Applying liquid nitrogen through different nozzles, with and without fungicide

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Key points

- In a low-yielding (3–4 t/ha) wheat trial (cv Trojan) affected by transient waterlogging, applying liquid nitrogen (N), in the form of Easy N®, through flat fan jets was slightly more damaging than streaming jets in terms of phytotoxicity to the key upper leaves, though this was not significant.
- The level of damage was exacerbated when the liquid fertiliser was mixed with fungicides; particularly when applied at booting (GS43).
- The amount of phytotoxicity measured when a fungicide was added depended on the formulation and the angle and leaf layer of the canopy leaf exposed to the spray.
- An emulsifiable concentrate (EC) formulation of fungicide generated twice the level of damage to that observed with suspension concentrate (SC) formulations.
- There were small differences between SC formulations of fungicides but in the main these were non-significant.
- Adding extra water reduced leaf scorch, but the effect was small relative to other differences observed. Similar effects were seen when an adjuvant was added to the SC formulation.
- The variable nature of the yield results did not allow significant comment to be made on yield data.

Location: Riverine Research Centre, Yarrawonga
Sowing date: 18 April 2016
Rotation: First wheat following canola
Variety: Trojan
Stubble: Canola unburnt
Rainfall: GSR: 642.8mm April–November

Introduction

'Easy N®' liquid fertiliser by Incitec Pivot is an alternative nitrogen source to solid urea. The product offers operational efficiencies, such as chemical compatibility with other products, such as fungicides, to allow a single pass multitask application, providing growers with time and labour efficiencies. While Easy N is more expensive than urea, these efficiencies may provide value in themselves.

This research trial aimed to provide data for the Riverine Plains region to demonstrate the relative compatibility of these products, the degree of associated foliar damage and the relative impact of this leaf damage on crop yield.

Objectives

The aim of this trial was to assess any damage to the top four leaves of the wheat crop canopy (as a percentage of leaf area affected [LAA]) seven days after treatment application at second node (GS32) and booting (GS43) stages with different forms of nitrogen. The specific objectives were to:

- assess the phytotoxicity (scorch) of liquid Easy N versus solid urea at GS32 and GS43
- compare the impact of applying liquid Easy N through streaming nozzles and flat fan spray jets
- assess the impact of co-applying emulsifiable concentrate (EC) or suspension concentrate (SC) formulations of foliar fungicides with liquid Easy N
- examine the influence of water rate on scorch at both application timings.

Method

The research trial was carried out near Yarrawonga, Victoria at the Riverine Research Centre. The trial was sown to wheat (cv Trojan) on 17 May 2016. Treatments were applied at two timings: on 17 August at second node (GS32) and again at booting (GS43) on 16 September (Table 1). The trial site was wet at both application timings

The products used were:

- Easy N (normal water rate: 100L/ha water) at 38kg N/ha
- Easy N (200L/ha water) at 38kg N/ha
- Tilt 250® EC fungicide (an EC formulation) at 500mL/ha
- Amistar Xtra® fungicide (an SC formulation) at 800mL/ha

- Prosaro® fungicide (an SC formulation) at 300mL/ha
- Prosaro fungicide + BS1000® (a wetting agent) at 0.25% (v/v).

Note: With damage to the flag leaf being regarded as more important than early-season damage, more treatments were trialled at the later booting timing (GS43) compared with the second node (GS32) timing. Prosaro with and without adjuvant was only assessed at GS43.

The trial received growing season rainfall (GSR) for April – November of 642mm, with 138.2mm of rainfall recorded during September. The trial site was subject to transient waterlogging, particularly in replicate four of all treatments, the results from which were removed from the final statistical analysis of wheat yield and quality. All other assessment data is based on the four replicates in the trial.

Treatments

Treatments are presented in Table 1.

