PRNC100

PRNC 100

PUERTO RICO NUCLEAR CENTER

RADIATION-INDUCED STERILITY FOR POPULATION CONTROL

OF THE SUGARCANE BORER (DIATRAEA

Summary Progress Report

\964 - 1967

Dacdd S, Galker, Prin? pal Loventigator

OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT

NO, AT (40-1)-1892 FOR U. 5. ATOMIC EXERGY COMMISSION

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PROJECT SUIMARY REPORT: July, 1964 - June, 1967

Potential for Ganne-Induced Sterility

tn Control of the Sugarcane Borer

(eab.) to

Puerto Rico

uch supported by the USABC Division

of Biology and Medicine under

contract no. AT (40-1) - 1833

Report prepared April, 1967, by David

Walker

Principal Investigator, Puerto Rico Nuclear Center

Mayaguez, Puerto Rico

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24 Original Objectives

1, to determine if the sugarcane borer, Distraco saccharalis

(ob.), con be rendered sterile by subjecting ic to gamma iz¥adiation,

and

2. to study the bionontes of this species with reference to

phases of the life cycle that arc applicable to a mase-release progres

in Puoreo Rico.

B. ?The Problen in Relation to the eonoay

?The sugarcane borer Digtraea saccharalis is tropical and sub-

tropics} in distribution and is knoun to infest crops from northern

Louisiana to Peru and Brazil. It is of economic inportance to the

Production of sugorcane, corn, milo, Fico, lenongrarses, pasture and

forage grosses. Principal erops offected in Latin fmerica are sugal

cane, lemongrass, citronella, snd corn. Serious losses of sugar

production have been reported in the United States, Mexico, Guatenslo,

El Salvador, Nicaragua, Costa Rico, Panama, Columbie, Puerto Rico and the rest of the "lest Indies. Heovy infestations have been reported in connercial plontings of Lenongrass and citronella grase in Guatensle. World annuel loss ts difficult to estimate. Mortorell (1965) reports fan annual loss of three million dollars to the Puerto Rican suger industry ond Chorpentier, ot al (1965) eite six million dollars tn United Stetes cane production. The infestation rate is two or three tines higher in the continental United States then in Puerto Rico (Charpentier, et al, 1965).

Denage to young plants of less than tue months oge 4# more severe than in older cone.? Infestation in young plents 9 celled "desd heart? because the terminal bud is Killed by the feeding Larva. Usually these young plants are killed and when there is widespread donage to young plants the vhole fleld must be replanted. Older plants are nore Tesistont to attack and usually outgrow damage. Yield is greatly

reduced by the borer through stunted growth, reduction in sucrose content, sugar tnversion, and increased susceptability to plant Atseases ond other Insect posts

In Puerto Rico cane mortality is high when the young succulent ants are subjected to heavy attack by cane borers and aphids at the same tine

Under natural conditions, tho sugarcane borer lays ies eget fon the leaf of the sugsreane plant. After hatching and initial feeding fon the leaf during the first ond second stages, the third stage Larva tunnels into the plant stem inside of the leaf axil, where it 1s Protected from virtually all types of conventional insecticidal

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applications that are of practical use under comercial rowing

Conditions, Pupation takes place in this tunnel within the stem.

During ehe early summer months whes sunlight, temperature, and rato fall are optimen for capid cane provth the larval period can be Completed in twenty-five days, However average Larval grovth period 4s 35 days and during the less favorable tines of the year the Leeval period 4¢ more than 45 days.

?when diapause occurs it takes place as fifth or sixth stage larvae and laste two of three sonths. In Puerto Rico larvae begin Blapause in Decenber. Tt 1s believed that the onset of diapause ts Controlled by hormonal factors that are controlled by exposure to Ghort-day length in the preceding generation. If this is so, the fegulative mechanise nust be in very delicate balance because the Ghange in day Length in Puerto Rico ts less then one hour from sunmer towinter. Adulte and larvae are most abundant during the sumer, ?ace population increase 1e dependent upon the rapid cone growth Caused by high rainfall and high tenperature. Thus, optimum con= Gieione for larval growth and reproduction occur in? Puerto Rico during April, Yay and June. After Avgust the cane plant ts not as Gottable for supporting Larvae because of sts saturation.

