Grower Summary

BOF 73

Evaluation of potential alternative herbicides for narcissus following the loss of active ingredients

Final 2012

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Headline

The following products showed promise for weed control in narcissus:

- post flower-cropping: Wing-P + Barton WG# (pendimethalin/dimethenamid-P + florasulam), Stomp Aqua + Kerb Flo (pendimethalin + propyzamide),Stomp Aqua + Butryflow (pendimethalin + bromoxynil);
- dormant period: Intruder, Ceancrop Amigo (chlorpropham) + Sencorex SC (metribuzin) tank-mix. Chikara (flazasulfuron) also looked promising but authorisation for OPP is unlikely in the near future.

#Barton (new, WG formulation of florasulam) was in trial, the company have now decided to continue manufacture of Boxer (SC florasulam) as a specialist product for narcissus. Boxer is safe (BOF 52) at all timings and has an EAMU.

Background

The narcissus crop is grown for three or more years and weeds reduce yield and quality of flowers and bulbs. Weeds also interfere with picking and bulb lifting. Frequent use of the current limited range of herbicides can lead to a build-up of weed species that may escape control and risk development of resistance. Several options have been lost and herbicide dose rates have been reduced, for example metazachlor to 1000 g a.i./ha (equivalent to Butisan S 2.0 L/ha) to be applied now 'over three years'. Obtaining authorisation of herbicide application pre-cropping is difficult because of operator exposure to 'dislodgeable residues' at flower cropping. In previous trials (BOF 52) there were very few weeds at this stage suggesting that focussing on treatments post cropping would yield the greatest benefits.

Weeds germinate after soil disturbance by flower pickers and Lawson (1976) showed that weeds have the greatest effect if they are not controlled during the period after flowering when narcissus bulbs begin floral initiation. Weeds should therefore be removed post-cropping, before the period of flower initiation and bulb increase.

The aim of this trial was therefore to find safe effective herbicide alternatives post-cropping (Trial A). Whilst a trial was in progress however, it made sense to assess persistent residual herbicides applied during the dormant period in order to also widen the range of treatments available at this stage and perhaps avoid the need for a pre-cropping treatment and this was done in a separate area (Trial B).

Summary

The herbicide screening trials were in a three-year down crop cv. Tamsyn in its' second year in 2011 on a light silt soil at Fosdyke, South Lincolnshire. All treatments were applied at single and double 'overlap' rates in two replicates. The weather after post-cropping application was very dry from March 2011 and there was no significant rainfall until the end of June 2011. This reduced the risk of damage resulting from leaching of soil-acting residual herbicides. The autumn and winter were unusually mild, but picking flower buds on the farm crop was interrupted by snow in February 2012 when temperatures dropped to minus 17°C.

Trial A Post-cropping herbicide treatments applied 4 March 2011

Trial A post-cropping treatments were selected that had residual soil and foliar activity. Herbicides were applied when there were a few patches of small nettle, groundsel and ivy-leaved speedwell – all at cotyledon stage. Plots were monitored for herbicide damage to narcissus foliage, for weed control until 23 June 2011 when the untreated narcissus leaves had completely senesced and were detachable from the bulb, after dormancy for leaf and bud emergence; and for any effects on flower quality.

Herbicide Treatments Trial A

Trial A. Herbicides treatments were applied post-cropping at single and double rates in 200L/ha water volume on 4 March 2011.

