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Slow Release of Potash Fertilizer Through Polymer Coating

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Abstract: Slow release of fertilizers is one of the means of minimizing the fertilizer loss. This can be achieved by using different types of coatings, like Plaster of paris, Wax etc. Present study is envisaged to study the dissolution rate of water soluble polymer coated potash prepared in the form of a cylindrical pellet. The polymer used is Polyacrylamide which is also useful in reducing soil erosion. The variables studied are quantity of fertilizer, quantity of water surrounding the pellet, replenishment time. It has been observed that lower the quantity of fertilizer and lower the quantity of water, slower the release is. The strength of the pellet is observed to play a vital role in the studies on replenishment time. Conductivity measurements are carried out for finding out the dissolution of potash into water. For highlighting the effectiveness of coating, the dissolution studies in the absence of polymer coating are also carried out.

Keywords: Fertilizer; polyacrylamide; slow release; soil erosion; replenishment time.

1. Introduction

Overuse of fertilizers and pesticides is one of the causes for the degradation of environment and soil. Slow release fertilizers are the newest and most technically advanced way of supplying mineral nutrients to crops. Compared to conventional fertilizers, their gradual pattern of nutrient release meets plant needs, minimizes leaching, and therefore improves fertilizer use efficiency. Slow release can be achieved by providing coatings like Plaster of Paris [1], resins and waxes.

Literature was available for comparing three slow release N fertilizers namely, urea-formaldehyde, phosphorus-coated urea and sulphur coated-urea [2]. It was observed that application of sulphur-coated urea SCU, phosphorus-coated urea (PCU) and urea- formaldehyde in a descending order was very favorable and reduces nitrate pollution.

Work was also reported [3] for Nitrogen release of the nanofertilizer from three elevations in Sri Lanka (pH 4.2, 5.2 and 7) and these studies were compared with that of a commercial fertilizer. The nanofertilizer showed an initial burst and a subsequent slow-release even on day 60 compared to the commercial fertilizer, which released heavily early followed by the release of low and non-uniform quantities until around day 30[4].

The feasibility of using surfactant-modified zeolite (SMZ) as a carrier for fertilizer and for slow release of phosphorus (P) was investigated [5]. The results indicated that SMZ is a good sorbent for $PO4^{3-}$, and a slow release of P was achievable.

Sulfur-coated urea was one of the first slow release fertilizer and nitrogen release is delayed by the thickness of the sulfur coating [6]. Although still used in agriculture, sulfur-coated urea is rarely used in forest, conservation, and native plant nurseries.

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Majority of the studies reported above considered slow release of nitrogen [7] only and it is found to be widely applied in the nurseries [8]. However, potash is also a major ingredient in the fertilizer mix. Polymer-coated controlled release (PCRF) are the newest and most technically sophisticated fertilizers being used in horticultural plant production, and consist of a core of soluble nutrients surrounded by a polymer coating and nutrient release is precisely controlled by the chemical composition and thickness of the polymer coating. Compared to the previous categories that only supply nitrogen, PCRF supply all 3 “fertilizer elements”(nitrogen [N], phosphorus [P], and potassium [K]), and many formulations include calcium, magnesium, sulfur, and micronutrients. Slow-release fertilizer can also be achieved with a composition based on urea-modified hydroxyapatite nanoparticles encapsulated wood [9] . These studies suggested that there is a distinct advantage using polymer coatings compared to other coatings.

Hence, it is contemplated to carry out the slow release of potash fertilizer through a coating of polyacrylamide polymer. Polyacrylamide is chosen as the polymer since it reduces soil erosion [10].

The scope of study includes

(a) Preparation of cylindrical pellets for different ratios of potash and clay.
(b) Coating the pellet with the polymer.
(c) Dissolution of this polymer coated fertilizers in presence of different volumes of water. For measuring dissolution rates, conductivity of Potash in water is taken advantage of.

