2019 Spring Research Update

Intermountain Research and Extension Center

University of California
Agriculture and Natural Resources

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It's hard to believe spring is around the corner with the snow and freezing temperatures we experienced lately in Tulelake. IREC staff received positive feedback from the research update we sent last February, so the staff and I decided to do it again this year. Similar to last year, this newsletter is an attempt to compile research summaries and information on hot topics and get the information out before the rapidly approaching field season. I know everyone is tired of meetings, so this format will hopefully allow you to digest the information at your leisure. Please contact the office with questions or if you need additional information.

2018 was major headache as far as water and crop prices are concerned, but we did have some bright spots at IREC. We finished construction of our new multi-purpose conference and laboratory building in June and held a grand-opening in July at the IREC field day. This new building fills a vital need at IREC by providing meeting and laboratory space for researchers, 4-H, youth groups, and agricultural organizations. We held some events over the winter and I encourage everyone to consider the venue for their next business meeting, job fair, training, or community event. Information on reserving the meeting rooms can be obtained by calling Laurie Askew, IREC Office Manager, at 530-667-5117.

Other happening at IREC included the retirement of our long-time mechanic, Greg McCulley, in July and the hiring of his replacement, Skyler Peterson, in October. Congratulate Skyler on his new position and new baby boy! Also, welcome our new Siskiyou County office assistant, Myra Chavoya-Perez hired in February. Finally, we hired a new agronomy advisor in Siskiyou County to replace the legend, Steve Orloff. Giuliano Galdi started in January and is quickly getting up to speed and planning for the upcoming field season. Giuliano is originally from Brazil, got his master's degree from CSU Fresno, and recently worked for Dan Putnam, UC Davis, conducting alfalfa research related to salinity.

Sincerely,

Rob Wilson

IREC Director/Farm Advisor

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Alfalfa Pest Management Updates

University of California
Agriculture and Natural Resources
Research and Extension Center System

By Rob Wilson, IREC Director/ Farm Advisor

In 2018, alfalfa pest management studies were conducted at IREC focusing on management of alfalfa weevil and clover root curculio. Most of these studies were part of a larger statewide effort lead by Rachael Long and Dan Putnam. Rachael did a great job summarizing the results at the Western Alfalfa Conference held in Reno, NV in December. In the case you missed it, below are extracts pulled from her paper. For the complete report, visit the UC alfalfa workgroup webpage, click on the 2018 alfalfa symposium link, and download the paper titled managing weevils in alfalfa hay https://alfalfa.ucdavis.edu/+symposium/2018/index.aspx .

Other interesting papers presented at the symposium included a talk from Ian Grettenberger, UC Davis Entomologist, titled "**Importance of IPM Practices for Pesticide Resistance Management**" and a talk from Tom Getts, Lassen UCCE Farm Advisor, titled "**Tools of the Trade: Approaches for Weed Management in Established Alfalfa**". Ian's paper does a great job summarizing methods of avoiding insecticide resistance when managing alfalfa pests. This is especially important in our region as several alfalfa fields in Scott Valley have weevil populations resistant to pyrethroid insecticides. Alfalfa growers that treat for weevil most years must start practicing resistance management with insecticides in order to avoid resistance to your current favorite insecticide! Tom's paper summarizes weed control methods for established alfalfa including the newly registered herbicide, Sharpen. If you have difficulty controlling winter broadleaf weeds, make sure to read this article.

ALFALFA WEEVIL MANAGEMENT

Lifecycle and damage. The alfalfa weevil has one to two generations per year, a major one during winter or early spring, depending on field location, and a potential smaller second one, in late spring or early summer (Fig. 1). Most adults leave the field during the summertime and aestivate (go dormant) in protected areas (such as behind tree bark), though some stay in the field. During winter, adults migrate back into fields and lay eggs in old alfalfa stems. When eggs hatch, the larvae feed on the developing foliage, producing holes in the leaves and tattered foliage, which results in significant yield and quality losses to the first and sometimes even the second hay cutting. Stubble fields that are beginning to break dormancy are most at risk to injury by weevils. These should be monitored to ensure that weevils are not suppressing stand growth. Once the alfalfa is growing, it is more resilient to weevil damage. Healthy, actively growing alfalfa stands damaged by weevils can recover once weevil infestations are controlled.

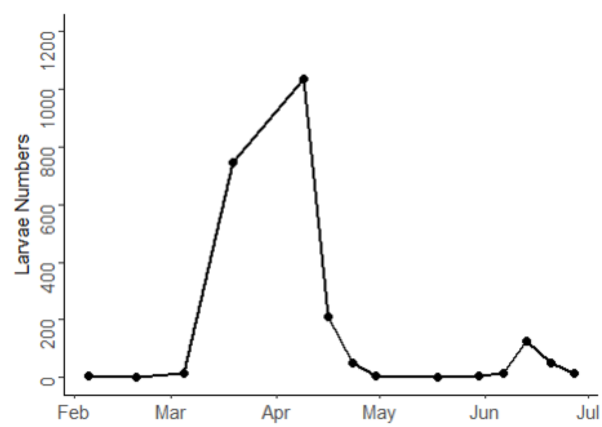

Figure 1. Alfalfa weevil larval counts from the Sacramento Valley, 2018.

Monitoring and Control

Biocontrol. Alfalfa weevils have natural enemies, but they are not effective enough to provide good control early in the season when most needed. The parasitoid wasp, *Bathyplectes curculionis* can provide up to 30% parasitism of larvae late season, but is frequently encapsulated and killed by the Egyptian strain. The parasitoid *Oomyzus incertus* is very effective, with up to 50% parasitism of the weevil larvae late season (Fig. 2), which, together with *B. curculionis,* likely explains the smaller second generation, as appears to be under good biocontrol. The fungus *Zoophthora phytonomi* can infect and kill larvae, providing up to 30% weevil suppression (Fig. 3), but is dependent on environmental conditions with high humidity or rainfall favoring infection (in dry years there is little infection).

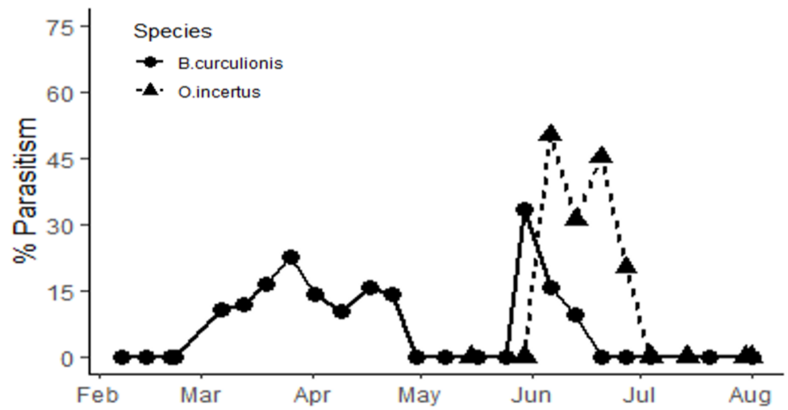

Figure 2. Percent parasitism of alfalfa weevil by the parasitoid wasps, *B. curculionis* and *O. incertus* in the Sacramento Valley, 2018.

Cultural practices. Cultural options for alfalfa weevil control are limited. Early harvest can avoid some damage, but this practice reduces yields and puts the stand at risk with surviving weevils feeding on stubble plants under windrows, potentially causing stand losses. 'Sheeping-off', or bringing in sheep to graze alfalfa during the wintertime, helps reduce weevil pressure when the sheep feed on the old stems and devour the weevil eggs, but is not always effective at completely controlling weevils. Overseeding fields with other forages not preferred by weevils (such as berseem clover or oats) does not prevent alfalfa damage, but fills in and makes up for a loss in production by the weevils. However, mixed hay changes the forage quality and marketability of the hay (Canevari et al. 2000; Leinfelder-Miles 2016).

Pesticides. Insecticides are the primary tool for controlling alfalfa weevils. Conventional insecticides include organophosphates (primarily chlorpyrifos, e.g. Lorsban), pyrethroids (e.g. Warrior), and an oxadiazine (e.g. Steward). Entrust (spinosad) is registered for organic production and only suppresses weevils (about 70% control; Long and Getts 2018). To find additional tools for weevil control, insecticide trials were conducted at UC Davis and Tulelake in 2018, using materials shown in Table 1, and in Riverside County in

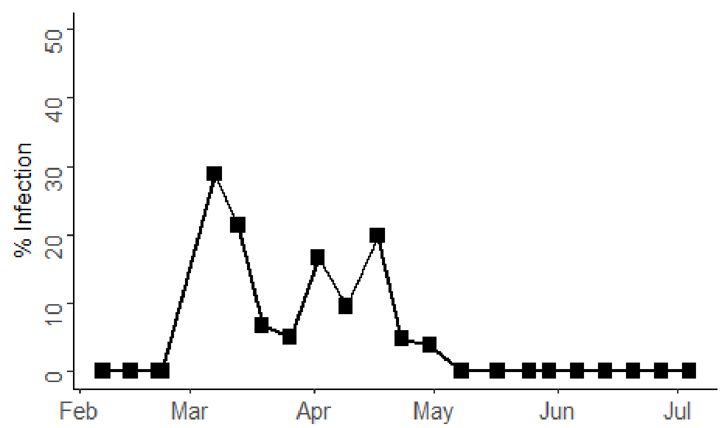

Figure 3. Percent infected weevil larvae by the fungus, *Zoophtora phytonomi,* in the Sacramento Valley, 2018.

the low desert. Figures 4 and 5 show the results of these trials, comparing registered and unregistered insecticides (noted by an asterisk, "*") for percent weevil control.

Table 1. Insecticides tested for alfalfa weevil control in alfalfa at UC Davis and Tulelake, CA, 2018. Experimental insecticides (not registered for use in alfalfa), are noted by an asterisk "*". A spreader sticker was included with all treatments.

Insecticide	**Chemical name**	**Rate/Ac**
Warrior II	lambda-cyhalothrin	1.92 fl oz
Lorsban Advanced	chlorpyrifos	32 fl oz
Cobalt Advanced	lambda-cyhalothrin+chlorpyrifos	38 fl oz
Steward EC	indoxacarb	11.3 fl oz
Steward EC+Warrior II	indoxacarb+lambda-cyhalothrin	8 fl oz+1 fl oz
Entrust SC	spinosad	4 fl oz
Exirel*	cyantraniprole	20 oz/ac
Torac 15EC*	tolfenpyrad	21 fl oz
Rimon 0.83EC* (IGR)	novaluron	12 fl oz
DoubleTake*	diflubenzuron (IGR)+lambda-cyhalothrin	4 fl oz
Knack (IGR)*	pyriproxyfen	10 fl oz

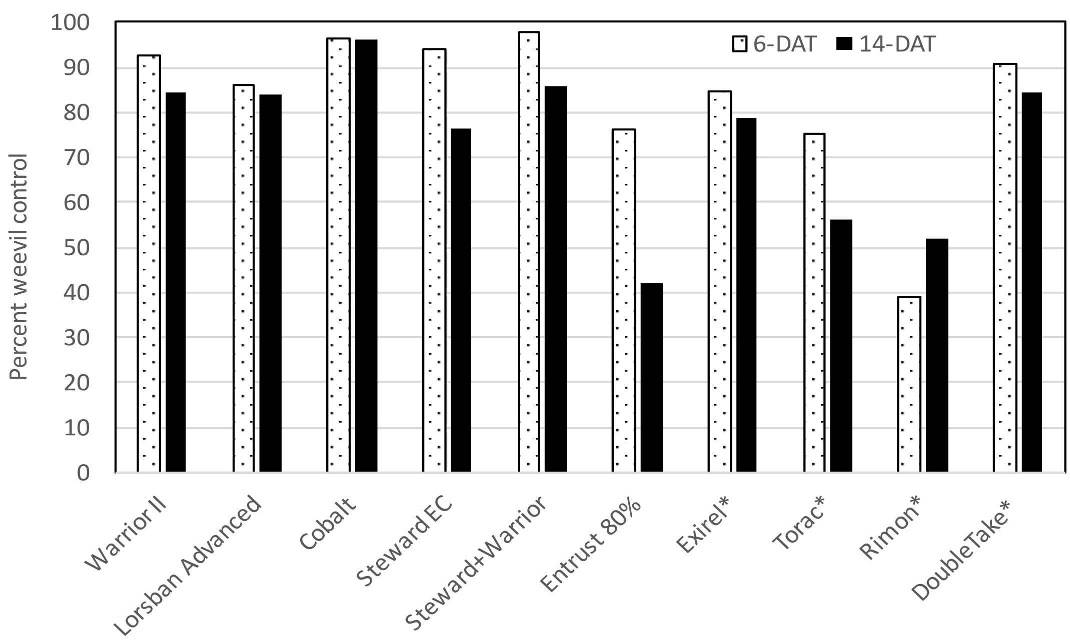

Figure 4. Alfalfa weevil insecticide trial, UC Davis, 2018. An asterisk (*) after an insecticide = NOT registered in alfalfa (experimental). Results are percent weevil control compared to an untreated check, 6 and 14 days after treatment (DAT).

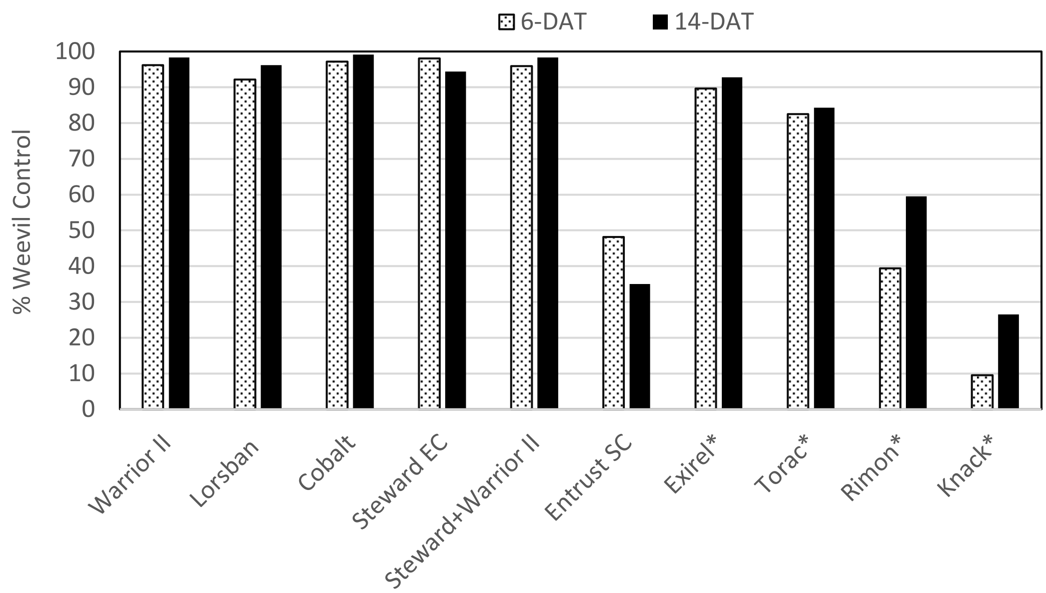

Figure 5. Alfalfa weevil insecticide trial, Tulelake, 2018. An asterisk (*) after an insecticide = NOT registered in alfalfa (experimental). Results are percent weevil control 6 and 14 days after treatment (DAT). Untreated plots for both DAT were about 45 weevils per sweep.

CLOVER ROOT CURCULIO MANAGEMENT

Lifecycle and damage. The clover root curculio has one generation per year (Fig. 7). They overwinter in fields in the egg and adult stages. In the Klamath Basin, adults begin to emerge mid-spring, when temperatures begin to warm (highs around 50^{o}F) and lay eggs at the base of alfalfa crowns, in the soil or duff. When eggs hatch, the larvae feed on the roots during the growing season, mostly in the top 8-inches of the soil, causing significant damage via reduced plant growth and stand losses. Feeding damage also creates entry wounds for secondary pathogens, including *Fusarium* and *Phytophthora,* further injuring them. Most adults leave the field during the summertime and come back in the fall to lay eggs that stay dormant until the following spring.

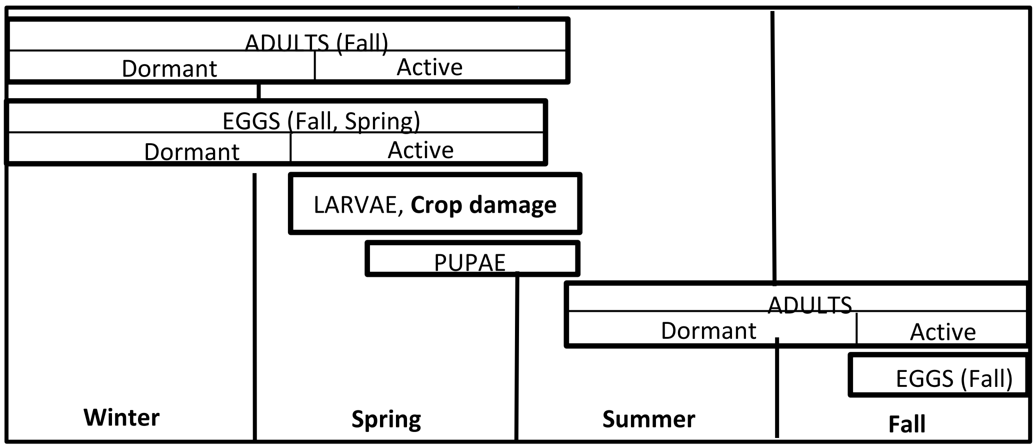

Figure 7. Clover root curculio life history in the Klamath Basin, based on 2018 sampling and Wenniger and Shewmaker (2014).

Monitoring and Control

The easiest way to determine if you have clover root curculio in your field is to look for patches of alfalfa plants that are not growing or wilted and then dig up plants to look for feeding damage on the roots. Larvae furrow and girdle plant roots, often leaving large gouges. The larvae are difficult to spot because they are small and cryptic.

