St. Joseph's Journal of Humanities and Science (Volume 9 Issue 1 January 2022) 17-23

St. Joseph's Journal of Humanities and Science

ISSN: 2347 - 5331

http://sjctnc.edu.in/6107-2/

A Comparative Study on Generation of Vermicompost Using a Fitting Gamma Distributed Random Effects Model

M. Vijayasankar[a*]

T. Ganesh Kumar[a]

ABSTRACT

The goal of the present study is to use of the deleterious hydro habitat aquatic weed *salvinia molesta* in converting vermicompost. This study shows the epigeic earthworms *Eudrilus eugeniae* and *Eisenia fetida* are applied for the purpose in vermireactors which are operated in continuous and batch mode. Also, to find their significant difference between the two earthworms using a fitting gamma distributed random effects model and derive its conclusion using SAS.

Keywords: Random effect model, vermicompost, SAS.

INTRODUCTION

Vermicompost is a natural and an eco-friendly bio fertilizer; the salvinia has a very high growth rate in terms of adaptability and competitiveness (Mitchell, 1970; Gaudet, 1973; Abbasi, and Nipaney, 1982 and Abbasi and Nipaney, 1985). The benefits of vermicompost are eco friendly bio fertilizer, improves root growth of plant, it is richer in micro nutrients and Improves soil structure. In developing countries, the collision of salvinia can be demoralizing as the weed mats mass the use of waterways for transportation, cutting off access to main services, farm lands, and hunting grounds (Thomas and Room, 1986; Bennett, 1966). *Salvinia molesta* (Mitchell), since it is a free hanging aquatic weed which has populated several parts of this world, notably India, Australia and Africa (Abbasi and Nipaney, 1985 and Ganeshkumar *et.al*., 2014). In this present study is to use of the deleterious hydro habitat aquatic weed *salvinia (S.molesta)* in converting vermicompost and comparing the modes by using gamma distribution model then analyse which mode is best for growing the plant.

[a*] Department of Statistics, St. Joseph's College of Arts and Science (Autonomous), Cuddalore-607 001, Tamil Nadu, India.

[a] Department of Zoology, St. Joseph's College of Arts and Science (Autonomous), Cuddalore-607 001, Tamil Nadu, India.

[*] E-mail: drvijayam81@gmail.com

VERMICOMPOSTING

A Circular, 7 Liter plastic Peakers (dia. 16 cm, depth 5 cm) are used as vermiconversion reactors. Healthy, adult *eugeniae* and *fetida* earthworm are randomly collected from the vermised maintained in the vermin hut, using animal dung as feed and used to conduct experiment. Each and every vermiconversion reactor is operated with earthworm density of 50/lit. of reactor. One kg (dry weight) of *Salvinia molesta* is kept over the triple layer of water soaked moist jute cloth used as bedding in the vermiconversion reactor (5lit. volume). All the vermiconversion reactors are supported in an identical situation with respect to moisture and temperature. vermiconversion reactors are operated in double modes (1) batch (2) continuous and one control reactor with everything the same as batch and continuous reactors, but without earthworms are operated.

BATCH MODE

The vermiconversion is stimulated in batch mode are harvested once in every 10 days to analyze the vermicast creation. The adult animals are collected, washed and blotted dry for weighing, and then immediately kept back in the reactors which are restarted with left over feed. The juveniles, if any, created in the before period, are separated and the 200 worms, with which the reactors has been started, are weighed and reintroduced. If there is any mortality, the required numbers of new adult earthworms are introduced to maintain the same number of worms.

CONTINUOUS MODE

In continuous mode of reactor, the procedure followed as the same of batch reactor, but each and every period is started again with left over substrate (salvinia) as feed from the before period. Also, the feed from control reactor equivalent to quantity of vermicast (dry weight) harvested from the before period is added as feed. In both continuous and batch mode reactors, when all the feed are consumed or very low feed was left, the reactors are started with new feed.

REACTOR OF VERMICOMPOST

In reactors with E.eugeniae, the vermicast improvement as the division of the feed mass was less than 8.2 and 8.0 % during the first and second period of the reactor operation. This representing the earthworms, it had been cultured with manure as the primary feed, obtained some time to adapt with the change over to salvinia feed. There was slow enlarge in vermicast output in the next period. Finally, in the 5th period, Vermicast output of 12.5% was recorded. In subsequent period, there was slowly increase in vermicast upto 9th period. From 10th to 18th period, the reactor output was following a specific trend; the maximum vermicast production of cast of 38% was recorded in the 18th run.

