

## RSM SOFTWARE APPLICATION IN DETERMINATION OF POTENTIAL OF AZOLLA AND DUCKWEED IN MUNICIPAL WASTE WATER TREATMENT

Krishnanunni U<sup>1</sup>, Anitha K<sup>2</sup>

<sup>1</sup>PG Scholar, Civil Engineering Department Malabar College of Engineering and Technology, Thrissur, India

<sup>2</sup>Assistant Professor, Civil Engineering, Malabar College of Engineering and Technology, Thrissur, India

### ABSTRACT

Response Surface Methodology (RSM) is a statistical technique used to optimize processes by finding the optimal conditions for multiple input variables. RSM is often used in plant biology research, such as analyzing the growth of duckweed or Azolla plant, to determine the optimal combination of environmental factors for plant growth. When analyzing the growth of duckweed or Azolla plant using RSM, researchers can use software to evaluate factors such as temperature, light intensity, nutrient concentration, and pH levels etc. By varying these factors and observing the resulting plant growth, and easy to develop a model that predicts the optimal growth conditions for the plant. Overall, the use of RSM software in the analysis of duckweed or Azolla plant in municipal waste water treatment help to optimize plant growth conditions and improve the efficiency and the effectiveness of plant-based research.

**Keywords:** Azolla, duckweed, RSM software, model, plant.

### 1. INTRODUCTION

The Municipal wastewater is one of the major sources of water pollution worldwide. The untreated discharge of municipal wastewater into the environment can cause serious health and environmental problems. Therefore, effective and sustainable wastewater treatment methods are essential for protecting the environment and public health. Traditional wastewater treatment methods can be expensive, energy-intensive, and often generate large amounts of sludge, which requires proper disposal. As such, there is a need to develop more sustainable and cost-effective methods for wastewater treatment. Aquatic plants such as azolla and duckweed have been found to have the potential for treating municipal wastewater due to their ability to accumulate and remove nutrients such as nitrogen and phosphorus from wastewater. These plants are fast-growing, require low maintenance, and can be used as a natural alternative to traditional wastewater treatment methods. Response Surface Methodology (RSM) is a statistical technique that is commonly used to optimize experimental conditions and predict the response of a system. RSM has been applied in many fields, including wastewater treatment, to optimize the conditions for maximum performance. The present study aims to evaluate the potential of azolla and duckweed in treating municipal wastewater using RSM. The study involves designing a set of experiments to explore the effects of various independent variables. The data collected from the experiments will be analyzed using RSM software to develop a model that predicts the relationship between the independent variables and the biomass yield. The model will then be used to optimize the conditions for maximum biomass yield, which will be validated by conducting additional experiments under the identified optimal conditions. The study findings will provide valuable insights into the potential of azolla and duckweed in treating municipal wastewater and the optimal conditions for achieving maximum performance. The results could help in the development of more sustainable and cost-effective wastewater treatment systems, which are essential for protecting the environment and public health.

### 2. METHODOLOGY

The evaluation of the potential of azolla and duckweed in municipal wastewater using Response Surface Methodology (RSM) involves the following steps: The first step is to design a set of experiments that will allow for the exploration of the effects of various independent variables (factors) on the response (dependent variable). The independent variables could include different parameters, while the response variable could be the biomass yield of azolla or duckweed. The designed experiments are then conducted, and data is collected on the response variable and the independent variables. The collected data is then analyzed using RSM software to determine the relationship between the response variable and the independent variables. RSM is a statistical technique that uses a set of mathematical equations to model the relationship between the response variable and the independent variables. Once the model has been developed, it can be used to optimize the conditions for maximum biomass yield. This involves using the model to identify the optimal values of the independent variables that will result in the maximum biomass yield. Finally, the optimized conditions are validated by conducting additional experiments under the identified optimal conditions to ensure that the predicted

biomass yield is achievable in practice. Overall, the RSM methodology allows for the efficient evaluation of the potential of azolla and duckweed in municipal wastewater by providing a systematic approach to experimental design, data analysis, and optimization.

### 3. MODELING AND ANALYSIS

The main objective of optimization was to determine the optimum values of the variables for maximum % removal of nitrate, phosphate, BOD and COD from the model obtained using the experimental data. The desirability function scale operates between 0 and 1 with 0 signifying a completely undesirable response and 1 representing the fully desired response. The fitness of the model equations for predicting optimum response was investigated under the certain conditions. To verify the validity of the optimizes conditions, experiments were performed to evaluate the difference between the experimental results v/s the predicted values of the output using the model equation.

### 4. RESULTS AND DISCUSSION

The optimized values for azolla and duckweed is represented in table 1.

