



## BIO-FORMULATIONS FOR PLANT GROWTH-PROMOTING *STREPTOMYCES* SP.

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### ABSTRACT

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A total of 19 strains of *Streptomyces* sp. viz., CAI-13, CAI-17, CAI-21, CAI-24, CAI-26, CAI-68, CAI-78, CAI-85, CAI-93, CAI-121, CAI-127, CAI-140, CAI-155, KAI-26, KAI-27, KAI-32, KAI-90, KAI-180 and MMA-32 were earlier reported by us as plant growth-promoters in chickpea, pigeonpea, sorghum, rice, pearl millet, tomato and chili. In the present investigation, the 19 strains of *Streptomyces* sp. were evaluated for development of a long term, eco-friendly and inexpensive formulation using different carrier materials such as peat, lignite, talc and talc + starch. *Streptomyces* strains were individually grown and inoculated into the four selected carrier materials and stored in the refrigerator at 4°C. Samples were collected at the end of every month and tested for their viability and shelf life by plate count method for 12 months. All the 19 *Streptomyces* strains were viable and grown in all the tested carrier materials, however, peat inoculants showed greater viability and maintained stable colony forming units when compared talc, lignite, and talc + starch inoculants. It is concluded that peat formulation is best suited for mass multiplying the selected 19 *Streptomyces* strains..

**KEYWORDS:** Plant Growth Promoting (PGP) microbes, bio-formulations, *Streptomyces* sp.

### INTRODUCTION

The use of beneficial microorganisms in agriculture has considerably increased over the last couple of decades due to the awareness of the environmental pollution due to synthetic pesticides and fertilizers, public health and sustainable agriculture (Mishra and Arora, 2016; Reigart and Roberts, 2013). Microorganisms and their products, including secondary metabolites, have been widely recognized as potential biocontrol as well as plant growth-promoting agents (Bashan *et al.*, 2014). Actinomycetes such as *Streptomyces* represent an excellent alternative for improving nutrient availability to crop plants and promoting innovation and sustainability in agricultural systems (Vijayabharathi *et al.*, 2018a, b). These attributes may be due to features such as quorum sensing controlled genes expression, multiplication rate, antibiotics, siderophores, cellulases, phytohormones, amino acid synthesis, chitinases, lipases,  $\beta$ -1, 3-glucanase production and ACC-deaminase production. *Streptomyces* and their secondary metabolites are widely reported to help the crops in enhancing shoot and root growth, nodulation and nitrogen fixation, grain yield, solubilisation of inorganic minerals (such as phosphorus, potassium and zinc) and biocontrol of insect pests and plant pathogens (Aggarwal *et al.*, 2016; Bhattacharyya *et al.*, 2017). Earlier, we reported 19 strains of *Streptomyces* having plant growth-promotion (PGP) potential in chickpea, pigeonpea, sorghum, rice, pearl millet, tomato and chili (Gopalakrishnan *et al.*, 2011; 2012; 2013; 2014;

2015a, b, c; 2016a, b; 2020a; 2021; 2022; Pratyusha and Gopalakrishnan, 2023; Sathya *et al.* 2016; Srinivas *et al.*, 2020, 2022).

In order to improve the potential of an efficient beneficial microbe under field conditions, it is important to optimize its mass multiplication protocols and formulations that enhances product quality, shelf-life and bioactivity. Selection of a good carrier material for the formulation is very critical as it can determine the failure or success of an bioagent application and disease management. The selection of a carrier material depends on how they support the beneficial microbes in good physiological conditions, shelf life, bioactivity, economic affordability and ease of application (Macik *et al.*, 2020). Carrier materials that are widely reported to be used in formulation include charcoal, talc, cellulose powder, peat, farm yard manure (FYM), compost, lignite and press mud, whereas each formulation has its advantages and disadvantages (Gopalakrishnan *et al.* 2016c; Berninger *et al.*, 2018). Generally, for *Streptomyces*, the formulations such as peat (a carbonized vegetable tissue formed in wet conditions by decomposition of various plants and mosses) and talcum (a natural mineral referred as steatite or soapstone and chemically referred as magnesium silicate,  $Mg_3Si_4O_{10}(OH)_2$ ; its very low moisture equilibrium enables for longer storage periods) are widely preferred (Bhattacharyya *et al.*, 2020).

In the present study, the 19 strains of *Streptomyces* sp. which were evaluated earlier under field conditions

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on different crops, were tested for the development of a long term, eco-friendly and inexpensive formulations using different carrier materials such as peat, lignite, talc and talc + starch.

## MATERIALS AND METHODS

### *Streptomyces* strains used in this study

All 19 *Streptomyces* strains used in this study were isolated earlier from different herbal vermi-composts and rhizosphere soils and reported as PGP and biocontrol agents in crops including chickpea, pigeonpea, sorghum, rice, pearl millet, tomato, and chili (Gopalakrishnan *et al.*, 2011; 2012; 2013; 2014; 2015a, b; 2016a, b; 2020a; 2021; Sathya *et al.* 2016; Srinivas *et al.*, 2020). Of the 19 *Streptomyces* strains, the genome sequences of 16 *Streptomyces* strains, showing potential for PGP activities in various crops have been decoded (Gopalakrishnan *et al.*, 2020b).

