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STATUS OF PP581 (VOLAK) RODENTICIDE DEVELOPMENT

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INTRODUCTION: In the Proceedings of the first Eastern Pine and Meadow Vole Symposium (March 1977, Winchester VA), ICI was introduced and basic technical information on PP581 presented. PP581 is a second-generation anticoagulant rodenticide, with the approved common chemical name of brodifacoum. The compound is also known as TALON™ in the form of 50 ppm (0.005%) grain-base pelletized bait as developed for control of commensal rodents. The proposed trade name for the orchard formulation of PP581 is VOLAK™. Brodifacoum has been seen to possess several novel characteristics in work with commensal and other rodent species, suggesting a considerable general potential for control of many pest species of rodents and in various use situations. These characteristics are:

1. Single-feeding action for most species. (Defined as giving over 90% control in 1 day no-choice or 3 day choice tests with 50 ppm bait)
2. Effective on anticoagulant resistant rodents. (As based on US and UK lab studies with warfarin-and cross-resistant rats and mice which were successfully killed by PP581)
3. No bait avoidance. (Beyond that avoidance shown by rodents to any new object or foodstuff, bait avoidance is not a factor and bait is well accepted by most rodents. The lapse of several days till death reduces the chance of rodents associating bait ingestion with poisoning symptoms.
4. Antidotable. (Vitamin K_1 injections are antidotal, as is the case for existing anticoagulant products)
5. Low hazard. (PP581 baits at 50 ppm should be as safe to most non-target animals and the environment as other anticoagulants in current use)

Against commensal rodents, namely the Norway rat, roof rat, and house mouse, the 50 ppm TALON formulation has shown between 40-6o% acceptance in the lab and generally over 80% control in field trials, giving near 100% control in several cases. Data to support a national TALON registration for commensal rodents has been submitted to EPA and it is expected that sales of TALON will commence in 1979.

EFFICACY TO ORCHARD VOLES: The efficacy characteristics as listed above would suggest advantages in the control of Microtus in orchards. Notably, the single-feeding action and good bait acceptance, if demonstrated for voles, should allow for an application rate lower than for existing anticoagulants with less potency. Byers has also reported suspected diphacinone resistance in pine mice (J. Amer. Hort. Soc. 103:65, 1978), hence efficacy to resistant rodents would be an additional advantage. In an effort to verify these and other potential advantages, studies of PP581 against Microtus have been conducted in the lab and field over the previous two years by Dr. Ross Byers and by ICI personnel. Based on data to date, which is summarized in the following sections, PP581 (VOLAK) has considerable promise as a single-feeding vole rodenticide of excellent efficacy.

ACUTE ORAL TOXICITY: Determinations of LD_{50} values for PP581 and other anticoagulants have been made (Byers, op cit) and are summarized below with equivalent amounts of 50 ppm bait to give an LD_{50} for a 25 g vole:

	Brodifacoum (PP581)		Chlorophacinone		Diphacinone	
SPECIES	LD_{50} (mg/kg)	Bait (g)	LD_{50} (mg/kg)	Bait (g)	LD_{50} (mg/kg)	Bait (g)
Pine	0.36	0.18	14.2	7.1	57.0	28.5
Meadow	0.72	0.36	-Not Determined-		14.0	7.0

Based on the LD_{50} determinations, it can be seen that the high oral toxicity of brodifacoum to Microtus should offer the potential of a single-feeding action, given suitable bait acceptance.

VOLAK BAIT EFFICACY STUDIES (LAB): Results (from Byers, op cit) from one and two day choice feeding tests with 50 ppm anticoagulant baits utilizing pine mice are summarized below:

Test Regime	Brodifacoum (PP581)	Chlorophacinone	Diphacinone
1 day choice test	9/10 killed	4/10 killed	0/10 killed
2 day choice test	10/10 killed	6/10 killed	0/10 killed

It can be seen from the above that PP581 appeared to act as an "acute" or single-feeding toxicant, namely giving good control after short periods of exposure to voles. Refinements in the testing procedure led to the establishment of a new protocol involving a 3 day choice test to assess efficacy of single-feeding baits with Microtus. This protocol, developed jointly by Ross Byers and Steve Palmateer (EPA) was presented at the ASTM Conference in Sacramento, Ca. in March 1977, and will be published in 1979 in a special publication of ASTM. Utilizing a draft of this protocol, with slight modifications, a 3 day choice test was conducted at ICI to provide more detailed information and verify single-feeding efficacy. Pine mice trapped from Winchester, Va. orchards were used. The results are summarized below:

Pine Mice	Av. Body Weight(g)	Av. Daily Pre-Test Consumpt.[1]	Av. Daily Test Consumpt.[2] PP581	EPA	Av. Days to Death[3]	Av. Total Dose(mg/kg)	Av. Percent Accept.[4]
10 male	25.4±1.7	2.7±1.0	5.3±2.4	1.6±0.8	6.0±1.4	31.0±12.4	75.9±10.1
10 female	25.0±3.5	2.0±0.6	4.7±1.7	1.5±0.7	6.7±2.1	29.1±12.2	75.8±9.9
Total Avs.	25.2±2.7	2.4±0.9	5.0±2.1	1.6±0.8	6.4±1.8	30.1±12.3	75.8±10.0

