Contribution of leaves to the yield of sunflowers – Willow Tree 2016–17

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Key findings

- Sunflower yields were greatly affected by the various defoliation treatments, ranging from 0.12 t/ha to 0.97 t/ha.
- Reductions in yield, of between 55% and 82% compared with the control resulted from total leaf removal at all three of the targeted growth stages (budding, start of flowering and flowering completion) as well as removing two-thirds of the leaves at budding.
- There was no negative effect on grain yield from removing the bottom third of leaves at budding or the start of flowering. Removing the bottom third of leaves at the start of flowering actually provided a slight yield advantage over the control treatment. The largest effect on plant height, head diameter and head arc length were caused by removing all leaves at the budding stage.

Introduction

Sunflowers are generally considered a minor crop in the northern grains region. However, they play an important role in providing a broadleaf summer crop rotation option. An individual sunflower plant produces on average 2000–6,000 cm^2 of leaf area, which drives yield and oil content.

Identifying which leaves contribute most towards yield and oil content helps inform decisions around disease, pest and general crop management in sunflower crops. Whether it is because the crop is infected with a disease such as powdery mildew, or has insect damage e.g. loopers, the end result is a need for growers and advisors to know where and when to spend money in crop protection to achieve the best economic return on investment through maintaining green leaf area.

Site details

Location	'Parraweena', Willow Tree
Co-operator	Joe Fleming
Soil nutrition	The site was soil cored before sowing to determine starting nutrition (Table 1). Starting nitrogen (N) levels were 93.2kg N/ha to a depth of 1.2 m.
Starting soil water and rainfall	The site was soil cored before sowing and found to have 130 mm of plant available water (PAW) to a depth of 1.2 m. Rainfall was recorded at the experiment site (Table 2).
Sowing date	9 October 2016
Fertiliser	150 kg/ha Gold N pre-sowing 10 L/ha Amps Kickstart plus Petrik applied at sowing
Hybrid	Ausigold 62
Harvest date	24 February 2017

Table 1. Soil chemical characteristics.

Characteristic	Depth (cm)				
	0–10	10–30	30–60	60–90	90–120
pH (1:5 $CaCl_2$)	6.4	6.7	7.0	7.8	8.1
Nitrate nitrogen (mg/kg)	14	8	6	6	6
Sulfur (mg/kg)	3.6	5.7	10.8	24.1	47.9
Phosphorus (Colwell) (mg/kg)	37	9	4	10	25
Organic carbon (OC) (%)	1.58	1.0	0.8	0.64	0.46

Table 2. In-crop rainfall at 'Parraweena', Willow Tree in 2016–17.

Month	September	October	November	December	January	February	March
Rainfall (mm)	163.2	93.6	67.6	73.6	66.2	51.8	123.0

Treatments

The experiment aimed to quantify the contribution of different sunflower leaves to yield and oil quality by applying 12 leaf defoliation treatments.

Defoliation treatments (12)

1. Control – no leaves removed (0/3)
2. Budding (2 cm bud) – remove all leaves (3/3)
3. Budding (2 cm bud) – remove top 10 leaves (1/3)
4. Budding (2 cm bud) – remove top 20 leaves (2/3)
5. Budding (2 cm bud) – remove bottom 10 leaves (1/3)
6. Start of flowering (R5.1) – remove top 10 leaves (1/3)
7. Start of flowering (R5.1) – remove top 20 leaves (2/3)
8. Start of flowering (R5.1) – remove all leaves (3/3)
9. Start of flowering (R5.1) – remove bottom 10 leaves (1/3)
10. Flowering complete (R6.1) – remove top 10 leaves (1/3)
11. Flowering complete (R6.1) – remove top 20 leaves (2/3)
12. Flowering complete (R6.1) – remove all leaves (3/3)

Treatments were applied by cutting off the leaves using secateurs, but leaving the leaf axil intact. Treatments were applied on:

Budding cuts – 7 and 8 December 2016

R 5.1 – 23 December 2016

R6.1 – 6 January 2017.

Results

Plant height

The height of five plants in each plot was measured before harvest, taken from ground level up to the point of attachment at the back of the head. The average plant height in the experiment was 141.7 cm. Removing all leaves at the budding stage had the greatest affect on plant height, at only 117.5 cm, a 25% reduction (Table 3).

Head diameter and arc length

The head diameter and arc length of five plants in each plot were measured before harvest. Head diameter was measured across the back of the head and arc length across the front face of the head. The average head diameter was 15.9 cm across all treatments. Total leaf removal at budding had the largest impact on head diameter, reducing it to 3.6 cm. This was closely followed by removing 2/3 of the leaves at budding and removing all the leaves or 2/3 at the start of flowering (Table 3).

The average arc length was 16.5 cm. There were significant differences between defoliation treatments. Removing all leaves at budding had the largest affect on arc length reducing it to 3.2 cm. Removing all leaves at the start of flowering and removing 2/3 of leaves at budding also significantly reduced the arc length to 10.4 cm and 7.3 cm respectively. There was no effect on arc length from all of the 1/3 leaf removal treatments compared with the control (Table 3).

Table 3. Impact of defoliation treatments on sunflower plant structures.

