Shallow seeding could lead to herbicide damage in wheat

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Key messages

Interaction of shallow seeding, good soil moisture and soil residual herbicides Terbyne® Xtreme® 875 WG (terbuthylazine) at 1.2kg/ha, its higher rate and mixture with TriflurX® (trifluralin 480 g/L) at 3L/ha, and Sakura® (pyroxasulfone) at 118g + TriflurX® at 3L/ha caused significant yield reduction across all the wheat varieties at Mullewa on a sandy loam/loam soil. A mixture of Monza® (sulfosulfuron) at 25g/ha with TriflurX® at 3L/ha also registered significant yield loss in EGA Bonnie Rock, Calingiri, Corack and Eagle Rock at Mullewa. In contrast, only the higher rate of Terbyne® Xtreme® 875 WG caused significant yield reduction in Calingiri, Mace and Yitpi at Katanning where varieties were sown at optimum depth of 3-4 cm on a sandy loam soil having good soil moisture.

Split application of Boxer Gold® (1.75L/ha pre-seeding followed by 0.75L/ha post-seeding pre-emergent), pre-seeding Boxer Gold® (prosulfocarb + s-metolachlor) at 2.5L/ha applied mixed with TriflurX® at 3L/ha or Monza® at 25g/ha and its post-emergent application at Z12-Z13 (alone) was tolerated well by all the varieties at Mullewa and Katanning except EGA Bonnie Rock (at Mullewa). Pre-emergent TriflurX® at 3L/ha followed by post-emergent Boxer Gold® at 2.5L/ha at Z12-Z13 caused significant yield loss in Bonnie Rock and Corack at Mullewa, but this sequential application was tolerated well by all the varieties at Katanning.

Aptitude® (metribuzin + carfentrazone) at 200g + MCPA Amine 500 at 0.5L/ha and its higher rate applied at Z13-Z14 to the shallow sown wheat varieties under good soil moisture and at comparatively high temperature (23.6^{o}C) conditions at Mullewa caused significant yield reduction across all the wheat varieties. However, at Katanning only Cobra, Mace, Trojan and Yitp registered low crop safety margin for Aptitude® + MCPA Amine 500 at 200g + 0.5L/ha rate.

Aims

To identify herbicide sensitivities of new and current wheat varieties with the view to reduce yield losses due to herbicides damage.

Method

Two field trials under weed free conditions, one each at Mullewa and Katanning Research Facilities were conducted during 2015 crop season. At Mullewa, the trial was on a sandy loam/loam soil (pH $CaCl_2$ 6.3 and OC 0.43%) and at Katanning, it was on sandy loam soil (pH $CaCl_2$ 5.1. and OC 2.5%). The trials were laid out in criss-cross design with three replications. The 6 wheat varieties (Table 1 and 2) were sown in 10 - 12 m long and 1.1 m wide plots at 75 kg/ha seed rate using knife points followed by press wheels on 4 June and 16 June at Mullewa and Katanning, respectively. Agstar® Extra at 80kg/ha was applied at seeding and urea at 50kg/ha was top dressed on 4 June at Mullewa and K-Till® Extra at 100 kg/ha was applied at seeding at Katanning. The soil moisture content at planting (0-10 cm) was 9.3 and 6.7% at Mullewa and Katanning, respectively. The moisture content of the trial sites was determined by following the volumetric method using a moisture metre.

It was aimed to seed to trials 3-4 cm deep. At Katanning the nominated seeding depth was achieved, but at Mullewa the overall depth was shallower. It is suspected that there was a problem in hydraulic system of the cone-seeder in flattening the seeding machine which resulted in very sallow seeding in 2-3 out of 5 rows in each plot at Mullewa.

The herbicide treatments (Table1 and 2) were applied in 1.5 m wide strips across the varieties, using a spray rig fitted with air induction nozzles and shields on the boom, and calibrated to deliver 75-80L/ha of water. The herbicide treatments were applied on the following dates:

Treatment timing	Mullewa	Katanning
Before seeding	3 June	16 June
Immediately Post Plant	4 June	16 June
Z12-Z13	24 June	21 July
Z13-Z14	3 July	24 July
Z14-Z15	7 July	3 August

The varieties and herbicide treatments were randomised within each replicate. The herbicide plot centre to centre was 1.8 m and there was a 70 cm buffer between any two herbicide treatment plots. Every 5th herbicide plot was kept as an untreated control plot to check the spatial variability. The wheat varieties were evaluated for visual injury at 2-4 weeks after treatment application and again at flowering using a 0 to 100 % scale, where 0 = no visible injury and 100 = complete plant death.

