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STUDIES ON THE CULTURE OF THE EARTHWORM, *EUDRILUS EUGINAE*, AND ITS USE AS FEED FOR *MACROBRACHIUM IDELLA* AND FERTILIZER SOURCE FOR *BRASSICA COMPENSIS*

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ABSTRACT

Studies on the culture of *Eudrilus euginae* in boxes with different levels of pig manure, feeding of dried *E. euginae* to the freshwater shrimp, *Macrobrachium idella*, and the application of earthworm castings (vermicompost) as fertilizer for pechay (*Brassica compensis*) were conducted.

The best production of *E. euginae* was obtained with 75% manure and 25% sawdust as bedding. Earthworm castings from the treatment had the lowest nitrogen, potassium and organic matter contents. Results indicated that nutrient content of vermicompost decreases with increase in earthworm production.

M. idella fed with the earthworm had higher total weight gain, lower feed conversion ratio and greater production of juveniles compared with those of the shrimp fed with the dried freshwater fish, *Therapon plumbeus*. *E. euginae* had greater values of crude protein and fat on a moisture-free basis basis compared with *T. plumbeus*.

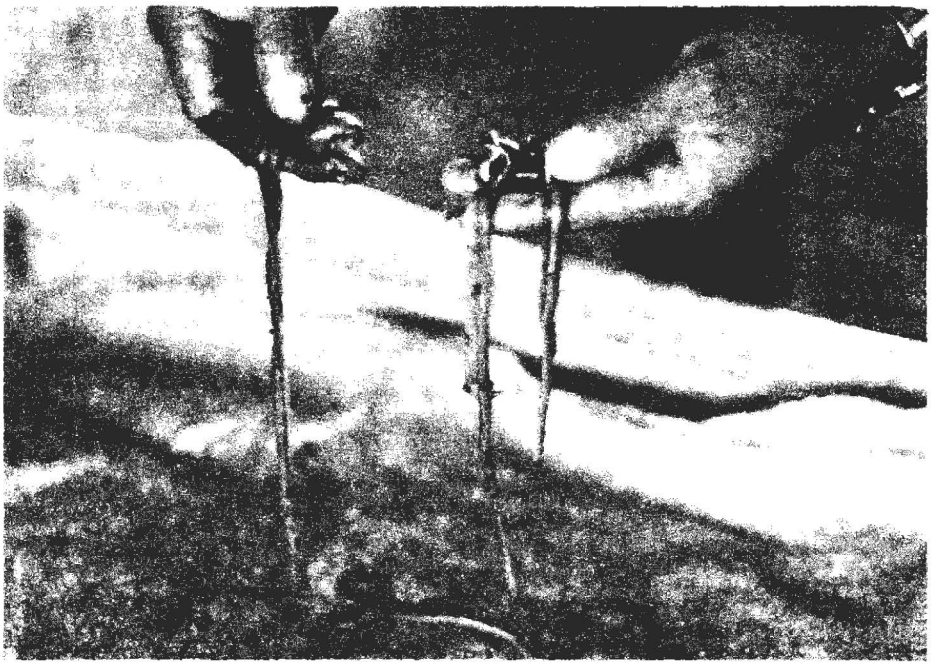
The highest yield of *pechay* was achieved with fertilization using 50% vermicompost and 50% complete fertilizer. Yields of *pechay* with partial vermicompost fertilization were significantly greater compared with that using 100% complete fertilizer. Fertilization cost with 100% vermicompost was lowest.

Introduction

The present foreign exchange crisis of the Philippines is expected to reduce the importation of animal feed ingredients and chemical fertilizers. There is an urgent need for the development of import substitutes using local and available resources.

Earthworms have been identified as potential sources of animal protein for poultry, livestock and fish feeds (Ulep, 1982; Sabine, 1978; Guerrero, 1983). Earthworm meal has been analyzed to have high quality protein (67-70% crude protein) comparable with that of imported fish meal. It also has higher metabolizable energy than fish meal (Ulep, 1982).

In studies conducted by Guerrero (1983), weight gain, survival rate and feed conversion of *Tilapia nilotica* fed with a diet containing 15% earthworm meal (*Perionyx excavatus*) were significantly better than those of *T. nilotica* fed with



African nightcrawler *(Eudrilus euginae)* breeders

a standard diet containing fish meal. According to Pascual (personal communication), addition of 5% earthworm meal in the feed of *Penseus monodon* improved attractability of pellets and significantly increases weight gain of the prawn compared with the fish meal-diet.