### Viability and shelf life of different carrier bio-formulations

A total of four carrier materials were tested that includes peat, lignite, talc and talc + starch. The selected 19 strains of *Streptomyces* were inoculated (30 ml) individually on sterilized peat/lignite/talc/ talc + starch-based carrier materials (40 g) and allowed to multiply at room temperature (28±2 °C) for two-weeks. At the end two-week incubation, formulated peat/lignite/talc/talc + starch-based inoculants were evaluated for survival and longevity (shelf life) of *Streptomyces*, and this was considered as '0' month. The survival and longevity of bio-inoculants was tested by plate count method. In brief, physiological saline tubes were prepared, and serial dilution of the formulations was done by mixing 10 g of inoculants in 90 ml saline, and serially diluted up to 10<sup>-8</sup> dilutions. Samples (0.1 ml of 10<sup>-3</sup>-10<sup>-8</sup> dilutions) were spread plated on actinomycetes isolation agar followed by the incubation of plates at 27±1 °C for 96 h. At the end of incubation, the *Streptomyces* colonies were counted and represented as colony forming units (CFU) and the CFU was enumerated at one-month interval for a period of 12-months.

## RESULTS AND DISCUSSION

To maximize the potential of the PGP microbe's application in the field conditions, it is essential to stabilize them and increase their shelf-life (Bishnoi, 2015). In this regard, bio-formulations were made that includes an active microbe and a carrier material, which stabilizes and protects the microbial moiety (Aamir *et al.*, 2020). Different types of carrier materials are available namely, charcoal, cellulose powder, lignite, peat, talc,

vermiculite, and diatomaceous earth (Gopalakrishnan *et al.*, 2016c; Zayed, 2016). In the present investigation, we evaluated four different carrier materials such as peat, lignite, talc and talc + starch for their ability to support our 19 *Streptomyces* strains which were demonstrated earlier as PGP and biocontrol agents under field conditions. The results showed that all 19 *Streptomyces* strains survived and maintained (at least 10<sup>6</sup> CFU/ ml) up to 12 months in all the four tested formulations. Of the four tested formulations, peat inoculants showed greater viability and maintained stable colony forming units when compared talc, lignite and talc + starch carriers. In the peat formulations, all the 19 peat inoculants survived and maintained at least 10<sup>7</sup> CFU/ ml up to 12 months while five peat inoculants (CAI-68, CAI-78, CAI-127, CAI-140 and CAI-155) were found to have at least 10<sup>8</sup> CFU/ ml up to 12 months. Next to the peat, lignite was also found to suit better for *Streptomyces* strains as 3 of the 19 strains (CAI-21, CAI-68 and CAI-155) maintained at least 10<sup>8</sup> CFU/ ml up to 12 months (Table 1). It is concluded that peat formulations were best suited for mass multiplying the selected 19 *Streptomyces* strains.

In the present study, all the four carrier bio-formulations were effective and showed promising viability of the 19 *Streptomyces* isolates up to a period of 12 months. This indicates the protective nature of the carrier materials and their ability to support the growth of the *Streptomyces* strains. Literature evidence also supports the usage of these carrier materials and mainly the peat formulations in particular, are known to evenly distribute and stabilize the microbes (Bashan *et al.*, 2014; Bhattacharyya *et al.*, 2020). Peat-based formulation is the widely used and most marketed PGP microbial inoculants and is most commonly used in bio-products producing industries (Gopalakrishnan *et al.*, 2016c). In peat-based formulations, beneficial bacteria are metabolically very active and its multiplication continues during the storage and/or incubation periods as long as sufficient moisture, nutrients, and the optimum temperatures are maintained (Deaker *et al.* 2011). However, one of the main drawback of the peat formulations is its unavailability in many countries.

The survival and establishment of PGP microbe under field conditions in the rhizosphere in competition with native microbial flora is absolutely essential in order to avail the maximum benefits out of it. In the present study, it is evident that the peat and lignite carrier materials followed by talc and talc + starch are efficient in stabilizing and maintaining the viability of the selected 19 agriculturally important *Streptomyces* strains up to a year. This key information could be further explored for commercial production of the PGP *Streptomyces* strains

Table 1. Viability and longevity of 19 strains of *Streptomyces* spp. on four different formulations (Peat, lignite, talc and talc + starch) for 12 months