The borer's long Larval Life-span and short adult 1 fe-span

are the sain biological obstacles inherent in using the Gass-release ?method for population control of this species.

In order of their effectiveness natural control agents are: ants (egg predator); Telchogracna sinutum (Hymenoptera, Chalcididae)s (eae. predator); Lixophags diateses (Diptera, Larvavoridae); mtcro~ Srganises such as Cordycepe spp. (attack larvae and pupae); and other pathogenic fungi and bacteria. ?The nost effective of these natural Eonerel agents Kill. the Larvae before they have had a chance to

Gamage the plant, Natural control by predators and parasites say Teach 70L during dry periods although this varies considerably throush= ue the year.

?The practice of burning standing cane before harvest and of burning cane trath after harvest has helped reduce the level of adult population. Probably re-infestation Cakes place from alternate hoots each year under these cultural practices.

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©. Relation of Other Work to PREC Program

?The USDA and other Agoncies have several research and operational prograas devoted to eradication of insects by the sterile male release technique, These include the following insects under investigation:

Dipters

Scrow-worm fly (operational phase)

Melon fly

Mexican fruit fly

Oriental fruit fly (operational phase)

Mediterranean fruit fly (advanced field testing phase)

Olive frust fly

Lepidoptera

oypsy soth

Codling woth

Pink bollwre,

Corn carvorn

European Cornborer

Oriental fruit noth

This List includes projects in which steriitty is radio-

Anduced or chenteally-tndueed,

The Diptera projects are in a sore advanced state than the Lepidoptera projects. In general the plant-fecding Diptera are tuch ore casily aass-produced under artificial conditions than Lepidoptera. This 1s duc to their simpler dietary reqirenents, higher resistance to bacteria and fungi, behavior differences and to other factors. In Addition the food reqitronents of plant~feading Diptera are betece known than those of the Lopidoptara. Yet many of our damaging agti-cultural pests are Lepidoptera.

The discovery and cubsoquent evaluation of the taportance
of sex pherorones has added a new potential in control of Lepidoptera,
?This wethod 1s particularly promising for the suppression of those
insects that have a short adult Life epan and that pass through chetz
immature stages in the soil, in plant stems and fruits, or in other
Places that are inaccessible by conventional chemical control methods;
oF those insects for which conventional control geasures are ineffectual
or only partly effective. This approach fe new and so Little knovledge
hhag been gained from studies of it that tt te difficult to accurately
Predict the future potential of its usefullness, Natural chenteal
attractants produced by the insect are usually very specific in thelr
activity. Most of the prelininary biological testing has been done
with natural substances produced by the insects themselves, During

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this phase of developsent the results have deen spectacular. Solution
SEiene probleas associated vith {2olating the chemically-active subs~
Cance and subsequently evaluating specific activity has been a very
painstaking task in the gypsy soth project and in sintlar prograns.

Baye fou of the substances have becn isolated and chenically {den tifled. Asong those that are kuown are the cabbage Looper pheromone feolated by Berger (1966). Hensle, is attempting Lsolation and Chemical identification of the sex pheronone produced by feaale

D. seccharalis.

?Tests vith syathetic pheromone have not becn as conclusive ?as was anticipated. This ie due to the fact that the synthetically Banufactured custances contain sore than the single laevorotatory Tsover chat serves ae sexual releasor in the insect. Trace tmpurt-ties neutealize or alter the effectiveness of the specific teoner.

Ganma-induced sterility of the codling woth has been studied by Proverbs (1962), spruce budvors by Berryman (1966), che pine shoot noth by Lee (1966), the European Corn Borer by Walker (1966), cora Carvorn by Garcia (1966), pink bolluorn by Ouye, et al (1964) and the havel orange worn by Husseiny and Madsen (1964). ALI of these prow jects are orfented to applied insect control. Ganma exposure doses Fequlred to sterilize the adults have been found for most of these [nseces, but the radiation effect on tongovity, mating capacity, and behavior has not yee been fully studied in all? of then.

