CONTROL OF YELLOW NUTSEDGE WITH EFFECTIVE CROP ROTATIONS

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Introduction

Fewer herbicides are registered for weed management in specialty crops than in agronomic crops. Consequently, growers often take advantage of the wider array of herbicides available for use in agronomic crops grown in rotation to manage weed species that are difficult to control in vegetable crops. Yellow nutsedge (*Cyperus esculentus*) has become a major weed problem in many agricultural fields in the Treasure Valley of eastern Oregon and southwestern Idaho. The severity and negative effects of yellow nutsedge are especially noticeable when fields are direct seeded onions. Surveys have indicated an average 42% loss of onion yield in fields heavily infested with yellow nutsedge.

Control of yellow nutsedge presents a challenge because of its ability to reproduce by rhizomes and tubers that are able to survive in the soil for 3 to 4 years. Farming activities, particularly tillage and irrigation, play a significant role in yellow nutsedge distribution in infested fields. Therefore, successful control of yellow nutsedge in the Treasure Valley will require integrated approaches, including effective crop rotations and use of herbicides with proven efficacy in every crop grown in a rotation. The objective of this study was to evaluate the effects of various herbicide programs used in the crop rotation preceding onion.

Materials and Methods

The study was initiated in 2015 in a field infested with yellow nutsedge near the Malheur Experiment Station, Ontario, Oregon (43.9924 N, -117.0076 W). The study was a randomized complete block design with four replications. Plot size was 15 ft (8 beds wide) by 45 ft in length. The crops and herbicide programs from 2015 to 2019 are presented in Table 1. Each year the crop was planted on 22-inch beds. The herbicide program used in each year was designed to avoid carryover in the soil to injure the terminal crop.

Soil sampling to quantify initial yellow nutsedge tuber density was conducted during spring 2015 after beds were formed and the study laid out. The process was repeated at the end of 2017 (after dry bean harvest) and prior to seeding onions during spring 2019 in order to quantify changes in yellow nutsedge tuber density in response to herbicide treatments. The process involved randomly drawing five soil cores measuring 4.25 inches in diameter and 12 inches deep from each plot. The composite soil sample from each plot was processed to recover yellow nutsedge tubers using a washing and sieving method. Tubers from each plot were placed in a resealable plastic bag (zip lock plastic bags) and stored in the dark at 40°F until they were counted and weighed.

The study area was moldboard plowed each year and groundhogged twice before forming beds to facilitate furrow irrigation. Fertilizer was applied to provide nutrients as determined by soil tests after each crop cycle. The study was planted to Dekalb Roundup Ready® (RR) corn hybrid

'DK-51-39' with seeds spaced 7 inches within the row in 2015 and 2016. Rotational crops in 2017 and 2018 were dry beans (seeded at 80 lb/acre) and winter wheat (seeded at 100 lb/acre), respectively.

All herbicide treatments (except Outlook® in 2019) were applied using a CO_2 pressurized backpack sprayer fitted with a boom equipped with 8002EVS TeeJet nozzles calibrated to deliver 20 gal/acre. The study was furrow irrigated (2015–2018) as needed on a calendar schedule to maintain moisture in the top 12 inches of the soil profile. Drip irrigation was used in 2019 during the onion cycle.

Production practices, including spraying for insects and diseases, followed recommended local production practices for each crop. Weeds were controlled in wheat using Brox®-M at 2 pt/acre (bromoxynil 0.5 lb ai/acre + 2-methyl-chlorophenoxyacetic acid at 0.5 lb ai/acre) across the entire study area in 2018.

In 2018, wheat stubble was flailed immediately after harvest and the field was irrigated. The study area was disked twice, plowed, and groundhogged. The field was fumigated using K-Pam® at 15 gal/acre and beds were formed at 22-inch spacing on November 1, 2018. The beds were harrowed down and the onion variety 'Vaquero' was planted on April 5, 2019. Lorsban® 15G insecticide was applied at 3.7 oz/1000 ft of row (chlorpyrifos 0.101 lb ai/acre) on April 11, 2019.

