International Journal of Agricultural Technology 2022Vol. 18(4):1415-1428
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Increasing growth, seed product and phosphorus uptake efficiency of Soybean (*Glycine max* (L.) Merrill) in Alfisol using phosphorus fertilization methods

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Cahyono, O., Minardi S., Hartati, S. and Rifaldi, D. (2022). Increasing growth, seed product and phosphorus uptake efficiency of Soybean (*Glycine max* (L) Merrill) in Alfisol using phosphorus fertilization methods. International Journal of Agricultural Technology 18(4):1415-1428.

Abstract The result of the study showed that adding dolomite and fast soluble phosphorus (FSP) fertilizer increased growth, seed yield and P uptake efficiency on Soybean. This study recommended using FSP fertilizer at a dose of 150 kg ha^{-1} plus dolomite to increase growth and seed yield of Soybean in Alfisols. There was an increase in growth by 35.79% and seed product by 69.76% compared to the treatment of 150 kg ha^{-1} SP36 with no application of dolomite. Meanwhile, it was recommended to use 100 kg ha^{-1} FSP + dolomite due to its ability to increase the P uptake efficiency by 93.2 % compared to the treatment of 150 kg ha^{-1} SP36 without dolomite application.

Keywords: Alfisol, Efficiency, Fast soluble phosphate, Soybean

Introduction

Soybean (*Glycine max* (L) Merrill) is one of the main food crops grown in Indonesia, alongside rice and maize. It plays a significant role in both human and animal nutritional needs. The demand for soybeans continues to increase far beyond national production. Therefore, to resolve this problem and reduce importation, its production was increased through marginal land-use intensification (Alvernia *et al.*, 2017). However, some problems limit plant yield such as, the poor efficiency of P fertilization, which on average is relatively 20% (Veneklaas *et al*., 2012). Meanwhile, the rest ~~that~~ is not absorbed by plants that will be left in the soil to form insoluble compounds and having potential lost through erosion and leaching (Conijn *et al*., 2018).

Several reasons restrict soybean yields, one of which is the lack of phosphorus (Bruno *et al.*, 2018). This is caused by dwindling fertile land due to the continuous use of chemical fertilizer. Soybean production is usually poor,

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mostly owing to insufficient fertilization and acidic soil conditions. Besides, the plant requires adequate and balanced nutrients. According to Aainaa *et al.* (2018), efficient P fertilizer management provides high crop yield and sufficient nutrition supply. However, there are numerous obstacles associate with the production of soybean on marginal land, such as nutrient-poor terrestrial ecosystem, and inadequate soil organic matter (Mutammimah *et al*., 2020).

Optimal nutrient management, including a balanced fertilization method based on soil fertility and plant needs for nutrients, has the potential to maintain production sustainability while protecting fertilizer raw materials and increasing nutrient uptake efficiency. However, in reality, fertilization is often not carried out in a balanced manner resulting in low nutrient use efficiency (Chuan *et al.,* 2016). Because P fertilizer is an expensive fertilizer and made from mineral resource that is unrenewable, it is critical to increase the P use efficiency in order to decrease farmer expenses and assist conserve limited rock phosphate supplies in the future (Pavinato *et al.,* 2017).

Previous studies have been carried out to determine the efficiency of P fertilization on various crops. For instance, studies on the efficiency of P fertilization on two soybean cultivars were carried out by Dalshad *et al*. (2013), faba bean under poor agroecosystem input (Nebiyu *et al.,* 2016), and rainfed condition (Daoui *et al*., 2012). The use of coated P fertilizers with humic acid was studied by Volf and Rosolem (2021), which reported that the P efficiency was insignificant. Devi *et al*. (2012) studied the effect of different P fertilizer sources on soybeans and reported that the Single Super Phosphate that was applied with P solubilizing bacteria yielded better results compared to the others. Boosting the effectiveness of this manure using the foliar application method was studied by Rafiullah *et al*. (2020). It was concluded that the use of this procedure led to increased production of maize and wheat.

