Electronic Supporting Information

Insights into Hydrophobic (Meth)acrylate Polymers as Coating for Slow-Release fertilizers reduce Nutrients Leaching

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I- Industries of commercially available coated fertilizers by polymers

II-Mathematical Modelling of Release Kinetics

__Figure captions__

Fig. S1 FTIR spectra of TFEMA , PTFEMA , PFEHEMA and PPFEHEMA.

Fig. S2 Water Contact Angle (WCA) of: (a) PTFEMA and (b) PPFEHEMA.

Fig. S3 Elastic behavior of PPFEHEMA after stretching.

Fig. S4 Thickness of DAP coated with PTFEMA and PPFEHEMA 1L and 2L and the corresponding percentage coating weight % (red color).
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Fig. S5 Nutrients saturation time of uncoated DAP and coated DAP using PTFEMA and PPFEHEMA 1L and 2L.

Fig. S6 Example of release kinetic plots Ln (M_t/M_∞) *versus* Ln(t) of coated DAP with PTFEMA and PPFEHEMA

I- Industries of commercially available coated fertilizers by polymers

Commercially available natural resins and polymers coatings for controlled-release fertilizers are manufactured by different companies. More data about polymer Coated NPK Fertilizers Market Size & Share Analysis - Growth Trends & Forecasts (2024-2029) can be found in the following website:

https://www.mordorintelligence.com/industry-reports/bio-degradable-polymer-coated-npk

Some examples of these companies (including their websites) are mentioned in the following table *:

Polymer Coating	**Company**	**Trademark****	**Release characteristics**
Polyolefin : PE/EVA[a]	Manufactured by JCAM AGRI in Japan Distrubed in USA by Florikan®	Nutricote ® (NPK = 18-6-8)	Longevity /Release: 360 days at 25 °C**
Alkyd-resin	ICL Specialty Fertilizers	Osmocote ® (NPK = 15-9-12)	Longevity /Release: 5-6 months at 21 °C
Polyurethane	Manufactured by Koch Agronomic Services (USA) Distributed by Harrell's	Polyon ® (NPK = 19-4-8)	The longevity of Polyon® is related to the coating thickness

[a] : PE : polyethylene and EVA : poly(ethylene-co-vinyl acetate) copolymer

florikan controlled release fertilizers

ICL Specialty Fertilizers

Harrell's Growing a Better World®

* M.E. Trenkel. Slow and controlled-release and stabilized fertilizers, international fertilizer industry association, pp. 1–163, 2010. https://www.fertilizer.org/wp-content/uploads/2023/01/2010_Trenkel_slow-release-book.pdf

** https://ipps.org/uploads/docs/6jSR%20Creamer%202018.pdf

Osmocote®: https://icl-growingsolutions.com/ornamental-horticulture/brands/osmocote-5/
Nutricote®: https://www.jcam-agri.co.jp/en/product/nutricote.html
Florikan®: https://www.florikan.com/about
Polyon® : https://www.harrells.com/
https://polyon.com/agriculture.html

II-Mathematical Modelling of Release Kinetics

Mathematical modeling is essential to gain deeper insight in understanding the nutrients release characteristics of the coated DAP, studied from the semi-empirical Ritger-Peppas model equation S1 [1]:

$$\frac{M_t}{M_\infty} = k\, t^n \qquad Eq.S1$$

where M_t and M_∞ represent the amounts of nutriment released at time t and at equilibrium, respectively, k is the diffusion constant which depends on the type of coating material, t is the release time while n is a diffusional exponent characterizing the release mechanism[2] . This model can be used to describe the release rate of fertilizers from polymer devices. In the case of $n \leq 0.5$, the nutrient release mechanism indicates Fickian diffusion. When n=1, the transport mechanism dominates, leading to zero-order release (Case II transport) corresponding to the relaxation release polymeric matrix. If n value is ranging between 0.5 and 1.0, the nutrient release behavior can be regarded as the superposition of both above phenomena, which is called "anomalous transport" (non-Fickian) driven by a combination of diffusion and relaxation of the coating matrix [3]. For n values greater than 1, a strong influence of the coating on retarding the release is assumed, which is gradually assigned to the diffusion (accelerating the process) by opening pores or degrading the structure (erosion of polymeric chain) [2–4] .

