Insecticide resistance status in UK potato crops

Summary

- This publication by the Insecticide Resistance Action Group (IRAG) summarises the resistance status of pest insects of UK potato crops
- The peach–potato aphid (*Myzus persicae*) and potato aphid (*Macrosiphum euphorbiae*) are the main aphid pests of potatoes
- These guidelines apply primarily to the peach–potato aphid, as this aphid is associated with significant insecticide resistance issues
- Peach–potato aphids with high levels of resistance to pyrethroids and some carbamates now predominate across the UK
- Available insecticides in potatoes effective against peach–potato aphid include neonicotinoids and those containing the active ingredients pymetrozine, flonicamid or spirotetramat
- Grain aphids (*Sitobion avenae*) with moderate levels of resistance to pyrethroids are widespread in the UK. This aphid does not colonise potato but can transmit viruses
- Available insecticides in potatoes, effective against grain aphid, include neonicotinoids and products containing the active ingredients pymetrozine, flonicamid or spirotetramat and pyrethroids
- To minimise the risk of insecticide resistance appearing and spreading, insecticide use should be minimised through the use of thresholds and IPM programmes, products should be used at their full label rate and modes of action (MoA) should be alternated in the spray programme (where more than one treatment is required)
- These guidelines should be used in conjunction with IRAG's 'Background to insecticide resistance and its management' publication
- All IRAG publications can accessed via the dedicated web page – ahdb.org.uk/knowledge-library/IRAG
- Approved chemical names or the name of the chemical group they belong to are used throughout this document. The names of products registered in the UK that contain these insecticides are available at secure.pestcides.gov.uk/pestreg/ProdSearch.asp

Aphid pests of potato crops

Peach–potato aphid (*Myzus persicae*) and potato aphid (*Macrosiphum euphorbiae*) are the main aphid pests of potatoes. Glasshouse potato aphid (*Aulacorthum solani*) and buckthorn–potato aphid (*Aphis nasturtii*) are sporadic pests of potatoes. Melon aphid (or cotton aphid) (*Aphis gossypii*) is mainly a glasshouse pest that occurs very occasionally on potato crops in the UK. In addition, bulb and potato aphid (*Rhopalosiphoninus latysiphon*) may also be found. All these species can colonise potatoes and, therefore, transmit persistent viruses, such as potato leaf roll virus (PLRV). Persistent viruses are transmitted following ingestion of sap and virus passing through the aphid digestive system into the sap.

There are a number of aphid species that do not use potato as a host but, nevertheless, alight on potato plants and probe the leaves. These non-colonising species can transmit non-persistent, rapidly acquired potyviruses, such as Potato Virus Y (PVY) and Potato Virus A (PVA). Laboratory methods have been used to study which aphid species are the most important in spreading potyviruses. Peach–potato aphid is considered to be the most efficient vector of PVY and laboratory results of virus infection bioassays are used to calculate Relative Efficiency Factor (REF) values, which reflect the transmission efficiency of a particular aphid species in relation to that of peach–potato aphid (Table 1).

Up to date information on aphid pest monitoring in potato and an indication of regional virus pressure can be found at aphmon.fera.defra.gov.uk/index.cfm.

Table 1. Currently used PVY Relative Efficiency Factor values for different aphid species. Adapted from Fox *et al.* (2017).

Common name	Species	Relative Efficiency Factor (REF) for Potato Virus Y (PVY)
Pea aphid	*Acyrthosiphon pisum*	0.70
Black bean aphid	*Aphis fabae*	0.10
Buckthorn–potato aphid	*Aphis nasturtii*	0.40
Glasshouse potato aphid	*Aulacorthum solani*	0.20
Leaf-curling plum aphid	*Brachycaudus helichrysi*	0.21
Cabbage aphid	*Brevicoryne brassicae*	0.01
Willow–carrot aphid	*Cavariella aegopodii*	0.50
Blackcurrant-sowthistle aphid	*Hyperomyzus lactucae*	0.16
Potato aphid	*Macrosiphum euphorbiae*	0.20
Rose–grain aphid	*Metopolophium dirhodum*	0.30
Shallot aphid	*Myzus ascalonicus*	0.20
Violet aphid	*Myzus ornatus*	0.20
Peach–potato aphid	*Myzus persicae*	1.00
Bulb and potato aphid	*Rhopalosiphoninus latysiphon*	0.20
Bird cherry–oat aphid	*Rhopalosiphum padi*	0.40
Grain aphid	*Sitobion avenae*	0.60

Insecticide resistance status of aphid pests of potatoes

Peach–potato aphid

The various mechanisms of resistance in peach–potato aphids have been monitored for many years (see the 'Background to insecticide resistance and its management' publication for details).

Aphids with high esterase (conferring variable resistance to a number of insecticide groups, particularly organophosphates), MACE (conferring strong resistance to some dimethyl-carbamates within the carbamate mode of action group) and kdr (conferring moderate resistance to pyrethroids) were widely distributed on potato crops in eastern England in 1996. MACE and esterase resistance then appeared to decline to low levels by 2000, possibly because peach–potato aphids carrying these resistance mechanisms appear to suffer greater mortality during times of stress (e.g. during colder winters).

MACE aphids resurged in central and eastern Scotland in 2001, however, and have since spread to the rest of the UK. These more recent changes are due to new forms of peach–potato aphid appearing that carry MACE

and an alternative form of kdr, called ‘super-kdr’. The aphids are better adapted to the current UK environment. Peach–potato aphids with high levels of resistance to pyrethroids and some carbamates now predominate across the UK.

