Desiccation Demonstration Study of Lentils

Project Location(s):

- Scott Saskatchewan, R.M. #380 Legal land description: NE 17-39-20 W3

Project start and end dates (month & year): May 2019 and completed January 2020

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Summary:

Chemical desiccation can be a very effective harvest tool to improve lentil harvestability. The timing of application is critical to ensure yields and seed quality are not comprised. The effects of a desiccant can occur immediately after application and therefore the timing can not be comprised. Applying a desiccant does not hasten maturity but rather improves harvestability. Ensuring the crop is at the proper application stage is the first step in ensuring a chemical desiccation will be effective. An early application may reduce seed size and yield of lentil and increase the risk of wrinkling. This demonstration was developed to provide a visual representation of the effects of application timing and to highlight the desiccant options available to producers. The demonstration consisted of a (RCBD) with two application timings (early and optimal) and four desiccants (Reglone Ion, Heat LQ, Heat LQ and glyphosate, and glyphosate alone) and one unsprayed check to result in a total of nine treatments. The study was established on small red lentils at Scott, Saskatchewan 2019. The results indicated that the timing of application, regardless of the desiccant used, was the most important factor for achieving a successful harvest. Desiccants applied at the optimal timing resulted in an 11% yield gain and 4.8% increase in seed weight compared to the early application timings. Applying desiccants early resulted in lower yields as the crop was not fully matured at application resulting in smaller, shriveled seeds. An additional benefit of applying desiccants at the proper time was the overall shortened dry down period. Reglone Ion and Heat LQ with glyphosate provided the fastest crop dry down and lowest plant moisture at harvest. These two traits improved overall harvestability of the lentil crop. Glyphosate was the slowest and least effective method in drying down lentils. The drying period was the most prolonged under both early and optimal application timings and it also had the highest seed moisture. Overall, application timing was the most important factor in achieving a successful harvest. Desiccant selection also played an influential role in harvest timing as Reglone Ion and Heat LQ with glyphosate resulted in the fastest dry down. This shortened drying window would be very beneficial when time is a limiting factor.

Objective:

This demonstration highlighted the importance of proper application timing when using a chemical desiccant. The objective of this study is to evaluate early and optimal application timings using four different chemical desiccants.

Methodology:

The demonstration was arranged as a randomized complete block design (RCBD) with four replicates and eight treatments at Scott, SK 2019 (Table 1). The trial was sown on wheat stubble using a Fabro knife opener drill with 10-inch row spacing. A fertilizer blend of 0-75-33-0 @ 77 lb/ac was applied with the seed according to soil sampling results taken in the fall prior. A granular inoculant was applied with the seed at 3.3 lb/ac. The lentil variety Impulse was seeded at 130 seeds/m^2. Further details regarding treatment applications can be found in Appendix A1.

Treatment List:

Table 1. Lentil pre-harvest management rates treatment list for Scott, SK 2019.

TRT	Product	Volume	Timing
1	Reglone Ion	20 gal/ac	Early
2	Heat LQ Merge (0.4 L/ac)	20 gal/ ac	Early
3	Glyphosate	10 gal/ac	Early
4	Heat LQ Glyphosate Merge (0.2 L/ac)	20 gal/ac	Early
5	Reglone Ion	20 gal/ac	Optimized
6	Heat LQ Merge (0.4 L/ac)	20 gal/ac	Optimized
7	Glyphosate	10 gal/ac	Optimized
8	Heat LQ Glyphosate Merge (0.2 L/ac)	20 gal/ac	Optimized

Data Collection:

Two application timings where conducted in this experiment, along with a check that received no desiccation application. An early application was applied when 50% of plant was yellow to brown in colour and containing 35-50% seed moisture. Later, an optimized application was applied when the pods on the bottom third of the plant were brown with hard seeds detached from pod that rattled when shaken, or when 80% of plant is yellow to brown in colour. The pods in middle third had seeds that were full in size and firm showing 100% colour change from light green to tan-brown. The top third of the plant showed 50-75% colour change and was slightly green in colour, seeds were fully formed and firm with a seed moisture less than 30%.