The efficiency of P fertilization was improved by synchronizing the time it was supplied with that of its uptake by the plants. This tends to limit the physical contact between the P ions and P fixing soil components. The longer the soil colloid fix or forms precipitated compound, the more stable the bond (Barrow, 2015). Application of fast soluble P fertilizer using the split addition methods in accordance with the plant growth phase reduces the contact time between P ion and P fixing soil component. However, there are no study on the impact of fast soluble fertilizer on soybeans. Therefore, this study is aimed to assess the effect of P application methods on the growth, product, and uptake efficiency of Soybean in Alfisols.

Materials and methods

This study was carried out on Alfisols in Jumantono, Karanganyar, from July 2020 to January 2021 at an altitude of 149 m above sea level. A randomized completely block design consisting of 5 phosphate fertilizations, 2 liming treatments and 4 blocks used as replications was adopted. The P fertilization approach comprises of P_0 = 0 kg ha^{-1} (without P fertilization), P_1 = 150 kg ha^{-1} SP36 applied at planting time (0 day after planting), P_2 = 150 kg ha^{-1} of fast soluble P fertilizer applied at 0, 15 and 30 days after planting (dap), P_3 = 100 kg ha^{-1} of fast soluble P fertilizer applied at 0, 15, 30 (dap), P_4 = 75 kg ha^{-1} of fast soluble P fertilizer applied at 0, 15 and 30 (dap). The 2 dolomite levels applied were K_0 = without dolomite and K_1 = dolomite applied to increase soil pH = 7.

The size of the tilled land was 2 m x 2 m, and as many as 40 plots were prepared. Meanwhile, before treatment, soil samples collected at 5 points were analyzed to determine some of its chemical properties, including pH (H_2O), pH (KCl), available P and P retention, organic C content, total N, exchangeable K, Ca, Mg and Fe.

Fermented cow manure was applied to all plots at a dose of 10 tonnes per hectare, at two weeks before planting. All plots were treated with Urea and Potassium chloride at doses of 175 kg ha^{-1} and 200 kg ha^{-1} respectively. In addition, both fertilizers were administered twice, 70% was applied at 10 dap while the remaining was at 30 dap. The soil was also treated with P fertilizer and soybean seeds were planted in each plot using a planting space of 20 cm x 40 cm. The plants were cultivated and maintained till they were harvested. The growth parameters include plant height, number of leaves and branches, the weight of wet and dry shoot and root, the number of pithy pods, total pods, seed weight, P uptake, P uptake efficiency, physiological and agronomic efficiencies of P were measured. The recorded data were statistically analized using an Analysis of Variance and Tukeys' test of 5%. The effect of the treatment on P efficiency was measured using the following formulas (Mengel and Kirkby, 2001).

$$\text{P uptake efficiency} = \frac{(\text{P uptake } fertilized\ crops - \text{P uptake } control\ treatment)}{\text{P applied}}\, x\ 100\% .. (1)$$

$$\text{Physiological Efficiency of P} = \frac{(\text{Seed product } fertilized\ crops - \text{Seed product } control\ treatment)}{(\text{P uptake } fertilized\ crops - \text{P uptake } control\ treatment)}\ \text{g/g} ... (2)$$

$$\text{Agronomic Efficiency of P} = \frac{(\text{Seed product } fertilized\ crops - \text{Seed product } control\ treatment)}{(\text{P applied})}\ \text{g/g} ... (3)$$

Results

The characteristics of Alfisols are shown in Table 1.

