He said sampling work detected SFNB strains moderately resistant to fungicide in the Esperance region from 2016 onwards, and highly resistant strains in the Great Southern and Esperance regions from 2017 onwards.

Current control measures for SFNB include the application of effective fungicides as well as on-farm practices that reduce disease establishment, reproduction, dispersal and survival. The use of varieties that contain genetic resistance to the disease is also effective.

"But due to the current lack of highly resistant cultivars, SFNB is controlled mainly using fungicides," Fran said. "Growers need to take a cautious approach with controlling SFNB and implement adequate integrated disease management strategies to minimise the ongoing selection of SFNB resistant populations.

"Being a stubble-borne disease, rotating crops or managing stubble are paramount for reducing disease carry-over, and selecting varieties that have disease resistance will reduce the severity of SFNB during the growing season.

"But these measures will not be very effective unless growers choose fungicides carefully.

"Any spray program that is heavily dependent on Group 3 fungicides will increase the risk of resistant populations developing," Fran warns.

Seed dressings and fungicide mixtures

"I encourage growers to use seed dressings, as well as in-furrow and foliar products containing fungicide mixtures from different chemical groups (Groups 3, 7 and 11), and to remove tebuconazole from control programs in areas where resistance has been found.

"This will help to limit the spread of resistance in SFNB and its emergence in other barley growing regions of Australia."

In addition to using cultivars with good disease resistance levels, other cultural practices that growers can use to limit the development of resistance in SFNB include using disease-free seed; employing stubble management strategies to reduce the disease load; rotating crops; grazing with livestock; and, maintaining good farm hygiene.

Recommended chemical management strategies

- Only spray if necessary – limit applications;
- Choose fungicide mixtures with different modes of action (if available);
- Never apply the same Group 3 fungicide consecutively;
- Avoid consecutive use of fungicides with the same mode of action from Groups 7, or Succinate dehydrogenase inhibitor (SDHI), and Group 11, or quinone outside inhibitors (Qol);
- Incorporate the use of seed dressings (Group 7), in-furrow (Group 11) and foliar products containing fungicide mixtures from different chemical groups (such as Groups 3 (DMI), 7 (SDHI) and 11 (Qol) – in combination with limited use of propiconazole and no stand-alone tebuconazole use;
- Ideally use DMI-based mixtures (eg. Prosaro containing prothioconazole and tebuconazole) only once, followed by mixtures with other actives (preferably from Groups 7 or 11);
- If resistance is present or suspected, avoid or minimise use of that mode of action, as continuing its use will only further select for resistance; and,
- Do not exceed label rates.

CCDM research into SFNB is supported by GRDC investment, with this latest work also involving the Department of Primary Industries and Regional Development (DPIRD) and the Foundation for Arable Research in Australia.

More information about SFNB management is available in the GRDC Barley GrowNotes at *https://grdc.com.au/grownotes*

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Are our weed seed ecology studies done correctly?

By Bhagirath S. Chauhan, Associate Professor, QAAFI, University of Queensland, Gatton

AT A GLANCE

- Studies on weed seed germination ecology have increased in Australia – this is a good thing. But we need to understand some basics to correctly conduct these studies.
- This article provides answers to some basic questions related to seed germination ecology.

WEEDS are among the most important biological constraints to crop production. They are also a problem on roadsides, railway lines and in the natural environment. Weeds reduce the productivity of a number of primary industries. For example, in Australia weeds cost grain growers alone more than $3 billion annually.

Herbicides are used widely to manage weeds but there are concerns around environmental pollution, the scarcity of products with new modes of action and the evolution of herbicide resistance in weeds. Globally, about 500 unique cases of herbicide-resistant weeds have been recorded and Australia is in second place – after the US – on this unenviable list.

There is a need to develop integrated weed management (IWM) strategies to reduce reliance on herbicides. But to develop IWM programs, a basic understanding of weed biology is required, and seed germination ecology is an important component of weed biology.

Mistakes are being made

In my view, mistakes are being made in seed ecology studies. This article sets out to answer some basic questions related to weed seed germination ecology studies. Some ideas are taken from Baskin *et al* (*Seed Science Research*, 2006, 16:165–168) and

Bhagirath Chauhan.

I strongly suggest that all researchers working in this area should read this article.

The following questions and answers outline what I believe we need to know to ensure weed ecology studies are done correctly.

Question 1: *How should I collect weed seeds?*

Answer 1: Collect only mature seeds as green seeds may not be fully viable. After drying, green seeds look similar to mature seeds but in reality, they may not be viable. The best way to collect mature seeds is by shaking the plant. Pulling seeds from a panicle/inflorescence may result in non-viable seeds in the sample. These seeds are okay if you need to grow seedlings. For example, you can increase seed rate, even if viable seeds are only 10 per cent. But if the aim is to evaluate percent germination, the used seeds should be 100 per cent viable.

Q2: *When should I do a germination test for seed dormancy?*

A2: Initial germination tests (ie. the dormancy level in fresh seeds) should be conducted very soon after seed collection. Seeds may be dried for two to three days in natural conditions (avoid contact with water) and then the test should be conducted. Some researchers conduct germination tests after storing seeds for a few weeks at room temperature. This is not an accurate test as 'after-ripening' can occur at room temperature.

Q3: *What should I use to germinate: Naked or intact seeds?*

A3: Intact seeds (ie. natural dispersal unit) should be used. For example, turnip weed is dispersed in round siliques; therefore, siliques should be used to test germination. Removing the silique and using naked seeds results in very high germination. In natural conditions, the silique deteriorates slowly and so a staggered germination is observed.

Q4: *What kind of seeds should I use in the seed bank persistence study?*

A4: Fresh, intact and viable seeds should be used in these studies. Sometimes, researchers can take weeks or months to count seeds and then bury them for their studies. This is not correct. Seeds after-ripened at room temperature may have different dormancy levels than seeds after-ripened in natural conditions. Before placing seeds in the field, an initial germination test should be conducted to determine the dormancy level in fresh weed seeds.

Q5: Am I using weed names correctly?

A5: In my view, we should be using names which are understood by both growers and agronomists. The common names are different in various countries. For example, awnless barnyard grass in Australia is junglerice in the US. But researchers should know the Latin names of weeds. In illustration, there is often confusion about brassica weeds such as wild turnip (*Brassica tournefortii*); turnip weed (*Rapistrum rugosum*); wild radish (*Raphanus raphanistrum*); Indian hedge mustard (*Sisymbrium orientale*); African mustard (*Sisymbrium thellungii*); and, London rocket (*Sisymbrium irio*).

Q6: *What temperature and light conditions should I use?*

A6: Fluctuating temperatures should be used to test germination as constant temperatures are not encountered in most weed situations. In some cases, lower germination is found at constant temperatures compared with alternate temperatures. Constant temperatures are used when the aim is to find a base temperature for germination. Similarly, continuous light conditions should be avoided. Complete dark conditions can also be used to simulate seeds buried in the soil.

Q7: *How should seeds be cold stratified?*

A7: For cold stratification, imbibed seeds should be used. Using dry seeds may result in a change in seed moisture, which can affect seed viability. The temperature for cold stratification should be between 0 and 5°C. Seeds cannot be cold stratified in a freezer. ■