPF application to soil + 75% inorganic fertilizer)	0.21	170.3	0.67
P4 (LOPF application to soil + 100% inorganic fertilizer)	0.23	175.8	0.70
P5 (LOPF application to seeds and soil)	0.19	159.8	0.38
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	0.21	164.3	0.44
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	0.21	178.4	0.73
P8(LOPF application to seeds and soil + 100% inorganic fertilizer)	0.24	209.9	0.93

Based on laboratorium analysis, the land that was applied LOPF without inorganic fertilizer application (P1 and P5) showed the lowest levels of N, available P and exchangeable K. It was categorized as low N and K, while available P was classified as very high in all treatments. Nutrient imbalance in this research area also affected the productivity of red chili plants. P nutrient has very important role in flower formation, but the low of available K nutrient becomes a limiting factor on the growth and production of red chili plants, because K nutrient functions as an enzyme activator and distributes assimilation products to all plant tissues [17].

3.5. Nutrient Levels and Uptake of Red Chili Plants

As well as the soil analysis, nutrient levels of N, P, and K in red chili plants were also analyzed after the plants were 33 days old, when 70% of the red chili plants in each plot had been flowering. LOPF application and its combination with inorganic fertilizer had no significant effect on NPK nutrient levels and uptake in red chili plants. The analysis of nutrient levels and uptake in red chili due to LOPF application are presented in Table 4. The highest nutrient uptake was found in P5 treatment (LOPF application to soil and seeds). It is presumably that LOPF-enriched microorganisms are more effective in assisting nutrient supply if they are not combined with urea and NPK fertilizers, so that the NPK uptake was higher.

Table 4. Nutrient levels and uptake of NPK in red chili plants due to LOPF application

Treatment	Nutrient Level (%)		
	N total	P2O5	K2O
P0 (100% inorganic fertilizer)	4.08	0.26	4.23
P1 (LOPF application to soil)	4.07	0.28	4.28
P2 (LOPF application to soil + 50% inorganic fertilizer)	4.31	0.29	4.78
P3 (LOPF application to soil + 75% inorganic fertilizer)	4.32	0.26	4.38
P4 (LOPF application to soil + 100% inorganic fertilizer)	4.22	0.27	4.17
P5 (LOPF application to seeds and soil)	4.20	0.28	4.93
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	4.02	0.28	4.32
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	4.19	0.28	4.28
P8 (LOPF application to seeds and soil + 100% inorganic fertilizer)	4.18	0.27	4.06
Treatment	Nutrient Uptake (g/plant)		
	N total	P2O5	K2O
P0 (100% inorganic fertilizer)	0.140	0.009	0.145
P1 (LOPF application to soil)	0.173	0.012	0.201
P2 (LOPF application to soil + 50% inorganic fertilizer)	0.185	0.013	0.204
P3 (LOPF application to soil + 75% inorganic fertilizer)	0.159	0.010	0.161
P4 (LOPF application to soil + 100% inorganic fertilizer)	0.146	0.009	0.145
P5 (LOPF application to seeds and soil)	0.213	0.014	0.248
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	0.165	0.012	0.174
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	0.138	0.009	0.140
P8 (LOPF application to seeds and soil + 100% inorganic fertilizer)	0.172	0.011	0.168

3.6. Total Population of N-fixing, P and K Solubilizing Bacteria

Based on the analysis of variance, LOPF application either combined or not combined with inorganic fertilizer had no significant effect on the population of N-fixing bacteria, but had a significant effect on P and K solubilizing bacteria. The average bacterial population for each treatment is presented in Table 5.

The application of LOPF and its combination with inorganic fertilizer increased the population of N-fixing bacteria (*Alcaligens* sp. and *Ochrobactrum* sp.) although not significantly affected. The lowest population of Alcaligens sp. was found in the control treatment (no application of LOPF). Treatment significantly increased the population of P and K solubilizing bacteria (*Bacillus* sp.). The population of microorganisms in the application of LOPF to the soil also to soil and seeds combined with inorganic fertilizers were significantly different with the treatment of 100% recommended inorganic fertilizer.

Table 5. Populations of N-fixing, P and K solubilizing bacteria to LOPF application and its combination with inorganic fertilizer

Treatment	Total Bacteria (log cfu g^{-1})		
	N_2 fixer (*Alcaligens* sp.)	N_2 fixer (*Ochrobactrum* sp.)	P and K solubilizing (*Bacillus* sp.)
P0 (100% inorganic fertilizer)	5.28	4.46	5.99[a]
P1 (LOPF application to soil)	5.64	4.99	6.38[ab]
P2 (LOPF application to soil + 50% inorganic fertilizer)	5.97	4.89	6.43[ab]
P3 (LOPF application to soil + 75% inorganic fertilizer)	5.72	4.83	6.64[bc]
P4 (LOPF application to soil + 100% inorganic fertilizer)	6.66	4.98	6.93[d]
P5 (LOPF application to seeds and soil)	6.28	4.97	6.95[bc]
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	5.60	4.92	6.95[b]
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	5.65	4.89	6.96b[c]
P8(LOPF application to seeds and soil + 100% inorganic fertilizer)	5.61	4.88	7.34[d]

Remarks : The values followed by different small letters within each column indicates significantly different.