Table 1. Characteristics of the Alfisols used in this study

No	**Soil characteristics**	**Values**
1.	pH (H_2O)	5.50
2.	pH (KCl)	5.13
3.	C-organic (%)	1.87
4.	Total N (%)	0.16
5.	Total P (ppm)	99.41
6.	Available P (ppm)	3.12
7.	P retention (%)	87
8.	Ca (me/100 g)	1.26
9.	Mg (me/100 g)	0.87
10.	K (me/100 g)	0.24
11.	Fe (ppm)	44.71
12.	CEC (me/100 g)	38.20
13	Texture	Clay

Growth and seed product of Soybean on the application of FSP fertilizer and dolomite

The present study indicated that the P and dolomite addition significantly affected the number of leaves and branches as well as shoot dry weight. However, the treatments had an insignificant effect on plant height, root and fresh shoot weights.

The maximum number of leaves, namely 34.9, was achieved by FSP application at the rate of 150 kg ha^{-1} FSP + dolomite (K_1P_2). Conversely, the minimum, which as many as 15.85 leaves, was found at the treatment of with no dolomite + 75 kg ha^{-1} FSP (K_0P_4) as shown in Table 2. The maximum number of branches, 10.27 was achieved using 150 kg ha^{-1} FSP + 0 dolomite (K_0P_2), and a minimum of 5.87 was achieved without P + no dolomite treatment (K_0P_0). The maximum weight of dry shoot obtained as 16.16 g was realized by the addition of 150 kg ha^{-1} FSP + dolomite (K_1P_2), while a minimum weight of 6.79 g was achieved without the P + dolomite treatments (K_0P_0).

The yield components under the treatments are shown in Table 3. The result showed that the administration of P fertilizer and dolomite had a significant effect on the pithy pods number, pods weight and seeds weight. The acquired data showed that the maximum number of pithy pod, 44.17 was achieved using the treatment of 150 kg ha^{-1} FSP + dolomite (K_1P_2). Conversely a minimum of 15.87 pithy pods was found at the treatment of without P +

without dolomite (K_0P_0). The use of FSP fertilizer increased the number of soybean pithy pods with or without dolomite application. The addition of fast soluble P fertilizer significantly improved both pods and seeds weight. The maximum weight of pods, 25.63 g, was discovered when 150 kg ha^{-1} FSP + dolomite (K_1P_2) was added to the soil, while a minimum of 8.85 g, was achieved with the treatment of 0 P + 0 dolomite (K_0P_0). A maximum seed weight of 21.61 g, was achieved by the application of 150 kg ha^{-1} FSP + dolomite (K_1P_2), while a minimum of 7.19 g, was obtained without the treatment of P + dolomite (K_0P_0).

Table 2. Number of soybean leaves, branches and shoot dry weight on the application of FSP fertilizer and dolomite

Treatment	**Mean**		
	Number of leaves	Number of branches	Dry weight of shoots (g)
K_0P_0 = 0 dolomite + 0 P	17,27 a[\3]	5,87 a	6,79 a
K_0P_1 = 0 dolomite + 150 kg/ha SP36[\1]	18,27 a	10,27 b	11,90 ab
K_0P_2 = 0 dolomite + 150 kg/ha FSP[\2]	22,25 ab	9,95 ab	10,47 ab
K_0P_3 = 0 dolomite + 100 kg/ha FSP[\2]	17,22 a	8,92 ab	9,09 ab
K_0P_4 = 0 dolomite + 75 kg/ha FSP[\2)]	15,85 a	5,92 a	12,74 ab
K_1P_0 = + dolomite + 0 P	19,47 a	8,32 ab	8,49 a
K_1P_1 = + dolomite + 150 kg/ha SP36[\2*)]	30,67 bc	8,90 ab	13,16 b
K_1P_2 = + dolomite + 150 kg/ha FSP[\1]	34,9 c	8,02 ab	16,16 b
K_1P_3 = + dolomite + 100 kg/ha FSP[\2]	33,05 c	9,10 ab	9,30 ab
K_1P_4 = + dolomite + 75 kg/ha FSP[\2]	22,45 ab	6,97 ab	9,24 ab

[1]/SP6 was administered once during planting
[2]/FSP was applied trice at 0, 15 and 30 days after planting
[3]/Mean values within a column followed by the same letters are insignificantly different at $p < 0.05$ according to Honesty Significant Difference.

