UC Cooperative Extension

UC Davis Alfalfa/Forage/Biofuels Field Day

Thursday, May 11, 2023, Davis, CA

Sponsored by: California Crop Improvement Association, UC Cooperative Extension, Division of Agriculture and Natural Resources, and UC Davis Department of Plant Sciences, For further information on alfalfa see:

https://alfalfa.ucdavis.edu

University *of* California
Agriculture and Natural Resources

2023 UC Davis Alfalfa/Forages & Small Grains Field Day
May 11th, 7:30 a.m. – 3:30 p.m.
Supported by the California Crop Improvement Association (CCIA)

Department of Plant Sciences Field Facility, UC Davis
(2400 Hutchison Dr, Davis CA 38.5390, -121.7800)
Continuing Education Units (CEUs): 3.5 CCA; 1.5 CDFA INMP (formerly CURES**)**
REGISTER HERE (no charge for event)

7:30 **Sign-in** (*refreshments available*)
7:55 **Welcome and Introductions** (CCIA Directors Katy Soden and Timothy Blank)
8:00 **Travel** on Wagons to Field

Alfalfa/Forage/Biofuel Field Tour
CEUs: 1.5 CCA (0.5 soils, 0.5 IPM, 0.5 sustainability)**; 0.5 CDFA INMP** (irrigation)

STOP A.
8:10 **Alfalfa Breeding Efforts at UC Davis**—*Charlie Brummer*
8:20 **Choosing Varieties for Pest Resistance**—*Dan Putnam, UC Davis*
8:30 **Test your Weed IQ – Identification of weeds**—*Brad Hanson, UC Davis*

STOP B
8:45 **IPM and Importance of Management of Insect Resistance in Alfalfa**—*Ian Grettenberger, UC Davis*
8:55 **Sorghum Projects for Forage and Biofuels**—*Jackie Atim, Kearney Research Center and UC Merced*
9:05 **Improving agronomic and grain quality traits in sorghum, under well-watered and drought conditions**—*Christine Diepenbrock, UC Davis*
9:15 **Use of Compost to improve soils in alfalfa**—*Michelle Leinfelder-Miles UCANR and UC Davis*

STOP C
9:30 **Flood or Drought? Alfalfa Strategies for coping with California's Future**—*Dan Putnam UC Davis*
9:40 **Teff as an Alternative Summer Forage Crop**—*Dan Putnam, UC Davis*
9:50 **Overhead Irrigation Technologies for Improved efficiency**—*Isaya Kisekka, UC Davis*

STOP D Small Grains Field Tour Agenda
CEUs: 2.0 CCA (1.0 nutrient management, 1.0 crop management)**; 1.0 CDFA INMP** (N management)

10:05 **Updates from UC Davis small grains breeding program** *Jorge Dubcovsky (UC Davis)*
10:20 **Effects of genotype and environment on productivity and quality in Californian malting barley** *Maany Ramanan, Taylor Nelsen, Mark Lundy, Christine Diepenbrock, Glen Fox (UC Davis/UCCE)*
10:30 **California Grain Foundation and research on food use of triticale** *George Fohner (CA Grain Foundation)*
10:40 **Small grain research update from Tulelake** *Rob Wilson and Darrin Culp (UC Intermountain REC)*
10:55 **Evaluating digestate and hydrolysate as alternative N sources in small grains** *Valentina Roel and Cameron Pittelkow (UC Davis)*
11:05 **Biosolids as a N fertilizer source in California small grains** *Konrad Mathesius, Daniel Geisseler, Makina Savidge, Mark Lundy, Taylor Nelsen, Neil Andersen (UC Davis/UCCE)*
11:15 **Helping farms in the Central Coast get nitrogen scavenging credits for cereal cover crops** *Eric Brennan (USDA-ARS, Salinas) and Richard Smith (UCCE)*
11:25 **DIY in-field plant tissue tests to determine N sufficiency in wheat** *Karla Estrada (UC Davis)*
11:30 **Updates on small grain research and production in the Central Valley** *Mark Lundy (UC Davis/UCCE)*
11:45 **Tour small grain variety trials**
11:55 **RETURN TO HEADQUARTERS**

