

ABSTRAK

PERBAIKAN KUALITAS TANAH TERDEGRADASI MELALUI PEMBENTUKAN MIKROAGREGAT OLEH CACING TANAH

Oleh

AEP SUPRIYADI

NIM : 30611011

(Program Studi Doktor Biologi)

Degradasi tanah merupakan masalah global yang sangat berat di daerah tropis dan sub-tropis di abad ke-21. Dampak tanah terdegradasi menghilangkan kemampuan biologis tanah, menurunkan resistensi dan resiliensi tanah, berdampak pada turunnya produksi pertanian, dan jasa ekosistem. Penelitian ini bertujuan memperbaiki kualitas tanah terdegradasi melalui pembentukan mikroagregat oleh cacing tanah, menemukan mekanisme perbaikan tanah terdegradasi, dan kualitas mikroagregat yang terbentuk. Penelitian dilakukan dua tahap, yaitu penilaian kualitas tanah, dan perbaikan kualitas tanah dengan penambahan cacing tanah dan bahan organik yang berasal dari daerah penelitian. Identifikasi kualitas tanah dilakukan dengan metode survey pada 5 penggunaan tanah di Gunung Geulis Kabupaten Sumedang, yaitu : 1) Agroforestry (AF); 2) lahan kebun pisang (AS1) 3) lahan palawija (AS2); 4) lahan campuran pisang dan palawija (AS3); dan 5) hutan lindung (FS). Hasil analisis mineral klei tanah adalah kaolinit, ordo *Inceptisol*, dari famili *Humic Lithic Eutrudepts*. Hasil kualitas tanah termasuk sangat rendah dengan indek AS1 (0,3881), AS2 (0,3614), AS3 (0,3981), dan AF (0,3985), dan di lahan FS berkualitas rendah (0,4814) pada skala maksimum 0,9565. Proporsi mikroagregat tinggi tetapi daya tahan terhadap dispersi air (*Water Stability Aggregate*) sedang (69,31%) dengan jumlah agregat stabil sangat rendah (28,13%) dan indeks stabilitas agregat rendah (44,05). Fauna tanah yang ditemukan di Kawasan Gunung Geulis berasal dari 12 ordo yaitu *Haplotaxida*, *Hymenoptera*, *Entomobryomorpha*, *Araneae*, *Coleoptera*, *Orthoptera*, *Isoptera*, *Mantodea*, *Diptera*, *Hemiptera*, *Blattodea*, dan ordo *Acarina*. Fauna yang bersifat soil engineers ada 4 ordo yaitu Ordo *Haplotaxida*, *Hymenoptera*, *Entomobryomorpha*, dan ordo *Acarina*. Diantara empat ordo yang bersifat soil engineers adalah cacing tanah ordo yang dominan adalah *Haplotaxida* (*Amyntas aeruginosus*, *Amyntas illotus* species-group) dan Semut ordo *Hymenoptera* (*Solenopsis*, *Formicidae* (*Anoplolepis gracilipes*, *Diacamma* sp., *Lasiolepis* sp., *Nylanderia* sp., *Pheidole* sp., *Pheidole* sp., *Cardioconyla* sp., *Tetramorium* sp., *Myrmecaria* sp., *Pheidologeton*, *Camponotus* sp., *Polyrhachis* sp.)). Perbaikan kualitas tanah dilakukan dengan penambahan cacing tanah dan kompos pada tanah dari lahan pertanian palawija yang telah ditetapkan memiliki indeks kualitas tanah sangat rendah (AS2). Metode penelitian adalah percobaan destruktif selama tiga bulan dengan tiga kali pengamatan, dan Rancangan Acak Kelompok (RAK) pola Faktorial. Taraf faktor agregat (A) terdiri 4 taraf, yaitu agregat makro (841 – 2000) μm , meso (250 – 841) μm , mikro (44 – 250) μm , dan agregat campuran

