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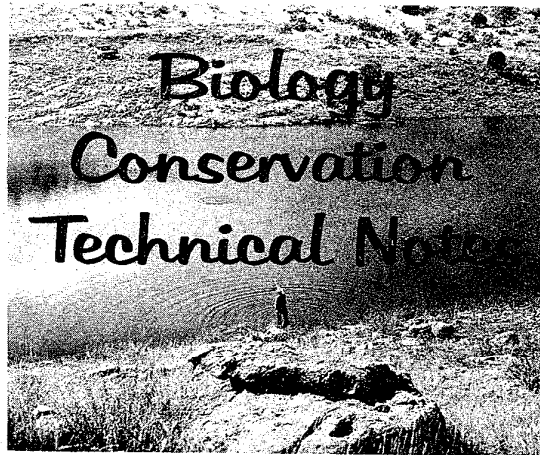


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U. S. DEPARTMENT OF AGRICULTURE NEW MEXICO SOIL CONSERVATION SERVICE

BIOLOGY NOTE NO. 17

August 10, 1971

SUBJECT: Animal Guides

Attached is a supply of a new issue in the Animal Guide Series entitled "Earthworm Culture" and a single copy of a completion report entitled "Commercial Production of Earthworms."

The animal guide is intended as a technical reference for work units, as well as for distribution to landowners interested in growing earthworms for both commercial and personal use.

The animal guide is a direct result of a field trial conducted in the Aztec Work Unit on commercial production of earthworms. The completion report is intended for SCS reference and is not for public distribution.

Additional copies of the animal guide may be ordered from the State Office Supply Room, using Form AD-14.

Attachment

AC's & DC's

Area Biologists

Regional Biologists - Portland, Lincoln, Forth Worth, Upper Darby

State Biologists: Arizona, California, Colorado, Idaho, Montana,
Nevada, Oregon, Washington, Wyoming & Utah

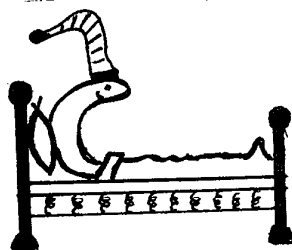
BIOLOGY

ANIMAL GUIDE

U. S. Dept. of Agriculture Albuquerque, New Mexico Soil Conservation Service

EARTHWORM CULTURE

Commercial earthworm growers in New Mexico have experienced production problems. The inability to standardize temperatures, bedding material and feeding practices has caused die-offs and uneven production. The Soil Conservation Service, in cooperation with interested commercial growers, has field tested a new production system which appears to be more satisfactory than commonly used methods.



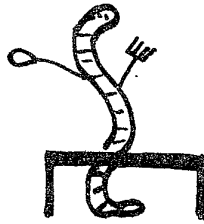
BEDDING

A bedding material prepared with equal parts of fine mesh PERLITE and ground newspaper has proven to be very satisfactory. Under production conditions the bedding remained friable, maintained a desirable moisture content and did not tend to become soured. The ratio of perlite to newspaper may be adjusted to meet local conditions. Perlite is a form of volcanic rock which is mined and processed primarily for use as a light weight aggregate in construction materials, insulation and greenhouse bedding.

To prepare the bedding material, remove and discard the color sections of newspapers, grind the paper in a hammermill using $\frac{1}{4}$ " or $\frac{1}{2}$ " screens. Mix in the perlite and wet the mixture to the point when two or three drops of water can be squeezed from a handful. This degree of "barely wet" should be maintained in the beds during production.

Oats may be sown on the beds, grown to 6" height, then turned under. Experience indicates that the oat sprouts may remove animal wastes and help to keep the bedding in superior condition.

Following a production cycle, the used bedding material is normally discarded. Beds are cleaned and disinfected and new bedding material is installed before restocking.



FEEDING

Information available to guide growers in the selection of recommended worm feeds has been sketchy and contradictory. Consequently, production rates and feeding schedules have been highly variable. Poor selection of feeds and poor feeding practices usually lead to disease and low quality production.