	Herbicide Product	*Active substance*	*Product l or kg/ha*
0.	Untreated	-	-
1.	Callisto	Mesotrione	1.5L
1x2	Callisto	Mesotrione	1.5L x2
2.	Wing-P + Barton WG	pendimethalin/dimethenamid-P+florasulam	4.0L + 10g
2x2	Wing-P + Barton WG	pendimethalin/dimethenamid-P+florasulam	(4.0L + 10g)x2
3.	HDCH1+ Stomp Aqua + Goltix	confidential + pendimethalin+metamitron	2.0L+2.9L+2.8L
3x2	HDCH1+ Stomp Aqua + Goltix	confidential + pendimethalin+metamitron	(2.0L+2.9L+2.8L)x2
4.	Defy + Sencorex SC	prosulfocarb + metribuzin	2.5L + 0.58L
4x2	Defy + Sencorex SC	prosulfocarb + metribuzin	(2.5L + 0.58L)x2
5.	Butryflow + Stomp Aqua	bromoxynil + pendimethalin	1.0L + 2.9L
5x2	Butryflow + Stomp Aqua	bromoxynil + pendimethalin	(1.0L + 2.9L)x2
6.	Cadou Star	flufenacet/isoxaflutole	0.425 kg
6x2	Cadou Star	flufenacet/isoxaflutole	0.425 kg x 2
7.	Stomp Aqua + Kerb Flo	pendimethalin + propyzamide	2.9L + 3.0L
7x2	Stomp Aqua + Kerb Flo	pendimethalin + propyzamide	(2.9L + 3.0L)x2
8.	Sumimax	Flumioxazin	100ml
8x2	Sumimax	Flumioxazin	100ml x2

+ = tank-mix; new formulations 10g Barton = 50ml Boxer; 0.58L Sencorex SC = 0.5kg Sencorex WG

Crop Safety and Weed Control

Some herbicides caused leaf damage and premature senescence and in the following year resulted in delays; a reduction in bud numbers and lower bulb yields were also likely, but bulb yield was not recorded. Weeds also have an impact but under dry conditions tall species (fat-hen and small nettle) were not vigorous and they did not shade the crop on untreated plots until late June. Black-bindweed not controlled by Cadou Star completely over-ran the ridges and had an effect. Although groundsel was not controlled by Stomp Aqua + Kerb (treatment 7), it covered the bottom of the ridge and was suppressed by the crop.

Three herbicide tank-mixes appeared safe:

Stomp Aqua + Kerb Flo (2.9 + 3.0) L/ha, there was no damage from this single dose rate and negligible effects from the double dose. Groundsel was not controlled by Stomp Aqua or Kerb Flo (see table below), but the tank-mix was effective on tall species and Kerb, which is persistent, provided long term control of fat-hen. After dormancy the most advanced narcissus were on the Stomp + Kerb plots, the only ones free from fat-hen during early dormancy and where was no damage. By 27 January there were more buds at cropping stage than on untreated plots and greater number of total buds for single and double doses.

A tank-mix with Barton, Wing-P or Butryflow would be needed to control groundsel to avoid increasing problems in following crops but crop safety would need to be tested as this combination was not tested in the trial reported here.

Wing-P + Barton (4.0 L + 10g) /ha at single dose was safe and gave the best weed control - plots were weed-free until senescence on 23 June. The dimethenamid-P component of Wing-P gave long-term control of groundsel. Barton, which is foliar-acting, controlled weeds that had already emerged. Compared with untreated plots cropping was not delayed and numbers of narcissus buds at cropping stage, and total buds were not reduced.

Butryflow + Stomp Aqua (1.0 + 2.9) L/ha also appeared very safe at the single dose rate. However, Butryflow, a contact-acting herbicide, killed groundsel present at the time of application, but more emerged later. Cropping was not delayed and numbers of narcissus buds at cropping stage, and total buds were not reduced.

Four herbicide treatments were not safe:

Sumimax(100ml/ha) caused the most severe damage (see Appendix 1) - scorch to narcissus foliage and flowers, and premature senescence by the end of May, a month earlier than untreated plots. The narcissus bulbs therefore had very little time to initiate new flowers. Emergence after dormancy was delayed, and leaf height reduced. At cropping stage 27 January there were very few flower buds on Sumimax plots at single dose and none for the double dose. A few more emerged later. Sumimax plots became weedy earlier than other treatments.

The other three treatments also reduced the time for flower initiation because of damage to the foliage. The main herbicide effects were loss of turgidity (leaves floppy) followed by early leaf senescence compared with untreated narcissus.

Defy + Sencorex(2.5 + 0.583) L/ha caused the most damage: loss of leaf wax, slight scorch followed by loss of leaf turgour, then early senescence. Defy contains a powerful wetter, and this increased the effect of Sencorex. There was delayed emergence after dormancy and on 27 January a very large reduction in total bud numbers for single and double dose rates although narcissus was weed-free until the 23 June.

