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Yield Response of Peanut (*Arachis hypogaea* L.) to Compound Fertilizer

Tanggap Tanaman Kacang Tanah (*Arachis hypogaea* L.) *terhadap Penggunaan Pupuk Majemuk*

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ABSTRAK

Penelitian bertujuan untuk mengevaluasi pengaruh takaran pemberian tiga jenis pupuk majemuk yang berbeda terhadap hasil tanaman, dan peningkatan keuntungan petani kacang tanah. Tiga jenis pupuk majemuk yaitu NPK 14-0-46, NPK 19-9-19 dan NPK 11-11-11, masing-masing diuji di tiga lahan kering petani yang terletak berdampingan menggunakan varietas kacang tanah HypoMa-1 di Kabupaten Langkat, Provinsi Sumatera Utara Di setiap lahan petani, penelitian menggunakan Rancangan Acak Lengkap dengan tujuh perlakuan dan empat ulangan. Tujuh perlakuan terdiri dari 100% takaran pupuk cara petani dan enam tingkat takaran pupuk majemuk yang masing-masingnya ditambah 50% takaran pupuk cara petani. Pada setiap jenis pupuk majemuk yang diuji, hasil polong dan biji kacang tanah meningkat secara kuadratik, dengan laju peningkatan yang berbeda, seiring dengan peningkatan takaran pupuk majemuk. Hasil polong dan hasil biji tertinggi 1649 kg/ha dan 1072 kg/ha didapatkan pada 50% takaran pupuk petani + 200 kg NPK 14-0-46. Untuk pupuk majemuk NPK 19-9-19 hasil polong dan hasil biji tertinggi adalah 1632 kg/ha dan 1032 kg/ha dengan 50% takarn pupuk petani + 500 kg NPK 19-9-19; sedangkan untuk pupuk majemuk NPK 11- 11-11 hasil polong dan biji tertinggi adalah 1421 kg/ha dan 930 kg/ha dengan 50% pupuk cara petani + 250 kg NPK 11-11-11. Namun, analisis usahatani parsial menunjukkan keuntungan tertinggi dengan menggunakan varietas kacang tanah HypoMa-1 diperoleh pada takaran masing-masing 50% pupuk cara petani + 200 kg NPK 14-0-46 atau 300 kg NPK 19-9-19 atau 250 kg NPK 11-11-11 di lahan kering Kabupten Langkat, Sumatera Utara.

Kata kunci: hasil polong, lahan kering, pendapatan, senjang hasil

ABSTRACT

The purpose of this study was to evaluate the application effects of three different compound fertilizers on yield, and assess the income increase at different rates of compound fertilizers. Three compound fertilizers namely NPK 14-0-46, NPK 19-9-19 and NPK 11-11-11 was conducted at three different farmers' field in Langkat District, North Sumatra Province under upland conditions. In each farmers' field, a Randomized Complete Block Design was applied with four replications per treatment. Seven treatments tested consisted of full rate of farmer fertilizer practice and six rates of each compound fertilizer plus half rate of farmer fertilizer practice. In each of compound fertilizer tested, pod yield and seed yield increased quadratically as increasing compound fertilizer rates. The highest pod yield and seed yield of peanut were 1649 kg/ha and 1072 kg/ha, respectively with half rate of FFP + 200 kg of NPK 14-0-46. For compound fertilizer NPK 19-9-19 the highest pod yield and seed yield were 1632 kg/ha and 1032 kg/ha with half rate of FFP + 500 kg of NPK 19-9-19 while for compound fertilizer NPK 11-11-11 the highest pod yield seed yield were 1421 kg/ha and 930 kg/ha with half rate of FFP + 250 kg of NPK 11-11-11. However, adding each half rate of farmer fertilizer practices with 200 kg of NPK 14-0-46 or 300 kg of NPK 19-9-19 or 250 kg of NPK 11-11-11 with HypoMa-1 cultivar gave the highest values of the benefit for the farmers under upland soil in Langkat, North Sumatra.