Some general guidelines for selecting a satisfactory production worm feed are:

1. Protein content should be less than 14 percent.
2. The protein should be from non-animal sources.
3. The protein should be supplied by a combination of plant sources.
4. The feed must be free of salt.
5. The feed must not contain herbicide or insecticide contamination.

Very satisfactory growth and reproduction, with no loss of bedding quality, was experienced during controlled feeding with commercial cow-calf supplements. This type of livestock feed is available under a number of trade names from most feed companies. Purina salt free "Grass Stretcher"* was utilized in feeding trials. These general types of livestock supplement feeds contain vitamins, minerals, multiple plant protein sources and contain no animal sources of protein.

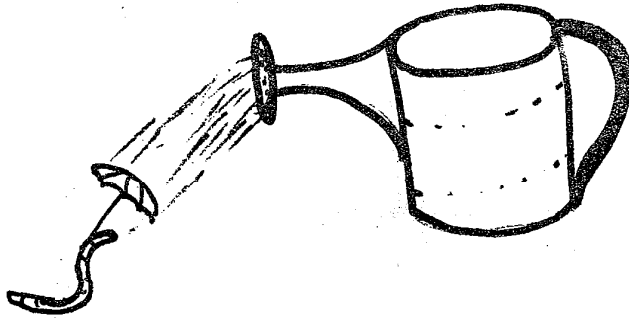
Finely ground whole corn has also proven to be a satisfactory production food. Insure that the corn has not been treated with pesticides.

Worms are fed by first wetting the surface of the bedding material, then spreading a 6 to 8 inch wide band of feed along the surface of the bed. A satisfactory production feeding rate is one ounce of feed for each square foot of bed.

The frequency of feeding will vary with bedding temperature and the density of worms in the bed. In most cases the food will be consumed in 2 to 3 days, at which time more food is distributed.

Overfeeding is not only wasteful but causes fermentation and degradation of the bedding. Toxic conditions in the bedding may be produced as a result of overfeeding or using unsuitable foods.

*The use of a trade name does not constitute an endorsement of product lines by the Soil Conservation Service, but is intended only as being descriptive of a general type of product.



WATERING

Some of the more serious production problems result from poor watering practices. The perlite-paper bedding material will maintain a desirable moisture content from the top of the bed to the bottom if watering is done properly. Over-watering will cause a pool of water to form in the bottom of the bed, which leads to fouling of the bedding material. When the bedding is allowed to dry out the worms move to deeper layers and cannot utilize the feed which is placed on the surface.

Worm beds should be sprinkled and not flooded. The bedding material should be kept fairly damp, but not saturated. Test the bedding material frequently to determine when watering is needed. Do not provide drainage openings in the bottom of the beds.

Maintaining a high humidity and a relatively constant air temperature in the building will help to stabilize watering practices. When beds are artificially heated it will be necessary to increase the frequency of watering.

The water used should be within a 10° F. temperature range of the bedding temperature. Cold water will shock the worms and production will decline.

Maintaining a pH of 7.0 to 8.0 in the bedding moisture appears to benefit production. Normal aging of the beds occurs during the production cycle as waste products and unconsumed feed accumulates. This aging process results in a lowered pH. Satisfactory production techniques for buffering to the desired pH range have not been developed.

