

RINGKASAN

Beras merupakan makanan pokok yang dikonsumsi setiap hari oleh hampir seluruh masyarakat Indonesia. Pangan dianggap aman selama tidak mengandung cemaran biologis, kimia, atau bahan lain yang dapat membahayakan kesehatan manusia. Kondisi lahan sawah yang tercemar logam berat dapat diatasi dengan upaya penggunaan bahan pembenah tanah. Penggunaan biochar dan pupuk organik dapat menjadi upaya untuk meningkatkan produksi pertanian serta meningkatkan kualitas tanah sawah dan mengurangi risiko pencemaran logam berat. Penelitian ini bertujuan untuk mengetahui pengaruh aplikasi biochar terhadap karakter fisiologi dan hasil tanaman padi pada kondisi lahan sawah tercemar logam berat, mengetahui pengaruh aplikasi pupuk organik terhadap karakter fisiologi dan hasil tanaman padi pada kondisi lahan sawah tercemar logam berat, dan mengetahui pengaruh aplikasi biochar dan pupuk organik terhadap karakter fisiologi dan hasil tanaman padi pada kondisi lahan sawah tercemar logam berat.

Penelitian ini dilaksanakan di wilayah pertanaman padi Desa Pesawahan, Kecamatan Rawalo, Kabupaten Banyumas yang merupakan daerah yang terkontaminasi logam berat Pb dan Cd, Balai Pengujian Standar Instrumen Lingkungan Pertanian Pati, Laboratorium Perlindungan Tanaman, Laboratorium Agronomi & Hortikultura, Laboratorium Agroekologi Fakultas Pertanian, serta Laboratorium Riset, Universitas Jenderal Soedirman. Penelitian dilaksanakan pada bulan Mei hingga Oktober 2024. Rancangan percobaan yang digunakan berupa Rancangan Acak Kelompok (RAK) faktorial yang terdiri atas dua faktor kombinasi perlakuan. Faktor pertama adalah perlakuan biochar sekam padi (2, 4, 6 t/ha). Faktor kedua adalah perlakuan pupuk organik (2.5, 5, 10 t/ha). Berdasarkan kedua faktor tersebut, didapat kombinasi perlakuan sebanyak 9 perlakuan. Setiap perlakuan masing-masing diulang sebanyak 3 kali, sehingga secara keseluruhan menghasilkan 27 unit percobaan. Variabel yang diamati yaitu kerapatan stomata, kadar klorofil, total stomata, jumlah anakan produktif, jumlah dan bobot gabah hampa per rumpun, jumlah dan bobot gabah isi per rumpun, persentase bobot gabah hampa dan isi per rumpun, bobot 1000 biji, bobot gabah per rumpun, bobot kering tajuk fase generatif akhir, indeks panen, hasil, suhu, kelembapan udara, intensitas cahaya, curah hujan, kadar awal dan akhir logam berat Pb dan Cd dalam tanah, serta kadar logam berat Pb dan Cd pada beras. Data hasil pengamatan dianalisis secara statistik dengan uji F dengan taraf kepercayaan 95% untuk mengetahui pengaruh perlakuan. Apabila hasil analisis yang dilakukan menunjukkan adanya perbedaan yang nyata, maka analisis dilanjutkan dengan uji *Duncan's Multiple Range Test* (DMRT) dengan taraf kepercayaan 95%.

Hasil penelitian menunjukkan bahwa aplikasi biochar 2 t/ha dengan pupuk organik 2,5 t/ha mampu meningkatkan kerapatan stomata sebesar 30,03% dan total stomata sebesar 30%. Peningkatan dosis biochar hingga 6 t/ha mampu meningkatkan klorofil *a* sebesar 1,78%, klorofil total sebesar 2,38%, jumlah gabah isi sebesar 4,44%, bobot gabah isi sebesar 8,80%, bobot gabah per rumpun sebesar 8,89%, dan hasil sebesar 5,92%. Peningkatan dosis pupuk organik hingga 10 t/ha mampu meningkatkan klorofil *b* sebesar 3,53%, jumlah anakan produktif sebesar