Keywords: benefit, pod yield, upland, yield gap

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is one of the choicest world agriculturally economic important crop (Krishna *et al*., 2015). Worldwide, peanut has its own importance due to largest source of edible oil and its high nutritional value of kernel as human food, and haulm as animal feed. Among the Asian countries, India holds the largest acreage (6.7 million ha) followed by China (4.7 million ha), Indonesia, Myanmar, Pakistan and Thailand (Kulkarni *et al*., 2018). In Indonesia, peanut become one of the main food crops after rice, corn and soybeans. As a high economic value commodity, it contains high nutritional food, especially protein and fat (Simanjuntak *et al*., 2014). Hence, peanut is an important component of cropping systems of smallholder farmers in Indonesia. Unfortunately, low average pod yields of the crop continue to pose a serious challenge in production, causing serious shortfalls in supply (Silitonga *et al*., 2018). Indonesia is a peanut importing country besides the European Union and Viet Nam.

The fertilizers are very important for plant growth and improvement; mainly of the applied fertilizers stay unavailable to plants due to numerous factors such as leaching and degradation by hydrolysis, insolubility and decomposition (El-Metwally *et al*., 2018). Nutrients are removed and consequently lost as result of cropping with crop harvests, there is need to replace lost nutrients through the application of inorganic fertilizers in order to maintain a positive nutrient balance (Ouedraogo *et al*., 2018).

Peanut plants require higher nitrogen (N) than cereal crops, such as rice and corn. The high protein content of seeds (around 28%) causes a high demand for N elements. Most of the N needs (60–80%) are met by fixation of N nodules (Castro, 1999). The positive response of peanut plants to N fertilizer shows that N needs are not fully met by N_2 fixation. N fixation from air is the result of mutually beneficial cooperation between peanut plants and Rhizobium microbes in root nodules. The development of root nodules to be able to fix N takes 25-30 days (Gage, 2014). Therefore, N from the soil is needed during the initial period of plant growth.

Phosphorus (P) exists in nature in a variety of organic and inorganic forms. Despite P compounds are abundant in agricultural soils, more than 80% of soluble P in soil becomes immobile and unavailable for plant uptake due to low solubility and fixation in soil (Schneider *et al*., 2019). Kruse *et al*. (2015) reported that the recovery rate of P fertilizer by plants is only about 25%. The remaining 75% is accumulated in soil in an immobile form bound to Al or Fe in acid soils, or Ca and Mg in alkaline soils. Peanuts require high potassium (K) nutrients (Dinh *et al*., 2014). Potassium is a catalytic agent in plant metabolic processes, such as: (1) enzyme activation, (2) reducing loss of transpiration water through stomata regulation, (3) increasing production of adenosine triphosphate (ATP), (4) helping assimilate translocations, and (5) increase N uptake and protein synthesis (Hasanuzzaman *et al*., 2018).

It is well established fact that there is positive correlation between fertilizer use and productivity. About 50% increase in agricultural production in recent years can be attributed to fertilizers (Ahmed *et al*., 2016). Therefore, supply of essential nutrient elements is considered as one of the basic needs to achieve the potential yield. Farmers tend to used chemical fertilizers individually for adequating the needs of plant nutrient elements. Due to they are more economical, affordable, easy to use and quick in response (Ouedraogo *et al*., 2018). Taking all these aspects in consideration in order to raise production level, the present study was therefore to evaluate (a) the application effects of three different compound fertilizers on yield, and (b) assess the income increase at different rates of compound fertilizers.

MATERIALS AND METHODS

Description of Study Area

The experiments were conducted at three different farmers' field in Pasar VI village, Sei Bingei sub-district, Langkat District, North Sumatra Province. The Pasar VI village is geographically located in latitude 3^{o}32'52" N and longitude 98^{o}28'52" E and 60.3 m altitude. Fertilizer recommendation for peanut under upland and lowland irrigated is the same, mostly as blanket recommendation for single cropping. Presently, the cropping system in the region is dominantly maize-peanut. Farmers usually plant the peanut varieties HypoMa 2 and Talam 1. The experiments were conducted during the dry season from November 2018 to February 2019.

