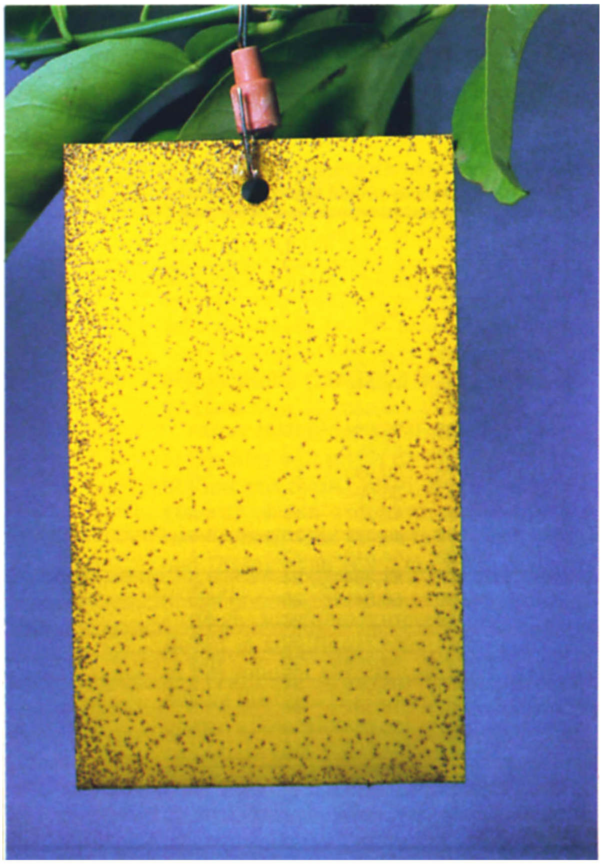

Yellow polyvinyl "sticky card" of the type used to trap California red scale males.

and serve as a basis for action or nonaction in the following year.

Predictive values generated from the various analyses are shown in table 1. The column with percent fruit with 11 or more scale per fruit was generated by comparing proportions of infested fruit with more than 11 scale against those proportions that had more than 1 scale. Thus, mean male catch of 184, 16,038, and 49,022 for the first, second, and fourth flights, respectively, can result in a mean of about 20 and 6.6 percent of the fruit with 1 or more and 11 or more scale, respectively, at the end of the growing season. In one of our orchards, male trap catches at the end of the first and second flights (181, 11, 299) projected 20 and 15 percent fruit infestations, respectively. The observed fruit infestation was 14.3 percent (1 or more scale). Twig infestation was 2.1 adult females per 10 twigs, which indicated a 14 percent (1 or more scale) fruit infestation. Thus, the second flight was a better predictor than the first, and the twig sample at the end of the year substantiated this information.

The value of our predictive fruit infestation levels under an IPM program is to assess fruit infestations before they occur. Proper trapping and data interpolation should generate three possible outcomes: (1) no action, (2) contemplation, and (3) control action. In the first case, no serious problems are expected, in the second, a "wait and see" or "willing to take a risk" attitude is taken, and in the third, action is necessary because the expected fruit infestation will be above a tolerable level.

The assumption in all three situations is that some degree of fruit infestation must be accepted. The projected amount of acceptable fruit infestation is a matter of individual preference and for that reason no "economic thresholds" are offered here. Whether a scale population is going to overinfest fruit and damage the tree depends on the density of the scale on the tree in the beginning of the year, rate of scale survival during the fruit growing season, rate of predation and parasitism, age and physiological condition of the tree, and other pest control practices. In our experience, 17-year-old navel orange trees in good physiological condition situated in Exeter, California, were able to support scale populations that inflicted 31.9 and 40 percent fruit infestations (1 or more scale) without apparent damage to the trees at the end of the season.

Through proper assessment of red scale populations, unnecessary scalicide sprays are avoided. At least in one orchard, proper monitoring resulted in a between-treatment interval of about 36 months. The economic and ecological implications of averting unnecessary scalicide treatments are obvious. We propose that by proper use of the pheromone trap and correct interpretation of male trap catches, an assessment of fruit infestation can be made before it occurs.