2. Experimental Procedure

2.1. Preparation of pellet

Known quantity of potash and wet clay are mixed. Casting is done in a unique cylindrical mold so as to ensure same dimensions to all the pellets. The pellet is dried for one hour in a sealed container. This is coated with tooth paste (tooth paste containing calcium acts as secondary nutrient to the soil) to ensure subsequent proper attachment of the polyacrylamide polymer to the surface of the pellet. The pellet is dipped in polyacryl amide polymer. The polymer coated pellet is shown in Figure 1.

Figure 1. Polymer coated Potash fertilizer

The above procedure is repeated for various quantities of potash and clay (with & without coating) and is listed in Table 1.

Table 1. List of experiments

S.no	Quantity of potash (gm)	Quantity of water surrounding the pellet(ml)
1	0.25	100/200
2	0.5	100/200
3	0.75	100/200

2.2. Preparation of calibration chart

During dissolution experiments, the amount of potash leached through the coating is based on conductivity measurements; Calibration chart for amount of potash vs. conductivity is prepared and is shown in Figure 2 for 100 ml water and Figure 3 for 200 ml water.

The Conductivity of polymer solution and clay are measured and found to be zero.

The pellets (with and without coating) are separately dipped in 100 ml water and their conductivity with respect to time is measured. From the calibration charts, amount of potash leached or dissolved is calculated.

The above procedure is also repeated for 200 ml water as well.

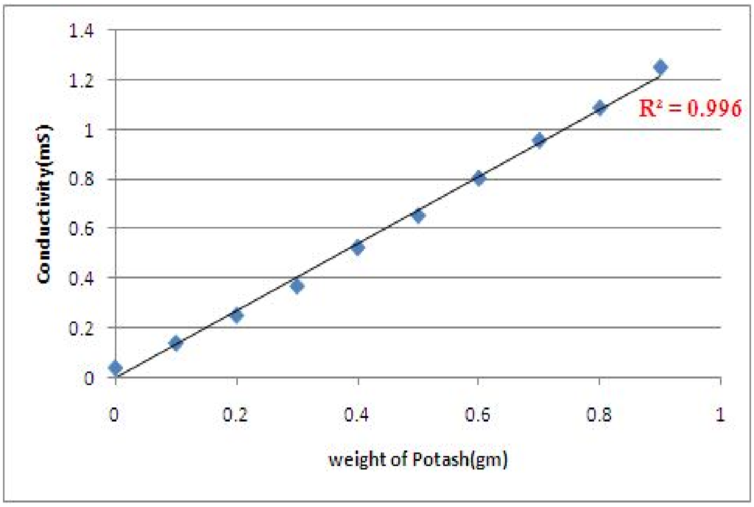

Figure 2. Calibration chart of amount of potash and conductivity in 100 ml of water

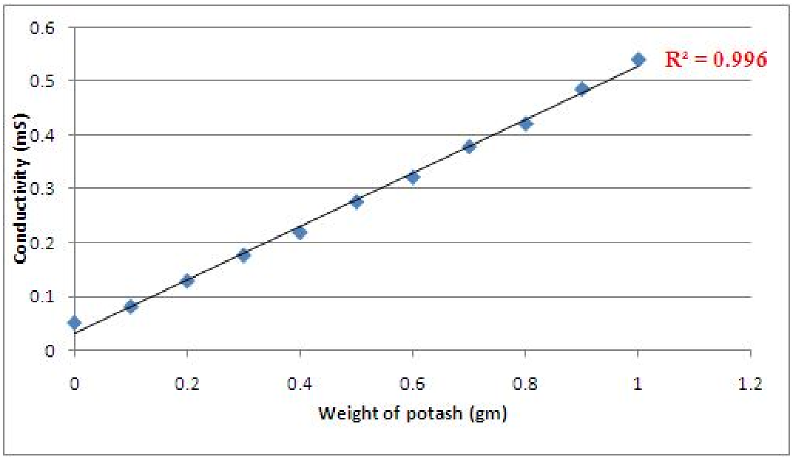

Figure 3. Calibration chart of amount of potash and conductivity in 200 ml of water

3. Results and Discussion

3.1. Effect of variation of quantity of potash on leaching rate

Variation of leaching (dissolution) rate for different quantities of potash with and without coating are shown in Figure 4.

