**Supplementary Material for: Slow release fertilizers based on polyphosphate/montmorillonite nanocomposites for improving crop yield**

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**Table S1.** Recent advancement in nanocarrier as fertilizer for slow nutrient release.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No | Nanomaterials | Preparation method | Fertilizer particle shape | Nutrient element | Reference |
| 1 | Urea-Montmorillonite Nanocomposites | Extrusion processing | Cylindrical  | N | (Pereira et al., 2012) |
| 2 | Polymer (polyacrylamide hydrogen or polycaprolactone) /montmorillonite/urea composite | Extrusion processing | Cylindrical | N | (Pereira et al., 2015) |
| 3 | Montmorillonite-urea nanocomposites | Aqueous suspension technique | Powder | N | (Golbashy et al., 2017) |
| 4 | Carboxymethyl cellulose-g-poly (acrylamide)/montmorillonite superabsorbent composite | Free-radical graft copolymerization | Powder | N | (Kenawy et al., 2018) |
| 5 | Chrysotile-K2HPO4 mixtures | Mechanical grinding | Powder | P+K | (Borges et al., 2018) |
| 6 | Lignin/montmorillonite/urea composite | Extrusion processing | Cylindrical | N | (Gu et al., 2019) |
| 7 | Urea-hydroxyapatite-montmorillonite nanohybrid composites | Solvent assisted grinding techniques | Powder | N | (Madusanka et al., 2019) |
| 8 | Urea/urea-formaldehyde polymer nanocomposites | Extrusion processing | Cylindrical | N | (Yamamoto et al., 2019) |
| 9 | Zeolite/Fe2O3 nanocomposites | Quick green precipitation method | Powder | Zn+Fe | (Hossein et al., 2020) |
| 10 | Sodium alginate-g-poly (acrylate-co-acrylamide) /montmorillonite superabsorbent nanocomposite | Dissolution reaction | Powder | B | (Helmiyati et al., 2020) |

**Table S2.** The central composite design matrix employed for two independent variables.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | UP  | K  | Angle of response (°) | Particle hardness (N) |
| 1 | 1 | 0.5 | 35.39 | 85.50 |
| 2 | 0.5 | 1 | 30.70 | 24.94 |
| 3 | 0.75 | 0.40 | 35.39 | 60.60 |
| 4 | 0.75 | 0.75 | 31.82 | 42.30 |
| 5 | 0.75 | 0.75 | 31.64 | 41.02 |
| 6 | 1.10 | 0.75 | 33.04 | 70.10 |
| 7 | 1 | 1 | 30.98 | 59.36 |
| 8 | 0.5 | 0.5 | 31.82 | 19.72 |
| 9 | 0.75 | 1.10 | 32.64 | 38.92 |
| 10 | 0.75 | 0.75 | 31.45 | 44.88 |
| 11 | 0.40 | 0.75 | 30.56 | 18.57 |
| 12 | 0.75 | 0.75 | 31.09 | 48.90 |
| 13 | 0.75 | 0.75 | 31.54 | 44.66 |

**Table S3.** The central composite design matrix employed for two independent variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Time (min) | Temperature (℃)  | Particle hardness(N) | Angle of response (°) |
| 1 | 300 | 120 | 43.41 | 35.1 |
| 2 | 300 | 80 | 14.6 | 35.4 |
| 3 | 210 | 100 | 55.15 | 30.98 |
| 4 | 337.279 | 100 | 55.5 | 31.07 |
| 5 | 210 | 100 | 59.74 | 31.93 |
| 6 | 210 | 100 | 62.54 | 31.16 |
| 7 | 210 | 100 | 61.23 | 31.02 |
| 8 | 210 | 100 | 62.14 | 31.02 |
| 9 | 120 | 120 | 47.01 | 35.1 |
| 10 | 210 | 71.7157 | 0.56 | 37.5 |
| 11 | 120 | 80 | 2.7 | 36.7 |
| 12 | 210 | 128.284 | 42 | 39.42 |
| 13 | 82.7208 | 100 | 34.44 | 33.14 |



**Figure S1.** Schematic diagram showing column packing and leachate collection of the leaching experiment.



**Fig. S2**. TGA and DTG curves for thermogram of for the prepared fertilizers



**Fig. S3.** Nitrogen gas adsorption-desorption isotherms and surface area of the prepared fertilizers.

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