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Responses such as Flushing, Flowering, Pod Reserving, and Yield of TSH 858 Clone Cacao (Theobroma cacao L.) to an Increase in Dose of Balanced N.P.K.Ca.Mg 12.9:11.4:16.8:10.6:4.8 Fertilizing

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Abstract: Response of cacao plants to fertilizer is influenced by plant condition and homogeneity, which requires an optimal dose to obtain the best vegetation and yield. Cacao plants will experience deficiency if they receive a below-optimal fertilizer dose, and they will experience toxicity when they receive an above-optimal fertilizer dose. This study aimed to determine the best dose of balanced N.P.K.Ca.Mg fertilization for productive and non-productive yield of TSH 858 clone cocoa and a more suitable dose for flush (young shoot and leaves), cherelle (young fruit), and fruit development to increase cacao yield. This research consisted of two parallel experiments on productive and non-productive plants in the same area. It used randomized non-factorial design, with treatments consisting of four levels of dose N.P.K.Ca.Mg 12.9 : 11.4 : 16.8 : 10.6 : 4.8 stages, namely: 896; 1,120; 1,344; and 1,568 (g tree^{-1}). Observations were made for 24 weeks on the parameters such as the number of flushes, flowers, cherelles, fruit stock, water shoot, size of flushing leaves, fruit volume, fruit and seed weight. Dose of fertilizer insignificantly affected all observation parameters; a dose of 1,344 g tree^{-1} produced the best yield with 39.7 cherelles and 25.0 fruits stock. Higher dose of 1,568 g tree^{-1} tended to reduce the number of flushes, flowers, cherelles, fruit stock, fruit volume, fruit weight, and seed weight. Productive plants had a better response to fertilization than non-productive plants; therefore, individual productive plants need preliminary inventory before intensive fertilization. The research recommends a maximum dose of fertilizer at 1,344 g tree^{-1}.

Keywords: balanced fertilizer, dose, productive cacao.

促甲状腺激素 858 克隆可可（可可树）的潮红，开花，荚果保留和产量对平衡 N.P.K.Ca.Mg 剂量增加的响应 12.9：11.4：16.8：10.6：4.8

摘要：可可植物对肥料的反应受植物状况和同质性的影响，这需要最佳剂量才能获得最佳植被和产量。如果可可植物接受的肥料剂量低于最佳水平，则会出现营养不足的情况；而当植物获得的肥料剂量高于最佳水平时，它们就会出现毒性。这项研究旨在确定平衡 NPKCa.Mg 施肥的最佳剂量，以生产促甲状腺激素 858 克隆可可的生产性和非生产性产量，以及更合适的剂量用于潮红（幼枝和叶片），小（幼果）和果实发育增加可可产量。这项研究包括在同一地区对生产性和非生产性植物进行的两个平行实验。它使用了随机的非析因设计，其治疗包括四个级别的

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N.P.K. Ca.Mg 剂量水平，分别为 12.9：11.4：16.8：10.6：4.8 阶段，即：896； 1,120; 1,344; 和 1,568（g 树-1）。对 24 周的参数进行了观察，这些参数包括潮红的数量，花，小樱桃，水果储备，水生芽，潮红的叶子的大小，果实的体积，果实和种子的重量。施肥剂量对所有观测参数影响不大；剂量为 1,344 g 树-1 的最佳产量为 39.7 切瑞尔和 25.0 水果。 1,568 g 树-1 的较高剂量往往会减少潮红，花朵，小樱桃，水果储备，果实体积，果实重量和种子重量的数量。与非生产性植物相比，生产性植物对施肥的反应更好。因此，个别生产性工厂需要在精耕细作之前先进行初步盘点。研究建议最大肥料剂量为 1,344 g 树-1。

关键词：平衡肥料，剂量，可可。

1. Introduction

Optimal yield is determined by sufficient nutrition supply; the nutrition carried away when harvested must be replaced through fertilization. Cacao yield of 1 ton dried seeds contained 36.6 kg N, 6.3 kg P, 61.2 kg K, 7.2 kg Ca, and 6.3 kg Mg [1]. Without fertilization, nutrient supply in the soil will be reduced; thus, the plants become non-productive [2]. Responses of plants to fertilization vary in criteria of nutrient: deficient, sufficient, and toxic. Nutrient deficiency will limit yield indicated by deficiency symptoms; extreme deficiency is lethal on plants. Sufficient nutrients lead to optimal growth and yield. An excess of a particular nutrient causes deficiency symptoms of the other nutrients. A high concentration of nutrients poisons and disturbs plant growth; acute toxicity causes death to plants [3, 4].