Soil Sampling and Analysis

A composite soil sample from three different farmers' field was collected in zigzag manner using an auger for digging to a depth of 30 cm before the start of the experiment. Soil sample was analyzed at Agricultural Institute of Assessment Technology (AIAT) North Sumatra Laboratory. They were air dried, crushed and sieved through a 2-mm sieve and analyzed for their physicochemical properties (Table 1). Based on particle size distribution, soil texture was classified as loamy sand. Due to high percentage of sand, this soil is low nutrient retention because of low cation exchange capacity (CEC), and generally low organic matter content and fertility.

Field Experiments

The experiment was laid out in three farmers' fields which were located side by side. Three different compound fertilizers were used namely 14-0-46, NPK NPK 19-9-19 and NPK 11-11-11. Seven treatments tested consisted of full rate of farmer fertilizer practice and six rates of each compound fertilizer plus half rate of farmer fertilizer practice as illustrated in Table 2. In each farmer's field a Randomized Complete Block Design was applied with four replications per treatment. Variety use was HypoMa 2, a high-yielding Spanish peanut cultivar with 90-92 days maturity period was released in the year 2012 by Indonesian Legumes and Tuber Crops Research Institute. Standard plant-population density is 40cm x 20cm hill spacing with 2 seeds/hill with a plot size of 4m × 5m. For nitrogen the source was Urea, for P the source was triple superphosphate, and for K the source was potassium chloride. All inorganic fertilizers were added at the time of planting according to the treatment dose. Fertilization is done by making a run on the line of plants, and then covered with soil.

Weeding was done manually at 2 weeks after planting and the weeding was done depending on the state of weeds that grow around the plant. Piling was done two times simultaneously with weeding. The first piling was done at 2 weeks after planting (WAP) by raising the soil from around the plant forming long bunds so that the soil becomes loose so that gonophore can penetrate the soil, the next piling done at age 7 WAP. Harvesting was characterized by brownish yellow leaves, some deciduous leaves, hardened stems and pods full and hard contain. Harvest is done when the plant is 90 days after planting was done by removing the entire plant.

Growth yield and yield parameters observed were plant height, and number of branches per plant at 2 and 4 weeks after planting (WAP), and at harvesting pod yield, seed yield, number and weight of pod per plant. The partial budgets were constructed for fertilizer farmers' current practice was compared using three compound fertilizers with different rates.

The purpose of partial budgets was to evaluate the differences in cost and benefits among different fertilizer application rates. In the preparation of partial budget, all the costs of production were not considered an only the cost that varied among management practices systems were taken into account.

Table 1. Physical and chemical properties of studied soil, Pasar VI village, Langkat, North Sumatra, DS 2018

Soil Property	Method	Value
Particle size distribution (%):		
• Clay		2.42
• Silt		24.22
• Sand		73.36
Organic-C (%)	Walkley & Black	1.09
Total-N (%)	Kjeldahl	0.42
P-Bray (ppm)	Bray I	6.17
pH H_2O	1:1	5.16
Exchangeable cations	NH4-Ac 1N, pH 7	
K (me/100g)		0.44
Ca (me/100g)		8.26
Mg (me/100g)		5.26
CEC (me/100g)	NH4-Ac pH 7	9.72
Fe (ppm)		30.99
Al (ppm)		5.67

Table 2. The treatment of three compound fertilizer and rates for peanut plant in Langkat, North Sumatra, DS 2018