Ten plants were pulled, with seeds extracted from the pods, weighed, dried for 24 hours then weighed again to determine seed moisture percentage. Once the appropriate moisture content was attained the suitable plots were sprayed based on application timings. At both application timings photos of the plot, plant, pods, and seeds (arranged from bottom to top of plant) were taken, along with photos of the seed samples after drying. Dry down ratings occurred 4, 8, 12, 16, 20, 24, 28 days after application (DAA) and at harvest along with photos being taken. Ratings consisted of the dry down of the crop and weed control on a 0 – 100 scale where 0 = no control, 100 = full control. To determine percent plant moisture, chaff from behind the combine was collected, weighed, dried and weighed again. The calculation to determine plant and seed moisture percentage was (wet weight – dry weight) / (wet weight)*100.

When the plots were ready to combine, the date, percent moisture per plot and seed moisture percentage content was recorded. Harvest occurred when dry down ratings approached 90% control. This resulted in two separate dates, Reglone Ion applied early was harvested September 13th, while the remaining treatments were harvested on October 7th. Yields were determined from cleaned harvested grain samples and corrected to the required moisture content. Thousand kernel weights (TKW) were also collected as an additional seed quality indicator. Weather data was collected from Environment Canada.

Growing Conditions:

The 2019 growing season started out extremely dry in April with only 6.1 mm of precipitation and continued into May with 12.7 mm. The average temperatures of April and May fell well within the long-term average of 4.2 ºC and 9.1ºC. The month of June also had normal temperatures (14.9 ºC) but precipitation increased by 28.6% (97.7mm) compared to the long-term average. July was a slightly colder month with a decline of 1.2 ºC lower than the long-term average with higher than normal precipitation of 107.8 mm compared to 69.4mm. August was far below the long-term rainfall average with 18 mm and cooler temperatures throughout the majority of the month with a few exceptionally warm days. September temperatures on average were normal, however, temperatures were higher at the beginning of the month and were substantially lower in the last 2 weeks. Precipitation in September was 37% higher compared to the long-term average. There was also a snow fall event that occurred on September 29th. October temperatures were cooler compared to the long-term average but received less precipitation. On average, there was 120.5 less growing degree days compared to the long-term average. The majority of these days fell between July and August, resulting in a very delayed crop maturity.

Table 2. Mean monthly temperature, precipitation, and growing degree day accumulated from April to October 2019 at Scott, SK.

Year	April	May	June	July	August	September	October	Average/ Total
----------Temperature (°C) ----------								
2019	4.2	9.1	14.9	16.1	14.4	11.3	0.9	10.1
Long-term[z]	3.8	10.8	14.8	17.3	16.3	11.2	3.8	11.1
----------Precipitation (mm)----------								
2019	6.1	12.7	97.7	107.8	18	41.8	6.6	290.7
Long-term[z]	24.4	38.9	69.7	69.4	48.7	26.5	17	294.6
----------Growing Degree Days----------								
2019	35.2	185.3	295.4	333.3	291.1	202.6	18	1360.9
Long-term[z]	44	170.6	294.5	380.7	350.3	192.3	49	1481.4

[z] Long-term average (1985 - 2014)

Results:

Dry Down Ratings

Application timings provided a large range of variability in herbicide desiccant efficacy and therefore can be used to evaluate the four herbicide desiccant options. Herbicides applied early had an extended dry down period compared to the optimal timing, in which 24 DAA was required for most herbicides to provide adequate dry down (Figure 1). Reglone Ion was an exception, in which the majority of plants were turned a dark brown (90% control) 8 DAA. Heat LQ and glyphosate applied early resulted in the second fastest dry down in which 80%, 87.5% and 90% control was reached 12, 16 and 20 DAA. Heat LQ applied alone was much slower as control was < 80% 16 DAA and only reached 90% control 30 DAA (just prior to harvest) (Figure 1). Glyphosate applied alone resulted in the slowest dry down when applied early as 90% control was not achieved prior to harvest (30 DAA) and ratings were similar to the unsprayed check.

