

RINGKASAN

Jawa Tengah merupakan produsen kentang terbesar kedua di Indonesia yang umumnya berada di kawasan dataran tinggi, seperti di Desa Pekasiran, Kecamatan Batur, Kabupaten Banjarnegara. Produktivitas kentang di Kecamatan Batur pada tahun 2024 mencapai 1,83 ton/ha. Produksi kentang di tentunya memerlukan upaya intensifikasi untuk mempertahankan produktivitas pertanaman kentang seperti pupuk dan pestisida kimia sintetik namun upaya tersebut dapat mengakibatkan pencemaran logam berat timbal dan kadmium di lingkungan pertanian sehingga perlu diatasi dengan melakukan remediasi menggunakan mikroorganisme maupun tanaman.

Pseudomonas spp. juga memiliki kemampuan untuk mengikat logam berat. *Pseudomonas* spp. dapat melakukan pengasaman dengan menghasilkan asam organik (asam sitrat, malat, oksalat, glukonat, dan asetat) dimana asam organik dapat mengkhelasi kation logam berat, serta menggantinya dengan melarutkan unsur hara esensial.

Cendawan *Dark Septate Endophytes* (DSE) dapat ditemukan pada kondisi dengan kontaminasi logam berat dan dapat menurunkan toksisitas logam berat. Cendawan DSE juga memproduksi enzim hidrolisis untuk menginduksi pelepasan nutrisi sehingga dapat tersedia bagi tanaman, serta senyawa organik pada cendawan DSE dapat ditransfer langsung ke tanaman sehingga nutrisi organik dapat dimanfaatkan untuk tanaman.

Serai wangi (*Cymbopogon nardus* L.) merupakan tanaman dari famili *Gramineae* (rumput-rumputan) yang masih satu famili dengan akar wangi. Serai wangi dapat berperan untuk fitoremediasi dalam menyerap logam berat kemudian di lokalisasi pada bagian sel atau jaringan tanaman.

Penelitian ini bertujuan untuk mengetahui pengaruh *Pseudomonas* spp., cendawan DSE, dan serai wangi terhadap potensi dalam produksi tanaman kentang serta potensi bioremediasi logam berat kadmium dan timbal. Penelitian ini diharapkan dapat memberikan informasi dan menjadi rekomendasi terkait penggunaan *Pseudomonas* spp., cendawan DSE, dan serai wangi dalam meningkatkan produksi tanaman kentang dan menurunkan logam berat kadmium dan timbal.

Penelitian ini dilaksanakan di Desa Pekasiran, Kecamatan Batur, Kabupaten Banjarnegara, Provinsi Jawa Tengah; Laboratorium Tanah dan Perencanaan Sumberdaya Lahan, Fakultas Pertanian, Universitas Jenderal Soedirman; Laboratorium Pusat Riset Mikrobiologi Terapan, Badan Riset dan Inovasi Nasional pada bulan Juni 2024 sampai dengan Desember 2024. Penelitian didesain dengan menggunakan Rancangan Acak Kelompok non faktorial dengan 8 perlakuan dan 4 ulangan berupa: A = kontrol, B = *Pseudomonas* spp., C = cendawan DSE, D = serai wangi, E = *Pseudomonas* spp. + serai wangi, F = cendawan DSE + serai wangi, G = *Pseudomonas* spp. + cendawan DSE, H = *Pseudomonas* spp. + cendawan DSE + serai wangi. Variabel yang diamati berupa jumlah umbi, bobot umbi total, bobot umbi satuan, diameter umbi, produktivitas kentang, pH tanah, Cd tanah, Cd kentang, BCF Cd, Pb tanah, Pb kentang, BCF Pb.

