EVALUATING THE IMPACT OF CARBAMIDE-LOADED DOUBLE EMULSION ON MAIZE GROWTH

G. Gowtham[1], Dr. A. Lakshmanan[2]*, Dr. S. Marimuthu[3], Dr. M. K. Kalarani[4], Dr. D. Amritham[5], Jakku Prasanna[6]

Abstract

Maize (Zea mays L.) is a vital global cereal crop, essential for food security and economic stability. Efficient nutrient management is crucial for enhancing maize yields while minimizing environmental impacts. Conventional urea fertilization faces challenges, including nutrient losses and environmental pollution. This study investigates the potential of carbamide loaded double emulsion as a novel delivery system for maize cultivation. Field experiments, utilizing a Randomized Block Design, evaluated different concentrations of Nano foliar fertilization (carbamide-loaded double emulsion) and conventional urea. Results showed that Nano foliar fertilization, especially at 2%, significantly increased maize plant height and dry matter accumulation, rivaling the effects of conventional urea. These findings highlight the promise of double emulsion technology in optimizing nutrient management, promoting sustainable maize growth, and advancing eco-conscious agricultural practices.

Keywords: *Maize, Double-emulsion, Carbamide*

[1] Ph.D. Scholar, Centre for Agricultural Nanotechnology, TNAU, Coimbatore
[2] *Professor (Rtd.), Centre for Agricultural Nanotechnology, TNAU, Coimbatore
[3] Associate Professor (Agronomy), AC&RI, Eachangkottai, TNAU
[4] Director, Directorate of Crop Management, TNAU, Coimbatore
[5] Assistant Professor (Biochemistry), Department of Biochemistry, CPMB & B, TNAU, Coimbatore
[6] Ph.D. Scholar, Department of Agronomy, TNAU, Coimbatore

***Corresponding Author:** Dr. A. Lakshmanan
*****Email: microlaxman@yahoo.com

DOI: 10.53555/ecb/2024.13.02.17

Introduction:

Maize (*Zea mays* L.) is one of the most vital cereal crops worldwide, serving as a staple food source for millions of people and playing a crucial role in animal feed and industrial applications. The sustainable cultivation of maize is of paramount importance, as it directly affects food security and economic stability. In this context, optimizing nutrient management strategies is essential to enhance maize yields while minimizing environmental impacts.

Fertilizers are a cornerstone of modern agriculture, and carbamide (urea) is among the most commonly used nitrogen fertilizers. However, the efficient utilization of urea in maize cultivation remains a significant challenge due to its susceptibility to various losses, such as volatilization, leaching, and denitrification. These losses not only reduce the effectiveness of the fertilizer but also contribute to environmental pollution and greenhouse gas emissions.

To address these challenges, innovative delivery systems, such as double emulsions, have emerged as potential solutions. Double emulsions are complex systems consisting of an inner core, an intermediate phase, and an outer shell. They have shown promise in protecting and controlling the release of active compounds, including fertilizers, pesticides, and nutrients, in agricultural applications. By encapsulating carbamide within a double emulsion, it is possible to enhance nutrient utilization efficiency, reduce losses, and promote sustainable maize growth.

This research paper aims to evaluate the impact of carbamide-loaded double emulsion on maize growth. Specifically, we have investigated the potential benefits of this novel delivery system in terms of overall crop performance. By conducting a pot and field experiments, we have assessed the effects of carbamide-loaded double emulsion on maize growth parameters, including plant height, leaf area, biomass accumulation, and grain yield.

The findings of this study have the potential to provide valuable insights into the practical application of double emulsion technology in modern agriculture, contributing to more sustainable and efficient maize cultivation practices. Moreover, understanding the advantages of this innovative approach may pave the way for broader adoption of similar delivery systems in the agricultural sector, with implications for enhancing global food security and environmental stewardship.

Material and Methods

A field experiment was conducted at the Eastern Block Farm, located within the Agricultural College and Research Institute of Tamil Nadu Agricultural University in Coimbatore, India. The objective of this experiment was to assess the impact of carbamide loaded double emulsion applied through foliar spraying on maize cultivation.