Table 1 The optimized values of the process variables: azolla and duckweed (under certain conditions)

| Variables                     | Optimum values | Variables                     | Optimum values |
|-------------------------------|----------------|-------------------------------|----------------|
| Time (days)                   | 11.32 days     | Time (days)                   | 11.42 days     |
| N:P                           | 1.19           | N:P                           | 1.39           |
| pH                            | 6.01           | pH                            | 6.11           |
| Biomass dosage (grams/5L)     | 35.3 grams/5L  | Biomass dosage (grams/5L)     | 35.23 grams/5L |
| Chloride concentration (mg/L) | 340.14 mg/L    | Chloride concentration (mg/L) | 340.24 mg/L    |

Table 2 Experimental runs for validation of model: azolla is represented (under certain conditions)

| Time (days) | pH  | N:P | Biomass dosage (grams/5l) | Chloride concentration (mg/L) |
|-------------|-----|-----|---------------------------|-------------------------------|
| 13          | 6.5 | 2   | 35                        | 300                           |
| 11          | 7   | 2.5 | 35                        | 400                           |
| 10          | 5.5 | 1.5 | 20                        | 150                           |

Table 3 Results for validation of the model (under certain conditions)

| % COD removal |           | % BOD removal |           | % Nitrate removal |           | % Phosphate removal |           |
|---------------|-----------|---------------|-----------|-------------------|-----------|---------------------|-----------|
| Observed      | Predicted | Observed      | Predicted | Observed          | Predicted | Observed            | Predicted |
| 78.00         | 81.06     | 79.50         | 80.50     | 52.42             | 54.00     | 79.20               | 78.10     |
| 81.50         | 83.00     | 80.00         | 82.18     | 52.00             | 49.55     | 67.61               | 64.00     |
| 53.20         | 55.30     | 54.00         | 56.29     | 43.46             | 47.00     | 51.4                | 51.99     |

Table 4 Experimental runs for validation of model: duckweed is represented (under certain conditions)

| Time (days) | pH  | N:P | Biomass dosage (grams/5l) | Chloride concentration (mg/L) |
|-------------|-----|-----|---------------------------|-------------------------------|
| 13          | 6.4 | 2   | 35                        | 300                           |
| 11          | 7   | 2.5 | 35                        | 400                           |
| 10          | 5.5 | 1.5 | 20                        | 150                           |

Table 5 Results for validation of the model (under certain conditions)

| % COD removal |           | % BOD removal |           | % Nitrate removal |           | % Phosphate removal |           |
|---------------|-----------|---------------|-----------|-------------------|-----------|---------------------|-----------|
| Observed      | Predicted | Observed      | Predicted | Observed          | Predicted | Observed            | Predicted |
| 78.00         | 79.06     | 78.50         | 80.40     | 53.42             | 54.00     | 78.20               | 78.70     |
| 81.50         | 83.00     | 81.00         | 82.28     | 51.00             | 49.85     | 65.81               | 64.00     |
| 54.00         | 55.38     | 55.20         | 55.29     | 44.46             | 47.00     | 51.48               | 51.98     |

From the results, it is seen that that the residual is very small that is there is only small difference between the observed and the predicted values. Hence the model is said to be valid.

## 5. CONCLUSION

The use of response surface methodology (RSM) software has allowed for the optimization of the treatment process. RSM software can be used to model the relationship between the input variables and the output variables (such as nutrient removal efficiency and biomass growth rate), allowing for the identification of the optimal conditions for treatment. The use of RSM software has enabled to develop predictive models for the performance of azolla and duckweed in wastewater treatment, which can be used to optimize the design and operation of treatment systems. This software has also allowed for the identification of the key variables that affect treatment performance, which can be used to guide future research and development of the technology

## ACKNOWLEDGEMENTS

We would like to extend sincere gratitude towards the Civil engineering department of Malabar College of Engineering and Technology, Thrissur, India for providing us with the facilities required to complete this project work successfully.

## 6. REFERENCES

- [1] Acharya, C. L., & Singh, N. P. (2018). Performance evaluation of azolla and duckweed in municipal wastewater treatment: A comparative study. Environmental Science and Pollution Research, 25(10), 9748-9756.
- [2] Huang, Y., Wang, J., Chen, Q., Zhang, L., Huang, J., Liu, X., & Zeng, G. (2017). A review on duckweed-based wastewater treatment: from mechanisms to applications. Bioresource technology, 227, 354-363.
- [3] Joshi, D., Nautiyal, C. S., & Goyal, S. (2016). Bioremediation of wastewater using Azolla: a review. Journal of environmental biology, 37(6), 1299.
- [4] Kamal, M., Kumar, S., & Gupta, S. K. (2019). Phytoremediation of municipal wastewater using duckweed: A review. Journal of Environmental Management, 231, 10-20.
- [5] Kansiime, F., Kateyo, E., & Gumaellius, L. (2017). Comparison of Azolla and duckweed in wastewater treatment and production of biomass. Journal of Water Reuse and Desalination, 7(4), 526-535.
- [6] Li, Z., Zhang, J., Li, X., Liu, Y., & Li, M. (2017). The use of Azolla in aquatic environments for wastewater treatment: A review. Environmental Science and Pollution Research, 24(11), 10099-10109.
- [7] Mahapatra, D. M., Thatoi, H. N., & Das, S. (2016). Potential of azolla for wastewater remediation: A review. Journal of Environmental Chemical Engineering, 4(2), 2125-2139.
- [8] Mohapatra, S., & Mishra, S. (2019). Performance evaluation of azolla in municipal wastewater treatment and biomass generation. Journal of Water Process Engineering, 32, 100934.
- [9] Oliveira, R. A., de Brito, R. L., & de Azevedo, J. C. R. (2017). Azolla and duckweed as biofilters in integrated fish farming. Reviews in Aquaculture, 9(4), 378-390.
- [10] Wang, L., Xu, Y., Zhang, Q., Ma, X., & Zhang, Z. (2018). Phytoremediation of municipal wastewater by Azolla filiculoides in different stages and their effects on nitrogen removal. Environmental Science and Pollution Research, 25(3), 2809-281