GENERALIZED LINEAR MODEL

The class of generalized linear models discussed (Nelder and Wedderburn 1972). It is a traditional linear model of mean population of depends on a linear predictor model via a nonlinear link function method. McCullagh and Nelder (1989) discussed the statistical methods for applying in generalized linear models. Aitkin et. al., (1989) and Dobson (1990) gave many illustrations of generalized linear models.

Gamma Distribution of Random Effects Models

The log-likelihood for a random-effects model is

$$\mathcal{L} = \log \prod_{j=1}^{n} \int_{-\infty}^{\infty} f\left(\epsilon_j\right) \left\{ \prod_{t=1}^{n_i} f_y \left(x_{jt}\beta + \epsilon_j \right) \right\} d\epsilon_j$$

where f_y is the assumed density function of entire this model result and f is the density function of the i.i.d random effects model of ϵ_j. The estimating equation is derived of the log-likelihood in terms of β and the parameters of the assumed random-effects distribution.

(Cameron and Trivedi 2013; Allison 2009; Hausman et. al., 1984) -A random effects model might be derived from a gamma distribution to random effect with Poisson setting. This distribution follows to an analytic output of the integral in the likelihood.

For a random effects model specification, w.k.t

$$\Pr(y_{j1},\ldots,y_{jn_j}\mid\alpha_j,x_{j1},\ldots,x_{jn_j})=\left(\prod_{t=1}^{n_j}\frac{\lambda_{jt}^{y_{jt}}}{y_{jt}!}\right)\exp\left\{-\exp(\alpha_j)\sum_{t=1}^{n_j}\lambda_{jt}\right\}\exp\left(\alpha_j\sum_{t=1}^{n_j}y_{jt}\right)$$

In this general Poisson model we use this hypothesize that the average of the outcome variable y is denoted by λ_{jt} = exp($x_{jt}\beta$) and this panel setting we decide that each panel has a different average that is represented by exp(x_{jt} $\beta+\alpha_j$)=λ_{jt} ϵ_j. Since the random effect model ϵ_j = exp(α_j) is +ve, we choose a gamma distribution adding the restriction that this mean of the random effect is equal to one. So that there is only one more additional parameter "θ" to be obtained.

$$f(\epsilon_j)=\frac{\theta^\theta}{\Gamma(\theta)}\epsilon_j^{\theta-1}\exp(-\theta\epsilon_j)$$

Hence, we take the product to obtain the j.d.f function for the observations of a single panel is written by

$$\Pr(y_{j1},\ldots,y_{jn_j}\mid\epsilon_j,x_{j1}\ldots,x_{jn_j})=\left\{\prod_{t=1}^{n_j}\frac{(\lambda_{jt}\epsilon_{jt})^{y_{jt}}}{y_{jt}!}\right\}\exp\left(-\sum_{t=1}^{n_j}\lambda_{jt}\epsilon_{jt}\right)$$

$$=\left\{\prod_{t=1}^{n_j}\frac{\lambda_{jt}^{y_{jt}}}{y_{jt}!}\right\}\exp\left(-\epsilon_j\sum_{t=1}^{n_j}\lambda_{jt}\right)\epsilon_j^{\sum_{t=1}^{n_j}y_{jt}}$$

Moreover, since all the panels are independent and the joint density function of all panels connected with each of the panels.

Now, we are assuming that ϵ_j follows a gamma distribution with average value is one and variance is $1/\theta$ hence the unconditional on ϵ_j

$$\Pr(y_{j1},\ldots,y_{jn_j}\mid X_j)=\frac{\theta^\theta}{\Gamma(\theta)}\left(\prod_{t=1}^{n_j}\frac{\lambda_{jt}^{y_{jt}}}{y_{jt}!}\right)\int_0^\infty\exp\left(-\epsilon_j\sum_{t=1}^{n_j}\lambda_{jt}\right)\epsilon_j^{\sum_{t=1}^{n_j}y_{jt}}\epsilon_j^{\theta-1}\exp(-\theta\epsilon_j)d_{\epsilon_j}$$

$$=\frac{\theta^\theta}{\Gamma(\theta)}\left(\prod_{t=1}^{n_j}\frac{\lambda_{jt}^{y_{jt}}}{y_{jt}!}\right)\int_0^\infty\exp\left\{-\epsilon_j\left(\theta+\sum_{t=1}^{n_j}\lambda_{jt}\right)\right\}\epsilon_j^{\theta+\sum_{t=1}^{n_j}y_{jt}-1}d_{\epsilon_j}$$

$$=\left(\prod_{t=1}^{n_j}\frac{\lambda_{jt}^{y_{jt}}}{y_{jt}!}\right)\frac{\Gamma\left(\theta+\sum_{t=1}^{n_j}y_{jt}\right)}{\Gamma(\theta)}\left(\frac{\theta}{\theta+\sum_{t=1}^{n_j}\lambda_{jt}}\right)^{è}\left(\frac{1}{\theta+\sum_{t=1}^{n_j}\lambda_{jt}}\right)^{\sum_{t=1}^{n_j}y_{jt}}$$