Table 3. Insecticide trial for clover root curculio control applied on May 10, 2018, Tulelake, CA. An experimental insecticide (not registered for use in alfalfa), is noted by an asterisk "*". There were no differences for larval counts or yield between treatments.

Insecticide	Chemical name	Rate/Ac
Coragen	chlorantraniliprole	5 fl oz
Entrust SC	spinosad	4 fl oz
Agri-Mek*	abamectin	16 fl oz
Besiege 2X	chlorantraniliprole+lambdacyhalothrin	9 fl oz

Unfortunately, there are no insecticides registered to control CRC larvae in alfalfa. A trial was conducted in 2018 to look at the efficacy of insecticides listed in Table 3. However, there was no significant reduction in the number of larvae, root damage, or yield differences between treatments at harvest. Insecticide sprays in the springtime targeted to weevil adults are not effective because the adults are active and lay eggs for a long time (spring to summer), escaping pesticide treatment. We are currently evaluating whether a late spray for adult control at the end of the season, when adults come back into the field, might help reduce the adult population and subsequent egg and adult overwintering numbers, reducing infestations the following spring.

Current management recommendations for CRC include rotating infested fields to a non-host crop (something other than alfalfa and legumes, including clovers, soybeans, or cowpeas), avoiding planting new alfalfa next to infested fields, and proper irrigation and nutrient management, to ensure a heathy stand that is better able to withstand larval damage (especially accompanying secondary diseases). In addition, equipment should be cleaned after visiting infested fields to prevent spreading the pest to new fields (Wilson and Askew 2016).

SUMMARY

Managing weevil pests in alfalfa, including alfalfa weevils and clover root curculio, takes an integrated approach. This includes crop rotation for at least two years, monitoring pests, and applying insecticides (for alfalfa weevil) when thresholds are reached. Clover root curculio is more challenging to control with infestations occurring below the soil line in alfalfa fields and no insecticides registered to control them. Research will continue in 2019 to investigate ways to better manage these two key weevil pests in alfalfa hay production. This research is supported by grants from the California Department of Pesticide Regulation (DPR), which does not necessarily recommend or endorse any opinion, commercial product, or trade name used, and USDA-NIFA funds. Thanks to the staff at UC Davis and the Tulelake IREC for their help in collecting and processing alfalfa samples.

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Latest Alfalfa Variety Yield Results

University of California Agriculture and Natural Resources

Research and Extension Center System

By Dan Putnam, Chris DeBen, Brenda Perez, Charlie Brummer, UCCE and UC Davis

Choosing superior varieties of alfalfa is a significant economic factor for alfalfa growers. A large number of commercial varieties are currently available, enabling wide range of options. UC trials provide unbiased data from a wide range of environments related to variety performance of alfalfa. In California, alfalfa is grown from the Oregon border to the Mexican border, and throughout the Great Central Valley, which consists of the Sacramento and San Joaquin Valleys. The tables below represent sites using a 3-4 cut system (dormant varieties) in the Intermountain Region. See the University of California Alfalfa and Forages Website for full report and more information. http://alfalfa.ucdavis.edu

Yield Studies: The California Alfalfa Cultivar Yield, Fall Dormancy, and Forage Quality Trials are open to any certified alfalfa cultivar, which is sold or is likely to be sold in California. Blends or brands (unless they are certified blends) are not included in these trials. Experimental cultivars with a high likelihood of release within the next few years are tested as space permits. Two new trials were established in 2017: a variety trial was planted in Tulelake, and a subsurface drip-irrigated salinity trial at Westside Field Station in Five Points.

The plantings were at approximately 25 lbs/acre live seed. Plots were 3' to 4' wide and 13 to 20 feet long, depending upon location and specific layout. Four to six replicates of each cultivar were planted at each location, depending upon the expected variation at that site. Experimental design was a randomized complete block design. Harvests for yield estimation were obtained from approximately a 3' x 18' area per plot using a flail-type or cutter-bar type forage harvester, and dry matter yield determined by oven-drying subsamples to a constant weight. A representative group of 5-6 varieties were taken at each harvest, and the average dry matter used for yield determination. Cutting schedules were determined by the most common practice in that region and are the same for all varieties within a trial. The data is obtained from each of the locations and analyzed and summarized at the UC Davis campus. **Tulelake results from 2018 and combined results of 2017-2018 are listed below.**

2018 YIELDS, TULELAKE ALFALFA CULTIVAR TRIAL. TRIAL PLANTED 5/22/17

Note: Single year data should not be used to evaluate alfalfa varieties or choose alfalfa cultivars

	FD	Cut 1 6-Jun		Cut 2 5-Jul		Cut 3 9-Aug		Cut 4 25-Sep		YEAR TOTAL			% of VERNAL
						Dry t/a							
Released Varieties													
Nexgrow 6422Q	4	3.62	(10)	2.05	(3)	2.29	(13)	1.93	(9)	9.89	(1)	A	114.0
SW4107	4	3.63	(9)	1.89	(20)	2.35	(4)	1.98	(1)	9.84	(2)	A	113.4
54Q29	4	3.63	(8)	1.95	(12)	2.27	(16)	1.92	(10)	9.76	(5)	A B	112.5
Integra 8450	4	3.55	(12)	1.97	(5)	2.29	(14)	1.91	(11)	9.72	(7)	A B C	112.0
WL377HQ	5	3.36	(19)	1.98	(4)	2.35	(5)	1.98	(2)	9.66	(8)	A B C D	111.4
WL365HQ	5	3.24	(24)	2.09	(2)	2.36	(2)	1.94	(4)	9.64	(9)	A B C D E	111.1
SW5213	5	3.41	(17)	1.97	(7)	2.22	(22)	1.91	(13)	9.51	(11)	A B C D E F G	109.6
SW5210	6	3.52	(13)	1.84	(27)	2.22	(24)	1.93	(6)	9.51	(12)	A B C D E F G	109.6
FG R513W224S	5	3.31	(21)	1.92	(17)	2.34	(6)	1.94	(5)	9.50	(13)	A B C D E F G	109.5
Integra 8420	4	3.22	(27)	2.10	(1)	2.22	(23)	1.89	(17)	9.42	(14)	B C D E F G H	108.6
Xtra-3	4	3.19	(31)	1.96	(8)	2.33	(7)	1.93	(7)	9.41	(15)	B C D E F G H	108.5
Archer III	5	3.70	(4)	1.71	(39)	2.23	(19)	1.77	(29)	9.41	(16)	B C D E F G H I	108.4
AmeriStand 545NT RI	5	3.20	(28)	1.97	(6)	2.25	(18)	1.93	(8)	9.35	(17)	C D E F G H I	107.8
Hi-Gest 360	3	3.68	(6)	1.75	(36)	2.08	(37)	1.80	(25)	9.30	(18)	D E F G H I J	107.2
Dekalb 43-13	4	3.38	(18)	1.85	(26)	2.23	(20)	1.81	(24)	9.27	(19)	D E F G H I J	106.9
Integra 8444R	4	3.35	(20)	1.91	(18)	2.18	(26)	1.82	(23)	9.27	(20)	D E F G H I J	106.8
WL363HQ	5	3.30	(22)	1.87	(23)	2.22	(21)	1.86	(20)	9.26	(21)	E F G H I J K	106.7
Nexgrow 6585Q	5	3.11	(35)	1.92	(16)	2.31	(12)	1.91	(12)	9.25	(22)	E F G H I J K L	106.6
FG R410W253	4	3.03	(40)	1.96	(9)	2.32	(9)	1.89	(14)	9.20	(24)	F G H I J K L	106.0
Genuity-RR	4	3.19	(30)	1.90	(19)	2.21	(25)	1.89	(15)	9.20	(25)	F G H I J K L	106.0
FG R513W227S	5	3.10	(37)	1.88	(22)	2.36	(3)	1.86	(19)	9.20	(26)	F G H I J K L	106.0
FG R513M225S	5	3.20	(29)	1.96	(10)	2.27	(15)	1.76	(31)	9.19	(27)	F G H I J K L	105.9
WL 372HQ-RR	5	3.27	(23)	1.94	(13)	2.13	(32)	1.85	(21)	9.19	(28)	F G H I J K L	105.9
PGI459	4	3.52	(14)	1.66	(40)	2.12	(34)	1.72	(33)	9.01	(31)	I J K L M N	103.8
Ameristand 427TQ	4	3.69	(5)	1.54	(43)	2.08	(38)	1.64	(42)	8.95	(32)	J K L M N	103.1
Ameristand 445-NT	4	3.61	(11)	1.55	(42)	2.05	(41)	1.64	(41)	8.86	(35)	L M N O	102.0
4R200	4	3.07	(39)	1.72	(38)	2.16	(28)	1.77	(30)	8.72	(37)	N O P	100.4
Vernal	2	3.50	(15)	1.50	(44)	2.00	(44)	1.68	(36)	8.68	(39)	N O P	100.0
Experimental Varieties													
msSunstra-143146	3	3.78	(1)	1.95	(11)	2.32	(11)	1.79	(26)	9.83	(3)	A	113.3
Hybriforce-3430	3	3.75	(2)	1.83	(28)	2.32	(8)	1.89	(16)	9.79	(4)	A B	112.9
Hybriforce-4400	4	3.71	(3)	1.94	(14)	2.27	(17)	1.83	(22)	9.74	(6)	A B C	112.3
Hybriforce-3420/Wet	4	3.64	(7)	1.85	(25)	2.37	(1)	1.71	(34)	9.57	(10)	A B C D E F	110.3
msSunstra-155203	6	3.16	(33)	1.81	(31)	2.32	(10)	1.96	(3)	9.25	(23)	E F G H I J K L	106.5
SW4466	4	3.44	(16)	1.75	(35)	2.06	(40)	1.88	(18)	9.13	(29)	G H I J K L M	105.2
msSunstra-155202	6	3.22	(26)	1.94	(15)	2.14	(31)	1.74	(32)	9.03	(30)	H I J K L M N	104.0
H0415ST202	4	3.17	(32)	1.78	(33)	2.13	(33)	1.79	(27)	8.87	(33)	K L M N	102.2
RRL414M377	4	3.24	(25)	1.82	(29)	2.02	(43)	1.78	(28)	8.86	(34)	K L M N	102.1
H0415A3144	4	3.09	(38)	1.80	(32)	2.15	(30)	1.69	(35)	8.73	(36)	M N O P	100.6
RRL414M104	4	3.12	(34)	1.74	(37)	2.18	(27)	1.65	(38)	8.69	(38)	N O P	100.2
RRL514W209	5	3.10	(36)	1.76	(34)	2.15	(29)	1.62	(43)	8.63	(40)	N O P	99.5
H0415QT111	4	2.89	(42)	1.81	(30)	2.10	(35)	1.65	(39)	8.46	(41)	O P Q	97.4
H0515QT102	5	2.79	(44)	1.88	(21)	2.09	(36)	1.67	(37)	8.43	(42)	P Q	97.1
RRL414W208	4	2.83	(43)	1.87	(24)	2.07	(39)	1.64	(40)	8.42	(43)	P Q	97.0
RRL514W201	5	2.97	(41)	1.60	(41)	2.04	(42)	1.59	(44)	8.20	(44)	Q	94.5
MEAN		3.33		1.85		2.21		1.81		9.20			
CV		6.67		7.61		5.25		5.53		3.66			
LSD (0.1)		0.26		0.17		0.14		0.12		0.40			

Trial seeded at 25 lb/acre viable seed at Intermountain Research and Extension Center, Tulelake, CA.
Entries followed by the same letter are not significantly different at the 10% probability level according to Fisher's (protected) LSD.
FD = Fall Dormancy reported by seed companies.

2017-2018 YIELDS, TULELAKE ALFALFA CULTIVAR TRIAL. TRIAL PLANTED 5/22/17

	FD	2017 Yield	2018 Yield Dry t/a	Average		% of Vernal
Released Varieties						
Integra 8450	4	3.76 (11)	9.72 (7)	6.74 (6)	B C D E F	115.1
WL365HQ	5	3.80 (9)	9.64 (9)	6.72 (7)	B C D E F G	114.7
SW5210	6	3.74 (12)	9.51 (12)	6.63 (8)	C D E F G H	113.2
PGI459	4	4.16 (3)	9.01 (31)	6.59 (9)	D E F G H I	112.5
FG R513W224S	5	3.64 (18)	9.50 (13)	6.57 (10)	D E F G H I	112.3
Dekalb 43-13	4	3.81 (8)	9.27 (19)	6.54 (11)	E F G H I	111.7
WL363HQ	5	3.78 (10)	9.26 (21)	6.52 (12)	E F G H I	111.3
SW5213	5	3.51 (22)	9.51 (11)	6.51 (13)	E F G H I	111.2
Nexgrow 6585Q	5	3.74 (13)	9.25 (22)	6.50 (14)	E F G H I J	111.0
Integra 8444R	4	3.72 (15)	9.27 (20)	6.50 (15)	E F G H I J	110.9
Xtra-3	4	3.54 (21)	9.41 (15)	6.48 (16)	F G H I J K	110.6
Genuity-RR	4	3.74 (14)	9.20 (25)	6.47 (17)	G H I J K	110.5
Nexgrow 6422Q	4	3.03 (35)	9.89 (1)	6.46 (18)	G H I J K L	110.4
FG R513M225S	5	3.71 (16)	9.19 (27)	6.45 (19)	G H I J K L	110.2
SW4107	4	3.04 (29)	9.84 (2)	6.44 (21)	H I J K L	110.0
FG R410W253	4	3.61 (20)	9.20 (24)	6.41 (22)	H I J K L M	109.4
54Q29	4	3.04 (30)	9.76 (5)	6.40 (23)	H I J K L M	109.3
AmeriStand 545NT RI	5	3.41 (23)	9.35 (17)	6.38 (24)	H I J K L M	109.0
WL377HQ	5	3.04 (27)	9.66 (8)	6.35 (26)	I J K L M N	108.5
FG R513W227S	5	3.27 (24)	9.20 (26)	6.23 (27)	J K L M N O	106.5
Integra 8420	4	3.03 (34)	9.42 (14)	6.23 (28)	J K L M N O	106.3
Archer III	5	3.03 (38)	9.41 (16)	6.22 (29)	K L M N O P	106.2
4R200	4	3.67 (17)	8.72 (37)	6.19 (30)	L M N O P	105.8
Hi-Gest 360	3	3.03 (39)	9.30 (18)	6.17 (31)	M N O P	105.3
WL 372HQ-RR	5	3.02 (42)	9.19 (28)	6.11 (32)	N O P Q	104.3
Ameristand 427TQ	4	3.04 (25)	8.95 (32)	6.00 (33)	O P Q R	102.4
Ameristand 445-NT	4	3.04 (26)	8.86 (35)	5.95 (35)	P Q R S	101.6
Vernal	2	3.03 (32)	8.68 (39)	5.86 (39)	Q R S T	100.0
Experimental Varieties						
msSunstra-143146	3	4.30 (1)	9.83 (3)	7.07 (1)	A	120.7
Hybriforce-4400	4	4.14 (4)	9.74 (6)	6.94 (2)	A B	118.5
Hybriforce-3430	3	3.98 (6)	9.79 (4)	6.89 (3)	A B C	117.6
Hybriforce-3420/Wet	4	4.09 (5)	9.57 (10)	6.83 (4)	A B C D	116.6
msSunstra-155203	6	4.28 (2)	9.25 (23)	6.76 (5)	B C D E	115.5
msSunstra-155202	6	3.86 (7)	9.03 (30)	6.45 (20)	G H I J K L	110.1
SW4466	4	3.62 (19)	9.13 (29)	6.38 (25)	H I J K L M N	108.9
RRL414M377	4	3.04 (28)	8.86 (34)	5.95 (34)	P Q R S	101.6
H0415ST202	4	3.03 (37)	8.87 (33)	5.95 (36)	P Q R S	101.5
H0415A3144	4	3.03 (36)	8.73 (36)	5.88 (37)	Q R S T	100.4
RRL414M104	4	3.03 (40)	8.69 (38)	5.86 (38)	Q R S T	100.1
RRL514W209	5	3.03 (31)	8.63 (40)	5.83 (40)	R S T	99.6
H0415QT111	4	3.02 (44)	8.46 (41)	5.74 (41)	R S T	97.9
H0515QT102	5	3.02 (41)	8.43 (42)	5.72 (42)	R S T	97.8
RRL414W208	4	3.02 (43)	8.42 (43)	5.72 (43)	S T	97.7
RRL514W201	5	3.03 (33)	8.20 (44)	5.62 (44)	T	95.9
MEAN		3.44	9.20	6.32		
CV		8.16	3.66	3.63		
LSD (0.1)		0.33	0.40	0.27		

Trial seeded at 25 lb/acre viable seed at Intermountain Research and Extension Center, Tulelake, CA.

Entries followed by the same letter are not significantly different at the 10% probability level according to Fisher's (protected) LSD.

FD = Fall Dormancy reported by seed companies.

Revisiting Standard Russet Norkotah vs. Improved Norkotah Strains

University of California Agriculture and Natural Resources
Research and Extension Center System

By Darrin A. Culp, Robert Wilson, Kevin Nicholson, UC ANR IREC

Standard Russet Norkotah was released out of North Dakota State in 1987. It was quickly adopted as the standard fresh market russet in short growing season areas because of its uniform tubers, high percentage of count carton tubers, good storability, resistance to bruising during harvest, and resistance to second growth and hollow heart (Johansen et al., 1988). The major short-comings for R. Norkotah are weak determinate vines, a small root system, and high susceptibility to most diseases including PVY and Verticillium wilt.

In 1989, strain selection of R. Norkotah was initiated by the Texas Potato Variety Development Program to produce an improved strain with more vigorous vines and high yield potential. Some 192 giant hill and/or tall type plants were selected from seedsmen and/or commercial Russet Norkotah fields in Colorado, while 183 were selected from commercial fields in Texas (Miller et al., 1999). After numerous years of selection and testing throughout the Western Region, Colorado eventually released R. Norkotah Selection #3 (CORN 3) and R. Norkotah Selection #8 (CORN 8) in 1998. Similarly, Texas released the R. Norkotah clones Norkotah 112 (TXNS112), Norkotah 278 (TXNS278), Norkotah 223 (TXNS223) and Norkotah 196 (TXNS196).