No.	Treatments
T1	Full rate of FFP
T2	Half rate of FFP + 50 kg of NPK 14-0-46
T3	Half rate of FFP + 100 kg of NPK 14-0-46
T4	Half rate of FFP + 150 kg of NPK 14-0-46
T5	Half rate of FFP + 200 kg of NPK 14-0-46
T6	Half rate of FFP + 250 kg of NPK 14-0-46
T7	Half rate of FFP + 300 kg of NPK 14-0-46
T1	Full rate of FFP
T2	Half rate of FFP + 100 kg of NPK 19-9-19
T3	Half rate of FFP + 200 kg of NPK 19-9-19
T4	Half rate of FFP + 300 kg of NPK 19-9-19
T5	Half rate of FFP + 400 kg of NPK 19-9-19
T6	Half rate of FFP + 500 kg of NPK 19-9-19
T7	Half rate of FFP + 600 kg of NPK 19-9-19
T1	Full rate of FFP
T2	Half rate of FFP + 100 kg of NPK 11-11-11
T3	Half rate of FFP + 150 kg of NPK 11-11-11
T4	Half rate of FFP + 200 kg of NPK 11-11-11
T5	Half rate of FFP + 250 kg of NPK 11-11-11
T6	Half rate of FFP + 300 kg of NPK 11-11-11
T7	Half rate of FFP + 350 kg of NPK 11-11-11

Full rate of Farmer Fertilizer Practice (FFP) is 200 kg urea + 150 kg SP36 + 150 kg KCl/ha

The profit analysis provides a comparison of expected costs and benefits between the farmer‘s fertilizer practice and three compound fertilizers with different rates. Data collected were statistically analyzed and Duncan’s multiple-range test was applied to examine significance of differences between the treatment means. Statistical analysis was conducted using STAR (IRRI, 2013).

RESULTS

Pod Yield, Seed Yield, and Number of Pod per Plant

In the present experiment different rates of inorganic fertilizer from different compound fertilizers had a significant effect on pod yield and seed yield as presented in Table 3. In each of compound fertilizer tested, pod yield and seed yield increased quadratically as increasing compound fertilizer rates. The rate of incretions, however were different. For compound fertilizer NPK 14-0-46 the highest pod yield and seed yield were 1649 kg/ha and 1072 kg/ha, respectively with half rate of FFP + 200 kg of NPK 14-0-46. For compound fertilizer NPK 19-9-19 the highest pod yield and seed yield were 1632 kg/ha and 1032 kg/ha with half rate of FFP + 500 kg of NPK 19-9-19. For compound fertilizer NPK 11-11-11 the highest pod yield seed yield were 1421 kg/ha and 930 kg/ha with half rate of FFP + 250 kg of NPK 11-11-11. Total number of pod plant-1 increased quadratically with increasing rate of all compound fertilizers tested. Number of big pod increased almost linearly while number of small pod decreased linearly.

Table 3. Pod, seed yield, and number of pod of peanut as affected by NPK compound fertilizer rates in Langkat, North Sumatra, DS 2018