for $X_j=(x_{j1},\ldots,x_{jn_j})$

The log likelihood (follows gamma heterogeneity) is then derived and applying

$$v_j=\frac{\theta}{\theta+\sum_{t=1}^{n_j}\lambda_{it}}\quad\text{and}\quad\lambda_{jt}=\exp(x_{jt}\beta)$$

$$\Pr\left(Y_{j1}=y_{j1},\ \ldots,\ Y_{jn_j}=y_{jn_j}\mid X_j\right)=\frac{\prod_{t=1}^{n_j}\lambda_{jt}^{y_{jt}}\Gamma\left(\theta+\sum_{t=1}^{n_j}y_{jt}\right)}{\prod_{t=1}^{n_j}y_{jt}!\,\Gamma(\theta)\left(\sum_{t=1}^{n_j}\lambda_{jt}\right)^{\sum_{t=1}^{n_j}y_{jt}}}v_j^{\theta}\left(j-v_j\right)^{\sum_{t=1}^{n_j}y_{jt}}$$

The log-likelihood for gamma distributed - random effects model may then be solved by integrating over ϵ_j. We note that by rearranging the terms in the joint density function of the integral term may be modified to one since it is the integral of another gamma random variable. After modification the log-likelihood function is then specified equation as

$$\mathcal{L}=\sum_{j=1}^{n}w_j\left\{\log\Gamma\left(\theta+\sum_{j=1}^{n_j}y_{jt}\right)-\sum_{j=1}^{n_j}\log\Gamma\left(1+y_{jt}\right)-\log\,\Gamma(\theta)+\theta\,\log\,v_j\right.$$

$$\left.+\log\left(1-v_j\right)\left(\sum_{t=1}^{n_j}y_{jt}\right)+\sum_{t=1}^{n_j}y_{jt}\left(x_{jt}\beta\right)\right\}-\left(\sum_{t=1}^{n_j}y_{jt}\right)\log\left(\sum_{t=1}^{n_j}\lambda_{jt}\right)$$

Where w_j is the user – specified weight for panel j; if no weights obtained w_j=1.

The estimating equation $\psi(\Theta)=\psi(\beta,\theta)$ for a gamma distributed random effects Poisson model is then given by setting the derivative of the log-likelihood to zero

$$\begin{bmatrix}\left\{\dfrac{\partial L}{\partial\beta_i}\right\}\\ \left\{\dfrac{\partial L}{\partial\theta}\right\}\end{bmatrix}_{(p+1)\times 1}=[0]_{(p+1)\times 1}$$

Where

$$\frac{\partial\mathcal{L}}{\partial\beta_i}=\sum_{j=1}^{n}\sum_{t=1}^{n_j}x_{ijt}\left[y_{jt}+\lambda_{jt}\left(\left(v_j-1\right)\frac{\sum_{l=1}^{n_j}y_{jl}}{\sum_{l=1}^{n_j}\lambda_{jl}}-v_j\right)\right]\left(\frac{\partial\lambda}{\partial\alpha}\right)_{jt}$$

$$\frac{\partial\mathcal{L}}{\partial\theta}=\sum_{j=1}^{n}\left[\psi\left(\theta+\sum_{j=1}^{n_j}y_{jt}\right)-\psi(\theta)+\ln\,v_j+\left(1-v_j\right)-\frac{v_j}{\theta}\sum_{j=1}^{n_j}y_{jt}\right]$$

and v_j is defined in equation (6), in this derivation with respect to θ equation (11). Note: we use ψ() (Capital Psi) it represents the estimating equation. We are fitting this gamma distributed random effects Poisson model for vermicompost data.

STATISTICAL ANALYSIS AND INTERPRETATION

The standard results of fitting this gamma distributed - random effects model for the vermicompost data are obtained as in the below Table 1 to Table 4.