Results

i) Phytotoxicity (levels of leaf damage)

Measurement of foliar damage seven days after the second node (GS32) application showed minimal effects when Easy N was applied in isolation (Table 2). The greatest phytotoxic ratings of 3–3.2% on flag-4 were measured when Easy N was applied in conjunction with either fungicide.

The larger crop canopy at booting (GS43) resulted in greater overall levels of foliar damage seven days after application (Table 3), compared with that recorded at GS32 (Table 2). On the flag leaf there was no significant difference between stream jets and flat fan nozzle application systems. The increase in water rate also didn't have any significant effect on leaf damage.

When fungicide was added with Easy N at booting (GS43) using the flat fan nozzles, the application of Tilt 250 EC resulted in significantly greater leaf damage on the flag leaf (26%) compared with the SC fungicides (Table 3). While the damage with Amistar Xtra was approximately half that measured with Tilt 250 EC (14%), it was still significantly greater than when Easy N was applied without any fungicide. Adding Prosaro caused the least damage to the flag, similar to that of Easy N alone. The addition of the BS1000 wetting agent to Prosaro increased the damage slightly, but not significantly.

There was no significant impact of nozzle type or water rate on leaf damage when Easy N was applied to flag-1. The pattern of leaf damage due to product was similar on flag-1, with Tilt 250 EC causing significantly greater leaf damage (14%) compared with SC fungicide products.

While flag-2 leaf showed a significant relative effect of leaf damage due to fungicide treatments, the actual values were low (<3.5%), likely due to this leaf receiving less product due to obstruction of the upper leaves.

ii) Disease control

Despite the wet spring during 2016, the wheat (cv Trojan) remained disease free in this trial. All plots received two fungicide applications (Prosaro 150ml/ha + Hasten 1%v/v on 17 August followed by Tilt on 16 September) at the

TABLE 1 Treatments applied to trial, Yarrawonga, 2016

No.	Nitrogen application	Fungicide	Rate	Timing
1.	Control 1 (standard N @ GS33)	---		GS32
2.	Urea @ 38kg N/ha	---		GS32
3.	Easy N stream nozzle @ 38kg N/ha	---		GS32
4.	Easy N flat fan nozzle @ 38kg N/ha	---		GS32
5.	Easy N flat fan nozzle @ 38kg N/ha	Tilt 250 EC	500 mL/ha	GS32
6.	Easy N flat fan nozzle @ 38kg N/ha	Amistar Xtra 280 SC	800 mL/ha	GS32
7.	Control 2 (standard N @ GS33)	---		GS43
8.	Urea @ 38kg N/ha	---		GS43
9.	Easy N stream nozzle @ 38kg N/ha	---		GS43
10.	Easy N flat fan nozzle @ 38kg N/ha	---		GS43
11.	Easy N flat fan nozzle @ 38kg N/ha (200L/ha water)	---		GS43
12.	Easy N flat fan nozzle @ 38kg N/ha	Tilt	500mL/ha	GS43
13.	Easy N flat fan nozzle @ 38kg N/ha	Amistar Xtra	800mL/ha	GS43
14.	Easy N flat fan nozzle @ 38kg N/ha	Prosaro 420SC / BS1000	300mL/ha / 0.25%	GS43
15.	Easy N flat fan nozzle @ 38kg N/ha	Prosaro 420 SC	300mL/ha	GS43

All treatments received a solid urea application of 39kg N/ha on 26 August, when the crop was at GS33.

TABLE 2 Phytotoxicity severity (% leaf area affected — LAA) on flag-2, flag-3 and flag-4, and green leaf retention (GLR) on flag-4, 23 August, at third node (GS33) seven days after application (7DAA) at second node (GS32)