Strains	<i>Streptomyces</i> spp. population at monthly intervals in CFU/ml												
	0 days	1	2	3	4	5	6	7	8	9	10	11	12
<b>CAI-13</b>													
Peat	1.8x10 <sup>10</sup>	1.6x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.0x10 <sup>10</sup>	9.7x10 <sup>9</sup>	8.0x10 <sup>9</sup>	6.3x10 <sup>8</sup>	4.8x10 <sup>8</sup>	4.1x10 <sup>8</sup>	3.4x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.9x10 <sup>8</sup>	4.5x10 <sup>7</sup>
Lignite	1.6x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.1x10 <sup>8</sup>	1.0x10 <sup>8</sup>	8.0x10 <sup>8</sup>	5.9x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.4x10 <sup>8</sup>	6.0x10 <sup>7</sup>
Talc	5.9x10 <sup>9</sup>	7.3x10 <sup>9</sup>	6.6x10 <sup>9</sup>	6.1x10 <sup>9</sup>	5.4x10 <sup>9</sup>	4.6x10 <sup>9</sup>	4.0x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.3x10 <sup>8</sup>	7.0x10 <sup>7</sup>	6.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	5.0 x10 <sup>6</sup>
Talc+ Starch	7.0x10 <sup>9</sup>	6.5x10 <sup>9</sup>	5.9x10 <sup>9</sup>	5.6x10 <sup>9</sup>	5.0x10 <sup>9</sup>	3.7x10 <sup>9</sup>	3.5x10 <sup>8</sup>	2.3x10 <sup>8</sup>	1.5x10 <sup>8</sup>	7.5x10 <sup>7</sup>	4.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	3.9x10 <sup>6</sup>
<b>CAI-17</b>													
Peat	1.3x10 <sup>10</sup>	1.4x10 <sup>10</sup>	1.3x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.1x10 <sup>10</sup>	9.8x10 <sup>9</sup>	8.3x10 <sup>8</sup>	5.8x10 <sup>8</sup>	4.3x10 <sup>8</sup>	4.0x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.4x10 <sup>8</sup>	5.3x10 <sup>7</sup>
Lignite	5.8x10 <sup>9</sup>	5.3x10 <sup>9</sup>	4.8x10 <sup>9</sup>	4.4x10 <sup>9</sup>	3.9x10 <sup>9</sup>	3.1x10 <sup>9</sup>	2.5x10 <sup>8</sup>	1.5x10 <sup>8</sup>	7.5x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.1x10 <sup>7</sup>	6.8x10 <sup>6</sup>	4.7x10 <sup>6</sup>
Talc	3.4x10 <sup>9</sup>	3.0x10 <sup>9</sup>	2.6x10 <sup>9</sup>	2.4x10 <sup>9</sup>	2.3x10 <sup>9</sup>	1.8x10 <sup>9</sup>	1.0x10 <sup>8</sup>	5.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.4x10 <sup>7</sup>	1.4x10 <sup>6</sup>	1.2x10 <sup>6</sup>
Talc+ Starch	5.5x10 <sup>9</sup>	5.1x10 <sup>9</sup>	4.6x10 <sup>9</sup>	4.3x10 <sup>9</sup>	4.2x10 <sup>9</sup>	2.4x10 <sup>9</sup>	1.5x10 <sup>8</sup>	8.3x10 <sup>7</sup>	3.5x10 <sup>7</sup>	3.6x10 <sup>7</sup>	1.6x10 <sup>7</sup>	1.7x10 <sup>6</sup>	1.0x10 <sup>6</sup>
<b>CAI-21</b>													
Peat	2.0x10 <sup>10</sup>	1.9x10 <sup>10</sup>	1.7x10 <sup>10</sup>	1.6x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.4x10 <sup>10</sup>	1.01x10 <sup>10</sup>	7.2x10 <sup>8</sup>	6.5x10 <sup>8</sup>	5.6x10 <sup>8</sup>	4.2x10 <sup>8</sup>	2.2x10 <sup>8</sup>	9.0x10 <sup>7</sup>
Lignite	2.1x10 <sup>10</sup>	1.8x10 <sup>10</sup>	1.6x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.3x10 <sup>10</sup>	1.3x10 <sup>10</sup>	9.7x10 <sup>9</sup>	7.2x10 <sup>8</sup>	6.2x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.1x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.0x10 <sup>8</sup>
Talc	1.6x10 <sup>9</sup>	1.43x10 <sup>9</sup>	1.32x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.1x10 <sup>9</sup>	8.9x10 <sup>8</sup>	7.3x10 <sup>9</sup>	5.4x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.9x10 <sup>8</sup>	3.0x10 <sup>8</sup>	1.8x10 <sup>8</sup>	6.0x10 <sup>7</sup>
Talc+ Starch	1.25x10 <sup>9</sup>	1.3x10 <sup>9</sup>	1.1x10 <sup>9</sup>	9.8x10 <sup>8</sup>	9.0x10 <sup>8</sup>	8.2x10 <sup>8</sup>	6x10 <sup>9</sup>	3.9x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.5x10 <sup>8</sup>	1.6x10 <sup>8</sup>	6.5x10 <sup>7</sup>	3.4x10 <sup>7</sup>