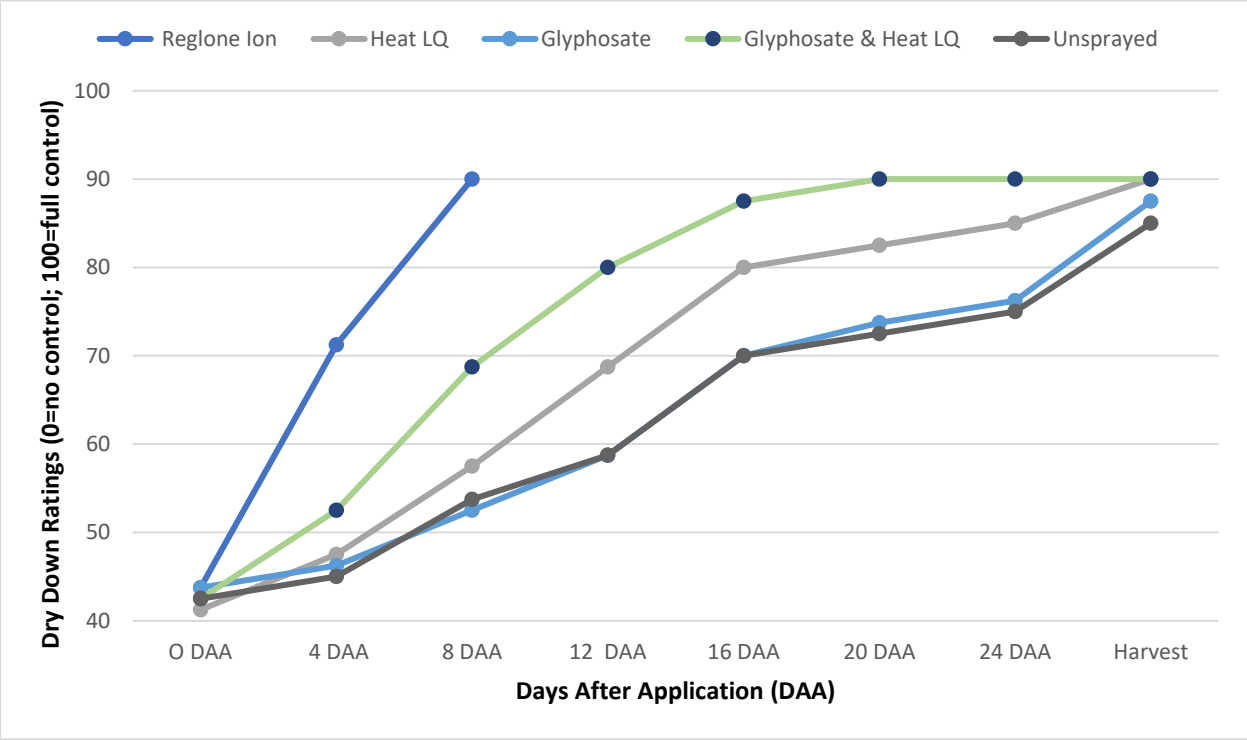

Figure 1. Early application timing comparisons between desiccation products using dry down ratings (0=no control; 100 = full control) from 0 – 24 days after application (DAA) and at harvest in lentils at Scott, SK in 2019.

Desiccants applied at the optimal time required a shorter period of time to reach 90% control (16 DAA vs. 24 DAA) compared to the early application timings (Figure 1; 2). Reglone Ion had a similar dry down period to the early application timing with 90% control reached between 8 to 12 DAA. Heat LQ and glyphosate and Heat LQ alone had very similar ratings with 85.5% and 85% control at 16 DAA and 90% control at harvest (19 DAA). Glyphosate applied at optimal timing resulted in slightly lower ratings than Heat LQ, but was marginally better than the unsprayed check (Figure 2).

