

MORPHOLOGICAL AND PHYSIOLOGICAL RESPONSES OF BANANA (*Musa sp.*) GENOTYPES SUBJECTED TO DROUGHT STRESS

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**AGRONOMY AND HORTICULTURE STUDY PROGRAM
FACULTY OF AGRICULTURE
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SUMMARY

VILLIAN TOUMAE. Morphological and Physiological Responses of Banana (*Musa* sp.) Genotypes Subjected to Drought Stress. Supervised by EDI SANTOSA as first SUPERVISOR and Eva Erdayani as second SUPERVISOR.

The nutritional and economic value of bananas (*Musa spp.*) makes them one of the most important fruit crops globally and highly valued. Banana plants have extensive root systems for water and nutrient uptake but are highly susceptible to drought stress, which affects the plant's growth, physiological performance, as well as productivity. This study aimed to evaluate the impact of different watering frequencies: watering 8x/month (L1), 4x/month (L2), 2x/month (L3), 1x/month (L4), on the morphophysiological responses and drought tolerance of three *Musa* genotypes, including Cavendish (V1), Tanduk (V2), and Pisang Awak (CV3), was investigated, in experiment one, while experiment two was the continuation of the selected drought treatment (L3) to test wild banana (*Musa acuminata*) genotype tolerance.

The experiment was conducted under greenhouse conditions using a nested experimental design with three replications. Four watering frequencies were imposed over two months: eight times per month (L1, well-watered control), four times per month (L2), twice per month (L3), and once per month (L4). Watering frequency was treated as the main factor, while genotype was nested within each watering treatment. Morphological parameters, including plant height, leaf number, pseudostem diameter, biomass, root length, root number, and leaf area, were measured together with physiological characteristics such as photosynthetic rate, stomatal conductance, intrinsic water-use efficiency (iWUE), chlorophyll fluorescence, chlorophyll content, stomatal density, and relative water content. Biochemical indicators, including malondialdehyde (MDA) and proline content, as well as plant survival percentage, were also determined.

Results show that frequency of watering had a dramatic impact on most of the morphological, physiological, and biochemical characteristics. Plants subjected to L3 and L4 were severely impacted by drought, experiencing low growth, reduced biomass accumulation, low photosynthetic activity, and inadequate chlorophyll fluorescence compared to plants grown under L1 and L2. Different genetic varieties responded to moderate drought differently. When the stress was moderate (L3), Pisang Awak (V3) performed better according to morphological attributes, while Cavendish (V1) did considerably well when well-watered (L1). When stressed by drought (L4), Pisang Tanduk (V2) performed better than Cavendish (V1) in physiological processes, whereas all three varieties behaved similarly under L3.

Among the tested treatments, treatment L3, watering twice a month, was found to be the most effective in inducing drought stress in the bananas and was suitable for evaluating drought tolerance. Under treatment L3, visible drought symptoms in the plants were observed three to four weeks after treatment.

Keywords: chlorophyll fluorescence, malondialdehyde, net photosynthesis, proline, relative water content



RINGKASAN

VILLIAN TOUMAE. Respons Morfologi dan Fisiologi Tanaman Pisang (*Musa sp.*) terhadap Cekaman Kekeringan. Dibimbing oleh EDI SANTOSA dan EVA ERDAYANI.

Tanaman pisang (*Musa spp.*) adalah tanaman perennial yang memiliki sistem perakaran yang luas untuk penyerapan nutrisi dan kelembapan, namun tetap sangat rentan terhadap cekaman kekeringan. Penelitian ini menilai dampak frekuensi penyiraman terhadap respons morfofisiologis dari tiga genotipe *Musa*, Cavendish (V1), Tanduk (V2), Pisang Awak (V3) yang diberi empat frekuensi penyiraman selama dua bulan dengan tiga ulangan: penyiraman delapan kali sebulan (kontrol L1), empat kali sebulan (L2), dua kali sebulan (L3), dan sekali sebulan (L4).

Penelitian ini dilaksanakan di Rumah Kaca Kebun Percobaan Cikabayan, Bogor, pada bulan Desember 2025 sampai Maret 2026. Percobaan ini disusun menggunakan Rancangan Acak Lengkap Bersarang dengan dua faktor: penyiraman (faktor utama) dan genotipe (faktor bersarang). Peubah yang diamati meliputi sifat pertumbuhan tanaman: (tinggi, jumlah daun, diameter batang semu, biomassa, panjang akar, jumlah akar, luas daun), respons fisiologis (fotosintesis, fluoresensi klorofil, kandungan klorofil, kepadatan stomata, kandungan air relatif), respons biokimia (malondialdehida, prolin), dan persentase kelangsungan hidup tanaman (*survival percentage*).

Hasil penelitian menunjukkan bahwa penyiraman secara signifikan memengaruhi peubah-peubah tersebut, di mana L3 dan L4 menyebabkan cekaman kekeringan yang parah yang menunjukkan nilai rata-rata lebih rendah dibandingkan dengan L1 dan L2 (Tabel 3 – 8). Perbandingan genotipe bersarang dalam 4 taraf penyiraman menunjukkan bahwa Pisang Awak (V3) menunjukkan toleransi kekeringan yang lebih tinggi berdasarkan respons morfologis pada frekuensi penyiraman dua kali per bulan (L3). Secara fisiologis, ketiga genotipe tersebut menunjukkan respons serupa pada penyiraman dua kali sebulan (L3), sedangkan pada penyiraman satu kali per bulan (L4), Pisang Tanduk (V2) lebih toleran daripada Pisang Cavendish (V1). Frekuensi penyiraman dua kali per bulan (L3) diidentifikasi sebagai perlakuan yang paling ideal untuk menyeleksi toleransi terhadap cekaman kekeringan, karena mampu memicu gejala awal kekeringan dalam waktu tiga hingga empat minggu setelah perlakuan. Perlakuan ini menghasilkan perbedaan yang nyata antartingkat frekuensi penyiraman pada berbagai karakter morfofisiologis, meliputi tinggi tanaman, jumlah daun, diameter batang semu, biomassa, konduktansi stomata, laju fotosintesis, efisiensi penggunaan air intrinsik (iWUE), serta fluoresensi klorofil, sekaligus mempertahankan tingkat kelangsungan hidup tanaman yang memadai sehingga memungkinkan perbandingan yang bermakna antargenotipe.

Kata kunci: fluorosensi klorofil, Malondialdehyde, laju photosintesis, Prolin, kandungan air relatif

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VILLIAN TOUMAE

Thesis

As one of the requirements for accomplishing a degree of
Masters of Science in
Agronomy and Horticulture Study Program

**AGRONOMY AND HORTICULTURE STUDY PROGRAM
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Bogor, August 2026

Villian Toumae



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