Lygus on Vegetable Seed Crops

promising new insecticides and combinations revealed by tests on beet and carrot seed plants in Sacramento Valley

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New treatments for control of lygus bug—*Lygus hesperus* Knight—should be evaluated in terms of their effects on beneficial as well as harmful insects.

Seasonal and area tolerances of lygus bug to DDT or toxaphene, and the possible over-all increase in bug tolerance, have intensified the search for better control materials for carrot and table beet seed plants and other seed crops in the Sacramento Valley.

Laboratory tests in 1956 and 1957 showed that DDT or toxaphene combined with Dylox or malathion resulted in quicker lygus bug mortality and lasted for a longer time than any of these insecticides alone. Malathion and Dylox used alone gave satisfactory bug control, but were not so long-lasting as DDT. Di-Syston, Thiodan, and a combination of DDT with Trithion also were identified as new treatments of potential value.

At that time, DDT was still satisfactory for lygus bug control in the Sacramento Valley. DDT did not appreciably reduce numbers of honeybees or cause a buildup of red spiders. It did not cause high mortality of minute pirate bugs, the predators useful for biological control of red spiders. Dylox and malathion resulted in satisfactory lygus control and caused no red spider buildup but, as they did not last so long as DDT, they were of no advantage on the carrot seed crop.

Under the conditions of the 1956 and 1957 field experiments, DDT-Dylox emerged as the only new treatment that might be substituted for DDT or toxaphene for lygus bug control. This combination treatment significantly increased bug mortality over that caused by DDT alone, and did not build up red spiders or significantly reduce the numbers of honeybees. The toxaphene-Dylox combination was also significantly more toxic to lygus than DDT. However, toxaphene-Dylox, toxaphene-malathion, and DDT-malathion combinations were more toxic than DDT-Dylox to beneficial predaceous insects present in carrots grown for seed, and caused a buildup of red spider.

Field Experiments

In replicated field experiments on table beet seed plants at Davis in 1958, DDT again gave satisfactory lygus control, and was the least harmful of the effective materials to predaceous pirate bugs and ladybeetles. By reducing the bug population, DDT also increased the yield of seeds and the weight or size of the seeds. Seed increase would appear greater if there had been more bugs to control.

The DDT-Dylox combination treatment again appeared to give the greatest lygus bug control. It was significantly better than toxaphene, but not quite significantly better than DDT. It increased seed yield and weight or size of the seeds most significantly, when compared with all of the other treatments.

Of the treatments investigated, DDT-Dylox was the most toxic to minute pirate bugs and ladybeetle predators. This created no additional problems in the table beet seed crop, because tests have shown that Dylox gives enough direct control of red spiders to compensate for reduction of biological control. However, DDT-Dylox should be used with caution and only after consideration of the many factors involved.

The combination of DDT with Di-Syston appeared comparable to DDT-Dylox for bug control and was somewhat less toxic to the predators. However, this treatment resulted in a smaller yield and size of seeds than followed use of DDT-Dylox, and a very low seed viability, and appeared toxic to the plants under the conditions of the experiments.

Thiodan, DDT-Trithion, toxaphene, and DDT-toxaphene also proved satisfactory for lygus bug control on table beet seed plants, and afforded increases in yield and size of seeds. Next to DDT alone, the DDT-Trithion combination was least toxic to predators.

Under the conditions of these experiments, Di-Syston was unsatisfactory for

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Effects of Experimental Treatments on Insects and Seeds
Table Beet Seed Plants, Davis, 1958[1]

Treatment		Lygus reduction[2]				Predator reduction[2]				Av. yield and germination of table beet seeds						
		Adults + nymphs		Adults		Pirate adults + nymphs		Lady-beetle adults		Yield/plant		Wt/100 seeds		Seed balls germ.		
Material	Lbs./acre	%	Signif.[3]	%	Signif.	%	Signif.	%	Signif.	Gms.	Signif. incr.	Gms.[4]	Signif. incr.	No.	%	Signif. incr.
DDT + Dylox	1 1	98	5	96	5	87	1	80	5	10.33	5	1.52	1	137.4	83.4	0
DDT + Di-Syston	1 1	98	5	95	5	69	5	75	0	10.03	0	1.38	X	104.6	75.4	X
DDT + Toxaphene	1 1	97	0	87	0	57	0	63	0	9.58	0	1.35	X	142.2	87.4	0
DDT + Trithion	1 1	96	0	95	5	33	X	64	0	9.30	0	1.32	X	148.8	90.2	0
Thiodan	1	95	0	83	0	65	0	63	0	10.0	0	1.36	X	164.8[5]	94.8	5
DDT	1	93	0	69	X	14	X	47	X	9.38	0	1.33	X	126.0	81.8	0
Toxaphene	1	84	X	63	X	48	0	47	X	9.81	0	1.23	X	134.2	82.8	0
Di-Syston	1	67	X	67	X	44	X	55	X	9.12	X	1.37	X	118.6	80.8	X
Di-Syston drench	2	54	X	38	X	27	X	28	X	8.87	X	1.31	X	136.2	82.4	0
Check		..	X	..	X	..	X	..	X	8.27	X	1.16	X	115.0	75.8	X

[1] Sprayed June 3, 1958. Five replications of each treatment.
[2] Average of three successive counts, at 3, 7, and 14 days after treatment.
[3] Final step in a statistical comparison with all of the poorer treatments—marked X; those marked 0 are nonsignificant.
[4] DDT-Dylox resulted in 1,860 seed balls per ounce, compared with 2,440 in the check.
[5] Another set of germination tests showed that Thiodan was not so superior as these results indicate.

protection for the birds in case heat should fail; usually the pen temperatures were kept at about 50°F. Commercial nests were provided and a daily egg-production record was maintained, without trapnesting. Ordinary commercial feeds available in the Owens Valley were used. A feed storage bin of approximately three-ton capacity was located outside the building. Arrangements provided for the incubation of eggs at the Crooked Creek Laboratory and for brooding chicks at the Mount Barcroft Laboratory.

