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PHC2018/02: Impact on Scottish crops if the molluscicide metaldehyde is withdrawn

Summary

This report sets out estimates for the crop loss and value to Scottish crop production should the molluscicide metaldehyde be withdrawn. This would leave ferric phosphate as the only available chemical control option. Short term losses are negligible as the substitution of ferric phosphate carries no additional treatment costs and has equivalent efficacy. Longer term there is some risk should resistance arise to this single site mode of action active, and ferric phosphate (although of lower mammalian toxicity to metaldehyde) has some environmental impacts of its own.

Introduction

Slugs are a perennial problem in crops across the arable and horticultural sector. Some crops such as oilseed rape (up to 59% of the UK area) and wheat (up to 22% of the UK area) are significantly affected by slugs; the extent of this depends on the season (Clarke *et al*., 2009). Estimates by Nicholls (2014) suggest that the withdrawal of molluscicide use could lead to potential annual crop losses in the UK to slugs of £18M in oilseed rape, £25.5M in wheat, and £53M in potatoes. Even with currently available molluscicides, the value of crop loss to slugs in vegetables is estimated to be upwards of £8M a year.

In Scottish crops, losses are likely to be proportionally higher than Nicholls' (2014) estimate for the UK due to Scotland having wetter soils and narrower rotations compared to the rest of the UK. Using Nicholls' (2014) formulae for calculating crop losses to slugs, Scottish estimates are annual losses in winter oilseed rape > £0.8M and winter wheat >£1.4M.

In arable crops such as wheat and oilseed rape slugs can kill or stunt plant development with a subsequent reduction in yield. In crops such as potatoes and vegetables the damage caused by slugs affects the quality of the produce, and in some crops such as lettuce and strawberries there is a zero tolerance for slug damage. Consequently, molluscicide use tends to be prophylactic in many of these latter crops where slug damage affects the quality of the produce.

The molluscicide methiocarb was withdrawn in 2015, and this has led to a subsequent increase in the proportion of use of the molluscicide metaldehyde in Scottish crops (Fig. 1). For example, metaldehyde use in ware potatoes increased from 23% of crops treated in 2014 to 52% of crops treated in 2016, and in seed potatoes from 8% in 2014 to 34% in 2016. Whilst some of these increases in metaldehyde use can be attributed to a season of increased slug risk, growers appear to be simply using metaldehyde as a direct alternative to methiocarb.

Whilst there has been an increase in the use of the molluscicide ferric phosphate from 2014 to 2016, this is not at the same scale as the increase in metaldehyde.