Ti ACCOMPLISHMENTS

he reader is referred to Technical Reports 1 (1965), 2 (1966), and 3 (1967) for complete reports of this Project. Conclusions may be sumarized a8 follows:

AL Sterility, Adult Longevity, Mating Behavior and Vigor:

sterilis.d by exposure to 30 Kilorade, and

?No apparent somatic danage occure vhen? adults. of either sex are exposed to 50 Kilorads or less (Walker, 1965). Thirty-five Kilorads wee chosen for sterilizing adults to be Liberated In cage tests. There Le no apparent effect on longevity, oviposition rate, fecundity nor mating ability by thir treatnent. There is [ndlZece evidence that mating capacity 4s actually increased by radiation (Walker, 1967), we do not anticipate that there will be problems Wosociated with adverse effects due co irradiation in an eradication progran with the sugarcane borer,

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B. Delayed Leehal Effect:

Survival and egg hatchability have been measured in the offspring of adults subjected to exposure co sub-sterilizing level

of radiation by Walker (1957). Husseiny and Madeen (1964) report a similar effect in the navel orange worn moth, Paranyelois transitelle, and North (1966) cites similar response with the eaBbage looper noth, Tetchoplusts af. At exposures as iow as 4 kr. there ie a striking Feduction in hatchability of the 2 offepring from irradlated borer Parents. This effect occurs regardless of whether the male or female parent (in the P generation) was treated. We believe that the delayed Tethal effect is due co the character of the diffuse kinetechore (centromere) in Lepidoptera chromosones. In the preliminary series of tests in vhich forty-nine matings were made the net hatch vas 31 percent of the eggs produced by the P generation and 26 percent of the egge produced by the Fy generation,

At the present tine che results of a second serics of tests

fare being cvaluated. The folloving matings vere made in the parental

() generation in this serie

Mating combinations of P generation Adulte

8

Serter Male

a R (irradiated)

2 n

c R

D ®

Exposures were made at 1, 2 and 4 Kr. in this second sertes.

?The survival rate of Fy larvae ae vell as rate of grovth are

being scored. After ecdysis these F, adults have been ated to test the effect on egg hatch in the Fy generation.

The FL nating tests wore ade in April and May, 1967 and the Fp rate of egg hatch 12 nov being observed.

In these tests the lethal offect was greater on ogg hatch= ability of the Fp generation than Fy generation. In Fz matings we spect the greatest lethal effect inC x C sibling matings, and the least effect in the A or B with normal outbreeding matings, If we hhave enough tine to do co, we will continue the delayed lethal effect nto the fourth generation. Our preliainary results indicate that the Lethal effect can be observed in larval survival of the Fp generation.

©. Cage Testing:

Eight cages vere built on the College Farm tn April, 196

?These vere buile Co tose population change under field conditions

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+6.

Bach cage if 40 ft. wide, 40 £?. Long and 10 ft. high. The supports are ade of 1 1/2" galvanized stecl pipe and are covered with paren screen. The screen has a 37 percent shade factor. Mesh size ie 60 openings per square inch. We release sterile and normal adults treo these cages and seasure the reproductive rate. Reproductive rate te

?Beasured by harvesting the corn plants and extracting the Fy Larvae from then,

Results from 14 tests arc shown in Table 1. Mean increase
An tests vhere normal sales and fenales were released was approni. ately six fold. In comparison competition tests yielded lese chan wuaity. By comparison the rate of infestation in corn plants

outside the cage were nearly double the highest infestation within the age (18 970 of stalks infosted outside as compared with 11 o7o inside the cage).

Hose Rang:

Two hundred species of grass have been examined for

Biatraca larvae utilizing specizens from the living gras auseua at

the University in Mayaguez subject to heavy borer attack. Larvae were

found in twelve species of these grasece a5 shown in Table 2,

E. Diet Toot

Our ultimate goal is to develop an inexpensive food that

fulfills che following criteria:

high rate of survival to aduie

2. rapid development through Larval stages

3. production of vigorous adults as measured by length of

Life span, oviposition rato and mating frequency.