The linearisation of Eq. S1 leads to Eq. S2:

$$Ln\frac{M_t}{M_\infty} = Ln\, k + n\, Ln(t) \qquad (Eq. S2)$$

References

1 P. L. Ritger and N. A. Peppas, *Journal of Controlled Release*, 1987, **5**, 23–36.
2 R. Bortoletto-Santos, C. Ribeiro and W. L. Polito, *J Appl Polym Sci.*, 2016, **133** , 1-8.
3 X. Wang, S. Lü, C. Gao, X. Xu, Y. Wei, X. Bai, C. Feng, N. Gao, M. Liu and L. Wu, *RSC Adv*, 2014, **4**, 18382.
4 K. Lubkowski, A. Smorowska, M. Sawicka, E. Wróblewska, A. Dzienisz, M. Kowalska and M. Sadłowski, *Polish Journal of Chemical Technology*, 2019, **21**, 52–58.

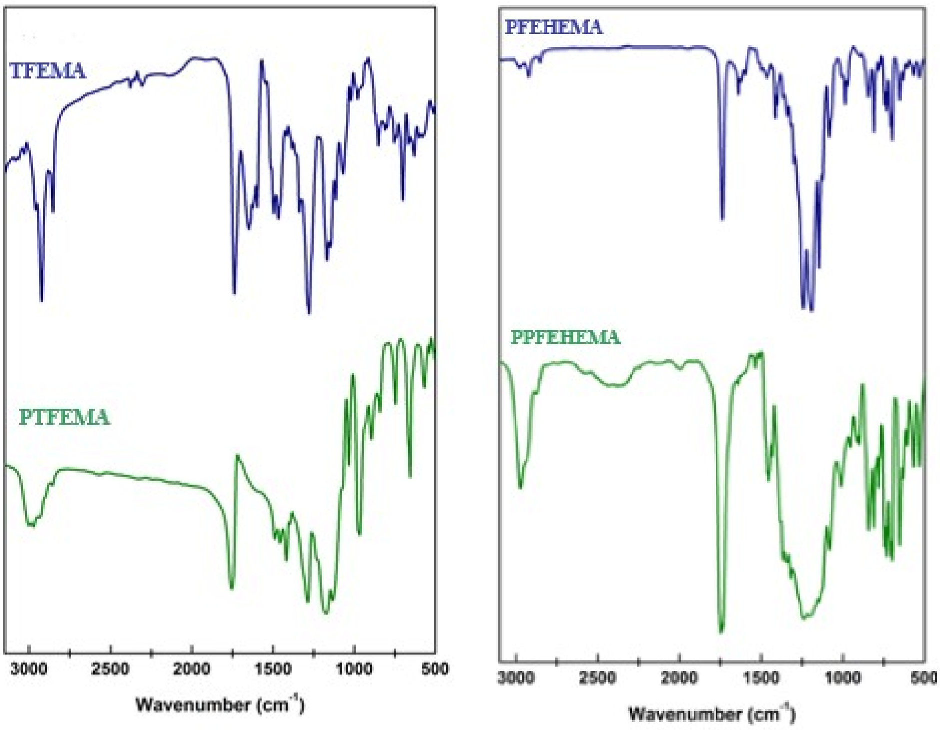


Fig. S1 FTIR spectra of TFEMA, PTFEMA , PTFEMA and PPFEHEMA.