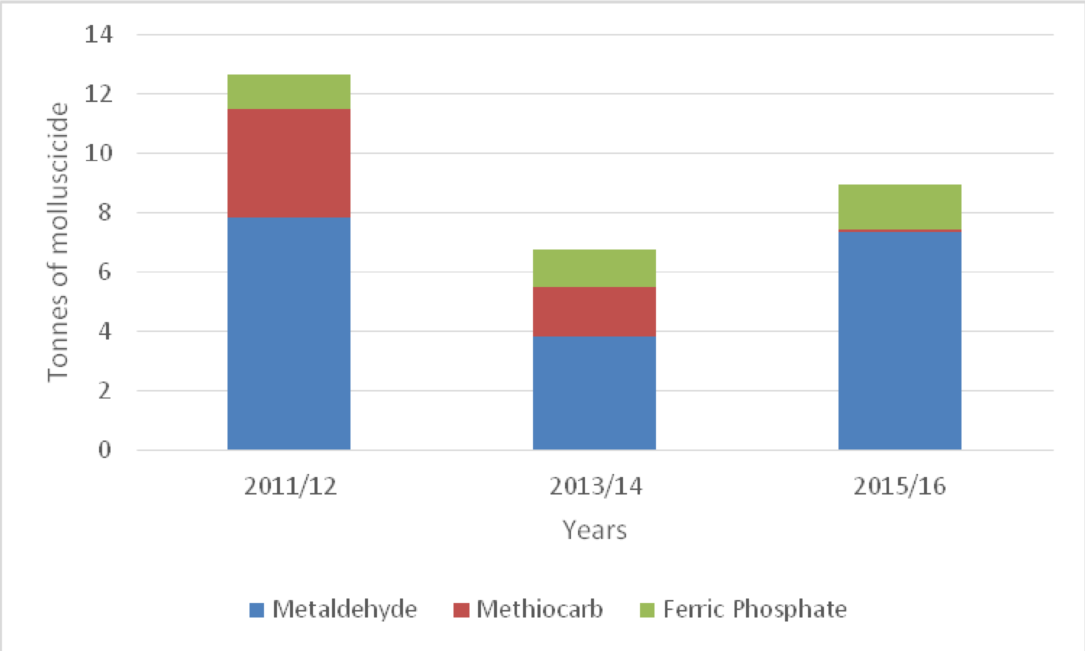
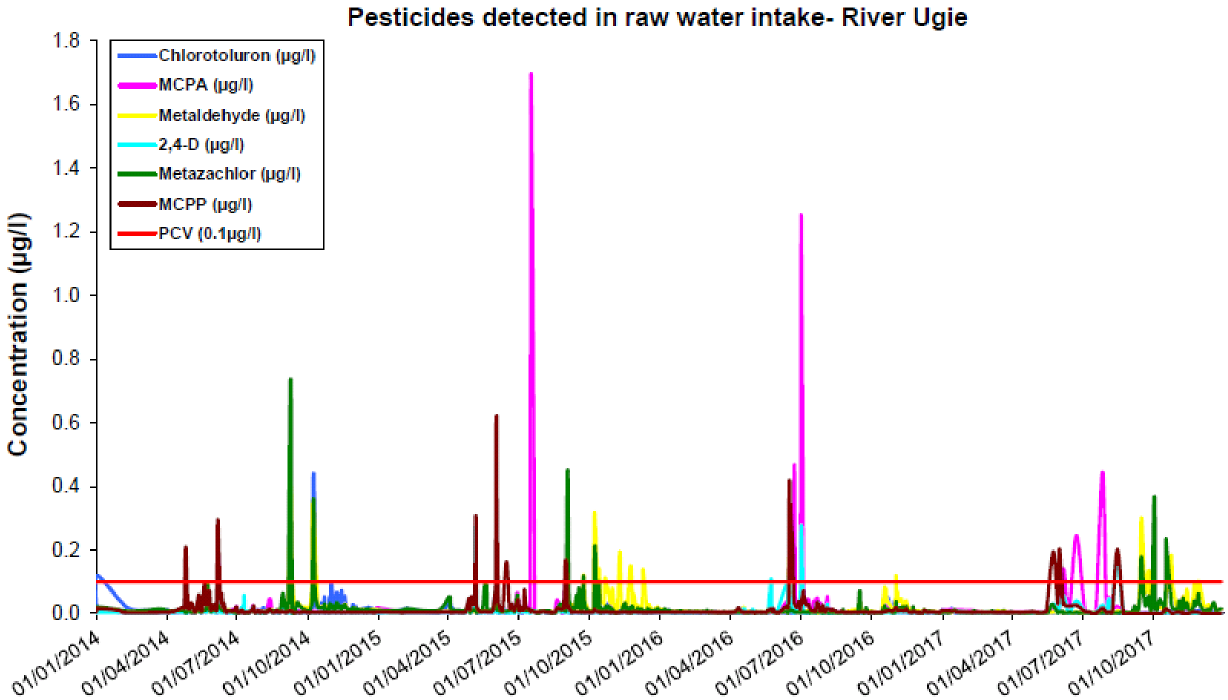


Fig. 1. Graph of overall Scottish use of metaldehyde, methiocarb and ferric phosphate on arable, vegetable and soft fruit crops from 2011/12 to 2015/16. Note methiocarb was withdrawn from use in 2015.