HDCH1 + Stomp Aqua + Goltix (2.0 + 2.9 + 2.8) L/ha although initial effects were less severe, after dormancy there was a delay and reduction in number of buds at cropping stage and in total bud numbers for both dose rates. Weed control was very good.

Callisto 1.5 L/ha appeared safe at this single dose, but not at double dose where leaves showed some yellowing. However, severe damage from both dose rates was seen after dormancy: leaf emergence was slightly delayed, crop thinning was seen on 27 January and there was a reduction in total bud numbers for single and double dose rates. Callisto performed well on the weed species in this trial but gaps pre-weed-emergence include knotgrass and annual meadow-grass.

Marginal crop safety:

Cadou Star: dose rates tested 0.45kg/ha (lower than the normal cereal dose) and 0.45kg/ha x 2 caused some yellowing of the foliage. The 0.45kg/ha dose appeared safe but there was stunting, delay and fewer buds on plots treated with the double dose, although this may have been caused partly by earlier crop suppression from the black bindweed which overran the crop. It does not control black-bindweed and it also has a weakness on knotgrass, both spring-germinating.

Flower quality

In 2012 on trial area A, flower buds were not cropped and were left to open in the field so that flower development and quality could be assessed. Snow on 4 February (10cm) and 9 February, and temperatures down to minus17°C on 11 February caused damage to leaf tips, and some buds subsequently failed to open. A few (< 1%) flowers with abnormalities were recorded on all plots. However, there were no differences between herbicide treatments and untreated narcissus. None of the herbicide treatments affected flower quality (see table). There were no signs of perianth fusing or cup malformations and anthers were fully formed.

Some post-cropping herbicide treatments in 2011 caused leaf damage and premature senescence and in the following year resulted in delays in bud cropping stage which is unacceptable for a variety grown for early market, a reduction in bud numbers, and reduced vigour. Assessments of open flowers (13 March) showed there were also delays in flower opening as a result of herbicide damage. A subsequent effect on bulb yield (not recorded) was likely. However, flower quality was not affected.

Crop tolerance scores, flower yield and quality scores for herbicides treatments applied post cropping on 4 March 2011 (Trial A).

		Date:	26/5/11	27/1/12			13/3/12
	Herbicide Product	*Product L or kg /ha*	*crop score (% s)*	*crop score*	*buds cs/6 m*	*total buds/ m*	*quality score*
0	Untreated	-	10 (10)	10	16	73	5
1	Callisto	1.5 L	8.5 (20)	6 th d	5	51	5
1x 2	Callisto	1.5 L x 2	6 (35)	4 th d	1	44	5
2	Wing-P + Barton	4.0 L + 10g	10 (10)	10	17	78	5
2x 2	Wing-P + Barton	(4.0 L + 10g) x 2	9 (15)	9.5	18	78	5
3	HDCH1+Stomp Aqua+Goltix	2.0 L+ 2.9 L+2.8 L	6.5 (30)	7	3	56	5
3x 2	HDCH1+Stomp Aqua+Goltix	(2.0 L+ 2.9 L+2.8 L)x2	4 (40)	6 d	1	32	5
4	Defy + Sencorex SC	2.5L + 0.58L	4 (40)	5 d	2	35	5
4x 2	Defy + Sencorex SC	(2.5L + 0.58L) x2	3 (50)	4 d	1	25	5
5.	Butryflow + Stomp Aqua	1.0L + 2.9 L	10 (10)	10	13	81	5
5x 2	Butryflow + Stomp Aqua	(1.0L + 2.9 L)x2	9 (15)	9	9	69	5
6	Cadou Star	0.425 kg	7.5 y (20)	10#	13	77	5
6x 2	Cadou Star	0.425 kg x 2	5 y (30)	7st d#	4	51	5
7	Stomp Aqua + Kerb Flo	2.9 L + 3.0 L	10 (10)	10	31	86	5
7x 2	Stomp Aqua + Kerb Flo	(2.9 L + 3.0 L) x2	9 (15)	10	36	89	5
8	Sumimax	100ml	1 (95)	2th d	0	7	5
8x 2	Sumimax	100ml x2	0 (100)	1th d	0	0	5

Assessments following treatment:
Crop tolerance scores (0=complete kill; 7=acceptable damage; 10=no damage)
% s = % leaves senesced.
After dormant period:
number of buds (35cm length) at cropping stage (cs) on 6m ridge;
total number of buds/m ridge,
Quality of open flowers - abnormality, malformation, size (score 1=unacceptable; 5 no herbicide effect = untreated)

= infestation of black bindweed after cropping; d = delay; th= thinning; st= stunting; y = yellowing

Cropping buds on the farm crop began on 27 January 2012 and finished 25 February.