<b>CAI-24</b>													
Peat	4.0x10 <sup>10</sup>	3.1x10 <sup>10</sup>	2.9x10 <sup>10</sup>	1.9x10 <sup>10</sup>	1.8x10 <sup>10</sup>	1.3x10 <sup>8</sup>	0.9x10 <sup>8</sup>	2.4x10 <sup>7</sup>	1.4x10 <sup>7</sup>	7.0x10 <sup>7</sup>	3.5x10 <sup>7</sup>	2.6x10 <sup>7</sup>	1.2x10 <sup>7</sup>
Lignite	3.3x10 <sup>9</sup>	2.8x10 <sup>9</sup>	2.3x10 <sup>9</sup>	2.0x10 <sup>9</sup>	1.6x10 <sup>9</sup>	1.1x10 <sup>8</sup>	0.7x10 <sup>8</sup>	2.9x10 <sup>7</sup>	1.4x10 <sup>7</sup>	8.0x10 <sup>6</sup>	3.1x10 <sup>6</sup>	1.8x10 <sup>6</sup>	1.1x10 <sup>6</sup>
Talc	4.6x10 <sup>9</sup>	4.1x10 <sup>9</sup>	3.7x10 <sup>9</sup>	2.9x10 <sup>9</sup>	2.4x10 <sup>9</sup>	2.2x10 <sup>8</sup>	1.1x10 <sup>8</sup>	3.7x10 <sup>7</sup>	2.4x10 <sup>7</sup>	1.0x10 <sup>7</sup>	5.0x10 <sup>6</sup>	2.9x10 <sup>6</sup>	1.2x10 <sup>6</sup>
Talc+ Starch	4.0x10 <sup>9</sup>	3.6x10 <sup>9</sup>	3.2x10 <sup>9</sup>	3.0x10 <sup>9</sup>	2.7x10 <sup>9</sup>	2.1x10 <sup>8</sup>	1.1x10 <sup>8</sup>	3.1x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.0x10 <sup>7</sup>	4.2x10 <sup>6</sup>	2.6x10 <sup>6</sup>	1.0x10 <sup>6</sup>
<b>CAI-26</b>													
Peat	4.0x10 <sup>10</sup>	3.1x10 <sup>10</sup>	2.9x10 <sup>10</sup>	1.9x10 <sup>10</sup>	1.8x10 <sup>10</sup>	2.5x10 <sup>8</sup>	1.4x10 <sup>8</sup>	6.5x10 <sup>7</sup>	2.0x10 <sup>7</sup>	3.2x10 <sup>7</sup>	2.0x10 <sup>7</sup>	9.0x10 <sup>7</sup>	5.0x10 <sup>7</sup>
Lignite	3.3x10 <sup>9</sup>	2.8x10 <sup>9</sup>	2.3x10 <sup>9</sup>	2.0x10 <sup>9</sup>	1.6x10 <sup>9</sup>	9.5x10 <sup>8</sup>	7.6x10 <sup>8</sup>	6.5x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.9x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.1x10 <sup>8</sup>	2.7x10 <sup>7</sup>
Talc	4.6x10 <sup>9</sup>	4.1x10 <sup>9</sup>	3.7x10 <sup>9</sup>	2.9x10 <sup>9</sup>	2.4x10 <sup>9</sup>	4.4x10 <sup>8</sup>	2.5x10 <sup>8</sup>	1.5x10 <sup>8</sup>	7.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	3.0x10 <sup>7</sup>	1.8x10 <sup>7</sup>	7.5x10 <sup>6</sup>
Talc+ Starch	4.0x10 <sup>9</sup>	3.6x10 <sup>9</sup>	3.2x10 <sup>9</sup>	3.0x10 <sup>9</sup>	2.7x10 <sup>9</sup>	4.7x10 <sup>8</sup>	3.1x10 <sup>8</sup>	2.7x10 <sup>8</sup>	1.5x10 <sup>8</sup>	8.0x10 <sup>7</sup>	4.2x10 <sup>7</sup>	2.3x10 <sup>7</sup>	1.1x10 <sup>7</sup>
<b>CAI-68</b>													
Peat	1.6x10 <sup>10</sup>	1.3x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	7.8x10 <sup>8</sup>	7.1x10 <sup>8</sup>	6.4x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.6x10 <sup>8</sup>	2.2x10 <sup>8</sup>
Lignite	1.4x10 <sup>9</sup>	1.3x10 <sup>9</sup>	1.2x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.8x10 <sup>8</sup>	7.1x10 <sup>8</sup>	6.1x10 <sup>8</sup>	6.2x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.5x10 <sup>8</sup>	2.6 x10 <sup>8</sup>	2.0 x10 <sup>8</sup>
Talc	1.4x10 <sup>9</sup>	1.3x10 <sup>9</sup>	1.2x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.1x10 <sup>9</sup>	9.6x10 <sup>8</sup>	8.6x10 <sup>8</sup>	7.4x10 <sup>8</sup>	6.9x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.4x10 <sup>8</sup>	3.4x10 <sup>8</sup>	2.1x10 <sup>8</sup>
Talc+ Starch	1.2x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	8.7x10 <sup>8</sup>	8.1x10 <sup>8</sup>	7.8x10 <sup>8</sup>	3.5x10 <sup>9</sup>	5.7x10 <sup>8</sup>	5.0x10 <sup>8</sup>	4.2x10 <sup>8</sup>	3.0x10 <sup>8</sup>	1.9x10 <sup>8</sup>	1.2x10 <sup>8</sup>