Earthworm castings (vermicompost) have value as soil amendments or as organic fertilizer. The castings have a high cation-exchange rate with a carbon to nitrogen ratio under 20:1 which is suitable for plant assimilation. Castings produced from animal waste contain 3.0% nitrogen (dry weight), 0.32% phosphorous and 0.4% potassium (Dacayo, 1981).

In pot experiments, Dacayo (1981) found the positive response of lettuce, ginger, *Portulaca oleracea*, African daisy and *pechay* to varying proportions of soil and vermicompost. Significantly higher yields were obtained with 50% soil and 50% vermicompost with lettuce, 100% vermicompost for ginger, and 25% soil + 75% vermicompost for *P. oleracea* and *pechay* over the control (soil).

The earthworm *Eudrilus euginae* is an introduced species in the Philippines. Egg capsules of the earthworm were received by the senior author from Dr. Otto Graff of West Germany in 1982. The species originates from West Africa and is widely distributed in tropical and subtropical countries. *E. euginae* is fast-growing and recommended for vermicomposting in the tropics (Graff, 1981).

We conducted three studies. Study I was to determine the effect of different

Culture boxes of *Eudrilus eugenae*

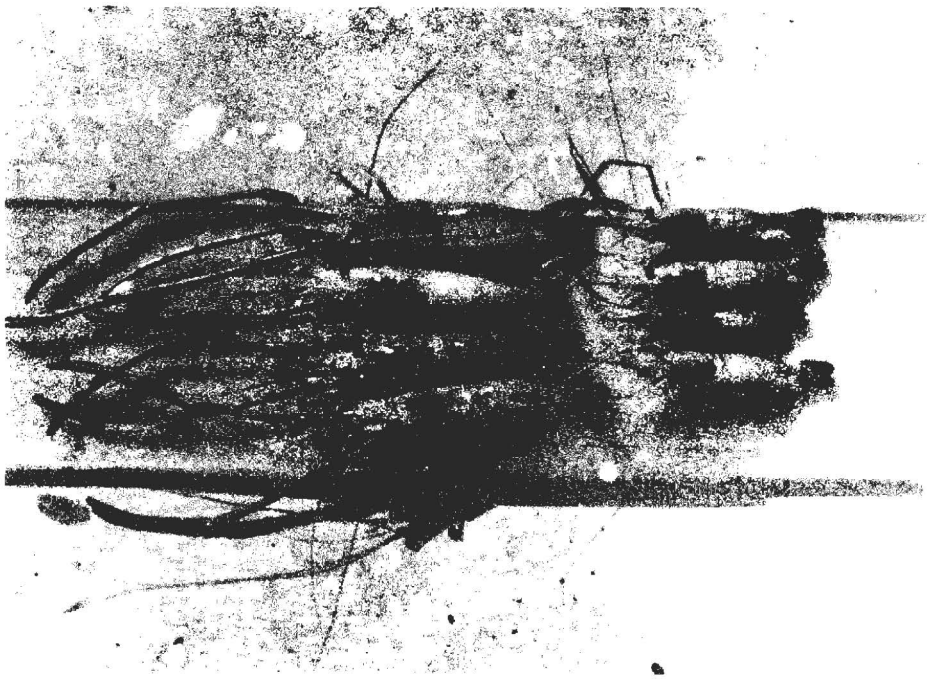
pig manure levels on the growth of *E. eugenae* cultured in boxes. Study II was on the feeding of dried *E. eugenae* to the freshwater shrimp *Macrobrachium idella* in outdoor pools. The use of vermicompost for fertilizing *pechay* (*Brassica compensis*) in field plots was evaluated in Study III.

Materials and Methods

Study I was conducted at the Technology Resource Center's Vermiculture Project in San Ildefonso, Bulacan. Wooden boxes measuring 61 x 46 x 20 cm each and lined with polyethylene sheets were used as culture units. Three levels of pig manure were tested for growth of *E. eugenae*. The treatments were: I – 100% manure, II – 75% manure + 25% sawdust, and III – 50% manure + 50% sawdust. Eight kilograms of the dried bedding were placed in each box. Water was mixed with the bedding to maintain a moisture content of 60-80%. The bedding was allowed to ferment for one week before stocking of the earthworm.

