

## **IMPLEMENTASI SISTEM *MONITORING* PERGERAKAN TANAMAN UNTUK MENDETEKSI KONDISI ABNORMAL PADA JERUK (*Citrus sp.*)**

### **INTISARI**

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Jam biologis tanaman mengatur berbagai aktivitas harian tanaman mulai dari tingkat gen. Jam biologis akan membentuk ritme harian dengan periode mendekati 24 jam yang disebut dengan ritme sirkadian. Ritme sirkadian biasanya membentuk gelombang sinusoidal yang dapat dideskripsikan kedalam bentuk matematika meliputi: periode, amplitudo, frekuensi, dan fase. Pada penelitian sebelumnya, telah didesain dan dikembangkan sistem monitoring pergerakan tanaman berupa *automatic growth chamber*, untuk menganalisis ritme sirkadian pada tanaman. Namun, penelitian mengenai pengaruh infeksi patogen/virus terhadap tanaman belum dilakukan untuk mengimplementasikan sistem yang telah dibuat. Tujuan dari penelitian ini yaitu untuk mengimplementasikan sistem *monitoring* pergerakan tanaman untuk mendeteksi kondisi abnormal pada tanaman jeruk yang terinfeksi virus tristeza dan menganalisis pengaruhnya berdasarkan ritme sirkadian. Pada penelitian ini diamati dua tanaman jeruk dengan kondisi normal dan terinfeksi virus tristeza didalam dua buah *automatic growth chamber*. *Growth chamber* tersebut diatur untuk dapat mengambil data citra setiap interval waktu 30 menit dari dua proyeksi kamera yaitu atas dan samping. Data citra selanjutnya dianalisis menggunakan *software* pycharm dengan mengaplikasikan teknik Shi Tomasi dan Lucas Kanade untuk mengestimasi pergerakan tanaman dan memvisualisasikannya kedalam bentuk vektor. Nilai periode, amplitudo, frekuensi dan fase dapat diestimasi dengan bantuan *software* Rstudio dengan menerapkan metode FFT. Dengan menggunakan *software* Rstudio dapat diperoleh visualisasi dari data dalam bentuk grafik ritme dan gelombang. Dilakukan uji Kolmogorov Smirnov untuk mengetahui kedua sampel data berbeda atau tidak. Dari analisis yang dilakukan diketahui tanaman jeruk normal bergerak lebih aktif dan perpindahannya lebih besar dari tanaman jeruk terinfeksi tristeza dengan nilai amplitudo 63,61 px. Tanaman jeruk terinfeksi CTV mengalami *delay* gerakan, dibuktikan dengan nilai beda fase sebesar 0,492645. Hasil uji Kolmogorov Smirnov menunjukkan perbedaan gerakan antar kedua tanaman.

Kata kunci: ritme sirkadian, jam biologis, aliran optik, *Automatic Growth Chamber*, virus tristeza

## **IMPLEMENTATION OF PLANT MOTION MONITORING SYSTEM TO DETECT ABNORMAL CONDITIONS IN *Citrus sp.***

### **ABSTRACT**

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The plant biological clock regulates the various daily activities of the plant from the gene level. The biological clock can be detected in all types of plants under a wide variety of conditions. The biological clock will form a daily rhythm with a period of nearly 24 hours called the circadian rhythm. Circadian rhythms usually form sinusoidal waves which can be described in the mathematical form: period, amplitude, frequency, and phase. In previous research, a plant movement monitoring system in the form of an automatic growth chamber was designed and developed to analyze circadian rhythms in plants. However, research on the effect of pathogenic / virus infections on plants has not been carried out to implement a system that has been created. This study aims to implement a plant movement monitoring system to detect abnormal conditions in citrus plants infected with the Tristeza virus and to analyze its effects based on circadian rhythms. In this study, two citrus plants with normal conditions and infected with the Tristeza virus were observed in two automatic growth chambers. The growth chamber is set to be able to capture image data every 30 minutes from two camera projections (the top and the side projection). Image data is analyzed using pycharm software by applying the Shi Tomasi and Lucas Kanade techniques to estimate the displacement of plants and visualize them in vector form. The value of the period, amplitude, frequency, and phase can be estimated using Rstudio software by applying the FFT method. By using Rstudio software, data visualization is obtained in the form of rhythm and wave charts. The Kolmogorov Smirnov test was conducted to determine whether the two data samples were different or not. From the analysis, it is known that normal citrus plants move more actively and their displacement is greater than citrus plants infected with Tristeza with an amplitude value of 63.61 px. Citrus plants infected with CTV experienced a movement delay, as evidenced by the phase difference value of 0.492645. The Kolmogorov Smirnov test results showed differences in movement between the two plants.

**Keywords:** Circadian rhythm, biological clock, optical flow, plant motion monitoring system, citrus tristeza virus