Artifictal diet studies have gone through three develop:

?mental phases since the project began. ?In the flest phase a tusber of siete made fron sugarcane fiber, cane sten, and cane leaf extracts were tested. Sone of these contained supplementary ingredients for Amcreased vitamin and protein content. Also teated were mumrous aodifications of diets that had beon successfully used for rearing other species of Lepidoptera. Resulting survival was very low and the few survivors that reached adulthood developed very slovly. The fe began when Dr. Kenneth dagen of the University of Fecoumended carrot pouder supploncnt. Fifty formations of thie basic dict were tested. Fron the best three formlations further modifications vere tested to determine if any apecific ingredient could be substituted or oliminated. The resulting PRN: diet 48 the culmination of this second phase. This Jict contains brewer's yeast, carrot pouder, corn stalk fiber, ascorbic acid, agar, and wold inhibicor.

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Table 2

Known Hosterange of Diatraea sacchsralis in Puerto Rico

Spantsh English

Setentifte Hane comon name Common name Uset

ra nate corn re

2 cana de azucar sugarcane Fe

3. Sorghue vulgare nélto silo a

4, Gysbopogon cttratus ?Liaonet 110 enon grass Fe

5. Cymbopogon nardue yerba de Linen eftronella re

6. Bleustne indica pata do gallina goonegrass P

7. GCuchiaces aexicans _?_?eeostntte teoutntte ?

8. Paspalue secens yerba dulce svcetgral c

9. Loptochioe f41tforate yerba de hilo arrowgra c

10. axonopus scoparius 7 ©

1. TeSpateus Lax guatenela prase | P

12, Oryea sativa arroe rice re

?Gracece weed a6 pasture grace (P), field erop (FC), and wild grass

(©) of no comercial valve.

Plants are Listed in the order of susceptibility to attack by
Diatrsea Larvae. Sone of these plants are not common comercial
Varieties here. No doubt there are other hosts anong other native
Brasses not in the collection.

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In the third phase we are sosking to improve survival rate

jand promote faster developnent. Formulations to which we have added

ingredients known to be required by other Lepidoptera are being

tested, Tests have been sade with alpha-tocopherol, vheat ger oll,

corn oil, and mineral supplesents. None of these have improved our
fe dice.

Further diet coste 1411 be based upon the known nutritional
requirements of phytophagous Iepidoptera. Vanderzant and other USDA
Anvestigators arc testing essential requirexente by working with
holitic diets (holly defined). then it beconas possible to predict

the general nutritional requirements of phytophagous Lepidoptera, we Mill be able to select natural food saterials that supply large ?asounts of the specific requirements.

In general, Lepidoptera larvae are contiderably more fas tidious tn their food requirements than diptera larvae. Probably the apecific nutritional requirements change during grovth, since substances required during carly larval stages may not be eeeential later, and vice versa. The narrow host-range of many species of lepidoptera confirms this.

The long larval grovth period is a particularly serious problem in artificially rearing this species.? The food decomposes uring the tuenty to chirty day period required for larval growth. Because the larvae tunnel into the food, extracting then from the food is difficult and time-consuming, It is necessary to extract then when the food decomposes and they must be transferred to fresh food. There fare tuo possible solutions to thie problea:

(Q)_to develop a diet that {# nutritionally superior so that

Larvae complete dovelopsent before the food decomposes,

(2) to select a fi

Laboratory culture.

groving genetic strain of Diatraea for the

We have been studying both of these approaches. Relative to

the first, larval life span during winter has been shortened from 45

days in nature to 30 days or less 1n the laboratory az a result of

Amproved dict. Even under best conditions the fastest developing Larvae

required 17 days. In relation to the second possibility, teste

have been made with 197 lines with shore larval life span. Apparently

larval 1ife span is a function of many genetic Factors. Even within

the best pure strain there was a great deal of variation in development

Fate anong offspring. Lines were also selected for longer adult life

span. Variation anong these lines was less than in the Larval experinent.

It will be difficult to develop a laboratory strain that hae a short

and uniform grovth-rate and is long-lived in the adult stage.

