INTISARI

Penelitian ini bertujuan mengkaji mekanisme toleransi tanaman kedelai [*Glycine max* (L.) Merr. cv. Grobogan] terhadap cekaman ganda, yaitu cekaman biotik berupa interferensi teki (*Cyperus rotundus* L.) dan cekaman abiotik berupa kekeringan. Penelitian mencakup (1). keterkaitan antara kandungan asam absisat (ABA) dan asam salisilat (AS) dengan toleransi tanaman kedelai dengan metode HPLC, (2). kandungan ROS yang tebentuk dan sistem pertahanan antioksidatif dengan metode spektrofotometri (3). aktivitas enzim PAL dan komposisi fenolik dengan metode HPLC, (4). perubahan anatomis dan (5). perubahan fisiologis dengan metode gravimetri dan spektofotometri. Penelitian menggunakan metode eksperimental dengan rancangan acak lengkap pola faktorial (3X3). Faktor pertama adalah tingkat interferensi teki (0, 3 dan 6 teki) dan faktor kedua adalah tingkat cekaman kekeringan (FTSW 1, FTSW 0,5 dan FTSW 0,25). Masing-masing perlakuan dengan lima ulangan. Parameter yang diamati adalah konsentrasi ABA dan AS, kandungan glutathion, asam askorbat, fenol total, prolin, klorofil a, klorofil b, karotenoid, O_2^- dan H_2O_2, aktivitas enzim SOD, CAT, APX dan PAL, komposisi fenolik, pertumbuhan tanaman dan struktur anatomi akar, batang dan daun. Hasil penelitian menunjukkan interferensi teki pada kondisi cekaman kekeringan menyebabkan kandungan AS dan ABA pada daun kedelai meningkat. Kandungan O_2^- meningkat pada semua kombinasi perlakuan, namun kenaikan H_2O_2 hanya terjadi pada perlakuan interferensi tiga atau enam teki tanpa cekaman kekeringan (FTSW 1) dan pada kekeringan ringan (FTSW 0,5), sedangkan pada kombinasi cekaman yang lain kandungan H_2O_2 turun. Pada cekaman ganda interferensi teki dan kekeringan, aktivitas SOD, CAT dan APX cenderung turun dengan naiknya tingkat interferensi teki, sebaliknya aktivitas enzim cenderung naik dengan meningkatnya tingkat cekaman kekeringan. Kandungan glutathion, asam askorbat dan fenol total meningkat dengan naiknya tingkat interferensi teki maupun tingkat cekaman kekeringan. Kandungan prolin meningkat hanya pada kondisi cekaman kekeringan berat tanpa atau dengan interferensi tiga atau enam teki, sedangkan pada kombinasi cekaman yang lain tidak menunjukkan perbedaan yang nyata dibanding kontrol. Aktivitas PAL meningkat pada semua kombinasi perlakuan, namun komposisi fenolik menunjukkan hanya asam vanilat, asam 2,5-dihidroksibenzoat, asam kafeat, asam siringat, asam trans-sinamat dan asam salisilat yang meningkat pada semua kombinasi perlakuan. Kandungan asam 4-hidroksibenzoat dan asam trans-firulat turun dengan naiknya tingkat interferensi teki, sebaliknya meningkat dengan naiknya tingkat cekaman kekeringan. Kandungan asam kumarat meningkat pada kondisi tanpa cekaman kekeringan dengan interferensi tiga atau enam teki, sebaliknya turun pada kekeringan ringan atau berat dengan interferensi tiga atau enam teki. Cekaman ganda interferensi teki dan kekeringan menyebabkan penurunan kandungan klorofil a, klorofil b dan karotenoid, penurunan pertumbuhan, penurunan diameter sel xilem akar, batang, daun dan penurunan panjang sel penutup stoma, peningkatan tebal dinding sekunder sel xilem akar, batang dan daun. Pengaruh kumulatif cekaman

ganda terhadap pertumbuhan tanaman kedelai bersifat *cross synergism*. Dari nilai nisbah akar tajuk diketahui penghambatan pertumbuhan akar terutama disebabkan oleh interferensi teki, sedangkan penghambatan pertumbuhan tajuk terutama disebabkan oleh cekaman kekeringan. Kemampuan toleransi tanaman kedelai cv. Grobogan terhadap interferensi teki pada kondisi cekaman kekeringan terutama ditentukan oleh peran ABA dan AS serta antioksidan non enzimatis berupa : asam askorbat, glutathion, senyawa fenol dan prolin.