Table 3. Number of soybean pithy pods and weights of pods and seeds on the application of FSP fertilizer and dolomite

Treatments	**Mean**		
	Number of pithy pods per plant	Pod weight per plant (g)	Seed weight/ plant (g)
K_0P_0 = 0 dolomite + 0 P	15,87 a[\3]	8,85 a	7,19 a
K_0P_1 = 0 dolomite + 150 kg/ha SP36[\1]	32,62 cd	18,95 de	12,73 c
K_0P_2 = 0 dolomite + 150 kg/ha FSP[\2]	35,32 cde	20,97 def	15,99 de
K_0P_3 = 0 dolomite + 100 kg/ha FSP[\2]	35,87 cdef	21,31 def	12,20 c
K_0P_4 = 0 dolomite + 75 kg/ha FSP[\2]	23,75 ab	13,56 bc	9,81 b
K_1P_0 = + dolomite + 0 P	22,15 ab	10,80 ab	9,44 ab
K_1P_1 = + dolomite + 150 kg/ha SP36[\1]	40,72 def	23,44 ef	20,59 f
K_1P_2 = + dolomite + 150 kg/ha FSP[\2]	44,17 f	25,63 f	21,61 f
K_1P_3 = + dolomite + 100 kg/ha FSP[\2]	42,25 ef	25,35 f	16,16 e
K_1P_4 = + dolomite + 75 kg/ha FSP[\2]	28,72 bc	17,02 cd	13,61 cd

[1]/SP36 was administered once during planting
[2]/FSP fertilizer was applied trice at 0, 15 and 30 days after planting
[3]/Mean values within a column followed by the same letters are insignificantly different at $p < 0.05$ according to the Honesty Significant Difference.

Soybean P uptake and P efficiency on the application of FSP fertilizer and dolomite

P uptake and efficiency are shown in Table 4. It was discovered that the addition of P fertilizers, either SP36 or FSP, increased the soybean P uptake. The application of 150 kg ha^{-1} FSP fertilizer without dolomite increased the P uptake from 15.87 mg $plant^{-1}$ to be 35.87 mg $plant^{-1}$. On the contrary, the treatment with dolomite increased from 22.15 to 44.17 mg $plant^{-1}$, as shown in Table 4.

Table 4. Soybean P uptake, and P fertilization efficiencies on the application of FSP fertilizer and dolomite

Treatments	P uptake (mg/plant)	P uptake efficiency (%)	Agronomic P efficiency (g seed/g P added)	Physiological P efficiency (g seed/g P added)
K_0P_0	15,87 a\3	-	-	-
K_0P_1\1	32,62 cd	12.2 a	29.47 a	241.60 a
K_0P_2\2	35,32 cde	12.46 a	46.83 b	375.96 c
K_0P_3\2	35,87 cdef	10.09 a	40.12 b	396.44 c
K_0P_4\2	23,75 ab	10.32 a	27.95 a	270.87 ab
K_1P_0	22,15 ab	-	-	-
K_1P_1\1	40,72 def	16.31 ab	71.28 b	437.03 d
K_1P_2\2	44,17 f	22.58 c	76.75 b	339.93 c
K_1P_3\2	42,25 ef	23.57 c	71.76 b	303.76 bc
K_1P_4\2	28,72 bc	19.9 bc	68.30 b	343.13 c

[1]/SP36 was administered once during planting
[2]/FSP fertilizer was applied 3 times at 0, 15, and 30 days after planting
[3]/Mean values within a column followed by the same letters are insignificantly different at $p < 0.05$ according to Honesty Significant Difference.