There are three fertilization approaches: nutrient deficiency correction, nutrient maintenance, and nutrient loss. Nutrient deficiency correction is performed to overcome particular nutrient status as a limiting factor; a critical value of nutrient deficiency is detected by soil analysis. An increase in fertilization usage is followed by an increase in yield so that the economic value is determined by the difference between fertilizer price and yield. A maintenance approach is performed to increase the status of nutrients in the soil to the ideal level, with the value of soil analysis higher than the critical value of nutrient deficiency, advantageous in the long run. The nutrient deficiency (when harvested) approach theoretically restores the nutrient loss when harvested to maintain productivity and prevent soil degradation [5, 6].

The results of a soil test can be interpreted into three categories, namely: (1) low, indicating that fertilization will increase growth and yield; (2) high, indicating that fertilization cannot increase growth and yield; and (3) sufficient, indicating that fertilization can still increase growth and yield. From the results of the same soil test, different fertilization can be recommended. As an instance, fertilization is only applied if it possibly increases the economic value. Alternatively, fertilization is applied to maintain soil fertility in accordance with the nutrient loss when harvested, although the soil test indicates nutrient sufficiency [7].

Plants require different nutrients in different growth phases, and optimal nutrients have to be available in the soil and for the plants for maximum yield. Comparisons among N, P, K, and the other nutrients in plant tissues indicate nutrition availability in soil [8]. The role of N, P, K, Ca, and Mg is that they are required for flowering, fruiting, and growth of cacao. Interpretation analysis of nutrition in cacao leaf consisted of three zones (Fig. 1), namely: deficient nutrition zone, which is visually visible in leaf, sufficient nutrition zone, and toxic nutrition zone [9].

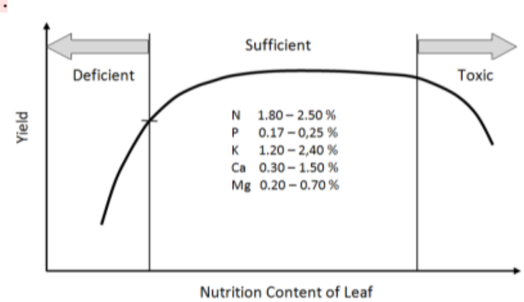


Fig. 1 Correlation between nutritions in leaf and cacao yield

The recommendation for tentative fertilization to >5 years old cacao plants is 220 g urea, 18 g TSP, 170 g MOP, and 120 g kieserite [10] with a total dose of 690 g tree^{-1} year^{-1}. As stated in [11], balanced fertilization of N.P.K.Ca.Mg 12.9:11.4:16.8:10.6:4.8 with dose 800-1,120 g tree^{-1} for 6 months demonstrates good yield.

Interspecific competition creates plant heterogeneity influenced by soil fertility variations, rooting, plant spacing, and fertilization. Individual plant competes for one to another to obtain water and nutrition supply for root growth. Intense competition occurs when nutrition is limited, and soil water condition varies, water as preferred at lowest water potential. In the competition aщ light, plants will place their leaves on the other plants to increase photosynthesis rate so that the most competitive individual plant will dominate the others [12, 13]. There are some characteristics of TSH 858 clone cacao, namely continuous flowering, low кcherelle wilt rate (7%), weight 1.15 g seed^{-1}, and productivity of 1.76 ton ha^{-1} (high) [14, 15]. This research objective was to determine the dose of N.P.K.Ca.Mg fertilizer 12.9:11.4:16.8:10.6:4.8 to increase cacao yield in productive plants.