Vine Maturity

Standard R. Norkotah is the earliest to mature. Russet Norkotah Selection #8, Norkotah 112, Norkotah 278, Norkotah 223 and Norkotah 196 are considered intermediate maturing lines. R. Norkotah Selection #3 is the latest maturing line selection. Norkotah clonal strains exhibit fewer Verticillium wilt and early-die symptoms compared to standard Norkotah. In 2010, Jansky et al. found that this disease tolerance was due to immature plant physiology in the strains, and not because of an ability to limit fungal growth and reproduction in stem tissue, which would be considered resistance. Thus, R. Norkotah Selection #3 is the most tolerant of Verticillium wilt and/or early-die of any other Norkotah types due to its late maturity.

Potato Yields

Texas A&M and Colorado State University conducted multiple trials from 1992-1994 comparing standard Russet Norkotah to Norkotah clonal strains. These studies showed that the Texas strains usually out yielded standard R. Norkotah by 20-30% (Miller et al., 1998). A Washington State University study from 2011 to 2013 compared six russet-type potato varieties and four R. Norkotah strains for yield and gross revenue (Spear et al., 2016). All varieties were grown under an early harvest and late harvest scenario. The Washington study showed R. Norkotah strains produced higher late-harvest yields and gross revenue returns compared to standard R. Norkotah. Conversely, early-harvest R. Norkotah Selection #3 produced lower yields and gross revenue when compared to standard R. Norkotah (Spear et al., 2016). The lower yield for Selection 3 associated with the early harvest was likely due to it being the latest maturing of the originally released clones.

Local studies comparing Norkotah clonal strains to standard Norkotah have produced mixed results. In 1998, OSU hosted a field performance experiment in Klamath Falls, OR. Standard Norkotah was planted with R. Norkotah Strains during a short growing season. Plots were planted June 8th and vines killed September 19, 1998. In this study, the R. Norkotah strains yielded less than standard Norkotah (James et al., 1999). Similar to the early harvest in the Washington study, the low yield for R. Norkotah strains was likely caused by the late planting date and the larger, later maturing vines not having enough season to produce comparable yields to standard R. Norkotah. Results for IREC and KBREC studies in 1997-1998 are presented in Tables 1 and 2 respectively. In these studies, R. Norkotah clonal strains out yielded standard Norkotah, although the clonal strains produced higher amounts of 2's and culls. The clonal strains also produced a higher percentage of tubers with hollow heart compared to standard Norkotah in Tulelake.

In summary, the yield benefits of Norkotah clonal strains are maximized with a longer growing season and growers will likely see little benefit from Norkotah clonal strains in late planted fields or fields harvested early. Growers should also expect a higher amount of culls and 2's when growing Norkotah clonal strains compared to Standard Norkotah (see Tables 1 &2). Both clonal strains and standard Norkotah offer high resistance to bruising, particularly shatter bruise, good eye appeal, and a high proportion of U.S. No. 1 tubers.

Table 1. UC IREC Tulelake, CA Western Regional Potato Variety Trial Results 1997-98 (2-Year Average)

	Total yield cwt/acre	US #1's cwt/acre	% US #1	2's + cull cwt/acre	< 4 oz cwt/acre	% Hollow heart	% Vascular discoloration	Merit (0-5, 5=best)
R. Norkotah	398.67	332.33	82.67	14.33	51.67	2.67	0.00	4.37
Norkotah 112	442.33	371.00	83.00	35.67	36.33	11.00	2.67	3.67
Percent Difference from R. Norkotah	11%	12%	0%	149%	-30%	313%	267%	-16%
Norkotah 278	417.00	339.67	80.33	40.67	37.00	11.00	0.00	4.10
Percent Difference from R. Norkotah	5%	2%	-3%	184%	-28%	313%	0%	-6%
Norkotah Sel. 3	498.50	390.00	77.50	89.00	19.50	12.50	8.50	3.35
Percent Difference from R. Norkotah	25%	17%	-6%	521%	-62%	369%	850%	-23%
Norkotah Sel. 8	378.50	304.50	80.50	53.00	21.50	16.50	0.00	3.35
Percent Difference from R. Norkotah	-5%	-8%	-3%	270%	-58%	519%	0%	-23%

Table 2. OSU KBREC Klamath Falls, OR Western Regional Potato Variety Trial Results 1997-98 (2-Year Average)

	Total yield cwt/acre	US #1's cwt/acre	% US #1	2's + cull cwt/acre	< 4 oz cwt/acre	% Hollow heart
R. Norkotah	452.50	395.00	87.00	6.50	38.00	18.00
Norkotah 112	482.00	389.50	80.00	31.00	43.50	14.00
Percent Difference from R. Norkotah	7%	-1%	-8%	377%	14%	-22%
Norkotah 278	458.50	371.50	80.50	18.50	47.00	11.50
Percent Difference from R. Norkotah	1%	-6%	-7%	185%	24%	-36%
Norkotah Sel. 3	521.00	434.00	81.00	40.50	31.50	25.50
Percent Difference from R. Norkotah	15%	10%	-7%	523%	-17%	42%
Norkotah Sel. 8	505.50	413.00	79.50	37.00	37.50	13.00
Percent Difference from R. Norkotah	12%	5%	-9%	469%	-1%	-28%

Seed Piece Spacing **(University of Idaho recommendation taken from Bohl et al. 2003)**

- **Standard Russet Norkotah**- 11 to13 inches
- **R. Norkotah Selections #8, 112, 278, 223 and 196**- 10 to 12 inches
- **R. Norkotah Selection #3**- 9 to11 inches

Nitrogen Management **(University of Idaho recommendations taken from Bohl et al. 2003)**

Nitrogen fertilizer quantities for all R. Norkotah types should be based on pre-plant soil nitrogen levels, years out of potato production, whether the soil has been fumigated, and total yield goals. All required nitrogen can be applied pre-plant or split-applied in season. Listed below are the timing recommendations for split-applying nitrogen for different R. Norkotah types.

- **Standard R. Norkotah, R. Norkotah Selection #8, Norkotah 112, Norkotah 278, Norkotah 223 and Norkotah 196**
  - Apply 60-70 percent of total nitrogen preplant.
  - In-season applications should be applied in small increments (20-30 #N/A) with nearly all nitrogen applied by the end of the first flush of flowers. All in-season applications of nitrogen should be complete by the first signs of senescence.
- **R. Norkotah Selection #3**
  - Apply 50-60 percent of total nitrogen preplant.
  - In-season nitrogen applications should be applied in small increments through early bulking based on petiole samples. Nitrogen fertilization is slightly delayed for Selection # 3 compared to Standard Russet Norkotah and other line selections.

<u>Irrigation Management</u> (University of Idaho recommendations taken from Bohl et al. 2003)

- **Standard R. Norkotah, R. Norkotah Selection #8, Norkotah 112, Norkotah 278, Norkotah 223 and Norkotah 196**
    - These lines have shorter vines and small root systems. More frequent irrigations with smaller quantities of water is recommended to prevent leaching nitrogen below the root zone.
    - Avoid early season moisture stress, since this can cause plants to become more susceptible to early-dying.
    - Keep soil moisture above 65% of field capacity for the entire growing season.
    - Avoid excess water at first signs of senescence. Plant water use declines rapidly at the start of senescence. The plants will not survive longer with more water.
- **R. Norkotah Selection #3**
    - Similar water use pattern to Russet Burbank.
    - Avoid early season moisture stress. R. Norkotah #3 is more tolerant than other R. Norkotah lines.
    - Keep soil moisture above 65% of field capacity for the entire growing season.
    - Avoid excess water at first signs of senescence. Plant water use declines more rapidly than Russet Burbank later in season.

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Historical Tulelake Trial Results for Released Russet Varieties

University of California
Agriculture and Natural Resources
Research and Extension Center System

By Kevin Nicholson and Rob Wilson, UC ANR IREC

Several russet varieties have been released from public breeding programs over the last 15 years with fresh market appeal. Below is a list of some of the more popular varieties along with their yield results from IREC research trials. Each variety's percentage change compared to standard Russet Norkotah is included for comparison purposes. Variety descriptions were obtained from the Potato Variety Management Institute (PVMI) website http://www.pvmi.org/varieties/varieties.htm , Colorado Certified Potato Growers Association website http://potatoes.colostate.edu/programs/potato-breeding/cultivars/ , and Texas A&M Potato Breeding website http://potato.tamu.edu/varieties.html. Varieties are listed in chronological order starting with most recent for the years they were evaluated in Tulelake.

Castle (POR06V12-3): *Long, medium to late russet suitable for the fresh and processing markets with an exceptional disease resistance package including PVY and fusarium resistance. It has been highly rated for culinary quality. Weaknesses include susceptibility to shatter bruise and prone to hollow heart in early harvest trials. Dormancy length of tubers is shorter than Russet Burbank.*

Mountain Gem (AO3158-2TE1): *A medium to late maturing variety with both high early and full season total and U.S. No. 1 yields. It has greater resistance to tuber late blight, tuber malformations and most internal and external defects than Russet Burbank. Susceptible to shatter bruise. Dormancy length of tubers is shorter than Russet Burbank.*

Targhee (AO1010-1): *A dual purpose variety with vine maturity similar to Russet Burbank. It produces a high yield of attractive, long tubers with brown-russeted skin and higher marketable yields and merit relative to Russet Burbank. It has moderate specific gravity and produces lighter colored fries out of storage than standard processing varieties. Fresh merit evaluation scores have been high indicating that it has excellent potential as a dual-purpose variety. Dormancy length of tubers is similar to Russet Norkotah and slightly shorter than Russet Burbank.*

Teton (A0008-1TE): *A cross between Blazer Russet and Classic Russet. The tubers are oblong with moderate russet, good skin and shallow eyes. Is resistant to dry rot but is soft rot and shatter bruise susceptible. Needs to be managed for hollow heart. Yields at 100-110 days after planting are similar or slightly higher than standard Russet Norkotah, but note that the tubers are generally 1-2 oz heavier on average if planted at the same in-row spacing as Russet Norkotah. Teton Russet should be handled as gently as possible to minimize bruising and skinning. Dormancy length of tubers is slightly shorter than Russet Burbank.*

Classic (A95109-1): *An early-maturing, russeted clone that produces a high percentage of U.S. No. 1 tubers. Its attractive tubers make it very suitable for use by the fresh-pack industry and could also be used as an early processor. Is resistant to external and internal tuber defects and is resistant to common scab. Classic also has moderate resistance to Verticillium wilt and dry rot. Weakness include lower specific gravity and susceptibility to shatter bruise and lenticel swelling. Dormancy length of tubers is shorter than Russet Burbank.*

Owyhee (AO96160-3): *A mid to late season russet variety with good appearance and processing quality. It produces reasonable yields with a high percentage of U.S. No. 1 tubers with relatively good size uniformity. It has high specific gravity, light fry color, few sugar ends, and few internal and external tuber defects. It is resistant to common scab and* Fusarium *dry rot and has moderate susceptibility to PVY and PLRV.*

Reveille (ATX91137-1RUS): *a uniform, medium-early high pack-out fresh market russet with excellent culinary qualities. High percentage of US No. 1 tubers. Resistant to hollow heart, second growth, and blackspot bruise. Susceptible to verticillium wilt and late blight. Dormancy length of tuber is longer than Russet Burbank.*

Canela Russet (AC92009-4RU): *A medium yielding fresh market russet with a very high percentage of U.S. No.1 tubers. Resistant to hollow heart and black spot bruise. Moderately resistant to shatter bruise and PVY. Dormancy length of tubers is longer Russet Burbank.*

Rio Grande Russet (AC89536-5RU): *Oblong, medium-heavy russet with high total yield potential and high percentage of US No. 1 tubers. Medium maturity with good resistance to hollow heart, second growth, blackspot bruise, and shatter bruise. Dormancy length of tubers is shorter than Russet Burbank.*

Ranger Russet (A7411-2): *Full season variety which produces high yields of high quality, long russet tubers. Resistant to verticillium wilt, PVX, PVY, and fusarium dry rot. Highly resistant to hollow heart. Susceptible to common scab and blackspot bruise. Dormancy length of tubers is shorter than Russet Burbank.*

Russet Burbank: *A later maturing variety with moderately high yields. Wide adaptability with excellent baking and processing quality. Good-long term dormancy length of tubers for tablestock.*

Table 1: Tulelake Yields for Released Russet Varieties and the % Difference Compared Standard Russet Norkotah.

	Total yield cwt/A	US #1's cwt/A	% US #1	< 4 oz cwt/A	Cull cwt/A	Merit (0-5, 5=best) [1]	Avg tuber size (oz)	% Hollow heart
Castle (POR06V12-3)[2]	378.33	265.33	70.33	65.67	47.33	3.30	5.33	5.67
% difference from Norkotah	-4%	-17%	-14%	61%	49%	-5%	-14%	-11%
Mountain Gem (AO3158-2TE1)[3]	473.33	406.33	85.67	42.33	24.67	3.83	5.43	5.00
% difference from Norkotah	21%	28%	5%	-12%	1%	-1%	6%	0%
Targhee (AO1010-1)[4]	510.67	405.33	79.33	87.67	17.67	3.57	5.03	0.33
% difference from Norkotah	26%	28%	1%	32%	-15%	-11%	-3%	-92%
Teton (A0008-1TE)[5]	457.00	396.33	86.67	44.33	16.33	3.23	6.73	4.33
% difference from Norkotah	19%	34%	12%	-43%	63%	-6%	25%	30%
Classic (A95109-1)[6]	398.33	341.67	85.67	35.33	21.33	4.30	7.80	2.00
% difference from Norkotah	24%	40%	12%	-18%	-35%	16%	28%	-54%
Owyhee (AO96160-3)[6]	373.33	315.33	84.33	45.67	12.33	4.55	6.77	2.00
% difference from Norkotah	17%	29%	10%	6%	-62%	23%	11%	-54%
Reveille Russet (ATX91137-1RU)[7]	379.50	332.00	87.00	25.00	22.50	4.15	6.50	0.00
% difference from Norkotah	16%	29%	10%	-18%	-42%	12%	0%	-100%
Canela Russet (AC92009-4RU)[8]	282.33	241.67	85.33	21.00	19.67	4.03	8.10	1.33
% difference from Norkotah	-15%	3%	22%	-59%	-58%	0%	11%	-76%
Rio Grande Russet (AC89536-5RU)[9]	536.67	464.00	85.33	42.00	30.67	4.10	N/A	8.67
% difference from Norkotah	47%	54%	4%	40%	-7%	0%	N/A	53%
Ranger Russet[10]	455.26	352.94	77.23	64.34	34.80	3.07	6.17	0.00
% difference from Norkotah	15%	14%	-1%	10%	67%	-12%	-1%	-100%
Russet Burbank[10]	421.39	308.29	73.00	64.09	37.06	3.02	5.69	7.03
% difference from Norkotah	6%	-1%	-7%	10%	77%	-13%	-9%	-11%

1: 1=Worst, 5=Best - Fresh Market Russet Merit Score takes into account multiple factors including tuber shape, eye depth, russeting, and shape uniformity.

2: This variety was evaluated in Tulelake between 2013-2015 as an entry in the Western Regional Variety Trial.

3: This variety was evaluated in Tulelake between 2012-2014 as an entry in the Western Regional Variety Trial.

4: This variety was evaluated in Tulelake between 2010-2012 as an entry in the Western Regional Variety Trial.

5: This variety was evaluated in Tulelake between 2008-2010 as an entry in the Western Regional Variety Trial.

6: This variety was evaluated in Tulelake between 2004-2006 as an entry in the Western Regional Variety Trial.

7: This variety was evaluated in Tulelake between 2004-2005 as an entry in the Western Regional Variety Trial.

8: This variety was evaluated in Tulelake between 2002-2004 as an entry in the Western Regional Variety Trial.

9: This variety was evaluated in Tulelake between 2000-2002 as an entry in the Western Regional Variety Trial.

10: This variety was evaluated in Tulelake between 2008-2018 as an entry in the Western Regional Variety Trial.

