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折光率法在包膜尿素养分释放快速测定中的校验与改进

Innovation and evaluation of refractive index (RI) method of rapid determination for urea release rate of coated urea

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中文关键词: [折光率](#), [尿素](#), [养分](#), [控释尿素](#), [养分释放](#), [快速测定](#), [改进](#)

英文关键词: [refractive index](#), [urea](#), [nutrients](#), [coated urea](#), [nutrient release](#), [rapid determination](#), [innovation](#)

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中文摘要:

以不同肥效期的15个自制包膜尿素为检测样品,以肥水质量比为1/5的恒温静水溶出法为控释尿素的培养方法,同时采用常规方法和工作曲线折光率法测定培养液中的尿素含量,并对养分释放曲线进行Richards方程的非线性回归分析用以计算样品的肥效期,对比研究现配工作曲线折光率法与同期培养工作曲线法同常规方法测定结果之间的异同,以期对控释尿素养分释放测定提供更准确的快速测定方法。研究表明:系列标准尿素溶液分别培养0、1、6、7、14、21、28和56 d后,其折光率与浓度之间的关系均可用直线方程表示(决定系数 ≥ 0.998),其中同期培养曲线的预测误差为0.34~1.13 g/L,而现配曲线的预测误差为0.71~4.85 g/L,采用尿素标准溶液工作曲线检测同等培养期的尿素溶液有利于提高测定结果的准确性。与H₂SO₄消煮法(常规方法)相比,采用新鲜工作曲线折光率法测定控释尿素养分释放的计算结果提高10%以上,采用标准尿素溶液与包膜尿素同期培养的方法,折光率法测定结果与常规方法之间的系数为0.990。为进一步分析折光率法检测包膜尿素肥效期准确性,采用Richards方程模拟2种方法所测的释放曲线并计算养分达到75%的时间点即肥效期,结果表明,常规方法和折光率法测得15个包膜尿素的肥效期为21.9~245.9和22.0~210.1 d,两者相差最小值和最大值分别为0.2和41.4 d,相对偏差则分别为0.8%和25.1%。其中肥效期较短的包膜尿素的测定偏差较小,肥效期较长尤其是达到180 d以上的包膜尿素可能由于后期释放过于缓慢导致预算误差扩大,其误差区间为27.6~40.4 d,这属于可接受范围。说明了同期培养工作曲线折光率法可以作为常温条件下的控释尿素养分释放的速测方法,并可利用模型较准确地预测包膜尿素的肥效期。研究结果可为包膜尿素养分释放率及肥效期的快速、准确测定提供参考。

英文摘要:

Abstract: The rapid method to evaluation of controlled release fertilizer had been established in China, which included the electrical conductivity (EC) method and the refractive index(RI) method. The RI method was only applied for polymer coated urea. The substrates of the coated ureas were organic chemicals, however, during the the incubation, the urea release could be transformed into inorganic form such as NH₄⁺, which would influence the test accurateness of the RI method. It was possible to incubate a working curve companied with tested samples would cancel the effect of urea form change. So 15 self-made coated ureas with different longevities were taken as samples, which were divided into three groups according to their nutrient release rates, and the samples were incubated in still pure water under the constant temperture of (25±0.5)°C with the fertilizer/water ratio of 1/5, at the same time standard concentration urea solution was incubated under the same condition to get a working curve. And the urea incubation solutions were collected after 1, 7, 14, 21, 28, 42, 56, 70, 98, 126, 154, 210, 266 days during the incubation with renewal of pure water. After that the routine determination of H₂SO₄ degestion method and the RI method with a working curve at the same incubation interval companied with the tested samples were applied to test nutrient release rate of the coated urea, further more the Richards equation was applied to make a nonliner analysis for each nutrient release curve and calculate the longevities of coated ureas. Finally, the results tested by different methods were used to analyse their similarities and differences and offer a more accurate and rapid determination for polymer coated urea. The results were as follows. Firstly, the EC values of a series of standard concentration urea solution increased with the incubation period prolonged, but urea mass concentration and their RI values always had a significant linear correlation relationship ($r_2 \geq 0.998$) after 0, 1, 6, 7, 14, 21, 28 and 56 days during the incubation. However, the errors tested of the fresh working curves were from 0.71 to 4.85 g/L, which would be decreased to the range of 0.34 to 1.13 g/L by using working curves at a same incubation interval companied with samples. Secondly, compared to the routine determination of H₂SO₄ degestion, the data of nutrient release rate of coated ureas were lifted more than 10% by using the RI method with the fresh working curve, but the new RI method based on the working curve at a same incubation interval would cancel the difference of results, which had a conversion coefficient of 0.990 with the traditional one's. Thirdly, in order to further analysis the accurateness of the new RI method, the Richards equation was applied to model nutrient release curve and calculate the longevity of each sample whose time point to nutrient release amount getting 75%. Results showed that the longevities tested of 15 coated ureas were 21.9-245.9 days and 22.0-210.1 days respectively by using the routine and new method, the minimum and maximum deviation of the new method was 0.8% and 25.1% respectively. The probable reason was that, when the coated ureas with a longer longevity getting more than 180 days were taken as samples, because of nutrient being released too slowly during the later stage, it was easy to bring the greater deviation tested, and their errors were from 27.6 to 40.4 days, but it was acceptable according to routine to label the longevity of controlled release fertilizer and permitted to move up or down about two months. In summary, it was proved that the RI method based on a working curve at the same incubation companied with tested samples was a rapid determination for coated urea, and the longevity would be forecasted accurately by using the Richards equation. Furthermore, the result of this study could offer a reference of a rapid and accurate method to test the nutrient release rate and longevity of polymer coated urea.

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