There was a wide variation in bud numbers on untreated plots and the reductions on treatments apparent in the table above give indications only.

Percentage weed cover by species and total recorded on plots on 25 May (82 days after treatment) and total on 23 June (111 days after treatment after crop senescence) following post cropping herbicide treatments on 4 March 2011 (trial A).

	Herbicide	*Product L or kg /ha*	*Small nettle*	*Groundsel*	*Black-bindweed*	*Fat-hen*	*TOTAL 25 May*	*TOTAL 23 June*
0.	Untreated	-	35	40	2	20	97	100
1.	Callisto	1.5 L	0	0	0	0	0	10
1x2.	Callisto	1.5 L x 2	0	0	0	0	0	0.5
2.	Wing-P + Barton	4.0 L + 10g	0	0	0	0	0	0
2x2.	Wing-P + Barton	(4.0 L + 10g) x 2	0	0	0	0	0	0
3.	HDCH1+Stomp Aqua+Goltix	2.0 L + 2.9 L+ 2.8 L	0	0	0	0	0	2
3x2.	HDCH1+Stomp Aqua+Goltix	(2.0 L + 2.9 L+ 2.8 L) x2	0	0	0	0	0	0.5
4.	Defy + Sencorex SC	2.5L + 0.58L	0	0	0	0	0	0.5
4x2.	Defy + Sencorex SC	(2.5L + 0.58Lx2	0	0	0	0	0	0
5.	Butryflow + Stomp Aqua	1.0L + 2.9 L	0	0.3	0	0	0.3	3
5x2.	Butryflow + Stomp Aqua	(1.0L + 2.9 L)x2	0	0.3	0	0	0.3	3
6.	Cadou Star	0.425 kg	0	0	3	0	3	10
6x2.	Cadou Star	0.425 kg x 2	0	0	11	0	11	26
7.	Stomp Aqua + Kerb Flo	2.9 L + 3.0 L	0	40	0	0	40	70
7x2.	Stomp Aqua + Kerb Flo	(2.9 L + 3.0 L) x2	0	2	0	0	2	2
8.	Sumimax	100ml	1	1	0	0	2	14
8x2.	Sumimax	100ml x2	0	0.5	0	0.5	1	10

Trial B dormant stage herbicide treatments applied 20 October 2011

Trial B treatments were selected that had persistent soil residual activity, with glyphosate added as a tank-mix for all treatments and also applied to 'untreated' plots to control emerged weeds. Plots were assessed after dormancy for leaf and bud emergence, flower quality and for weed control.

At the growth stage pre-cropping, when narcissus leaves were 5-10 cm tall, another herbicide application would not have been needed following any of the trial B treatments because they were all effective. At bud cropping stage the weeds were too small to affect the flower development or to interfere with picking on any treatment or untreated plots. Flushes of groundsel that were not controlled by some treatments were killed by frost.

Herbicide Treatments Trial B

Trial B herbicides were applied pre-emergence at narcissus dormant stage at single and double rates in 200L/ha water volume on 20 October 2011 (# note Jouster should be applied after 1 November).