2018 Potato Variety Development in Tulelake

University of California
Agriculture and Natural Resources
Research and Extension Center System

By Rob Wilson, Darrin Culp, & Kevin Nicholson, UC ANR IREC

Three potato variety trials were conducted at the Intermountain Research and Extension Center (IREC) in Tulelake, CA. Trials were categorized by market type and included a Russet trial with twenty-three entries, a Specialty trial with seventeen entries, and a Chipping trial with six entries. Entries included selections from the Western Regional (WR) variety development program, Southwest Regional (SWR) variety development program, and varieties of local interest. The tables below highlight some of the results for the three trials. To see the complete report including all results and pictures of the entries, go to the link shown below. http://irec.ucanr.edu/Research/Past_Research/Potato_Projects_313/

Table 1: 2018 Intermountain Research and Extension Center Russet Variety Trial

Clone/Variety	Total cwt/a	Culls + 2's cwt/a	%1's	U.S. 1's	Merit score (1-5, 5=best)	Tubers per plant	Average tuber size (oz)
Ranger Russet	422.0	28.5	77.0	323.9	3.3	7.1	5.5
Russet Burbank	442.1	34.6	74.0	327.9	3.8	7.7	5.4
Russet Norkotah	360.8	27.6	68.0	246.0	3.9	7.5	4.9
A07061-6	488.4	18.8	71.0	345.6	2.0	9.9	4.7
A071012-4BF	519.1	23.4	86.0	447.7	3.1	6.7	7.5
A07769-4	450.3	14.0	85.0	383.5	3.8	6.8	6.2
A08433-4VR	421.0	20.5	79.0	333.3	3.6	7.1	5.5
A10021-5TE	475.7	12.4	78.0	375.3	3.6	8.7	5.2
AO02183-2	431.8	18.4	82.0	354.7	3.4	6.8	5.9
AO06191-1	393.4	26.4	84.0	331.7	3.9	5.1	7.5
AOR06576-1	455.7	26.7	83.0	376.7	3.3	7.0	6.3
AOR07781-5	389.8	38.7	77.0	299.5	3.0	6.3	6.0
AOR07821-1	413.9	17.3	85.0	349.6	3.1	6.3	6.3
AOTX05043-1Ru	347.6	22.8	75.0	262.2	2.1	6.9	5.3
CO08155-2RU/Y	418.5	22.7	66.0	274.9	3.0	9.9	4.3
CO08231-1RU	360.6	10.0	59.0	213.5	3.4	8.6	4.0
CO09036-2RU	408.4	14.5	69.0	284.1	3.8	8.3	4.7
CO09076-3RU	446.4	57.8	71.0	316.1	2.1	7.4	5.8
CO09205-2RU	388.3	21.3	74.0	288.7	4.1	7.4	4.9
COTX05095-2Ru/Y	490.4	25.7	79.0	385.1	3.8	8.6	5.5
CO10087-4RU	298.0	10.4	76.0	227.0	3.8	6.1	5.1
CO10091-1RU	358.8	6.8	67.0	241.9	3.0	7.8	4.4
AO6030-23	445.4	26.3	81.0	362.9	3.8	6.9	6.0
Mean	**418.5**	**22.9**	**80.0**	**319.6**	**3.3**	**7.0**	**5.5**

Table 2: 2018 Intermountain Research and Extension Center Specialty Variety Trial

Clone / Variety	Skin color	Flesh color	Total cwt/a	Culls cwt/a	Merit score (1-5, 5=best)	Tubers per plant	Average tuber size (oz)
Chieftan	Red	White	631.5	34.3	3.8	9.8	6.2
Red LaSoda	Red	White	613.4	113.8	2.5	7.8	7.5
ATTX05175S-1R/Y	Red	Yellow	550.4	18.6	3.8	18.2	2.9
COTX04193S-2R/Y	Red	Yellow	480.4	16.7	3.9	13.7	3.3
CO08037-2P/P	Purple	Purple	353.5	7.7	4.0	12.0	2.9
CO09079-5PW/Y	Purple/Yellow	Yellow	432.8	17.2	2.8	18.0	2.3
Yukon Gold	Yellow	Yellow	438.1	30.6	3.5	7.8	6.4
CO09128-3W/Y	Yellow	Yellow	334.5	8.9	2.9	17.8	1.9
CO09128-5W/Y	White	Yellow	345.1	6.2	3.5	16.9	1.9
CO09218-4W/Y	Yellow	Yellow	390.3	13.7	3.1	12.5	3.1
ATX02263-1R/Y	Red	Yellow	425.6	40.1	2.6	17.1	3.5
CO06215-2R	Red	White	545.9	17.0	3.8	12.1	4.3
AC10376-1W/Y	Yellow	Yellow	526.4	33.0	2.0	17.1	3.0
CO10064-1W/Y	Yellow	Yellow	487.2	26.6	4.0	14.5	3.4
CO10097-2W/Y	Yellow	Yellow	510.5	4.9	2.3	10.5	4.6
CO10098-4W/Y	Yellow	Yellow	428.5	29.9	2.9	13.6	3.1
CO10098-5W/Y	Yellow	Yellow	322.0	44.9	2.1	12.5	3.6
			387.7	**27.3**	**3.1**	**13.6**	**3.8**

Table 3: 2018 Intermountain Research and Extension Center Chip Variety Trial

Clone / Variety	Total cwt/a	Culls cwt/a	Merit score (1-5, 5=best)	Tubers per plant	Average tuber size (oz)
Atlantic	438.2	26.0	3.4	7.4	5.9
AC01144-1W	348.8	7.7	4.0	8.8	3.7
AOR09034-3	459.6	22.5	3.3	10.6	4.2
NDA081453CAB-2C	386.6	10.9	3.6	7.2	5.1
CO10073-7W	403.1	20.4	3.5	9.0	4.2
CO10076-4W	387.8	12.5	2.6	8.5	4.5
	404.0	**16.7**	**3.4**	**8.5**	**4.6**

2018 Tulelake Peppermint Weed Control Research

By *Rob Wilson, Center Director, UC ANR*

Statement of purpose. Determine the comparative efficacy of saflufenacil (Sharpen powered by Kixor herbicide) to currently registered broadleaf herbicides on local broadleaf weeds in dormant peppermint.

Statement of Research. This study compared the efficacy of saflufenacil with currently labeled postemergence broadleaf herbicides on broadleaf weeds that are problems in mint. Saflufenacil isn't currently registered for use in peppermint, but BASF is supportive of efforts to register saflufenacil herbicide in numerous crops in the U.S. including mint. The goal of this research is to develop new tools for weed management in peppermint production.

Research Methods. The California trial was conducted in an established peppermint fields near Tulelake, CA. The field was irrigated with solid-set sprinklers and managed for one cutting per season. Winter weeds at trial sites included prickly lettuce, tansy mustard, and common groundsel. Summer weeds included redroot pigweed, kochia, and common lambsquarter. Saflufenacil was applied postemergence (POST) to dormant mint on February 7th, 2018 at 0.045 lbs ai/a (proposed 2.0 oz/a product labeled rate) with MSO at 1% (v/v) plus AMS at 2% (w/v). A 2X and 3X rate of saflufenacil along with the local standard (Gramoxone + Zeus) was included in the treatment list. Dormant tank mix partners (Chateau, Zeus, and Zidua) were also applied with the saflufenacil. To further test crop safety and efficacy of saflufenacil on emerged weeds, Sharpen was applied 0, 2, 4, and 8 weeks following mint green-up. The entire treatment list is shown in Table 1.

Plots were 10 by 30 feet and herbicide treatments were replicated four times in a randomized complete block design. Herbicides were applied with a small plot CO_2 sprayer at 20 GPA. Crop injury and weed control were evaluated six separate times from May 1st to July 12th. Mint hay yield was measured in mid-August by harvesting a known area in each plot and weighing. A subsample of hay from each plot was weighed, dried and steam distilled to determine oil yield.

2018 Tulelake, CA Saflufenacil Treatment List

Trt #	Product Name	Active Ingredient	Appl. Code	Product per acre (fl oz or oz)
1	Nontreated			
2	Gramoxone + Zeus + NIS	paraquat + sulfentrazone	Dormant mint	32 + 6
3	Sharpen 1X + MSO + AMS	saflufenacil	Dormant mint	2
4	Sharpen 2X + MSO + AMS	saflufenacil	Dormant mint	4
5	Sharpen 3X + MSO + AMS	saflufenacil	Dormant mint	6
6	Sharpen + Zeus + MSO + AMS	saflufenacil +sulfentrazone	Dormant mint	2 + 6
7	Sharpen + Chateau + MSO + AMS	saflufenacil + flumioxazin	Dormant mint	2 + 4
8	Sharpen + Zidua + MSO + AMS	saflufenacil + pyroxasulfone	Dormant mint	2 + 1.69
9	Sharpen 1X + MSO + AMS	saflufenacil	green-up	2
10	Sharpen 2X + MSO + AMS	saflufenacil	green-up	4
11	Gramoxone + NIS	paraquat	green-up	32
12	Sharpen 1X + MSO + AMS	saflufenacil	2 wks post green-up	2
13	Sharpen 2X + MSO + AMS	saflufenacil	2 wks post green-up	4
14	Gramoxone + NIS	paraquat	2 wks post green-up	32
15	Sharpen 1X + MSO + AMS	saflufenacil	4 wks post green-up	2
16	Sharpen 2X + MSO + AMS	saflufenacil	4 wks post green-up	4
17	Sharpen 1X + MSO + AMS	saflufenacil	8 wks post green-up	2
18	Sharpen 2X + MSO + AMS	saflufenacil	8 wks post green-up	4

Nonionic surfactnat (NIS) added at 0.25 % v/v;
Methlyated seed oil (MSO) added 1% v/v;
Ammonium sulfate (AMS) aded at 2% v/v

Tulelake, CA Results

Peppermint Response to Saflufenacil- Saflufenacil (Sharpen) exhibited good crop safety when applied at or before peppermint green-up (Table 1). 1X and 2X rates caused minimal early season injury that was comparable with the current standard, paraquat (Gramoxone) + sulfentrazone (Zeus). Tank-mixing dormant preemergence herbicides with Sharpen was safe in established peppermint (Table 1). Delaying Sharpen application until 4 weeks and 8 weeks after peppermint green-up increased crop injury compared to earlier applications (Table 1). These treatments caused significant stunting in July especially Sharpen applied 8 weeks after mint green-up. The injury carried into harvest delaying peppermint bloom compared to other treatments (Table 2). Few treatment differences were observed in mint biomass and oil yield except for lower biomass and oil yields in the untreated and Gramoxone treatments due to excessive weed competition (Table 2).

Table 1. Peppermint Injury from 2018 Saflufenacil (Sharpen) Treatments in Tulelake, CA.

Trt #	Herbicide Treatment	5/1/2018	5/14/2018	5/29/2018	6/22/2018	7/2/2018	7/12/2018
		peppermint injury					
		0-10 scale 10=mint dead					
1	Untreated Control	0 f	0 d	0 e	0.5 bcd	2.25 a *	1.5 abc *
2	Gramoxone + Zeus- dormant mint	1.25 cde	0.5 cd	0.5 cde	0 d	0.5 b	0.75 abc
3	Sharpen 2 fl. oz- dormant mint	0.75 de	0.375 cd	0.25 de	0 d	1.37 ab	0.5 bc
4	Sharpen 4 fl. oz- dormant mint	1.25 cde	0.75 bcd	0.75 cde	0.25 cd	0.5 b	0.5 bc
5	Sharpen 6 fl. oz- dormant mint	1.25 cde	0.875 bcd	1 bcde	0.5 bcd	1 ab	0.25 bc
6	Sharpen 2 fl. oz + Zeus- dormant mint	1 cdef	0.5 cd	1 bcde	0 d	0 b	0.5 bc
7	Sharpen 2 fl. oz + Chateau- dormant mint	0.75 def	0.5 cd	0.5 de	0 d	0 b	0 c
8	Sharpen 2 fl. oz + Zidua- dormant mint	1 cdef	0 d	0.125 de	0 d	0.375 b	0.5 bc
9	Sharpen 2 fl. oz- mint green-up	1.75 cde	0.625 bcd	0.875 bcde	0 d	0.25 b	0.5 bc
10	Sharpen 4 fl. oz- mint green-up	2 bc	0.625 bcd	1 bcde	0 d	0.75 ab	0.25 bc
11	Gramoxone - mint green-up	1.25 cde	0.5 cd	0.25 de	0 d	0 b	0.5 bc
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	3.25 a	1.125 abcd	0.75 cde	0.5 bcd	1 ab	1 abc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	3.5 a	1.875 ab	1.5 abcd	0.5 bcd	1 ab	0.875 abc
14	Gramoxone- 2 weeks post mint green-up	2.75 ab	1.375 abc	1.25 abcde	0.5 bcd	1.5 ab	1 abc
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	0.25 ef	1.5 abc	1.375 abcde	0.75 bcd	1.5 ab	1.5 abc
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	0.25 ef	2.375 a	1.875 abc	1.63 abc	1.75 ab	1.25 abc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	0.25 ef	0 d	2.5 a	1.75 ab	2.25 a	2 ab
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	0.25 ef	0 d	2.25 ab	3a	3a	2.5 a

* Crop injury in the untreated control was related to severe stunting caused by excessive weed competition.

Table 2. Peppermint % Bloom, Green Biomass, and Oil Yield at Harvest in Tulelake, CA.

		8/9/2018	8/9/218	8/9/2018
		mint bloom	mint biomass yield	mint oil yield
Trt #	Herbicide Treatment	%	tons/acre (green)	lbs/acre
1	Untreated Control	11 abc	6.7 c	15.4 c
2	Gramoxone + Zeus- dormant mint	16 a	10.5 abc	41.2 abc
3	Sharpen 2 fl. oz- dormant mint	16 a	9.3 abc	38.5 abc
4	Sharpen 4 fl. oz- dormant mint	15 a	10.3 abc	42.8 abc
5	Sharpen 6 fl. oz- dormant mint	15 a	11.4 ab	53.6 ab
6	Sharpen 2 fl. oz + Zeus- dormant mint	15 a	11.7 abc	56.4 ab
7	Sharpen 2 fl. oz + Chateau- dormant mint	16 a	13.5 a	71.3 a
8	Sharpen 2 fl. oz + Zidua- dormant mint	15 a	11.6 ab	52.4 ab
9	Sharpen 2 fl. oz- mint green-up	14 ab	10.0 abc	54.7 ab
10	Sharpen 4 fl. oz- mint green-up	11 abc	12.2 ab	45.5 abc
11	Gramoxone - mint green-up	16 a	8.8 bc	34.2 bc
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	14 ab	9.6 abc	40.0 abc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	11 abc	11.2 abc	38.0 abc
14	Gramoxone- 2 weeks post mint green-up	13 abc	9.3 abc	38.5 abc
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	11 abc	10.3 abc	36.8 abc
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	9 abc	10.7 abc	41.8 abc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	5 c	12.2 ab	51.2 abc
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	6 bc	12.1 ab	38.4 abc

* Crop injury in the untreated control was related to severe stunting caused by excessive weed competition.

Saflufenacil Weed Control- The best control of winter annual weeds and summer weeds was achieved by applying Sharpen at a 1X rate in combination with Zeus or Chateau (Table 3). Tank-mixing Sharpen with Zeus or Chateau greatly improved control of summer annual weeds (Tables 3 & 4). Sharpen provided similar or better control of winter annual weeds (prickly lettuce, tansy mustard, and groundsel) and early emerging summer annuals (lambsquarter and kochia) compared to Gramoxone (Tables 3 & 4). Improved weed control from Sharpen compared to Gramoxone was especially apparent when the herbicide application was delayed until shortly after mint green-up.

Potential Fit of saflufenacil for Weed Control in Peppermint – Saflufenacil appears to be an excellent alternative to Gramoxone for early season weed control in peppermint. Crop injury from saflufenacil at 1X and 2X rates was similar to Gramoxone. Saflufenacil provided similar or better weed control compared to Gramoxone at all application timings especially later applications. UC testing of saflufenacil in alfalfa and peppermint over the last couple years has shown saflufenacil provides improved control of large winter annual broadleaf weeds and dandelion compared to Gramoxone.

Table 3. Percent Weed Control from 2018 Saflufenacil Treatments in Tulelake, CA

		5/29/2018 Weed Control						6/22/2018 Weed Control		
		prickly lettuce	tansy mustard	redroot pigweed	common lambsquarter	common groundsel	kochia	redroot pigweed	common lambsquarter	kochia
Trt #	Herbicide Treatment	% control 100=no weeds						% control 100=no weeds		
1	Untreated Control	0 d	0 f	33 ab	45 bcde	0 e	13 bc	20	13 bc	40 abcde
2	Gramoxone + Zeus- dormant mint	64 abc	95 ab	60 ab	73 abcd	96 a	88 ab	63	73 abc	88 abc
3	Sharpen 2 fl. oz- dormant mint	68 abc	88 abcd	0 b	15 cde	98 a	18	63	0 c	30 bcde
4	Sharpen 4 fl. oz- dormant mint	75 abc	94 abc	20 ab	13 de	100 a	0 c	45	13 bc	0 e
5	Sharpen 6 fl. oz- dormant mint	90 a	100 a	38 ab	65 abcd	100 a	28	50	43 abc	25 cde
6	Sharpen 2 fl. oz + Zeus- dormant mint	83 ab	100 a	73 ab	78 abc	100 a	75 abc	95	75 abc	75 abcd
7	Sharpen 2 fl. oz + Chateau- dormant mint	86 a	95 ab	90 ab	95 a	100 a	75 abc	95	94 a	91 abc
8	Sharpen 2 fl. oz + Zidua- dormant mint	64 abc	90 abcd	45 ab	18 cde	98 a	20 abc	70	18 abc	0 e
9	Sharpen 2 fl. oz- mint green-up	90 a	93 abc	55 ab	40 bcde	21 de	20 abc	40	25 abc	10 de
10	Sharpen 4 fl. oz- mint green-up	86 a	83 abcd	0 b	60 abcde	79 ab	38 abc	45	67 abc	50 abcde
11	Gramoxone - mint green-up	48 bc	46 de	0 b	0 e	35 cde	25 abc	30	13 bc	40 abcde
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	55 abc	55 bcd	58 ab	85 a	38 bcde	88 ab	75	66 abc	88 abc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	83 ab	84 abcd	83 ab	80 ab	69 abc	98 a	75	57 abc	88abc
14	Gramoxone- 2 weeks post mint green-up	38 cd	48 de	25 ab	50 abcde	28 cde	63 abc	50	37 abc	100 a
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	48 bc	33 ef	38 ab	70 abcd	61 abcd	88 ab	25	45 abc	95 ab
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	60 abc	55 bcd	75 ab	88 a	80 ab	98 a	68	67 abc	88abc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	90 a	53 bcd	100 a	95 a	81 ab	100 a	95	87 ab	90 abc
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	93 a	50 cde	100 a	100 a	90 a	100 a	100	95 a	100 a

Table 4. July Weed Density in 2018 Saflufenacil Treatments at Tulelake, CA.