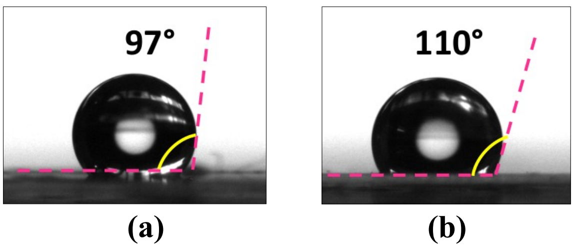


Fig. S2 Water Contact Angle (WCA) of: (a) PTFEMA and (b) PPFEHEMA

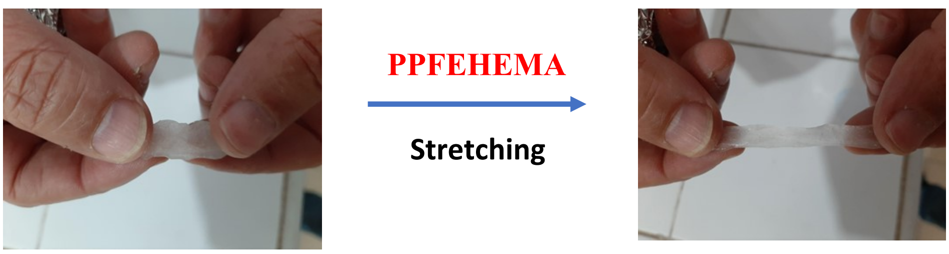
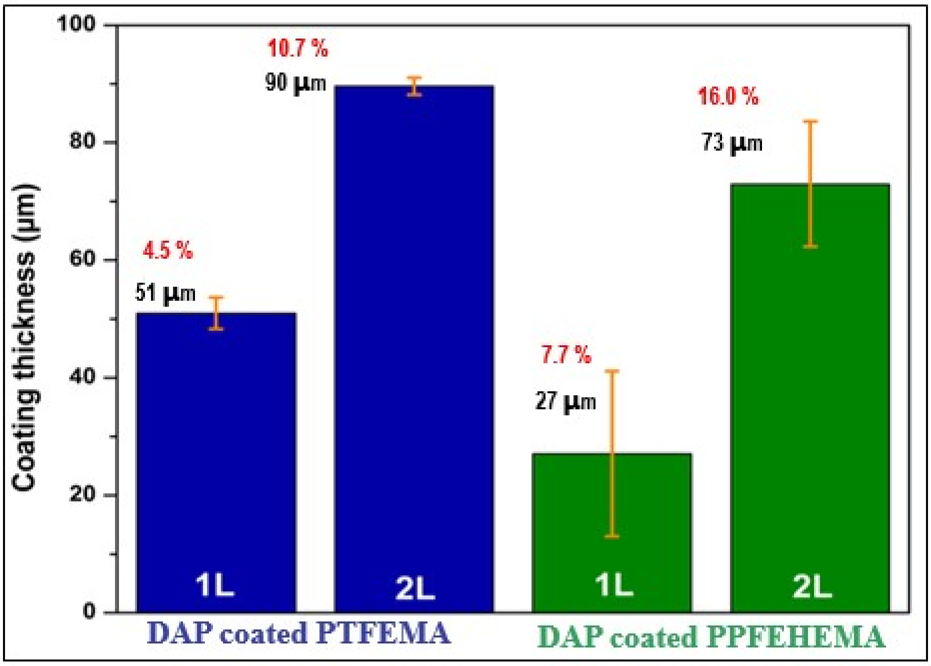


Fig. S3 Elastomer behavior of PPFEHEMA after stretching.