Treatment	Plant height (cm)	Head diameter (cm)	Head arc length (cm)
Control – no leaves removed (0/3)	144.7	19.1	21.4
Budding – remove all leaves (3/3)	117.5	3.6	3.2
Budding – remove top 10 leaves (1/3)	146.8	18.1	17.6
Budding – remove top 20 leaves (2/3)	137.6	9.8	7.7
Budding – remove bottom 10 leaves (1/3)	152.5	19.6	22.2
Start of flowering – remove top 10 leaves (1/3)	146.6	18.1	19.4
Start of flowering – remove top 20 leaves (2/3)	132.9	17.1	16.9
Start of flowering – remove all leaves (3/3)	139.4	11.6	10.4
Start of flowering – remove bottom 10 leaves (1/3)	146.3	19.2	21.2
Flowering complete – remove top 10 leaves (1/3)	139.4	18.1	19.6
Flowering complete – remove top 20 leaves (2/3)	157.3	19.6	20.6
Flowering complete remove all leaves (3/3)	138.9	17.5	17.6
l.s.d. ($P = 0.05$)	13.05	2.36	4.38

Grain yield

Harvested grain yield at 9% moisture ranged from 0.12 t/ha to 0.97 t/ha at this site. There was a large and significant effect from defoliation treatments on yield. The largest effects on yield resulted from removing all leaves at all three of the targeted growth stages (budding, start of flowering and flowering completion). Removing the top 2/3 of the leaves at budding resulted in a similar yield reduction as the total leaf removal treatments (Figure 1).

Removing the bottom 1/3 of leaves at the start of flowering (R5.1) improved yield compared with the control. Removing the top 1/3 of leaves at budding, start of flowering or flowering completion did not affect yield compared with the control, neither did removing the bottom 1/3 of leaves at budding or removing 2/3 of leaves at the start of flowering or flowering completion (Figure 1).

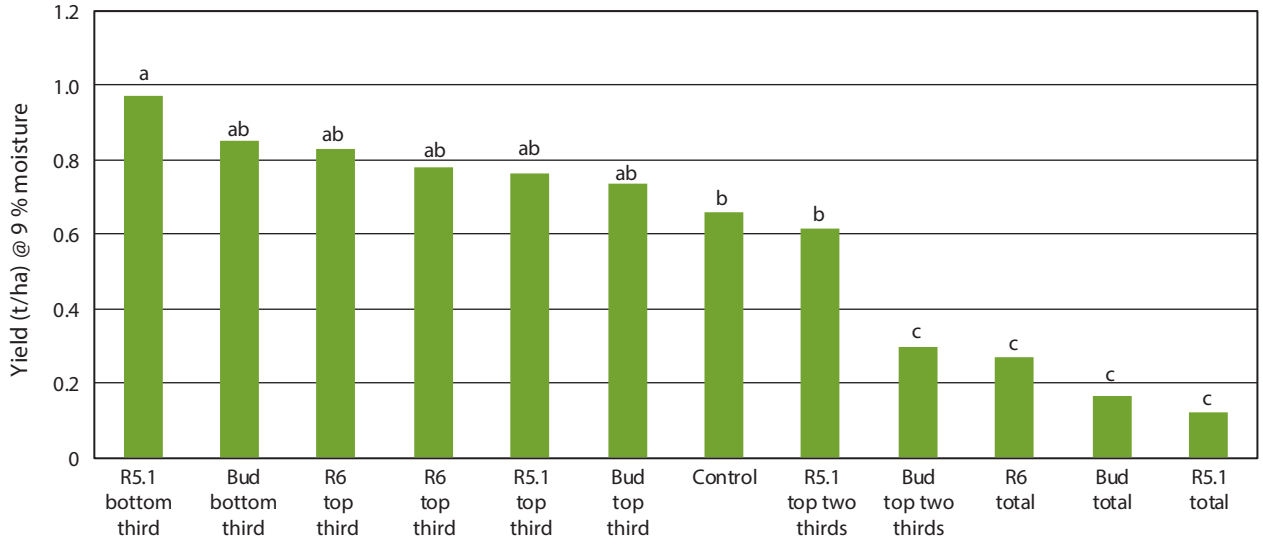

Figure 1. Effect from defoliation treatments on grain yield (t/ha).

Grain quality

Sub samples from each plot were collected at harvest and analysed for 1000 grain weight and test weight. Oil contents were not available at the time of publication.

The average 1000 grain weight in the experiment was 41.2 grams. Defoliation treatments did not significantly affect 1000 grain weight (data not shown).

The average hectolitre weight in the experiment was 35.6 kg/hL, which is well above the receival standard of 32 kg/hL (data not shown).

Conclusions

Defoliation treatments significantly affected grain yields. The largest reductions in yield, between 55% and 82 % when compared with the control, resulted from a treatment where all leaves were removed at all three of the targeted growth stages (budding, start of flowering and flowering completion) and another where the top 2/3 of the leaves were removed at budding.

Removing the bottom 1/3 of leaves at the start of flowering improved yield compared with the control. While removing the top 1/3 of leaves at budding, start of flowering or flowering completion did not affect yield compared with the control, neither did removing the bottom 1/3 of leaves at budding or removing 2/3 of leaves at the start of flowering or flowering completion

The defoliation treatments had significant effects on plant structures, namely plant height, head diameter and arc length. Removing all leaves at the budding stage had the greatest effect on plant height and arc length, causing a 25% reduction in height and an 85% reduction in arc length. Total leaf removal at budding also had the largest effect on head diameter, reducing it to 3.6 cm compared with the control at 19.1 cm diameter.

Therefore, based on the preliminary results generated from this one experiment, it appears that the bottom one third of leaves contribute the least value towards yield on a sunflower plant.

However, this experiment is one of a series conducted during the 2015–2017 seasons, comparing the effect of leaf loss on crop yield and quality. These results should therefore be considered carefully until an across sites and seasons analysis is completed on the entire data set.

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