The experimental design was kept as simple as possible, for easy maintenance under severe conditions. The first objective of the experiment was to develop a high-altitude strain of chickens by breeding the survivors for several successive generations. Because adaptation to high altitude probably depends on many physiological processes, not all of which may be present in any individual, such an adapted strain would collect these factors and thus facilitate their recognition and study.

The high-altitude colony was stocked with day-old chicks from the random-bred SCWL line at Davis. These birds were preferred to other available lines because the large colony maintained at Davis serves as a genetically stable population for comparison with the high-altitude strain.

The effect of exposure to high altitude on survival was quite marked. Of the original group—184 chicks, excluding those sacrificed for organ weights and other tests—84% died in the first year. Mortality was particularly severe during brooding—39%; excluding these early deaths, there was a 69% mortality. Males—with 88% mortality—were much more susceptible to high-altitude stress than females—with 53%. Because of the very high mortality, the flock was examined for infectious disease, but none was found. The principal cause of death appeared to be a chronic heart insufficiency. Progeny of the original stock—whether hatched at the Crooked Creek Laboratory or at Davis—suffered about 50% mortality in the first year, almost equally divided between the sexes.

The effect of high altitude on growth was not what would be expected from the excessive mortality. Up to maturity the high-altitude birds were about 15%–25% heavier than similar groups raised at sea level. Isolation, with the consequent improved hygienic condition of the flock, may have aided the enhanced growth. Possibly some of the growth effect may result from selection, if the weaker and perhaps more slowly growing individuals are eliminated.

In mortality after six months of age, selection did not appear to be a factor. Birds dying at that time had apparently adapted and grown normally. Several weeks before death they would become listless and lose weight progressively. Exhaustion of the adaptive capacity is also known in man—as Monge's disease. Natives of high-altitude stock may suddenly become acutely mountain-sick; they must go to lower elevations or perish. In man, as in these birds, a chronic circulatory failure is prominent.

Birds of sea-level origin raised at high altitude were altered physiologically: heart rates were decreased, respiratory frequency and circulating red cell concentrations were greatly increased, as compared with sea-level birds. However, differences disappeared after several weeks when birds were brought to sea level.

The birds raised at high altitude attained sexual maturity at the usual age. The egg production of the flock ranged between 50 and 60 eggs per hundred hens per day during the first year of laying. Male fertility was adequate; 88% of the incubated eggs were fertile. However, hatchability at Crooked Creek—elevation 10,000′—was quite low: 3% for eggs of the parent stock and 9% for their second generation. At Davis—sea level—the hatchability for all groups was about 60%.

Detailed metabolic studies have been deferred until the high-altitude strain is developed. Attempts to induce or simulate the adapted condition in previously unexposed birds must await completion of the high-altitude studies.

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The White Mountain High-Altitude Research Station in Mono County has laboratories at elevations of 10,000′, 12,500′, and 14,250′. Nello Pace, Professor of Physiology, University of California, Berkeley, is Operations Director.

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bug control as either a spray or a drench.

Chlorinated hydrocarbon-phosphate combination treatments—such as DDT-Dylox—apparently resulted in a complementary chemical action which caused greater mortality of lygus nymphs than did DDT or toxaphene alone. In most cases, it caused also a higher percentage mortality of the adult bugs—a most significant and unusual result.

Lygus control depends on many factors, which in turn depend on a host of additional factors.

Lygus Control Dependency Factors

Population Density	**Crop**	**Types, Acreage**
	Bioclimate	**Geography, Crop**
	Predator	**Species, Number**
	Biotic potential	**Climate, Food**
Chemical	**Type of crop**	**Seed, Market**
	Time of application	**Plant devel., Season**
	Type of application	**Foliage, Tolerance, and Thoroughness**
	Number of bugs	**Climate, Food**
Tolerance	**Chemical used**	**Metabolism, Genetic**
	Type of crop	**Nutrition, Season**
	Biotic potential	**Bioclimate, Food No. of generations**
	Application	**Thoroughness, Amount**

The density of the lygus population depends on crop types and acreage; on bioclimate in relation to the crop and local geographic features; on the number and species of predators; and on the bug's biotic potential, in relation to climate and food supply.

The selection of the chemical to use should be based on a consideration of the type of crop—whether for seed or for market—and on the lygus population density with its various factors. The season of chemical application will depend on the amount or stage of plant development. Effectiveness of the method will depend on the type and thoroughness of application, on the amount of foliage, and on the tolerances of the beneficial and destructive insects.

In turn, insect tolerance to a chemical compound depends on the chemical used, probably in relation to the insect metabolism and the processes of genetic selection. Tolerance may vary with the type of crop and the nutrition it provides according to the season; with the amount of chemical and thoroughness of application; and with the biotic potential and the number of generations. Tolerance depends also on the length of time during which insects that can tolerate the particular chemical have been reproducing themselves under similar conditions of crop and climate.

Experiments with other chemicals and combinations are being planned with special emphasis on as many as possible of the dependency factors.

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