Linuron Use in Arizona & California Agriculture

Linuron Use in Arizona and California Crops

The herbicide linuron (e.g., Lorox DF) has broad-spectrum activity, except against plants in the Apiaceae (=Umbelliferae) family, which includes celery, carrots, parsnips, parsley and cilantro. It is inexpensive and highly effective. It also has a long soil residual compared to most other herbicides, which is a reason many growers of other crops do not use it. In Arizona, linuron is reportedly used exclusively on celery, carrots, parsnips, parsley and cilantro, with celery and carrots being most prominent in terms of acres. In California, uses are reported on a broader range of crops, but carrots are most prominent (77% of California use), along with celery and cilantro.[1] In 2017 in California farm-gate value of carrot production was $615 million, celery was $302 million and cilantro $55 million.

The production system and biological aspects of these plants in the Apiaceae family make weed management extremely challenging. These crops are grown over a long period (120+ days) and require a lot of water. In both California and Arizona, celery is transplanted but all the other Apiaceous crops are direct seeded. Both carrot and celery are grown on beds. Apiaceous crops are generally planted at high density, though it takes a long time for the canopy to close, which provides opportunities for weed establishment. Once the plants grow out, the large canopy rules out any mechanical weed control methods, because it cannot be done without damaging the crop. Linuron can be sprayed over the top of the crop with very minimal or no crop damage. In Arizona, this approach is used in both celery and carrot production. Because of its long soil residual, a single application of linuron maintains effective weed control under these watering conditions for the entire season. Linuron is effective against a broad range of weeds, including lambsquarter, purslane, carpetweed and morning glory. It also controls grasses, such as barnyard grass.

Human Health and Ecological Concerns for Linuron

Linuron is identified as a Highly Hazardous Pesticide, consistent with Article 7.5 of the FAO Code of Conduct on Pesticide Management, which considers prohibition of substances that pose unacceptable risks to humans or the environment, based on risk assessments, after risk mitigation and good marketing practices have been followed (FAO 2016, SAN 2017). A human health draft risk assessment developed by the US Environmental Protection Agency (EPA) as part of registration review in 2016 indicated both acute and chronic risks of concern for dietary exposures (food and drinking water) for the general U.S. population and all subgroups (infants, children, women of reproductive age, etc.). The largest contribution to dietary risk is from drinking water. For example, modeled levels of chronic dietary exposure were 23x the chronic population adjusted dose for adults, and 59x for infants. Risks to pesticide handlers were also identified, even when using “label-specified personal protective equipment for the majority of occupational handler scenarios, even at the highest level of appropriate mitigation available

[1] Source: California Department of Pesticide Regulation Pesticide Use Database; Arizona Pest Management Center Pesticide Use Database

(e.g., engineering controls)" (Rikard et al. 2016). Toxicological effects of linuron identified through animal studies and cited in EPA's human health risk assessment, based on a robust toxicological database, include changes in hematopoietic stem cells (which give rise to other blood cells); changes in male reproductive systems; and decreases in hormones responsible for regulation of metabolism (Rikard et al. 2016). An ecological draft risk assessment developed by EPA scientists (Jewett & Koper 2016) identified potential risks to fish, amphibians, aquatic invertebrates, aquatic and terrestrial plants, birds, reptiles, terrestrial amphibians, and mammals, based on currently registered uses of linuron. While EPA has accepted public comments on their published draft risk assessments for linuron, including comments representing Arizona and California growers (Fournier et al. 2017, Nunez 2017, Sano 2017), to date they have not issued a proposed interim decision, which could impact future registrations of this herbicide.

No health incident data could be found for linuron exposures (related to carrot production) in the California Pesticide Illness Database, nor any recorded incidents in Arizona. Linuron is on the Ground Water Protection Lists in both Arizona and California. Both states requires linuron applications to be reported.

Application Method and Rates

In both Arizona and California carrots and celery linuron is applied by ground. Arizona growers exclusively use a single post-emergent, over-the-top application in carrots and celery, when plants are young. Only a single application is needed for season long weed control, and other herbicides are not needed in many instances. Product rates used in Arizona carrots range between 16 oz (0.5 lb AI/acre) and 32 oz (1.0 lb AI/acre). Arizona rates in celery trend between 24 oz (0.75 lb AI/acre) and 48 oz (1.5 lb AI/acre), with 32 oz (1.0 lb AI/acre) being the most common.

In California, pre-emergent weed control in carrots is applied by chemigation. Post-emergence weed control is also used, also applied by chemigation. An active ingredient rate of 0.25 lb AI/acre is used after planting but before plant emergence. The second application is 0.75 to 1.25 lb AI/acre approximately 30 days after emergence (~ 3 true leaves) Not to exceed 1.5 lb AI/acre total. Post-emergent treatment is more effective (CFCAB & CMCC 2005). In California celery, linuron is typically applied at a rate of 0.5 lb AI/acre two to four weeks after transplanting.