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F. Rearing Nethod and Handling Techniques

The rearing and handling techniques presently utilized to aintain ovr colony of approrinately 10,000 larvae are the reault of testing several factors, as these bear on feeding response. Larval feeding behavior suggests that the stimulant co taste food (phago-stioulane) is an olfactory response that develops after larvae ature, whereas taste stinulates actual feeding. Imediately after hatching young Larvae vender about over the food surface. Later

they feed vigorously after first canpling the food. Conditions of food content, Light intensity, tesperature, hunidity and carbon Atoxtde level have been studied, to provide relatively satisfactory larval feeding response

Table 3 summarizes the life span of Diatraca sacch:
in the Laboratory on PRK dict. In artificial culture more larvae die in the first stage before feeding than at any other tine during their Life. During the period of early larval grouth (firet to third larval stadia) 2 large surface area with rough texture is needed to promote vigorous feeding. At the third stage when the larvae fore tunnels in the food they need large volune of food. Overcrouding, causes accidental cannibalion if there is insufficient food mass for tonne] making.

We have tested the PANG diet in containers of different size

?and shape to obtain the optimn relation of surface area and volune. Glass shell-vials (32 ml.) with cotton stoppers have produced the best yield. ?Rearing in traye would be easier since they can be filled and cleaned easily. Mortality has been high in tray teats because of dessication. Dr. Frank Novell (1965) suggested pouring the food in trays and spraying the surface with paraffin wax to prevent drying. ?This method is successful for laboratory rearing the codling woth Survial wi aca Larvae in pareffin-coated

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Table 3

Synopsis of Ltfe-span of D. saccharalie

tn the laboratory?

Lifespan of Length Activity at thie Main Cause of

Scage Stadium? = Stage Death

(ays)

Fee. 4 t09 0.6 ?0.0.8 eabryonte development wold

o

First 4 t018 2 to 4 surface feeding doeatcation and

Lary.) starvation

Second 3t018 3 t0.7 tunnel forming bacteria

Larval (6),

Third 3 to 18 6 ko 18 tunnel forming wold and bacteria

Larval (7)

Fourth 5 to 21 15 to 29 tunnel forming, stops wold and bactersa

Larval = (11) feeding before pupating _ starvation

Pupal 5 to 10-18 to. 27 quiescent in eunnel accidental canntbalies

© by tunneling Larval,

dessication, bacteria

Adult 1 to 1115 to 25 rests during day, nuptial old age, dessteation

Male (3.5) Flight and mating at night mold, starvation

Adult 1 to 1318 to 29 same as males oviposite old age, dessieation,

Fenale (5.2) during day and ntghe old, starvation

Total 25 co 107-2 to 29 -

as)

Yerom Walker, 1966

FRange, the average {8 shown in parenthesis.

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TIT- PUBLICATIONS

The following have been published:

1964. Blononics of che Sugarcane Borer Diatraca

saccharalie (Fab.). TIT. Oviposition Rate,

?Jour. Beon. Ent. 37 (4): 515-6.

1965. Bionomies of the Sugarcane Diateas

saccharalis (Fab.) I. 4 Description of the Mating

Behavior, Proc. Entom. Soc, ?ash. 67 (2): 80-3

1965. Bionomics of the Sugarcane Borer Diatr:

seccharalie (Fab.) IT. Longevity of Adult

Proc. XII Intl. Cong. Sugar Technologist

PP. (in press)

1966, Improved Kenic diets for che Sugarcane Borer

in Pucrto Rico, Jour. Eeon. Ent. 59 (I): 1-4,

1966, Potential for control of the Sugarcane Borer

Through Radio-induced etertlity, TABA/FAO

Symposium on Radiation, Radiotsotopes and Rearing

Methods in the Control of Ingect Poste, Oct. 17-21,

1966, Tel Aviv, Israel, in press.

B. ?The following are in preparation:

1, Gaumarinduced stertlity tn D. saccharalie.