Cont...

Table 1. Cont...

Strains	<i>Streptomyces</i> spp.- population at monthly intervals in CFU/ml												
	0 days	1	2	3	4	5	6	7	8	9	10	11	12
<b>CAI-78</b>													
Peat	1.8x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.4x10 <sup>10</sup>	1.3x10 <sup>10</sup>	1.3x10 <sup>10</sup>	1.2x10 <sup>9</sup>	9.0x10 <sup>8</sup>	7.8x10 <sup>8</sup>	6.8x10 <sup>8</sup>	4.8x10 <sup>8</sup>	3.8x10 <sup>8</sup>	2.3x10 <sup>8</sup>	1.0x10 <sup>8</sup>
Lignite	1.2x10 <sup>9</sup>	1.1x10 <sup>9</sup>	9.8x10 <sup>8</sup>	8.9x10 <sup>8</sup>	7.7x10 <sup>8</sup>	6.7x10 <sup>8</sup>	4.3x10 <sup>8</sup>	3.4x10 <sup>8</sup>	2.7x10 <sup>8</sup>	1.6x10 <sup>8</sup>	9.0x10 <sup>7</sup>	3.0x10 <sup>7</sup>	2.1x10 <sup>7</sup>
Talc	8.7x10 <sup>9</sup>	7.9x10 <sup>9</sup>	6.8x10 <sup>8</sup>	6.4x10 <sup>8</sup>	6.0x10 <sup>8</sup>	5.4x10 <sup>8</sup>	3.3x10 <sup>8</sup>	2.6x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.4x10 <sup>8</sup>	6.5x10 <sup>7</sup>	4.7x10 <sup>7</sup>	1.5x10 <sup>7</sup>
Tale+ Starch	1.6x10 <sup>9</sup>	1.5x10 <sup>9</sup>	1.2x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.3x10 <sup>9</sup>	7.0x10 <sup>9</sup>	4.1x10 <sup>8</sup>	3.4x10 <sup>8</sup>	2.8x10 <sup>8</sup>	1.9x10 <sup>8</sup>	8.0x10 <sup>7</sup>	4.0x10 <sup>7</sup>	2.4x10 <sup>7</sup>
<b>CAI-85</b>													
Peat	1.4x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.0x10 <sup>10</sup>	9.8x10 <sup>9</sup>	8.7x10 <sup>9</sup>	7.8x10 <sup>9</sup>	6.7x10 <sup>8</sup>	6.1x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.0x10 <sup>8</sup>	1.5x10 <sup>8</sup>	1.1x10 <sup>8</sup>	7.5x10 <sup>7</sup>
Lignite	1.2x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	9.0x10 <sup>8</sup>	8.6x10 <sup>8</sup>	7.0x10 <sup>8</sup>	6.3x10 <sup>8</sup>	5.5x10 <sup>8</sup>	4.0x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.1x10 <sup>8</sup>	5.0x10 <sup>7</sup>
Talc	1.1x10 <sup>9</sup>	9.7x10 <sup>8</sup>	9.2x10 <sup>8</sup>	7.8x10 <sup>8</sup>	7.4x10 <sup>8</sup>	7.0x10 <sup>8</sup>	6.1x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.3x10 <sup>8</sup>	6.3x10 <sup>8</sup>	2.1x10 <sup>8</sup>	1.0x10 <sup>8</sup>	4.0x10 <sup>7</sup>
Tale+ Starch	1.0x10 <sup>9</sup>	9.4x10 <sup>8</sup>	8.1x10 <sup>8</sup>	7.7x10 <sup>8</sup>	6.6x10 <sup>8</sup>	6.0x10 <sup>8</sup>	5.3x10 <sup>8</sup>	4.8x10 <sup>8</sup>	3.9x10 <sup>8</sup>	3.0x10 <sup>8</sup>	1.9x10 <sup>8</sup>	1.0x10 <sup>8</sup>	3.5x10 <sup>7</sup>
<b>CAI-93</b>													
Peat	5.0x10 <sup>9</sup>	3.8x10 <sup>9</sup>	3.4x10 <sup>9</sup>	3.4x10 <sup>9</sup>	2.9x10 <sup>9</sup>	2.6x10 <sup>9</sup>	1.2x10 <sup>8</sup>	5.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	3.4x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.0x10 <sup>7</sup>	5.5x10 <sup>6</sup>
Lignite	6.5x10 <sup>9</sup>	5.1x10 <sup>9</sup>	4.9x10 <sup>9</sup>	3.9x10 <sup>9</sup>	3.5x10 <sup>9</sup>	3.0x10 <sup>9</sup>	2.4x10 <sup>8</sup>	6.0x10 <sup>7</sup>	3.0x10 <sup>7</sup>	2.9x10 <sup>7</sup>	1.6x10 <sup>7</sup>	7.0x10 <sup>6</sup>	2.0x10 <sup>6</sup>
Talc	5.5x10 <sup>9</sup>	5.2x10 <sup>9</sup>	4.7x10 <sup>9</sup>	4.2x10 <sup>9</sup>	3.8x10 <sup>9</sup>	3.1x10 <sup>9</sup>	1.5x10 <sup>8</sup>	8.5x10 <sup>7</sup>	4.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.0x10 <sup>7</sup>	5.0x10 <sup>6</sup>	3.5x10 <sup>6</sup>
Tale+ Starch	4.8x10 <sup>8</sup>	3.9x10 <sup>8</sup>	3.7x10 <sup>8</sup>	3.0x10 <sup>8</sup>	2.7x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.4x10 <sup>8</sup>	6.5x10 <sup>7</sup>	2.5x10 <sup>7</sup>	7.0x10 <sup>6</sup>	5.0x10 <sup>6</sup>	4.2x10 <sup>6</sup>	2.9x10 <sup>6</sup>