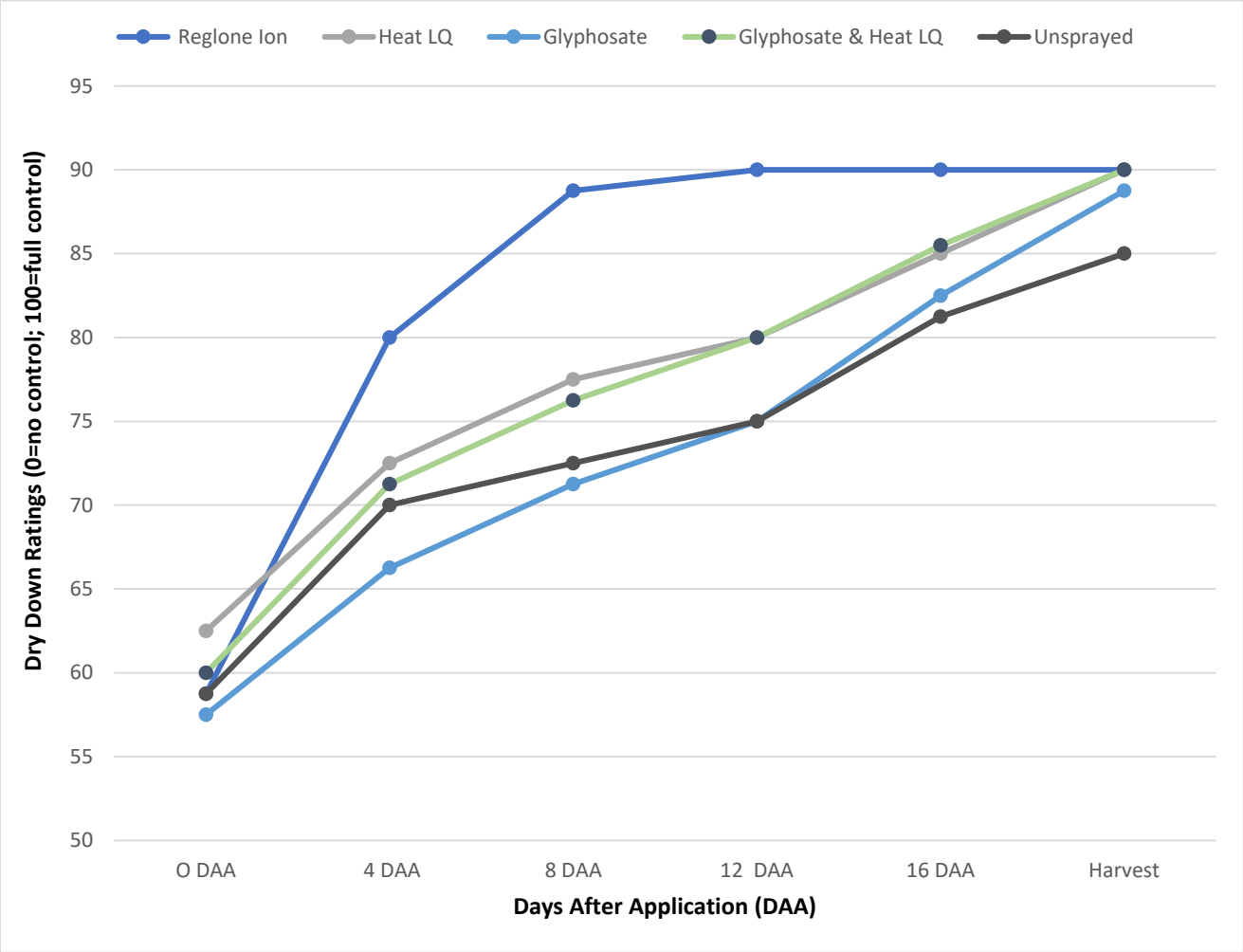

Figure 2. Optimal application timing comparisons between desiccation products using dry down ratings (0=no control; 100 = full control) from 0 – 16 days after application (DAA) and at harvest in lentils at Scott, SK in 2019.

Plant moisture percentage

Desiccation products had a significant effect on plant moisture percentage ($P<0.0001$). The two highest plant moisture percentages were when Reglone Ion and glyphosate were applied at the early stage (35.7% and 17.1% respectively). The lowest plant moisture was obtained from Heat LQ and glyphosate applied at the early stage (10.6%), followed by Reglone Ion at the optimized application timing (11.7%) (Figure 3). As expected, overall early application timings resulted in 19.2% plant moisture, followed by the check with 14.5% and lastly, late application timing resulted in the lowest plant moisture percentage with 12.5%. The low plant moisture recorded at the optimal application timing is likely attributed to the mature nature of the lentils that facilitated greater desiccant efficacy. Whereas, the early application timings were applied on less mature plants and thus were less efficacious (Figure 4).