2. Mortality-staging in ogre of 2

Lectures have been given in Central America in cooperation vith the Atons for Peace Progra. Lectures were given at he National Untversities and Graduate Instructional Centere in Guatemala, El Salvador, Nicaragua and Costa Rica. In addition $. Garcta-Rivera has been trained to etudy the potential for controlling the corn carvorm, Heliothte rea in E1 Salvador and Juan Rodrigues {n Nicaragua has been given similar training to evaluate the potential with Laphygne frugiperda, the ??cogollero del maiz?. Both of These pests cause serious damage to crops in Central Ane~ rica. Training was also given for study of the coffee Yeaf miner, and the pests affecting lemon grass in Guate- mala and Ei Salvador.

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Iv- sumaRY

?The ultimate objective of the project has been to determine if the sugarcane borer could be eradicated by the release of sterile adults, Inplicit in this objective are a number of related aepecter

1. to determine the stage cud point within the stage to be sterilized,

2. ko determine if the 1ife-span, fecundity, ?and general vigor 1s affected by sterilizing,

ing capability

3. t0 develop a laboratory method for mass~producing this Angect capable of producing Large numbers of individuals at a low cont,

4. to study the Life cycle in the Laboratory and under field conditions with particular reference to grouth rate, reproductive potential, mating behavior, and other aspects of the bionontes ecology relevant to a successful overflooding program.

n

?The first objective has beon completed. Only the adult stage can be sterilized without producing excessive somatic damage and subsequent high mortality. Larval and pupal stages can be sterilized at ouch lover exposures. The dose/sterility effect relationship appears to be roughly exponential, but there 12 considerable variation in individual teste at sub-sterilizing exposures.

Life. spen and oviposition rate Ls not affected by sterilizing the adults of either sex. Mating capability of sterile adults 4s equal or slightly superior to normal adults. This 1s true vhether the individuals have been veared on tho host-plant or from artificial diet. We have succeeded in rearing this species in the Laboratory 4a saall numbers at high labor cost.

The artificial diet developed is well-adapted to rearing the insect Lf the insect ts consinvslly provided with fresh food. Since 17 to 30 days are pascec co Invval stages it Lo not possible to maintain the food free of brcterial and gold grouth. Tf Larvae are transferred to fresh food bafore contamination becones too heavy survival is improved. The high labor iavestment of manually renoving larvae from contaminated so frech food 42 a problem given considerable attention but ie {2 not yee solved.

The second major prodlem in mass-rearing 1s co develop a low cost Aiet. The ingredients for our present diet cost approximately two dollars per thousand larvee. This 1s about one hundred fold greater than the cost of producing phytophagous diptera and about three hundred times the cost of mass-producing the screw worm. High food-cost a

contamination probleme are inherent in resting lepidoptera under artificial condietons:

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We have obtained considerable data on grouth rate in Laboratory rearing but there have not been extensive field studies on this insect in Puerto Rico. We sorely need data on the population of adults in

the field, and the variation of adult populations throughout the year. Unfortunately we have not been able to study this because of lack of personnel. Sone indireet inferences on the net natural reproductive rate fan be nade from our field tests 4 ceges, but tt would be risky to Gxtrapolate this date co ficld conditions of cane production. It is expected that the study of Hensley (1965) on the sex pheronone will provide us with greatly improved acthoda for trapping adult males and that this sethod will enable uc to make accurate estimates of field population, Hensley's group expects to be able to make a chemical ?analysis of che pheronone in the near future.

The potential for eradicating this species through a coabined progran of trapping using synthetic pheronone in combination with the Felease of sterile adults apperars to be prontsing.

Limitations of thie progran are: 1) lack of @ good rearing ethod, and 2) incomplete knowledge of the biology of this species

onder field conditions. Since ve were not responsible for these under the 1964 Meoorandun of Understanding ve did not direct our attention to these problens. Unfortunately the cooperating agencies were unable to solve these problens before terminating their prograns.

?The PRNC comattment proposed in project objectives under the Menorandun of Understanding between the USDA Entomology Research Division, UPR Agricultural Experizent Station, and PRNC vill be com pleted at the end of Fiscal Year 1967. Further field work and a mas Fearing sethod will have to be developed before the progran will be ready for large scale field testing. A logical sequence of necessary stages Le shown in Table 4 of the Appendix.