		7/2/2018 Weed Density			
		redroot pigweed	common lambsquarter	common groundsel	kochia
Trt #	Herbicide Treatment	# of weeds per plot			
1	Untreated Control	233 a	23bc	45 a	2 b
2	Gramoxone + Zeus- dormant mint	58 b	12 bcd	1 d	1 bc
3	Sharpen 2 fl. oz- dormant mint	38 b	54 ab	1 d	14 abc
4	Sharpen 4 fl. oz- dormant mint	74 ab	51 abc	0 d	29 a
5	Sharpen 6 fl. oz- dormant mint	61 b	36 abc	0 d	16 abc
6	Sharpen 2 fl. oz + Zeus- dormant mint	10 b	12 cd	0 d	11 abc
7	Sharpen 2 fl. oz + Chateau- dormant mint	12 b	8 cd	0 d	0 c
8	Sharpen 2 fl. oz + Zidua- dormant mint	15 b	43 abc	1 d	14 abc
9	Sharpen 2 fl. oz- mint green-up	72 ab	29 bc	30 abc	21 ab
10	Sharpen 4 fl. oz- mint green-up	54 b	24 bc	10 d	18 ab
11	Gramoxone - mint green-up	101 ab	58 a	37 ab	15 abc
12	Sharpen 2 fl. oz- 2 weeks post mint green-up	178 a	20 bcd	34 abc	2 bc
13	Sharpen 4 fl. oz- 2 weeks post mint green-up	158 a	16 cd	16 cd	1 bc
14	Gramoxone- 2 weeks post mint green-up	127 ab	24 bc	30 abc	1 bc
15	Sharpen 2 fl. oz- 4 weeks post mint green-up	133 ab	14bcd	19 bcd	1 bc
16	Sharpen 4 fl. oz- 4 weeks post mint green-up	133 ab	18 bcd	9 d	1 bc
17	Sharpen 2 fl. oz- 8 weeks post mint green-up	123 ab	7 d	8 d	1 bc
18	Sharpen 4 fl. oz- 8 weeks post mint green-up	116 ab	6 d	4 d	0 c

2018 Small Grain Variety Testing Research at IREC

University *of* California
Agriculture and Natural Resources

Research and Extension Center System

By Mark Lundy, Assistant Cooperative Extension Specialist, University of California

Each year the UC Small Grain Variety Testing Program tests commercial and advanced small grain varieties across a wide range of growing conditions in the state of California in order to determine the relative commercial potential of genotypes. Because of the climatic differences in the Intermountain Region, the varieties grown in this part of the state largely differ from those grown in other parts of California. As a result, the trials carried out in this region are a blend of entries from Oregon State University trials and University of California Trials, with the addition of some varieties of regional interest to seed dealers and growers. These trials are carried out by the Intermountain Research and Extension Center staff. Fall-planted, winter wheat trials were conducted at two Siskiyou County locations during the 2017-18 growing season (Tulelake and Montague). In addition, spring-planted hard wheat, spring-planted soft wheat, and spring-planted barley trials were grown at the IREC in Tulelake during 2018. Grain yield and quality was measured from these trials and reported on both single-year and multi-year bases on the UC Small Grains website (http://smallgrains.ucanr.edu/Variety_Results/2018/).

Multi-year, multi-trial data tends to produce more reliable estimates of crop productivity potential. For this reason, the UC Small Grain Variety Testing Program emphasizes the multi-year trial data in our reporting, and we recognize that the value from the 2018 trials was augmented by efforts in previous seasons. Indeed, the year-over-year consistency in the trial efforts at IREC helps to create ever-accruing value in the multi-year dataset. To begin to unlock this value for the various clientele who use this data, the UC Small Grain Variety Testing Program has developed a dynamic webtool for customizing and sorting the results from the multi-year trial efforts, including for the Intermountain Region trials. One of the webtools (http://smallgrainselection.plantsciences.ucdavis.edu/) produces multi-year summaries, while the other (http://smallgrainselection.plantsciences.ucdavis.edu/explore/) allows users to customize selections by single trials or groups of trial. In addition to these online resources, up-to-date summaries of the performance of commercially released cultivars tested in the Intermountain Region between 2016 and 2018 are provided as an addendum to this document.

3-year (2016-2018) and 1-year (2018) yield and protein estimates from Intermountain Region hard spring wheat trials (commercially release varieties only).

Region/Group	Crop Group	Crop Type	Years	Name	UC Number	3-yr Yield (lb/acre)	3-yr St.Err. Yield (lb/acre)	3-yr Yield Rank	Diff. from overall mean.x	St.Err.Diff. from overall mean.x	P-Value	2018 Yield (lb/acre)	2018 St.Err.Yield (lb/acre)	2018 Yield Rank	3-yr Protein (%)	3-yr St.Err. Protein (%)	3-yr Protein Rank	Diff. from overall mean.y	St.Err.Diff. from overall mean.y	3-yr P-Value	2018 Protein (%)	2018 St.Err.Protein (%)	2018 Protein Rank
InterMnt	SPRINGWHEAT	HWS	2016-2018	LCS STAR	19046	8697	869	10	938	218	0	-	-	-	12.36	0.78	72	-0.62	0.18	0	-	-	-
InterMnt	SPRINGWHEAT	HWS	2016-2018	WB HARTLINE	19100	8498	897	12	738	308	0.05	-	-	-	13.23	0.81	44	0.25	0.26	0.41	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	SY BASALT 04W40240R	19062	8315	869	17	556	218	0.04	-	-	-	12.69	0.78	61	-0.3	0.18	0.14	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	LCS IRON	19045	8311	869	18	551	217	0.04	9628	289	21	12.92	0.79	55	-0.07	0.2	0.78	14.22	0.29	39
InterMnt	SPRINGWHEAT	HRS	2016-2018	JEFFERSON	19041	8220	897	23	461	308	0.26	-	-	-	13.62	0.81	29	0.63	0.26	0.03	-	-	-
InterMnt	SPRINGWHEAT	HWS	2016-2018	LCS ATOMO	19044	8220	869	24	460	218	0.09	-	-	-	12.85	0.78	59	-0.13	0.18	0.52	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9200	19094	8132	869	29	373	218	0.18	-	-	-	13.91	0.78	20	0.93	0.18	0	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9717	29172	8115	897	30	356	307	0.37	9781	289	16	13.02	0.82	52	0.04	0.3	0.91	14.54	0.29	35
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9229	19095	8047	873	34	287	232	0.35	-	-	-	13.7	0.79	27	0.71	0.2	0	-	-	-
InterMnt	SPRINGWHEAT	HWS	2016-2018	WB 7417	19093	8034	869	35	274	218	0.35	-	-	-	14.2	0.78	16	1.22	0.18	0	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	SY SELWAY	19065	8005	860	38	245	177	0.3	9286	289	33	13.64	0.78	28	0.66	0.16	0	15.17	0.29	21
InterMnt	SPRINGWHEAT	HWS	2016-2018	UI PLATINUM	19077	7991	860	42	232	177	0.33	9278	289	34	12.59	0.78	63	-0.39	0.16	0.02	14.45	0.29	36
InterMnt	SPRINGWHEAT	HRS	2016-2018	UC CENTRAL RED	29180	7956	897	43	196	307	0.64	9621	289	22	13.41	0.82	39	0.43	0.3	0.19	14.93	0.29	27
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9518	19096	7915	860	47	155	177	0.52	9466	289	26	14.59	0.78	9	1.61	0.16	0	15.83	0.35	11
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9668	19097	7865	869	50	105	217	0.74	9723	289	18	14.69	0.79	8	1.7	0.2	0	16.1	0.29	8
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB PATRON	29147	7863	897	51	103	308	0.8	-	-	-	13.74	0.81	25	0.76	0.26	0.01	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	SY COHO	19064	7805	860	54	45	177	0.83	9511	289	25	13.76	0.78	24	0.78	0.16	0	15.23	0.29	20
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9411	29153	7764	897	56	5	308	0.99	-	-	-	13.54	0.81	33	0.56	0.26	0.05	-	-	-
InterMnt	SPRINGWHEAT	HWS	2016-2018	WB 7566	29167	7743	897	57	-16	307	0.98	9409	289	29	13.17	0.82	48	0.19	0.3	0.59	14.69	0.29	31
InterMnt	SPRINGWHEAT	HRS	2016-2018	BULLSEYE	19019	7704	897	58	-55	308	0.88	-	-	-	13.93	0.81	19	0.95	0.26	0	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	SY STEELHEAD	19066	7687	869	59	-72	218	0.8	-	-	-	14.37	0.78	11	1.39	0.18	0	-	-	-
InterMnt	SPRINGWHEAT	HWS	2016-2018	WB 7202 CLP	29171	7657	897	63	-103	307	0.8	9322	289	31	12.43	0.82	70	-0.55	0.3	0.09	13.95	0.29	43
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9350	29152	7554	869	64	-206	217	0.49	9423	289	28	13.33	0.79	42	0.35	0.2	0.11	14.57	0.29	34
InterMnt	SPRINGWHEAT	HRS	2016-2018	LCS TRIGGER	29193	7537	897	65	-223	307	0.59	9202	289	35	12.43	0.82	69	-0.55	0.3	0.09	13.95	0.29	42
InterMnt	SPRINGWHEAT	HRS	2016-2018	UC LASSIK	19043	7531	897	66	-229	307	0.58	9196	289	36	13.09	0.85	50	0.11	0.37	0.8	14.61	0.35	33
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9662	29154	7507	869	69	-253	217	0.37	9091	289	39	14.35	0.79	12	1.37	0.2	0	15.99	0.29	9
InterMnt	SPRINGWHEAT	HRS	2016-2018	SY GUNSIGHT	29178	7497	897	70	-263	307	0.52	9162	289	37	13.46	0.82	37	0.48	0.3	0.15	14.98	0.29	26
InterMnt	SPRINGWHEAT	HRS	2016-2018	MSU LANNING	29176	7396	897	73	-364	307	0.37	9061	289	41	15.32	0.82	4	2.33	0.3	0	16.84	0.29	4
InterMnt	SPRINGWHEAT	HRS	2016-2018	WB 9879 CLP	19099	7355	869	75	-405	217	0.14	8706	289	51	13.84	0.79	22	0.86	0.2	0	15.62	0.29	13
InterMnt	SPRINGWHEAT	HRS	2016-2018	ALUM	19016	7344	860	76	-415	177	0.06	8999	289	43	13.79	0.78	23	0.81	0.16	0	15.4	0.29	16
InterMnt	SPRINGWHEAT	HRS	2016-2018	YECORA ROJO	19106	7298	860	78	-462	177	0.03	8742	289	50	14.33	0.78	13	1.35	0.16	0	15.48	0.29	15
InterMnt	SPRINGWHEAT	HRS	2016-2018	GLEE	19025	7267	869	79	-492	217	0.07	9286	289	32	13.43	0.79	38	0.44	0.2	0.04	14.76	0.29	29
InterMnt	SPRINGWHEAT	HRS	2016-2018	LCS Buck Pronto	19018	7152	897	82	-608	307	0.11	8817	289	46	14.94	0.82	5	1.96	0.3	0	16.46	0.29	5
InterMnt	SPRINGWHEAT	HRS	2016-2018	HRS 3419	19029	7052	897	88	-708	308	0.06	-	-	-	12.98	0.81	54	0	0.26	0.99	-	-	-
InterMnt	SPRINGWHEAT	HRS	2016-2018	LCS LUNA	29169	6949	897	89	-811	307	0.03	8614	289	52	12.87	0.82	57	-0.11	0.3	0.76	14.39	0.29	37
InterMnt	SPRINGWHEAT	HRS	2016-2018	WA 8280 CLP	29185	6903	897	92	-857	307	0.02	8568	289	54	13.97	0.82	18	0.99	0.3	0	15.49	0.29	14
InterMnt	SPRINGWHEAT	HRS	2016-2018	KELSE	19042	6808	869	94	-952	217	0	8197	289	55	14.7	0.79	7	1.71	0.2	0	16.39	0.29	6

3-year (2016-2018) and 1-year (2018) yield and protein estimates from Intermountain Region soft spring wheat trials (commercially release varieties only).

Region/Group	Crop Group	Crop Type	Years	Name	UC Number	3-yr Yield (lb/acre)	3-yr St.Err. Yield (lb/acre)	3-yr Yield Rank	Diff. from overall mean.x	St.Err.Diff. from overall mean.x	P-Value	2018 Yield (lb/acre)	2018 St.Err.Yield (lb/acre)	2018 Yield Rank	3-yr Protein (%)	3-yr St.Err. Protein (%)	3-yr Protein Rank	Diff. from overall mean.y	St.Err.Diff. from overall mean.y	3-yr P-Value	2018 Protein (%)	2018 St.Err.Protein (%)
InterMnt	SPRINGWHEAT	SWS	2016-2018	WB 6341	19091	9330	860	3	1570	177	0	11293	289	1	10.53	0.78	102	-2.45	0.15	0	11.84	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	WB 6430	19092	9080	855	4	1321	154	0	10850	216	4	11.1	0.77	96	-1.88	0.13	0	12.59	0.19
InterMnt	SPRINGWHEAT	SWS	2016-2018	UI STONE	19078	8884	860	6	1124	177	0	10866	289	3	10.98	0.78	99	-2	0.15	0	12.46	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	ALTURAS	19015	8844	914	8	1085	354	0.01	-	-	-	11.04	0.82	98	-1.95	0.3	0	-	-
InterMnt	SPRINGWHEAT	SWS	2016-2018	WA TEKOA	29150	8703	869	9	943	217	0	10660	289	5	11.32	0.78	93	-1.66	0.18	0	12.84	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	RYAN WA 8214	29148	8395	897	14	636	308	0.1	-	-	-	11.74	0.81	88	-1.24	0.26	0	-	-
InterMnt	SPRINGWHEAT	SWS	2016-2018	WA RYAN	29192	8258	897	21	498	307	0.21	9923	289	11	11.34	0.81	92	-1.64	0.26	0	12.86	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	WB 6121	19090	8242	864	22	483	194	0.04	9954	289	8	12.1	0.78	79	-0.88	0.16	0	13.67	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	WB 1035 CL	29151	8175	897	27	415	308	0.31	-	-	-	11.92	0.81	84	-1.07	0.26	0	-	-
InterMnt	SPRINGWHEAT	SWS	2016-2018	WA MELBA	19050	8105	860	31	346	177	0.12	9649	289	20	10.63	0.78	101	-2.35	0.15	0	12.16	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	WHIT	19105	7952	897	44	192	308	0.65	-	-	-	11.88	0.81	85	-1.1	0.26	0	-	-
InterMnt	SPRINGWHEAT	SWS	2016-2018	WB 1035 CLP	19089	7816	869	53	56	217	0.83	9876	289	13	12.58	0.78	65	-0.4	0.18	0.04	14.31	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	ALPOWA	19014	7658	869	62	-101	218	0.74	-	-	-	11.75	0.78	87	-1.23	0.18	0	-	-
InterMnt	SPRINGWHEAT	SWS	2016-2018	SY SALTESE	29149	7521	869	68	-239	217	0.4	9439	289	27	12.11	0.78	78	-0.88	0.18	0	13.66	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	WA SEAHAWK	19054	7216	855	80	-544	154	0	8922	289	44	12.05	0.77	82	-0.93	0.13	0	13.2	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	WA LOUISE	19048	6597	860	97	-1162	177	0	7918	289	57	12.39	0.78	71	-0.6	0.15	0	13.89	0.25
InterMnt	SPRINGWHEAT	SWS	2016-2018	DIVA	19023	5767	869	101	-1992	218	0	-	-	-	12.69	0.78	62	-0.3	0.18	0.14	-	-

3-year (2016-2018) and 1-year (2018) yield estimates from Intermountain Regions spring barley trials (commercially release varieties only).

Region/Group	Crop Group	Crop Type	Years	Name	UC Number	3-yr Yield (lb/acre)	3-yr St.Err. Yield (lb/acre)	3-yr Yield Rank	Diff. from overall mean	St.Err.Diff. from overall mean	P-Value	2018 Yield (lb/acre)	2018 St.Err.Yield (lb/acre)	2018 Yield Rank
InterMnt	BARLEY	2RSM	2016-2018	FRANCIN	9148	7615	886	4	1408	234	0	9140	521	1
InterMnt	BARLEY	2RSM	2016-2018	EXPLORER	9147	6935	915	7	728	306	0.05	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	OSU FULL PINT	9059	6917	888	9	709	216	0	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	UC BUTTA 12 96	9049	6908	886	10	700	235	0.01	7738	521	3
InterMnt	BARLEY	6RSF	2016-2018	STEPTOE	9077	6629	914	15	422	306	0.3	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	SYNERGY	9154	6512	915	16	304	306	0.45	-	-	-
InterMnt	BARLEY	2RSF	2016-2018	BARONESSE	9048	6496	914	17	289	306	0.47	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	LCS GENIE	9149	6283	915	28	75	306	0.85	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	CDC BOW	9145	6270	915	29	63	306	0.86	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	AC METCALFE	9047	5886	888	37	-321	216	0.25	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	HARRINGTON	9060	5884	914	38	-323	306	0.43	-	-	-
InterMnt	BARLEY	2RSM	2016-2018	UC TAHOE	9085	5843	921	40	-365	359	0.44	7082	521	4
InterMnt	BARLEY	2RSM	2016-2018	CDC COPELAND	9054	5752	876	45	-455	186	0.04	7781	521	2
InterMnt	BARLEY	2RSM	2016-2018	CDC FRASER	9146	5690	915	49	-517	306	0.18	-	-	-

3 year (2016-2018) and 1-year (2018) yield and protein estimates from Intermountain Regions (Montague and Tulelake combined) winter wheat trials (commercially released varieties only).

