Weed management in chickpeas – problem weeds and crop safety


Key words
Chickpeas, herbicides, crop safety

GRDC codes
NGA00004; ICN00016

Take home messages
1. There are a number of key broadleaf weeds that are not effectively managed by common residual herbicide programs of isoxaflutole (e.g. Balance®) in mixture with simazine or terbuthylazine (e.g. Terbyne Xtreme®)
2. No new option or mixture currently provides a consistent improvement on the current ‘unsatisfactory’ commercial approaches
3. Management of problem broadleaf weeds remains a challenge in chickpea production
4. Understanding soil behaviour characteristics of residual herbicides may assist in avoiding crop safety issues

Chickpea problem broadleaf weed management

Residual broadleaf weed control in chickpea production is primarily managed using the active ingredients isoxaflutole e.g. Balance®, simazine or terbuthylazine e.g. Terbyne® Xtreme®. These herbicides provide effective control of a wide range of broadleaf weeds. However there are a number of common weeds that are often not effectively controlled. These include: Mexican poppy (Argemone ochroleuca), spiny emex (Emex australis), variegated thistle (Silybum marianum), wireweed (Polygonum aviculare), climbing buckwheat (Fallopia convolvulus) and slender celery (Cyclospermum leptophyllum). When combined with the poor competitive ability of chickpeas, these rapidly become major management issues.

What was done?

NGA has conducted a number of herbicide screening trials since 2010 to evaluate the potential of new chickpea herbicide registrations and potential mixtures for management of these weeds. This paper summarises key work conducted during 2015 and 2016. Although these trials are established in areas of paddocks where the target weed was an issue in the previous season, trials must be established pre-emergent to both crop and weed. As a consequence, it is much more difficult to get uniform weed populations and consistency of result than in standard post-emergent herbicide trials.

Although the key focus for these trials is weed efficacy, all trials are assessed for crop safety. Plant stand counts are a standard assessment, together with impacts on crop biomass or colour, assessed visually or by NDVI. Comments on crop safety from these trials are included in the crop safety section of this paper.
2015

Table 1. Products evaluated 2015

<table>
<thead>
<tr>
<th>Product(s)</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sakura®</td>
<td>Alone or followed by Balance</td>
</tr>
<tr>
<td>Outlook®</td>
<td>Alone or followed by Balance</td>
</tr>
<tr>
<td>Stomp®</td>
<td>Followed by Balance</td>
</tr>
<tr>
<td>diuron</td>
<td>Mixture with Balance</td>
</tr>
<tr>
<td>Terbyne Xtreme + imazethapyr¹</td>
<td>Mixture with Balance</td>
</tr>
</tbody>
</table>

¹ Note: Skipper® (imazethapyr) is registered for use in chickpea in Qld & NSW in a mixture with Terbyne. Other formulations of imazethapyr may not be registered in these states. Refer to product labels.

Trials were established at Thallon, Brookstead and Nowley with target weeds Mexican poppy, slender celery and Australian bindweed (*Convolvulus erubescens*). Robust weed efficacy data was only generated from the Mexican poppy site (untreated had ~14 weeds/m²).

Balance 100g/ha in mixture with simazine 900DF 1.0kg/ha and Balance 100g/ha in mixture with Terbyne Xtreme 700g/ha were used as the benchmark commercial programs.

The highest level of activity was recorded by the Balance + simazine or Balance + Terbyne Xtreme mixtures. NB these mixtures do NOT have a registration for either the suppression or control of Mexican Poppy and have not provided effective commercial activity against Mexican Poppy. Although many of the other treatments recorded some activity against this weed, they were significantly poorer than the two commercial benchmarks.

2016

Table 2. Products evaluated 2016

<table>
<thead>
<tr>
<th>Product(s)</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sakura®</td>
<td>Mixture with Balance PSPE</td>
</tr>
<tr>
<td>Outlook®</td>
<td>Mixture with Balance PSPE</td>
</tr>
<tr>
<td>Stomp®</td>
<td>Mixture with Balance PSPE</td>
</tr>
<tr>
<td>diuron</td>
<td>Mixture with Balance PSPE</td>
</tr>
<tr>
<td>Bladex®²</td>
<td>Mixture with Balance PSPE</td>
</tr>
<tr>
<td>Group C + imazethapyr</td>
<td>Mixture with Balance PSPE</td>
</tr>
</tbody>
</table>

¹ Note: Bladex (cyanazine) is registered for use against some ‘difficult ‘weeds in chickpeas e.g. it is registered for control of spiny emex in NSW and wireweed and deadnettle in NSW & Qld.