The experimental design employed in this study followed a Randomized Block Design (RBD), which consisted of six distinct treatments, each of which was replicated three times.

These treatments encompassed different concentrations of the Nano foliar fertilization (carbamide-loaded double emulsion), at rates of 2%, 1.5%, 1%, and 0.5%. Additionally, conventional urea was applied at a concentration of 2%, and an absolute control group was included for comparison.

The selected maize crop variety for this study was CO H(M) 06, and it was planted with a spacing arrangement of 60 cm × 20 cm, employing the ridges and furrows method. To facilitate proper germination, the field received immediate irrigation after sowing. Subsequently, the field was periodically irrigated to maintain soil moisture levels at an optimal saturation point, with irrigation frequency adjusted according to the prevailing moisture conditions in the field.

The three foliar sprays were applied at the vegetative stage, tasseling and grain-filling stage, respectively, in accordance with the specific concentrations designated for each treatment.

Results and Discussion Plant height (cm)

Plant height serves as a clear indicator of the progress and maturation of plants. Variations in plant height can signal modifications in essential physiological activities, such as the splitting, elongation, and specialization of cells. Consequently, it offers valuable information about the general well-being and vitality of the plant.

The information presented in the Table 01 illustrates how different treatments impact the height of maize plants (cm) over time. The average plant height consistently grew as the crop aged. A substantial growth spurt was observed during the transition from the vegetative phase to the reproductive phase, followed by a more gradual increase. There were significant variations in maize plant height across all recorded growth stages.

The maize plants reached their greatest height (79.31 cm) after 30 days of sowing when treated with T1 (Nano foliar fertilization @ 2%). This height was statistically comparable to the plants treated with conventional urea @ 2% (78.11 cm), closely followed by treatment T2 (Nano foliar fertilization @ 1.5%). When observing the 60 and 90 days after sowing (DAS) stages, the tallest

maize plants were found in the plots where a foliar spray of nano fertilizer formulation @ 2% was applied. These results were similar to the plants treated with conventional urea @ 2%. In contrast, the lowest plant heights of 61.56 cm, 121.46 cm, and 130.12 cm were recorded in the control plots at 30, 60, and 90 DAS, respectively, where no foliar spray was administered.

Table 01: Impact of carbamide-loaded double emulsion on plant height of maize

Treatments	Plant height (cm)		
	30 DAS	**60 DAS**	**90 DAS**
T_1: Nano foliar fertilization @ 2%	79.31	192.65	229.71
T_2: Nano foliar fertilization @ 1.5%	72.45	164.52	198.31
T_3: Nano foliar fertilization @ 1%	68.70	159.82	171.11
T_4: Nano foliar fertilization @ 0.5%	63.43	130.59	137.41
T_5: Conventional urea @ 2%	78.11	185.42	225.14
T_6: Control	61.56	121.46	130.12
SEd	1.32	3.87	4.38
CD (P=0.05)	2.80	8.21	9.30

Dry matter (kgha^{-1})

The objective of nano foliar fertilization is to amplify nutrient accessibility to the plant, with the potential outcome of heightened biomass accumulation. Tracking shifts in dry matter contents offers valuable observations into the treatment's efficacy in fostering plant growth and augmenting biomass production. The data regarding significant difference in maize dry matter production (kgha^{-1}) at various stages with the application of nano fertilizer formulation at different concentrations and conventional formulation is furnished in Table 02.

At 30, 60 and 90 DAS, the dry matter production ranged from 228.72 to 898.13, 2981.73 to 6973.13 and 5678.13 to 11341.73 kgha^{-1} respectively. The highest dry matter was produced with nano foliar fertilization @ 2% which was statistically comparable with foliar spray of conventional urea at 2% (807.42, 6751.43 and 10758.13 kgha^{-1}) at all the stages respectively. Minimal amount of dry matter production was noticed in control plots at all the stages. The increase in dry matter of T_5 was about 49.94 and T_1 was about 47.22 per cent over the control at 90 days after sowing.