Our projections fall within an acceptable range of expectations. In the very few years when mild summers were encountered, our projections were somewhat underestimated. Even so, the citrus grower would have an idea of what is going to happen. Thus, pheromone trapping can more accurately measure California red scale population densities than can occasional visual observations. By doing so, trapping can improve the quality of decision-making in citriculture. However, caution is needed in utilization of the trap because of the male scale's sensitivity to extreme temperatures, winds above 1.6 km per hour, direct pesticide applications for other pests in the same orchard, pesticide drifts from neighboring orchards, trap placement in relation to neighboring orchards, and quality of pheromone used.

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Nitrogen

The continuing increase in production cost and the environmental concerns regarding nitrate pollution point to a need for more efficient fertilization of vegetables. Nitrapyrin [2-chloro-6 (trichloromethyl) pyridine] has been reported to reduce nitrogen losses by inhibiting bacterial action in soils (bacteria convert ammonium to nitrate, which is subject to loss by denitrification and by leaching).

Recent studies have investigated nutrient uptake and growth patterns in lettuce, Brussel sprouts, and celery, but little information is available on cauliflower.

This article presents data from field trials on the efficiency of nitrogen fertilizer uptake by cauliflower. We used isotopically labeled nitrogen at various rates in single and split applications with and without nitrapyrin.

The cauliflower cultivar 123 was direct-seeded on 40-inch beds with 16 inches between plants and one row per bed. Each treatment was replicated five times in plots of six beds by 60 feet long in a randomized complete block design. The soil was a Watsonville loam with a perched water table 3½ feet below the soil surface during the summer growing season.

Preplant soil analyses from check plots for bicarbonate soluble phosphorus (58 ppm), potassium (263 ppm), and DTPA extractable zinc (3.2 ppm) would generally indicate that these nutrients were in sufficient supply for normal growth and development of cauliflower. However, all plots received 200 pounds of 0-20-20 fertilizer banded into soil as the beds were listed up for planting. Nitrogen as ammonium sulfate was sidedressed into beds a few days before planting at rates of 0, 60, 120, and 180 pounds of nitrogen per acre in single applications. Rates of 120, 180, and 240 pounds were also applied as split applications: the second half was banded into the beds 35 days after planting or after one-third of the growing season had passed. Separate single-application treatments of 60, 120, and 180 pounds nitrogen received 0.5 pound per acre of nitrapyrin as a 10 percent aqueous solution injected into the dry ammonium sulfate band.

uptake by cauliflower

Norman C. Welch □ Kent B. Tyler □ David Ririe
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Adding nitrapyrin to fertilizer improved nitrogen uptake and crop yield

Watsonville-area cauliflower field.

Isotopically labeled nitrogen as ammonium sulfate was applied to the entire 60 feet of the two center beds. Its purpose was to show how much of the nitrogen present in whole top samples was derived from the fertilizer.

The cauliflower crop was harvested from 60 feet of bed over seven harvests. As each plant approached harvest maturity, it was inspected every four days to determine the peak of fresh market quality. Each head was trimmed to leave only jacket leaves that a commercial harvesting crew would pack.

Leaf midrib levels of nitrate-nitrogen (NO_3-N) in this experiment proved to be a reliable guide to the nitrogen status of this crop. Early in the season, midrib nitrate-nitrogen levels in the no-nitrogen and 60-pound nitrogen plots (table 1) were significantly below those in all other treatments. Near cauliflower maturity, the 120-pound single-treatment nitrate-nitrogen level was below the level that would normally result in maximum yield.

These results indicate that the 60-pound rate with and without nitrapyrin did not provide enough nitrogen to supply crop demand. At the 120-lb rate, the nitrogen applied in one application was more subject to leaching or denitrification loss than that applied in split applications or with nitrapyrin. Midrib nitrate-nitrogen levels remained significantly higher in the nitrapyrin treatment.