9,26%, persentase bobot gabah isi sebesar 2,67%, bobot 1000 biji sebesar 3,12%, bobot kering tajuk fase generatif akhir sebesar 7,07%, dan indeks panen sebesar 1,75%. Peningkatan dosis biochar dan pupuk organik hingga 4 t/ha dan 5 t/ha mampu menurunkan jumlah gabah hampa sebesar 24,10%, bobot gabah hampa sebesar 20,50%, dan persentase bobot gabah hampa sebesar 21,77%. Aplikasi biochar pada dosis 4 t/ha mampu menurunkan kadar Pb tanah hingga 21,27%. Pupuk organik dosis 2,5 t/ha mampu menurunkan kadar Pb tanah hingga 15,77%. Sementara itu, peningkatan dosis biochar hingga 6 t/ha mampu menurunkan kadar Cd tanah hingga 56,88%. Aplikasi pupuk organik pada dosis 5 t/ha mampu menurunkan kadar Cd tanah hingga 59,94%.



SUMMARY

Rice is a staple food consumed daily by almost all Indonesians. Food is considered safe as long as it does not contain biological, chemical, or other contaminants that can harm human health. Contamination of rice fields with heavy metals can be addressed through the use of soil conditioners. The use of biochar and organic fertilizers can be an effort to increase agricultural production, improve the quality of rice fields, and reduce the risk of heavy metal contamination. This study aims to determine the effect of biochar application on the physiological characteristics and yield of rice plants in heavy metal polluted paddy fields, to determine the effect of organic fertilizer application on the physiological characteristics and yield of rice plants in heavy metal polluted paddy fields, and to determine the effect of biochar and organic fertilizer application on the physiological characteristics and yield of rice plants in heavy metal polluted paddy fields.

*This study was conducted in the rice-growing area of Pesawahan Village, Rawalo Subdistrict, Banyumas Regency, which is an area contaminated with heavy metals Pb and Cd, the Pati Agricultural Environmental Instrument Testing Center, the Plant Protection Laboratory, the Agronomy & Horticulture Laboratory, the Agroecology Laboratory of the Faculty of Agriculture, and the Research Laboratory, Jenderal Soedirman University. The research was conducted from May to October 2024. The experimental design used was a factorial Randomized Group Design (RGD) consisting of two factors of treatment combinations. The first factor is rice husk biochar treatment (2, 4, 6 t/ha). The second factor is organic fertilizer treatment (2.5, 5, 10 t/ha). Based on these two factors, 9 treatment combinations were obtained. Each treatment was repeated 3 times, resulting in a total of 27 experimental units. The variables observed were stomatal density, chlorophyll content, total stomata, number of productive tillers, number and weight of empty grains per clump, number and weight of filled grains per clump, percentage of empty and filled grain weight per clump, 1000 seed weight, grain weight per clump, late generative phase crown dry weight, harvest index, yield, temperature, air humidity, light intensity, rainfall, initial and final levels of heavy metals Pb and Cd in soil, and levels of heavy metals Pb and Cd in rice. Observation data were statistically analyzed using the *F* test with a 95% confidence level to determine the effect of treatment. If the results of the analysis showed a significant difference, the analysis was continued with Duncan's Multiple Range Test (DMRT) at the 95% confidence level.*

The results showed that the application of 2 t/ha of biochar with 2.5 t/ha of organic fertilizer increased stomatal density by 30.03% and total stomata by 30%. Increasing the biochar dose up to 6 t/ha can increase chlorophyll a by 1.78%, total chlorophyll by 2.38%, grain number by 4.44%, grain weight by 8.80%, grain weight per plant by 8.89%, and yield by 5.92%. Increasing the organic fertilizer dose to 10 t/ha increased chlorophyll b by 3.53%, productive tiller number by 9.26%, grain weight percentage by 2.67%, 1000 grain weight by 3.12%, dry weight of the generative phase canopy by 7.07%, and harvest index by 1.75%. Increasing

the biochar and organic fertilizer doses to 4 t/ha and 5 t/ha, respectively, reduced the number of empty grains by 24,10%, empty grain weight by 20,50%, and the percentage of empty grain weight by 21,77%. Applying biochar at a dose of 4 t/ha can reduce soil Pb levels by 21,27%. Organic fertilizer at a dose of 2,5 t/ha reduced soil Pb levels by up to 15,77%. Meanwhile, increasing the biochar dose to 6 t/ha reduced soil Cd levels by up to 56,88%. Applying organic fertilizer at a dose of 5 t/ha reduced soil Cd levels by up to 59,94%.

