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Pest birds cause serious damage to agricultural crops in most situations only when the number of individuals is very high. Often, large populations of avian pest species spend the hours of darkness congregated in roosts where they become vulnerable to certain control methods. Such is the case in California where certain pest species, particularity starlings and blackbirds, can often be found roosting in cattail-tule marshes. From these relatively concentrated populations the birds disperse to cause in some, but not all, cases of serious damage to certain agricultural crops. The obvious disadvantage resulting from the tendency of these birds to concentrate in roosts is that the number of individuals often becomes extremely high and the resulting damage to local agricultural crops extensive. Conversely, the roost concentrations facilitate reduction of population size by application of an avicide on a roosting population.

The major problem of reducing the numbers of bird pests occupying such roosts is centered in the selection of a suitable avicide, that is, an economically feasible compound which is as selective to the pest species as possible and which does not persist in, or contaminate the environment. Two likely candidate compounds for such use (based primarily on chemical characteristics which result in very low toxicity to mammals and some degree of avian selectivity) are 3-chloro *p*-toluidine hydrochloride (coded DRC-1339 by the Denver Research Center, U.S.D.I.) and the free base of this compound, 3-chloro, 4-methyl aniline (coded, I believe, DRC 1347). Both have been tested extensively in the Starling Control Research Laboratory at the University of California at Davis for use as avicides applied to cattail-tule roosts.

The selection of which form of this avicide—the hydrochloride or the free base—is most potentially useful depends on the type of situation in which the avicide is to be applied. Preliminary studies suggest that when applied as a spray, the free base is more biologically active but tends to persist in an aquatic environment for a longer period of time than does the hydrochloride form. This persistence may be due to the non-solubility of the free base in water, a characteristic which also precludes employment of water as a carrier solvent in the spray formulation. Because of this, the free base compound is not, in my opinion, suitable for use as an agent for roost control in the situation presently demanding attention in California. However, the non-solubility and persistence of the free base in an aquatic environment does not preclude the use of this compound in other

situations. For example, incorporation of the free base in "foam" or "gel-layer" formulations for use in certain non-aquatic roost environments is certainly worthy of investigation.

The major roost habitat of depredating birds in California consists of cattail-tule marshes. Because of this, our research efforts have largely been devoted to the development of toxic formulations based on the hydrochloride form for aerial applications as a spray. We found that a simple formulation consisting of 3% DRC-1339 and ½ % Turgitol TMN in water is essentially 100% lethal to redwing blackbirds occupying cattail-tule roosts when the spray is applied at 60 gals/acre. This formulation and application rate resulted from an extensive series of tests conducted on blackbirds, starlings, ducks, and pheasants caged together in a cattail-tule roost. Although essentially 100% lethal to blackbirds, the 3% DRC-1339 concentration was only about 20% effective on the starling population. A complete kill on starlings as well as blackbirds occurs when the DRC-1339 concentration is increased to 5%. Repeated application of either concentration did not result in any mortality to ducks and pheasants. In fact, we applied the 5% spray on pheasants to the extent that their feathers turned yellow before any of the birds succumbed.

The results of the tests on caged birds led to a field trial where the 3% formulation was applied by air to a small, stagnant water, cattail-tule marsh. This trial was sponsored by the Colusa County and California State Departments of Agriculture. The test objective was to evaluate aerial application methods and the persistance of the toxicant in the treated area. No attempt was made to evaluate the effects on the target species (about 5,000 tri-colored redwing blackbirds), but there is no doubt in my mind that the control was effective.

Laboratory tests indicated that application would result in death to the blackbirds about 20 hours after treatment. The time of treatment was about 8 p.m., and theoretically the animals treated should have become incapacitated shortly after the following noon. Because of this, we did not anticipate finding many dead or dying birds in the treated area, since they would become incapacitated after the morning flights had left the roost. Regardless, a number of dead and dying birds were found in, and immediately adjacent to, the roost during the day following the toxic treatment. These were undoubtedly individuals that had received a particularly large amount of the toxic spray.

Chemical analysis of water samples taken periodically after the application showed no measurable amounts (that is, amounts greater than 1 p.p.m.) of the toxicant within a few days after treatment. However, although much encouraged, I am by no means satisfied that these analyses completely document the persistent characteristics of this toxicant in an aquatic environment. I intend to explore the fate of the compound in such situations during whatever investigational time is necessary to either endorse or condemn the use of DRC-1339 for such purposes. Presently, the results of such investigations are very encouraging to say the least, but much additional experimentation will be required before we fully understand the ecological implications of aerial application of DRC-1339 in such a situation.