Seed moisture percentage

The varying desiccation products had a significant effect on percent seed moisture ($P<0.0001$). Similar to plant moisture, Reglone Ion at the early application stage resulted in the highest seed moisture (17.3%) (Figure 3). In conjunction to plant moisture, Heat LQ and glyphosate at the early stage along with Reglone Ion at the optimized stage resulted in the lowest seed moisture percentage (7.7% and 7.9% respectively). These results relate to plant moisture percentages as the desiccation products affect the seed similarly to how they affect the plant. This is also shown when comparing overall treatment application timings, early timing resulted in the highest seed moisture percentage with 10.9%, followed by the check with 10.6% and lastly, the late application timing had the lowest seed moisture content of 8.9% (Figure 4).

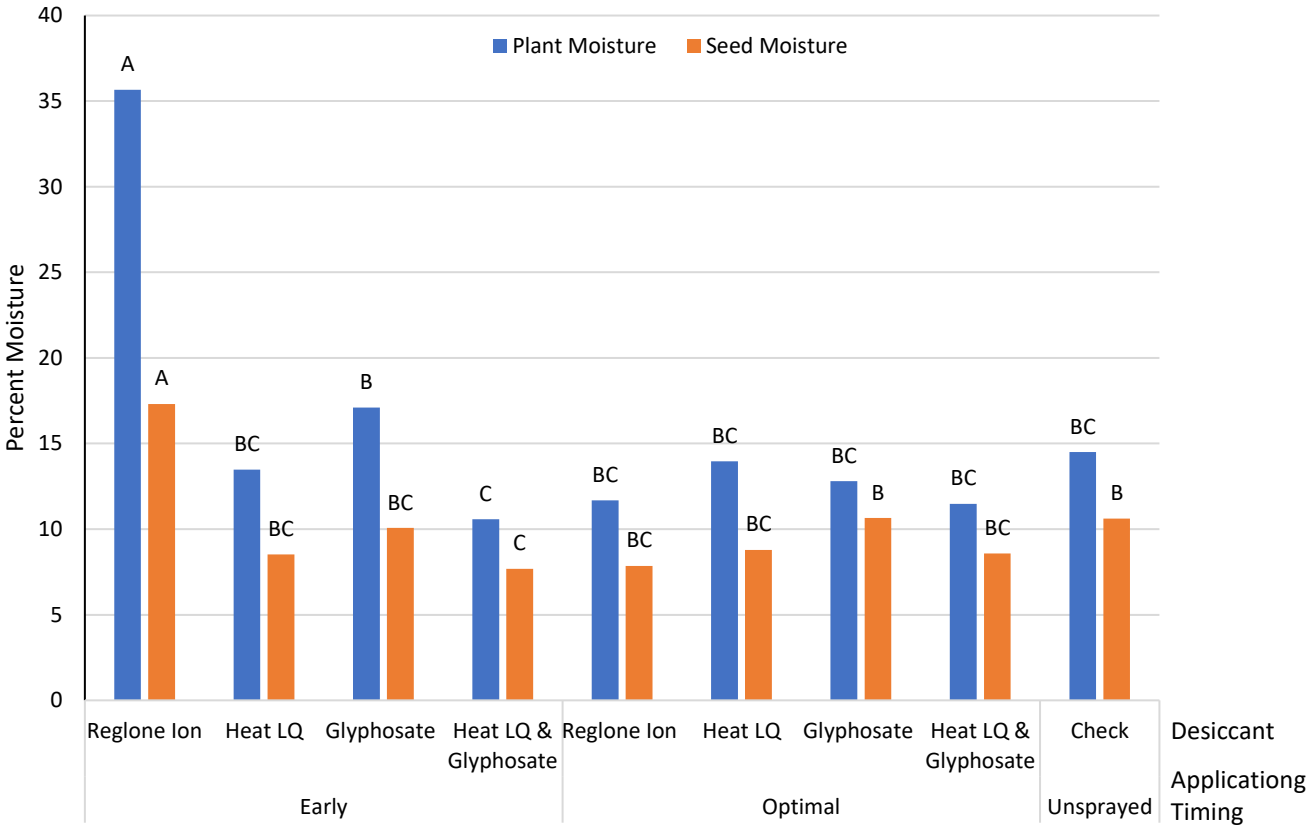

Figure 3. Plant and seed moisture percentages compared between the check and the desiccation products applied at the two specific application timings in lentils at Scott, SK in 2019.

