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Effects of N and P dosages on crop growth, yield, and attack of pod borrer (*Etiela zinchenella*) of soybean c.v. Detam-1 grown at swampy land

Pujiwati, H.[1*], Ginting, S.[2], Susilo, E.[3], Suharjo, U. K. J.[1] and Husna, M.[1]

[1]Agroecotechnology Study Program, Department of Agronomy, Faculty of Agriculture, Bengkulu University, St. Raya Kandang Limun, Kota Bengkulu 38371, Indonesia; [2]Plant Protection Study Program, Department of Plant Protection, Faculty of Agriculture, Bengkulu University, St. Raya Kandang Limun, Kota Bengkulu 38371, Indonesia; [3]Agrotecnology Study Program, Department of Agronomy, Faculty of Agriculture, Ratu Samban University, St. Jenderal Sudirman No. 87 Arga Makmur Kabupaten Northern Bengkulu, Indonesia.

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Abstract Soybean (*Glycine max* (L.) Merr.) is one of the best protein sources for Indonesians. However, the national soybean production does not meet the demand due to the low crop productivity, which causes major pests and poor soil nutrients. The best rate of N and P in promoting crop growth was investigated to get maximum yield, and minimize pod borer attacked by *Etiela zinchenella* on soybean c.v. Detam 1. The results showed that the interaction of N and P significantly affected the number of leaves, the number of pods produced, and the percentage of pod attached by pod borer. We concluded that the interaction between 25 kg.ha^{-1} Urea + 100 kg.ha^{-1} TSP showed the best growth, the highest yield, and the lowest percentage of pod attacked by pod borer.

Keywords: *Etiela zinchenella*, N, P, Soybean

Introduction

Soybean (*Glycine max* (L.) Merr.) is one of the best protein sources, consumed as tempeh or tofu by most Indonesian. Work together with *Badryrhizobium japonicum*, soybean crops fix free nitrogen (N_2) from the air and convert it to amino acid consumed directly by the crops (Prakoso *et al*., 2018) for growth and producing soybean grain (Fabre and Planchon, 2000). To increase national soybean production, Indonesia needs to expand the growing area by using marginal soil, like the swampy area. However, swampy soil needs special treatment due to its poor nutrient content (Chozin *et al*., 2019). To overcome the problem, the grower needs to put a lot of N, P, K into the soil. However, fertilizing swampy soil needs to consider the

[*] **Corresponding Author:** Pujiwati, H..; **Email:** hesti_pujiwati@unib.ac.id

rate of each nutrient to assure the best plant growth and yield (Wood *et al*., 1993). Krisnawati and Adie (2015) have recommended 50 kg.ha^{-1} Urea to get the maximum growth and yield of soybean.

Nutrient deficiency will reduce plant growth and yield, because of which growers must ensure that they give enough nutrients to the crops. Pest's attack is another factor that may reduce crop yield. Marwoto and Saleh (2003) reported that the presence of pod sucker reduces yield up to 80%. Among the pest that significantly reduces crop yield are *Riptortus linearis, Nezara viridula, Etiela zinchenella* dan *Ophiomiya phaseoli* (Mulyaningsih, 2017). *E. Zinchenella* is pod borer pest which high population with intensity 66,44 and gave positive contribution in increasing pod damage. Every increase of 1% of the population of *E. Zinchenella*, then the extent of the damage potentially pods have elevated 0.502% (Rahayu *et al*., 2018). Based on Apriyanto *et al*. (2009) research, the damage caused of *E. Zinchenella* on soybean because *E. Zinchenella* has hight larva density in fields.

Improving crop tolerance to pest attack could be done by applying balance fertilizing (Untung, 2000). One of the principles of integrated pest control is health culture plant including the acquisition of sufficient nutrients (Indiati and Marwoto, 2017). Fertilizer treatment was expected to reduce the intensity od pod borrer attack.

In this respect, we intend to find out the best N and P rates to promote crop growth, get maximum yield, and minimize pest attack, because excessive use of an organic fertilizer destroys soil structure and pollutes the environment. Conversely, nutrient deficiency will reduce plant growth and crop yield (Hanafiah *et al.*, 2005). Therefore, the objective of this experiment was to find out the best rate of N and P in promoting crop growth, get maximum yield, and minimize pod borer attack by *Etiela zinchenella* on soybean c.v. Detam 1.

Materials and methods

The experiment was conducted from December 2020 to March 2021 at the Research Experiment Station of Faculty of Agriculture, Bengkulu University, Beringin Raya, Muara Bangkahulu, at 3^{o}45’15,24751”S 102^{o}16’17,1768”E, 14,4 m asl. It was swampy land. The experiment used a Completely Randomized Design arranged in factorial (2 factors, 3). The first factor was N dosage (0, 25, 70, 75 kg.ha^{-1} Urea) and the second factors was P dosage (0, 50, 100, 150 kg.ha^{-1} TSP). The plant materials used were soybean c.v. Detam 1. Variable measured plant height, number of leaves, number of branches, number of the pod and percentage of pod attacked by *E. zinckenella.*

The percentage of *E. zinckenella* was calculated according to the following formula:

I = (a/b) x 100%, where I: percentage of pod attacked by *E zinckenella*, a: number of pods attacked by *E zinckenella* and b: number of total pods produced.