The study area was treated with Prowl® H_2O at 2.0 pt/acre (pendimethalin 0.95 lb ai/acre) late pre-emergence on April 17, 2019. Post-emergence applications of Brox® 2EC at 12 fl oz/acre (bromoxynil 0.188 lb ai/acre) plus GoalTender® at 4 fl oz/acre (oxyfluorfen 0.125 lb/ai acre) were made when onion seedlings were at the 2- and 4-leaf stages (May 23 and June 19, 2019). Post-emergence application on June 19 included Poast® at 1.5 pt/acre (sethoxydim 0.28 lb ai/acre) plus a crop oil concentrate at 2 pt/acre to control grassy weeds. Outlook (dimethenamid-P) at 7 fl oz/acre was chemigated through drip irrigation diluted in enough solution to last 12 hours on June 6, 13, and 20, 2019. In-season fertilizer was applied according to the soil and tissue test results. Preventative sprays for diseases and insects were applied aerially by a commercial contractor using various insecticides including Movento® (spirotetramat), Radiant® (spinetoram), and Lannate® (methomyl).

Late-season evaluations for visible onion plant injury and yellow nutsedge control were done on September 5, 2019. Assessments for visible onion plant injury and yellow nutsedge control were based on a scale of 0% (no onion injury or no yellow nutsedge control) to 100% (complete onion plant kill or total yellow nutsedge control).

Plant tops were flailed on September 10 and onion bulbs lifted on September 11, 2019 and left in the field to cure. Bulbs were handpicked from the middle 15 ft of the two center beds on September 20, 2019. Bulbs were graded for yield and quality based on USDA standards as follows: bulbs without blemishes (U.S. No. 1), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The U.S. No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of U.S. No.1 bulbs greater than 2¼ inches in diameter.

Data were subjected to analysis of variance and the treatment means were compared using protected LSD at the 0.05% level of confidence.

Results and Discussion

The number of yellow nutsedge tubers in response to different herbicide programs used in rotational crops from 2015 to 2019 are presented in Figure 1. At the end of the two-year corn cycle (2015 and 2016) and dry beans (2017), yellow nutsedge tubers had been reduced 75 to 93% across herbicide treatments compared to 50% in the untreated control. The greatest tuber reduction was observed for herbicide programs that included Dual II Magnum (pre-plant incorporated) during the corn cycle. Reduction of tubers in the untreated control was a direct result of planting full-canopy crops (corn in 2015 and 2016, dry bean in 2017, and wheat in 2018). Even though the reduction was not as high as that provided by the herbicide treatments, it is consistent with the fact that yellow nutsedge does not tolerate shading.

Estimated visible yellow nutsedge control in onion during 2019 (Figure 2) closely resembles the results for the number of tubers in the soil (Figure 1). Control ranged from 83% for the less intensive herbicide program to more than 90% for the most aggressive programs (Figure 2). These results further demonstrated that yellow nutsedge was best controlled by use of intensive, carefully planned herbicide programs that included crops with full canopies and use of soil-applied herbicides in the years preceding onion.

The number of harvested onion bulbs in each treatment is presented in Figure 3. The bulb number ranged from 73,458 to 92,070 per acre across different herbicide programs compared to 72,270/acre for the untreated control (Treatment 1). The highest number of harvested bulbs (92,070/acre) was obtained in treatment 3, the herbicide rotation program that received Yukon® at 8 fl oz/acre in 2015 and 2016 (during the corn cycle) followed by Eptam® at 4 pt/acre + Sonalan® at 2 pt/acre + Outlook at 14 fl oz/acre on dry beans in 2017. This treatment also had the highest reduction in yellow nutsedge tubers (98%) at the end of 2017 (Figure 1).