Uptake of total and fertilizer nitrogen was higher with nitrapyrin than in the single application without it at the 120- and 180-pound rates (table 2). However, the uptake of fertilizer nitrogen was not significantly better in the nitrapyrin treatments than in the split application at the 60 and 120 pound rates, and at the 180 pound rate, the split application was superior to the nitrapyrin treatment. The ability of cauliflower to use soil nitrogen is evident from the low 30 to 40 percent of isotopically labeled fertilizer nitrogen found for most of the treatments.

Adding nitrapyrin to the fertilizer band resulted in significantly larger yields than in plots receiving single and split applications of the 60- and 120-pound rates of nitrogen (table 3). Maximum yields were obtained in this trial with 120 or 180 pounds nitrogen with nitrapyrin or split applications of 180 or 240 pounds nitrogen per acre.

In conclusion, single applications of nitrogen at planting, as ammonium sulfate, were inefficient and resulted in less nitrogen uptake and reduced yields than split applications. Addition of nitrapyrin to single preplant applications of nitrogen improved yield and resulted in increased uptake of nitrogen. Split application of nitrogen at the 120-pound rate resulted in a significantly lower yield of cauliflower than a single application of 120-pound nitrogen plus nitrapyrin.

Cauliflower, like many other vegetables, needs an abundant supply of nutrients close to harvest for high yields and top quality. Nitrogen is needed in large amounts at that time, and should be applied in the ammonium form with a nitrification inhibitor or in two or more applications to reduce leaching losses.

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TABLE 3. Yield of cauliflower as affected by nitrogen rate, number of applications, and combination with nitrapyrin

N treatment	Nitrapyrin application	Fresh market cauliflower yield*
lb/acre	*lb/acre*	*ton/acre*
0	0	1.34 a
60 split	0	3.46 b
60 single	0.5	5.05 c
120 single	0	4.76 c
120 single	0.5	7.86 e
120 split	0	7.20 d
180 single	0	7.00 d
180 single	0.5	8.01 e
180 split	0	8.04 e
240 split	0	8.05 e

* Means followed by different letters were significantly different at the 1% level, DMRT.

TABLE 1. Cauliflower midrib nitrate-nitrogen levels at two stages of growth

Nitrogen treatment*	Nitrapyrin	Midrib nitrate-nitrogen: Before curd formation	Midrib nitrate-nitrogen: At ⅓ curd formation
lb/acre	*lb/acre*	*ppm*	*ppm*
0	0	3,620 a	554 a
60 split	0	4,154 a	804 a
60 single	0.5	8,306 b	1,156 ab
120 single	0	9,554 bc	496 a
120 single	0.5	10,464 c	3,294 c
120 split	0	9,570 bc	1,976 b
180 single	0.5	11,208 c	4,810 d
180 single	0	11,054 c	2,490 bc
180 split	0	10,730 c	3,888 cd
240 split	0	10,380 c	5,714 d

* Nitrogen as ammonium sulfate. Single application as preplant; split, one-half preplant, one-half 35 days later.
† Means followed by different letters were significantly different at the 1% level, by the Duncan's multiple range test (DMRT).

TABLE 2. Total nitrogen (N) uptake and fertilizer N efficiency of cauliflower as determined by isotopically labeled nitrogen

N treatment	Nitrapyrin	Plant N*	Fertilizer N absorbed*
lb/acre	*lb/acre*	*lb/acre*	%
0	0	17.7 a	0
60 split	0	34.2 b	30.1 a
60 single	0.5	83.4 c	29.5 a
120 single	0	85.0 c	36.0 ab
120 single	0.5	149.5 e	37.7 ab
120 split	0	132.0 d	39.5 b
180 single	0.5	148.8 f	42.7 b
180 single	0	117.3 d	35.3 ab
180 split	0	164.8 fe	40.3 b
240 split	0	203.8 f	43.9 b

* Means followed by different letters were significantly different at the 1% level, DMRT.