GENERAL MANAGEMENT CONSIDERATIONS

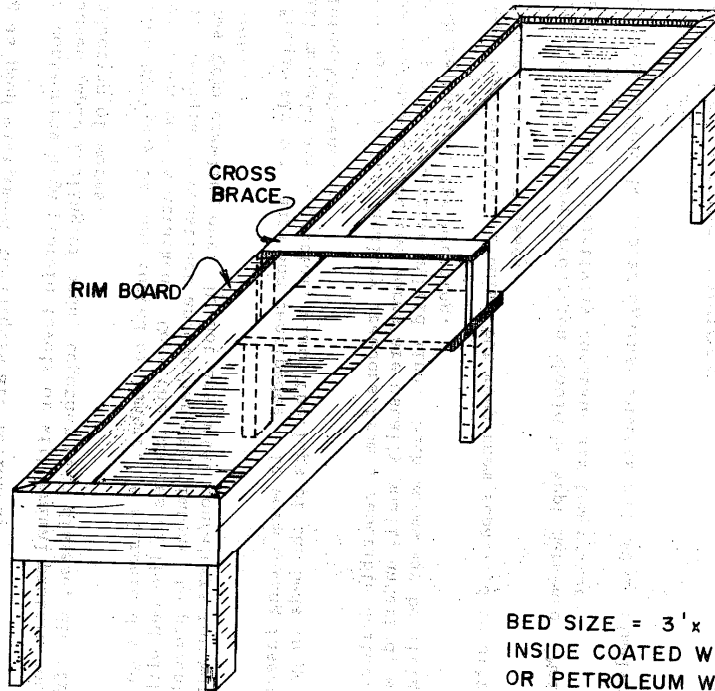
1. Peat and sphagnum moss have been traditionally used for bedding, as have various types of rotted manures. None of these bedding materials have proven to be as satisfactory as the perlite-paper mixture during production trials.
2. The perlite-paper mixture does not require frequent turning or mixing, as long as good management techniques are followed.
3. Rations containing high protein levels or with animal protein sources have caused rapid fouling of beds, together with disease, die off and low production of worms.
4. Production beds may be constructed of lumber. A standard design for a typical worm bed is attached. Coat the insides of the bed with parafin. Be sure to construct an overhanging rimboard to prevent the worms from crawling out. Do not use metal containers for worm production.
5. Check frequently for ants and centipedes. If worm eating insects or small mammals are a problem, place the legs of the beds in pails containing kerosene.
6. Purchase good quality, healthy breeders from a reputable dealer. Bargains are cheaper but the worms are usually small, underfed, or may be of a non-productive hybrid line. Such worms may be alright for fishing but not for breeding.
7. Grow more than one kind of worm; but keep them separated in different beds. Diversity is an asset.
8. Buildings used for worm production should be kept darkened. Maintain a high humidity and a relatively constant air temperature.

The building should be sealed against insects and small animals.

ADDITIONAL REFERENCE SOURCES

Shields Publications, P. O. Box 472, Elgin, Illinois 60120
publishes a general line of "How-to-do-it" booklets.

TYPICAL COMMERCIAL WORM BED



BED SIZE = 3' x 10'
INSIDE COATED WITH HOT PARAFIN
OR PETROLEUM WAX.
2" RIM BOARD - KEEPS WORMS FROM
CRAWLING OUT OF BEDS.
SIDES AND BOTTOM - 1" x 12" BOARDS
LEGS = 2" x 4" OR LARGER
BEDS MAY BE STACKED 2 OR 3 HIGH.

COMPLETION REPORT

Commercial Production of Earthworms

A Field Trial Conducted by

the

USDA - Soil Conservation Service

and

Animas Bait Company

Aztec, New Mexico

September 9, 1970

Prepared by

Roy Mann, District Conservationist
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Soil Conservation Service
New Mexico

ABSTRACT

Intensive earthworm culture is subject to significant production variables such as feeds and feeding techniques, ph of growing media, media, and water content of media. Differences in total production, expressed as weight-gain, were found when common varieties of earthworms were held for 90 days. Three different foods, three ph levels, drained and undrained beds, and a new soil-less bedding material were evaluated.

INTRODUCTION

This short term trial was conducted for the purpose of identifying some of the variable factors which influence intensive culture of earthworms.

Commercial growers have experienced serious death losses. These losses occur periodically as the bedding environment changes. These changes usually are the result of deterioration of the bedding and anaerobic conditions resulting from too much water in the beds. It seems to be somewhat traditional for commercial growers to use organic bedding materials. The most commonly used material is peat moss. This bedding material often causes massive die-offs. Generally such a situation is a mystery to the ordinary worm grower.