	Herbicide (all + Roundup Biactive 3.75L/ha)	*Active substance*	*Product/ha*
0.	Untreated	-	-
1.	Jouster#	Napropamide	7.0L
1.x2	Jouster	Napropamide	7.0L x 2
2.	Ronstar	Oxadiazon	4.0L
2 x2	Ronstar	Oxadiazon	4.0L x 2
3.	Chikara	Flazasulfuron	0.15kg
3 x2.	Chikara	Flazasulfuron	0.15kg x 2
4.	Cadou Star	flufenacet/isoxaflutole	0.85kg
4x2.	Cadou Star	flufenacet/isoxaflutole	0.85kg x 2
5.	Intruder + Sencorex SC	chlorpropham + metribuzin	2.0L (fb 2.0 L) + 0.88L
5.x2	Intruder + Sencorex SC	chlorpropham + metribuzin	(2.0L (fb 2.0L) + 0.88L) x2
6.	Intruder + Linurex 50SC	chlorpropham + linuron	2.0L (fb 2.0L) + 1.2L
6x2	Intruder + Linurex 50SC	chlorpropham + linuron	(2.0L (fb 2.0L) + 1.2L) x2

fb= followed by; + = tank-mix; 0.88 L Sencorex SC = 0.75kg Sencorex WG;

Chikara at 0.15 kg/ha appeared very safe to the crop. It is the most expensive (at this dose rate), but the most persistent herbicide. There were no differences in leaf height, number of flower buds at cropping stage, and total bud numbers between treated and untreated plots. It was the most effective on the weeds at this site. However, it does not control fat-hen or annual meadow-grass.

Intruder + Sencorex {2.0 (followed by 2.0) + 0.88} L/ha, there were no differences in leaf height, number of flower buds at cropping stage, and total bud numbers between treated and untreated plots. Intruder (chlorpropham) does not control groundsel, and the tank-mix with Sencorex was more effective than the standard treatment of Intruder + Linurex 50SC and the cost is similar. Sencorex could be a useful replacement for linuron.

Jouster 7.0 L/ha appeared safe to narcissus but it has a limited weed spectrum, although it would control willowherb.

Cadou Star at single dose rate 0.85 kg/ha caused some yellowing of narcissus foliage when it emerged, but otherwise no damage. It is less persistent than some of the other treatments.

Ronstar 4.0 L/ha was not safe to the crop. It delayed emergence, leaves were stunted and all were damaged. Leaf tips were scorched by herbicide as they emerged but the flower buds enclosed within the leaves were not affected. Damage was more severe from the double dose. The number of flower buds at cropping stage, and total bud numbers were lower than untreated narcissus. Weed control was good but it would not control chickweed. The cropping delay, potential for effect on the bulb resulting from leaf damage and high cost mean it is unacceptable for narcissus.

Although there had been some willowherb in this field in the past, numbers on the trial area were negligible and it is likely that Sencorex had prevented a problem. Jouster, Ronstar, Sumimax and Chikara control willowherbs but only Jouster is safe and available.

Flower Quality

Open flowers were assessed for quality. The flower abnormalities due to adverse weather described in Trial A were also visible in Trial B in untreated and treated plots, and with similar frequency. None of the herbicide treatments affected flower quality and there were no differences between herbicide-treated and untreated narcissus. There were no signs of perianth fusing or cup malformations, anthers were fully formed. Scores for quality showed that there were no other abnormalities or flower deformities attributable to the herbicide treatments.

The only visible herbicide damage was severe leaf scorching from Ronstar (treatment 2, and 2x2), and this significantly reduced the effective leaf area and may possibly reduce bulb yield.Leaves protected the emerging bud from herbicide damage. Although flower quality was not affected, flowering was delayed.

Financial Benefits

Herbicides have been lost as a result of pesticide legislation. Hand-weeding costs would be too high to consider as an option. Without suitable herbicides, narcissus production costs could be prohibitive. If weed cover prevents picking narcissus flower buds, or if it is impossible to lift bulbs because weeds clog machinery, then the worst case is a crop loss of 100%. Weeds have the greatest effect if they are not controlled during the period after flowering when narcissus bulbs begin floral initiation (Lawson, 1976), and Lawson showed that in the following year there were 22-25% fewer flowers and a 13% reduction in bulb yield (at current prices, losses of £2,000/ha for flowers, £2,248 for bulbs).

This project has identified potential crop-safe, effective herbicide alternatives:

Applied post-cropping of flowers: Stomp Aqua + Kerb Flo (which would need the addition of a herbicide for groundsel control), Wing-P + Barton, Stomp Aqua + Butryflow.