Table 02: Impact of carbamide-loaded double emulsion on dry matter accumulation (kgha^{-1}) of maize

Treatments	Dry matter (kgha^{-1})		
	30 DAS	**60 DAS**	**90 DAS**
T_1: Nano foliar fertilization @ 2%	898.13	6973.13	11341.73
T_2: Nano foliar fertilization @ 1.5%	754.74	5344.81	8554.15
T_3: Nano foliar fertilization @ 1%	680.90	4867.20	7832.27
T_4: Nano foliar fertilization @ 0.5%	330.53	3203.51	6547.29
T_5: Conventional urea @ 2%	807.42	6751.43	10758.13
T_6: Control	228.72	2981.73	5678.13
SEd	43.62	347.13	576.56
CD (P=0.05)	92.54	736.36	1223.08

Discussion

The observed differences in plant height among the treatments can be attributed to the varying nutrient availability and concentrations provided by each treatment. Nano foliar fertilization offer essential nutrients that are vital for plant growth, particularly during the early stages of development. Higher concentrations of nano foliar fertilization (2% and 1.5% treatments) likely provided an ample supply of essential nutrients, promoting greater cell division and elongation. This led to increased plant height compared to treatments with lower nutrient concentrations (1 and 0.5 per cent) and the control plots. Adequate nutrient levels play a key role in driving various physiological processes, such as photosynthesis and metabolism, which collectively contribute to enhanced growth. This observable increase in plant height is attributed to the concurrent promotion of cellular development owing to the heightened nitrogen availability. The strategic utilization of exogenously applied nanoparticles has been underscored by a multitude

of investigations, such as those conducted by Mandeh *et al*. (2012) and Song *et al*. (2013), showcasing a significant amplification in plant growth and developmental processes.

The nano-encapsulated nutrients possess a significantly higher surface area-to-volume ratio, enabling more efficient nutrient release and uptake by plant cells. This enhanced accessibility to essential nutrients promotes robust cell division and elongation, consequently contributing to larger leaf areas. The increased nutrient accessibility facilitates higher rates of photosynthesis, leading to an increased assimilation of carbon dioxide and subsequent conversion into biomass and hence the higher dry matter accumulation. The findings were in accordance with Mahmoodi *et al*. (2020); Midde *et al*. (2022) and Mallikarjuna *et al*. (2023).

Conclusion:

In conclusion, the application of carbamide-loaded double emulsion through foliar spraying has demonstrated significant positive effects on maize growth, as evidenced by increased plant height and enhanced dry matter accumulation. The highest concentration of Nano foliar fertilization at 2 per cent proved particularly effective, leading to taller maize plants and greater biomass production, comparable to conventional urea at 2 per cent. These findings underscore the potential of double emulsion technology as a promising approach for optimizing nutrient management in maize cultivation, offering sustainable benefits by improving crop performance while minimizing nitrogen losses, thereby contributing to more efficient and environmentally responsible agricultural practices.

References:

1. Mandeh, M., Omidi, M., & Rahaie, M. (2012). In vitro influences of TiO_2 nanoparticles on barley (*Hordeum vulgare* L.) tissue culture. Biological trace element research, 150, 376-380.
2. Song, U., Shin, M., Lee, G., Roh, J., Kim, Y., & Lee, E. J. (2013). Functional analysis of TiO_2 nanoparticle toxicity in three plant species. Biological trace element research, 155, 93103.
3. Mahmoodi, B., Moballeghi, M., Eftekhari, A., & Neshaie-Mogadam, M. (2020). Effects of foliar application of liquid fertilizer on agronomical and physiological traits of rice (*Oryza sativa* L.). Acta Agrobotanica, 73(3).
4. Midde, S. K., Perumal, M. S., Murugan, G., Sudhagar, R., Mattepally, V. S., & Bada, M. R. (2021). Evaluation of nano urea on growth and yield attributes of rice (*Oryza Sativa* L.). Chemical Science Review and Letters, 11(42), 211-214.
5. Mallikarjuna, H. B., & Kanavi, J. B. (2023). Influence of comparative application of conventional and nano urea on paddy growth and yield.