The purpose of this trial was to identify the causes of these die-offs and to determine the environmental variables which limit production. The trial was conducted in a manner that could be repeated by a commercial grower and without special laboratory equipment or atmosphere. The owner therefore conducted the trial with technical assistance from the Soil Conservation Service. The Animas Bait Company had standard ten by three by one foot beds. Some modification of the beds was necessary.

REVIEW OF LITERATURE

Literature available on commercial or intensive production of earthworms is very limited. Most manuals are written by commercial worm growers residing in the southeastern and midwest regions of the United States. Texts of these publications tend to be made up of, "Secrets to Worm Raising" or, "Observations of a Worm Grower". Careful review of these manuals show that contradictions within and between the materials render them virtually worthless to anyone interested in factual information on worm growing.

Some recommendations proved to be unsatisfactory or even lethal under some of New Mexico's conditions.

METHODS AND PROCEDURES

Beds - Twenty small beds of 1.97 sq. foot surface area were stocked with one hundred grams of thirty day old African night crawlers per bed. Ten beds were provided with drains and ten beds were undrained. Drainage was provided by plastic tubes with collection jars attached to the beds. Beds were sloped so that water collected on downslope ends. Tubes were regulated so that no more than .25 inches of water was allowed to collect in the bed.

Culture Media - Organic bedding materials customarily used for worm production vary greatly in composition and other properties. Horticultural grade perlite was used to eliminate this variable. Perlite is inert and holds moisture well and it is light and porous. There is a quality about pure perlite that is irritating to earthworms. This was assumed to be a physical abrading effect that causes the worms to crawl to the surface of the beds instead of down into the perlite. The perlite had to be modified. A very usable and healthy bedding material was developed by mixing one part of perlite with one part of finely ground newspaper. This was the bedding material used during the ninety day trial.

Controlled ph - Eight beds were used to check ph effects on worm production. These eight beds were sown to oats, grown to a height of 8 inches, clipped, turned under, and resown as needed. Checks were made for ph's of 6.5, 7.0, 7.5, and 8.0. Beds were watered with ph standardized solutions of muriatic acid or calcium hydroxide as buffering agents. The beds were divided so that ph's could be maintained on both drained and undrained beds.

Feeding - The feed and feeding part of the trial used three different foods. Initially the three foods were oats, alfalfa meal, and a commercial livestock feed known as "Purina grass-stretcher". They were chosen for the following reasons:

1. Alfalfa meal was highly recommended in a worm growing manual. It is being recommended by worm growers to other growers on a nationwide basis.
2. Oats, sprouted and turned into the bedding, was selected because it was thought that the growing oats would temper the abrasive effect of perlite and would supply a source of food.
3. Prepared livestock feeds were reviewed and one, referred to as "Purina Grass-Stretcher", was selected on the basis of its total nutritional value.
4. All of the feeds tested were non-animal protein based feeds. It has been found that under New Mexico conditions animal protein feeds decompose rapidly in worm beds and cause massive die-offs.

Feeds were provided at the rate of two ounces per bed, every two days. The feed was placed in a band six inches wide on the surface of each bed.

Modifications of the feeding plan was necessary immediately after the trial began. Alfalfa meal, when placed in a damp bed, deteriorated very rapidly and die-off began within 24 hours. Symptoms observed were those characteristic of protein poisoning as defined by some growers. The same symptoms had been observed in the Aztec area in organic bedding which had deteriorated and had become putrid. Symptoms occur in the form of alternate constricting and swelling of the body segments. There appears to be hemorrhaging within each swollen segment. A higher ph occurs within each swollen segment than is found in unswollen parts of the earthworms body. Bedding material was invariably lower than ph 6.5 when symptoms occur. Swollen segments may indicate kidney malfunction in each segment.

Finely ground whole corn grain was substituted for the alfalfa meal. Corn was chosen because it is being used by growers in the area and the grain is fairly consistant as to composition.

The first trial feeding with "grass-stretcher" also presented a die-off problem. The feed was checked and was found to contain a high percentage of salt (NaCl). A salt free form of this feed was acquired and proved to be very satisfactory.