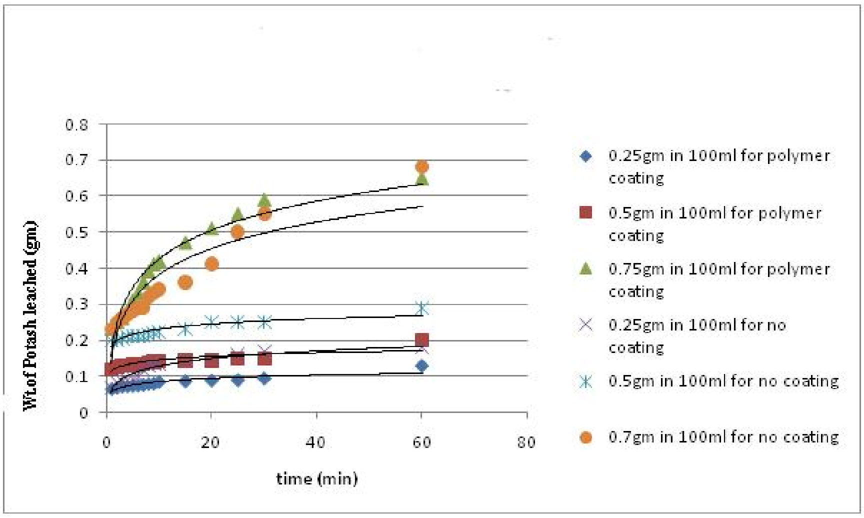

Figure 4. Dissolution rate of potash in the presence and absence of coating for 100 ml water.

From the figure, it can be concluded that lower the amount of potash, lower the dissolution rate. This is further confirmed in the following plot (Figure 5) drawn when the pellet is dipped in 200 ml water.

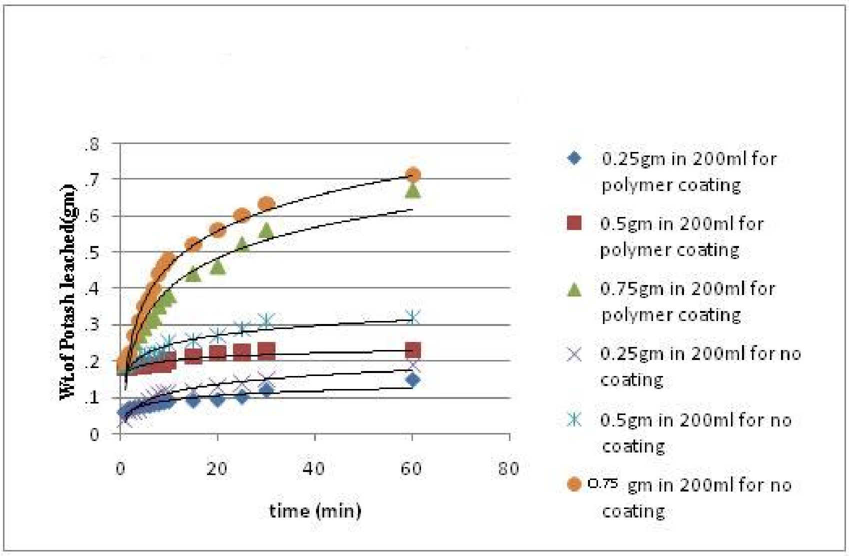

Figure 5. Dissolution rate of potash with and without coating in presence of 200 ml water

Hence, lower the quantity of potash, slower is the release of fertilizer. Hence, subsequent experiments are performed with 0.25 gms of potash fertilizer only.

3.2. Effect of water surrounding the pellet on dissolution rate

The leaching rate of pellet with and without coating in presence of 100 ml water is shown in Figure 6 for 0.25 gm of potash mixed with 10 gms of clay.

It can be seen from the figure that the presence of polymer coating has slowed down the dissolution rate of potash. It can also be concluded from figure that in the absence of coating only 0.18 gm out of 0.25 gms of potash could be leached in one hour where as in presence of coating, 0.11 gms of potash could be leached there by justifying the purpose of coating.