This study stated that fast soluble P fertilizer treatment with dolomite significantly increased the soybean P uptake efficiency. The P uptake efficiency of the SP36 fertilizer + dolomit treatment was as high as 16.31%, and using FSP fertilizer + dolomit it was increased to 22.58%, 23.57%, and 19.90% at the FSP fertilizer treatment of 150, 100, and 75 kg ha^{-1}, respectively.

The present study stated that the addition of fast soluble P fertilizer had been discovered to improve agronomic P efficiency. Its application without dolomite increased the agronomic efficiency from 29.47 g g^{-1} (gram of seed yield per gram of P added) to 46.83 g g^{-1} (at the FSP dose of 150 kg ha^{-1}) and 40.12 g g^{-1} (at the FSP dose of 100 kg ha^{-1}). Meanwhile, the use of FSP fertilizer accompanied by the application of dolomite did not increase significantly the agronomic efficiency.

The administration of fast soluble P fertilizer affected the soybean physiological efficiency of P, which was proven by the acquired data, which stated it was higher when treated with 150 and 100 kg ha^{-1} of FSP compared to application of SP36 at the dose of 150 kg ha^{-1}. Meanwhile, the application of FSP fertilizer and dolomite reduced the physiological P efficiency (Table 4).

Discussion

Soybean growth and seed product based on FSP fertilizer and dolomite application

The addition of P fertilizer, either SP36 or FSP, increased the number of leaves, branches, and shoot dry weight. This study reported that applying P fertilizer and dolomite resulted in better growth, indicated by the increased number of leaves and shoot dry weight. However, compared to the SP36, the use of FSP improved better the growth of soybean. An increase of 91.02% was detected in the number of leaves obtained with the treatment of dolomite plus 150 kg ha^{-1} of FSP fertilizer compared to those applied with the 150 kg ha^{-1} of SP36 with no dolomite treatments. Similarly, the dry shoot weight increased significantly ($p < 0.05$) from 11.90 g to 16.16 g or an increase of 35.8%. However, the administration of P fertilizer without dolomite resulted in a lower dry shoot weight. This shows the important role of dolomite in cultivating acid soils. The previous study by Anis *et al.* (2020) found that dolomite treatment significantly increased soil pH, exchangeable calcium, exchangeable magnesium and reduced exchangeable aluminum. Dolomite treatment significantly increased the weight of shoot, the Ca and Mg uptake of soybean. Plant height, pod weight and seed weight of soybean under the dolomite treatment at a dose of 2.5 x Al-dd or equivalent to 39.9 tons ha^{-1} tended to be higher than other treatments. Pod weight and seed weight tended to increase with increasing dolomite dose.

The use of dolomite in Alfisols also had a positive effect on soybean growth and yield. This is consistent with previous studies by Wijanarko and Taufiq (2016) which reported that dolomite application in Tidal land increased soybean growth and yield. This is a good ameliorant that raises soil pH and reduces Al saturation in solution (Chimdi *et al*., 2012; Nora *et al*., 2014; Sadiq and Babagana, 2012). Shaaban *et al*. (2015) further stated that the pH of the soil treated with dolomite tends to increase till the 17th day when it becomes relatively stable. The applied dolomite dissolves, thereby providing calcium (Ca^{2+}) and magnesium (Mg^{2+}) into the soil solution, which replaces aluminum (Al^{3+}) and it is neutralized by OH^- ions.

The available P in the soil was low, 3.12 ppm; therefore, the addition of P fertilizer significantly increased plant growth. In accordance with this, the rate of photosynthesis was increased, leading to the production of excessive biomass. The results obtained proved the importance of P element in plant growth. Phosphorus plays a vital role in living cells, namely during the process of energy transfer and various other biochemical reactions (Devi *et al*., 2012). This is consistent with previous studies, which stated that the source of element P and its level of application influenced soybean growth (Lamptey *et al*., 2014).