Treatments	Pod Yield (kg/ha)	Seed Yield (kg/ha)	Number of Pod/Plant		
			Big Size >65 g/Pod	Small Size <65 g/Pod	Total
			NPK 14-0-46		
T1	1083$_{c}$	704$_{c}$	13.5$_{d}$	11.5$_{a}$	25.0$_{c}$
T2	1105$_{c}$	796$_{c}$	15.7$_{c}$	11.2$_{a}$	26.9$_{c}$
T3	1477$_{b}$	960$_{b}$	22.5$_{b}$	9.7$_{b}$	32.2$_{b}$
T4	1589$_{ab}$	1033$_{ab}$	26.5$_{ab}$	8.2$_{bc}$	34.7$_{a}$
T5	1649$_{a}$	1072$_{a}$	27.7$_{a}$	7.5$_{c}$	35.2$_{a}$
T6	1561$_{ab}$	1015$_{ab}$	28.5$_{a}$	5.7$_{d}$	34.2$_{a}$
T7	1422$_{b}$	1010$_{ab}$	25.5$_{ab}$	4.5$_{d}$	30.0$_{b}$
			NPK 19-9-19		
T1	961$_{c}$	728$_{c}$	11.8$_{d}$	11.6$_{a}$	23.4$_{c}$
T2	1081$_{c}$	851$_{b}$	16.1$_{c}$	10.5$_{ab}$	26.6$_{c}$
T3	1335$_{bc}$	888$_{b}$	22.3$_{b}$	8.9$_{b}$	31.2$_{ab}$
T4	1471$_{b}$	893$_{b}$	23.8$_{b}$	7.6$_{b}$	31.4$_{ab}$
T5	1530$_{ab}$	895$_{b}$	24.6$_{b}$	6.4$_{bc}$	31.0$_{b}$
T6	1632$_{a}$	1032$_{a}$	28.3$_{a}$	4.7$_{c}$	33.0$_{a}$
T7	1528$_{ab}$	962$_{ab}$	25.6$_{ab}$	5.6$_{bc}$	31.2$_{ab}$
			NPK 11-11-11		
T1	1046$_{c}$	693$_{d}$	14.3$_{d}$	9.9$_{a}$	24.2$_{d}$
T2	1166$_{c}$	788$_{cd}$	18.0$_{c}$	8.7$_{b}$	26.7$_{c}$
T3	1180$_{c}$	827$_{c}$	21.7$_{bc}$	6.2$_{bc}$	27.9$_{bc}$
T4	1243$_{b}$	888$_{c}$	24.3$_{b}$	4.8$_{c}$	29.1$_{b}$
T5	1421$_{a}$	930$_{b}$	28.3$_{a}$	4.5$_{c}$	32.8$_{a}$
T6	1316$_{ab}$	975$_{a}$	24.7$_{b}$	4.1$_{c}$	28.8$_{b}$
T7	1311$_{ab}$	945$_{ab}$	24.3$_{b}$	4.1$_{c}$	28.4$_{b}$

In a column, means followed by the same letter are not significantly different at the 5% level by Duncan’s multiple range test

Weight of Pod, Plant Height and Number of Brunches per Plant

Among the various compound fertilizers tested, weight of fresh and dry pod per plant was highest at T5 with half rate of FFP + 200 kg of NPK 14-0-46; half rate of FFP + 400 kg of NPK 19-9-19; half rate of FFP + 250 kg of NPK 11-11-11 (Table 4). The highest plant height and number of branches per plant, both at 2 and 4 WAP have been observed at T7 (half rate of FFP + 300 kg of NPK 14-0-46; half rate of FFP + 600 kg of NPK 19-9-19; half rate of FFP + 350 kg of NPK 11-11-11 or the highest rate of each compound fertilizers tested.

Economic analysis based on the average yield of each treatment across all repetitions, in which farmer's recommended fertilizer practices were compared with three different compound fertilizers at different rates under upland soil in Langkat, North Sumatra (Table 5). For compound fertilizer NPK 14-0-14, NPK 19-9-19, and NPK 11-11-11, the average yield using farmers' fertilizer practice was 1083, 961, and 1046 kg/ha respectively compared with 1649, 1632, and 1421 for the highest pod yield of compound fertilizer, respectively. These represent an exploitable yield gap of 52%, 70% and 36%. Furthermore, there were a 51, 29, 40%, increase in gross margin after deducting fertilizer costs when using each half rate of farmer fertilizer practices with 200 kg of NPK 14-0-46 or 300 kg of NPK 19-9-19 or 250 kg of NPK 11-11-11, respectively.

Table 4. Plant height, weight of pod, and number of branches per plant of peanut as affected by NPK compound fertilizer rates in Langkat, North Sumatra, DS 2018