Marketable onion yield in 2019 is presented in Figure 4. The yield reflected the number of harvested bulbs and the level of yellow nutsedge control in crops grown in rotation preceding onion. Marketable yield ranged from 605.1 to 785.2 cwt/acre across herbicide programs compared to 577.6 cwt/acre for the untreated control. The marketable yield for the less aggressive herbicide program (Treatment 2 in Table 1) was 605.1 cwt/acre and similar to the untreated control.

The results from this study indicate that the best yellow nutsedge reduction can be obtained with strategically designed rotational programs involving corn, dry bean, and wheat prior to seeding onion. In heavily infested fields, growing corn for two consecutive years followed by another crop prior to planting onion provides the best yellow nutsedge tuber reduction. However, planting corn and not using soil-active herbicides (e.g., Dual Magnum or Outlook) with proven effectiveness would provide only minimal control of yellow nutsedge.

Acknowledgements

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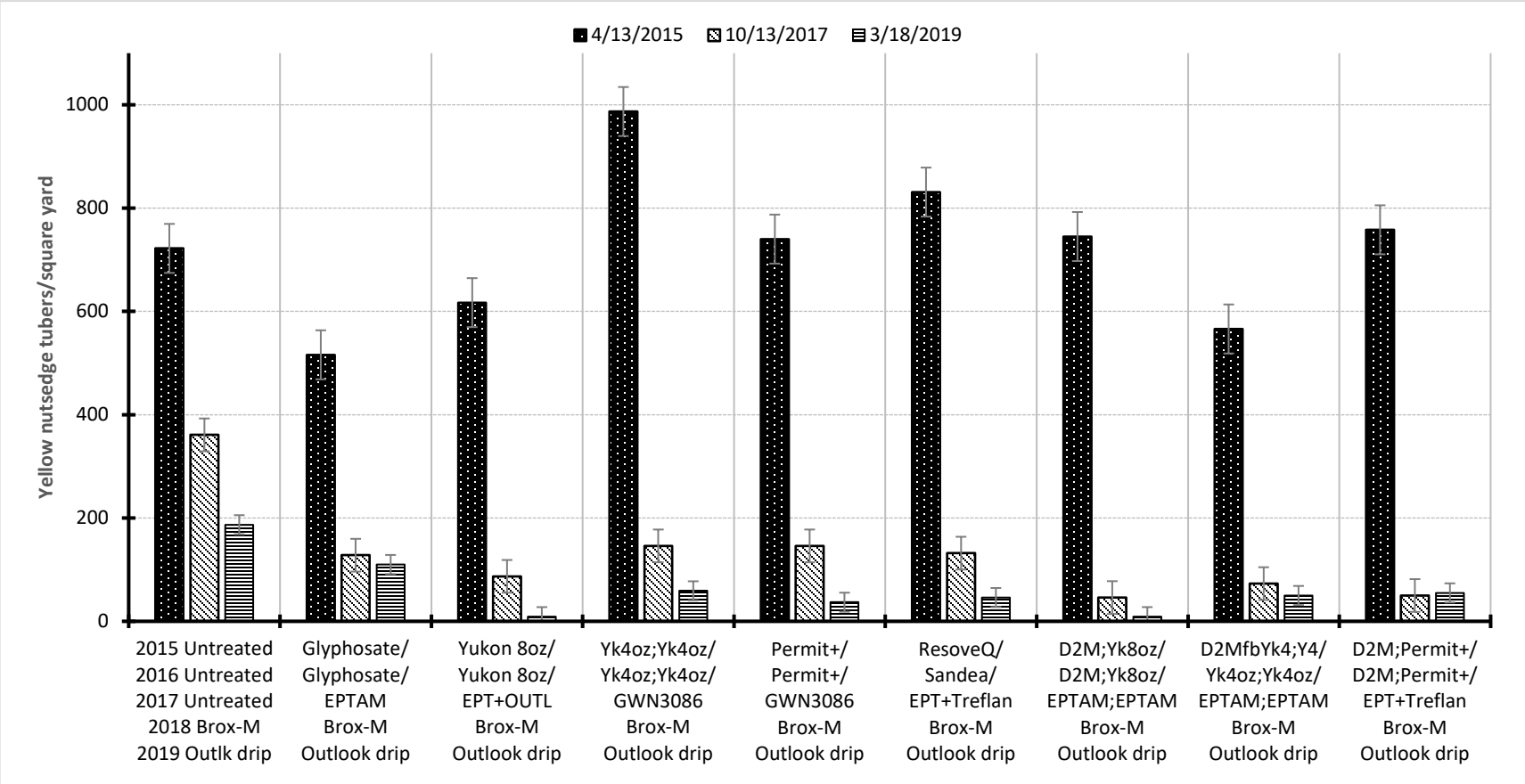
Table 1. Herbicide treatments used in various crops grown in rotation from 2015 through 2018 and in onion in 2019 at the Malheur Experiment Station, Ontario, OR.