The present study discovered that the addition of FSP significantly increased the soybean seed product. The administration of 150 kg ha^{-1} FSP fertilizer led to higher pithy pods number per plant, pod weight per plant and seed weight per plant compared to SP36 application. The application of FSP both with and without dolomite resulted in higher soybean seed yields than the use of SP36 fertilizer at the same dose. Without application of dolomite, the addition of 150 kg ha^{-1} FSP produced soybean seed weight of 15.99 g per plant, while the treatment of 150 kg ha^{-1} SP36 without dolomite produced only 12.73 g per plant, or an increase of 25.61%. Meanwhile, with the application of dolomite, the treatment of FSP 150 kg ha^{-1} produced seed yield as high as 21.61 g per plant, an increase of 69,76% compared to the use of SP36 fertilizer at the same dose with no dolomite application. The increase in seed weight and yield components of various crops due to the application of P fertilizer is in accordance with the results of previous studies (Amanullah and Khan, 2015; Kabir *et al.,* 2013; Kaya, 2018; Lamptey *et al.,* 2014; Rafiullah *et al.,* 2020).

The present study reported that the use of FSP tends to increase soybean growth and yield. The FSP fertilizer used in this study was the SP36 fertilizer which was reduced in size to flour size, in order to increase its solubility, because the finer the particles, the larger the surface area, and the faster its solubility in the soil solution (David Jones and David, 2016; Wu *et al.,* 2021). The method of FSP fertilizer application allowed time synchronization of P release and uptake by the plants. A previous study reported that the addition of FSP fertilizer improved the available P in Entisols (Cahyono, 2009).

Soybean P uptake and efficiency based on the treatments of P fertilizer and dolomite

The treatment of P fertilization without or with the application of dolomite, increased P uptake in soybean plants; however, the use of FSP increased P uptake higher than the use of SP36. The application of FSP without dolomite at a dose of 100 kg ha^{-1} resulted in higher P uptake compared to the treatment of 150 kg ha^{-1} SP36, which was 35.87 mg per plant compared to 32.62 mg per plant. Meanwhile, with dolomite application this treatment increased P uptake from 32.62 mg per plant to 42.25 mg per plant, an increase of 29.52%. This result was in accordance with the previous research which found that P uptake by soybean treated with SP36 fertilizer at a dose of 150 kg ha^{-1} was not significant to the P uptake in treatment of 100 kg ha^{-1} FSP, 35.1 g $plant^{-1}$ and 34.98 g $plant^{-1}$. The highest P uptake, 39.2 mg $plant^{-1}$, was achieved by the FSP fertilizer treatment at a dose of 150 kg ha^{-1} (Cahyono and Minardi, 2022).

The increased soybean P uptake was related to two reasons, method and timing of application. Firstly, the finer size of FSP fertilizer was applied to accelerate its solubility in the soil. This is because the finer the size, the faster the dissolution. It is in line with the study carried out by David Jones and David (2016) and Wu *et al.* (2021), which stated that the finer particle size of dolomite quickly dissolves in the soil. This method also limits the physical relationship between the P ions and soil reactive components. The longer the anion is absorbed into the colloidal surface or forms a precipitated compound, the more stable the bond configuration tends to occur. An increased P is expected to move from the surface to the uptake sites (Barrow, 2015).

Secondly, FSP was administered in 3 split applications at 0, 15, and 30 DAP. Provision of P according to time supports the success of plant growth. The available P content in the soil was discovered to be relatively high a few days after fertilization, although it gradually decreases as the plant grows. The rapid decline occurred 30 days after planting (Yan *et al.*, 2016). Previous studies reported that fast soluble P fertilizer on annual crops is usually effective when applied 0, 15, and 30 days after planting (Cahyono, 2009). Johnston and Bruulsema (2014) stated that for fertilization to be more efficient, therefore, there is a need to consider the right dose, type, timing, and placement of fertilizer.