Nitrogen application	Fungicide	Timing	Flag-2	Flag-3	Flag-4	
			Phytotoxicity (% LAA)	Phytotoxicity (% LAA)	Phytotoxicity (% LAA)	GLR (%)
-	-	GS32	0[b]	0[c]	0[c]	83.9[a]
Urea @ 38kg N/ha	-	GS32	0[b]	0[c]	0[c]	83.5[a]
Easy N stream nozzle @ 38kg N/ha	-	GS32	0.7[a]	0.6[bc]	0.6[c]	88.7[a]
Easy N flat fan nozzle @ 38kg N/ha	-	GS32	0.1[b]	0.6[bc]	1.6[b]	83.6[a]
Easy N flat fan nozzle @ 38kg N/ha	Tilt 250 EC 500mL/ha	GS32	0[b]	1.2[b]	3[a]	84.6[a]
Easy N flat fan nozzle @ 38kg N/ha	Amistar Xtra 280 SC 800mL/ha	GS32	0.2[b]	2.3[a]	3.2[a]	89.3[a]
Mean			**0.2**	**0.8**	**1.4**	**6.9**
LSD p=0.05			0.4	0.6	0.9	85.6
P value			0.024	<0.001	<0.001	0.303

Figures followed by different letters are regarded as statistically significant

TABLE 3 Phytotoxicity severity (% LAA) on the flag, flag-1 and flag-2, 23 September start of head emergence (GS51); seven days after application (7DAA) at booting (GS43)

Nitrogen application	Fungicide	Timing	Flag	Flag-1	Flag-2
			Phytotoxicity (% LAA)	Phytotoxicity (% LAA)	Phytotoxicity (% LAA)
-	-	GS43	0.0[c]	0.0[e]	0.0[d]
Urea @ 38kg N/ha	-	GS43	0.0[c]	0.0[e]	0.1[d]
Easy N stream nozzle @ 38kg N/ha	-	GS43	5.7[bc]	2.8[de]	2.0[bc]
Easy N flat fan nozzle @ 38kg N/ha	-	GS43	3.2[c]	3.5[cde]	1.8[bc]
Easy N flat fan nozzle @ 38kg N/ha (200L/ha water)	-	GS43	2.4[c]	2.0[e]	0.9[cd]
Easy N flat fan nozzle @ 38kg N/ha	Tilt 250 EC 500mL/ha	GS43	25.7[a]	14.1[a]	3.4[a]
Easy N flat fan nozzle @ 38kg N/ha	Amistar Xtra 800mL/ha	GS43	13.7[b]	7.0[bc]	2.3[abc]
Easy N flat fan nozzle @ 38kg N/ha	Prosaro 300mL/ha, BS1000 0.25%	GS43	6.2[bc]	6.4[bcd]	2.7[ab]
Easy N flat fan nozzle @ 38kg N/ha	Prosaro 300mL/ha	GS43	4.6[c]	7.8[b]	3.5[a]
Mean			**6.8**	**4.8**	**1.8**
LSD			8.8	3.9	1.4

Figures followed by different letters are regarded as statistically significant.

same time as individual treatments received fungicide with liquid fertiliser. These fungicides were applied as a separate pass with flat fan jets applied with a hand boom. There was no observable difference in disease level due to how the fungicide was delivered, however this maybe partly due to the disease resistance shown by Trojan.

iii) Grain yield and quality

The high variability within treatments means there are no statistically significant treatment effects on yield.

There was a significant replicate effect on yield that resulted in the fourth replicate being excluded from the analysis due to waterlogging, however transient waterlogging was a general feature of the spring in Yarrawonga during the 2016 season, which contributed to the high in-trial variability.

When liquid and solid nitrogen applied at second node (GS32) were compared, there was no evidence to suggest the form of nitrogen influenced grain protein content. There were also no significant differences in test weight or screenings (Table 4).

When nitrogen was applied at booting (GS43) there was a non-significant trend for the solid urea treatment to be higher yielding compared with the Easy N treatments, but the high variability means no clear treatment effects were seen. In addition, there was no clear yield penalty in treatments measuring higher phytotoxic effects (i.e.