Trt	Year	Crop	Treatment[a]
1	2015	Corn	Untreated
	2016	Corn	Untreated
	2017	Bean	Untreated
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 fl oz/a (applied through drip irrigation at 7-day intervals)
2	2015	Corn	Roundup PowerMax 32 fl oz/a + AMS + NIS
	2016	Corn	Roundup PowerMax 32 fl oz/a + AMS + NIS
	2017	Bean	Eptam 4 pt/a + Sonalan 2 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 floz/a (applied through drip irrigation at 7-day intervals)
3	2015	Corn	Yukon 8 oz/a + Roundup PowerMax 32 fl oz/a + AMS + NIS
	2016	Corn	Yukon 8 oz/a + Roundup PowerMax 32 fl oz/a + AMS + NIS
	2017	Bean	Eptam 4 pt/a + Sonalan 2 pt/a + Outlook 14 fl oz/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 fl oz/a (applied through drip irrigation at 7-day intervals)
4	2015	Corn	Yukon 4 oz/a + Roundup PowerMax + AMS + NIS fb Yukon 4 oz/a + Roundup PowerMax + AMS + NIS
	2016	Corn	Yukon 4 oz/a + Roundup PowerMax + AMS + NIS fb Yukon 4 oz/a + Roundup PowerMax + AMS + NIS
	2017	Bean	GWN-3086 4 pt/a + Sonalan 2 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 floz/a (applied through drip at 7 day intervals)
5	2015	Corn	Permit Plus 0.75 oz/a + Roundup PowerMax 32 fl oz/a + AMS + NIS
	2016	Corn	Permit Plus 0.75 oz/a + Roundup PowerMax 32 fl oz/a + AMS + NIS
	2017	Bean	GWN-3086 4 pt/a + Sonalan 2 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 floz/a (applied through drip irrigation at 7 day intervals)
6	2015	Corn	Resolve Q 1.25 oz/a + Roundup PowerMax 32 fl oz/a + AMS + NIS
	2016	Corn	Sandea 1.33 oz/a + Roundup PowerMax 32 fl oz/a + AMS + NIS
	2017	Bean	Eptam 4 pt/a + Treflan 0.75 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 fl oz/a (applied through drip at 7-day intervals)
7	2015	Corn	Dual II Magnum 1.33 pt/a + Yukon 8 oz/a + Roundup PowerMax + AMS + NIS
	2016	Corn	Dual II Magnum 1.33 pt/a + Yukon 8 oz/a + Roundup PowerMax + AMS + NIS
	2017	Bean	Eptam 4 pt/a + Sonalan 2 pt/a fb Eptam 4 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 fl oz/a (applied through drip irrigation at 7-day intervals)
8	2015	Corn	Dual II Magnum 1.33 pt/a + Yukon 4 oz/a + Roundup PMax + AMS+NIS fb Yukon 4 oz/a+Roundup PMax+ AMS+NIS
	2016	Corn	Yukon 4 oz/a + Roundup PowerMax + AMS + NIS fb Yukon 4 oz/a + Roundup PowerMax + AMS + NIS
	2017	Bean	GWN-3086 4 pt/a + Sonalan 2 pt/a fb GWN-3086 4 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 fl oz/a (applied through drip irrigation at 7-day intervals)
9	2015	Corn	Dual II Magnum 1.35 pt/a + Permit Plus 0.75 oz/a + Permit Plus 0.75 oz/a + Roundup PowerMax + AMS + NIS
	2016	Corn	Dual II Magnum 1.35 pt/a + Permit Plus 0.75 oz/a + Permit Plus 0.75 oz/a + Roundup PowerMax + AMS + NIS
	2017	Bean	GWN-3086 4 pt/a + Treflan 0.75 pt/a
	2018	Wheat	Brox-M 2 pt/a
	2019	Onion	Outlook 7 fb 7 fb 7 fl oz/a (applied through drip irrigation at 7-day intervals)