The method of P fertilizer application significantly affected the P uptake, agronomic and physiological efficiencies. P uptake efficiency is described as the percentage of P fertilizer absorbed by plants and the amount added. Agronomic efficiency is the increase of crop yield due to the P added. Conversely, physiological efficiency increases crop yield due to the increased P uptake (Mengel and Kirkby, 2001).

The results of this study showed that the use of FSP fertilizer at a dose of 100 kg ha^{-1} resulted in the highest P uptake efficiency, 23.57%. This result was higher than the efficiency of P uptake in the SP36 treatment at the dose of 150 kg ha^{-1}, either with or without dolomite application. Compared to the use of SP36 without dolomite, FSP treatment of 100 kg ha^{-1} increased the P uptake efficiency by 93.2%, which increased from 12.2% to 23.57%.

The P uptake efficiency of the present study is consistent with the study carried out by Veneklaas *et al.* (2012), which stated that it is usually within 10% to 30%. Most of the unabsorbed P from fertilizers were left in the soil and formed insoluble compounds with mineral elements such as Ca, Fe, and Al, leading to poor absorption efficiency (Charana Walpola, 2012; Shen *et al.*, 2011; Shah *et al.*, 2013). This process occurs over time after P fertilizer is added to the soil (Miller *et al.,* 2011). It was estimated that P loss from conventional fertilization methods ranges from 30 to 70%, depending on the application method and soil conditions (Jin *et al.,* 2011).

The poor uptake efficiency indicates that the plant absorbs P from the added fertilizer in a small amounts. Therefore, the number of dissolved P anions in the soil and that plants absorb determines whether the uptake efficiency is high or low. According to Flatian *et al.* (2018), the effect of the P fertilization on sorghum plants reached a maximum of 5.4%, when 40 ppm of SP36 was added. Meanwhile, the contribution of P fertilizer causes an insignificant increase in the total uptake and dry weight of sorghum plants. The results of previous studies carried out by Suyono and Citraresmini (2010) stated that the P contribution from SP36 and organic fertilizers was unable to increase the dry weight of rice plants (straw and un-hulled rice) in soils with moderate phosphorus nutrient status. Fageria *et al.* (2013) discovered that P uptake efficiency in shoots and seeds of several annual crops from descending to ascending order are as follows maize, upland rice, soybeans, and beans.

The residual P fertilizer that remains in the soil is not only wasteful, however, it also leads to serious environmental problems (Azeem *et al.,* 2014; Eghbali Babadi *et al.,* 2015; Kuscu *et al.,* 2014; Rashidzadeh and Olad, 2014; Zhang *et al.,* 2011). Meng *et al.* (2019) reported that this manure leaves a Cd residue in the soil, absorbed by plants. This is derived from the phosphatic rock, while manufacturing fertilizer due to high Cd solubility and toxicity.

The application time was adjusted for 15 and 30 days after planting. The result showed that the addition of FSP fertilizer reduces P fixation in the soil, thereby synchronizing the time of release and absorption.

The study summarized that using dolomite and fast soluble P (FSP) fertilizer increased soybean growth, seed yield, and P uptake efficiency. This study recommended that to increase the growth and seed yield of Soybean in Alfisols, FSP fertilizer at a dose of 150 kg ha^{-1} plus dolomite needs to be used. This has been proven to boost growth by 35.79% and seed yield by 69,76% compared to treatment using 150 kg ha^{-1} of SP36 with no application of dolomite. Meanwhile, to improve P uptake efficiency, it was recommended that 100 kg ha^{-1} of FSP plus dolomite be applied because it has been proven to boost P uptake efficiency as high as 93.2%, which increased from 12.2% to 23.57%

compared to the treatment of 150 kg ha^{-1} SP36 without dolomite application. To acquire a detailed result of P efficiency in soybeans, it is necessary to carry out further study involving the application of FSP on various soybean varieties.

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(Received: 30 October 2021, accepted: 10 April 2022)