In some Scottish vegetable crops metaldehyde is used on the whole crop area (e.g. Brussels sprouts, cauliflower in 2015). Ferric phosphate is also used extensively in slug management programmes with metaldehyde, accounting for 48% and 31% of molluscicide use in the 2013 and 2015 vegetable crops respectively.

There are issues regarding the molluscicide metaldehyde exceeding drinking water standards (Marshall, 2013; Castle *et al*., 2017). Some water companies are able to manage metaldehyde concentrations by limiting the amount of water abstracted from rivers into storage reservoirs. For others, this was considered as an option, but found not to be feasible or sustainable, particularly where a number of affected drinking water sources are directly abstracted into the water treatment works. Consequently, there have been occasions when trace concentrations of metaldehyde have been detected in treated drinking water. These concentrations are extremely low – the highest (in England) being around 1ug/l (micrograms per litre) and mostly much lower. However, the concentrations are above the European and UK standards for pesticides in drinking water set at 0.1ug/l.

In Scotland data from Scottish Water has found exceedances of the 0.1ug/l limit for metaldehyde in raw water from the River Ugie and River Deveron in the last few years (Fig. 2). Water treatment is able to reduce these levels in the drinking water supply.



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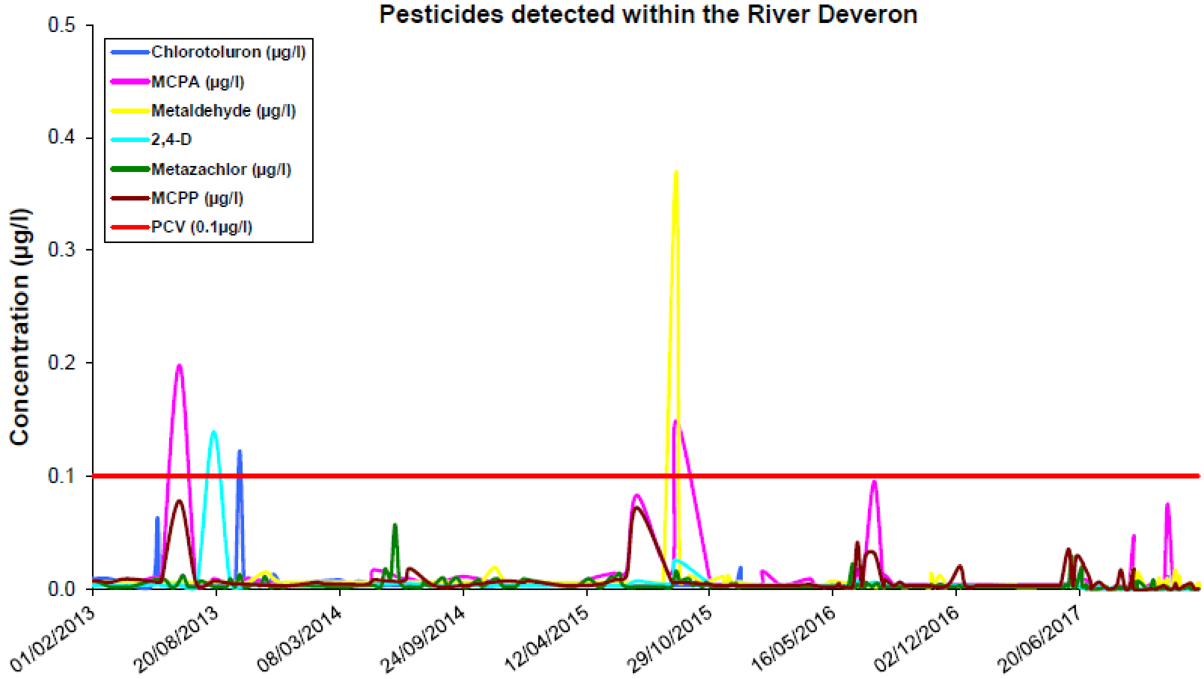

Fig. 2. Pesticides (including metaldehyde in yellow) found in raw water abstracted from the Rivers Ugie (top) and Deveron (bottom) over the last few years. The European and UK standards for pesticides in drinking water are 0.1ug/l (the red line). Data supplied by Scottish Water.