Methods of Watering - Commercial worm beds are either sprinkle watered or are flooded with a hose. There are advocates for drained, sprinkled beds and advocates for undrained or drained flooded beds. In order to determine the best system of watering for the paper-perlite beds sprinkled drained and undrained and bottom watered undrained were used.

RESULTS AND DISCUSSION

The trial was terminated after 90 days. All worms were removed from each bed and weighed. Weights were recorded in grams. Observations were made on the undrained to establish reproduction rates plus weight. The drained beds were weighed only.

Significant differences in total production were observed with each different treatment.

The greatest single effect on reproduction was noted when sprouted oats was the sole food source. This feed had a detrimental effect on the reproductive capacities of the worm. Final weights in all oat fed beds were negative. The final weights were considerably less than the initial stocking weights. The average weight per bed of oat fed worms was 64.05 grams which is a net loss of 36%.

Reproductive rates were judged very low. Oat fed undrained beds had a 9.24% greater average weight than those in the drained beds. Least weight losses occurred at ph of 8.0. Final weights for oats ph 8.0 beds were 79 grams in drained beds and 86 grams in undrained beds. See Chart A.

Lowest average production was found in beds fed oats and drained. The undrained oats fed bed was second lowest in total production. The most productive beds were those fed "grass-stretcher" and that were undrained. Corn in an undrained bed and "grass-stretcher" in a drained bed produced third and fourth highest figures, respectively. Table I summarizes the total results of the field trial.

Total production was greater in the undrained beds. Total final weights, excluding ph check beds, were 603.93 grams produced in drained beds and 734.58 grams in undrained beds. Similar results were found in the ph beds. Drained beds in ph control section were 64.25 grams and undrained beds in the same section yielded 69.24 grams. Weight losses were least in the drained bed in the ph section.

Water applied by sprinkling yielded greater production in all cases than water applied by bottom flooding.

CONCLUSIONS

Various kinds of food, bedding material, method of watering, ph, and degree of drainage of beds can affect growth and reproduction in earthworms.

Culture Media - The mixture of perlite and ground paper proved to be of special importance. Absolutely no die-off was experienced in this material. The same feeds used in organic beds produce rotten beds and dead worms. This important difference may be due to the lack of the tremendous populations of micro-organisms found in the organic bedding. Micro-organisms are reduced drastically in the perlite mixture. When using the perlite-paper bedding, undrained beds appear to have an advantage over drained beds. Many commercial beds were inspected in which peat moss was the principle media. Drainage would be beneficial in these beds. The characteristics of perlite provides built in environmental qualities which make drainage less important.

Controlled ph - The effective regulation of ph within worm beds requires more control than is normally found in a commercial or intensive worm growing operation. Ph can be controlled. It cannot be maintained within a narrow range. Considerably more time and expertise is required than the average operation permits. No conclusions may be drawn from the limited data collected. It appears that a ph slightly above 8.0 may be optimum.

Feeding - There are significant differences in growth and reproduction when earthworms are fed sprouted oats. Both fine ground corn and "grass-stretcher" are superior to oats. Both corn and "grass-stretcher" proved to be satisfactory feeds. "Grass-stretcher" should be the better feed over a longer growing period due to the fact that it has vitamins and minerals added. Unsalted "grass-stretcher" must be used as salt causes die-offs in beds. There is a need for further food testing.

GENERAL CONSIDERATIONS

By using a bedding material such as perlite and paper, a standard complete feed and proper moisture control commercial growers can dramatically reduce die-offs and increase production. Die-offs alone contribute to the greatest losses experienced in northeastern New Mexico.

Costs of frequently turning and changing beds can be greatly reduced by using paper and perlite bedding.