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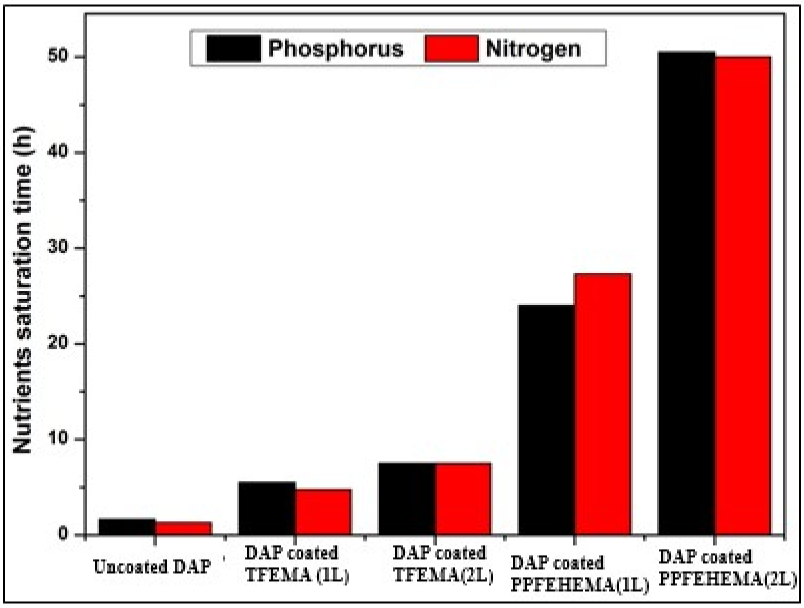
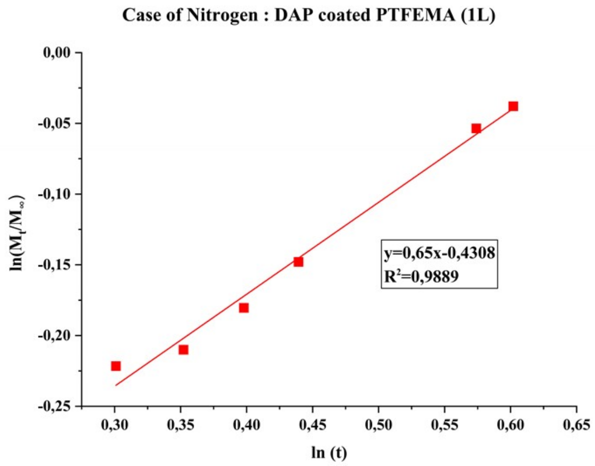
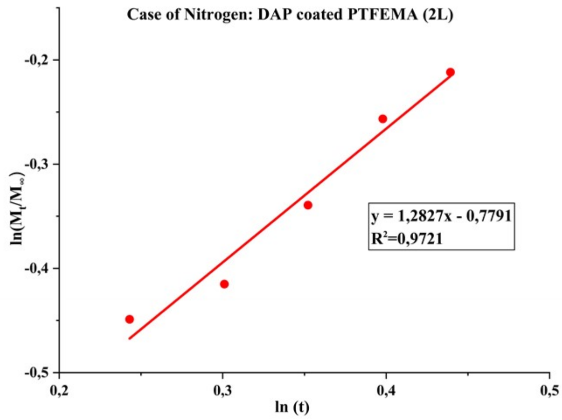
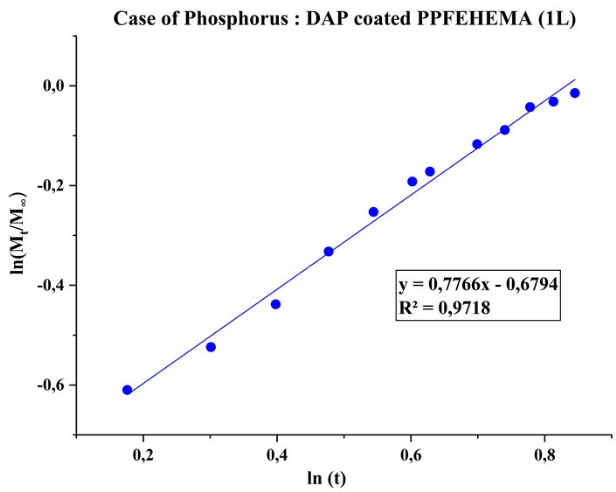


Fig. S5 Nutrients saturation time of uncoated DAP and coated DAP using PTFEMA and PPFEHEMA 1L and 2L.







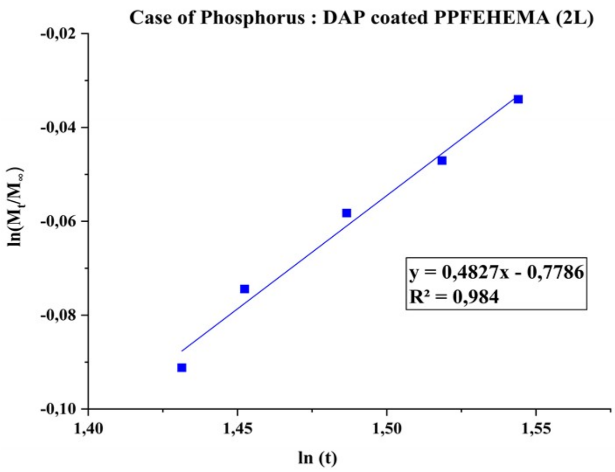


Fig. S6 Example of release kinetic plots Ln (M_t/M_∞) *versus* Ln(t) of coated DAP with PTFEMA and PPFEHEMA