To determine the effect of selected herbicide treatments on plant density at Mullewa, wheat plants were counted from 2 spots per plot from an area of 2 rows x 1 m on 1 July 2015. A similar procedure was followed to count the number of wheat heads at Mullewa and Katanning on 5 and 16 October, respectively.

The trials were harvested on 29 October at Mullewa and on 11 December at Katanning. The net plot size ranged from 8 -10 m x 1.1 m. However, to convert plot yield to hectare basis 1.8 m plot width was used. Wheat grain yield data was subjected to ANOVA using the Genstat program, and the least significant differences (l.s.d. P = 0.05) was calculated.

The total rainfall from May to October at Mullewa and Katanning was 151 and 212 mm, respectively. At Mullewa September and October and at Katanning October were very dry.

Crop safety margins: Higher than label rates of some the herbicides were included in the trials to determine the crop safety margin of the herbicides at the maximum label rates. Good crop safety margin means that a herbicide at its maximum label rate and at the higher rate(s) was tolerated well by a crop variety. Whereas, low crop safety margin for a herbicide indicates that the variety tolerated the maximum label rate well, but at higher than the label rate(s) there was significant yield loss. A low crop safety margin implies that when spraying under less than optimal conditions, herbicide damage and yield loss may occur. For example, when overlapping herbicide; spraying under wet conditions (for soil active and residual herbicides) and /or there are stressed plants due to abiotic/biotic factors.

Results and Discussion

The effect of herbicides during early crop growth stages, at flowering and on grain yield (Table 1 and 2) of wheat varieties was as follows:

Bonnie Rock, Calingiri, Corack, Eagle Rock, Mace and Wyalkatchem were tested at Mullewa and their grain yield ranged from 2.6 to 3.3t/ha. Calingiri, Cobra, Eagle Rock, Mace, Trojan and Yitpi were tested at Katanning with a grain yield range of 1.5 to 1.8t/ha. Mace was the highest and EGA Eagle Rock the lowest yielding variety at both the sites.

Terbyne® Xtreme® 875 WG (terbuthylazine, group C) has been registered on cereals for control or suppression of certain grass and broadleaf weeds since 2014. At Mullewa, Terbyne® Xtreme® at 1.2kg/ha, at a higher rate and label rate (1.2kg/ha) mixed with TriflurX® caused 15-35, 65-80 and 30-45% reduction (statistically significant) in wheat plant population m^{-2} (around 6 weeks after seeding) and 15-35, 80-94 and 18-45% reduction in number of wheat heads m^{-2} across all wheat varieties, respectively (Photo 1). At flowering time, these treatments also registered around 15% reduction in height and biomass across varieties. These phytotoxic symptoms ultimately resulted in significant reduction in grain yield across all the varieties at Mullewa. In contrast, at Katanning Terbyne® Xtreme® at 1.2 kg/ha alone and in mixture with TriflurX® at 3L/ha did not produce any visual symptoms and all the varieties yielded at par with their respective untreated control plots. However, Terbyne® Xtreme® at higher than label rate resulted in significantly lower number of heads m^{-2} across all the varieties except Trojan and as a result Calingiri, Mace and Yitpi recorded significantly lower yield as compared to the untreated control plots.

At Mullewa, Sakura® at 118g + TriflurX® at 3L/ha resulted in significant yield loss across all the varieties and Monza® at 25g + TriflurX® at 3 L/ha caused significant yield reduction in EGA Bonnie Rock, Calingiri, Corack and Eagle Rock. These results are contrary to the previous trial results. According to Sakura® labels, it is compatible with trifluralin, but no specific rates of trifluralin to mix with Sakura® have been mentioned. At Katanning, Sakura® + TriflurX® mix was not tested and Monza® at 25 g + TriflurX® at 3L/ha mix was tolerated well by all the varieties.

Pre-emergent split application (pre-seeding + PSPE) and post-emergent use of Boxer Gold® is registered now on wheat and barley. Boxer Gold® at 1.75L/ha applied pre-seeding followed by 0.75L/ha post seeding pre-emergent, Boxer Gold® at 2.5L/ha mixed with TriflurX® at 3L/ha (only at Mullewa) or Monza® at 25g/ha and its post-emergent application at Z12-Z13 (alone) was tolerated well by all the varieties at both sites except EGA Bonnie Rock at Mullewa. TriflurX® at 3L/ha followed by Boxer Gold at 2.5 L/ha at Z12-Z13 caused significant yield loss in EGA Bonnie Rock and Corack at Mullewa, but it was tolerated well by all the varieties at Katanning. Interestingly at Mullewa, a mixture of Boxer Gold® at 2.5 L/ha with TriflurX® at 3 L/ha applied before seeding, reduced plant population of wheat varieties by 15-35% (data not shown), but this loss was compensated by higher number of heads per plant (data not shown) and thus there was no significant effect on grain yield except EGA Bonnie Rock. The maximum rate of trifluralin 480g/L registered to use with 2.5 L/ha Boxer Gold® is 1.5L/ha.

