IRAC Guidelines for Resistance Management of Neonicotinoids

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IRAC Neonicotinoid Working Group

Introduction:

The use of neonicotinoid insecticides has grown considerably since the forerunner of this group - imidacloprid was first introduced in 1991. Today seven insecticides belonging to this chemical class are available to farmers all over the world and classified as group 4A within the IRAC mode of action classification scheme. All neonicotinoids are agonists of insect nicotinic acetylcholine receptors.

Several of the insect pests which are the prime target for neonicotinoid insecticides have been shown to possess a high potential for resistance development - *Myzus persicae* green peach aphid, *Aphis gossypii* cotton aphid, *Phorodon humuli* hop aphid, *Bemisia tabaci* sweet potato whitefly, *Trialeurodes vaporariorum* greenhouse whitefly, *Nilaparvata lugens* brown planthopper, *Nephotettix cincticeps* green rice leafhopper, *Laodelphax striatellus* smaller brown planthopper, *Sogatella furcifera* whitebacked planthopper, *Leptinotarsa decemlineata* Colorado potato beetle and *Cydia pomonella* codling moth.

The guidelines presented here are designed by the Neonicotinoid Working Group of the Insecticide Resistance Action Committee (IRAC). They are based on guidelines published by Elbert et al. in 1996 and 2005, respectively.
As pest problems and control practices differ considerably between countries, crops and climatic conditions, these guidelines must cover a wide range of flexible options thus allowing regional experts to develop, implement and adapt these options to address the local conditions.

Guidelines for Correct Use of Neonicotinoids and Resistance Management:

1. **Always use products at the recommended label rates and spray intervals with the appropriate application equipment**.
   Neonicotinoid insecticides used at rates higher or lower than recommended on the label can result in resistance and/or unwanted effects on non-target organisms and the environment. Always make sure that all the spray equipment is in good condition and that there is no blocking of nozzles or filters as this always results in spraying incorrect rates which can result in resistance developing.

2. **Rotation of insecticide chemistries acts against rapid selection of resistant populations**.
   By diversifying the chemistries (mode of actions) the farmer is avoiding prolonged selection for one resistance mechanism. Carefully planned rotation of active ingredients from different mode of action groups provides the best option for minimizing resistance development. Sufficient intervals should be left between applications of active ingredients with the same modes of action.
   When spraying a product to control a multi-generation pest, the choice of insecticides in the rotation strategy needs to allow for follow up applications with other active ingredients enabling the farmer to prevent season long exposure of the target pest to a single chemical group or mode of action. The unique systemic properties of certain members of the neonicotinoid chemical class allow these products to be applied either directly to the soil, as a seed treatment or as foliar spray. This also needs to be taken into account when planning chemistry rotation in order to prevent resistance developing and it is recommended to use an effective foliar product with different mode of action after the use of a neonicotinoid as either a seed treatment or a soil application.

3. **Use suitable rotation partners for neonicotinoids**.
   An extensive range of insecticides with different modes of action which can be used as rotation partners for neonicotinoid insecticides, are available to the farmer. Advice on suitable rotation partners can be obtained from IRAC's mode of action classification available at http://www.irac-online.org/documents/moa/moa.doc.
   Local rotation strategies should be developed according to the insecticides registered for the particular use in question and commercially available to the farmer. Other factors which need to be considered include: the crops grown, prevalent refuge crops, the insect pest complex, their seasonal distribution and resistance profiles together with occurrence and relevance of beneficial organisms.

Further information is available at: www.irac-online.org or enquiries@irac-online.org

When using mixtures containing a neonicotinoid as one of the components, always use the full recommended rates of the individual active ingredients.

The use of mixtures whether as a premix or tank mix, containing two effective active ingredients with different modes of action is becoming very popular either to increase the spectrum of insect pests controlled or to prevent the development of resistance. More and more mixtures containing both a pyrethroid and a neonicotinoid are being used against difficult to control insect pests. The use of such mixtures in any form is not recommended if the target pest is already resistant to one of the modes of action in the mixture! Do not develop an over reliance for a specific mixture as this can result in selection for multi-resistant populations which are very difficult to control. When using mixtures always be sure to change the active ingredient combinations and not to repeatedly use only one mixture of the same active ingredients or modes of action within a single cropping cycle.

4. **The use of neonicotinoids against different pests in the same crop**.
Multiple uses of different neonicotinoids against more than one pest species in the same crop is feasible but needs at the local level, to take into account the pest populations dynamics, overlapping of the various species, their relative importance and each species' potential risk for developing resistance. When two species appear simultaneously always use the recommended rate for the more difficult to control species. When they appear independently at different crop stages then always use the individual recommended rate for each species.

5. **Do not control a multi-generation pest exclusively with neonicotinoids**.
Using neonicotinoid insecticides continuously across a single crop season increases the risk of resistance developing to the whole chemical class even if insect pests show different levels of sensitivity to the different neonicotinoid insecticides commercially available.

6. **Never use neonicotinoids for follow up treatments where resistance has already reduced their effectiveness.**
The use of follow up treatments, more often than not necessitating higher rates than recommended, whether as solo treatments or in mixtures, may continue to promote and contribute to escalating resistance levels and thus should be avoided.

7. **The use of non specific products helps to prevent the development of resistance.**
Plant protection products such as oils and soaps having a non specific mode of action are good resistance management tools which should be recommended for use in rotation or combination with neonicotinoid insecticides, provided that they effectively control both susceptible and resistant target pest populations.

8. **Plan the use of neonicotinoid insecticides in such a way that they complement the efficacy of the prevalent beneficial organisms**.
The contribution of beneficial organisms to pest control can be significant in many cropping systems and can also play an important part in resistance management. They can effectively help control the target pests irrespective of their degree of resistance or resistance mechanism and thus can help slow down the resistance selection process. In many crops neonicotinoid applications are actually soil treatments either incorporated as granules, applied through irrigation systems or as seed treatments. These techniques help conserve the above ground beneficial organisms so their activity can then complement the initial control provided by the neonicotinoid insecticides. Thought should also be given to intelligent timing of the applications of neonicotinoids to periods of lower beneficial organism activity or during their protected life stages when they are less likely to come into contact with the insecticide treatment.

9. **Good agricultural practices should be applied alongside physical and biological pest control methods.**
There are many ways today's farmer can help prevent resistance developing by simply complying with the concepts of integrated crop management. Monitoring and adhering to recommended pest and/or damage thresholds, respecting the usefulness of natural enemies, simple sanitation and removal of post-harvest residues in the fields, the use of resistant crop varieties and even by simply avoiding continuous year round cultivation of a single crop can all help to slow down and even prevent resistance development.

10. Integrate escape crops into the cropping system.

The use of escape crops not treated with neonicotinoids form an important reservoir for susceptible pest populations. Neighboring crops that are not treated with neonicotinoids at all, allow interbreeding between the treated and untreated insect populations thus diluting the genes for resistance. This has proved to be one of the most successful strategies for insecticide resistance management and should be actively continued to maintain susceptibility to the neonicotinoids in the future.

11. Monitor problematic pest populations in order to detect first shifts in sensitivity.

Neonicotinoid baseline sensitivity data for representative field populations have in many cases been established before the products became widely used. Re-examining the insecticide sensitivity of these populations at regular intervals can detect possible changes in susceptibility. Resistance monitoring carried out at regular intervals is strongly recommended and can detect possible changes in pest sensitivity. Monitoring methods for the major agricultural pests have been established by IRAC and can be found on the IRAC website (http://www.irac-online.org/).

References

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