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/~ RECOMMENDATIONS

LE the work 48 to be continued with the objective of population suppression or eradication by release of sterile adults I recomend concentrating on these objectives:

1. Fleld studies, to determine

a. fluctuation of the adult population tn nature,

Bl hose range 12 Puerto Rico,

1 tate of population suppression by sterile releases in

nature,

4, effect of multiple releai erations.

fon eubsequent

2. Laboratory studies, with the ata

a. to develop an nproved diet for mass-rearing,

BI to develop rearing and handling techniques for ma

rearing,

fe, to study the Lethal effect over several successive

eration

4, to pelect an tpproved genotic strain for laboratory

rearing.

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VI. REFERENCES CITED

Berger, R. S. 1965, Isolation, identification, and eyntheate of the

?sex attractant of the cabbage looper, Trichoplusia nt. Ann.

Entom. Soc. Aner. 59 (3): 767-8.

Berryman, A. 1966. Personal Comuunication, Wash. State Univ.

Polinan, Wah.

Charpentier, L. J. R. Mathes, W.J. Me Corsack, and J.W. Sandford 1965.

Injury and losses caused by ehe sugarcane borer in Loutetana

Paper number 10. Proc, XIT Int. Cong. Sugar Cane Tech. (in

press)

Carcta-Rivera, S. 1965, Unpublished data. Centro de Investigactones,

Santa Tecla, El Salvador.

wley, 8. D. 1966. Pet

onal communication. Lovtatana State Untv.,

ston Rourge, La.

Howell, F. 1966. Personal communication. Agricultural Experiment

Station, Wenatchee, Wa

Husseiny, M.M., and H. F. Madsen 1964, Ster{ltzation of the navel orange worm, Paranyelots transitella (Walker) by radiation. Hilgerdia. 36 (9): 113-7.

Lee, R. D. 1966. Exploratory studies on eradication of the pine caterpillar, Dendrolinus spectabilie, Butler, by use of gonna radiation, IAEA Sympostum, Tel Aviv, Israel.

Martorell, L.F., and $.P, Medina-Gaud 1965. Status of important of

Ansect pes wreane 1n Puerto Rico and their control. Paper Wo. 145, Proc. XII Intl. Cong. Sugarcane Tech, (1a press).

---Page Break---

-ue

REFENRENCES (cont)

North, D. T., 1967, Radtation-induced male sterility exhibited tn
the P, and F, generation in Lepidoptera, abstract, Rad.
Research Soctety Yeeting. San Juan, Fuerte Rico, My TALL,

Ouye, MT. et el, 1964. Determinations of the optimum sterilizing
dosage for pink bollvoras treated as pupee with gamma
radiation. Jour. Econ, Ent. 57 (3): 387-90,

Proverbs, M, D, and J. R. Newton. 1962, Influence of gaoma radiation
on the developoent and fertility of the codLing aoth

Gaxpocapea pononella (L.) (Lepidoptera, Olethreutidae).
Canad. Jour. Zoo. 40: 401-20,

Sith, C. N., editor, 1966, Insect Colonization and Mass Produetion.
Acadente Press, New York: 618 pp.

Walker, D. ¥. 1965. Technical Report No. 1 Induced Sterility for
Population Control of the Sugarcane Borer in Puerto Rico.

P.R, Nuclear Center, Mayagues: 20

1966. T. R, No. 2: Radiation-induced Sterility for

Population Control of the Sugarcane Borer in Fuerto Rico.

P. R. Nuclear Center, Mayaguez: 41 pp.

1967. 7, R. No, 3 (in press)

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VIT- APPENDIX

?TABLE 4

Developnant Stages in a Species

Eradication Prograa®

seep = 30 so,00ne0 [1 7 7

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seep = 100 e sx0.0mee [>

Series

for species that have not been raised under artificial

?conditions ond species for which the biology is poorly known.

Series B: for species thst can be grown in the laboratory and for

which the biology is fairly well-known,

Series C: for species that can be masc-resred in the laboratory

and for which the biology 1s well-known.