<b>CAI-121</b>													
Peat	1.7x10 <sup>10</sup>	1.6x10 <sup>10</sup>	1.6x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.4x10 <sup>10</sup>	1.2x10 <sup>9</sup>	7.6x10 <sup>8</sup>	7.0x10 <sup>8</sup>	6.6x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.2x10 <sup>8</sup>	2.1x10 <sup>7</sup>	8.8x10 <sup>7</sup>
Lignite	1.0x10 <sup>10</sup>	9.4x10 <sup>9</sup>	9.2x10 <sup>9</sup>	8.3x10 <sup>9</sup>	7.8x10 <sup>9</sup>	7.2x10 <sup>9</sup>	5.0x10 <sup>8</sup>	4.6x10 <sup>8</sup>	4.2x10 <sup>8</sup>	3.4x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.6x10 <sup>7</sup>	5.5x10 <sup>7</sup>
Talc	1.30x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.4x10 <sup>8</sup>	8.5x10 <sup>8</sup>	7.9x10 <sup>8</sup>	6.1x10 <sup>8</sup>	5.1x10 <sup>8</sup>	4.1x10 <sup>8</sup>	3.0x10 <sup>8</sup>	2.1x10 <sup>8</sup>	1.0x10 <sup>7</sup>	1.0x10 <sup>7</sup>
Tale+ Starch	1.28x10 <sup>9</sup>	1.1x10 <sup>9</sup>	9.9x10 <sup>8</sup>	9.5x10 <sup>8</sup>	8.9x10 <sup>8</sup>	8.1x10 <sup>8</sup>	6.0x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.7x10 <sup>8</sup>	3.0x10 <sup>8</sup>	2.1x10 <sup>8</sup>	2.0x10 <sup>6</sup>	1.4x10 <sup>6</sup>
<b>CAI-127</b>													
Peat	1.4x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.1x10 <sup>10</sup>	9.8x10 <sup>9</sup>	9.1x10 <sup>9</sup>	9x10 <sup>8</sup>	7.0x10 <sup>8</sup>	5.8x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.3x10 <sup>8</sup>	1.9x10 <sup>8</sup>	1.7x10 <sup>8</sup>
Lignite	1.3x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	8.9x10 <sup>8</sup>	8.1x10 <sup>8</sup>	5.8x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.1x10 <sup>8</sup>	3.5x10 <sup>8</sup>	2.7x10 <sup>8</sup>	1.6x10 <sup>8</sup>	4.1x10 <sup>7</sup>
Talc	1.2x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.5x10 <sup>8</sup>	9.0x10 <sup>8</sup>	7.8x10 <sup>8</sup>	7.3x10 <sup>8</sup>	8.1x10 <sup>8</sup>	7.4x10 <sup>8</sup>	6.4x10 <sup>8</sup>	5.6x10 <sup>8</sup>	4.9x10 <sup>8</sup>	2.4x10 <sup>8</sup>	4.4x10 <sup>7</sup>
Tale+ Starch	1.1x10 <sup>9</sup>	9.2x10 <sup>8</sup>	7.6x10 <sup>8</sup>	6.8x10 <sup>8</sup>	6.1x10 <sup>8</sup>	5.6x10 <sup>8</sup>	5.5x10 <sup>8</sup>	4.7x10 <sup>8</sup>	3.4x10 <sup>8</sup>	1.8x10 <sup>8</sup>	1.1x10 <sup>8</sup>	4.5x10 <sup>7</sup>	4.1x10 <sup>7</sup>
<b>CAI-140</b>													
Peat	1.5x10 <sup>10</sup>	1.4x10 <sup>10</sup>	1.3x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.0x10 <sup>10</sup>	9.0x10 <sup>9</sup>	8.4x10 <sup>8</sup>	7.0x10 <sup>8</sup>	6.8x10 <sup>8</sup>	6.0x10 <sup>8</sup>	3.5x10 <sup>8</sup>	2.5x10 <sup>8</sup>	2.1x10 <sup>8</sup>
Lignite	1.2x10 <sup>10</sup>	1.1x10 <sup>10</sup>	9.9x10 <sup>9</sup>	9.1x10 <sup>9</sup>	8.7x10 <sup>9</sup>	7.7x10 <sup>9</sup>	7.2x10 <sup>8</sup>	5.1x10 <sup>8</sup>	4.5x10 <sup>8</sup>	5.2x10 <sup>8</sup>	2.1x10 <sup>8</sup>	1.2x10 <sup>8</sup>	9.0x10 <sup>7</sup>
Talc	9.9x10 <sup>9</sup>	9.3x10 <sup>9</sup>	5.6x10 <sup>9</sup>	4.6x10 <sup>9</sup>	4.3x10 <sup>9</sup>	6.6x10 <sup>9</sup>	5.6x10 <sup>8</sup>	4.8x10 <sup>8</sup>	4.1x10 <sup>8</sup>	2.9x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.1x10 <sup>8</sup>	4.4x10 <sup>7</sup>
Tale+ Starch	9.5x10 <sup>9</sup>	8.5x10 <sup>9</sup>	7.9x10 <sup>9</sup>	7.3x10 <sup>9</sup>	6.3x10 <sup>9</sup>	5.5x10 <sup>9</sup>	4.8x10 <sup>8</sup>	4.0x10 <sup>8</sup>	3.4x10 <sup>8</sup>	3.9x10 <sup>8</sup>	1.7x10 <sup>8</sup>	7.5x10 <sup>7</sup>	6.0x10 <sup>7</sup>