All data were analyzed with Analysis of Variance (ANOVA) followed by mean separation with DMRT at 5%.

Results

The results of soil analysis before planting showed that the soil solution was acidic (pH 4.25) with medium N content (0.23%), low P content (3.19%), high C-organic (3.69%), and low K (0.25%). The ANOVA showed that N significantly affected crop growth (plant height and leaf number), P did not considerably affect crop growth, and the interaction between N x P significantly affected only plant height (Table 1).

Table 1. ANOVA of Plant growth in response to N, P, and their interaction

No	Variable measured	Treatments			CV
		N	P	N x P	
1	Plant height 7 DAP	5,86 **	0,60 ns	4,76 **	10,69
2	Leaf number 7 DAP	4,82 **	1,18 ns	2,10 ns	18,75
3	Branch number 7 DAP	2,43 ns	0,59 ns	0,49 ns	33,51

** = significantly different,
ns = non-significant
CV = coefficient of variance

Table 2. Effects of N and P interaction on plant height (cm)

N Fertilizer	P Fertilizer			
	0 kg.ha^{-1} (P_0)	50 kg.ha^{-1} (P_1)	100 kg.ha^{-1} (P_2)	150 kg.ha^{-1} (P_3)
	Plant Height (cm)			
0 kg.ha^{-1} (N_0)	54,00 bc	54,33 bc	62,00 abc	60,00 abc
25 kg.ha^{-1} (N_1)	66,33 ab	54,00 bc	67,00 a	62,33 abc
50 kg.ha^{-1} (N_2)	63,00 abc	64,33 abc	59,33 bc	52,67 c
75 kg.ha^{-1} (N_3)	60,00 abc	69,33 a	63,67 abc	66,00 ab

Note: Means followed by different letter were significantly other at DMRT 5%

Result showed that the best plant growth was found in N_3P_2 (75 kg ha^{-1} N + 50 kg ha^{-1} P) along with N_1P_2 (25 kg ha^{-1} N + 100 kg ha^{-1} P), while N_3P_3 showed the poorest one (50 kg ha^{-1} N + 150 kg ha^{-1} P) and Control Treatment (0 kg ha^{-1} N + 0 kg ha^{-1} P) as shown in Table 2. These findings suggested that both N and P worked dependently in promoting plant growth, represented by plant height. One may choose a combination of low N + high

P or high N + low P to get the best plant growth. While N promoted shoot growth, P promoted root growth, the absence of both resulted in poor plant growth.

N application significantly increased the number of leaf blades (Table 3), suggesting that the low soil N content did not support plant growth. This finding was in line with soil analysis results, showing that the soil N content was only 0.23%; therefore, it needed N fertilizer.

Table 3. Effect of fertilizer on number of leaf and number of branch

Fertilizer treatment	Number of the leaf (blade)	Number of the branch (#)
N fertilizer		
0 kg.ha^{-1} (N_0)	25,50 b	3,08
25 kg.ha^{-1} (N_1)	31,00 a	3,67
50 kg.ha^{-1} (N_2)	32,25 a	4,42
75 kg.ha^{-1} (N_3)	33,92 a	4,08
P fertilizer		
0 kg.ha^{-1} (P_0)	28,33	3,42
50 kg.ha^{-1} (P_1)	30,17	3,92
100 kg.ha^{-1} (P_2)	31,92	3,83
150 kg.ha^{-1} (P_3)	32,25	4,08

Note: Means at the same column followed by different letter were significantly other at DMRT 5%

Number of pod

The application of N and P significantly affected the number of the pod, in which the highest number was found in N_1P_2 (25 kg.ha^{-1} + 100 kg.ha^{-1}) while the lowest was found in N_0P_1 (0 N kg.ha^{-1} + 50 Pkg.ha^{-1}), which were 122.00 and 41.67, respectively (Table 4). Thus, it seemed that the higher the rate of P, the lower the crop productivity was. The same results have previously been reported by Simarangki (2000) on rice, where the crop absorbs only 10-15% of P fertilizer.

