Photo 1. Sunflower seeds become black when chemically tested for the presence of the phytomelanin layer. Normal seed is on the left; treated seed is on the right.

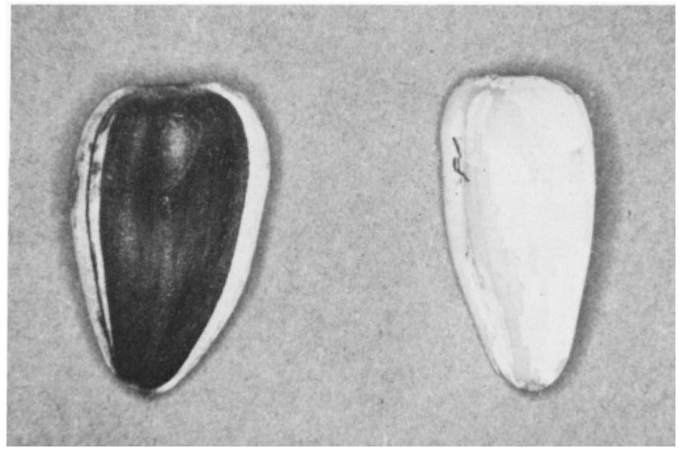


Photo 2. Sunflower seeds remain white when no phytomelanin layer is present. Normal seed is on the left; treated seed is on the right.

SUNFLOWER varietal resistance to sunflower moth larvae

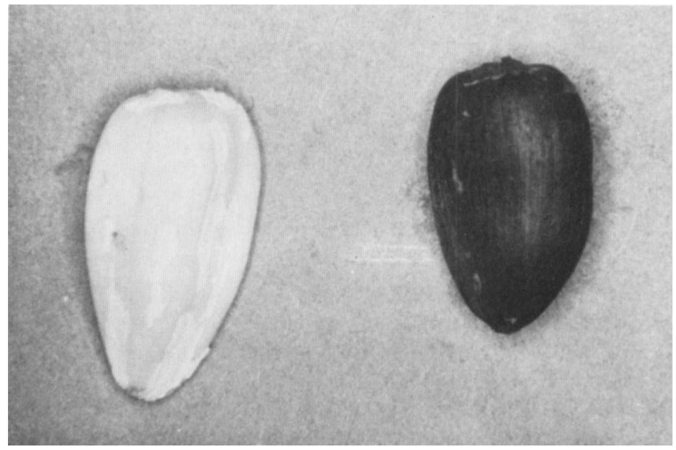


Photo 3. White treated seed with no armored layer on the left, and seed with the black armored layer on the right.

ELMER C. CARLSON · PAUL F. KNOWLES · JOHN E. DILLÉ

Damage to sunflower heads and seeds by larvae of the sunflower moth, Homoeosoma electellum (Hulst), is usually economically important. As an alternative to chemical methods of control, it appears that resistant sunflower varieties can be developed. Resistance or tolerance to larval feeding by the sunflower moth has been found in a few of our varieties, but only in those plants with a phytomelanin layer in the hull of the seed. Russian scientists, who term this the "armored layer," have found that this layer offers resistance to the larvae of the species of the sunflower moth commonly found in Russia.

THE SUNFLOWER MOTH, *Homoeosoma electellum* (Hulst), is a major limiting factor in the production of sunflower in Northern California and other areas in the United States. The larvae have damaged and/or destroyed, (depending on the season) 6 to 50% of the developing seeds at Davis, California. This seasonal fluctuation in population of the moth and seed injury appears to be due to variations in climate and parasite effectiveness, but is unpredictable at present. Pesticide control has usually been necessary, using two to three applications of endosulfan beginning at the onset of bloom. It can also be advantageous to plant sunflowers as early in the season as possible, and to use varieties that bloom early and uniformly. Early maturity will put the crop ahead of any significant moth emergence and larval infestation, and a uniform flowering date will reduce the number of insecticide applications needed for control.

Chemical control of this pest has brought problems with residues, pollu-

Photo 4. Cross-section of the hull or pericarp of a sunflower seed showing the presence of an armored layer or phytomelanin layer (PhM). Also shown is the epidermis (Ep), integument (In), and sclerenchyma (Sc).