There is currently a voluntary approach on metaldehyde usage developed by the Metaldehyde Stewardship Group (MSG) to promote and encourage best practice when using metaldehyde slug pellets, to minimise environmental impacts, and, in particular, protect water (www.getpelletwise.co.uk). These guidelines were updated in 2017 to advise that no metaldehyde pellets should be allowed to fall within a minimum of 10 metres of any field boundary or watercourse. For growers this may well lead to a direct switch from metaldehyde to ferric phosphate use, as it is more practical to apply ferric phosphate to the whole crop than to treat the crop edges with ferric phosphate and the rest with metaldehyde.

The MSG have advised SRUC that these voluntary guidelines are likely to be incorporated onto metaldehyde product labels in the near future so that they become statutory and not just voluntary as is the case at present.

If the occurrence of metaldehyde in UK drinking water catchments is not reduced significantly by the measures outlined above, or by the increased substitution of metaldehyde by ferric phosphate, Castle *et al*. (2017) in a recent review of metaldehyde in water suggest that metaldehyde use could be restricted in the UK, possibly as early as 2020.

Potential impact of metaldehyde withdrawal
Should metaldehyde use be further restricted or withdrawn completely, then ferric phosphate may be the only effective molluscicide available to Scottish (and UK) growers and this report sets out the possible impacts of a withdrawal.

Currently slug management relies on the following options. Each have their own issues which are summarised below: It highlights the unreliability of alternative methods and hence the current reliance of chemical control.

- Chemical strategies:- Molluscicide baits – these rely on the slug feeding on the bait, however there are issues with water contamination and restrictions on amounts applied/ha.
- Use of the cereal seed treatment clothianidin:- Only protects the seed from slug damage and is ineffective against leaf damage – this is a more expensive option is itself at risk of withdrawal being a neonicotinoid.
- Agronomic practices:- Includes minimum or zero tillage, fine seed beds and deeper sowing of cereal seed which can lead to reductions in slug damage – suitability is crop dependent and can be unreliable.
- Cropping strategies:- Includes rotation and the use of more tolerant cultivars - this restricts crop where there is a high risk of slugs and is often unreliable.
- Biological control:- Nemaslug and conservation of natural predators - High cost/ha (£80-100/ha) and predation of slugs is unpredictable.
- Physical control strategies:- Collection and destruction of pests/eggs from infested sites – this is labour intensive and impractical on a field scale and is undependable and weather dependant.
- Physical barriers:- Can be as simple as a strip of bare soil as a headland around the crop or a fence or screen of corrugated tin or wire mesh, commercial barriers (e.g. Molluskit), copper wire/strips, ditches around field, ringing plants with strips of cardboard dipped in metaldehyde suspension - this is labour intensive, undependable, potentially expensive and suited to small-scale operation only.

This report is premised on two direct costs if metaldehyde is withdrawn. The first (a) is any additional crop loss arising from a reduction in efficacy if the only remaining chemical control option (ferric phosphate) is used, and the second (b) the additional treatment cost conferred from its use. There may also be environmental impacts (c) arising from either option which we have not quantified or assessed in this report.

a) Available evidence on efficacy suggest that efficacy from ferric phosphate should it be directly substituted will be similar to that of metaldehyde. SRUC and others have carried out several trials comparing ferric phosphate efficacy to that of metaldehyde in a range of crops and in the main ferric phosphate tends to be as effective as metaldehyde.

