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THE APPLICATION OF MANURE ON SESAME (*Sesamum indicum* L.) UNDER COASTAL SANDY LAND AREA IN YOGYAKARTA, INDONESIA

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Abstract - *The study aimed to determine the effect of the application of manure on sesame production under coastal sandy land area in Yogyakarta. Three-factor experiments were arranged in completely randomized factorial design with three replications. The first factor was types of manure, with three levels, chickens, goats and cows. The second factor was the dose of manures, with four levels, 0, 15, 30, and 45 ton ha $^{-1}$. The third factor was the variety of sesame, with two levels, black sesame 'Sumberrejo 3' (Sbr 3) and white sesame variety 'Sumberrejo 1' (Sbr 1). Growth and yield parameters observed were flowering time, plant dry weight, pod dry weight and oil content. The data were analyzed using analysis of variance followed by the Duncan's New Multiple Range Test at 5%. The results showed that the best treatment was application of chicken manure at 30 ton ha^{-1} which caused Sbr 1 flowered 46 days after planting and Sbr 3 flowered 42 days after planting. Total oil content of Sbr 1 was 46.77% and of Sbr 3 was 45.44% as a result of that treatment.*

Key Words: **Manure, White sesame, Black sesame.**

1. INTRODUCTION

Sesame seeds were usually consumed as a food or used in industrial products (edible oil, soaps, perfumes, paint oils, pharmaceuticals) [1]. The analysis of nutrient of sesame seeds showed that each 100 g of sesame seeds contain 571.17 of calories, 4.10 mg of copper, 2.44 mg of manganese, 0.33 g of tryptophan, 972.27 mg of calcium, 350.02 mg of magnesium, 14.52 mg of iron, 627.24 mg of phosphate, 7.76 mg of zinc, 0.77 mg of thiamine (vitamin B1) and 11.4 g of fiber [2]. The seeds contain 50% edible oils that don't go rancid easily and are definitely best used within a year [3].

The optimum yield sesame can be produced as an outcome of good crop cultivation under wide range of environments, possibly under coastal sandy areas. The crop grows well under tropical climate, with the 18°C (minimum temperature), full sunny radiation, and fertile soils. Unfortunately, the coastal sandy land area, is usually less fertile, due to less of soil organic materials and the composition of sandy land which is 98% of sand categorized as quite porous soils. The extremely high temperature at the surface of sandy soil is intolerance for any crops [4]. The manipulation for such marginal soil, by the application of paddy clay at 30 ton ha^{-1} and 20 ton ha^{-1} of manures has been able to change the soils to be more productive [4]. It also improves the biological activity in the soil [5] and soil health [6].

In case of the sandy soils, the organic matters has the role, mainly in improving the water holding capacity, generating humus and soil aggregates and increasing the availability of nutrients (particularly the micro nutrients and developments of microbial activity). Organic matter has the role for the improvement of vigorous crop growth, prolongation the leaf-live duration, metabolism, flowering, and fruit sets [7].

There are possibilities for sesame cropping at sandy coastal areas, because some farmers has done it and they harvest the sesame seeds. The previous observations indicated that the areas have the temperature at about 31°C and 5—7 wet months in a year. Those conditions were suitable enough for sesame cropping. Appropriate shelter, could be developed to break the fast wind, particularly under dry season, which contains the salt particles and is potentially damaging the crops.

Up to now, there is still no accurate information regarding the types of manure and their dose should be applied and the type of sesame variety should be cropped. This fact was the reason for such of research should be conducted.

2. MATERIALS AND METHODS

This study to determine the effect of the application of manure on sesame production under coastal sandy land

area in Yogyakarta. The materials prepared were three types of manure (goat, chicken and cow manures), while the doses of manures applied were 0; 15; 30; and 45 ton ha^{-1}. There were two varieties planted were Sbr 1 (white sesame variety) and Sbr 3 (black sesame variety). The equipment used were water sprinkler, and 10-kg polybags, thermo-hygrometers, lux meter type DX 100, pH meter, Licor series Li-6400, leaf area meter type L I-3100, oven, digital scale type 0-Thirsty and the apparatus for laboratory analysis for chlorophyll and fats content. The experiment were done at the Gadjah Mada University research station (7°15- 8°15 107° 29′ 30″ E, 7° 34′ 51″ and 7° 47′ 30″ S), the temperature reaches around 29-30°C during March to June 2012. A Completely Randomized Design (CRD), were chose to the 3x4x2 factorial experiment, with three replications. The individual crops were planted in 10-kg polybag. The manures were incubated for 2 weeks before they were mixed with the top soil and were filled to the polybags according to the level of treatment. The observation were done on agronomic aspects (days to flowering, dry matter production, seed yield, and oil content). The data were analyzed using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (α = 5%) as a post-hoc analysis. The sandy soil and manures were analyzed at Laboratory of Soil Sciences, Faculty of Agriculture, Surakarta State University on 2013 before the application to know the characteristics. The results are shown in the Table 1 and Table 2.