dari ketiganya dengan perbandingan 27% makro, 54% meso dan 19% mikro. Cacing tanah yang digunakan adalah dari Famili *Megascolecidae* (B) dan bahan kompos (C) campuran limbah pertanian dan serasah hutan masing-masing terdiri dua taraf yaitu dengan dan tanpa pemberian, sehingga terdapat 16 komposisi perlakuan masing-masing diulang 2 kali. Kompos ditambahkan 1,983 kg per 5 kg tanah untuk mencapai 20% karbon organik tanah. Cacing tanah ditambahkan 17 individu seberat 20 g. Jenis cacing tanah yang digunakan dari kelompok *Amyntas illotus* - *Megascolecidae*). Jumlah pot yang disiapkan 96 buah selama tiga bulan percobaan, yang setiap bulan diuji 32 pot. Mekanisme perbaikan kualitas tanah pada bulan satu sangat dipengaruhi oleh kenaikan kalium (6-7 kali) dan pori drainase cepat. Pori drainase cepat memfasilitasi akses distribusi air, udara untuk meningkatkan dekomposisi dan humifikasi bahan organik dan pH tanah. Mekanisme perbaikan stabilitas agregat bulan dua dan tiga sangat dipengaruhi peningkatan karbon organik terlarut (4 kali), sedangkan pada kualitas tanah sangat dipengaruhi oleh kalsium dapat tukar. Perbaikan terhadap sifat fisika terjadi pada bobot isi, distribusi pori, agregat stabil, peningkatan mikro dan makroagregat, luas permukaan dan volume pori mikro. Tanah lebih porous dengan peningkatan pori makro ($> 8,6 \mu\text{m}$) walau pori drainase lambatnya menurun, sedangkan pada pori kapasitas lapang terjadi peningkatan pada pori air tersedia ($0,2 - 8,6 \mu\text{m}$) dan menurunkan pori air tidak tersedia ($< 0,2 \mu\text{m}$). Perbaikan sifat fisika-kimia tanah terjadi peningkatan pada zat humat, C organik stabil dalam mikroagregat yang lebih dipengaruhi cacing tanah sedangkan eksopolisakarida oleh kompos. Perbaikan kualitas kimia tanah yaitu kapasitas tukar kation yang naik dari rendah atau sedang menjadi tinggi ($25 - 40 \text{ cmol}(+)\cdot\text{kg}^{-1}$), kejenuhan basa dari sedang menjadi sangat tinggi diatas 70% dan C stabil dalam mikroagregat. Jumlah karbon stabil tertinggi yang dapat ditambat dalam agregat mikro oleh interaksi cacing tanah dan kompos sebesar $25,00 \text{ ton}\cdot\text{ha}^{-1}$, sedang interaksi cacing tanah dan agregat terjadi pada agregat meso $25,96 \text{ ton}\cdot\text{ha}^{-1}$, dan interaksi antara kompos dengan agregat tertinggi terjadi pada agregat campuran $24,90 \text{ ton}\cdot\text{ha}^{-1}$. Stabilisasi agregat terjadi setelah satu bulan, ditunjukkan oleh perubahan permukaan agregat, lebih kasar, lebih banyak pori, dan perubahan proporsi mikroagregat. Volume pori mikro tertinggi pada meso agregat $0,58 \text{ cc}\cdot\text{g}^{-1}$ pada bulan satu, pada bulan dua dan bulan tiga terjadi pada makroagregat masing-masing sebesar $1,33 \text{ cc}\cdot\text{g}^{-1}$ dan $2,20 \text{ cc}\cdot\text{g}^{-1}$. Luas permukaan spesifik tertinggi dihasilkan oleh kompos tanpa cacing tanah pada agregat campuran bulan satu, dua dan tiga masing-masing $312,77 \text{ m}^2\cdot\text{g}^{-1}$, $591,23 \text{ m}^2\cdot\text{g}^{-1}$, dan $445,80 \text{ m}^2\cdot\text{g}^{-1}$. Proses pembentukan mikroagregat dan makroagregat di bulan satu dan dua menunjukkan berjalan bersamaan dengan koefisien regresi masing-masing sebesar 0,718%, dan 0,827%.

Keywords : *Aggregate size, Compost, Earthworm, Stability aggregate, Microaggregates, Soil quality.*

ABSTRACT

IMPROVEMENT OF SOIL QUALITY THROUGH MICROAGGREGATES FORMATION BY EARTHWORM

By

AEP SUPRIYADI

NIM: 30611011

(Doctoral Program in Biology)