2. Materials and Methods

2.1. Time, Location, Materials, and Equipment

The research was conducted for 6 months (January to July 2018) in 7 year-old-TSH 858 cacao clone. The research location was at the experiment plantation of IOPRI (Indonesian Oil Palm Research Institute) Sei Pancur, Deliserdang, at 70 m asl (above sea level). Artificial fertilizers applied consisted of Phonska 15.15.15, urea, MOP, and dolomite. The equipment used was an altimeter, gauge, calibrated cup, oven, caliper, digital scales, and other measuring instruments.

2.2. Research Methods

This research used an experimental design method consisting of 2 parallel experiments, carried out simultaneously, each on productive (P) and non-productive (nP) plants, in one area with heterogenic plants. Research methods in both experiments used Randomized Non Factorial Design, with 4 levels of treatments of dose N.P.K.Ca.Mg 12.9:11.4;16.8;10.6;4.8 (D) namely: 896; 1,120; 1,344; and 1,568 (g tree^{-1}). The treatment was repeated six times so that 4x6=24 units of experiments and every experiment unit consisted of 1 plant. Experimental plant units were determined based on girth size [16], plant spacing 3x3 m^2 (1,100 plants ha^{-1}). The data were analyzed by analyzing variance and T-test (Tukey's range test) [17].

2.3. Agronomic Practices

Plant maintenance refers to frequent harvest, pruning, weeding, pest, and disease control. Pruning was conducted at the beginning of this research (January). Water shoots pruning was conducted monthly, and shading plant (Gliricidia and coconut trees) pruning was conducted 1 m above cacao canopy. Fertilization was applied at the beginning of this research in accordance with the treatment (Table 1).

Table 1 Treatment of dose of balanced fertilizer N.P.K.Ca.Mg 12.5:10.9:16.4:10.3:4.8 in TSH 858 cacao clone

Dose of N.P.K.Ca.Mg 12.5:10.9:16.4:10.3:4.8	**Phonska 15.15.15**	**Urea 46% N**	**MOP 60% K_2O**	**Dolomite 40% CaO; 18% MgO**
	(g tree^{-1})			
D_1 = 896	672.0	33.0	85.0	136.0
D_2 = 1,120	840.0	41.0	106.0	169.0
D_3 = 1,344	1,008.0	49.2	127.2	203.0
D_4 = 1,568	1,176.0	57.4	148.4	237.0

Fertilizers such as Phonska, urea, MOP, and dolomite were evenly mixed, divided into 6 parts, and planted approximately 5 cm deep on 6 points in the distance of 70 cm from the plant point.

2.4. Measurement and Data Collection

Parameters were measured every four weeks for 24 weeks (6 months), consisting of the number of flushes, flowers, cherelles, fruit stock, water shoots [18], and flush leaf width [19]. In productive plants, cacao was harvested every week, and the seeds were cleaned and dried at 70°C for 24 hours. The parameters of harvested yield that were observed consisted of: fruit length, fruit volume (volumetric), dried fruit pod^{-1}, and dried seed weight. The contents of N, P, K, Ca, and Mg in leaves are determined at the beginning of this research.

3. Results and Discussion

After 24 weeks, the dose of balanced fertilizer N.P.K.Ca.Mg 12.9:11.4:16.8:10.6:4.8 insignificantly affected the number of flushes, flowers, cherelles, fruit stock, water shoot, and flush leaf width in productive or non-productive plants (Table 2). Productive plants demonstrated better responses than non-productive ones on all observation parameters. For productive plants, at dose D_1 tended to yield more number of flush and flower; dose D_3 yielded the best number of cherelle and fruit stock (39.7 cherelles and 25.0 pods), but the number of water shoots was less; dose D_4 tended to reduce the number of flushes, flowers, cherelles, and fruit stock. The development of cherelles is important in this research because cherelles (pods) will develop into fruit stock and seeds as the expected cacao yield. Application of 1,344 g tree^{-1} yielded 39.7 cherelles in productive plants and 24.0 cherelles in non-productive plants, indicating that fertilization priority is aimed at productive plants.