3.7. Percentage of Chili Flower Drop (%)

The components of red chili production consisting of the percentage of flower fall, number of fruit, and fresh weight of fruit due to LOPF application were observed in harvest periods 1-9. The average percentage of flower drop during the growth of red chili plants is presented in Table 6.

Table 6. The percentage of chili flower drop due to the application of LOPF and its combination with inorganic fertilizer

Treatment	Flower drop (%)
P0 (100% inorganic fertilizer)	44.65[bc]
P1 (LOPF application to soil)	42.89[bc]
P2 (LOPF application to soil + 50% inorganic fertilizer)	20.88[a]
P3 (LOPF application to soil + 75% inorganic fertilizer)	24.50[a]
P4 (LOPF application to soil + 100% inorganic fertilizer)	47.53[c]
P5 (LOPF application to seeds and soil)	46,63[bc]
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	25.93[a]
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	24.97[a]
P8 (LOPF application to seeds and soil + 100% inorganic fertilizer)	40.57[b]

Remarks: The value followed by different small letters within each column indicates significantly different.

Table 6 shows that the highest percentage of flower drop was found in P4 (LOPF application to soil + 100% inorganic fertilizer), but it was not significantly different from LOPF application without inorganic fertilizer. LOPF application succeeded in reducing the percentage of flower drop, if not combined with 100% NPK and urea fertilizer.

3.8. Number of Fruits and Red Chili Production

LOPF application and its combination with inorganic fertilizers had no significant effect on the number of fruits per plant and the total number of fruits, but significantly effected on total production per hectare. The average number and production of red chili plants for each treatment are presented in Table 7.

The treatment of P8 (LOPF application to seeds and soil + 100% inorganic fertilizer) produced the highest total fruit of red chili plants in Ultisols. In line with the number of fruits, the highest total production per hectare was also obtained in P8 treatment which was significantly different from other treatments. The application of LOPF to soil and seeds combined with inorganic fertilizer obtained the red chili production of 9.75 tons ha^{-1}, which was exceeded the national production of 8.77 tons ha^{-1} [18]. LOPF functions as biological fertilizer can help to provide nutrients, so that in the P8 treatment produced a high number of fruit and production.

Table 7. The average number of fruits and red chili production due to the LOPF application and its combination with inorganic fertilizer

Treatment	Number of fruit/plant	Number of fruits/ha (x10^6)	Total production (ton ha^{-1})
P0 (100% inorganic fertilizer)	117.33	8.07	4.68 ^{a}
P1 (LOPF application to soil)	123.25	7.96	4.81 ^{a}
P2 (LOPF application to soil + 50% inorganic fertilizer)	205.14	13.22	6.41 ^{bc}
P3 (LOPF application to soil + 75% inorganic fertilizer)	175.81	12.09	5.90 ^{abc}
P4 (LOPF application to soil + 100% inorganic fertilizer)	204.48	14.06	6.67 ^{c}
P5 (LOPF application to seeds and soil)	193.48	13.30	6.33 ^{bc}
P6 (LOPF application to seeds and soil + 50% inorganic fertilizer)	213.03	14.28	6.76 ^{c}
P7 (LOPF application to seeds and soil + 75% inorganic fertilizer)	183.31	11.96	5.24 ^{ab}
P8 (LOPF application to seeds and soil + 100% inorganic fertilizer)	274.57	17.84	9.75 ^{d}

Remarks: The value followed by different small letters within each column indicates significantly different.

4. Discussion

Based on the results of laboratory analysis, the soil in this study field had loam texture which consisted of 57% sand, 9% silt and 34% clay contents. This soil had a lumpy structure, good porosity, stable aggregate stability with a field capacity water content of 38%. This soil reacted slightly acidic, with moderate Al saturation, moderate Ca, Mg and Na cations and low K. Soils had very high total and available P, but low total N and K. With these conditions and high ratios of C and N, liming was still carried out at a dose of 1 x Al-ex (exchangeable Al), considering the slightly acidic pH and the optimal condition for soil microbial activity to reduce high C and N ratios. The soil in the study area had a low Cation Exchange Capacity (CEC) with high base saturation (BS). This condition caused low holding capacity of the soil so that even though it had been limed and the increase in soil pH was not significant. The average pH values for weeks 4 and 8 are presented in Table 1. During the time from week 4 to week 8, there was an increase in soil pH. It could be caused by the alkaline nature of organic compounds in the LOPF, where organic compounds could donate base cations, causing an increase in pH. The microbial activity of N_2 fixing, phosphate and potassium solubilizing bacteria that contained in LOPF can contribute nutrients that also affect the increase in soil pH. LOPF contains nitrogen fixing bacteria (*Alcaligens* sp. and *Ocrobactrum* sp.) and P and K solubilizing bacteria (*Bacillus* sp.). These bacteria will grow well if the environmental conditions are suitable and can affect soil pH and increase the plant growth [19].