Applied in the dormant period: Intruder etc. + Sencorex and the cost is similar to the standard, Intruder + Linurex. Jouster has a narrow weed spectrum and is twice the cost but controls willowherbs.

These herbicides appeared safe to narcissus and flower quality was not affected. A wider range of herbicides for a 3-year down crop will enable a weed control strategy using different herbicides at different timings and years, and this could prevent build-up of certain weed species and also avoid herbicide resistance.

Action Points

Results from this project show that there are potential herbicides that appear safe to narcissus when applied post-cropping or at dormant stage. The results are from only one trial and only one early variety Tamsyn. When available, potential treatments should be tested on a small area of crop first. Kerb should not be applied if a sensitive crop is sown the following autumn (e.g. cereals).

EAMUs will be needed for post-cropping Kerb Flo, Wing-P and Butryflow. None will be needed for herbicides for the dormant stage because they are already available for narcissus, with the exception of Chikara, which currently is NOT permitted in the presence of a crop. Although Barton (new, WG formulation of florasulam) was in trial, the company have decided to continue manufacture of Boxer (SC florasulam) as a specialist product for narcissus. Boxer is safe (BOF 52) at all timings and has an EAMU.

It may be possible to omit herbicide applications early post-emergence (leaves 5-10 cm tall), where options are limited because of risk to pickers from dislodgeable residues, and where timing is difficult to judge because of the variability of emergence across a field, where late application may damage buds.

Herbicides used in this project: Current Approval Status (1 April 2012)

Approved on or off-label for ornamental plant production (OPP) or under LTAEU – check the LTAEU LIAISON pages on the HDC website in order to update approvals status of products listed (www.hdc.org.uk) – note only visible to users who are logged in to the site.

SOLAs are now EAMUs (Extension of Authorisation for Minor Use).

Herbicide a.s.	*Product & formulation*	*Company*	*Authorised for OPP?*
Post-cropping trial A			
HDC H1	confidential	confidential	No UK approval yet
pendimethalin/ dimethenamid-p	Wing-P 250/212.5 g/L SC	BASF	EAMU OPP needed not yet requested
Phase 1 conversion			
mesotrione	Callisto 100 g/L SC	Syngenta	No EAMU OPP, not requested
bromoxynil	Butryflow 401.58g/L SC	Nufarm	No EAMU OPP,not yet requested; LTAEU until 1June 2011
pendimethalin	Stomp Aqua 455g/L CS	BASF	EAMU OPP
florasulam	Boxer 50g/L SC	Dow	EAMU narcissus will still be available
	Barton WG25% w/w	Dow	No EAMU OPP not needed
flumioxazin	Sumimax 300g/L SC	Interfarm	EAMU OPP
flufenacet/isoxaflutole	Cadou Star WG 480/100g/kg	Bayer	EAMU OPP
propyzamide	Kerb Flo 400g/L SC	Dow	OPP on-label Christmas trees only EAMU needed for narcissus
Phase 2 conversion			
metamitron	GoltixFlowable 700g/L	Makhteshim	LTAEU for OPP; EAMU OPP requested
	Goltix 90 90% w/w WG		LTAEU for OPP; EAMU OPP requested
prosulfocarb	Defy 800g/L EC	Syngenta	LTAEU for OPP; EAMU OPP requested,
metribuzin	Sencorex WG70% w/w	Interfarm	LTAEU for OPP; EAMU OPP requested,
	new Sencorex SC 600g/L	Bayer	New formulation waiting UK approval potatoes; EAMU OPP for SC requested
Pre-emergence trial B			
napropamide	Jouster 450 g/L SC	United Phosphorus	OPP on-label
oxadiazon	Ronstar Liquid 250 g/L	Certis	OPP on-label
chlorpropham	Intruder 400g/L EC	AgrichemBV	Narcissus on label pre- or post-emergence
	Cleancrop Amigo 400g/L		
linuron (Phase 1)	Linurex 50SC500g/L	Mahkteshim	EAMU OPP pre-emergence only
linuron on-label	Datura 500g/L	AgrichemBV	OPP on-label bulbs pre-emergence only
flazasulfuron	Chikara 25% w/w WG	Belchim	**No approval**. **Only for non-crop use**