Table 4. Effects of interaction between N and P on number of pods

N fertilizer	P fertilizer			
	0 kg.ha^{-1} (P_0)	**50 kg.ha^{-1} (P_1)**	**100 kg.ha^{-1} (P_2)**	**150 kg.ha^{-1} (P_3)**
	Number of pod (#)			
0 kg.ha^{-1} (N_0)	70,00 ef	**41,67** h	57,33 g	42,67 h
25 kg.ha^{-1} (N_1)	95,00 b	58,00 g	**122,00 a**	96,00 b
50 kg.ha^{-1} (N_2)	83,00 c	72,00 e	57,67 g	97,00 b
75 kg.ha^{-1} (N_3)	53,00 g	66,00 f	85,67 c	77,00 d

Note: Means followed by different letter were significantly other at DMRT 5%

Percentage of soybean pod attacked by E. zinckenella

The data showed that all crops were attacked by pod borer with different degrees of destruction (Table 5). The highest percentage (100%) of destruction was found in N_3P_2 (75 N kg.ha^{-1} + 100 Pkg.ha^{-1}) and the lowest (87.00%) was in N_1P_2 (25 N kg.ha^{-1} + 100 P kg.ha^{-1}). Surprisingly, the lowest percentage of pod attacked was not shown by N_0P_0 treatment (Table 5).

Table 5. Effect of N and P interaction on the percentage of soybean pod attacked by *E. zinckenella*

N fertilizer	P fertilizer			
	0 kg.ha^{-1} (P_0)	**50 kg.ha^{-1} (P_1)**	**100 kg.ha^{-1} (P_2)**	**150 kg.ha^{-1} (P_3)**
	Percentage of soybean pod attacked by pod borer (%)			
0 kg.ha^{-1} (N_0)	99,00 ab	92,67 gh	97,67 bc	94,33 efg
25 kg.ha^{-1} (N_1)	96,67 cd	96,67 cd	87,00 i	97,67 bc
50 kg.ha^{-1} (N_2)	94,67 ef	94,33 efg	97,33 bcd	95,67 de
75 kg.ha^{-1} (N_3)	93,67fgh	92,33 h	100,00 a	94,00 efgh

Note: Means followed by different letter were significantly other at DMRT 5%

Discussion

The condition of the swamp soil in this study was classified as acidic (pH 4.25) with low P, K, and moderate N nutrient content. Soy soil conditions with low nutrients are less than optimum for soybean plants, so to meet nutrient needs, N nutrients are added through urea and P nutrients through TSP fertilizers.

The interaction of doses of N and P had a significant effect on soybean plant height. Based on the description of the Detam 1 soybean variety by Balitkabi, the plant height of the Detam 1 variety was 58 cm. The plant height obtained in this study was higher than the variety description in almost every combination of N and P doses of treatment. This means that soybean nutrient needs in the vegetative phase were fulfilled by giving a minimum N dose of 25 kg.ha^{-1} and a minimum P of 50 kg.ha-1 in swampland. Soybean growth was best in the treatment of 75 kg ha^{-1} N + 50 kg ha^{-1} P. Although the best doses of N and P were obtained for soybean growth, increasing the dose of N did not increase soybean plant height.

Increasing the doses of N and P did not increase the number of soybean pods produced. The data from the research showed that the administration of N 75 kg.ha^{-1} had a lower number of pods than the dose of N 50 kg.ha^{-1}. According to (Sumarno and Manshuri, 2013), soybeans are

not very responsive to N fertilization to increase their production. Salvagiotti *et al*. (2008) reported that the response to soybean yields on low N application (0-50 kg $N.ha^{-1}$) was higher than with N fertilization > 50 kg $N.ha^{-1}$. Dosage of N and P fertilizers on soybeans was associated with pod borer attacks. The intensity of the pod borer was lowest at 25 N $kg.ha^{-1}$ + 100 P $kg.ha^{-1}$ (87%) and the highest at 75 N $kg.ha^{-1}$ + 100 P $kg.ha^{-1}$ (100%). Both treatment combinations had the best soybean vegetative value, but at lower doses of N, the intensity of pod borer attack was also low. According to Willis *et al*. (2003), if plants are given excess fertilizer, vegetative growth looks good but will be more susceptible to pest attack. The results of the study of Sutristo *et al.* (2020) the number of pod borer pests in the application of urea fertilizer 50 $kg.ha^{-1}$ + 150 kg phonska + 100 $kg.ha^{-1}$ SP36 on conventional technology of soybean cultivation in tidal land compared to the application of compound fertilizers phonska 100 $kg.ha^{-1}$ was not significantly different. That is, damage to soybean pods by borer at high fertilizer application does not reduce borer attack.

The intensity of pod borer attack on soybeans of Detam 1 variety in swampland is classified as very vulnerable. Based on the description of the Detam 1 soybean variety by Balitkabi, the Detam 1 variety is only resistant to pod sucking. The high pod borer attack on Detam 1 soybeans requires chemical pest control. Based on the results of the analysis by Willis *et al.* (2003); Indiati and Marwoto (2017), Soybean cultivation techniques to reduce pod borer attacks need to be carried out in crop rotation, sanitation, paying attention to planting time, trapping plants, and controlling physical, biological and pesticide pests.

It concluded that N and P interaction significantly affected the number of leaves, the number of pods produced, and the percentage of pod attached by pod borer. Interaction between 25 $kg.ha^{-1}$ N + 100 $kg.ha^{-1}$ showed the best growth, the highest yield, and the lowest percentage of pod attacked by pod borer.

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