Table 2 Average of number of flush, flower, cherelles, fruit stock, water shoot, and leaf width of flush in productive (P) and non-productive plants (nP) for 24 weeks

Treatment of Dose of Balanced Fertilizer (g tree^{-1})	**Number of Flush**		**Number of Flower**		**Number of Cherelle**		**Fruit Stock**		**Number of Water Shoot**		**Leaf Width (cm^2)**
	P	***nP***	***P***	***nP***	***P***	***nP***	***P***	***nP***	***P***	***nP***	***P***
D_1 = 896	297.8 a	147.8 a	336.5 a	167.5 a	34.2 a	10.7	23.3 a	3.0	27.7 a	16.7 a	193.6 a
D_2 = 1,120	241.0 a	119.8 a	266.2 a	170.0 a	26.7 a	13.2	18.0 a	2.8	30.3 a	11.7 a	211.0 a
D_3 = 1,344	285.5 a	119.3 a	321.7 a	173.0 a	39.7 a	24.0	25.0 a	6.2	24.3 a	12.7 a	177.7 a
D_4 = 1,568	256.5 a	137.3 a	326.8 a	233.8 a	34.2 a	19.3	19.7 a	5.3	32.3 a	13.5 a	185.7 a
	NS	NS	NS	NS	NS	-	NS	-	NS	NS	NS
$HSD_{.05}$	158.5	86.4	327.5	266.8	32.9	-	32.9	-	31.2	15.7	87.7

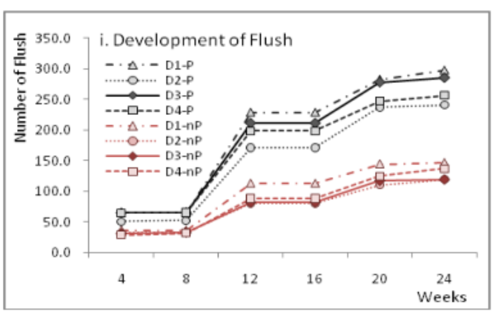
Note: The order of significance at α=0.05 level probability, and NS: not significant.

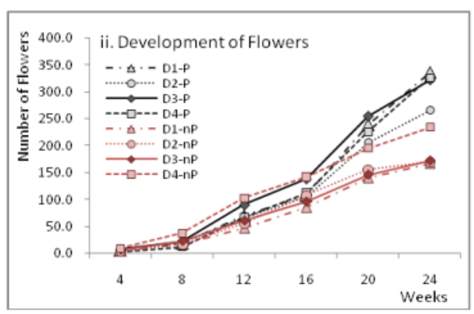
After 12 weeks, the dose of balanced fertilizer N.P.K.Ca.Mg insignificantly affected fruit volume, dried seed weight pod^{-1}, dried bark weight pod^{-1}, and dried weight seed^{-1} in productive plants. The responses of the plants demonstrated a tendency of an increase in fruit volume, pod weight, and seed weight. The best fruit and seed characteristics were obtained at dose D_3, and a decrease of weight seed^{-1} was found at dose D_4. Dose 1,344 g tree^{-1} tended to yield better, especially to the number of cherelles, fruit stock, fruit volume, fruit weight, and weight seed^{-1} (Table 3). The highest dose, 1,568 g tree^{-1}, tended to reduce the number of flushes, flowers, cherelles, fruit stock, fruit volume, fruit weight, and weight seed^{-1}.

Table 3 Average of fruit volume, dried seed weight pod^{-1}, dried bark weight pod^{-1}, and seed weight in productive (P) and non-productive (nP) plants for 12 weeks

Treatment of Dose of Balanced Fertilizer (g tree^{-1})	**Fruit Volume (mL)**		**Dried Seed Weight Pod^{-1} (g)**		**Dried Bark Weight Pod^{-1} (g)**		**Seed Weight (g seed^{-1})**		**Potency of Yield$^{**)}$ (g tree^{-1})**
	0 week	**12 weeks**	**0 week**	**12 weeks**	**0 week**	**12 weeks**	**0 week**	**12 weeks**	**24 weeks**
D_1 = 896	745.7 a	774.5 a	40.6 a	47.1 a	75.7 a	86.4 a	0.893 a	1.097 a	1,388.52
D_2 = 1,120	743.4 a	798.8 a	45.7 a	48.4 a	65.6 a	87.7 a	0.992 a	1.093 a	1,220.19
D_3 = 1,344	817.3 a	919.8 a	46.8 a	49.0 a	76.7 a	94.6 a	1.004 a	1.075 a	1,857.96
D_4 = 1,568	727.8 a	779.1 a	43.6 a	41.9 a	64.8 a	84.5 a	1.000 a	0.912 a	1,491.12
	NS	NS	NS	NS	NS	NS	NS	NS	-
$HSD_{.05}$	188,4	300,7	9,9	13,2	24,8	36,5	0,2	0,3	-

Note: **) Dried seed weight pod^{-1} x fruit stock; [a]The order of significance at α=0.05 level probability; and NS: not significant.