Metode pengukuran kandungan logam berat diukur menggunakan *Atomic Absorption Spectroscopy* (AAS) Hitachi Z-2000. Metode tersebut dipilih karena hasil pengukuran yang akurat, cepat, dan biaya lebih murah. Metode ekstraksi sampel dengan metode pengabuan basah dengan pelarut HNO_3 dan HClO_4 . Sampel, deret standar kadmium (0,01 ppm, 0,02 ppm, 0,04 ppm, 0,06 ppm, 0,08 ppm), deret standar timbal (0,1 ppm, 0,5 ppm, 1 ppm, 2 ppm, 4 ppm) diukur menggunakan AAS. Hasil perbandingan antara logam berat kentang dan logam berat tanah dihitung untuk menentukan biokonsentrasi faktor (BCF).

Hasil penelitian menunjukkan bahwa perlakuan berpengaruh nyata terhadap produksi kentang. Cendawan DSE dapat menghasilkan bobot umbi total sebesar 870 gram atau meningkatkan 13,10% dibandingkan kontrol. Cendawan DSE dapat menghasilkan bobot umbi satuan sebesar 163 gram atau meningkatkan 25,14% dibandingkan kontrol. Cendawan DSE dapat menghasilkan diameter umbi sebesar 6,5 cm atau meningkatkan 13,04% dibandingkan kontrol. Cendawan DSE dapat menghasilkan produktivitas kentang sebesar 21,75 ton/ha atau meningkatkan 13,10% dibandingkan kontrol.

Hasil penelitian menunjukkan bahwa perlakuan berpengaruh nyata terhadap remediasi logam berat. *Pseudomonas* spp. dapat menghasilkan Pb kentang sebesar 4,291 ppm atau menurunkan 45,24% dibandingkan kontrol. *Pseudomonas* spp. dapat menghasilkan BCF Pb sebesar 0,230 atau menurunkan 33,33% dibandingkan kontrol. *Pseudomonas* spp. dan serai wangi dapat menghasilkan Cd kentang sebesar 0,226 ppm atau menurunkan 5,04% dibandingkan kontrol. *Pseudomonas* spp. dan serai wangi dapat menghasilkan BCF Cd sebesar 0,932 atau menurunkan 6,80% dibandingkan kontrol. *Pseudomonas* spp., cendawan DSE, dan serai wangi dapat menghasilkan Pb tanah sebesar 16,604 ppm atau menurunkan 27,64% dibandingkan kontrol.

Hasil uji korelasi menunjukkan terdapat beberapa korelasi antar variabel. Bobot umbi total berkorelasi sangat kuat positif dengan produktivitas kentang, sehingga semakin besar bobot umbi total maka semakin besar produktivitas kentang. Cd tanah berkorelasi sangat kuat negatif dengan BCF Cd, sehingga semakin besar Cd tanah maka semakin kecil BCF Cd dan sebaliknya. Pb kentang berkorelasi sangat kuat positif dengan BCF Pb, sehingga semakin besar Pb kentang maka semakin besar BCF Pb. Terdapat korelasi antara produksi kentang dan remediasi logam berat diantaranya terdapat korelasi kuat positif pada bobot umbi satuan dengan Pb kentang serta bobot umbi satuan dengan BCF Pb, sehingga semakin besar Pb kentang dan BCF Pb maka semakin besar bobot umbi satuan.

Kata kunci : cendawan DSE, kentang, logam berat, *Pseudomonas* spp., serai wangi.

SUMMARY

Central Java is the second-largest potato producer in Indonesia, primarily located in highland areas, such as Pekasiran Village, Batur District, Banjarnegara Regency. Potato productivity in Batur District reached 1.83 tons/ha in 2024. Potato production certainly requires intensification efforts to maintain crop productivity, such as the use of synthetic chemical fertilizers and pesticides. However, these efforts can lead to heavy metal contamination with lead and cadmium in the agricultural environment, requiring remediation using microorganisms and plants.

Pseudomonas spp. also have the ability to bind heavy metals. *Pseudomonas* spp. can acidify by producing organic acids (citric, malic, oxalic, gluconic, and acetic), which can chelate heavy metal cations and replace them by dissolving essential nutrients.

Dark Septate Endophytes (DSE) fungi can be found in conditions with heavy metal contamination and can reduce heavy metal toxicity. DSE fungi also produce hydrolytic enzymes to induce the release of nutrients, making them available to plants. Organic compounds in DSE fungi can be transferred directly to plants, allowing them to utilize these nutrients.