Crop phytotoxicity and significant grain yield losses from Terbyne® Xtreme® alone and its mix with TriflurX®, Sakura® + TriflurX®, and Monza® + TriflurX® across wheat varieties at Mullewa appears due to the interaction of shallower

seeding (caused by the faulty hydraulic system on the cone seeder) with these residual herbicides and 37 mm rain that fell within 3 weeks of sowing (between 17-22 June 2015). Selectivity of these residual herbicides is a combination of positional and physiological selectivity. Terbyne® Xtreme® label reads “For crop safety, ensure cereal seed is covered with at least 3 cm and preferably 5 cm of soil”. Boxer Gold® has a short residual life in soil. Katanning also received 20 mm rainfall within a week of the trial seeding and this might have caused some movement of Terbyne® Xtreme® at the higher rate in the seeding slot and thus resulted in significant yield loss in 3 out of 6 wheat varieties. Terbyne® Xtreme® was tested in DAFWA’s herbicide tolerance trials for the first time during 2015 and it needs more testing to confirm the results.

Metribuzin 750 at 100g/ha and at the higher rate applied at Z12-Z13 caused 10-15% biomass reduction during early crop growth stages, but only the higher rate caused significant yield reduction across all the varieties at Mullewa. These results are contrary to the previous results from the Mullewa site. At Katanning, mertibuzin at both the rates was tolerated well by all the wheat varieties without exhibiting any visual symptoms. These results are in line with the previous results from the Katanning site.

Aptitude®, a mixture of metribuzin (group C) and carfentrazone (group G), is a new herbicide registered on cereals for control of weeds like wild radish, marshmallows, capeweed, fumitory, bedstraw, etc. At Mullewa, Aptitude® at 200g + MCPA Amine 500 at 0.5L/ha at Z13-Z14 caused 40% leaf necrosis and around 10% biomass reduction 2 weeks after its application. With the increase in this mixture’s rate, the intensity of these symptoms also increased, but new growth was unaffected. These symptoms at both rates resulted in significant reduction in grain yield across all the varieties at Mullewa. At Katanning, Aptitude® at both rates did not produce any visual symptoms. Aptitude® at the label rate (200g + 0.5L/ha MCPA Amine 500) was tolerated well by all the varieties, but at the higher rate it caused significant yield loss in Cobra, Mace, Trojan and Yitpi at Katanning. Aptitude® at 200g/ha rate contains 75g a.i. metribuzin and 18 g a.i. carfentrazone-ethyl.

Mullewa received 37 and 43 mm rainfall (in total) within 3 weeks before and after application of Aptitude® + MCPA treatments, respectively. Carfentrazone is a contact herbicide and its application under high soil moisture, high temperature and bright sunlight could accelerate spotting or necrosis on leaves. Metribuzin, even applied post-emergent is mainly taken up by roots and mainly causes leaf necrosis (Moore and Moore, 2015). Interaction of shallower seeding, good soil moisture and high temperature (maximum 23.6^{o}C) seems to be cause of significant yield reduction at both rates of Aptitude® at Mullewa. Aptitude® + MCPA treatments were applied around 11 am at both sites and on the day of treatment application (27 June) at Katanning, maximum temperature was 14^{o}c. Aptitude® was tested in DAFWA’ herbicide tolerance trials for the first time during 2015 and it needs further testing to confirm the results.

Triathlon (bromoxynil + diflufenican + MCPA) 1L/ha applied at Z13-14 caused visible spotting/bleaching on leaves across all the varieties during early crop growth stages at both sites, but reduced grain yield of Bonnie Rock, Mace and Wyalkatchem at Mullewa only. These results are contrary to previous results.

Bonnie Rock showed sensitivity to higher number of herbicides than the other varieties (Calingiri, Corack, Eagle Rock, Mace and Wyalkatchem) tested at Mullewa.