TABLE 4 Yield, protein, test weight and screenings on 11 December, 2016, at harvest (GS99)

Nitrogen application	Fungicide	Yield and quality				
		Timing	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
-	-	GS32	3.78^{abc}	10.8^{cd}	81.3^{a}	1.2^{a}
Urea @ 38kg N/ha	-	GS32	3.58^{bc}	12.2^{a}	81.2^{a}	1.0^{a}
Easy N stream nozzle @ 38kg N/ha	-	GS32	4.01^{abc}	12.1^{abc}	80.5^{a}	1.2^{a}
Easy N flat fan nozzle @ 38kg N/ha	-	GS32	3.72^{abc}	12.1^{ab}	80.0^{a}	1.2^{a}
Easy N flat fan nozzle @ 38kg N/ha	Tilt 500mL/ha	GS32	4.51^{a}	11.5^{a-d}	81.2^{a}	0.9^{a}
Easy N flat fan nozzle @ 38kg N/ha	Amistar Xtra 800mL/ha	GS32	4.04^{abc}	10.9^{bcd}	81.1^{a}	1.2^{a}
-	-	GS43	3.92^{abc}	11.3^{a-d}	81.1^{a}	1.1^{a}
Urea @ 38kg N/ha	-	GS43	4.37^{ab}	10.4^{d}	81.4^{a}	1.1^{a}
Easy N stream nozzle @ 38kg N/ha	-	GS43	3.82^{abc}	12.0^{abc}	80.4^{a}	1.1^{a}
Easy N flat fan nozzle @ 38kg N/ha	-	GS43	3.16^{c}	12.2^{a}	80.7^{a}	0.9^{a}
Easy N flat fan nozzle @ 38kg N/ha (200L water)	-	GS43	3.13^{c}	11.8^{abc}	80.4^{a}	1.2^{a}
Easy N flat fan nozzle @ 38kg N/ha	Tilt 500mL/ha	GS43	3.49^{bc}	12.0^{abc}	80.5^{a}	1.1^{a}
Easy N flat fan nozzle @ 38kg N/ha	Amistar Xtra 800mL/ha	GS43	3.28^{c}	12.1^{ab}	79.9^{a}	1.1^{a}
Easy N flat fan nozzle @ 38kg N/ha	Prosaro 300mL/ha BS1000 0.25%	GS43	3.73^{abc}	12.4^{a}	79.9^{a}	1.0^{a}
Easy N flat fan nozzle @ 38kg N/ha	Prosaro 300mL/ha	GS43	3.52^{bc}	12.1^{ab}	80.2^{a}	1.0^{a}
Mean			**3.74**	**11.7**	**80.7**	**1.1**
LSD			0.92	1.3	2.2	0.4

scorch) such as the Tilt 250 EC treatment, which showed a comparable average yield to those treatments with minimal leaf damage, such as the Easy N flat fan.

The grain protein contents in the Easy N treatment tended to be higher than the solid urea treatment, however, this was also non-significant.

Conclusions

In a low-yielding field trial, affected by transient waterlogging during spring, it was shown that applying liquid nitrogen through flat fan nozzles, compared with streaming nozzles, showed no consistent differences in leaf damage when assessed on the top four leaves of the canopy. However while the yields in this trial were variable, with flat fan nozzles targeting the leaves with the nitrogen application, there was a trend for yields to be lower than using streaming nozzles, where a greater percentage of nitrogen applied would be taken up from the soil.

When the liquid fertiliser was mixed with fungicides the level of damage increased, particularly when applied at booting (GS43). The extent of phytotoxicity when a fungicide was added depended on the formulation of the fungicide and the angle of the canopy leaf exposed to the spray. The EC formulation resulted in at least twice the level of damage than that observed with SC formulations. There were only small differences between the different SC formulations.

Increasing the water rate at the booting (GS43) application had no significant effect on phytotoxicity effects (leaf scorch), nor did adding adjuvant to one of the SC formulations.

The variable nature of the yield results does not allow significant comments to be made on yield.

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