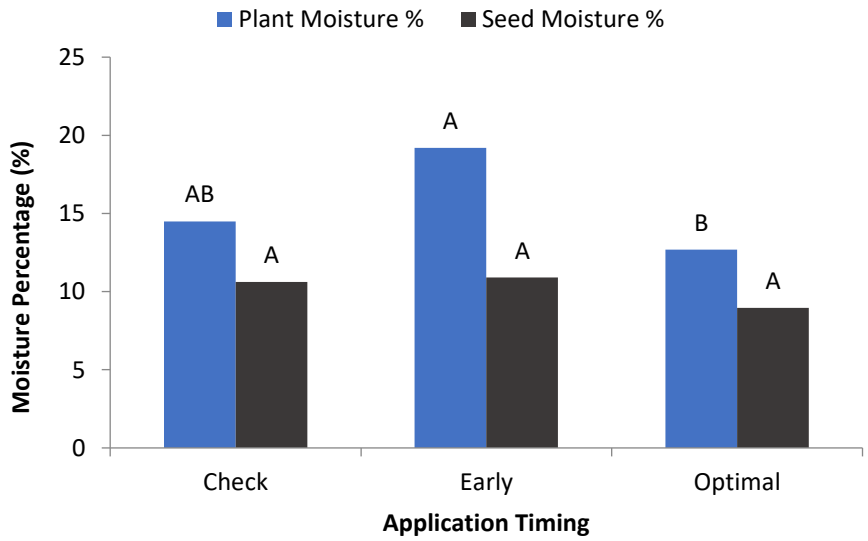

Figure 4. Plant and seed moisture percentages compared between the check, early and late application timings in lentils at Scott, SK in 2019.

Yield & Seed Weight

The effect of application timing and desiccation products had a significant effect on yield (P=0.0116) and seed weight (P=<0.0001). Desiccants applied at the optimal timing resulted in an 11% yield gain and a 4.8% increase in seed weight compared to the early application timings. Heat LQ and glyphosate at the optimal application timing resulted in the highest yield of 3896 kg/ha (58 bu/ac) and the second highest seed weight (Figure 5). Heat LQ applied alone and Reglone Ion resulted in second highest yields of 3866 kg/ha (57.6 bu/ac) and 3825 kg/ha (57 bu/ac) but had a 1.5% lower seed weight compared to Heat LQ and glyphosate. The unsprayed check had the median yield with 3748.94 kg/ ah (55.8 bu/ac) and highest seed weight of 47.9 g/1000s. The early application timing of glyphosate ≥ Heat LQ ≥ Heat LQ and glyphosate > Reglone Ion had the lowest yields (3679 kg/ha, 3470 kg/ha, 3270 kg/ha, and 3235 kg/ha, respectively) (Figure 5).

