OPTIMALISASI PENGGUNAAN MULSA DAN PUPUK UNTUK PENGURANGAN EMISI NITROUS OKSIDA (N_2O) DI LAHAN PERTANIAN BUDIDAYA TANAMAN CABAI (*Capsicum annum* L.): ANALISIS KOMPARATIF MODEL STATISTIK KLASIK DAN *MACHINE LEARNING*

INTISARI
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Sektor pertanian merupakan salah satu penyumbang utama emisi gas rumah kaca (GRK), khususnya nitrous oksida(N_2O) yang memiliki potensi penyebab pemanasan global. Penelitian ini mengevaluasi interaksi jenis pupuk (organik dan anorganik) dan mulsa (tanpa, organik, anorganik) terhadap emisi N_2O pada budidaya cabai (*Capsicum annuum* L.) di Kapanewon Mlati dan Pakem, Sleman. Penelitian menggunakan Rancangan Acak Kelompok (RAK) dengan 3 ulangan, sehingga total terdapat 24 plot. Emisi N_2O diukur menggunakan metode *closed chamber*, dan dianalisis menggunakan *Gas Chromatography*. Hasil penelitian menunjukkan adanya perbedaan emisi N_2O antara lokasi Mlati dan Pakem. Analisis statistik mengungkapkan bahwa di Mlati, jenis pupuk, mulsa, serta interaksi antara pupuk dan mulsa berpengaruh signifikan terhadap emisi N_2O. Sementara itu, di Pakem, hanya faktor mulsa dan interaksi antara pupuk dan mulsa yang memberikan pengaruh signifikan terhadap emisi N_2O. Selanjutnya, kombinasi pupuk dan mulsa organik (P1M1) menghasilkan emisi lebih rendah dibandingkan dengan kombinasi pupuk dan mulsa anorganik (P2M2) di kedua lokasi, yaitu 0,208 mg N_2O m^{-2} jam^{-1} di Pakem dan 0,693 mg N_2O m^{-2} jam^{-1} di Mlati, dengan penurunan emisi dibandingkan P2M2 sebesar 76,96% (Pakem) dan 50,40% (Mlati). Analisis PCA dan korelasi menunjukkan bahwa di Mlati, emisi N_2O sangat dipengaruhi oleh kadar lengas tanah dan nitrogen, serta memiliki hubungan negatif dengan pH tanah. Sebaliknya, di Pakem, kontribusi nitrogen dan curah hujan terhadap emisi N_2O relatif lebih rendah. Model *Random Forest* menunjukkan akurasi yang lebih tinggi dibandingkan dengan *Generalized Linear Model (GLM)* dalam memprediksi emisi N_2O, dengan nilai AUC sebesar 0,934 untuk Mlati dan 0,861 untuk Pakem. Pengelolaan mulsa dan pupuk secara optimal, didukung oleh penerapan model *machine learning*, dapat menjadi strategi mitigasi emisi gas rumah kaca (GRK) yang efektif dan presisi, serta berkontribusi terhadap pengembangan pertanian berkelanjutan di wilayah tropis.

Kata Kunci : Cabai keriting, emisi N_2O, pupuk, mulsa, akurasi model

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OPTIMIZATION OF MULCH AND FERTILIZER USE FOR REDUCING NITROUS OXIDE (N_2O) EMISSIONS IN CHILI (*Capsicum Annum* L) CULTIVATION: A COMPARATIVE ANALYSIS OF CLASSICAL STATISTICAL AND MACHINE LEARNING MODELS

ABSTRACT

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The agricultural sector is one of the main contributors to greenhouse gas (GHG) emissions, particularly nitrous oxide (N_2O), which has the potential to cause global warming. This study evaluated the interaction between fertilizer types (organic and inorganic) and mulch (none, organic, and inorganic) on N_2O emissions in chili (Capsicum annuum L.) cultivation in Kapanewon Mlati and Pakem, Sleman. The study used a randomized block design with three replicates, resulting in a total of 24 plots. N_2O emissions were measured using the closed chamber method and analyzed using Gas Chromatography. The results showed differences in N_2O emissions between the Mlati and Pakem locations. Statistical analysis revealed that in Mlati, fertilizer type, mulch, and the interaction between fertilizer and mulch had a significant effect on N_2O emissions. Furthermore, the combination of organic fertilizer and mulch (P1M1) produced lower emissions compared to the combination of inorganic fertilizer and mulch (P2M2) at both locations, namely 0.208 mg N_2O m^{-2} $hour^{-1}$ in Pakem and 0.693 mg N_2O m^{-2} $hour^{-1}$ in Mlati, with a 76.96% reduction in emissions compared to P2M2 (Pakem) and 50.40% (Mlati). PCA and correlation analyses revealed that in Mlati, N_2O emissions were strongly influenced by soil moisture and nitrogen content and had a negative relationship with soil pH. Conversely, in Pakem, the contribution of nitrogen and rainfall to N_2O emissions was relatively lower. The Random Forest model showed higher accuracy than the Generalized Linear Model (GLM) in predicting N_2O emissions, with an AUC value of 0.934 for Mlati and 0.861 for Pakem. Optimal mulch and fertilizer management, supported by the application of machine learning models, can be an effective and precise greenhouse gas (GHG) emission mitigation strategy, as well as contribute to the development of sustainable agriculture in tropical regions.

Keywords**:** Curly chilli, N_2O emissions, fertiliser, mulch, model accuracy

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