Treatments	Weight of Pod (g/Plant)		Plant Height (cm)		No. of Branches/Plant	
	Fresh	Dry	2 WAP	4 WAP	2 WAP	4 WAP
			NPK 14-0-46			
T1	36.7_{c}	23.0_{d}	24.5_{b}	30.5_{c}	3.5_{b}	7.3_{b}
T2	38.7_{c}	24.1_{d}	25.8_{b}	33.7_{bc}	3.8_{b}	7.9_{b}
T3	42.3_{bc}	26.3_{c}	26.9_{b}	35.4_{b}	3.5_{b}	8.9_{ab}
T4	47.2_{b}	29.5_{b}	27.1_{b}	37.0_{b}	3.5_{b}	9.1_{ab}
T5	52.9_{a}	33.2_{a}	28.9_{ab}	39.5_{a}	3.8_{b}	9.7_{a}
T6	51.6_{a}	31.0_{ab}	29.6_{ab}	40.9_{a}	4.3_{a}	9.6_{a}
T7	49.8_{ab}	31.1_{ab}	32.2_{a}	40.2_{a}	4.0_{a}	9.6_{a}
			NPK 19-9-19			
T1	35.4_{c}	22.2_{c}	21.4_{c}	28.9_{d}	3.0_{b}	6.7_{c}
T2	38.0_{c}	23.1_{c}	23.8_{c}	32.2_{c}	3.5_{b}	7.1_{bc}
T3	41.2_{bc}	25.1_{b}	25.6_{bc}	33.4_{bc}	3.7_{ab}	7.9_{b}
T4	44.7_{b}	27.3_{b}	27.2_{bc}	35.8_{b}	3.7_{ab}	8.1_{b}
T5	51.2_{a}	31.3_{a}	28.8_{b}	39.5_{a}	3.8_{ab}	8.7_{b}
T6	50.9_{a}	31.8_{a}	29.5_{b}	39.9_{a}	4.3_{a}	9.5_{a}
T7	49.3_{a}	30.0_{a}	31.1_{a}	39.1_{a}	4.4_{a}	9.6_{a}
			NPK 11-11-11			
T1	37.5_{c}	23.4_{c}	22.6_{b}	31.2_{c}	3.1_{b}	7.4_{c}
T2	41.2_{c}	25.3_{bc}	23.4_{b}	32.7_{b}	3.4_{b}	8.2_{bc}
T3	46.5_{c}	28.3_{b}	25.4_{ab}	33.4_{b}	3.5_{b}	9.0_{b}
T4	49.8_{c}	31.1_{ab}	26.1_{ab}	35.6_{a}	3.7_{b}	8.9_{b}
T5	56.7_{a}	34.1_{a}	27.8_{a}	35.9_{a}	3.8_{b}	9.7_{a}
T6	54.4_{ab}	34.0_{a}	28.6_{a}	34.5_{ab}	4.4_{a}	9.8_{a}
T7	53.2_{b}	33.1_{ab}	28.9_{a}	34.5_{ab}	4.3_{a}	9.6_{a}

In a column, means followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test

Table 5. Simple profit analysis between farmer's recommended fertilizer practices and three different compound fertilizers at different rates in Langkat, North Sumatra, DS 2018

Treatments	Pod Yield (kg/ha)	Revenue (USD/ha)[a]	Total Fertilizer Cost (USD/ha)[b]	Expected Benefit Above Fertilizer Costs (USD/ha)	Change in Benefit (USD/ha)
			NPK 14-0-46		
T1	1083	682.29	130.70	551.59	
T2	1105	696.15	100.44	595.71	44.12
T3	1477	930.51	135.53	794.98	243.39
T4	1589	1001.07	170.61	830.46	278.87
T5	1649	1038.87	205.70	833.17	281.58
T6	1561	983.43	240.79	742.64	191.05
T7	1422	895.86	275.88	619.98	68.39
			NPK 19-9-19		
T1	961	605.43	130.70	474.73	
T2	1081	681.03	135.53	545.50	70.77
T3	1335	841.05	205.70	635.35	160.62
T4	1471	926.73	275.88	650.85	176.12
T5	1530	963.90	346.05	617.85	143.12
T6	1632	1028.16	416.23	611.93	137.20
T7	1528	962.64	486.40	476.24	1.51
			NPK 11-11-11		
T1	1046	658.98	130.70	528.28	
T2	1166	734.58	100.44	634.14	105.86
T3	1180	743.40	117.98	625.42	97.14
T4	1243	783.09	135.53	647.56	119.28
T5	1421	895.23	153.07	742.16	213.88
T6	1316	829.08	170.61	658.47	130.19
T7	1311	825.93	188.16	637.77	109.49