Ferric phosphate molluscicides affect the slugs' digestive system by disrupting calcium metabolism, quickly causing a cessation of feeding, and slugs bury themselves in the soil where they subsequently die. This 'invisible death' does
not show the user that the molluscicide has been effective, whereas metaldehyde use leads to dead slugs remaining above the soil allowing the user to see that the product is working. This may be one reason why ferric phosphate use by growers lags behind that of metaldehyde at the moment and could be a subject for enhanced knowledge exchange and awareness messaging.

The MSG have informed SRUC that they expect ferric phosphate use to match or even overtake that of metaldehyde in the next two years or so, once the restrictions on metaldehyde use 10m from field boundaries begin to take hold, and particularly so if the MSG guidelines become statutory on metaldehyde product labels.

There is some industry concern that total reliance on ferric phosphate could increase the risk of resistance in slugs, as ferric phosphate has just the one site of action (calcium metabolism) within the slug. To date there is no evidence of any resistance, but with increased ferric phosphate use the risk will increase.

b) Comparing the cost of ferric phosphate molluscicide products (currently 13 products approved for professional use in the UK) to that of metaldehyde products (currently 34 products approved for professional use in the UK) is difficult as there are a range of products with varying prices and, in particular with metaldehyde, products with different concentrations of metaldehyde in the product (from 1.5% to 4% w/w) and different rates of application/ha. In addition, growers often vary the rates of metaldehyde application/ha to conform to the guidelines issued by the MSG of a total of 700g of metaldehyde active ingredient/ha in a calendar year, and a maximum of 210g between August and the end of December.

As a rough guide, the cost of applying the maximum single dose of ferric phosphate products is between £29-45/ha, compared to a maximum single dose of metaldehyde products of £31-50/ha. Note that growers often do not apply the maximum recommended dose, particularly with metaldehyde products.

c) There are some concerns about the environmental impact of ferric phosphate and in particular, the use of chelating agents such as EDTA and EDDS in the formulation that solubilises the iron and makes it more toxic to slugs. Some ferric phosphate products with chelating agents demonstrated detectable negative impacts on the survival, activity and growth of earthworms (Edwards et al., 2009; Langan & Shaw, 2006). The chelating agent EDTA present in many ferric phosphate molluscicide products has been reported to have an oral mammalian toxicity of 30 mg kg−1 to rats (Tamm & Speiser, 2006) and mice (Safety Data for ETDA, 2008) compared with an oral toxicity of metaldehyde of 630 mg kg−1 to rats and 250–1000 mg kg−1 to dogs (Berg, 1986). We have not attempted to attach a value to this potentially undesirable side effect but it should be balanced against the current concerns on water quality arising from metaldehyde use and the relative toxicities shown above. Ferric phosphate products are obviously subject to assessment by regulating authorities so these traits can be kept under review and assessment as new products come up for authorisation or where existing products come up for review.

Conclusion

Should metaldehyde use be restricted in Scotland, there is a similarly priced and equally effective alternative available in ferric phosphate, so growers would not carry any additional crop loss or treatment costs. Ferric phosphate is on a par with metaldehyde in terms of efficacy against slugs. We also recommend messaging around the efficacy of ferric phosphate and the visual after effects of treatment.

In terms of future trends, we anticipate that the potential loss of the cereal seed treatment clothianidin, will likely lead to an increase in the use of slug pellets i.e. ferric phosphate if metaldehyde is withdrawn from use. There are concerns regarding the environmental profile of ferric phosphate.

The promotion of integrated approaches to slug management such as minimum tillage, soil management etc. coupled with judicious use of molluscicides is being encouraged in current IPM messaging and will continue to be recommended to growers. Such methods will not give adequate or consistently reliable control of slugs so will not directly replace the use of chemical slug pellets however, they could go some way towards reducing application rates and application numbers.

We would highlight that there is a risk that exclusive use of ferric phosphate will increase the risk of resistance arising in slugs due it having a single site of action within slugs. This would leave no remaining control options leaving the vast majority of Scottish crop produce at risk.

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