?This vas prepared by John Munro and David Walker at the request

fof the participants of the Symposium on Insect Sterility and

Maserresring Methods in Tel Aviv, 1967. It will be included as

part of the published proceedings of this meeting.

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Stop 1. Using F1eld-collected material should test the following

against all stages of Life cycle, ond should include differences in

responce vithin stage {f possible:

2. tadfatton dose response of:

1) lethality and sterilicy

2) 1iferspan

3) oviposition rate

4) wating behavior

Bb. normal perforwance for the above ae a basis for

comparison.

Step 2, Laboratory Rearing

?The principal objective of this phase of the progras ie to

develop a reliable method of producing the insect in the Laboratory

under artificial conditions. ?One should strive to develop 3 aethod

that produces predictable reculte, not necessarily 4 aass-rearing

?sethod. Cost of production should not be an important criterion, and

At 1 Eecomnended that natural (host plant) food substances be costed.

a. Diets

Starting with the natural food materiel, prepare dtets
using added food substances to augnent nutritional level. Dict tests
should be performed on the neonatant larvae, and all ianature st
should be tested because specific nutritionsl requirenents are apt to
change durtag the course of the developnent.

Criteria to be measured should include: Length of
Hine required for cach stage (1.0. time between molte), rate of wize
Increase (length and dianeter), asount of food consumed, pupal weights,
longevity of adult 1ife span and of the pupal stage, observation of
sorphological and behavior aberrations in adulte (crumpled winge,
active movencnt, mating behavior, etc.), and survival rate over
several generations of laboratory rearing.

b. Develop handling techniques, and test containers in reparation for larger production. With the techniques and diet developed at this stage, one should strive for results that will tive the assurance of a predictable survival. The survival rate obtained at this phase may not be as high ae needed for mase-production.

. If possible a laboratory strain of the species should be selected for the qualities desired. ?Those qualities might include

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short larval 1i¢e-span, long adult Life-span, high reproductive rate,

high rate of survival and vigorous adules having high wating capability.

4. In addition, if a distinct phenotype, f.e, one that can be easily recognized in the f1eld by casual observation, can be selected, it vould greatly help in later field work.

Step 3. Biononics and Ecology in nature

Diurnal behavior, including datly sovenent, host-range and host-preference, tine of day and frequency of mating in nature, natural abundance, seasonal population fluctuation, and other pertinent aspects Of the ecology should be emphasized at this stage of the progr

It is oF no use to be able to produce sterile adulte if these adults are not suitable for their intended use. The sterile adults released should be equal to or superior to adults in nature in Kespect to longevity and mating capacity. High repreductive rate in the laboratory strain is desirable as it facklitates laboratory rearing.

Step 4. Small Scale Field test

?Test the wating ability, behavior and longevity of sterile
adults under natural conditions in contained field environment. The
test site should be isolated fron the greater environment, preferrably
Ae should be a snall island or an isolated land mass surrounded by
suitable geographic barriers such as mountains.

Size and seasonal change in the natural population should
be measured before, during and after this test. Trapping methods,
parking techniques? and distribution studies can be the natn tools? {oF
?measuring population changes in this phase of the propre

Step 5. Mass-rearing Methods

?The diet selected for mass-culture ust be cheap, and
should be of materials of uniform quality thet are readily available.
The food selected for sass-rearing should be easy to prepare in Large
quaneiy.

Disposal of food after use may be a problen in some
Programs. Attention should be given to obtaining large nusbers of
vigorous edules.

Step 6. Eradication Progr:

Measurement of effectiveness, strigent quarantine measures

for the future, suitable release and recapture methods, low-cost, and

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=a.

related factors are likely to be the most important considerations in

this phase of che progran,

General Gonents

Cost vill escalate drastically as the program procedes from

phase 4 to 5 and again from phase 5 to 6, Rough estimates of increase

ae shout @ five-fold increase from phase 4 t0'5, and 100 to 200 fold

from phase 5 to 6.

The policy of determining che Limteing factors ost likely to

Prevent success should receive the most attention in early theses ot

the program rather than leaving then till later,

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