Trials were established at Daymar, Pittsworth and Edgeroi with target weeds Mexican poppy, spiny emex, slender celery and variegated thistle. Good weed efficacy data was generated against all targets (untreated had >5-10 weeds/m²), except slender celery.

Balance 100g/ha in mixture with simazine 1.0kg/ha (900 g/kg ai) and Balance 100g/ha in mixture with Terbyne Xtreme 700g/ha (all applied PSPE) were again used as the benchmark commercial programs.

- Mexican poppy: No treatment significantly reduced weed numbers compared to the two commercial programs, despite a level of activity from nearly all treatments.
• Spiny emex: The Bladex program provided acceptable levels of commercial control (~95%) at ten weeks after planting but was slow in activity. Moderate numbers of spiny emex had emerged and were present at three and six weeks post planting. The Bladex program significantly reduced the weed population compared to Balance in mixture with simazine.

• Variegated thistle: A late change in cropping decision meant this trial was conducted under fallow conditions. No treatment significantly reduced weed numbers compared to the Balance mixture with Terbyne Xtreme.

Key points
Since 2010, NGA have conducted eighteen individual trials evaluating problem broadleaf weed control in chickpeas. Key overall messages:

• The addition of a Group C herbicide e.g. simazine or Terbyne Xtreme to Balance has consistently improved weed control compared to Balance alone
• Mixtures of Balance with simazine or Terbyne Xtreme have failed to provide commercially acceptable levels of activity against a number of broadleaf species
• To date, no new herbicide or mixture has provided a consistent improvement in problem weed control compared to Balance with simazine or Terbyne Xtreme
• Bladex has historically been an expensive option but should be considered in situations where paddocks with spiny emex issues are forced into chickpea production
• The registered mixture of Terbyne Xtreme and Skipper® at 20g/ha (imazethapyr 700 g/kg) should be considered where climbing buckwheat is a key problem, although crop effects can be an issue

Conclusions – weed control
The best way to manage these problem broadleaf weeds in chickpeas is simply to avoid growing chickpeas in those situations. However with chickpeas frequently being the highest profit winter crop in the northern grains region, there is temptation to push chickpeas into paddocks that may not be suited.

If spiny emex is a major constraint, Bladex should be considered.

If climbing buckwheat is a key constraint, the option of Terbyne Xtreme with a 20g/ha rate of Skipper is worth considering. This option, along with Stomp, may also be used to control wireweed. Check individual product labels.

For most other problem broadleaf weeds evaluated since 2010, the best available option is still to select a mixture of Balance with a Group C mixing partner that offers the most suitable weed spectrum for the individual paddock situation. Although this is unlikely to provide commercially acceptable management of these key weeds, this approach remains the best option currently available.

Chickpea crop safety with pre-emergent herbicides
No pre-emergent herbicide used in chickpea, or any other crop for that matter, can be considered completely ‘safe’ under all situations. However, with some understanding of the how each herbicide behaves in the environment, damage can usually be minimised or eliminated.

Potential for herbicide injury is a result of how much herbicide enters the seedling, how quickly the herbicide translocates and how fast the seedling can metabolise (detoxify) the herbicide that has been taken up.

Waterlogging, poor nutrition, disease etc. - Plants that are stressed reduce their metabolism, which slows the detoxification of herbicides that have entered the crop. Typically, crops showing herbicide injury are almost always affected by another significant stress event.
Soil type - All other things being equal, crops growing on lighter soil types are more likely to be exposed to higher levels of herbicide and are thus more prone to damage than crops on heavier structured soils. In lighter soils, less herbicide is bound to the soil and therefore more is available for crop uptake. For this reason, many herbicide labels recommend lower rates on lighter soils.

Soil moisture - pre-emergent herbicide damage is almost always associated with high soil moisture (particularly during germination/emergence before the plant is photosynthesising). High moisture levels are more likely to move herbicide down to the seed zone, while also increasing the amount of herbicide taken up by the crop.

Soil moisture is a two-edged sword. Under dry conditions, herbicide damage is less likely - however, herbicides with low solubility may fail to control the weeds as the low amount of herbicide dissolved in the limited available moisture may not be enough to control weeds.