DISCUSSION:

QUESTION: Do you intend to use it in trees?

SCHWAB: At the present time we do not intend to use this particular formulation to control birds nesting in trees. However, starlings are quite plentiful in certain holly orchards in Oregon where on occasion they cause considerable damage by defecation. We have made arrangements with an investigator in Oregon to spray some of this formulation on holly to determine possible phyto-toxicity.

QUESTION: Can this successfully be applied by any equipment other than aircraft?

SCHWAB: I believe that applications utilizing other types of equipment, for example "orchard-type" sprayers, would be just as effective and perhaps much less expensive than application by aircraft. The feasibility would probably depend on the access to the roost with respect to the delivery range of the spray device employed. We have not tested other delivery devices, since our ultimate goal is to control the starling population inhabiting Sherman Island; and this would definitely require application of the formulation via aircraft.

BEARD: Are there any sublethal effects on reproductive success with treatment with your compound?

SCHWAB: I have on many occasions evaluated the gonadal responses of starlings that have survived sub-lethal amounts of DRC-1339 administered orally. Comparison of the gonadal capabilities of these birds with those of non-treated birds strongly suggests that DRC-1339 has no effect on the reproductive system of this animal. Perhaps I should indicate that such comparisons have been made on male starlings only. As an aside, one of my associates, Mr. Charles Siebe who I'm sure many of you know personally, has repeatedly indicated that a *lethal* amount of DRC-1339 is the best reproductive inhibitor he knows of; and in light of our present knowledge I'm somewhat inclined to agree with him.

OCHS: Just what is the dermal toxicity of DRC-1339?

SCHWAB: I sincerely hoped to complete this discussion without this question being asked, since I cannot answer it with any real degree of confidence. We have conducted experiments to find the dermal LD of DRC-1339, but the results have been so variable that they are not particularly useful for our present goal—an aerial spray—with respect to this toxicant. During our investigations it became obvious that there is probably little relationship between dermal LD levels and death resulting from aerial application of DRC-1339. Consider, for example, that large droplets might cause death by direct penetration of the toxicant through the feathers and subsequent absorption of the compound through the skin. It is equally plausible that death results from respiratory intake via the "toxic mist" which settles on the area following the larger droplets. Further,

60 gals/acre results in thoroughly soaked vegetation (at least in cattail-tule areas such as we treated), and the animals may ingest a lethal amount of toxicant by preening soaked feathers. I believe that death following aerial application results from a combination of intake routes rather than dermal contact only. What I'm getting at is that the variety of potential routes of DRC-1339 into the body following aerial application appreciably reduces the significance of dermal LD levels as a measure of effectiveness or of biological activity of this toxicant.

DEGRAZIO: To answer Paul's question—the dermal toxicity of 1339, and this is from our labs in Denver, is 25 to 40 mg/kg, and through the foot is about 80 mg/kg. I don't know if Bob had that information handy or not.

SCHWAB: No, as a matter of fact I didn't know that Denver had determined the dermal toxicity levels of 1339 on the tri-colored redwing. Thanks for providing this information John, but let me again emphasize that I am virtually certain that death resulting from aerial application of 1339 involves more than dermal contact alone.

BRINK: What stands in the way of treatment of the Sherman Island roost? What's your proposed target date?

SCHWAB: I would not consider treating the Sherman Island roost with only the information on the toxicant presently available; nor could this be done without the complete endorsement of the California Game and Fish Department. This agency has been very understanding about the problems involving this roost. The have in the past mentioned certain conditions which must be met if they were to give the go-ahead for extensive use of this type of application, particularly on the large roost located on Sherman Island. Believe me, the conditions they have imposed are not at all out of line; they are the identical things we should be shooting for. The agency is concerned with potential danger to humans and non-target species, but I think that DRC-1339 has characteristics which might make possible the use of this compound if these were the only concerns. However, the Game and Fish Department is deeply concerned with the prospect of environmental contamination by this compound and so am I; we're not apart on this point at all. It is becoming increasing obvious that unless we can demonstrate conclusively that DRC-1339 is either a physically or biologically degradable compound, does not persist as a toxicant in the environment, and does not disrupt the ecosystem, we're not going to treat Sherman Island or any other large roost, especially those situated over open water. Personally, I am against spewing into our environment a toxicant that we know so little about. Limited testing to acquire knowledge is one thing, operational employment on extensive acreage is another. Frankly, registration of this material as an aerial-applied bird control chemical is going to require a great deal of prior experimentation to determine just what sort of a toxicant this compound really is with respect to the conditions mentioned above.