There is still no evidence of strong resistance to neonicotinoids in peach–potato aphids in the UK. As a result, this chemistry, which includes applications of thiamethoxam, thiacloprid and acetamiprid, has an important role to play in potatoes. The European Commission, however, has now adopted restrictions on the use of three neonicotinoid active substances (imidacloprid, clothianidin and thiamethoxam). **Authorisation for affected plant protection products will be withdrawn by 19 September 2018 at the latest. Any seeds treated with these neonicotinoids must be used before 19 December 2018.**

Peach–potato aphids that carry strong neonicotinoid resistance (conferred by a combination of a metabolic mechanism and a target site mechanism) are now common in some peach growing regions of southern mainland Europe and have spread to Greece and North Africa, as well as other crops (including potato). This situation is being carefully monitored in the UK and guidelines will be updated if the situation changes. Ongoing resistance screening work has also shown that there is currently no evidence of resistance to pymetrozine, spirotetramat or flonicamid in peach–potato aphids in the UK.

The maximum number of applications of any neonicotinoid containing product (see Table 2) is a statutory restriction introduced by CRD, in collaboration with IRAG, as a pro-active resistance management measure for peach–potato aphid.

Other aphids

Elevated levels of carboxylesterases have been detected in laboratory assays of some potato aphid individuals collected from the field in the UK. This indicates that potato aphid does have an increased risk of becoming resistant to some insecticide groups in the future. There is, as yet, no evidence of field resistance to insecticides in potato aphids.

Melon aphid (also referred to as cotton aphid) has been reported to be resistant to one or more of the following insecticide groups: carbamates, organochlorines, organophosphates, pyrethroids and neonicotinoids. However, samples collected from the UK have not been tested recently. Similarly, buckthorn-potato aphid has been reported to be resistant to carbamates but samples from the UK have not been tested for insecticide resistance recently.

There is no evidence of insecticide resistance in glasshouse potato aphid. Of the non-colonising aphid species, the only insecticide resistance issues that are currently known are with grain aphid and willow-carrot aphid. Grain aphid has been shown to carry kdr resistance, conferring moderate resistance to pyrethroids. Monitoring has shown this resistance to be widespread in the UK, with its frequency varying both regionally and annually. A population of willow-carrot aphids was found to be resistant to pyrethroids in 2017. The extent of this resistance in the UK is currently unknown.

Current insecticide options for aphid control

There are several modes of action (MoA) approved for use on commercially grown potatoes in the UK. The active ingredients available for aphid control in potatoes, spray restrictions and notes on resistance that would impact the control level achieved are detailed in Table 2. Further information on the MoA classification scheme can be found at irac-online.org/modes-of-action

Almost all seed potato crops and many ware crops are treated for aphids. Pyrethroid, neonicotinoid, pymetrozine and flonicamid insecticides are used, either alternately or, depending on the products, in mixtures.

On ware crops, more than one application is unlikely to be necessary in most seasons (provided it is fully effective), including seasons where aphid numbers build up rapidly during summer (usually late June) and natural enemy

numbers are low. In early to mid-July, aphid populations always decline naturally. Later aphid immigrations can occur in some years/localities, so regular monitoring through the season is essential.

Neonicotinoid products and aphid feeding blockers, such as pymetrozine or flonicamid, are likely to prove most effective against peach–potato aphids, irrespective of their resistance status.

Treatment efficacy should be monitored at a suitable time after application (this will be dependent on the active ingredients used but generally should be done after three days; pymetrozine and flonicamid will take longer to kill aphids).

To maximise efficacy and to protect insecticides from resistance, it is essential to follow best practice measures. The measures, many of which are common across crop production, are detailed in the IRAG's 'Insecticide resistance and its management' publication.

Table 2. Aphicides available for professional use on potatoes in the UK (as at June 2018), along with the mode of action (MoA), restrictions on use and notes on current UK resistance. For several of the active ingredients, more than one product is available.

Mode of action (chemical group)	Active ingredient(s)	Maximum permitted number of applications†	Peach–potato aphid resistance status in UK
3a (pyrethroids)	Cypermethrin	2	Strong resistance widespread
3a (pyrethroids)	Esfenvalerate	4	Strong resistance widespread
3a (pyrethroids)	Lambda-cyhalothrin	No limit	Strong resistance widespread
4a (neonicotinoids) ††	Acetamiprid	1 (ware), 2 (seed)	No resistance
4a (neonicotinoids) ††	Thiacloprid	1 (ware), 2 (seed)	No resistance
4a (neonicotinoids) ††	Thiamethoxam	1 (ware), 2 (seed)	No resistance
9B (pyridine azomethine derivatives)	Pymetrozine	2 (ware), 3 (seed)	No resistance
23 (tetronic and tetramic acid derivatives)	Spirotetramat	4	No resistance
29 (chordotonal organ Modulators)	Flonicamid	2	No resistance

† Where there is 'no limit' specified for the maximum permitted number of applications, the dose is expressed as a maximum individual and maximum total dose. †† Restrictions limit total number of any neonicotinoid containing product to two applications on potato crops

Further information

- ahdb.org.uk/knowledge-library/encyclopaedia-of-pests-and-natural-enemies
- Aphids and virus transmission in seed potato crops
- Virus management in seed potatoes 2018
- Practical measures to prevent and manage insecticide, fungicide and herbicide resistance for horticultural crops
- PVY vector information
- ahdb.org.uk/knowledge-library/IRAG

References

Fox, A., Collins, L. E., Macarthur, R., Blackburn, L.F. & Northing, P. (2017). New aphid vectors and efficiency of transmission of Potato virus A and strains of Potato virus Y in the UK. Plant Pathology, **66**: 325-335