Table: 1

Parameter	Degrees of Freedom	Estimate Value	S.E	Wald 95% CL		χ^2- Value	P- Sig.Value
Intercept	1	2.8139	0.1218	2.5752	3.0526	533.80	<0.0001
Continuous mode (E.eugeniae and E.fetida)	1	0.1491	0.1722	-0.1885	0.4867	0.75	<0.3866
scale	1	3.7453	0.8464	2.450	5.8324		

Table: 2

Parameter	Degrees of freedom	Estimate	S.E	Wald 95% CL		χ^2- Value	P- Sig.Value
Intercept	1	2.2488	0.1083	2.0365	2.4612	430.90	<0.0001
Discrete mode (E.eugeniae and E.fetida)	1	-0.0887	0.1532	-0.3890	0.2116	0.34	<0.5626
scale	1	4.7336	1.0787	3.0284	7.3988		

Table: 3

Parameter	Degrees of freedom	Estimate	S.E	Wald 95% CL		χ^2- Value	P- Value
Intercept	1	2.1601	0.1186	1.9276	2.3927	331.52	<0.0001
Both mode (E.eugeniae)	1	0.8029	0.1678	0.4741	1.1318	22.90	<0.0001
scale	1	3.9471	0.8938	2.5324	6.1522		

Table: 4

Parameter	Degrees of freedom	Estimate	S.E	Wald 95% CL		χ^2- Value	P- Value
Intercept	1	2.2488	0.1118	2.0297	2.4680	404.43	<0.0001
Both mode (E.fetida)	1	0.5651	0.1581	0.2551	0.8750	12.77	<0.0004
scale	1	4.4428	1.0183	2.8451	6.9379		

***Table 1, 2, 3 and 4 are Analysis of Parameter Estimates Table**

Table: 1(a)

Source	Degrees of freedom	χ^2- Value	P- Value
Continuous mode (E.eugeniae and E.fetida)	1	0.74	0.3891

Table: 2(a)

Source	Degrees of freedom	χ^2- Value	P- Value
Discrete mode (E.eugeniae and E.fetida)	1	0.33	0.5635

Table: 3(a)

Source	Degrees of freedom	χ^2- Value	P- Value
Both mode (E.eugeniae)	1	17.69	<0.0001

Table : 4(a)

Source	Degrees of freedom	χ^2- Value	P- Value
Both mode (E.fetida)	1	10.92	0.0022

***Table 1(a), 2(a), 3(a) and 4(a) are LR Statistics for Type 3 Analysis**

Table 1 shows that the fitting of linear model for the parameter of gamma distribution in GLM. Further, the P value is 0.3891 for the chi- square test statistic in this Type 3 analysis table 1(a) specified that the parameters of E.eugeniae and E.fetida are insignificant between the continuous modes. Table 2 shows that the fitting of linear model for the parameter of gamma distribution in GLM. Further, the P value of 0.5635 for the chi- square test statistic in the Type 3 analysis table 2(a) specified that the parameter of E.eugeniae and E.fetida are also insignificant between the discrete modes. Table 3 shows that the fitting of linear model for the parameter of gamma distribution in GLM. Further, the P value of 0.0001 for the chi- square test statistic in the Type 3 analysis table 3(a) specified that the parameter of E.eugeniae is highly significant between the both modes. Table 4 shows that the fitting of linear model for the parameter of gamma distribution in GLM. Further, the P value of 0.0022 for the chi- square test statistic in the Type 3 analysis table 4(a) Specified that the parameter of E.fetida is highly significant between the both modes.

CONCLUSION

In terms of efficiency of vermiconversion from reactors operated in continuous and batch modes have been successfully studied. From Table 3 and Table 4 showed that the P value of E.eugenia is 0.0001 and P –value of E.fetida is 0.0022 are compared with the standard P- value 0.05. From which both are significant but E.eugenia P value is highly significant when compare to P value of E.fetida. Hence, the continuous mode worked better than batch mode for both species. Between the two species, E.eugeniae is better performer than E.fetida in terms of vermicast generation. The earthworms hesitate to take fresh feed and accepted it as a diet only when used salvinia became older.

REFERENCES

1. Abbasi, S.A. and Nipaney, P.C., 1982. Tolerance and Growth of Salvinia on Waters Treated with Trace Elements. Basic Data Report No. WQE/BD-8/82, CWRDM, Calicut, p. 47.
2. Abbasi, S.A. and Nipaney, P.C., 1985. Wastewater treatment using aquatic plants. Survivability and growth of salvinia molesta (mitchell) over waters treated with zinc(i1) and the Subsequent utilization of the harvested weeds for Energy (biogas) production.
3. Bennett, F. D. 1966. Investigations on the insects attacking the aquatic ferns, Salvinia spp. in Trinidad and northern South America. Proceedings of the Southern Weed Conference 19: 497-504.
4. Ganeshkumar,T., Premalatha.M., Gajalakshmi. S., and Abbasi, S. A., 2014. New process for the rapid and direct vermicomposting of the aquatic weed salvinia (Salvinia molesta). Bioresources and Bioprocessing , 1:26.
5. Gaudet, J.J., 1973. Growth of a floating aquatic weed, Salvinia, under standard conditions. Hydrobiologia, 41: 77-106.