Region/Group	Crop Group	Years	Name	UC Number	3-yr Yield (lb/acre)	3-yr St.Err. Yield (lb/acre)	3-yr Yield Rank	Diff. from overall mean.x	St.Err.Diff. from overall mean.x	P-Value	2018 Yield (lb/acre)	2018 St.Err.Yield (lb/acre)	2018 Yield Rank	3-yr Protein (%)	3-yr St.Err. Protein (%)	3-yr Protein Rank	Diff. from overall mean.y	St.Err.Diff. from overall mean.y	3-yr P-Value	2018 Protein (%)	2018 St.Err.Protein (%)	2018 Protein Rank
InterMnt	WINTERWHEAT	2016-2018	LCS HULK	29058	8941	659	5	808	229	0	8910	2274	2	10.44	0.29	54	-0.24	0.18	0.44	11.19	0.34	9
InterMnt	WINTERWHEAT	2016-2018	ROSALYN	29090	8922	659	7	789	229	0.01	8608	2274	6	10.1	0.29	77	-0.57	0.18	0.01	10.63	0.34	35
InterMnt	WINTERWHEAT	2016-2018	BOBTAIL	29011	8908	659	8	776	229	0.01	8668	2274	3	10.46	0.29	51	-0.21	0.18	0.48	10.85	0.34	25
InterMnt	WINTERWHEAT	2016-2018	LEGION	29043	8850	727	11	717	381	0.15	-	-	-	9.81	0.38	86	-0.86	0.3	0.03	-	-	-
InterMnt	WINTERWHEAT	2016-2018	NORTHWEST DUET	29201	8833	728	13	701	383	0.17	8321	2274	11	10.61	0.38	34	-0.06	0.3	0.89	11.05	0.34	14
InterMnt	WINTERWHEAT	2016-2018	MARY	29059	8829	659	14	697	229	0.02	8327	2274	10	10.58	0.29	35	-0.1	0.18	0.78	10.99	0.34	19
InterMnt	WINTERWHEAT	2016-2018	NORTHWEST DUET	29044	8702	727	18	570	381	0.26	-	-	-	9.95	0.38	84	-0.73	0.3	0.07	-	-	-
InterMnt	WINTERWHEAT	2016-2018	TUBBS 06	29105	8675	659	19	543	229	0.08	7904	2274	21	9.99	0.29	81	-0.69	0.18	0	10.48	0.34	39
InterMnt	WINTERWHEAT	2016-2018	SY OVATION	29102	8656	674	21	524	270	0.14	8149	2274	16	10.54	0.31	41	-0.14	0.21	0.74	11.36	0.34	3
InterMnt	WINTERWHEAT	2016-2018	WB 1783	29146	8647	664	23	514	243	0.12	8663	2274	4	10.91	0.29	17	0.23	0.19	0.48	11.25	0.34	6
InterMnt	WINTERWHEAT	2016-2018	LCS BIANCOR	29042	8639	682	25	507	287	0.18	-	-	-	10.29	0.32	66	-0.39	0.23	0.25	-	-	-
InterMnt	WINTERWHEAT	2016-2018	WA 8232	29113	8617	682	27	485	287	0.19	-	-	-	10.17	0.32	73	-0.51	0.23	0.11	-	-	-
InterMnt	WINTERWHEAT	2016-2018	HUFFMAN	29027	8601	760	29	468	440	0.47	-	-	-	10.32	0.42	64	-0.36	0.35	0.59	-	-	-
InterMnt	WINTERWHEAT	2016-2018	KELDIN	29039	8541	760	33	408	440	0.54	-	-	-	10.91	0.42	16	0.23	0.35	0.73	-	-	-
InterMnt	WINTERWHEAT	2016-2018	JASPER	29037	8523	682	34	391	287	0.33	-	-	-	10.38	0.32	61	-0.29	0.23	0.44	-	-	-
InterMnt	WINTERWHEAT	2016-2018	TUBBS	29104	8440	682	36	307	287	0.47	-	-	-	10.09	0.32	78	-0.59	0.23	0.05	-	-	-
InterMnt	WINTERWHEAT	2016-2018	STEPHENS	29093	8342	659	39	210	229	0.54	8060	2274	18	10.61	0.29	33	-0.06	0.18	0.84	10.98	0.34	20
InterMnt	WINTERWHEAT	2016-2018	WA 8206	29112	8289	682	42	156	287	0.77	-	-	-	10.57	0.32	38	-0.11	0.23	0.79	-	-	-
InterMnt	WINTERWHEAT	2016-2018	WA 8234	29145	8235	694	48	103	314	0.83	-	-	-	10.79	0.33	23	0.11	0.25	0.81	-	-	-
InterMnt	WINTERWHEAT	2016-2018	UI SPARROW	29036	8221	682	50	88	287	0.83	-	-	-	10.25	0.32	68	-0.43	0.23	0.21	-	-	-
InterMnt	WINTERWHEAT	2016-2018	LCS SHARK	29057	8218	659	51	86	229	0.83	7058	2274	32	10.64	0.29	31	-0.04	0.18	0.89	11.1	0.34	12
InterMnt	WINTERWHEAT	2016-2018	KASEBERG	29038	8213	659	52	81	229	0.83	8217	2274	13	9.94	0.29	85	-0.74	0.18	0	10.41	0.34	40
InterMnt	WINTERWHEAT	2016-2018	SY COMMAND	29206	8185	728	54	53	383	0.92	7672	2274	27	10.13	0.38	75	-0.55	0.3	0.23	10.56	0.34	38
InterMnt	WINTERWHEAT	2016-2018	LCS ARTDECO	29041	8178	659	55	46	229	0.89	7421	2274	30	10.45	0.29	53	-0.23	0.18	0.46	11.2	0.34	7
InterMnt	WINTERWHEAT	2016-2018	SY RAPTOR	29208	8146	728	56	14	383	0.99	7633	2274	28	10.63	0.38	32	-0.05	0.3	0.91	11.06	0.34	13
InterMnt	WINTERWHEAT	2016-2018	NORTHWEST TANDEM	29045	8135	727	57	3	381	0.99	-	-	-	10.44	0.38	56	-0.24	0.3	0.66	-	-	-
InterMnt	WINTERWHEAT	2016-2018	WB 1529	29115	7904	659	64	-229	229	0.51	6902	2274	34	10.83	0.29	21	0.15	0.18	0.64	11.3	0.34	5
InterMnt	WINTERWHEAT	2016-2018	WB 1604	29116	7776	682	67	-357	287	0.39	6652	2274	37	10.52	0.32	45	-0.16	0.23	0.71	10.94	0.34	23
InterMnt	WINTERWHEAT	2016-2018	LCS DRIVE	29052	7606	674	69	-526	270	0.14	6675	2274	36	10.53	0.31	43	-0.15	0.21	0.71	11	0.34	17
InterMnt	WINTERWHEAT	2016-2018	NORTHWEST TANDEM	29202	7487	728	73	-646	383	0.19	6974	2274	33	10.71	0.38	27	0.04	0.3	0.93	11.15	0.34	11
InterMnt	WINTERWHEAT	2016-2018	SY ASSURE	29144	7032	664	78	-1100	243	0	6536	2274	39	11.51	0.29	8	0.83	0.19	0	11.03	0.34	15
InterMnt	WINTERWHEAT	2016-2018	YAMHILL	29128	6001	706	82	-2131	340	0	-	-	-	11.24	0.35	12	0.56	0.27	0.14	-	-	-
InterMnt	WINTERWHEAT	2016-2018	WINCORA	29127	5580	760	85	-2553	440	0	-	-	-	12.84	0.42	2	2.17	0.35	0	-	-	-
InterMnt	WINTERWHEAT	2016-2018	VERDANT	29107	5316	785	86	-2816	480	0	-	-	-	12.64	0.44	3	1.96	0.38	0	-	-	-

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Evaluation of Osprey Herbicide for Weed Control in Winter Wheat

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Introduction: Osprey herbicide (mesosulfuron) is a postemergent herbicide for control of grass and broadleaf weeds in wheat and triticale. Best results are obtained when Osprey is applied to young actively growing weeds. This study evaluated a spring application of Osprey to winter wheat in the tillering growth stage. Winter wheat in Tulelake is often planted in November making fall herbicide application rare unlike many other production regions where winter wheat is planted much earlier. The trial site had low weed pressure making weed control evaluations difficult, but trial location provided optimal conditions to evaluate crop injury and yield.

Methods: Herbicide treatments were applied April 9, 2018 using a CO_2 powered backpack sprayer at 15 gpa. Treatments were replicated 4 times in a randomized complete block design. Plots were 9ft by 20ft. Winter wheat ('Mary' winter soft white) was in the early tillering stage. Weeds were 2-4 inches tall. Numerous night-time frosts occurred the first couple weeks after application.

Results: All results are shown in the Table on page 34. Osprey treatments caused significant chlorosis and stunting that lingered for one month after treatment. Tank-mixing Buctril or Rhomene MCPA with Osprey increased crop injury compared to using Osprey alone. Weeds were too sporadic in plots to evaluate weed control. At harvest, plant height, grain yield, and grain test weight were similar across all treatments suggesting wheat recovered from early season injury caused by the herbicides.

Evaluation of Spring-Applied Osprey Treatments to Winter Wheat in Tulelake

Wheat: 'Mary' soft-white winter wheat (irrigated)

Herbicide Application: 4/9/2018 at early tillering; sporadic prickly lettuce and henbit (weeds 1-3 inches)

Crop Injury Rating: Visual evaluation of chlorosis and stunting; 0-10 rating scale 10= crop death

Weed Presence: Weeds were too sporadic for % control rating; % of plots with weed present

50% Heading Date: Date 50% of the plants had fully emerged heads.

Trt #	Treatment	Rate	Unit	Injury 4/18 0-10 rating	Injury 4/25 0-10 rating	Injury 5/7 0-10 rating	Injury 5/16 0-10 rating	Prickly lettuce 5/16 % of plots w/ presence	Henbit 5/16 % of plots w/ presence	Plant height at harvest (cm)	Grain Yield lbs/A	Grain test wt. per bushel
1	Untreated			0c	0d	0c	0	50	25	99	7238	59.8
2	OSPREY XTRA	4.754	OZ/A	2a	1.15bc	1b	0	0	0	98	7663	60.3
	NIS	0.5	v/v									
	U.A.N.	4	pt/A									
3	OSPREY 4.5 WDG	4.754	OZ/A	1.75ab	1.38bc	1b	0	75	0	100	7437	60.2
	NIS	0.5	% V/V									
	U.A.N.	4	PT/A									
4	SIMPLICITY	6.75	fl oz/A	1b	0.75cd	1b	0	50	0	98	7759	60.5
	NIS	0.5	v/v									
	U.A.N.	4	pt/A									
5	OSPREY XTRA	3.72	OZ/A	2a	1.75ab	1.5ab	0	0	0	98	7708	58.8
	BUCTRIL 2EC	1	PT/A									
	NIS	0.5	% V/V									
	U.A.N.	4	PT/A									
6	OSPREY XTRA	4.754	OZ/A	2a	2.38a	1.75a	0	25	0	99	7880	59.9
	Rhomene MCPA	8	OZ/A									
	NIS	0.5	% V/V									
	U.A.N.	4	PT/A									
7	OSPREY XTRA	4.754	OZ/A	1.5ab	1.63abc	0.88b	0	0	0	99	7740	60.1
	EXPRESS	0.25	OZ/A									
	NIS	0.5	% V/V									
	U.A.N.	4	PT/A									

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Evaluation of Fungicides and Seed Treatments for Suppression of Smut and White Rot in Onions

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Introduction

In 2018, three trials were conducted at the Intermountain Research and Extension Center to evaluate new fungicide approaches for suppressing white rot and onion smut. The first study looked at tank-mix combinations of fungicides applied in-furrow. The second study evaluated the influence of altering the band-width of fungicides applied in-furrow. The third study evaluated the effect of roto-till incorporating Fontelis in onion beds before planting in combination with tebuconazole applied-in furrow. The study site was infested with white rot and also had a high incidence of onion smut (unknown to the research team at the start of the field season). Thus, all white rot trials had high incidence of both diseases. **Some pesticides listed in this report are not registered for onion use in California. Make sure to follow all pesticide labels!**

2018 Site Information

- **Soil type-** mucky silty clay loam-4.6% OM
- **Growing season-** early May to late September
- **Irrigation –** solid-set sprinklers
- **Onions-** 36 inch beds with 4 seed-lines spaced 6 inches apart; 2-inch seed spacing; Olam processing variety
- **Design-** RCB with 5 blocks (reps)

2018 Study Methods

In early May 2018, the field was tilled and beds were shaped before onion planting. Onions were planted on 5/7/18. Fungicide treatments were applied in-furrow at planting time. In-furrow fungicides were applied using Teejet 8001 EVS nozzles @ 30 psi. The nozzles were mounted on the onion planter to apply a 3-inch band directly over the seed-line after seed placement but before furrow closure. The exception was the fungicide trial evaluating different band-widths where the width was set at 1.5 inches or 3 inches. Fontelis was roto-till incorporated into onion beds (2-3 inches deep) using a

Johnston roto-till bed shaper a day before planting. Onion stand density was measured in each plot by counting the number of green onions in all seed lines for the entire plot length. Onion vigor (color, height, and leaf cover) was visually estimated in each plot using a 0 to 10 scale, with 10 = highest vigor. Onion smut severity was visually evaluated on 7/19/18 when onions were in the 5-6 leaf growth stage using 0-10 scale with 10= most severe. Late season visual leaf dieback ratings were taken starting 9/12/18 using a 0 to 100% scale. Onion yield was measured by harvesting all onions in each plot on 10/10/18. Onions were run across a grade-line to remove loose soil and green tops. Onion bulbs were hand-sorted based on the presence of white-rot and smut. A total weight was recorded for disease-free onions, onions with white-rot symptoms (decay through 1st scale, mycelium, or sclerotia), and onions with smut (small bulbs with raised black blisters from spores). Onions with both symptoms (few onions) were classified as white rot.

Results

Fungicide Tank-mix Results- Significant results are presented in Figures 1 and 2. There was no difference between treatments regarding early-season vigor and onion smut severity. Late season leaf dieback differed between treatments with the untreated having the highest leaf dieback and Tebustar + Merivon, Tebustar+ Fontelis, and Tebustar + Fontelis + Merivon having lower leaf dieback compared to the untreated control (Figure 1). Total bulb yield and average bulb size did not differ between treatments. Disease-free yield (no white rot and smut) was different between Tebustar + Merivon and the untreated control (Figure 2). In summary, tank-mixing new fungicides with Tebustar produced similar or slightly better suppression of white rot compared to Tebustar alone.

Figure 1. Late season leaf dieback for fungicide combinations applied in-furrow at planting

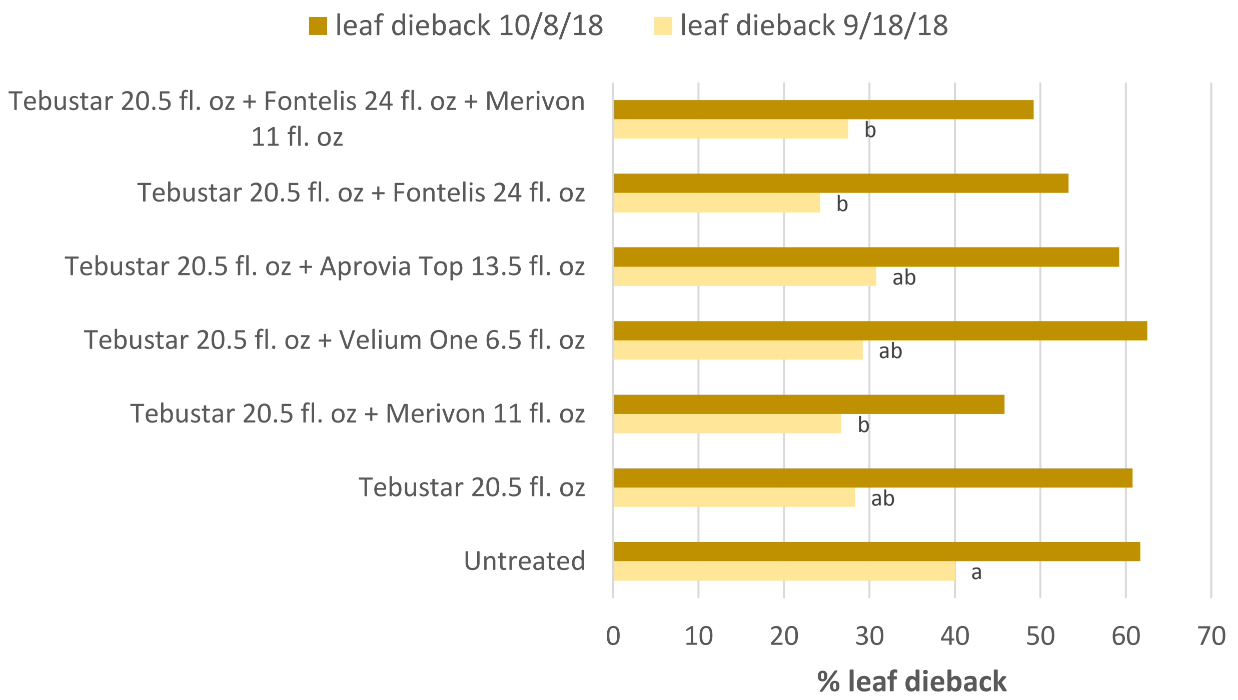
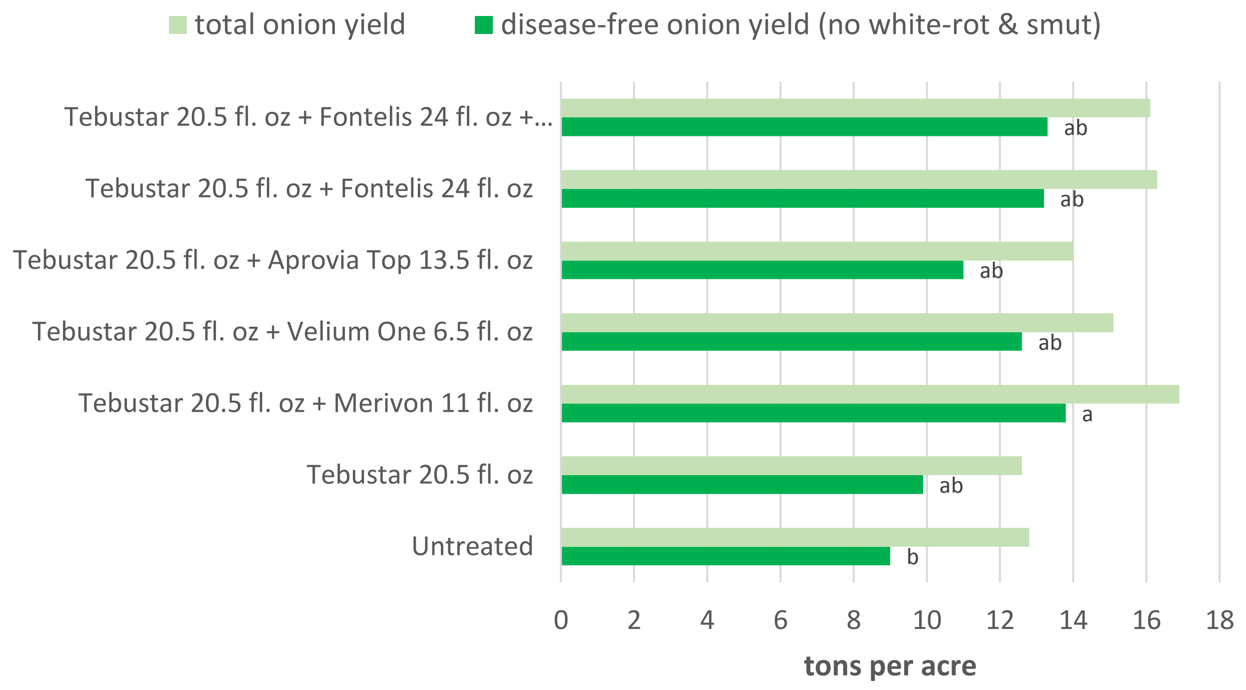


Figure 2. Onion yields for fungicide combinations applied in-furrow at planting



Altering In-furrow Fungicide Band-Width Results- Significant results are presented in Figures 3 & 4. Early season vigor did not differ between treatments suggesting narrowing the band-width to 1.5 inches for all tested fungicides did not injure the crop. Fontelis at the 1.5 inch band width had lower onion smut severity compared to the untreated control although the 1.5 inch Fontelis band width did not differ from other fungicide treatments. The untreated had higher late season leaf-dieback compared to fungicides, but leaf-dieback ratings did not differ between fungicide treatments. Disease-free onion yield differed between treatments (Figure 3). The untreated control had the lowest yield, and Fontelis at both band-widths and Merivon at the 1.5 inch band-width had the highest yield. Average bulb size followed the same treatment trend compared to disease-free yield. In summary, the 1.5 inch (narrow) band-width of Fontelis, Merivon, and Velium Prime numerically had the highest total yield and disease-free yield of the study, but the 1.5 inch band-width was statistically similar compared to the 3 inch band-width for all measured variables.