12:10 - 1:10 **CCIA Sponsored LUNCH**

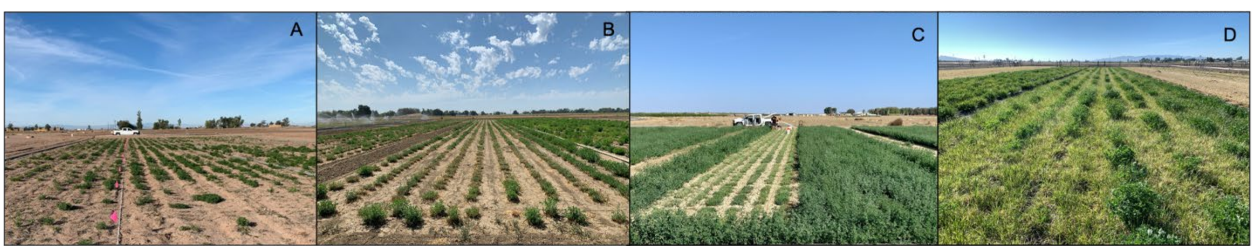
AFTERNOON:
1:20 **Depart for afternoon small grain breeding field day (see separate agenda)**

Breeding & Evaluating Alfalfa and Grass for Yield and Drought Tolerance

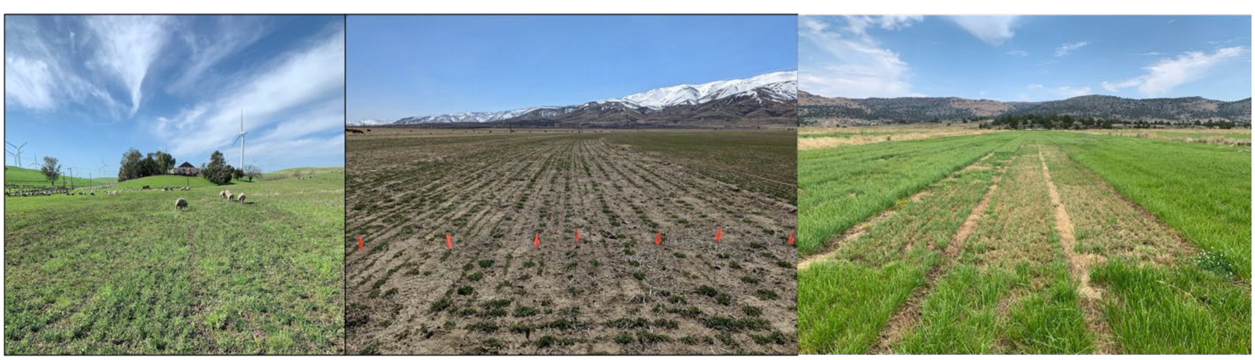
Charlie Brummer, Dan Putnam, Matt Francis, Kreingkrai Nonkum, Cree King – UC Davis
Josh Davy, Morgan Doran, Tom Getts, David Lile, Guiliano Gaudi, Grace Woodmansee, , Rob Wilson, Darren Culp – UC Cooperative Extension
Luke Garrod, Tony Turri, Kelsey Nichols, Wayne Hansen, John Brazie, Scott Murphy – farmer/rancher cooperators ecbrummer@ucdavis.edu

1. Improving yield using half-sib yield testing, drone-based prediction, and genomics

2. Selecting under full and deficit irrigation in Davis and in El Centro, salinity at Westside, with and without grass competition in Tulelake.



3. Developing alfalfa for non-irrigated rangeland – winter production and summer survival (Rio Vista, Paskenta, Wilson); on-farm alfalfa breeding nurseries (Herlong); grass variety trials (Susanville, Scott Valley, Shasta Valley, IREC, Davis) and breeding nurseries (Davis)