Table-1: The results of the sandy soil analysis

No.	Soil Characteristics	Values	Category
1.	Sand	92.00%	sandy
2.	Dust	4.40%	sandy
3.	Clay	3.60%	sandy
4.	pH (H_2O)	6.42	neutral
5.	pH (KCl)	6.13	neutral
6.	Organic matter	1.08%	very low
7.	C-organic	2.14%	very low
8.	N-total	0.18%	very low
9.	P_2O_5	1.02 ppm	very low
10.	K_2O	0.31 ppm	very low
11.	CEC	10.80 me%	low
12.	Particle density	1.4 g cm^{-3}	high
13.	Bulk density	2.6 g cm^{-3}	high

Category was determined based on Indonesian Soil Research Institute (2009)

Table-2: The chemical properties of manures

No.	Properties	Manure		
		Chicken	Cows	Goats
1.	Water content (%)	21.25	20.19	18.85
2.	pH (H_2O)	7.3	6.6	6.7
3.	BO (%)	51.05	45.01	41.31
4.	C-organic (%)	29.61	26.10	23.96
5.	N-total (%)	1.65	1.05	1.01
6.	C/N ratio	17.95	24.86	23.72
7.	P_2O_5	1.18	0.5	0.75
8.	K_2O	1.19	0.73	1.47

3. RESULTS AND DISCUSSIONS

The results in the following section are based on the order of statistical significance, which ranges from the highest level interaction to the main effects of treatments. From Table 3, the statistical analysis showed that type and dose of manures with sesame varieties interaction were occurred in flowering time, plant dry weight, pod dry weight, and oil content (P>F-value <0.05). Thus, the results are presented in a format corresponding to these significant interactions.

Table-3: P>F-value of main effects of types of manure (M), sesame varieties (V) and dose of manure (D) and their possible 2- and 3-way interactions for flowering time (FLO), plant dry weight (PDW), pod dry weight (PoDW) and oil content (OIL)

Source	d.f.	P > F-value			
		FLO	PDW	PoDW	OIL
M	2	0.0003	<0.0001	<0.0001	0.179
V	1	0.051	0.001	<0.0001	0.135
D	3	<0.0001	<0.0001	<0.0001	<0.0001
M×V	2	0.0004	<0.0001	0.163	<0.0001
M×D	6	0.004	<0.0001	<0.0001	<0.0001
V×D	3	<0.0001	<0.0001	0.036	<0.0001
M×V×D	6	0.0003	<0.0001	<0.0001	<0.0001
CV (%)		3.67	4.03	3.52	0.79

d.f., degree of freedom; CV, coefficient of variation

On white sesame, the fastest flowering time was found when 30 ton ha^{-1} of cow manure applied. On black sesame, fastest flowering time was found when 15 and 30 ton ha^{-1} of all type of manures applied. None of manure applied caused the slowest flowering time on all sesame varieties (Table 4).

Table-4. Flowering time and plant dry weight (DW) in response to 3-way interaction of types of manure, sesame varieties and doses of manure

Manure	Dose (ton ha^{-1})	Flowering time (day)		Plant DW (g)	
		Sbr 1	Sbr 3	Sbr 1	Sbr 3
Cow	0	49.00a	49.00a	28.73i	24.65jk
	15	42.00c	42.00c	40.44g	58.98g
	30	37.33d	42.00c	74.52a	67.06cd
	45	42.00c	49.00a	66.89cd	64.87d
Chicken	0	49.00a	49.00a	27.95ij	22.80k
	15	49.00a	42.00c	64.73d	58.87e
	30	46.67ab	42.00c	72.94ab	70.39bc
	45	42.00c	49.00a	69.13c	63.25d
Goat	0	49.00a	49.00a	24.66jk	32.63h
	15	42.00c	42.00c	55.22f	54.36f
	30	42.00c	42.00c	63.33d	63.72d
	45	44.33bc	46.67ab	43.05d	53.45f

Means on each variable were subjected with Duncan's New Multiple Range Test (α=0.05); Sbr 1, white sesame; Sbr 3, black sesame

The highest value of plant dry weight was found when 30 ton ha^{-1} of cow manure applied to white sesame. When no chicken manure applied to black sesame affected the lowest value of plant dry weight. The result was similar when no goat manure applied to white sesame (Table 4).