Conclusion

Under shallow seeding on a sandy loam/loam soil with good soil moisture conditions at Mullewa, the soil residual pre-emergent herbicides Terbyne® Xtreme® 875 WG at label rate (1.2kg/ha) alone and in mixture with TriflurX® at 3L and Sakura® at 118g + TriflurX® at 3L/ha caused significant yield loss across all the varieties at Mullewa. However, a mixture of Monza® at 25g/ha + TriflurX® at 3L/ha registered significant yield loss in EGA Bonnie Rock, Calingiri, Corack and Eagle Rock only. In contrast, on a sandy loam soil with optimum seeding depth (3-4 cm) and good soil moisture conditions during early growth stages at Katanning, only the higher rate of Terbyne® Xtreme® 875 WG caused significant yield reduction in 3 (Calingiri, Mace and Yitpi) out of 6 wheat varieties.

Boxer Gold® at 1.75L/ha applied pre-seeding followed by 0.75L/ha post seeding pre-emergent, pre-seeding Boxer Gold® at 2.5L/ha mixed with TriflurX® at 3L/ha or Monza® at 25g/ha and applied post-emergent at Z12-Z13 (alone) was tolerated well by all the varieties at both sites except EGA Bonnie Rock that registered significant yield loss at Mullewa. Pre-emergent TriflurX® at 3L/ha followed by post-emergent Boxer Gold at 2.5 L/ha at Z12-Z13 caused significant yield loss in Bonnie Rock and Corack at Mullewa, but was tolerated well by all the varieties at Katanning.

Aptitude® at 200g + MCPA Amine 500 at 0.5L/ha and its higher rate applied at Z13-Z14 under comparatively high temperature (23.6^{o}c) and good soil moisture conditions at Mullewa caused significant yield reduction across all the wheat varieties. However, at Katanning only the higher rate of Aptitude® + MCPA caused significant yield loss in Cobra, Mace, Trojan and Yitpi. At the time of application for these treatments at Katanning, the air temperature was lower (14^{o}C) than at Mullewa (23.6^{o}C).

Triathlon at 1L/ha applied at Z13-Z14 caused significant yield loss in Bonnie Rock, Mace and Wyalkatchem at Mullewa, but had no significant negative effect on the grain yield of any variety at Katanning.

References

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Note: Always follow label recommendations. The Department of Agriculture and Food WA, does not endorse the use of herbicides above the registered rate or off-label use of herbicides or off-label tank mixes. Crop tolerance and yield responses to herbicides are strongly influenced by seasonal conditions

Key words

Wheat, herbicides, tolerance, shallow seeding, grain yield.

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Photo-1: Left to right, buffer, plot number 1: Terbyne® Xtreme® 875 WG 1.2kg/ha, plot number 2: Terbyne® Xtreme® 875 WG higher rate and plot number 3: Untreated Control. The wheat variety at the front was Mace. The photo was taken 9 weeks after trial seeding on 11-08-2015 at Mullewa.

Table 1: Effect of herbicides on grain yield (% of untreated control) of wheat varieties at Mullewa during 2015 (15GE46).

Herbicides	Rate/ha	Timing	Bonnie Rock	Calingiri	Corack	Eagle Rock	Mace	Wyalkatchem
Untreated Control >>Grain yield (kg/ha)			100 2885	100 3022	100 3116	100 2629	100 3308	100 3073
Terbyne® Xtreme® (*Terbuthylazine*)	1.2 kg	Before seeding (BS)	**44**	**80**	**61**	**68**	**63**	**62**
Terbyne® Xtreme® (Terbuthylazine)	Higher rate	Before seeding	**2**	**8**	**2**	**11**	**12**	**10**
Terbyne® Xtreme® + TriflurX® (Terbuthylazine + trifluralin)	1.2 kg + 3 L	Before seeding	**71**	**78**	**55**	**64**	**76**	**47**
Monza® + TriflurX® (Sulfosulfuron + Trifluralin)	25 g + 3 L	Before seeding	**89**	**93**	**93**	**89**	97	95
Monza® + Boxer Gold® (Sulfosulfuron + (Prosulfocarb + S-metolachlor))	25 g + 2.5 L	Before seeding	**90**	97	97	93	96	98
Sakura® + TriflurX® (Pyroxasulfone + Trifluralin)	118 g + 3 L	Before seeding	**80**	**93**	**89**	**79**	**91**	**88**
Boxer Gold® + TriflurX® (Prosulfocarb + S-metolachlor) + Trifluralin))	2.5 L + 3 L	Before seeding	**89**	100	95	94	99	99
Boxer Gold® (Prosulfocarb + S-metolachlor)	1.75 L + 0.75 L	BS fb Immediately Post Plant	98	97	100	101	102	102
Boxer Gold® (Prosulfocarb + S-metolachlor)	2.5 L	Z12-Z13	96	97	99	98	96	93
TriflurX® fb Boxer® Gold (Trifluralin + (Prosulfocarb + S-metolachlor))	3 L fb 2.5 L	BS fb Z12-Z13	**90**	96	**92**	95	94	97
Metribuzin 750	100 g	Z12-Z13	96	99	101	100	96	97
Metribuzin 750	Higher rate	Z12-Z13	**91**	95	**88**	**90**	**93**	**92**
Aptitude® + MCPA amine 500 ((Metribuzin + Carfentrazone) + MCPA))	200 g + 0.5 L	Z13-Z14	**74**	**88**	**78**	**88**	**85**	**85**
Aptitude® + MCPA amine 500 ((Metribuzin + Carfentrazone) + MCPA))	Higher rate	Z13-Z14	**54**	**82**	**67**	**80**	**75**	**73**
Triathlon® (Bromoxynil + Diflufenican + MCPA)	1 L	Z13-Z14	**90**	96	95	97	**92**	**92**
l.s.d. (0.05) Control vs Herbicides (1-tail)			7	7	7	8	6	7
l.s.d. (0.05) Herbicides vs Herbicides (1-tail)			9	9	9	10	8	9
CV (%)			7	7	6	8	6	6