Alternatives:

As noted above, the dense canopies formed by these crop plants make mechanical weeding impossible to achieve without damage to the crop. In Arizona, prometryn (Caparol) is the most commonly used chemical alternative in celery and carrots, applied over-the-top, like linuron. Prometryn products are volatile and growers have concerns about drift to other sensitive crops in Arizona production systems. Prometryn also lacks the spectrum of control that linuron has. In

addition, Caparol has plant-back restrictions that do not work well for Arizona growers. Another alternative that works for dense, fall plantings of celery in central Arizona is a single pre-plant application of bensulide (Prefar). This approach is not effective on earlier celery plantings in Yuma (western AZ), where most Arizona celery is produced. It should be noted that while prometryn and bensulide (an organophosphate) are not on the highly hazardous pesticide list, both herbicides are identified as requiring risk mitigation, in both cases because of concerns with inhalation risk and risks to aquatic organisms and wildlife (SAN 2017).

In California, celery growers use prometryn and trifluralin as well. In California carrots, metam sodium (or metam potassium) was used more widely for weed control, but current application method restrictions have reduced its efficacy. Previously, growers sprinkler-applied metam sodium which resulted in a more even distribution of chemical at and near the surface of the soil. Shank application injects the chemical several inches deep in the soil but does not provide good distribution at and near the soil surface. Since most weed seeds need to be at or near the soil surface in order to germinate, shank application does not control weeds as well as sprinkler application. California carrot growers generally do not use prometryn, as it holds back carrot growth by 1-2 weeks. Carrot growers also commonly use trifuralin (Treflan) and pendimethalin (Prowl), and may use fluazifop-p-butyl (Fusilade), clethodim (Select Max), and EPTC (Eptam) depending on weed pressure. Note that EPTC, pendimethalin and trifluralin are on the list of pesticides requiring risk mitigation. Non-chemical practices include crop rotation, cultivation of the sides of the beds and the furrows, long term reduction of seed banks, and hand removal of weeds prior to weed seed development.

Mitigation Practices

Applicators in both states wear personal protective equipment (PPE) as specified on labels (e.g., coveralls, chemical-resistant gloves made of any waterproof material, shoes and socks, chemical-resistant headgear for overhead exposure) and observe 24-hour re-entry interval (REI) and 14-day pre-harvest interval (PHI). Linuron can leach into ground water or runoff to surface water, but these are not likely in the locations where carrots are grown in AZ or CA. All applications in both states are made by ground or chemigation, reducing potential for drift. Growers are mindful of windspeed and surrounding crops when making an application. In Arizona, all applications in carrots and celery are made over the canopy and product falls mainly on foliage. After application, chemical is exposed to UV light and expected to breakdown quickly. It is believed there is little likelihood of linuron leaching into ground water. Growers follow the guidelines recommended for rinsing out the sprayer to eliminate off-site application of the product.

Economic Impacts

Linuron is the most efficacious herbicide available in carrots and celery, and is also inexpensive. Conversations with growers and crop consultants in Arizona and California indicated that

linuron is a critical need for carrot production, as well as celery, because of its efficacy, long residual, and challenges of weed control inherent in these crops, as well as the shortcomings of the alternatives. In Arizona, professional pest control advisors (PCAs) working in both carrots and celery have expressed concerns that production of these crops may not be economically viable in Arizona if linuron were no longer registered for this use. One PCA who works with Arizona celery growers commented, "Before we went to the current production system relying on linuron, weed management was so challenging and expensive that some growers were ready to give up on the crop." Now acres have expanded. Another PCA indicated, "If we didn't have the Lorox in carrots, I don't know what we would do. There are not many alternatives, and none that work as well." California grower queried about linuron use in carrots indicated that linuron was critical to their production system. On grower said that, should it occur, "the loss of linuron would cripple the conventional carrot industry." Although the total lbs. of linuron use in California celery is not great, the herbicide is critically important for celery production according to a University of California Cooperative Extension farm advisor.

Extension Guidance

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Chemical	Commodity_or_Site	Pounds_Applied	Agricultural Applications	Area_Treated
LINURON	ASPARAGUS	830.05	27	818.3
LINURON	CABBAGE	2.25	1	18
LINURON	CARROT	40679.82	1306	53838.77
LINURON	CELERY	5504.51	876	9323.63
LINURON	CILANTRO	3803	700	6479.53
LINURON	DILL	171	10	342
LINURON	HERB, SPICE	39	2	58
LINURON	N-GRNHS FLOWER	7.09	38	44.75
LINURON	N-GRNHS PLANTS IN CONTAINERS	3.73	5	11
LINURON	N-OUTDR FLOWER	143.39	20	146
LINURON	N-OUTDR TRANSPLANTS	47	4	47
LINURON	PARSLEY	269.61	63	475.05
LINURON	PEAS	517.35	37	631.7
LINURON	POTATO	7	1	5
LINURON	RESEARCH COMMODITY	3.82	0	None
LINURON	RIGHTS OF WAY	0.03	1	1
LINURON	UNCULTIVATED AG	14	2	14

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