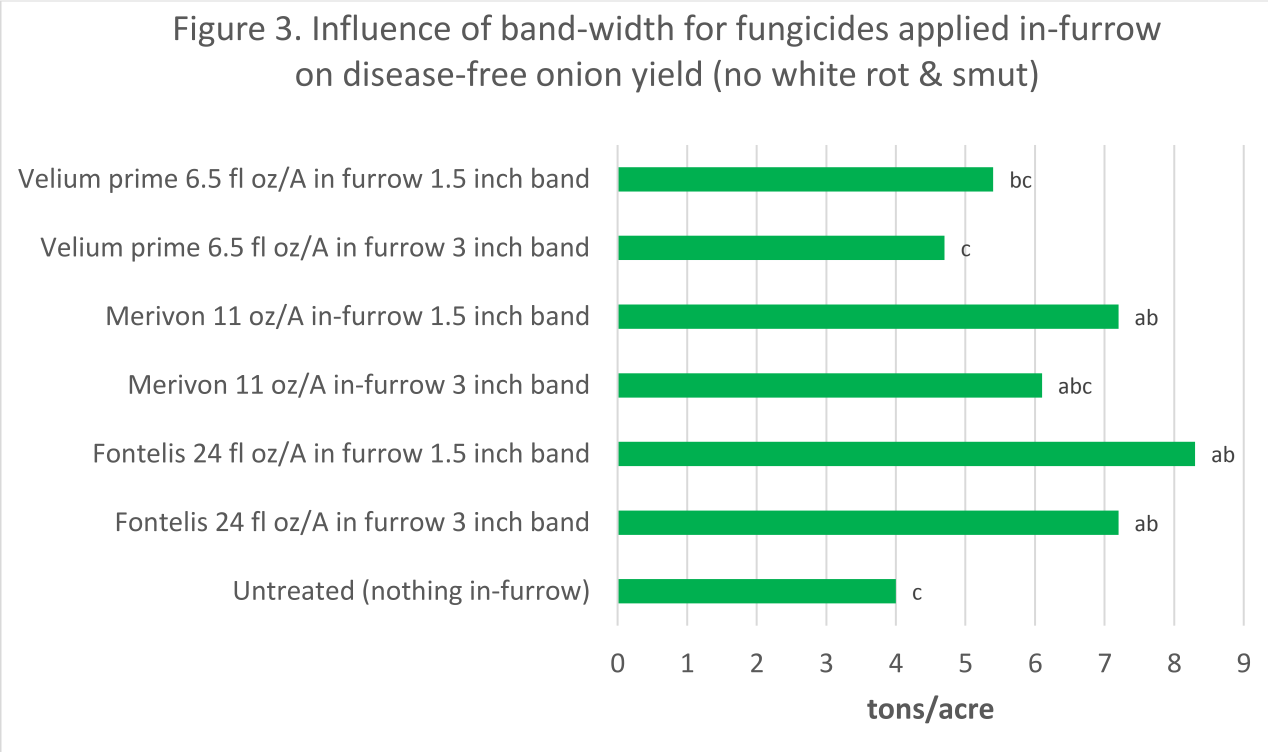


Figure 3. Influence of band-width for fungicides applied in-furrow on disease-free onion yield (no white rot & smut)
Velium prime 6.5 fl oz/A in furrow 1.5 inch band
Velium prime 6.5 fl oz/A in furrow 3 inch band
Merivon 11 oz/A in-furrow 1.5 inch band
Merivon 11 oz/A in-furrow 3 inch band
Fontelis 24 fl oz/A in furrow 1.5 inch band
Fontelis 24 fl oz/A in furrow 3 inch band
Untreated (nothing in-furrow)
bc
c
ab
abc
ab
ab
c
0
1
2
3
4
5
6
7
8
9
tons/acre

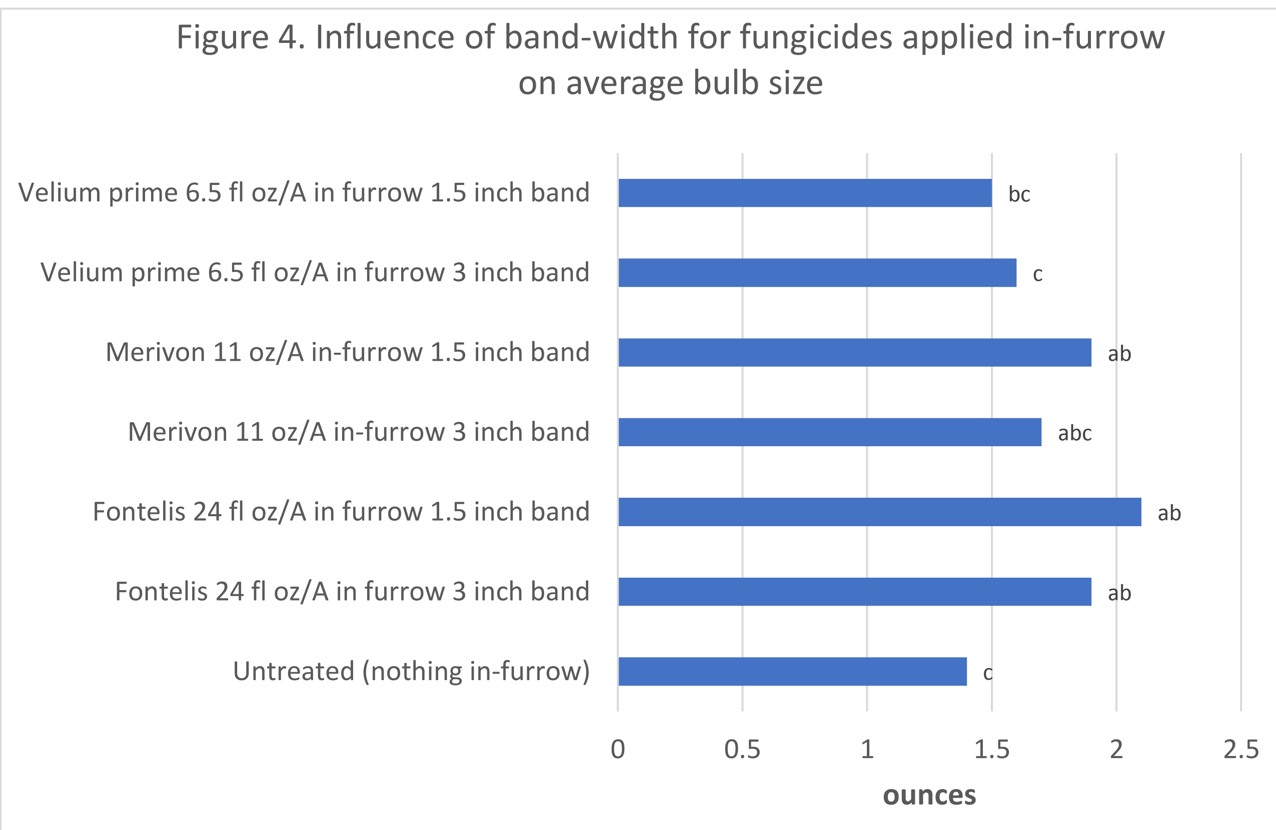


Figure 4. Influence of band-width for fungicides applied in-furrow on average bulb size
Velium prime 6.5 fl oz/A in furrow 1.5 inch band
Velium prime 6.5 fl oz/A in furrow 3 inch band
Merivon 11 oz/A in-furrow 1.5 inch band
Merivon 11 oz/A in-furrow 3 inch band
Fontelis 24 fl oz/A in furrow 1.5 inch band
Fontelis 24 fl oz/A in furrow 3 inch band
Untreated (nothing in-furrow)
bc
c
ab
abc
ab
ab
c
0
0.5
1
1.5
2
2.5
ounces

Roto-till incorporating Fontelis in combination with tebuconazole (Tebustar) in-furrow results- Roto-till incorporating Fontelis with tebuconazole had numerically higher early season vigor, higher onion stands, and lower late season leaf dieback compared to tebuconazole alone (Table 1). This combination of Fontelis and Tebustar also resulted in numerically higher total onion yield and disease-free clean yield. Future research is needed to examine this approach of roto-till incorporating Fontelis especially as it relates to increasing onion stands. The stand increase associated with rototilling Fontelis was likely related to suppression of early-season onion diseases not white rot since white rot rarely impacts onion stand and early season vigor.

Table 1. Influence of roto-till incorporating Fontelis in combination with Tebustar in-furrow

trt #	Treatment Name	Product Rate per Acre	4 leaf vigor rating(0-10 scale)	Late season leaf dieback (%)	Late season leaf dieback (%)	Onion stand at harvest (plants/ bed ft)	Total onion yield (ton/A)	Clean onion yield (ton/A)	Onion yield with white rot (ton/A)	Onion yield with smut (ton/A)
1A	Untreated (nothing in-furrow)	n/a	6.2b	37.5a	51.7	20.6b	13.3	9.9	2.2	1.2
2A	tebuconazole in-furrow	20.5 fl oz	6.9ab	30ab	43.3	23.1ab	15.6	12.4	1.8	1.4
3A	tebuconazole in-furrow Fontelis roto-till incorporated	20.5 fl oz 24 fl oz	7.2a	25.8b	40.8	25.9a	17.4	14	2	1.4

Special Thanks: The research team would like to thank the California Garlic and Onion Research Advisory Board and Olam International for financial or in-kind support of this research.

University of California
Agriculture and Natural Resources
Intermountain Research & Extension Center

RESEARCH REPORT
Number 190, 2018

Using Onion Seed Treatments to Protect Spring-Seeded Dehy Onions from Maggots and Onion Smut

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Introduction

Two studies evaluating seed treatments for management of maggots were conducted at IREC in 2018. One trial was part of a regional study evaluating seed treatments for maggots, and the other trial evaluated the influence of combining seed treatments with tebuconazole in-furrow. Both study sites had moderate onion smut pressure this year, thus differences in onion stand, vigor, and yield were influenced by both maggots and onion smut. Onion maggot, *Delia antiqua*, and seed corn maggot, *Delia platura*, were captured on yellow sticky traps placed along field edges. Larvae of both species feed on young onion plants, often resulting in seedling mortality. Onion smut, *Urocystis cepulae,* survives in the soil via spores that may persist for over 15 years. Spores are triggered to germinate by onion exudates like white rot. Onions are susceptible to infection from planting until the cotyledon is fully mature approximately 12-24 days after planting. Once plants are infected the fungus can spread to new leaves resulting in stunted plants, stand loss, and severe yield loss. ***Some pesticides listed in this report may not be labeled for use in onions. Please consult pesticide labels for use instructions.***

2018 Site Information

- **Soil type-** mucky silty clay loam-4.2% OM
- **Growing season-** early May to late September
- **Irrigation –** solid-set sprinklers
- **Onions-** 36 inch beds with 4 seed-lines spaced 6 inches apart; 4-inch seed spacing; fresh market Seminis LaSalle variety
- **Design-** RCB with 6 blocks (reps)

2018 Study Methods

Studies were conducted at the UC Intermountain Research and Extension Center. Plots were organized in a randomized complete block with 6 replications. Plots were 6 ft by 24 ft. Seed treatments were commercially applied by Incotec and in-furrow tebuconazole (Tebustar) was applied at 20.5 fl. oz/A using an even fan nozzle set to a 3 inch band at 40 GPA. Seed corn maggot and onion maggot flies were present with seed corn maggot being the dominant pest. Seed treatment efficacy was determined by measuring onion plant density and vigor multiple times during onion establishment. Onion plant density and bulb yield were measured at harvest. Onion stand (plant density) was determined in each plot by counting the number of green onions in the entire plot area (6 ft by 24 ft). Onion smut severity was visually evaluated on 7/19/18 when onions were in the 5-6 leaf growth stage using 0-10 scale with 10= most severe. Onion yield was measured by harvesting all onions in each plot on 10/10/18. Onions were run across a grade-line to remove loose soil and green tops. Onion bulbs were then hand-sorted based on the presence of smut and white rot. A total weight was recorded for disease-free onions, onions with white rot, and onions with smut (small bulbs with raised black blisters from spores).

Results

Influence of combining seed treatments with tebuconazole applied in-furrow at planting- Onion stand differed between treatments at all evaluation times (Figure 1). Interestingly, the fungicide component of both insecticide seed treatments influenced onion stand. The highest stand was obtained using Sepresto and the F-300 + Pro-Gro fungicide package. Adding thiram + peneflufen fungicides to Sepresto and tebustar in-furrow caused crop injury, stand-loss, and reduced vigor up until the 4-leaf stage (some data not shown in Figures), although this treatment gave good smut suppression. At the 5 to 6-leaf stage, Sepresto treatments had lower onion smut severity compared to all Regard treatments especially Regard without a fungicide package (Figure 2). The reason Sepresto suppressed onion smut better than Regard is unknown; it could be related to the insecticides' influence on maggot feeding and subsequent disease infection. Total onion yield differed significantly between treatments (Figure 3) with treatments having the highest stand and lowest smut severity having the highest yield. The percentage of bulbs with smut and white rot symptoms was less than 8% for all treatments. Regard with no fungicides had 92.4% disease-free yield while all other treatments had 96% or higher disease-free bulb yield.

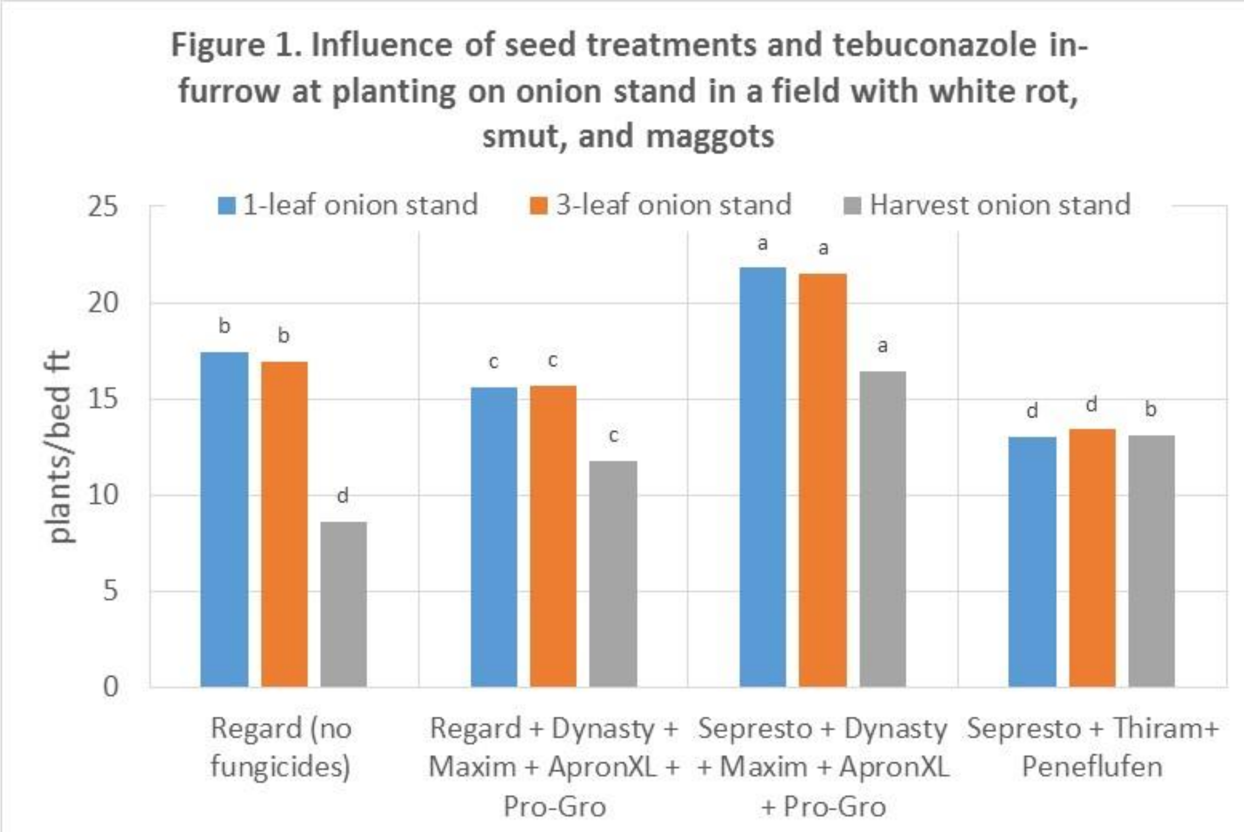


Figure 1. Influence of seed treatments and tebuconazole in-furrow at planting on onion stand in a field with white rot, smut, and maggots
1-leaf onion stand
3-leaf onion stand
Harvest onion stand
plants/bed ft
0
5
10
15
20
25
b
b
d
c
c
c
a
a
a
d
d
b
Regard (no fungicides)
Regard + Dynasty + Maxim + ApronXL + Pro-Gro
Sepresto + Dynasty + Maxim + ApronXL + Pro-Gro
Sepresto + Thiram+ Peneflufen