fb = Followed by, Bonnie Rock = EGA Bonnie Rock and Eagle Rock = EGA Eagle Rock. The names in the parenthesis are the chemical names. TriflurX® = trifluralin 480g/L. Figures in **BOLD** are significantly lower than untreated control.

Table 2: Effect of herbicides on grain yield (% of untreated control) of wheat varieties at Katanning during 2015 (15KA45).

Herbicides	**Rate/ha**	**Timing**	**Calingiri**	**Cobra**	**Eagle Rock**	**Mace**	**Trojan**	**Yitpi**
Untreated Control >>Grain yield (kg/ha)			100 1570	100 1654	100 1518	100 1828	100 1640	100 1670
Terbyne® Xtreme® (Terbuthylazine)	1.2 kg	Before seeding (BS)	104	97	104	94	92	93
Terbyne® Xtreme® (Terbuthylazine)	Higher rate	Before seeding	**90**	99	100	**86**	93	**88**
Terbyne® Xtreme® + TriflurX® (Terbuthylazine + triflurain)	1.2 kg + 3 L	Before seeding	104	106	101	100	101	94
Monza® + TriflurX® (Sulfosulfuron + Trifluralin)	25 g + 3 L	Before seeding	98	107	105	100	96	98
Monza® + Boxer Gold® (Sufosulfuron + (Prosulfocarb + S-metolaclor))	25 g + 2.5 L	Before seeding	96	102	92	97	94	91
Boxer Gold® (Prosulfocarb + S-metolaclor)	1.75 L + 0.75 L	BS fb Immediately Post plant	92	92	96	99	96	96
Boxer Gold® (Prosulfocarb + S-metolaclor)	2.5 L	Z12-Z13	99	98	100	108	96	95
TriflurX® fb Boxer Gold® (Trifluralin + (Prosulfocarb + S-metolaclor))	3 L fb 2.5 L	BS fb Z12-Z13	95	95	105	95	100	95
Metribuzin 750	100 g	Z12-Z13	107	110	112	105	111	112
Metribuzin 750	Higer rate	Z12-Z13	100	110	106	100	105	104
Aptitude® + MCPA amine 500 (Metribuzin + Carfentrazone) + MCPA))	200 g + 0.5 L	Z13-Z14	95	107	100	94	96	99
Aptitude® + MCPA amine 500 (Metribuzin + Carfentrazone) + MCPA))	Higer rate	Z13-Z14	94	**90**	95	**87**	**88**	**88**
Triathlon® (Bromoxynil + Diflufenican + MCPA)	1 L	Z13-Z14	101	105	105	106	97	100
lsd (0.05) Control vs Herbicides (1-tail)			10	9	10	8.6	10	9
lsd (0.05) Herbicides vs Herbicides (1-tail)			13	12	13	11	12	12
CV (%)			10	9	10	8	9	9

fb = Followed by, Eagle Rock = EGA Eagle Rock. The names in the parenthesis are the chemical names. TriflurX® = trifluralin 480g/L.
Figures in **BOLD** are significantly lower than untreated control.