Abbreviations: AMS = ammonium sulfate at 2.5% v/v; NIS = non-ionic surfactant at 0.5% v/v; fb = followed by; a = acre.
[a]Herbicides used; Roundup PowerMax 32 fl oz/a = glyphosate 1.13 lb ae/a; Brox-M 2 pt/a = bromoxynil 0.5 lb ai/a + 2-methyl-chlorophenoxyacetic acid 0.5 lb ai/a; Yukon 8 fl oz/a = halosulfuron 0.0626 lb ai/a + dicamba 0.275 lb ai/a; Sandea 1.33 oz/a = halosulfuron 0.0623 lb ai/a; Sonalan 2 pt/a = ethalfluralin 0.75 lb ai/a; Treflan 0.75 pt/a = trifluralin 0.375 lb ai/a; Resolve Q 1.25 oz/a = rimsulfuron 0.0144 lb ai/a + thifensulfuron-methyl 0.00313 lb ai/a; Dual II Magnum 1.35 pt/a = S-metolachlor 1.29 lb ai/a; Outlook 7 fl oz/a = dimethenamid-P 0.328 lb ai/a; Permit Plus 0.75 oz/a = halosulfuron 0.0347 lb ai/a; Eptam 4 pt/a = EPTC 3.5 lb ai/a.

Figure 1. Yellow nutsedge (*Cyperus esculentus*) tuber density in response to herbicides* used in various crops grown in rotation from 2015 to 2018 prior to planting onion in 2019 at the Malheur Experiment Station, Ontario, OR.



*Abbreviations: EPT = Eptam, OUTL = Outlook; Yk4oz = Yukon 4 fl oz/a; Yk8oz = Yukon 8 fl oz/acre; D2M = Dual II Magnum. Herbicide treatment details are presented in Table 1.

Figure 2. Estimated visible yellow nutsedge (*Cyperus esculentus*) control at the end of the corn rotation cycle (2016) and during the onion cycle in 2019 at the Malheur Experiment Station, Ontario, OR.