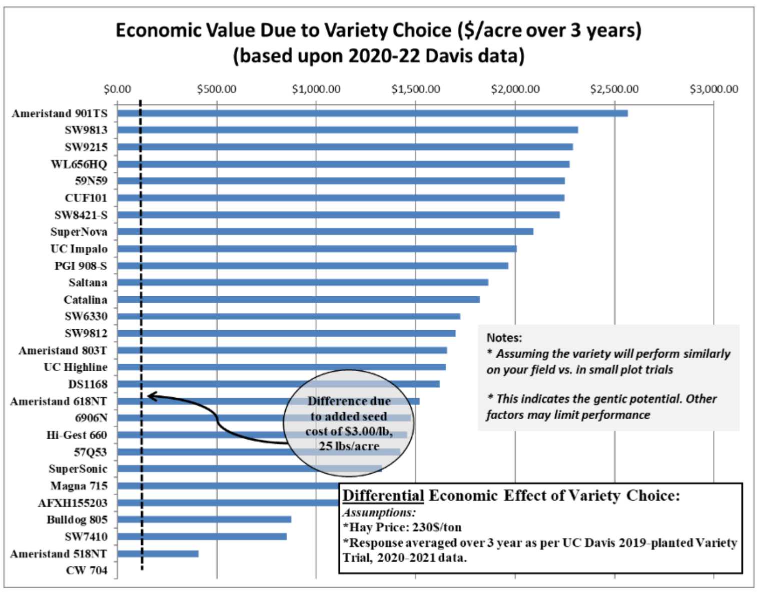


Understanding Alfalfa Cultivar Pest Resistance

Dan Putnam, UC Davis

What is an Alfalfa Variety? While alfalfa varieties may superficially look similar, each variety is really a population of plants – look carefully. Improved varieties have an average yield or other characteristic that may be superior or inferior to other lines.

Start with Yield. The economic Value of yield differences between varieties can be significant economically. Yield economic differences due JUST yield differences can be worth hundreds or thousands of dollars/acre over three years (see graph). Yield also predicts plant vigor and stand life that help with weed competition and recovery from pest damage.



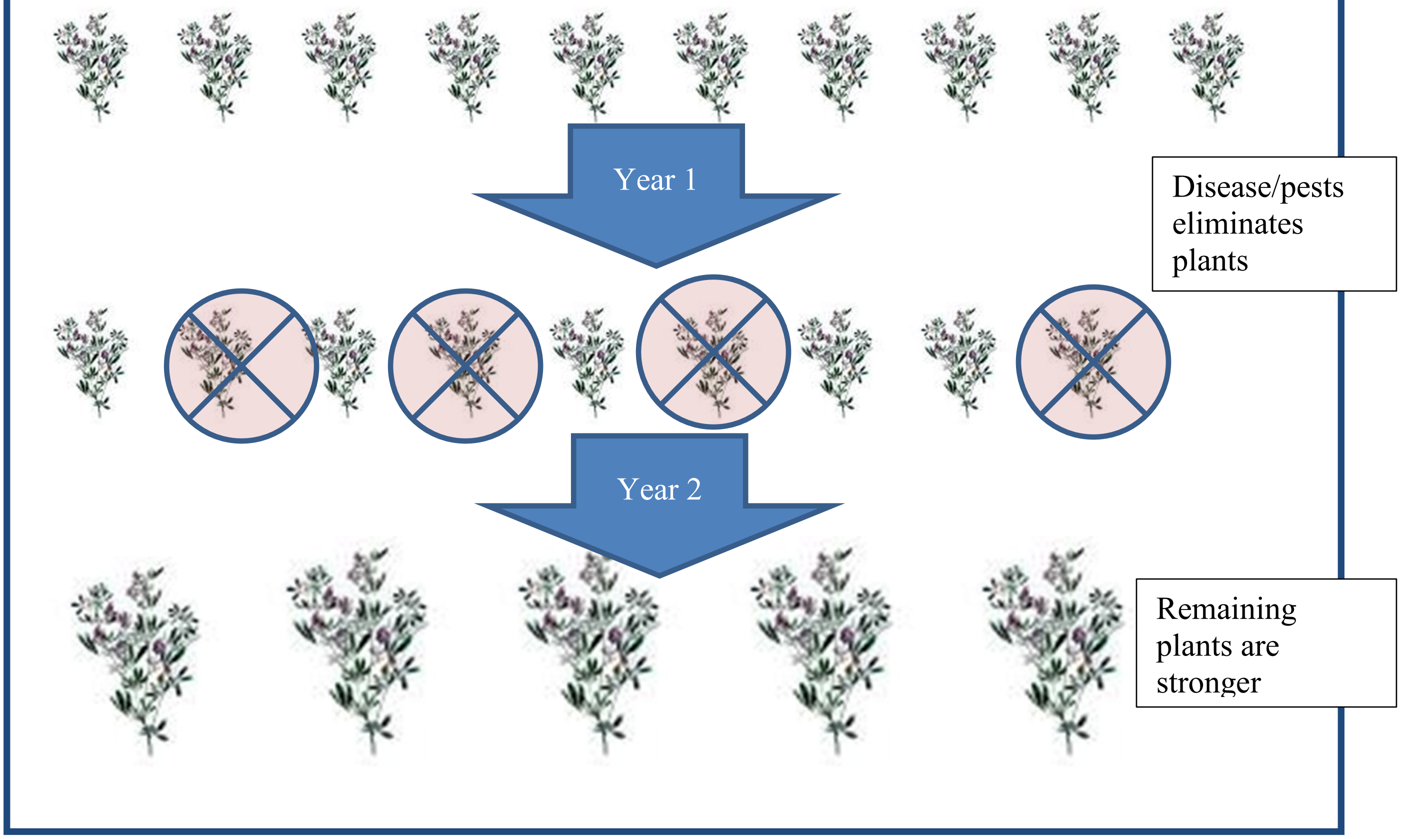
Varieties: Important fo Pest Management. Alfalfa variety choice can make a large difference in pest management. Key aspects are as follows:

1. Roundup-Ready Alfalfa – can assist with difficult weed problems.
2. Stand Persistence – prevents weed intrusion.
3. Insect, nematode, and disease genetic resistance—often the only cost-effective tool.
4. A pest may take some of the plants, but not all in a resistant variety.

Recommendations Sacramento/San Joaquin Valley:

Fall Dormancy:	4-9 Rating
Spotted Alfalfa Aphid (SAA):	R
Pea Aphid (PA)	HR
Blue Alfalfa Aphid (BAA):	HR
Pythopthora Root Rot (PRR).	HR
Bacterial Wilt (BW):	MR
Fusarium Wilt (FW):	HR
Stem Nematode:	HR
Root Not Nematode:	HR
Verticillium Wilt (VW)	R

How does Pest Resistance work?



Resistance Abbreviations		Percent resistance[1]
HR	Highly Resistant	>51%
R	Resistant	31-50%
MR	Moderately Resistant	15-30%
LR	Low Resistant	6-14%
S	Susceptible	<5%

Remember:

- Resistance is not absolute (it is a % of plants in a population)
- Even highly resistant varieties can be overwhelmed.
- Pest Resistance is often the only economic measure to combat many pests.
- Think of Pest Resistance as you do auto insurance—not important every year, but can be very important in those years with severe pest pressure.

- **Current Variety Leaflet:** https://www.alfalfa.org/publications.php
- **Variety Trial Data:** https://alfalfa.ucdavis.edu/+producing/variety/

Test your Weed IQ – Weed Identification

2023 UC Davis Alfalfa/Forages Field Day 05/11/23

Brad Hanson, Cooperative Extension Weed Specialists, UC Davis
bhanson@ucdavis.edu, 530-752-8115

University of California
Agriculture and Natural Resources
Making a Difference for California

Upcoming weed science meetings:

UC Weed Day	– June 21, 2023	Davis, CA
Weed Science School	– September 19-21, 2023	Davis, CA
California Weed Science Society	– January 24-26, 2024	Santa Barbara, CA

Various online information resources

Weed Science

UC Weed Research and Information Center:	http://wric.ucdavis.edu/
Weed Identification tool:	http://weedid.wisc.edu/ca/
UC Weed Science blog:	http://ucanr.org/blogs/UCDWeedScience/
Hanson lab page:	http://hanson.ucdavis.edu/

UC Integrated Pest Management Program

All ag crops:	https://ipm.ucanr.edu/agriculture/
Alfalfa	https://ipm.ucanr.edu/agriculture/alfalfa/
	UC IPM Guidelines: Alfalfa. UCANR Publication 3430 (download at above link)

Other:

- Livestock Poisoning Plants of California. DANR Publication 800 (available online) http://alfalfa.ucdavis.edu/-files/pdf/LivestockPoisoningPlantsNov2010.pdf
- Links to Weed ID sites http://wssa.net/weed/weed-identification/weed-id-pages/
- Weeds of the West (available from Western Society of Weed Science)
- Weeds of California and Other Western States (UC ANR catalog, other)
- Interactive Encyclopedia of North American Weeds – CD (Weed Sci Soc of America)

Weed ID (wait, *no one told me there was going to be a test!*)**:**

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8 ______________________

Insecticide resistance in alfalfa weevil

Madison Hendrick, PhD Student, Ian Grettenberger, Specialist, UC Davis

What is insecticide resistance?