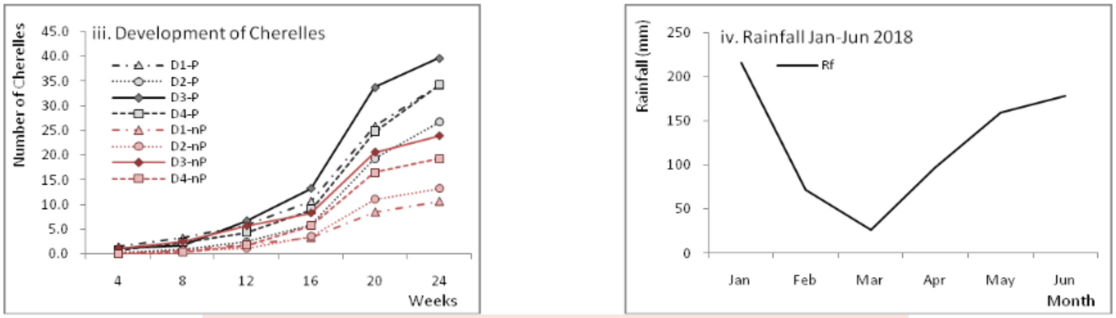


Fig. 2 The development of flushes, flowers, and the number of cherelles in 24 weeks

Flushing occurred in week 4, 12, and 20 in all treatments; the flowers developed in week 12-24; the cherelles developed in week 16-24, and rainfall rate was high in January, followed by the development of flush in the next month. Better development of flush and flowers was demonstrated in the treatment of D_1, but better development of cherelles was found in treatment D_3. Dose of 1,344 g tree^{-1} yielded the greatest number of cherelles in productive and non-productive plants for 24 weeks (January-June). Productive plants demonstrated better development in the number of flushes, flowers, and cherelles than non-productive plants (Fig. 2). The implication was that non-productive trees (rarely flowering) should not be fertilized intensively. Meanwhile, productive trees must be fertilized intensively to increase cocoa productivity and yields.

There was some strong correlation among variables. The number of flushes positively correlates with the number of flowers, cherelles, and fruit stock, but it had a negative correlation with shoots and leaf width of flush. The number of shoots negatively correlated with the number of flowers, cherelles, fruit stock, and fruit volume, but it positively correlates with the flushing leaf width. The flushing leaf width had a negative correlation with the number of flush, flower, cherelles, fruit stock, and fruit volume, but it positively correlates with the number of shoots and weight of seed^{-1} (Table 4). Shoots had to be routinely pruned because it was negatively correlated with flowering and yield.

Table 4 Correlations among the observed variables

Variable	**Number of Flowers**	**Number of Water Shoots**	**Flush Leaf Width**	**Number of Flowers**	**Number of Cherelles**	**Fruit Stock**	**Fruit Volume**	**Seed Weight**
Number of Flowers	1							
Number of Water Shoots	-0.707	1						
Flush Leaf Width	-0.579	0.468	1					
Number of Flowers	0.792	-0.265	-0.786	1				
Number of Cherelles	0.727	-0.655	-0.970*	0.786	1			
Fruit Stock	0.916	-0.878	-0.746	0.693	0.884	1		
Fruit Volume	0.270	-0.808	-0.562	0.035	0.640	0.627	1	
Seed Weight	0.334	-0.637	0.370	-0.309	-0.138	0.316	0.276	1