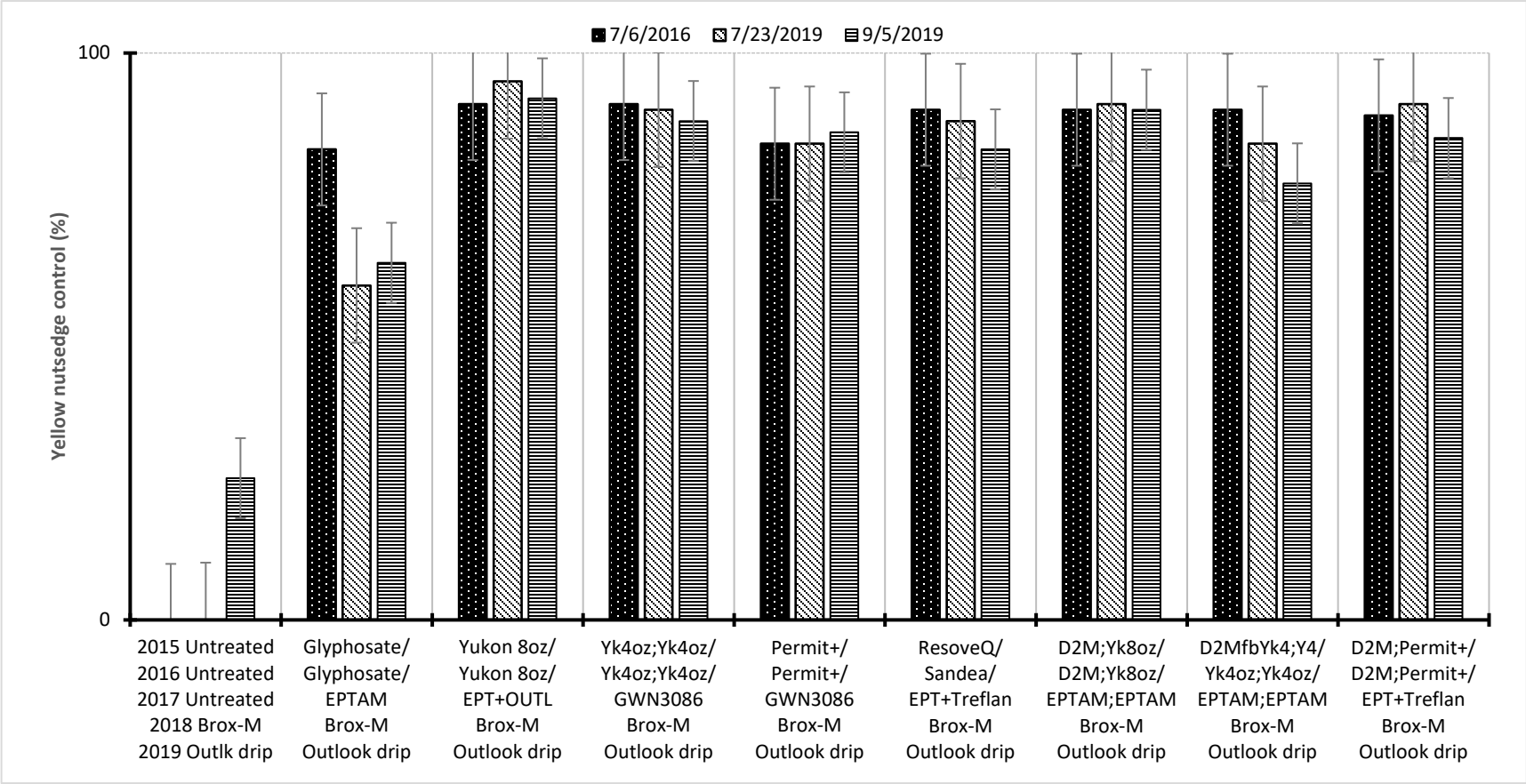


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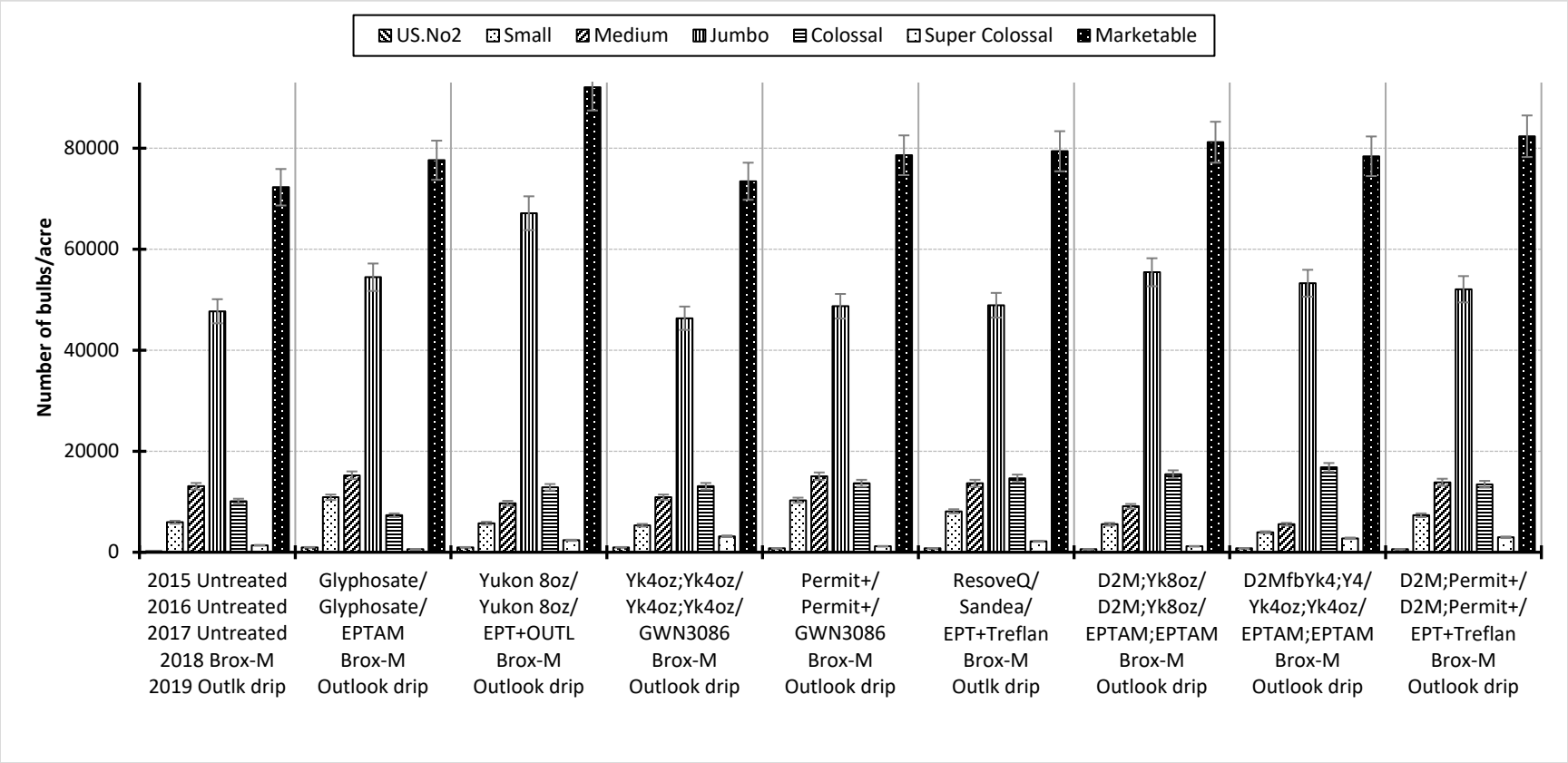
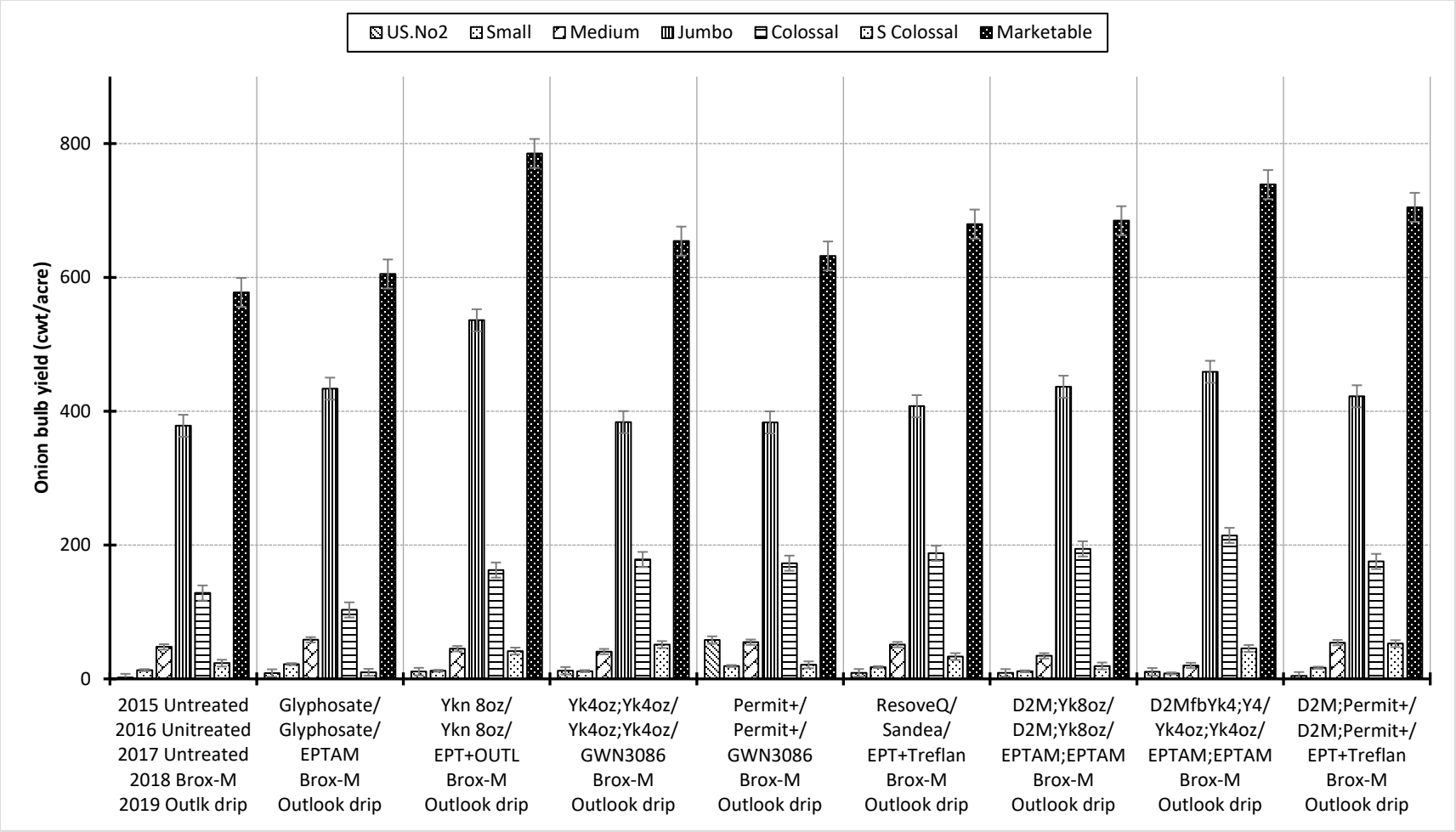
Figure 3. Number of harvested bulbs by grade (marketable yield is comprised of medium + jumbo + colossal + super colossal grades) in response to yellow nutsedge control with herbicides used in crops grown in rotation (2015–2018) preceding onion at the Malheur Experiment Station, Ontario, OR, 2019.



*Abbreviations: EPT = Eptam, OUTL = Outlook; Yk4oz = Yukon 4 fl oz/a; Yk8oz = Yukon 8 fl oz/acre; D2M = Dual II Magnum. Herbicide treatments details are presented in Table 1.

Figure 4. Onion yield by grade (marketable yield is comprised of medium + jumbo + colossal + super colossal) in response to yellow nutsedge control with herbicides used in crops grown in rotation (2015–2018) preceding onion at the Malheur Experiment Station, Ontario, OR, 2019.



*Abbreviations: EPT = Eptam, OUTL = Outlook; Yk4oz = Yukon 4 fl oz/a; Yk8oz = Yukon 8 fl oz/acre; D2M = Dual II Magnum. Herbicide treatment details are presented in Table 1.