Citronella grass (*Cymbopogon nardus* L.) is a plant from the Gramineae (grass) family, which is related to vetiver. Citronella grass can play a role in phytoremediation by absorbing heavy metals and then localizing them within plant cells or tissues.

This study aimed to determine the effects of *Pseudomonas* spp., DSE fungi, and citronella grass on potato production potential and the bioremediation potential of cadmium and lead heavy metals. This research is expected to provide information and recommendations regarding the use of *Pseudomonas* spp., DSE fungi, and citronella grass to increase potato production and reduce cadmium and lead heavy metals.

This research was conducted in Pekasiran Village, Batur District, Banjarnegara Regency, Central Java Province; Soil and Land Resource Planning Laboratory, Faculty of Agriculture, Jenderal Soedirman University; Applied Microbiology Research Center Laboratory, National Research and Innovation Agency from June 2024 to December 2024. The study was designed using a non-factorial Randomized Block Design with 8 treatments and 4 replications in the form of: A = control, B = *Pseudomonas* spp., C = DSE fungi, D = citronella grass, E = *Pseudomonas* spp. + citronella grass, F = DSE fungi + citronella grass, G = *Pseudomonas* spp. + DSE fungi, H = *Pseudomonas* spp. + DSE fungi + citronella grass. The variables observed were the number of tubers, total tuber weight, unit tuber weight, tuber diameter, potato productivity, soil pH, soil Cd, potato Cd, BCF Cd, soil Pb, potato Pb, BCF Pb.

Heavy metal content was measured using Hitachi Z-2000 Atomic Absorption Spectroscopy (AAS). This method was chosen due to its accuracy, speed, and low cost. Sample extraction was carried out using wet ashing with HNO_3 and HClO_4 solvents. Samples, a cadmium standard series (0.01 ppm, 0.02 ppm, 0.04 ppm, 0.06 ppm, 0.08 ppm), and a lead standard series (0.1 ppm, 0.5 ppm, 1 ppm, 2 ppm, and 4 ppm) were measured using AAS. The ratio of potato heavy metals to soil heavy metals was calculated to determine the bioconcentration factor (BCF).

The results showed that the treatments significantly affected potato yield. The DSE fungi produced a total tuber weight of 870 grams, a 13.10% increase compared to the control. The DSE fungi produced a unit tuber weight of 163 grams, a 25.14% increase compared to the control. The DSE fungi produced a tuber diameter of 6.5 cm, a 13.04% increase compared to the control. The DSE fungi produced a potato yield of 21.75 tons/ha, a 13.10% increase compared to the control.

The results showed that the treatments significantly affected heavy metal remediation. *Pseudomonas* spp. produced 4.291 ppm of potato Pb, a 45.24% reduction compared to the control. *Pseudomonas* spp. produced a BCF of Pb of 0.230, a 33.33% reduction compared to the control. *Pseudomonas* spp. and citronella grass produced 0.226 ppm of potato Cd, a 5.04% reduction compared to the control. *Pseudomonas* spp. and citronella grass produced a BCF of Cd of 0.932, a 6.80% reduction compared to the control. *Pseudomonas* spp., DSE fungi, and citronella grass produced 16.604 ppm of soil Pb, a 27.64% reduction compared to the control.

Correlation test results showed several correlations between variables. Total tuber weight correlated strongly positively with potato productivity, so that the greater the total tuber weight, the greater the potato productivity. Soil Cd correlated strongly negatively with BCF Cd, so that the greater the soil Cd, the lower the BCF Cd, and vice versa. Potato Pb correlated strongly positively with BCF Pb, so that the greater the potato Pb, the greater the BCF Pb. There was a correlation between potato production and heavy metal remediation, including a strong positive correlation between unit tuber weight and potato Pb and unit tuber weight and BCF Pb. Thus, the greater the potato Pb and BCF Pb, the greater the unit tuber weight.

Keywords : citronella grass, DSE fungi, heavy metal, potato, *Pseudomonas* spp.