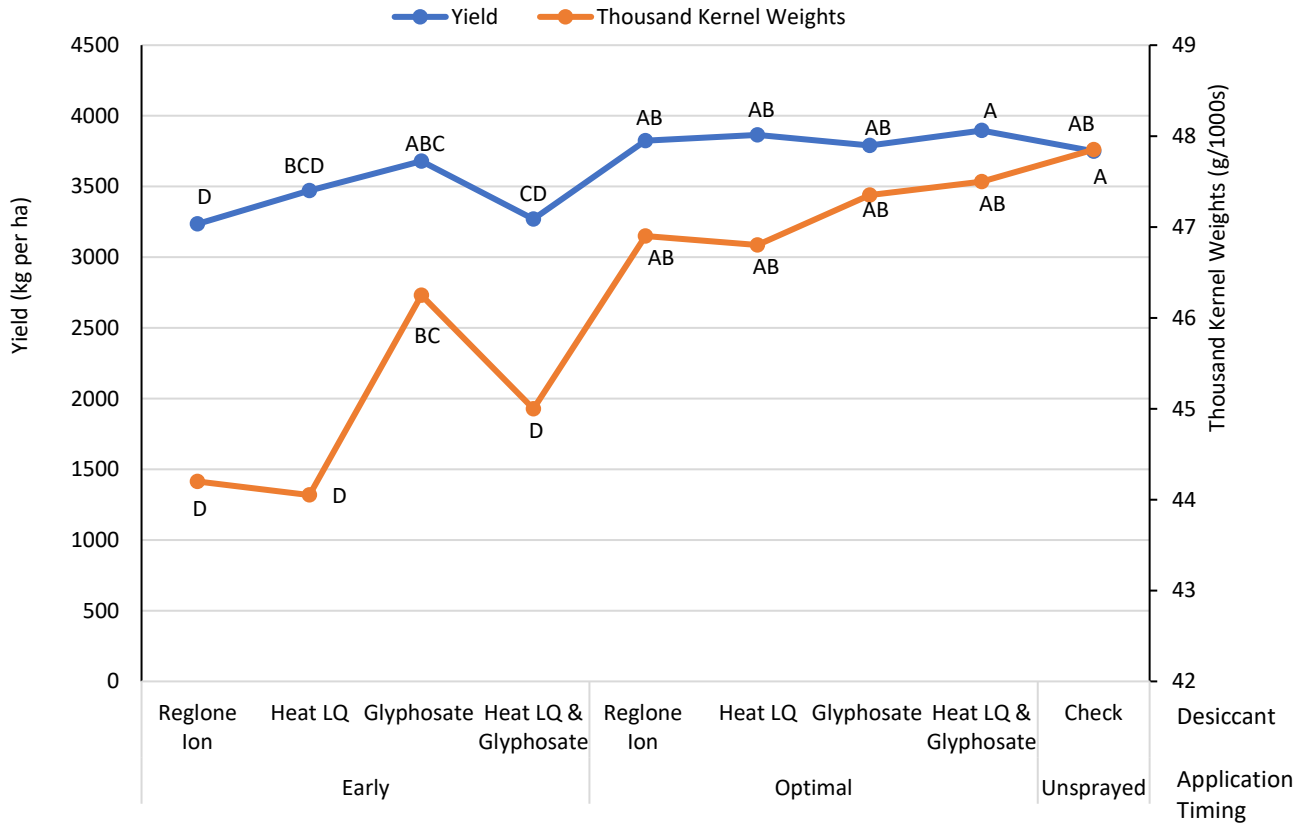

Figure 5. The effect of four desiccation products applied at two different application timings (early and late) compared to the unsprayed control on yield (kg/ha) and thousand kernel weight (g/1000s) at Scott SK, 2019. *Different letters indicate significant differences between treatments*.

Discussion:

The largest factor influencing lentil dry down, yield and seed weight was application timing. Early applications resulted in an 11% yield reduction and lower seed weight compared to the optimal application timing. In fact, the unsprayed check resulted in a 9% higher yield and a 6.1% heavier seed weight compared to the early application. This is likely attributed to the delayed harvest timing. In most years, the lentils are harvested at the end of August whereas harvest occurred in October. This allowed the unsprayed check to mature fully before freezing and therefore the weather acted as a natural desiccant. This is unlikely to occur in most growing seasons and it is not a recommended harvest management practice. The overall results indicated that desiccating early, regardless of herbicide selection, will result in both yield and seed weight reductions compared to the optimal application stage.

The most notable difference in efficacy occurred between the two application timings of Reglone Ion. Reglone Ion applied at the optimal timing resulted in the fastest dry down of 90% between 8 and 12 DAA. The quick dry down period is attributed to the chemical properties of this herbicide. Reglone Ion is a fast-acting contact herbicide that can cause rapid desiccation of leaf tissue particularly under hot, dry conditions (< 5 days). Under ideal conditions, Reglone Ion can therefore reduce wait periods to assist in an earlier harvest. However, unfavorable conditions persisted throughout the fall to result in delayed plant maturity and consequentially harvest. Harvest was further delayed by 7- 11 days after 90% control was achieved due to an early snow fall event. The dry plants were then susceptible to pod shatter and this is likely the cause for the slight yield reductions. Overall, Reglone Ion would serve as an excellent desiccant option when applied under favorable conditions and optimal timing.