Cont...

Table 1. Cont...

Strains	<i>Streptomyces</i> spp.- population at monthly intervals in CFU/ml												
	0 days	1	2	3	4	5	6	7	8	9	10	11	12
<b>CAI-155</b>													
<b>Peat</b>	2.2x10 <sup>10</sup>	1.8x10 <sup>10</sup>	1.7x10 <sup>10</sup>	1.6x10 <sup>10</sup>	1.5x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.0x10 <sup>9</sup>	8.7x10 <sup>8</sup>	7.2x10 <sup>8</sup>	6.4x10 <sup>8</sup>	4.5x10 <sup>8</sup>	2.5x10 <sup>8</sup>	2.5x10 <sup>8</sup>
<b>Lignite</b>	2.0x10 <sup>9</sup>	1.7x10 <sup>9</sup>	1.6x10 <sup>9</sup>	1.48x10 <sup>9</sup>	1.2x10 <sup>9</sup>	1.0x10 <sup>9</sup>	8.5x10 <sup>8</sup>	7.6x10 <sup>8</sup>	5.8x10 <sup>8</sup>	6.2x10 <sup>8</sup>	4.6x10 <sup>8</sup>	3.4x10 <sup>8</sup>	3.4x10 <sup>8</sup>
<b>Talc</b>	1.1x10 <sup>10</sup>	9.7x10 <sup>9</sup>	8.7x10 <sup>9</sup>	4.8x10 <sup>9</sup>	4.2x10 <sup>9</sup>	7.1x10 <sup>9</sup>	5.4x10 <sup>8</sup>	4.3x10 <sup>8</sup>	3.6x10 <sup>8</sup>	6.9x10 <sup>8</sup>	2.1x10 <sup>8</sup>	1.0x10 <sup>8</sup>	1.0x10 <sup>8</sup>
<b>Tale+ Starch</b>	1.31x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.8x10 <sup>9</sup>	9.4x10 <sup>9</sup>	8.3x10 <sup>9</sup>	6x10 <sup>8</sup>	5.4x10 <sup>8</sup>	4.6x10 <sup>8</sup>	5.0x10 <sup>8</sup>	2.6x10 <sup>8</sup>	8.5x10 <sup>7</sup>	8.5x10 <sup>7</sup>
<b>KAI-26</b>													
<b>Peat</b>	7.4x10 <sup>9</sup>	6.2x10 <sup>9</sup>	5.9x10 <sup>9</sup>	5.3x10 <sup>9</sup>	4.4x10 <sup>9</sup>	3.8x10 <sup>9</sup>	2.7x10 <sup>8</sup>	1.9x10 <sup>8</sup>	1.5x10 <sup>8</sup>	6.5x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.8x10 <sup>7</sup>	1.3x10 <sup>7</sup>
<b>Lignite</b>	5.7x10 <sup>9</sup>	5.4x10 <sup>9</sup>	5.0x10 <sup>9</sup>	4.0x10 <sup>9</sup>	4.3x10 <sup>9</sup>	3.8x10 <sup>9</sup>	2.5x10 <sup>8</sup>	2.1x10 <sup>8</sup>	1.2x10 <sup>8</sup>	5.5x10 <sup>7</sup>	2.5x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.0x10 <sup>7</sup>
<b>Talc</b>	7.0x10 <sup>9</sup>	6.3x10 <sup>9</sup>	5.8x10 <sup>9</sup>	3.7x10 <sup>9</sup>	3.2x10 <sup>9</sup>	4.4x10 <sup>9</sup>	1.9x10 <sup>8</sup>	1.6x10 <sup>8</sup>	1.1x10 <sup>8</sup>	5.0x10 <sup>7</sup>	2.0x10 <sup>7</sup>	1.8x10 <sup>7</sup>	1.1x10 <sup>7</sup>
<b>Tale+ Starch</b>	8.2x10 <sup>8</sup>	7.6x10 <sup>8</sup>	7.2x10 <sup>8</sup>	5.9x10 <sup>8</sup>	5.1x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.1x10 <sup>8</sup>	1.9x10 <sup>8</sup>	1.4x10 <sup>8</sup>	7.0x10 <sup>7</sup>	3.5x10 <sup>7</sup>	1.5x10 <sup>7</sup>	4.5x10 <sup>6</sup>
<b>KAI-27</b>													
<b>Peat</b>	1.3x10 <sup>10</sup>	1.1x10 <sup>10</sup>	9.9x10 <sup>9</sup>	8.9x10 <sup>9</sup>	8.1x10 <sup>9</sup>	7.9x10 <sup>9</sup>	6.6x10 <sup>8</sup>	5.6x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.0x10 <sup>8</sup>	3.5x10 <sup>7</sup>
<b>Lignite</b>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	9.1x10 <sup>8</sup>	8.9x10 <sup>8</sup>	8.1x10 <sup>8</sup>	6.6x10 <sup>8</sup>	5.2x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.5x10 <sup>8</sup>	2.4x10 <sup>8</sup>	1.1x10 <sup>8</sup>	2.8x10 <sup>7</sup>
<b>Talc</b>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.4x10 <sup>8</sup>	8.9x10 <sup>8</sup>	8.9x10 <sup>8</sup>	7.8x10 <sup>8</sup>	6.5x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.7x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.5x10 <sup>8</sup>	9.0x10 <sup>7</sup>	2.4x10 <sup>7</sup>
<b>Tale+ Starch</b>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.9x10 <sup>8</sup>	8.9x10 <sup>8</sup>	8.3x10 <sup>8</sup>	7.3x10 <sup>8</sup>	5.8x10 <sup>8</sup>	5.6x10 <sup>8</sup>	4.5x10 <sup>8</sup>	2.9x10 <sup>8</sup>	2.1x10 <sup>8</sup>	7.5x10 <sup>7</sup>	3.5x10 <sup>7</sup>
<b>KAI-32</b>													
<b>Peat</b>	1.2x10 <sup>10</sup>	9.9x10 <sup>9</sup>	9.2x10 <sup>9</sup>	7.9x10 <sup>9</sup>	7.4x10 <sup>9</sup>	6.3x10 <sup>9</sup>	4.8x10 <sup>8</sup>	3.5x10 <sup>8</sup>	2.6x10 <sup>8</sup>	2.1x10 <sup>8</sup>	9.5x10 <sup>7</sup>	2.5x10 <sup>7</sup>	2.2x10 <sup>7</sup>
<b>Lignite</b>	1.2x10 <sup>9</sup>	1.1x10 <sup>9</sup>	9.6x10 <sup>8</sup>	9.0x10 <sup>8</sup>	8.1x10 <sup>8</sup>	7.4x10 <sup>8</sup>	5.2x10 <sup>8</sup>	3.7x10 <sup>8</sup>	2.7x10 <sup>8</sup>	2.3x10 <sup>8</sup>	1.0x10 <sup>8</sup>	5.5x10 <sup>7</sup>	2.5x10 <sup>7</sup>