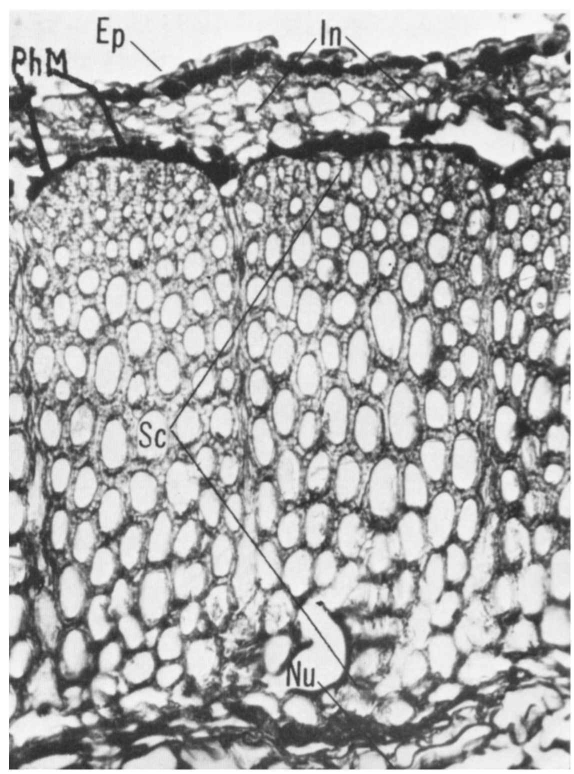


TABLE 1. SUNFLOWER VARIETAL TOLERANCE TO SUNFLOWER MOTH LARVAL DAMAGE, DAVIS, CALIFORNIA, 1970

Cross of sunflower	Damage index*	Color of† armored layer	Wt. of 100 seeds	Moth-damaged, seeds/100	Viable seeds/100
			gm	no.	no.
Calif. 5	1.60	W	7.5	5	97
310-2 X 525-2	0.17	B	7.4	2	96
310-2 X 526-1	0.75	G	9.2	5	88
Calif. 5 X 537-1 / 537-3	0.23	B	6.9	3	98
Selections					
310-2	2.8	W	14.0	10	92
525-1	0.07	B	13.0	1	85
525-2	0.14	B	—	—	—
526-1	0.33	G	6.5	1	94
526-2	0.10	B	—	—	—
526-3	0.29	B	—	—	—
537-1	0.40	G	—	—	—
537-3	0.23	B	12.0	4	93

* Damage index: 0 = no evidence of worm damage; 1 = 1 to 2 damaged spots; 2 = 3 to 5 damaged spots; 3 = 6 to 8 damaged spots; 4 = 9 to 11 damaged spots; 5 = 12 or more damaged spots.

† Seeds having an armored layer (a thin phytomelanin layer) remained black (B), while those not having this layer were white (W); and those that appeared gray (G) appeared to be intermediate (having only a thin layer). See text.

tion of the environment, and adverse effects on beneficial insects. Also, the necessity of using early varieties and early planting severely restricts the use of sunflowers in the cropping system. It would be more satisfactory to obtain a plant with built-in resistance or tolerance to the pest. This need has prompted the research reported in this article.

Included in the nursery at Davis in 1970 were a few named varieties and a diverse array of breeding materials, some stemming from natural crosses to wild types. Plantings were made both in early June and July.

Field evaluation

Field evaluations of head damage from larvae were made using a "damage index." "Spots" of damage (fairly discrete clumps of webbing and frass) on each head were counted, and scored according to six class values ranging from 1 for 1 to 2 damaged spots to 5 for 12 or more damaged spots. The average class score was the "damage index" for each variety (the sum of class × frequency, divided by the number of heads counted).

A chemical test was conducted and repeated several times on a few seeds of each variety to determine the presence or absence of an "armored layer" or phytomelanin layer. According to Russian researchers, sunflower seeds having this layer are tolerant to the species of sunflower moth common in Russia. The presence of the armored layer is apparently due to a single dominant gene.

The Russian plant breeders test for this armored layer by soaking seeds for 30 minutes in mixture of saturated solutions of potassium dichromate ($K_2Cr_2O_7$), three parts, and, sulfuric acid (H_2SO_4), one part (by volume). The pigments from the epidermis are removed by this mixture so that the armored layer can be seen—and which remain a black-slate color; while seeds lacking this layer will whiten. If the epidermis is not pigmented—as is the case with white or grey-striped seeds—the seeds must be boiled in the mixture for 10 minutes to remove the superficial tissues covering the armored layer. It appears that this mixture of chemical solutions actually removes or dissolves the pigments, outer epidermis, and parenchyma tissue, leaving the black armored layer exposed, if present.

Resistant selections

Data from the results obtained in 1970 at Davis (table 1) indicated that several selections appeared resistant or tolerant of sunflower moth larval damage. When compared with 310-2, a selection which was susceptible and had a damage index of 2.8, the following had much less damage 525-1, 525-2, 526-1, 526-2, 526-3, and 537-3. Compared with Calif. 5 (also susceptible but less so than 310-2), F_1 crosses showed resistance comparable with the resistant parent.