Adequate nitrogen supply to plants during the early growth period is essential for the initiation of leaf and flower primordial, but excess nitrogen conditions stimulate the growth of the vegetative phase and slowing the plant to enter the generative phase. Research on rice plants showed that high urea fertilization could trigger the growth of the vegetative phase and increase the number of tillers [20]. Research in barley, the high doses of urea fertilization led to excess N availability, thus inhibiting flowering time [21]. As well in this study, the increasing doses of urea and NPK fertilizers actually slowed flowering time as shown in Table 2.

Flower drop is one of the important problems that can reduce the productivity of red chili plants. One of the factors that can affect flower and fruit drop is the physiological factor of the plant itself, this is influenced by the activity and growth regulators such as auxin (IAA), gibberellins (GA3), and ABA [22]These growth regulators can regulate, change, and inhibit plant physiological processes, even in small amounts [23]. Lack of nutrients is also one of the physiological factors that cause flower drop. One of the macro elements that take an important role in the formation of flowers and fruit is potassium (K). If the plant lacks of potassium, the flowers on the plant will drop more easily [24].

Table 6 shows that the LOPF application was able in reducing the percentage of flower drop, unless it was followed by 100% NPK and urea fertilization. When this research was carried out, the rainfall was quite high especially in the beginning of flowering phase. According to the research in 2013, the high rainfall followed by low sunlight intensity can cause flower drop [25]. In the flowering process, sunlight has an effect on accelerating the process of flower formation and making flowers stronger and not easy to drop. The range of flower drop on LOPF applications is 20.88% to 47.53%. The highest flower drop in the LOPF treatment that applied to the soil with 100% NPK and urea fertilization, but it was not significantly different from the treatment of LOPF application without inorganic fertilization and also in treatment of inorganic fertilizer without LOPF application. Based on the research, 48.6% of the flowers drop happened [26], it was higher than the percentage of flower drop in this research that conducted in experimental field of Sriwijaya University.

The number of chilies is related to the number of flowers formed because pollination in flowers affects the formation of ovules [12]. The more flowers that are formed, the more potential for fruit formation. Nitrogen, phosphate, and potassium are macro nutrients that needed for plants, especially in fruit formation [13], so that the addition of inorganic fertilizers such as NPK fertilizer is needed to increase the number of chilies produced by plants. Biofertilizers made from seaweed enriched with microorganisms are not the main nutrients but help to make nutrients available to plants so that when combined with NPK fertilizers it is more optimal to provide nutrients for plants [27].

Each plant requires adequate nutrition in order to produce high yields. During the fertilization phase, the nutrients absorbed by the plant are accumulated in the fruit, tuber, or other plant parts produced. Every plant has the capacity to absorb nutrients, the lack or excess of nutrients can cause the results obtained are less than optimal. Plants that lack or excess nutrients cause the photosynthesis process to not run effectively so that the photosynthate produced will be reduced [28]. The important thing that limits the production of chili plants is the fruit drop in chili plants [29]. One of the pests that can cause fruit drop is fruit flies, where fruit flies will stick their stylets in and lay their eggs on chilies so that later fruit fly larvae live in chilies, causing fruit to rot and drop before harvest time [30]. Ripe fruit is usually more favoured by fruit flies. Fruit flies will lay eggs influenced by the shape, colour and texture of the fruit, fruit flies also prefer to lay their eggs on shaded and slightly soft fruit [31]. In this study, the attack of fruit flies was quite high, the effort done to overcome the attack of fruit flies was to use a biological pesticide made from neem leaves, which was sprayed on all parts of the plant.

Nutrient imbalance in the Ultisol of this research area also affected the productivity of red chili plants. N and K were categorized as low, while P was classified as very high. P element plays a very important role in flower formation, but the low of available K caused the limited production of red chili plants, because K element has functions as an enzyme activator and distributes assimilation products to all plant tissues [17].

5. Conclusion

Application LOPF combined with inorganic fertilizer had a significant effect on fruit weight and chili production (ton ha^{-1}). Application of LOPF on seeds and soil followed by 100% recommended dose of inorganic fertilizer gave the best results in increasing the production of red chili plants on Ultisol with a production of 9.75 tons ha^{-1}.

Acknowledgement

The authors acknowledge the financial support of Liquid Organic Pusri Fertilizer development by Pupuk Sriwidjaja Palembang Ltd. with work order number 5500026495. The authors also want to thank Shinta Dwi Intan Permatasari, S.P for helping us in this research.

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