Juvenile *E. eugenae* was stocked at 200 g per box. Four replicates (boxes) were used for each treatment. The boxes were kept under a shed and watered regularly to maintain moisture. Total fresh weight of the earthworm in each box was weighed after 30 days of culture. Samples of the castings were analyzed for NPK, organic matter and pH.

Study II was conducted at the Bureau of Fisheries and Aquatic Resources



Adult male (left) and female *Macrobrachium idella*

Fisheries Station in Los Baños, Laguna. Four 36-m^2 concrete pools with earth bottoms and maximum depth of 1m were used. The pools were filled with water from a shallow well to a depth ranging from 0.4 to 0.6 m. Dried chicken manure was applied at 1 ton/ha in the pools as basal fertilizer.

Live adults of the freshwater shrimp *Macrobrachium idella* were collected from Laguna Lake. Each pool was stocked with 96 g of *M. idella* with average individual weights of 5.6 to 5.8 g.

Two feeding regimes were tested. Dried *Therapon plumbeus*, a freshwater fish, was fed to the shrimp in two pools. Dried *E. euginae* was fed to the shrimp in the other two pools. Feeding was done daily for 60 days at the rate of 20% of shrimp biomass.

The total weight gain (adults and juveniles), feed conversion and juvenile production of the shrimp were evaluated after the two-month culture period. Proximate analyses of *T. plumbeus* and *E. euginae* samples were done.

Study III was also conducted in San Ildefonso, Bulacan. The soil in the experimental area was light-textured. Soil analysis showed it to have 1.8% organic matter, 47 ppm phosphorus, 8 ppm potassium and pH of 4.9.

Twelve plots measuring 5 x 1 m each were used. *Pechay* seedlings were planted 30 cm apart in three rows with 15 plants per row in each plot. Four fertilizer treatments were tested, namely: I -- vermicompost only, II – 50% vermi-

Pechay (*Brassica compensis*) fertilized with vermicompost

compost + 50% complete fertilizer (14-14-14). III – 25% vermicompost + 75% complete fertilizer, and IV – 100% complete fertilizer. Each treatment had three plots.

The fertilizers were applied at the rate of 25 g per plant for each application. One fertilizer application was done at planting and another after two weeks. The plots were watered regularly as needed.

The plants were harvested after 30 days from planting. Total yield of *pechay* and cost of fertilizer per plot were determined.

Results and Discussion

The results on the production of *E. euginae* with different levels of pig manure are presented in Table 1. Analyses of the data showed that the highest production of the earthworm was obtained with 75% manure + 25% sawdust (Treatment II) followed by Treatment III. Treatments II and III were significantly different from Treatment I ($P<0.05$).

Analyses of the vermicompost samples produced in Study I (Table 2) showed that the sample from Treatment II had the lowest nitrogen, potassium and organic matter contents. This is to be expected because of the bioconversion of the nutrients into earthworm flesh. The results also indicate that the nutrient content of vermicompost decreases with increase in earthworm production.

Table 1. Production of *E. euginae* in boxes with different levels of pig manure after 30 days.

Treatment	*Weight Gain*[a] *(kg)*	*% Weight Increase*
I	0.94	470
II	1.83*	915
III	1.57*	785

[a]Mean of four replicates
*Means are not significantly different.

Table 2. Analyses of vermicompost samples (oven-dry) from Study I.

Treatment	*Nitrogen (%)*	*Phosphorous (%)*	*Potassium (%)*	*Organic Matter (%)*	*pH*
I	2.85	0.12	0.48	45	5.8
II	1.75	0.15	0.28	35	6.0
III	2.0	0.13	0.30	40	6.2

Table 3. Average total weight gains, feed conversion ratios and average number of juveniles of *M. idella* fed with *T. plumbeus* and *E. euginae* for 60 days.

Feed	*Ave. Total Wt. Gain (g)*	*Feed Conversion Ratio*[a]	*Ave. No. of Juveniles*
T. plumbeus	375	1.82	448
E. euginae	407	1.67	674

[a]Feed Conversion Ratio = $\frac{\text{Total feed given}}{\text{Total weight gain}}$

Table 4. Proximate analyses of *T. plumbeus* and *E. euginae*.