<b>Talc</b>	9.6x10 <sup>9</sup>	9.2x10 <sup>9</sup>	8.8x10 <sup>9</sup>	8.4x10 <sup>9</sup>	7.5x10 <sup>9</sup>	6.6x10 <sup>9</sup>	6.7x10 <sup>8</sup>	4.2x10 <sup>8</sup>	2.7x10 <sup>8</sup>	1.9x10 <sup>8</sup>	8.0x10 <sup>7</sup>	4.0x10 <sup>7</sup>	1.4x10 <sup>7</sup>
<b>Tale+ Starch</b>	1.3x10 <sup>9</sup>	1.2x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.8x10 <sup>8</sup>	8.8x10 <sup>8</sup>	7.1x10 <sup>8</sup>	4.9x10 <sup>8</sup>	3.6x10 <sup>8</sup>	2.2x10 <sup>8</sup>	7.0x10 <sup>7</sup>	2.5x10 <sup>7</sup>	1.2x10 <sup>7</sup>
<b>KAI-90</b>													
<b>Peat</b>	1.3x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.0x10 <sup>10</sup>	9.5x10 <sup>9</sup>	9.3x10 <sup>9</sup>	8.1x10 <sup>9</sup>	5.6x10 <sup>8</sup>	4.8x10 <sup>8</sup>	4.0x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.2x10 <sup>8</sup>	1.0x10 <sup>8</sup>	2.8x10 <sup>7</sup>
<b>Lignite</b>	1.2x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.6x10 <sup>8</sup>	8.5x10 <sup>8</sup>	8.1x10 <sup>8</sup>	7.6x10 <sup>8</sup>	6.0x10 <sup>8</sup>	5.0x10 <sup>8</sup>	4.1x10 <sup>8</sup>	2.9x10 <sup>8</sup>	2.0x10 <sup>8</sup>	6.5x10 <sup>7</sup>	2.2x10 <sup>7</sup>
<b>Talc</b>	9.9x10 <sup>9</sup>	9.4x10 <sup>9</sup>	9.3x10 <sup>9</sup>	7.2x10 <sup>9</sup>	6.2x10 <sup>9</sup>	5.4x10 <sup>9</sup>	5.9x10 <sup>8</sup>	5.1x10 <sup>8</sup>	4.0x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.1x10 <sup>8</sup>	9.5x10 <sup>7</sup>	1.5x10 <sup>7</sup>
<b>Tale+ Starch</b>	1.4x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	6.7x10 <sup>8</sup>	5.6x10 <sup>8</sup>	6.1x10 <sup>8</sup>	4.6x10 <sup>8</sup>	4.1x10 <sup>8</sup>	3.0x10 <sup>8</sup>	2.1x10 <sup>8</sup>	1.7x10 <sup>7</sup>	1.4x10 <sup>7</sup>
<b>KAI-180</b>													
<b>Peat</b>	1.7x10 <sup>10</sup>	1.4x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.1x10 <sup>10</sup>	8.9x10 <sup>9</sup>	6.2x10 <sup>8</sup>	5.3x10 <sup>8</sup>	4.1x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.2x10 <sup>8</sup>	9.5x10 <sup>7</sup>	6.3x10 <sup>7</sup>
<b>Lignite</b>	8.4x10 <sup>9</sup>	8.1x10 <sup>9</sup>	7.5x10 <sup>9</sup>	6.5x10 <sup>9</sup>	6.1x10 <sup>9</sup>	5.6x10 <sup>9</sup>	4.2x10 <sup>8</sup>	3.5x10 <sup>8</sup>	2.6x10 <sup>8</sup>	2.9x10 <sup>8</sup>	2.0x10 <sup>8</sup>	7.5x10 <sup>7</sup>	2.2x10 <sup>7</sup>
<b>Talc</b>	7.9x10 <sup>9</sup>	7.6x10 <sup>9</sup>	7.0x10 <sup>9</sup>	6.5x10 <sup>9</sup>	6.0x10 <sup>9</sup>	5.2x10 <sup>9</sup>	3.5x10 <sup>8</sup>	2.6x10 <sup>8</sup>	1.6x10 <sup>8</sup>	8.0x10 <sup>7</sup>	3.5x10 <sup>7</sup>	2.5x10 <sup>7</sup>	2.0x10 <sup>7</sup>
<b>Tale+ Starch</b>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	8.9x10 <sup>8</sup>	8.3x10 <sup>8</sup>	7.9x10 <sup>8</sup>	6.3x10 <sup>8</sup>	4.8x10 <sup>8</sup>	4.1x10 <sup>8</sup>	2.0x10 <sup>8</sup>	1.0x10 <sup>8</sup>	4.5x10 <sup>7</sup>	2.6x10 <sup>7</sup>	1.2x10 <sup>7</sup>
<b>MMA-32</b>													
<b>Peat</b>	1.5x10 <sup>10</sup>	1.2x10 <sup>10</sup>	1.1x10 <sup>10</sup>	1.0x10 <sup>10</sup>	9.1x10 <sup>9</sup>	8.5x10 <sup>9</sup>	6.1x10 <sup>8</sup>	5.3x10 <sup>8</sup>	4.2x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.5x10 <sup>8</sup>	1.2x10 <sup>8</sup>	4.5x10 <sup>7</sup>
<b>Lignite</b>	1.4x10 <sup>9</sup>	1.2x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.7x10 <sup>8</sup>	9.0x10 <sup>8</sup>	8.3x10 <sup>8</sup>	6.7x10 <sup>8</sup>	5.7x10 <sup>8</sup>	4.4x10 <sup>8</sup>	3.3x10 <sup>8</sup>	2.7x10 <sup>8</sup>	1.3x10 <sup>8</sup>	1.5x10 <sup>7</sup>
<b>Talc</b>	1.3x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.6x10 <sup>8</sup>	8.9x10 <sup>8</sup>	8.3x10 <sup>8</sup>	5.8x10 <sup>8</sup>	5.4x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.6x10 <sup>8</sup>	2.5x10 <sup>8</sup>	1.1x10 <sup>8</sup>	3.5x10 <sup>7</sup>
<b>Tale+ Starch</b>	1.3x10 <sup>9</sup>	1.1x10 <sup>9</sup>	1.0x10 <sup>9</sup>	9.5x10 <sup>8</sup>	8.9x10 <sup>8</sup>	7.0x10 <sup>8</sup>	4.5x10 <sup>8</sup>	3.8x10 <sup>8</sup>	3.2x10 <sup>8</sup>	2.5x10 <sup>8</sup>	1.7x10 <sup>8</sup>	6.0x10 <sup>7</sup>	4.0x10 <sup>7</sup>

Cont...

at a low cost and in a sustainable manner.

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