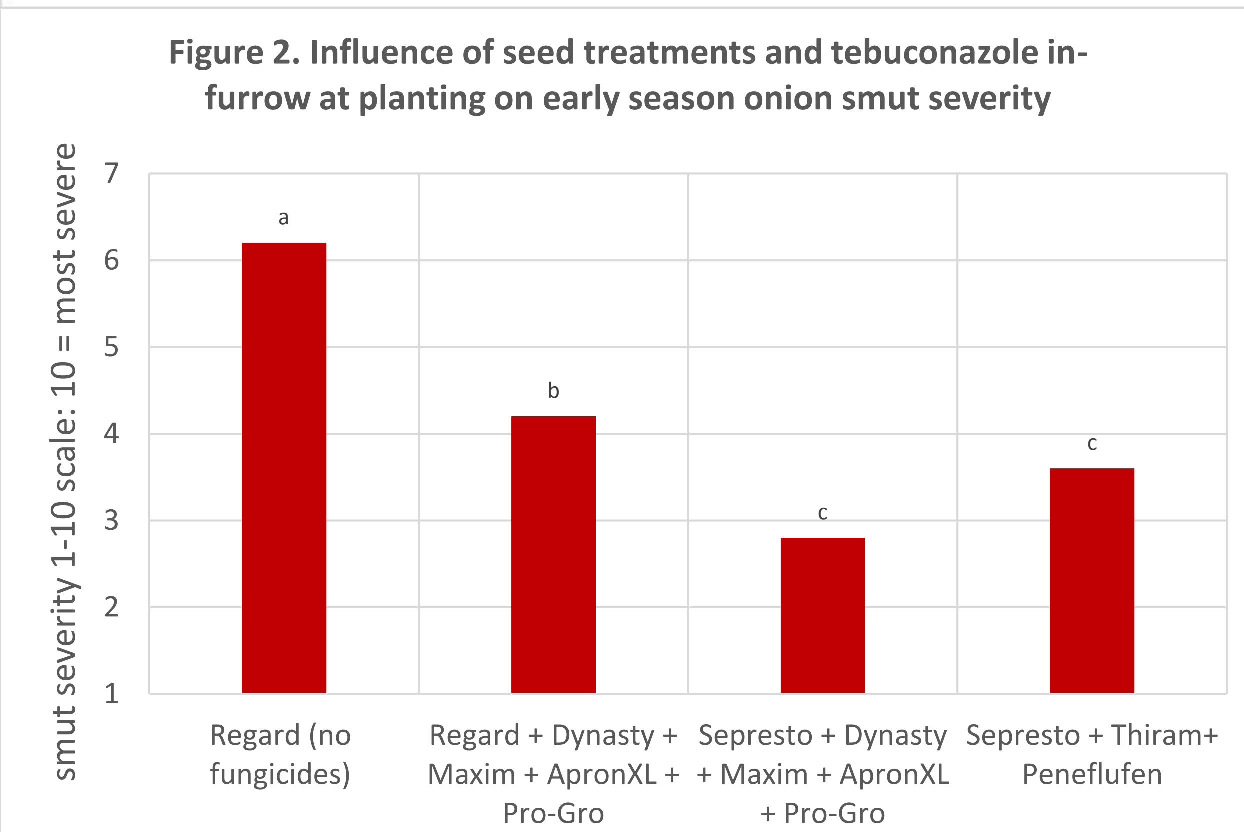
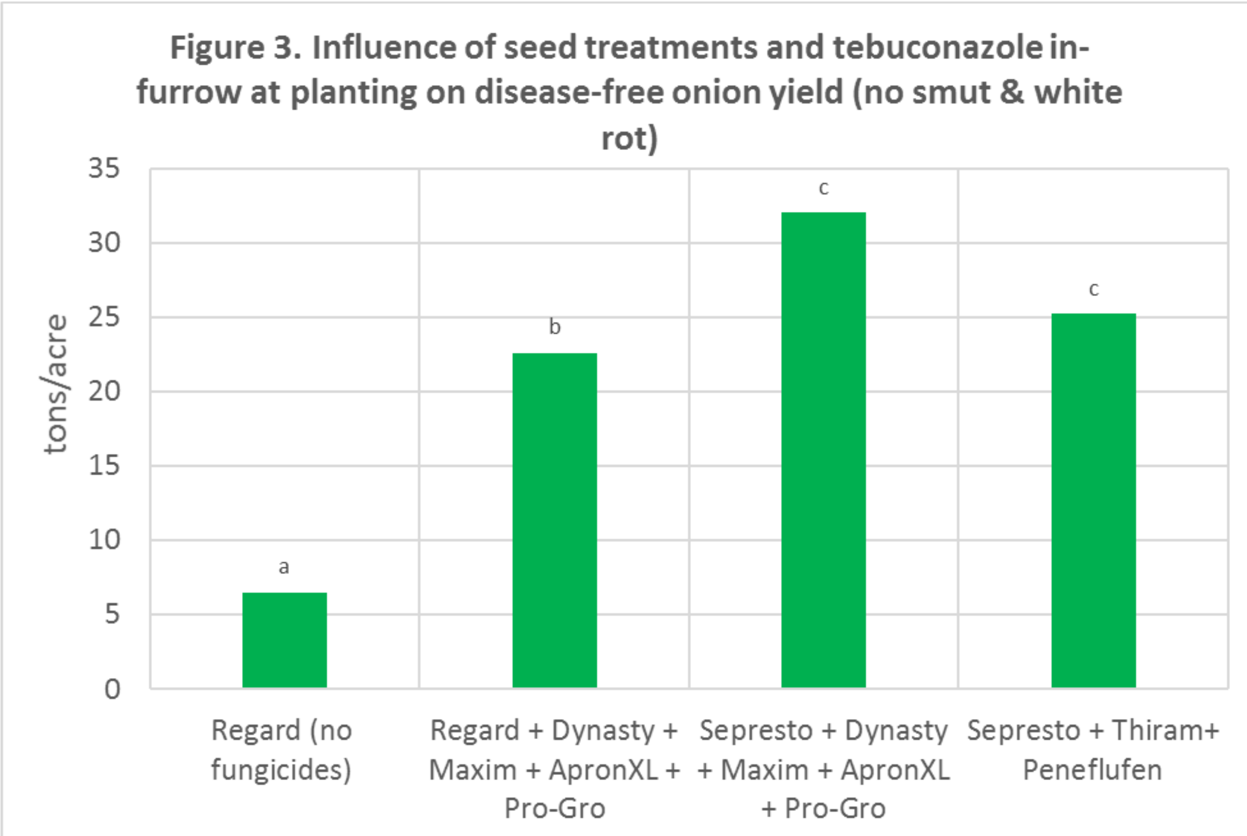


Figure 2. Influence of seed treatments and tebuconazole in-furrow at planting on early season onion smut severity
smut severity 1-10 scale: 10 = most severe
1
2
3
4
5
6
7
a
b
c
c
Regard (no fungicides)
Regard + Dynasty + Maxim + ApronXL + Pro-Gro
Sepresto + Dynasty + Maxim + ApronXL + Pro-Gro
Sepresto + Thiram+ Peneflufen



Influence of seed teatments alone (no fungicide applied in-furrow) for maggots and smut- Onion stand differed between treatments for all evaluations (Table). Regard + Cruiser had the highest onion stand at the 1-leaf and 3-leaf stages with 22 onions per bed ft. Sepresto and Trigard had the next highest onion stands with 20 plants per bed foot at the 3-leaf stage. Onions stands for all treatments decreased from the 3-leaf stage to harvest (Table). Regard only, Regard + fungicides, and no insecticide (control) + fungicides had the highest onion smut severity. Regard without fungicides had the lowest yield (15.5 ton/A) due to stand loss and smut severity (Table). Regard + Cruiser and Sepresto treatments yielded over 30 ton/A. These results generally agree with previous research, although Regard and Sepresto normally offer very similar yields and stands without smut pressure.

Table. 2018 Tulelake Onion Maggot Seed Treatment Study

Trt#	Treatment	1-leaf onion stand plants/ bed ft	3-leaf onion stand plants/ bed ft	Harvest onion stand plants/ bed ft	3-leaf onion vigor 0-10 scale	onion smut rating 0-10 scale; 10 = high severity	Onion yield ton/acre
1	No insecticide + Dynasty + Maxim + Apron XL + Pro-Gro	17 b	18 b	14.6 a	7 a	4.3 ab	26.6 a
2	Sepresto + Dynasty + Maxim + Apron XL + Pro-Gro	19 ab	20 ab	16.9 a	7 a	3.4 b	31.1 a
3	Regard + Cruiser + Dynasty + Maxim + Apron XL + Pro-Gro	22 a	22 a	17.7 a	7 a	3.3 b	34 a
4	Regard + Dynasty + Maxim + Apron XL + Pro-Gro	17 b	18 b	14.6 a	7 ab	4.1 ab	26.6 a
5	Trigard + Dynasty + Maxim + Apron XL + Pro-Gro	19 ab	20 ab	15.8 a	7 a	4 b	28.3 a
6	Sepresto + Thiram +Penflufen	18 b	19 ab	16 a	7 a	3.8 b	30.5 a
7	Regard only (=FarMore OI100)	18 ab	19 ab	10 b	6 b	5.8 a	15.5 b

ANOVA and Tukey's HSD was used for mean comparisons. Treatments with the same letter are not statistically different.

Special Thanks: The research team would like to thank the California Garlic and Onion Research Advisory Board for financial support, Alan George Taylor at Cornell University for arranging seed treatment, and Incotec Seed Coating for applying seed treatment.

University of California
Agriculture and Natural Resources
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RESEARCH REPORT

Number 191, 2018

Weed Management Strategies for Nightshade and Summer Annual Weeds in Garbanzo Beans (chickpea) grown in the Tulelake Basin

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The combination of poor cereal grain prices and high demand for chickpea from NW milling has increased the interest in growing garbanzo beans in Tulelake. In 2017, the Intermountain Research and Extension Center planted a trial to evaluate garbanzo bean development, yield and quality. The results were quite promising with yield averaging 2,500 lbs per acre and excellent bean quality for milling. We had no signs of insect or disease. Weeds, on the other hand, were a terrible problem. The plots required hand-weeding to prevent excessive competition, and cost-effective weed control strategies are needed for large scale production.

Weeds are a significant challenge to successful garbanzo bean production as garbanzo beans are a weak competitor with most weeds including hairy nightshade, cutleaf nightshade, pigweed, common lambsquarters, and prickly lettuce. Previous studies showed herbicides and proper crop rotation are critical to successful weed management in garbanzo beans. Pre-irrigation and tillage are other weed control options, but Tulelake's limited growing season makes pre-irrigation and tillage before planting impractical. Several studies documented herbicide efficacy in garbanzo beans, but little research and information is available that is relevant to irrigated production in Tulelake. Tulelake's soil, climate, and production practices are quite unique compared to other production regions. The soils and climate are very different from the rest of California, and Tulelake's irrigation production practices are different from Idaho and Washington where garbanzo beans are grown without irrigation.

Objectives: Evaluate herbicide efficacy and crop safety for garbanzo beans grown under irrigation in Tulelake.

- Compare the efficacy of currently registered herbicides applied at recommended timings
- Determine the weed control benefits and crop safety of herbicide tank-mixes
- Evaluate the potential of using pyroxasulfone (Zidua) and dimethenamid-P (Outlook) as a preemergence herbicides

Procedures: The experiment was conducted at the UC Intermountain Research and Extension Center in Tulelake, CA. Garbanzo beans were spring seeded and grown under solid-set irrigation. Garbanzo beans were planted using a 10 inch row spacing at 4.5 seeds/ft^2. Plots were 6ft by 20 ft with 4 replications. Yield was determined by direct combining using a research grain combine. Data included % weed control, weed density for all weed species, % visual crop injury, crop stand, and crop yield/quality.

Herbicide Treatment List

1. Untreated Control
2. Hand-weeded Control
3. Prowl H2O at 2.0 pt/A preplant incorporated shortly before planting
4. Prowl H20 at 2.0 pt/A preplant surface applied (no-till and reduced till option)
5. Prowl H20 at 2.0 pt/A post plant pre-emergence (within a 2 days of planting)
6. Sharpen at 2 oz/A + MSO at 1% post plant preemergence
7. Prowl H20 at 2.0 pt/A preplant surface applied and Sharpen at 2 oz/A + MSO 1% post-plant pre-emergence
8. Prowl H20 at 2.0 pt/A + Sharpen at 2 oz/A + MSO 1% post-plant pre-emergence
9. Prowl H20 at 2.0 pt/A + Goal 2xL at 8 fl. oz/A + Sharpen at 2 oz/A + MSO 1% post plant preemergence
10. Prowl H20 at 2.0 pt/A + Chateau at 1.5 oz/A + Sharpen at 2 oz/A + MSO 1% post plant preemergence
11. Zidua at 2.5 oz/A preplant incorporated
12. Zidua at 2.5 oz/A post plant preemergence

Results: See table for a complete review of results. None of the herbicide treatments caused a reduction in crop stand or early season crop injury. All Sharpen treatments provided excellent control of pigweed and hairy nightshade. Combining other herbicides with Sharpen did not improve weed control compared to Sharpen alone for the limited weed spectrum in the trial. Prowl H20 at most application timings numerically reduced weed density compared to the control. Zidua reduced nightshade density and numerically reduced pigweed density compared to the untreated control. Preplant incorporated treatments of Prowl H20 and Zidua consistently had lower weed density compared to post plant preemergence applications. The untreated control had the lowest chickpea yield due to weed competition (Table). Chickpea yield did not differ among herbicide treatments. Sharpen at 2 oz/A post-plant preemergence had the highest yield in the trial and was only treatment statistically different from the control.

Table. Influence of Herbicides on Weeds and Garbanzo Bean (Chickpea) Establishment and Yield.

Herbicide Treatments	Early season crop injury	Crop stand	Early season crop height	Pigweed	Hairy nightshade	Total weeds	Chickpea yield	Chickpea yield per plant
	0-10 rating	# plants/plot	cm	# weeds/plot			tons/A	grams
1. Untreated Control	1 a	271 a	28 a	32 a	9 a	48 a	1.07 b	7.75 b
2. Hand-weeded Control	0.75 a	238 a	25 a	11* ab	10* a	23* ab	1.34 ab	11.39 a
3. Prowl H2O at 2.0 pt/A preplant incorporated shortly before planting	1 a	290 a	26 a	14 ab	3 ab	18 ab	1.26 ab	8.76 ab
4. Prowl H20 at 2.0 pt/A preplant surface applied	1.25 a	255 a	25 a	17 ab	6 ab	23 ab	1.13 ab	9.1 ab
5 . Prowl H20 at 2.0 pt/A post-plant preemergence (within a 2 days of planting)	0.75 a	275 a	27 a	29 ab	4 ab	33 ab	1.17 ab	8.49 ab
6. Sharpen at 2 oz/A + MSO at 1% post-plant preemergence	0.75 a	269 a	26 a	0 b	0 b	0 b	1.52 a	11.18 ab
7. Prowl H20 at 2.0 pt/A preplant surface applied & Sharpen at 2 oz/A post-plant preemergence	0.75 a	249 a	26 a	0 b	0 b	2 b	1.43 ab	11.5 a
8. Prowl H20 at 2.0 pt/A + Sharpen at 2 oz/A post-plant preemergence	0 a	266 a	27 a	0 b	0 b	0 b	1.49 a	10.5 ab
9. Prowl H20 at 2.0 pt/A + Goal 2XL at 8 fl. oz/A + Sharpen at 2 oz/A post-plant preemergence	0.5 a	252 a	27 a	0 b	0 b	0 b	1.41 ab	10.9 ab
10. Prowl H20 at 2.0 pt/A + Chateau at 1.5 oz/A + Sharpen at 2 oz/A post-plant preemergence	0.75 a	262 a	27 a	0 b	0 b	0 b	1.37 ab	10.2 ab
11. Zidua at 2.5 oz/A preplant incorporated	0.5 a	247 a	25 a	6 ab	1 b	7 b	1.36 ab	10.95 ab
12. Zidua at 2.5 oz/A post plant preemergence	1 a	249 a	26 a	16 ab	6 ab	23 ab	1.28 ab	10 ab

Letters next to means represent significant difference. Treatments with different letters are statistically different using Tukey's HSD test.

**Reflects weeds that emerged after 1st weeding event. All weeds were removed from the hand-weeded plot after weed density measurements.*

Loading chicken manure

Potato emerging

Chopping cover crop

Kura clover trial

Mint Genome Project

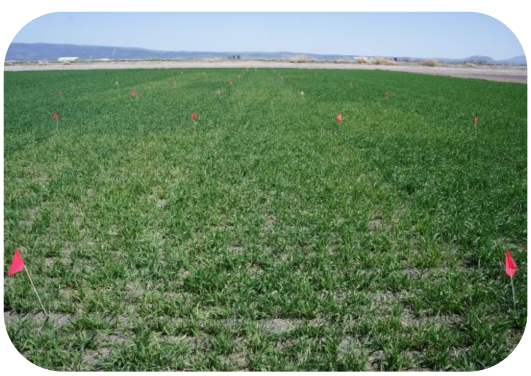
Onion maggot damage

Mint weed control study

One leaf onions

Low lignin alfalfa harvest

Weevil larvae feeding on alfalfa



Osprey weed control trial

Grain following the 2017 cover crop trial