However, when applied too early the beneficial nature of Reglone Ion can quickly become a severe disadvantage. Reglone Ion applied early had the highest plant and seed moisture, second lowest yield and lowest seed weight. When applied too early, the herbicide did not result in a true dry down but rather gave the appearance of a dried crop (Figure 6). Harvest was difficult due to the high plant moisture within the lentils and consequentially resulted in a yield loss as the seeds were difficult to remove from the pods (Figure 6).

Figure 6. Reglone Ion applied at the early application timing on small red lentils 4 DAA compared to the unsprayed check at Scott, 2019.

Applications of Heat LQ and glyphosate resulted in the second fastest dry down under early application timings as 90% control was reached 20 DAA compared to the standard 30 DAA. In comparison to previous years, lentil dry down occurred very slowly due to the cool, wet conditions that persisted throughout the fall. Although Heat LQ and glyphosate provided a faster dry down when applied early, both yield reductions and low seed weight occurred compared to the optimal application timing. This reduction in yield is likely attributed to pod shatter losses caused by the delayed harvest. Heat LQ applied alone was significantly slower then when Heat LQ and glyphosate were applied together at the early application timing. In contrast, there was very little difference in dry down time between the combination and single application of Heat LQ under optimal application timings. This could be attributed to the unfavorable environmental conditions restricting the translocation of glyphosate. Glyphosate is a systemic herbicide that requires translocation throughout the plant and thus requires plants to be actively metabolizing to be effective. Plant metabolism was likely slowed due to the unfavorable conditions and thus glyphosate did not provide additional dry down support when combined with Heat LQ.

The least effective desiccant under optimal application timings was glyphosate applied alone. Glyphosate was the slowest and least effective method in drying down lentils. The drying period was the

most prolonged under both early and optimal application timings and it also had the highest seed moisture. One contrasting trend to highlight is that the yield at the optimal timing was among the highest, however, this is likely because the plants were not as dried out and prone to shatter when it snowed. Therefore, there was less shatter loss associated with this treatment compared to the Reglone and Heat LQ applications.

Overall, environmental conditions played an important role in desiccant selection. Reglone Ion closely followed by Heat LQ with glyphosate at the optimal timing resulted in the fastest dry down. This would be very beneficial when time is a limiting factor. Under all conditions, glyphosate applied alone was the least effective desiccant.

Conclusion:

The timing of application, regardless of the desiccant used, was the most important factor for achieving a successful harvest. Desiccants applied at the optimal timing resulted in an 11% yield gain and 4.8% increase in seed weight compared to the early application timings. Applying desiccants early resulted in lower yields as the crop was not fully matured at application resulting in smaller, shriveled seeds. An additional benefit of applying desiccants at the proper time was the overall shortened dry down period. Reglone Ion and Heat LQ with glyphosate provided the fastest crop dry down and lowest plant moisture at harvest. These two traits improved overall harvestability of the lentil crop. However, as the plants were dry prior to the early snow fall event, these treatments were more prone to pod shatter and ultimately suffered a small yield loss. Glyphosate was the slowest and least effective method in drying down lentils. The drying period was the most prolonged under both early and optimal application timings and it also had the highest seed moisture. Under the early application timing, glyphosate dry down ratings were similar to the unsprayed check. This is likely attributed to the unfavorable environmental conditions that persisted after application. Overall, application timing and environmental conditions were the two most important factors in achieving a successful harvest. Desiccant selection also played an influential role in harvest timing as Reglone Ion and Heat LQ with glyphosate resulted in the fastest dry down. This shortened drying window would be very beneficial when time is a limiting factor.

Appendices

Appendix A

Table A1. Agronomic and treatment application information during the growing season at Scott, 2019.

	Product	Rate	Date
Fertilizer	0-75-33-0	77 lb/ac	May 20
Variety	Impulse	130 seeds/m^2	May 20
Pre-Plant Herbicide	Glyphosate 540 AIM EC	1 L/ac 35 mL/ac	May 19
In-Crop Herbicide	Ares Merge Centurion	244 mL/ac 0.5 L/100L 150 mL/ac	June 18 June 26
Fungicide	Priaxor	180 ml/ac	July 15
Desiccation	*As per protocol*		