The chemical soaking test was conducted on seeds of some of the selections in table 1. The seeds from those varieties appearing resistant in field evaluations remained black (photo 1) and had an armored layer, while seeds from susceptible varieties were white (photos 2 and 3). This confirmation of tolerance was obtained for 525-1, 525-2, 526-2, 526-3, and 537-3, which showed the armored layer in cross-section (photo 4). Seeds of susceptible Calif. 5 and 310-2 and others from the field had no armored layer.

Many progeny, consisting of hundreds of plants from several selections, were evaluated in a 1971 field planting of sunflowers, and some of the data are pre-

TABLE 2. ASSOCIATION OF SUNFLOWER SEED ARMORED LAYER, AND RESISTANCE TO DAMAGE FROM LARVAE OF THE SUNFLOWER MOTH. DAVIS, CALIFORNIA, 1971*

Pedigree	Row no.		Damage† index	Color‡	Range in seed size‡	Plants with color of armored layer§ B	Gray	W	Viable seeds/100
							no.		no.
Calif. 5 X 537-1 / 537-3	−1	1612–3	1.20	WB	S–M	0		8	—
	2	1615	.67	WB	S–M	2		1	99
310-2 X 525-2	1	1617	.67	B	SM–M	2		0	—
310-2 X 526-1	−1	1628	.60	WB–B	SM–M	5		0	90
310-2 X 526-1	2	1632–3	.60	WB	S–M	2	2	1	85
215-4 X 526-1	1	1666–8	.67	WB–BP	S–L	2	2	1	89
526-1	−1	1674	.67	WB–BP	S–M	5		0	95
526-1	2	1675	1.00	BP	S–L	2		0	—
526-1	3	1676	.71	WB–BP	S–L	6	1	0	80
526-1	4	1677	.63	WB–BP	SM–M	5		0	88
526-2	−1	1678	.67	WB–BP	S–M	2	1	1	89
526-2	2	1682	.67	WB–BP	S–M	1		3	—
526-3	−1	1684	1.00	BP	S–L	2		1	—
526-4	1	1685	1.00	BP	S–M	1	1	0	—
526-5	1	1686	.67	BP	M–ML	2	2	0	—
526-6	1	1687	.60	WB–BP	SM–L	2		1	—
Calif. 5 X 537-1 / 537-3	1	1699	1.42	WB	S–M	0	0	3	—
	2	1702–3	.89	WB–BP	S–M	2	0	5	95
Checks, Calif. 5	1	Buffers	2.35	WB	SM–M	0		50	
Susceptible	1	1652–6	3.30	Gray to B	S–SM	0		50	

* The data were obtained primarily from field plants with single heads and no branches that were tolerant to sunflower moth larval damage as indicated by field counts.

† Damage index: 0 = no evidence of worm damage; 1 = 1 to 2 damaged spots; 2 = 3 to 5 damaged spots; 3 = 6 to 8 damaged spots; 4 = 9 to 11 damaged spots; 5 = 12 or more damaged spots.

‡ The abbreviations used for seed color were: W = white, B = black, and P = purple; while sizes were: S = small, M = medium, and L = large, and combinations thereof.

§ Seeds having an armored layer (a thin phytomelanin layer) remained black, while those not having this layer were white; and those that appeared gray to be intermediate (having only a thin layer). See text.

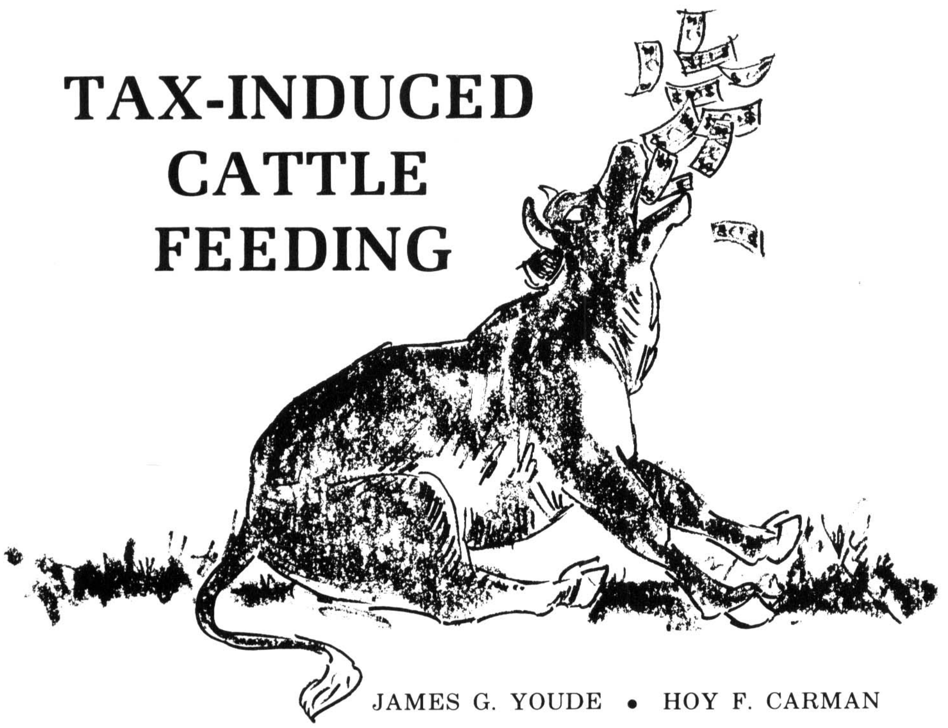
sented in table 2. The presence of the black armored layer was associated with reduced damage. The most consistently resistant progeny were of the selection 526-1, from which 18 plants were obtained that exhibited resistance. All of these had a damage index of from 0.63 to 1.0, and exhibited the black armored layer. The most susceptible selections (the controls) had an index of 3.0 and remained white (no armored layer). Where selections were segregated for presence or absence of the armored layer, as in the selections 526-2 and 526-3, only those plants showing a low damage index exhibited the phytomelanin layer.