[a] Based on farm gate price of 1 kg of pod = 0.45 USD/kg; USD = Rp. 14,250;

[b] Fertilizer prices are based on the nearest kiosk (USD/kg) Urea = 0.14; SP-36 = 0.16; NPK 11-11-11 KCl = 0.53; NPK 14-0-46 = 0.70; NPK 19-9-19 = 0.70; NPK 11-11-11 = 0.35

DISCUSSIONS

Results in experiment revealed that there were significant effect by all rates of different compound fertilizer treatments on yield and yield components. Increasing peanut yield and its components by using chemical fertilizers were reported by many researchers (Mahrous *et al*., 2015; Musa *et al*., 2017; Kulkarni *et al*., 2018). Nitrogen fertilizer is an important factor in achieving better growth and development of vegetative and reproductive organs of peanut and with increases of photosynthesis rate and photosynthetic matter production and sequently the yield components and pod or seed yield of peanut (Awadalla *et al*., 2017). The need for P elements in legumes that form root nodules is greater than those that do not form root nodules. Lack of P will inhibit N fixation and symbiotic interactions. Fertilization usually results in a buildup of P in peanut soils because of the low amount removed in the nuts and the low fixing capacity of sandy soils on which they are grown (Bairagi *et al*., 2017).

Low nutrient cation retention is a consequence of low activity 1:1 clay mineralogy (kaolinite, iron and aluminum hydrous oxides) or sandy texture. The limited capacity for the soil to retain exchangeable Ca, Mg and K is exacerbated in acidic soils because exchangeable acidity (H^+ plus Al^{3+}) is high, further decreasing the proportion of basic cations on the soil's limited cation exchange sites (Sutriadi and Setyorini, 2012; Kruse *et al*., 2015). Crops growing on acidic soils with low cation exchange capacity are more likely to show potassium (K) deficiency than calcium or magnesium deficiency because of the greater crop requirement for K (Hasanuzzaman *et al*., 2018).

Generally, plants increase the growth by application of fertilizer treatments. Improvement of plant growth was significantly found by the application of inorganic source of mineral nutrition. The results were in confirmation to results obtained by Kulkarni *et al.* (2018) that the applications of chemical fertilizers to peanut increased its plant height and number of branches per plant. The number and size of leaves was influenced by genotypes and environmental factors, such as soil, water, light and nutrients (Ahmed *et al*., 2016). Site Specific Nutrient Management methodology can be used to implement integrated nutrient inputs and practices so that nutrient use efficiency (i.e., nutrient taken up by the crop/unit of nutrient applied) is optimized for farmer profitability and environmental benefit.

The exploitable yield gap of a crop grown in a certain location and cropping system is defined as the difference between the yield under optimum management and the average yield achieved by farmers (Stuart *et al*., 2016). The exploitable yield gap is described as a percentage by dividing this value by the yield under optimum management. For each compound fertilizer NPK 14-0-14, NPK 19-9-19, and NPK 11-11-11, the represent an exploitable yield gap of 52%, 70% and 36%, respectively. However, there were a 51, 29, 40%, respectively increase in gross margin after deducting fertilizer costs when using each half rate of farmer fertilizer practices with 200 kg of NPK 14-0-46 or 300 kg of NPK 19-9-19 or 250 kg of NPK 11-11-11.

CONCLUSION

The study indicated that the groundnut showed greater response to the compound fertilizer treatments. For each compound fertilizer NPK 14-0-14, NPK 19-9-19, and NPK 11-11-11, the represent an exploitable yield gap of 52%, 70% and 36%, respectively. It is concluded that adding each half rate of farmer fertilizer practices with 200 kg of NPK 14-0-46 or 300 kg of NPK 19-9-19 or 250 kg of NPK 11-11-11 with HypoMa-1 cultivar gave the highest values of the benefit or income increase for the farmers under upland soil in Langkat, North Sumatra.

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