Analysis of leaves (P and nP) at the beginning of the research (Table 5) demonstrated that the content of N was above the normal level, P was below the low limit, K was above the normal limit, Ca and Mg were above normal level. The amount of P was low because of fruit yield that was not optimal; the amount of N above normal level supported vegetative development. The amount of Ca and Mg above normal level was antagonist with the absorption of K that was below normal limit. Productive plants had P deficiency and Ca surplus. Non-productive plants had P deficiency, N surplus, and lower P, K, Ca, and Mg contents than productive plants. The application of balanced N.P.K.Ca.Mg fertilizer with a high dose on non-productive plants did not optimally increase the number of flush, flower, and cacao yields. Productive plants had a better response than non-productive plants; therefore, fertilization for productive plants had to be distinguished from fertilization for non-productive plants. Before the fertilizer application, data of inventory was required to be made on the condition of plants, whether they were productive or not, so that fertilization goal (efficient and effective) can be achieved.

Table 5 Nutrient content (N, P, K, Ca, and Mg) of soil and leaves tested at the beginning of research

Analysis	N	P	K	Ca	Mg
Top soil*)	0.11 %	6.37 ppm	0.43 me/100 g	1.51 me/100 g	0.38 me/100 g
	Slightly low	Low	Moderate	Slightly low	Slightly low
Productive (P) plant leaf	2.40 %	0.159 %	1.80 %	1.53 %	0.49 %
Non productive (nP) plant leaf	2.60 %	0.154 %	1.55 %	1.23 %	0.44 %
Low	1.80 %	0.17 %	1.20 %	0.30 %	0.20 %
Normal	2.00 %	0.20 %	2.00 %	0.40 %	0.45 %
High	2.50 %	0.25 %	2.40 %	1.50 %	0.70 %

Note: *) pH = 4.9; C = 0.78%; and C/N = 7

3.1. Interactions among Nutrients N.P.K.Ca.Mg and Dose Increase

Nutrient N synergized with P; interaction of N/P led to repair of N and P efficiency. Interaction of N/P and N/P/K was a determining factor of high productivity [20]. In olives, increases in N, P, or K contents in root zones would increase nutrition concentrations in leaves. The availability of macronutrient N, P, and K was required to affect the intensity of flowers; the fruit set was affected by N and P, but it was not affected by K contents [21]. The absorption of nutrient K was an antagonist with Ca and Mg and the other cation [22]. An increase in K^+ in plant tissues consistently reduced concentrations of Ca^{2+} and Mg^{2+} in most plant species but still within growth rate and good yield [23]. Excessive fertilization increased salt concentrations that led to plasmolysis of root cells and root damage so that it poisoned plants [24]. Table 2 and Table 3 illustrate that high dose 1,568 g tree^{-1} (D_4) of balanced fertilizer N.P.K.Ca.Mg decreases plant responses for all parameters.

Application of a high dose of N boosted intensive vegetative growth [9]. In lychee, high concentrations of N were related to intensive development of flush but less flower and yield development [25]. In macadamia, applying high concentrations of N did not increase fruit quality, but it was required to fill reproduction tissues [26]. Increased supply of N also increased demand for other nutrition [22]. Nutrient P was important to improve flowering [9], the addition of fertilizer P was also important to transform cacao litter because cacao litter resulted in P immobilization [27]. In soybeans and tomatoes, high concentrations of P in soil increased the number of seeds and improved fruit quality significantly [28, 29]. Application of excessive fertilizer P increased ratio P to micronutrients Fe and Zn so that it caused deficiency symptoms [22]. This research indicated low P contents in leaves (Table 5) so that the usage of Phonska fertilizer as the source of P was expected to increase the supply of P [30].

In cacao, nutrient K is required for pod development and plant growth. It is suggested that fertilizer application after flowering (June) and the next 3 (three) months (September) [9]. Potassium (K) is an overflowing cation in plants, important in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomata activity, energy transfer, phloem transportation, cation-anion balance, and stress endurance [31]. An increase in the amount of K in soil from fertilization will increase the supply of K and induces root growth [32]. High accumulation of K in leaves will increase assimilation from leaf to seed; thus, the application of K was considered as a method to increase yields. Sufficient concentrations of K in the soil are essential for growth and produce a greater number of cacao seeds [33]. According to Snoeck *et al*. [9], Ca and Mg had to be applied simultaneously with the first application of K. The availability of Ca in great amounts decreases absorption of K and Mg. If Ca overflows, it causes Fe to be insoluble and decreases cell permeability. The nutrient of Mg significantly decreased the absorption of K and Ca in paddy [22].