Soil degradation is a 21st century global problem that is especially severe in the tropics and sub-tropics. The impact of degraded soil has affected the habitat of soil fauna destruction and loss of soil biological ability, loss of soil resistance and resilient. Some facts indicate of soil degradation decreased soil ecosystem services, and agricultural production. The objectives of research is to improve quality of degraded soil through microaggregates formation by earthworms. The research was conducted at Gunung Geulis area, Sumedang Regency, West Java – Indonesia. Research carried out in two phases, i.e the assessment soil quality, to determine the quality of degraded soil based on microaggregates, and the improvement of soil quality by added soil organic matter and indogenous of earthworms. Survey methode and sampling was done at 5 different land use types: 1) Agroforestry (AF) dominated by pine trees; 2) Agrosystem–banana (AS1) 3) Agrosystem–cereals (AS2); 4) Agrosystem– banana–cereal (AS3); 5) Protected forest (FS). Soil sampling was conducted by sistematic method, the result of identification study area. The result of soil quality assessment shows that soil belongs to inceptisol type with Udepts sub-orde and Eutrudepts group, and belongs to kaolinit mineral. The soil quality in five different land use types shows poor soil quality at FS (0.4814), AF (0.3985), and very poor soil quality at AS1 (0.3881), AS2 (0.3614) and, AS3 (0.3981), on a maximum scale 0.9565. The soil has a high proportion of microaggregates with water aggregate stability is moderate (69.31%), the stable aggregate is very poor (28.13%) with a poor aggregate stability index (44.05). The order among of five soil fauna found, there were soil engineers is Haplotaxida and Hymenoptera, i.e earthworms (Amyntas aeruginosus, Amyntas illotus species-group), ant (Solenopsis, Formicidae (Anoplolepis gracilipes, Diacamma sp., Lasiolepis sp., Nylanderia sp., Pheidole sp. 1, Pheidole sp. 2, Cardioconyla sp 1, Tetramorium sp., Myrmicaria sp., Pheidologeton, Camponotus sp., Polyrhachis sp 1). The destructive experimental design in the laboratory was used for the second research methode, i.e Randomized Block Design with factorial pattern. The expereiments using degraded soil was collected from Agrosystem-cereal (AS2). The quality of degraded soil (AS2) was determine has very low quality index in the previous study. The experiment consisting of three factors, namely the aggregate grain size (A), earthworms (B) and the dose of compost (C). Aggregate (A) Factors comprises four levels: macroaggregates ($a_0 = 2.000 - 0.841$) μm , messo-aggregate ($a_1 = 0.841 - 0.250$) μm , microaggregates ($a_2 = 0.250 - 0.044$) μm , and aggregate mixture (a_3) with a ratio of 27% macroaggregates, 54% messo-

aggregate and 19% of microaggregates, almost like a land area of research. Earthworms of Megascolecidae (B) factors consists of two levels ie without earthworms (b0), with earthworms (b1) and compost (C) consists of two levels ie without compost (c0) and with compost (c1). So there are 16 combinations of treatments Each combination treatment was repeated twice. so that all amounted to 96 pots. The compost was added to increase soil organic carbon (SOC) at least 20% In each treatment, 17 individuals (about 20 g) of earthworm (Amyntas illotus - Megascolecidae) were used for the treatments. These experiments conducted in random block design with factorial pattern and repeated twice. A total of 96 pots were prepared and 32 pots were examine every month. The mechanism of soil quality improvement in one month is most influenced by the increase in potassium (6 - 7 times) and the fast drainage pore. The fast drainage pore provide access of water and air distribution to improve the process of decomposition and humunification organic matter and soil pH. The mechanism of soil aggregate stability improvement in two and three month is most influenced by the increase of dissolved organic carbon (4 times), while on soil quality is most influenced by calcium.exchanged. Improvements in physical properties occur in bulk density, pore distribution, stable aggregate, microaggregate and macroaggregate enhancement, surface area and micro pore volume. The soil is more axle with increased macro pore ($> 8.6 \mu\text{m}$) although the slow drainage pore is declining, while at fieldy capacity pore there was an increase in available water pore ($0.2 - 8.6 \mu\text{m}$) and was declining on pore of water not available ($<0.2 \mu\text{m}$). Improvement of soil physics-chemical properties of an increase in humic substance, stable organic karbon that are more affected by earthworms while exopolisakarida by compost. Improvements in soil quality are indicated by changes in chemical properties ie cation exchange capacity rising from low or moderate to high ($25 - 40 \text{ cmol}(+)\text{.kg}^{-1}$), saturation of bases from medium to very high above 70%, and carbon stable in microagregates. The highest number of stable carbon that can be sequestered in micro aggregate by the interaction of earthworms and compost as $25.00 \text{ tonnes.ha}^{-1}$, while the interaction of earthworms and aggregates occurred in the meso aggregate of $25.96 \text{ tonnes.ha}^{-1}$. Aggregate stabilization occurs after one month, indicated by aggregate surface changes, more roughage, more pores, and a change in the proportion of microaggregates. The highest number of micro pore volume in micro aggregate as the results of interaction each month one, two and three months was $0,58 \text{ cc.g}^{-1}$ on messo aggregate, on macro aggregate $1,33 \text{ cc.g}^{-1}$ and $2,20 \text{ 1,33 cc.g}^{-1}$ respectively, while on surface area in micro aggregate in mixed aggggregate was $312,77 \text{ m}^2\text{g}^{-1}$, $591,23 \text{ m}^2\text{g}^{-1}$, dan $445,80 \text{ m}^2\text{g}^{-1}$ respectively. The process of microaggregate and macroaggregate formation occurs simultaneously in one and two months with the coefisien of proportion 0,718%, dan 0,827%. Respectively.

Keywords : Aggregate size, Compost, Earthworm, Stability aggregate, Microaggregates, Soil quality.