(Above values all ± one Standard Deviation)
1 - voles held for 6 days, given apples and ground chow ad lib; chow weighed
2 - voles had choice of 2 bowls during test, one with PP581 and other EPA diet
3 - days to death counted with beginning of test period as day 1
4 - % accept. expresses what % of total test intake was PP581

Three day choice tests with PP581 by Byers and Palmateer according to the same protocol also resulted in good acceptance and complete or near complete kills. Based on the LD_{50} studies, only 1 to 2 pellets (0.2-0.4 g) contain an average LD_{50} dose for pine and meadow voles. Therefore, good bait acceptance helps ensure kills for more animals after limited feeding.

HAND BAIT FIELD TRIALS: Trials in Virginia[1] and Indiana[2] orchards were conducted during the dormant season with various anticoagulants. Results (Byers, op cit and unpublished) are summarized below:

	Brodifacoum (PP581)		Chlorophacinone		Diphacinone	
Species	rate	kill*	rate	kill*	rate	kill*
Pine[1]	10 lb/A	94%	10 lb/A	96%	10 lb/A	69%
Pine[1]	5 lb/A	99%	10 lb/A	93%	10 lb/A	93%
Pine[1]	5 lb/A	95%	-Not Applied-		10 lb/A	91%
Meadow[2]	12 lb/A	100%	12 lb/A	87%	12 lb/A	87%

* - % kill inferred from reduction in voles trapped after treatment in comparison with trapping in control plots

Similar field trials have been conducted in Romney WV by Mr Dick Whiteman of ICI and preliminary reports indicate effective control was achieved at rates comparable to the above. Based on these trials, it appears that PP581 was as efficacious, if not more so, than existing anticoagulant vole rodenticides; even when used at half the rate of existing products. The results also suggested that PP581 might be especially efficacious as a broadcast bait.

FIELD EVALUATIONS OF BROADCAST APPLICATIONS: Dormant broadcast applications were conducted in Virginia[1] and Indiana[2] orchards for various anticoagulants. Results (from Byers, op cit and unpublished) are summarized below:

	Brodifacoum (PP581)		Chlorophacinone		Diphacinone	
Species	rate	kill	rate	kill	rate	kill
Pine[1]	25 lb/A	100%	22 lb/A	96%	-Not	Applied-
Pine[1]	15 lb/A	93%	15 lb/A	66%	-Not	Applied-
Meadow[2]	24 lb/A	93%	24 lb/A	86%	24 lb/A	74%

While it is not suprising that meadow mice can be effectively controlled with PP581, the possibility of effectively controlling pine voles by broadcast applications of 15 lb/A or less offers a promising approach to practical, cost-effective control of this troublesome species. However, hand baiting, although more laborious, will probably continue to be demonstrated as more effective at lower rates for both species with PP581 than broadcast applications.

As a further refinement, it might be suggested that PP581 as a liquid formulation, sprayed on vegetation, would be efficacious. Initial ranging studies indicate brodifacoum is not cost competitive by this application method. Such a spray, of course could also present a greater potential hazard to non-target organisms and the environment than use of broadcast baits where discrete particles are thinly distributed beneath vegetative cover. A spray is also potentially more hazardous than hand baiting where such baits are covered by a shingle or other object.

VOLAK REGISTRATION: ICI is firmly committed to achieving a national registration for broadcast and hand applications of VOLAK for control of Microtus pests in dormant orchards. In-house supportive environmental and toxicological studies have already been scheduled or initiated in the US and at ICI headquarters in the UK. Residue determinations for this compound are also being developed. Although modified VOLAK formulations and additional application techniques will be evaluated in the lab and in preliminary field trials in the months ahead, the current VOLAK formulation (50 ppm pellet) as tested in the studies reported herein, appears suitably efficacious for advanced field testing. It has therefore been decided to pursue field evaluations of VOLAK in additional regions of the country and against other species. ICI has submitted a request to EPA for an Experimental Use Permit for VOLAK to allow larger-scale field evaluations in several states during 1978 and 1979. Based on the available data, several researchers (notably many of those represented in this Proceedings) have expressed their willingness to evaluate VOLAK in the field. Orchards in Northeastern, Southeastern, Midwestern and Western states will be involved in these evaluations.

ICI is interested in having additional qualified researchers involved in the VOLAK field program and would welcome a response or inquiry from any interested party. Field protocols for different species have been developed which should help allow for comparison of results from trials in different parts of the country. Full national registration of VOLAK will take some time, especially due to the effort required to generate the detailed toxicological and environmental data as required by EPA. In the interum, selected researchers and growers will have access to VOLAK as an experimental compound. Once registration of the similar commensal product (TALON) is achieved, it is possible that VOLAK could be made more quickly available to growers on a regional basis under the provisions of section 24C of FIFRA, if a special need for the compound could be adequately documented and presented.