

IPM Factsheet 2: Alternatives to carbosulfan for controlling Colorado beetle in potato

Problems caused by Colorado beetle

The Colorado potato beetle *Leptinotarsa decemlineata* originates from North America, where it feeds on foliage of potato and other plants in the Solanaceae family (eggplant, tomato, peppers, tobacco) and some others. It has spread around the world and can be a serious pest of potato, stripping plants of leaves and stems in the worst cases. Heavy infestations can reduce tuber yields by an average 30% if the beetles are left unmanaged.

The importance of taking an IPM approach

Colorado beetle is notorious for rapidly developing resistance to insecticides and has become a 'super pest' for this reason. In many countries, older generation compounds in the carbamate, organochlorine and pyrethroid groups are mostly ineffective against the pest. Studies show that resistance can occur within 4 to 10 generations of a particular beetle population with repeated exposure to the same or similar insecticide. In warmer climates, where there are 2 or more beetle generations per year, this can mean that within 3-5 years related insecticide products may no longer provide control. There are now documented cases of Colorado beetle resistance to newer insecticide groups, including neonicotinoids and diamides.

Relying on chemical control as the main tactic against Colorado beetle can increase production costs and is highly risky if ineffective products are used or products are applied at the wrong time or sprayed only against larger beetle larvae and adults, which can often survive a poorly made application. Resistance risk increases if farmers fail to rotate between chemical groups with different modes of action or use the same insecticide to control both the overwintering generation and the offspring they produce. Excessive use of insecticides against hard to control beetles may also risk outbreaks of aphids in potato.

Good cultural controls, including effective crop rotation and field hygiene, form the backbone of IPM strategies for this pest. There are also several physical barrier methods which can be used to prevent or reduce numbers of beetles entering potato fields, and biological, manual and other direct control measures. It is important for farmers to have a good understanding of the Colorado beetle's life cycle under local conditions, its biology and behaviour in order to manage it economically and sustainably. A combination of preventative and direct control methods is required, adapted to the particular potato cropping system, region and farm size and informed by regular field monitoring for timely decision making.

Preventative measures that potato growers can take

Careful site selection and timing of potato cultivation: Most Colorado beetles emerging after winter or the non-potato season are only able to walk a short distance (around 500m)

so siting potato fields greater than this distance away from fields which were infested in the previous season will reduce numbers colonising the new crop. Avoiding the local peak period of beetle attack is another sensible tactic, by either planting early-maturing potato varieties or planting considerably later than the average.

Rotating with other crops: crop rotation alone will rarely be enough to avoid Colorado beetle infestation but it plays a major role in reducing the numbers colonising fields and surviving to the following season.

In Afghanistan: IPM recommendations are to follow potato with one year of wheat, one of alfalfa and one of maize.

In California: farmers can reduce beetle populations surviving from infested fields by planting a dense cereal crop the following year, which makes it difficult for the beetles to escape by flying, exposes them to predators and starves them of suitable food.

Trap crops: These attract the first colonising beetles into a border strip, where they can be destroyed. Trap cropping works well for small or medium farms.

In the USA: planting a trap crop of early sown potato two weeks before the main crop diverts beetles onto these plants in a confined strip, where they can be controlled mechanically before they move onto the main crop.

Good field hygiene: All potato haulms and other crop waste should be removed from the field after harvest. Removing weeds, especially those in the Solanaceae family, helps to reduce sites where the beetles can survive during the winter or dormant period.

Physical barriers and other protective methods: The Colorado beetle's limited flight ability and slow walking behaviour makes it relatively easy to trap at field edges using some form of pitfall trap. Another option is to use 'floating' row covers of fine fabric or mesh which exclude beetles from access to the growing foliage.

In Canada and USA: plastic-lined trenches constructed along potato field edges, with walls sloping at an angle of 46° or steeper, can capture over 80% of adult beetles migrating. Portable field-edge traps are now available.

Mulching with wheat or other cereal straw can reduce the beetle's ability to locate potato fields and the microenvironment under the mulch encourages the presence of predatory natural enemies of this pest.

Encouraging natural biological control: Ground beetles are important predators of Colorado beetle in the first half of the season and will climb up plants to feed on the second and third larval stages of the first generation of beetles. Later in the season, ladybird beetles and green lacewings are major predators, feeding on eggs and very small larvae. Mulched plots support larger numbers of predators than non-mulched ones, resulting in less

defoliation. Research in organic fields in the US shows that mulching to encourage natural enemies can increase tuber yields by 30%.

Direct interventions when extra control is needed

Regular field monitoring to observe the health of the crop is a basic principle of IPM. This aspect is very important for Colorado potato beetle management and field observation enables growers to know when the first beetles arrive and identify 'hot spots' for control actions. This pest tends to invade from the field edge, often only from one direction, so that actions can be targeted to the vulnerable area.

In Afghanistan: monitoring is recommended weekly, looking for adults and larvae on the upper leaf surface and egg masses underneath. Control action is needed when more than 10-15 larvae are found on a single plant.

Manual removal and other physical destruction methods: The Colorado beetle lays clumps of relatively large eggs on leaf undersides and the larvae tend to remain in clumps after hatching. This makes eggs and larvae fairly easy to find and target by physical methods in smallholder potato production.

In Afghanistan: egg masses, immature and adult beetles can be collected by hand and destroyed. Placing larvae and adults into a container of soapy water is sufficient to drown them.

Flaming equipment, used for weed control, can also be used to destroy overwintering Colorado beetles. Flaming should be done after the potato shoots emerge but before the plants reach 20cm in height, when they become more sensitive to heat and the canopy will hide more beetles. It is best done on sunny days when beetles are feeding actively on the top of plants. This method is especially suitable for organic growers who have no chemical options permitted. Studies in the US show that it can kill over 90% of overwintering adults, compared with 25-50% mortality using insecticides, and flaming also reduces egg hatch.

Deep tillage after harvest helps to uncover adults burrowing into the soil to survive the off-season or winter, and expose them to predators, damage and desiccate them.

Biopesticides: Several products based on the bacterium *Bacillus thuringiensis* (B.t.) are available, but growers should make sure to use only B.t. products designed for beetles (usually with the *tenebrionis* strain of this bacterium). Note that B.t. products need to be ingested by the beetle (i.e. they do not kill by contact) and only work against the larval stages, with the newly hatched larvae being most susceptible.

Fungal-based biopesticides using selected strains of *Beauveria bassiana* can infect and kill all stages of the beetle larvae and adults but don't work well at high temperature. For the most effective use of biopesticides (just as for synthetic insecticides), growers need to monitor the pest development and time their applications to target newly hatching larvae.

Botanical extracts and other non-chemical methods: Neem extract products have some efficacy against Colorado beetle in the early crop stages, although high spray concentrations can provoke phytotoxic damage to the plants. Sprinkling dry wheat bran over plants as a food source is a method for smallholders recommended in some countries. The ingested bran swells inside the beetle's stomach, reduces its feeding and can even kill it.

Several Colorado beetle attractant lures are available, using sex pheromones, male aggregation signals or lures based on the odours emitted by potato plants.

Sources of information used

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