Table-5. Pod dry weight (DW) and total oil content in response to 3-way interaction of types of manure, sesame varieties and doses of manure

Manure	Dose (ton ha^{-1})	Pod DW (g)		Oil Content (%)	
		Sbr 1	Sbr 3	Sbr 1	Sbr 3
Cow	0	5.16 gh	4.69 h	42.44 a	42.31 a
	15	10.10 de	9.92 e	45.55 c	46.25 d
	30	14.08 a	13.24 b	46.63 d	46.07 d
	45	12.79 b	12.72 b	47.20 e	45.62 c
Chicken	0	5.73 g	5.78 g	42.23 a	45.32 c
	15	10.70 d	9.78 e	45.45 c	43.31 b
	30	13.07 b	12.83 b	46.77 d	45.44 c
	45	12.08 c	12.10 c	43.74 c	45.14 c
Goat	0	5.27 gh	5.17 gh	45.29 d	42.12 a
	15	8.62 f	9.10 f	46.77 d	46.72 f
	30	11.62 c	10.55 d	45.81de	46.61 e
	45	12.04 c	10.11 de	43.44 b	47.08 f

Means on each variable were subjected with Duncan's New Multiple Range Test (α=0.05); Sbr 1, white sesame; Sbr 3, black sesame

On white sesame, the highest pod dry weight value was found when 30 ton ha^{-1} of cow manure applied. On black sesame, the highest pod dry weight was found when 30 and 45 ton ha^{-1} of cow manure or 30 ton ha^{-1} of chicken manure applied. None of manure applied caused the lowest pod dry weight in all sesame varieties (Table 5).

On white sesame, the highest oil content was found when 45 ton ha^{-1} cow manure applied. On black sesame, the highest oil content was found when 15 or 45 ton ha^{-1} goat manure applied. While the lowest oil content was found when none of manure applied generally (Table 5).

3.1. General Discussions

The problems occurred in coastal sandy soil, particularly in physical and chemical properties. The soil type is sandy soil and is categorized as marginal land. In physical properties, the soil was composed of 92% sand fraction, 4.4% dust fraction and 3.60% clay fraction. Those characteristics can lead to a high proportion of macro pores and cause soil has high permeability so that it lowered moisture and nutrient retention (Table 1). Cation Exchange Capacity (CEC) were detected low in the sandy soil caused by: (1) The low clay fraction is a source of the negative charge on the lattice of minerals and edge mineral which lower the adsorption of cations and (2) low organic matter resulted in low value of CEC as it is known that the presence of organic matter depends on the degrees the humification, such as humin, which can contribute a negative charge due to the dissociation of H^+ in the carboxyl and phenol group, which is enable adsorption and cation exchange to occur, and (3) the fraction of sand and dust is not balanced and it causes a low specific surface and contributes little portion to bulk soil commission [8]. On this type of soil used, the high sand fraction was not significant in contributing to soil CEC whereas CEC of a soil determines the number of positively-charged ions cations that the soil can hold. The neutral soil pH indicated that the soil was not saline soils even though it is located near the sea. Based on field observations, the land of sampling sites was not affected by seawater at high tide [9]. The optimum pH for the soil nutrient availability is about 6.4 for all the macro nutrients and micro nutrients. Consequently, the pH of the soil on the land is not a limiting factor in crop cultivation.

Statistical analysis showed that 30 ton ha^{-1} of cow manure gave the highest yield of pod dry weight as many as 14.08 g compared to other treatments (Table 5). The addition of manure, in addition to enrich nutrients to the soil will force the root to absorb more nutrients, then it will affect the process of photosynthesis to be optimal and subsequent accumulation of assimilates in the form of dry weight can be increased. Moreover, plant growth is

strongly influenced by the physical condition of the soil. This is due to availability of nutrients needed depends on more perfect structure of the soil. When manure applied, the soil become looser, the microorganisms' activity become productive and as a result, the nutrients become available and can be absorbed by plants [10].