Planting depth - Most pre-emergent herbicides used in chickpea have useful levels of soil binding that keeps a significant proportion of the herbicide bound near the soil surface under ‘normal’ conditions. Deeper planting provides increased separation between the germinating seed and the majority of the herbicide.

Application rate – Increasing application rate of pre-emergent herbicides will provide a longer period of residual weed control, however will also mean high concentration of herbicide that may come into contact with the crop at planting. Watch application rate, especially on lighter soils where there is less ability for the herbicide to bind. Follow label directions for rate and soil type.

Herbicide properties – Herbicides with high solubility and a lower $K_{oc}$ value (i.e. less tightly bound) will be more mobile in the soil, so are more likely to reach the germinating seed and therefore more likely to be taken up by the seedling. This makes these herbicides more likely to express herbicide injury, especially under conditions of high soil moisture.

The table below lists the water solubility (mg/L) and mobility (average $K_{oc}$) values for the key pre-emergent herbicides used in chickpeas in the northern grain region. These herbicides have been roughly prioritised from those which are most likely to cause crop injury to those herbicides least likely to express injury.

Incorporation at sowing – For some herbicides that are less mobile (bind tighter to the soil) increased crop selectivity can usually be achieved by using the incorporated by sowing (IBS) technique where the herbicide is applied to the soil prior to planting and the herbicide treated soil above the planting furrow is thrown into the inter-row during the planting operation. All other things being equal, IBS application will generally be safer than a post-sow, pre-emergent (PSPE) application as herbicide treated soil is removed from directly above the seed furrow. Care is needed however to ensure that treated soil is not thrown into adjoining crop rows. The IBS technique is critical for trifluralin and tri-allate e.g. Avadex® to provide soil cover of the herbicide soon after application, to reduce herbicide loss due to volatilisation.

Product label directions on how each herbicide should be used and incorporated should be read and followed.

Table 2. Main chickpea pre-emergent herbicide options showing key application timing(s), water solubility (mg/L @ 20°C) and mobility (as a $K_{oc}$ equilibrium constant) (adapted from http://www.grdc.com.au/SoilBehaviourPreEmergentHerbicides)

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Timing</th>
<th>Solubility (mg/L @ 20°C)</th>
<th>Mobility (average $K_{oc}$)</th>
<th>Potential risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimethenamid-P (e.g. Outlook)</td>
<td>IBS</td>
<td>High (1450)</td>
<td>Moderate (218)</td>
<td>Moderate – High</td>
</tr>
<tr>
<td>s-metolachlor (e.g. Boxer® Gold) + prosulfocarb</td>
<td>IBS</td>
<td>Moderate-high (480)</td>
<td>Moderate (200)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low (13)</td>
<td>Non-mobile (&gt;1300)</td>
<td></td>
</tr>
<tr>
<td>pyroxasulfone (e.g. Sakura)</td>
<td>IBS</td>
<td>Low (3.5)</td>
<td>Moderate (95)</td>
<td></td>
</tr>
</tbody>
</table>
**Crop safety observations NGA field trials 2010-2016**

NGA has conducted in excess of 30 residual herbicides trials in chickpeas since 2010, targeting broadleaf or grass weed efficacy. In all cases chickpeas were planted using commercial equipment as part of the full paddock. PSPE treatments were applied, generally on the day of planting but delayed in some situations to just prior to crop emergence.

There have been no crop safety issues for registered herbicides and rates in the vast majority of situations. Significant differences in plant establishment compared to the Untreated have only been found in 3 trials during that period. Interestingly in one trial it was the Untreated that recorded the lowest establishment and was significantly less than a number of herbicide treatments. Outlook alone has recorded significantly lower plant stand (~3-4 plants/m²) than the untreated in 2 of 23 trials conducted during 2014-16. There were no situations with significant plant stand reduction for Balance plus mixtures with simazine or Terbyne Xtreme during these trials.

There were no other obvious or concerning symptoms of herbicide crop effect recorded. NB all these trials were conducted with the primary focus of evaluating weed efficacy. Because of the potential for impact on yield from varying weed control levels, none of these trials were taken to yield assessment. Full crop safety evaluation needs to be conducted in weed free situations.

The field results support the safety of a wide range of registered residual herbicide options in chickpeas but indicate there will still be situations where a level of crop effect can occur.

**Acknowledgements**

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