Kata kunci : interferensi gulma, antioksidan, pengaruh komulatif, PAL.

ABSTRACT

The purpose of this research was to study tolerance mechanisms of soybeans [*Glycine max* (L.) Merr. cv. Grobogan] that were subjected to biotic and abiotic stress. The biotic stress was purple nutsedge (*Cyperus rotundus* L.) interference whereas the abiotic stress was drought. The research includes (1) the relationship between abscisic acid (ABA) and salicylic acid (SA) content with the tolerance of soybean plants with the HPLC method; (2) the reactive oxygen species (ROS) content that was formed and antioxidative defense systems with the spectrophotometry method; (3) phenylalanine ammonia-lyase (PAL) enzyme activity and phenolic composition with the HPLC method; (4) anatomical and (5) physiological changes that occur due to multiple stress by purple nutsedge interference and drought with gravimetriy and spectrophotometry method. Research was conducted using experimental methods with a completely randomized factorial design (3X3). The first factor was purple nutsedge interference level (0, 3 or 6 purple nutsedge) and the second factor was drought stress level (FTSW 1, FTSW 0.5 or FTSW 0.25). Each treatment was applied with five replications. The parameters measured were (1) concentrations of ABA, SA, glutathione, ascorbic acid, total phenols, proline, chlorophyll a, chlorophyll b, carotenoids, O_2^- and H_2O_2; (2) the activity of superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX) and PAL enzyms and (3) the growth and the anatomical structure of roots, stems and leaves. The results showed that multiple stresses of purple nutsedge interference and drought caused increase of ABA and SA content.The content of O_2^- increased in all treatment combinations, but the increase of H_2O_2 occurred for trials on clusters of three or six purple nutsedge plants and on interference with field capacity and a mild drought treatment only. The H_2O_2 content decreased in the other stress combinations. In the multiple stress treatments with purple nutsedge interference and drought, SOD, CAT and APX activity tended to decrease with the increase of purple nutsedge interference levels, otherwise SOD, CAT and APX activity tended to increase with the increase in drought stress levels. The content of glutathione, ascorbic acid and total phenols increased with the increase of purple nutsedge interference levels and drought stress levels. The proline content increased in severe drought stress conditions, with or without of three or six purple nutsedge interference. PAL activity increased in all treatment combinations, but only vanillic acid, 2,5-dihidrxybenzoic acid, caffeic acid, syringic acid, trans-cinnamic acid and salicylic acid increased in all treatment combinations. The content of 4-hydroxybenzoic acid and trans-ferulic acid decreased with the increase of the purple nutsedge interference treatment level, but increased

when the drought stress levels were increased. Coumaric acid increased in all treatment when stress with three or six nutsedge plant interference was applied without drought stress conditions. Otherwise coumaric acid decreased in mild or severe drought conditions when combined with three or six purple nutsedge interference. The multiple stress of purple nutsedge interference and drought caused a decrease of chlorophyll a, chlorophyll b and carotenoids, growth, xylem cells diameter of roots, stems, leaves and length of stoma cover cell, but increased thickness of secondary xylem cell walls of roots, stems and leaves. Cumulative effect of multiple stress on the growth of soybean plants was cross synergism. Root/shoot ratio value showed that root growth inhibition correlated mainly with purple nutsedge interference, whereas shoot growth inhibition was mainly correlated with drought stress. Soybean cv. Grobogan plants tolerance ability against multiple stress of purple nutsedge interference and drought was mainly determined by the role of the ABA and the SA as well as non-enzymatic antioxidants such as ascorbic acid, glutathione, phenol compounds and proline.

Keywords : weed interference, antioxidants, cumulative effect, PAL.