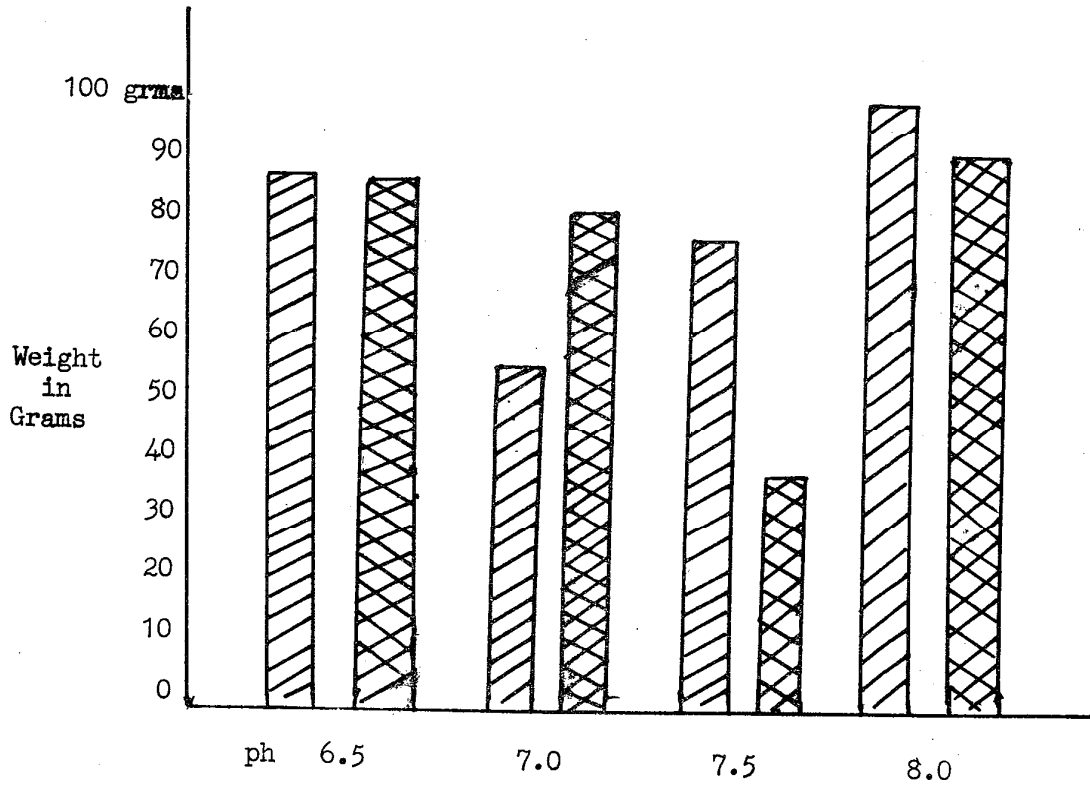
SUMMATION OF DATA



TABLE I

pH	Drainage	Method of Watering	Initial Stocking Rate in Grams	Food	Final Weight in Grams	Reproduction	Number of Worms
6.5	Undrained	NA	100	Oats	76.16	very low	118
7.0	"	NA	100	"	47.31*	" "	92
7.5	"	NA	100	"	67.50*	Low	103
8.0	"	NA	100	"	86.00	Low	161
	:	NA	100	"	(69.24 average)	-	-
6.5	Drained	NA	100	Oats	75.08	Mod. low	-
7.0	"	NA	100	"	70.93*	" "	-
7.5	"	NA	100	"	32.00*	" "	-
8.0	"	NA	100	"	79.00	very low	-
	"	NA	100	"	64.25 (average)	-	-
-	Undrained	Sprinkled	100	Oats	90.00	Medium	180
-	"	Flood	100	"	117.00	"	117
-	Drained	NA	100	"	40.92	very low	-
-	"	NA	100	"	47.04	very low	-
-	Undrained	Sprinkle	100	Corn	135.56	very high	207
-	"	Flood	100	"	130.00	" "	435
-	Drained	-	100	"	121.70	" "	-
-	Drained	-	100	Corn	167.07	very high	-
-	Undrained	Flood	100	Grass Stretcher	159.35	" "	320
-	"	Sprinkle	100	"	163.00	Extra "	163
-	Drained	-	100	"	118.00	very "	-
-	"	-	100	"	108.60	" "	-

*Discounted because not consistent

CHART A



 Undrained  Drained

ph and weight production comparisons
when fed on sprouted oats.