These finding are further confirmed when the pellet is surrounded by 200 ml water. This is shown in Figure 7.

It can be seen from the figures that lower the quantity of water surrounding the pellet, slower the release is. It can be concluded from figure that only 0.19 gm out of 0.25 gms of potash could be dissolved in one hour.

In order to dissolve potash completely, replenishment of water is done by removing water and adding fresh water to the pellet.

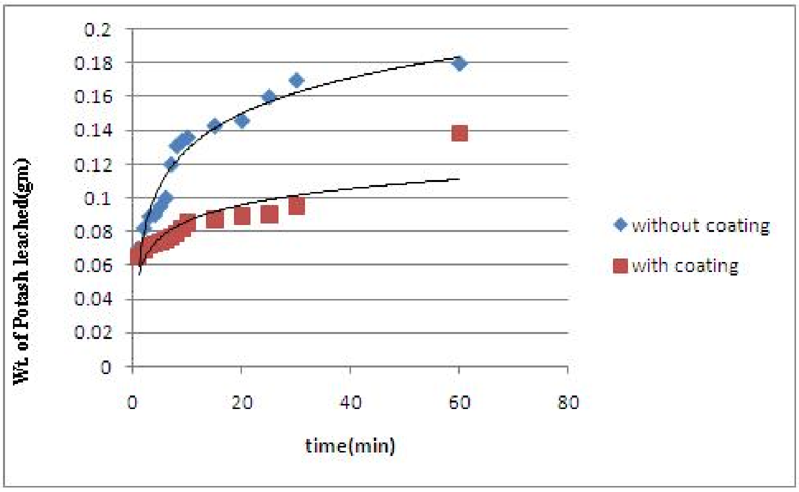

Figure 6. Pellet with and without coating in 100 ml water (0.25 gm mixed with 10 gm clay)

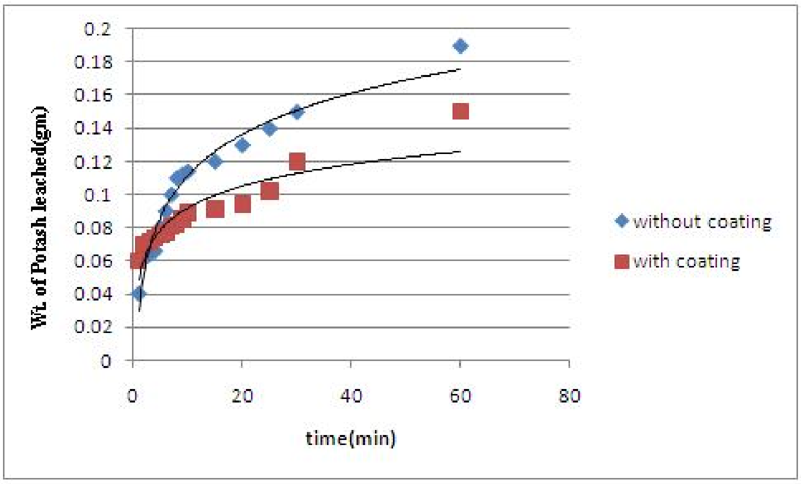

Figure 7. Pellet with and without coating in 200 ml water (0.25 gm KCl mixed with10 gm clay)

3.3. Effect on replenish time

During studies on replenish time, 0.25 gms of potash pellet dissolved in 100 ml and 200 ml lost its strength and got broken. Hence, the strength of the pellet plays a vital role during dissolution studies during replenishment time.

4. Conclusions

Some of the conclusions of the above study are

(a) Polymer coating definitely slows down the release of fertilizer as seen from the plot of dissolution rate in the absence and presence of coating.
(b) Lower the quantity of water, slower the release is and in this case it is 100 ml.
(c) Lower the quantity of potash, slower the release is and in this it is 0.25 gms.
(d) The strength of the pellet will be detrimental in replenishment in order to ensure complete leaching.
(e) The laboratory experiments are to be repeated for plant conditions to check the validity of the conclusions.

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