This is in accordance with the opinion [11] which states that in order to obtain good results, the plants should be provided with enough nutrients and organic matter which contain available macro nutrients and micro nutrients that plants need. Sources of nutrients derived from organic fertilizer required by plants growth, includes macro nutrients such as N, P, and K which are essential part of plant life. Nitrogen is a fundamental unit of proteins, nucleic acids, chlorophyll and other organic compounds play a role in the process of photosynthesis and plant production with elements of P and K [12]. Nitrogen is an integral part of the structure of chlorophyll, so green/pale or yellowish occurs due to shortage of N [13]. Chicken manure has a high nutrient content, including macro nutrients, and micro (N, P and Mg). It can be absorbed for the synthesis of chlorophyll so that the leaves become greener compared to the leaves of results of the application of cow or goat manure. Optimum leaf area will produce optimum dry weight assimilates then. In conclusion, the addition of manure into the plant medium will add nutrients to plants.

Availability of nutrients is very important for plant growth and development, because the nutrient will help in expediting the plant metabolism, such as photosynthesis which can produce high assimilate and later can be translocated to all parts of the plant. Thus, it will consequently affect the crop yield when the flowering time of plant closely related to the age of harvest [14]. Generally, the faster days to flowering cause the longer grain filling phase and the faster harvesting time. The results showed that the three factors (types of manure, doses and sesame varieties) provided significantly results in flowering time (Table 3). The fastest flowering time was 5.3 weeks or 37 days after planting at fertilizer treatment with doses of cow manure 30 ton/ha, the SBR varieties 1. While most long flowering time in the control treatment which is 7 weeks or 49 days. The addition of organic fertilizer 1-2 days delayed flowering (Table 4).

The environment around coastal sandy land where sesame plants were grown is known with such stress related to the temperature and nutrient limitations, can affect the crop cycle, including flowering time. High temperatures above the optimum level can affect the metabolism of plants so faster that be able to flower. Organic fertilizer applied on sandy soil can improve the soil surface so that the temperature is still maintained and flowering time is not too fast. This statement is consistent with [15] that high temperatures accelerate the appearance of the first flower on the plant sesame. Flowering of a plant closely related to the age of harvest. Generally, the faster days to flowering cause the longer grain filling phase and the faster harvesting time.

Types of manure, doses and sesame varieties influenced total oil content (Table 3 and 5). The economic value of sesame depends on oil content and protein. Variations on the production of sesame oil are strongly influenced by climatic conditions, soil type and level of maturity and plant varieties. Similarly, the physicochemical of sesame oil is directly related to the composition of oil and glyceride [16]. The results showed that the highest oil concentration obtained when chicken manure 30 ton/ha applied as many as 46.7% (Table 5). Manure doses given had not been able to increase the content of total and available soil N significantly, because the nutrient content of manure is relatively low (Table 2). Manure is able to supply N in organic forms such as proteins amino acids, amino sugars, NH_3-N, N-insoluble acid, N unknown hydrolyzed, and organic N were immobilized in the soil organisms, which may become available N (NH_4^+ and NO_3^-) through the process of mineralization in the dissolved form and then bounded to the clay or humus complex. It means that the higher the dose given will be followed by an increase of total N content and available N.

The positive effect of manure application on growth parameters, yield components and oil content on the treatment of cow manure 30 ton ha^{-1}. The role of manure was seen in physical improvement of the soil, such as soil aggregation and permeability towards air circulation, granulation, fixing power hold nutrients and water, plant roots easily penetrate deeper and wider so that the plants more robustly able to absorb nutrients and water, while in chemical function, it can increase soil CEC and the absorption of some nutrients, whereas in biological function, manure as organic matter is a major source of energy for activity of soil microorganisms, which serves in binding some plant nutrients and is beneficial to plant growth [17].

4. CONCLUSIONS

The use of chicken manure 30 ton ha^{-1} affected significantly in supporting the growth and production of sesame and sesame oil content as many as 47%. Overall, manure provided good growth for sesame at sandy coastal area. Improved sesame 'Sumberrejo 1' (white sesame) was more productive than 'Sumberrejo 3' (black sesame).

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