The readings or field evaluations given in the reported data were mostly from plants that were single-headed, and not branched. Moreover, the results given for the harvested seeds, evaluated chemically for presence or absence of the armored layer and for size and color, were primarily from those single-headed plants that exhibited little or no sunflower moth larval damage (scores of 1 or less). Many susceptible selections (and the controls) were also evaluated. However, field distribution of the moths was not uniform, which permitted some plants to escape damage. This would explain the fact that a few plants appeared resistant or tolerant in the field but did not have the armored layer.

Two F_1 crosses, 310-2 × 526-1 and 215-4 × 526-1, exhibited sunflower moth resistance in a few plants, all of which had the armored layer. This shows that the addition of the armored layer to commercial sunflower varieties should provide some resistance to larvae of the sunflower moth. More work must be done, however, to determine whether or not the armored layer has an adverse affect on meal or oil quality. Also to be determined is the inheritance possibility for the armored layer and effects on the insect.

Elmer C. Carlson is Specialist, Department of Entomology; and Paul F. Knowles is Agronomist and Head, Department of Agronomy and Range Science, University of California, Davis. *Graduate student, John Dillé, made the seed sections and took the microphotographs; and John Campbell, Nurseryman in Entomology, assisted with the field and seed evaluations. This study was based primarily on investigations under project 2418 and project 1812.*

TAX-INDUCED CATTLE FEEDING



JAMES G. YOUDE • HOY F. CARMAN

Cattle feeding for income tax deferral has resulted in many nonfarm investors providing substantial capital for cattle feeding in California. This recent growth in outside financing, accomplished mainly through limited-partnership arrangements, has potential economic implications to agriculture. Favorable aspects include a possible smoothing of seasonal variations in feeder and fed cattle prices with increased returns to feeder cattle producers. Participating cattle feedlot operators are better able to utilize their facilities and have probably benefited from their association with limited partnerships. There are also possible economic disadvantages. Non-participating feedlots may encounter problems obtaining the numbers of feeder cattle desired. If feedlots become dependent on these investors, as it appears they have in California, a change in tax laws or investor interest could create problems of adjustment in sources of financing. Also, if cattle funds are available on a sporadic basis, they could increase instability in the fed beef business.

IN OCTOBER, 1971 Joe Torte, an aggressive young Los Angeles attorney, had a "tax problem." A wrongful-injury law suit he had worked on for two years was settled in favor of his client, and he received a feed of $75,000 from the settlement. Combined with his "normal" 1971 professional income of $50,000, Torte faced a larged tax liability. He immediately began exploring methods of reducing his 1971 income tax payment.

While visiting with his accountant, Torte was advised that he should consider becoming a cattle feeder, thereby deferring his extraordinary income to a later year. He learned that he could defer taxes on the entire $75,000 with about 600 head of cattle. The total 1971 feeding investment, including prepurchased feed, is summarized below:

Cost of 600 head of cattle purchased	$103,000.00
Feed bill for 1971 (October, November, December	15,000.00
1972 Feed prepurchased	54,000.00
Total Investment (excluding interest)	172,000.00

Torte provided $37,000 in margin funds, leaving a loan balance of $135,000. He also prepaid $6,000 of interest expense for 1972. Hence, an investment of $43,000 has given him an income deferral of $75,000 from 1971 to 1972. Torte also gained considerable financial leverage as a cattle feeder: with 24.2 percent down he controls an investment of $178,000.