Nutrient (%)	*T. plumbeus*	*E. euginae*
Crude Protein	65.88	68.0
Fat	3.88	9.57
Nitrogen-Free Extract	22.35	11.05
Ash	7.29	9.07

Table 5. Average yield of pechay with different fertilizers and cost of fertilizer per plot after 30 days.

Treatment	*Ave. Yield/Plot (kg)*	*Cost of Fertilizer/Plot (₱)*
I	4.11*	2.25
II	4.66*	3.93
III	4.62*	4.78
IV	3.67	5.62

*Means are not significantly different.

All the samples were found to be slightly acidic. Of the three, however, the sample from Treatment I had the lowest pH. This may be attributed to its high organic matter content. Sawdust is believed to have benefited earthworm growth by improving texture and porosity of the bedding.

M. idella fed with the earthworm had higher average total weight gain, lower feed conversion ratio and greater average number of juveniles than with the fish feed (Table 3).

Proximate analyses of dried *T. plumbeus* and *E. euginae* (Table 4) showed that the latter had higher crude protein, fat, ash and crude fiber but lower nitrogen-free extract than the former on a moisture-free basis.

Our findings corroborate those of Pascual (personal communication) on the superiority of earthworm over fish as a feed for crustaceans. The amino acid profile of earthworm meal is comparable with that of imported fish meal and meat meal (Sabine, 1978). Lipids are known to be essential for the reproduction of animals.

The results of Study III show the advantages of the use of vermicompost (75% manure + 25% sawdust) over that of complete fertilizer for *pechay* in the study area (Table 5). The highest yield of *pechay* was achieved with Treatment II (50% vermicompost + 50% complete fertilizer). However, the lowest cost for fertilization was with Treatment I (vermicompost only). Treatments II and III were significantly different from Treatment IV ($P<0.05$).

The use of vermicompost is appropriate for light soils low in organic matter. With its high cation-exchange capacity, vermicompost provides cultured plants with more available nutrients in acidic soils (Dacayo, 1981). In general, the response of a plant to vermicompost will depend on soil conditions and the plant's nutritional requirements.

Acknowledgment

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Juliana B. Dacayo, Discussant

The use of vermicompost (VC) in agriculture as alternative/supplement to commercial fertilizer is timely during this period of energy crisis. Its relatively lower nitrogen content than most farmyard wastes like chicken manure thereby reducing its burning effect makes vermicompost safer to use in most crops.

Dr. and Mrs. Guerrero and myself started to work cooperatively on the earthworm and its castings at the Central Luzon State University in Nueva Ecija about five years ago. They concentrated their interest on the earthworm as protein source for feeds while I focused my attention on the utilization of the castings as nutrient source for agricultural crops.

The response of lettuce, pechay, ginger, green onions, *P. oleracea*, carrot, sweet corn and rice to added vermicompost is encouraging. Using vermicompost from a substrate consisting of cow manure, ipil-ipil and sawdust at equal proportion (1:1:1) in pot experiments, a mixture of 80% soil + 20% VC by volume proved best for lettuce, pechay, ginger, green onions and *P. oleracea* while in carrot 10% VC + 90% soil increased tuber yield by 29% over the control.

Field experiments on rice and sweet corn show that in corn an increment of 114% in ear yield was realized by the application of 5 tons VC. This was comparable to plants which received the recommended rate of inorganic fertilizer (60-40-0/ha.) Grain yield in rice was not affected up to an increment of 4 tons VC per hectare, however, 2 tons VC in addition to the recommended rate of inorganic fertilizer had 40% more grain yield than the control.

The residual effect of vermicompost had been tested on green onion in the greenhouse. The above-ground plant parts were cut every 30 days for 3 years. After the third year, plants in 20% vermicompost + 80% soil growth medium had total leaf yield comparable to those which received annually the recommended rate of inorganic fertilizer.

It is believed that the beneficial effect of vermicompost is a combination of its chemical, biological and physical properties which improve soil conditions making it more suitable for plant growth. The presence of enzymes beneficial to plants had been reported in the literature.

Aside from its favorable effect on plant growth, future studies should be geared on other aspects such as handling, storage as well as packaging in order to insure minimal nutrient losses prior to usage.