3.2. Increase in Dose of N.P.K.Ca.Mg and Diversity of Cacao Plants

The increase in the number of flushes demonstrated a good indication of generative component and yields, i.e., number of flowers, cherelles, fruit stock, fruit volume, and seed weight. Otherwise, the increase in the number of water shoots and width of flush leaf indicated a bad response showed a bad indication to generative components and yields, i.e., the number of flowers, cherelles, fruit stock, and fruit volume (Table 4). Application of a high dose of N fertilizer had to be avoided to prevent intensive vegetative growth (flush, shoots, and width of flushing leaves). Shoots should be avoided/pruned immediately to achieve better generative and yields. Competition between flush and flower occurred because both functioned as sink, which led to fewer flowers at the peak time of flushing. The increase in vegetative growth will decrease the number of flowers; flush season and flowering decreased fruiting [15]. Flush and shoots of cacao that were actively growing had high absorption of photosynthesis [34].

Heterogeneity and diversity of cacao plants are caused by variety in management, cultivation technique, location, and so on [35]. Plant diversity also results from various plant materials, soil fertility, pest and disease, wilt of plant, plant infilling, and different agronomic treatments. Fertilization is applied to increase yields, and it is frequently applied uniformly because it is a practical option, but it ignores plant diversity. The research results demonstrated that productive plants had better responses than non-productive plants to the application of fertilizer (Table 2 and Fig. 2). Therefore, plant diversity needs to be inventoried and mapped since the beginning of planting, and its inventory needs to be regularly updated along with the recommendation of fertilization. Productive plants need to be fertilized with optimal dose to increase production and stability. Meanwhile, non-productive plants need to be fertilized differently to restore plant conditions which possibly increase production.

3.3. Economic Considerations Concerning Fertilization

The best potential of yield 1,858 g dried seeds tree^{-1} for 24 weeks (Table 3), equivalent to 2.04 tons seeds ha^{-1} for 6 months (1,100 plants ha^{-1}), can be achieved by fertilizing 1,008 g Phonska, 42.9 g urea, 127.2 g MOP, and 203.0 g dolomite with total 1,344 g tree^{-1} (Table 1). Practically, advantageous fertilization is achieved if production responds very well to fertilization; economic profit can be increased in consideration of fertilizer price, yield, transportation, and so on [36]. Four right (4R) fertilization (right dose, time, method, and kind/form) can reach advantageous production continuously and for the long run [37]. The best advantage is usually achieved when fertilizer is applied below the maximum dose, which reduces nutrient loss to the environment, has better agronomic and economic practice, and reduces environmental effect [38].

3.4. Scientific Novelty Statement

Application of dose 1,344 g tree^{-1} of balanced fertilizer N.P.K.Ca.Mg 12.9:11.4:16.8:10.6:4.8 for 6 months demonstrated the best results in TSH 858 cacao clones with 39.7 cherelles and 25.0 fruit stock which were equal to 1,858 g of dried seed tree^{-1}. The balanced fertilizer N.P.K.Ca.Mg 12.9:11.4:16.8:10.6:4.8 is a mixture of Phonska (15-15-15), urea, MOP, and dolomite fertilizer with a ratio of 20.4: 1: 2.6: 4.1. It is recommended to apply the maximum dose at 1,344 g tree^{-1} to productive plants, but it is not recommended to do so to non-productive plants.

4. Conclusions

The dose of balanced fertilizer of N.P.K.Ca.Mg 12.9:11.4:16.8:10.6:4.8 had insignificant effects on all observed variables, i.e., number of flush, flower, cherelles, shoots, the width of flushing leaves, fruit stock, fruit volume, fruit weight, and seed weight. However, the dose of 1,344 g tree^{-1} demonstrated the best yield with 39.7 cherelles and 25.0 fruit stocks; a higher dose of 1,568 g tree^{-1} tended to reduce the observed parameters. The productive plants showed better fertilization responses than the non-productive plants; then, productive trees must be fertilized intensively to increase productivity and yields. It is required to inventory productive plants before starting fertilization with a maximum dose of 1,344 g tree^{-1}.

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