- Insecticide resistance is when an insect pest can tolerate typically lethal doses of an insecticide. This can result in control failures!
- Resistance occurs at the intersection between management practices and pest genetics; a combination of frequent insecticide use and the "right" mutation(s) in a pest.

Pyrethroid resistance in alfalfa weevils

- There are very few insecticides labeled for alfalfa weevil. Most are either pyrethroids, or are just not very effective. Indoxacarb is a highly effective "alternative" option.
- Studies in 2016 and 2018 identified Scott Valley and Palo Verde Valley as pyrethroid resistance hotspots in CA. Work done in 2020-2022 has corroborated this, as well as identified Merced County and possibly other areas in the San Joaquin Valley as areas of concern.
- There are still plenty of susceptible populations in California, but insecticide resistance management tactics need to be employed to preserve the materials we have, like indoxacarb.

RAW

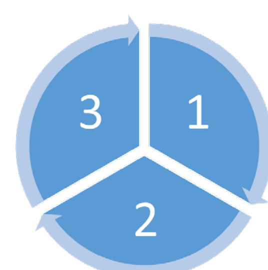
RESISTANT ALFALFA WEEVIL

What can we do about insecticide resistance?

- **First, make sure you are using good agronomic practices.**
  Making sure that you have a healthy, vigorous stand will help your fields tolerate damage somewhat more, reducing the need for insecticide applications.
- **Consider using cultural control practices**.
  Harvesting alfalfa early if pest pressure is high near harvest or having sheep graze fields over winter can reduce pest pressure without insecticide applications.
- **Pay attention to economic thresholds, spray only when necessary, and follow best practices.**
  By evaluating the severity of pests in your field and spraying based on the UCIPM guidelines, you can avoid adding extra, *unnecessary*, insecticide selection pressure to your field. Pay attention to application timing. Applying insecticides too early can risk missing the peak of pest pressure.

The worst application you can make is one that does not work.

- **Try to protect populations of natural enemies, such as parasitoid wasps, whenever possible.**
  There are many insects out there that will feed on or parasitize pest insects in your fields. If these natural enemy populations are protected and preserved, they can help suppress pests. Using more selective insecticides that target pests when you do spray can keep these natural enemy populations healthy.
- **Rotate Modes of Action for insecticides when possible!**
  Insecticides are all grouped based on how they affect a pest, otherwise called their Mode of Action (MoA), or group number. The best practice is to rotate between MoA's for successive generations of a pest. For alfalfa weevil, this means between years. Repeatedly using insecticides in the same group increases selective pressure and favors resistant genetics. However, using different modes of action provides a break from this selection pressure.



Interested in alfalfa weevil insecticide resistance? Contact Ian at imgrettenberger@ucdavis.edu

University of California ANR Grain and Forage Sorghum Variety Trials

Jackie Atim, Robert Hutmacher, Julie Pedraza, Chris de Ben, Tarilee Frigulti-Schramm, Jorge Angeles, Ernesto Duran, Brian Neufeld, Vince Silva, Maikon Lemos and Daniel H. Putnam

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is the fifth most globally important cereal crop, ranking behind rice, maize, wheat, and barley. Grain and forage sorghums are used for animal feed for dairy and beef industries, in the pet food and for bird seed, for feed in pork and poultry production. Sorghum is a candidate for renewable fuels and specialty chemicals industries, and have found uses in food systems, gluten-free beer and pastries.

Sorghum has characteristics helpful in adaptation to drought, high temperatures and marginal soils, making it one of the more highly adaptable forage crops in terms of adaptation to climate change. The majority of US grain sorghum production is in Kansas and Texas, with limited production in California. Forage sorghum may have a better fit in CA. California is expected to have expanding needs for adaptable crops well-suited to deal with limited water supplies and deficit irrigation, in a crop with relatively few needs in pest and disease management. Research at University of California is being conducted at UC Davis, UC-Kearney and UC-West Side Research and Extension Centers.

UC Research Projects

1. Forage and Sorghum Variety Trials (UCD, West Side and Kearney REC's)
2. Joint BioEnergy Institute/UC sorghum transgenics field trials.
3. Bacteria Enrichment patterns in the Root endosphere of drought-stressed sorghum
4. Deficit irrigation impacts on forage quality & composition for bioenergy use.

Fig 1: Forage biotypes *(can differ in height, duration of growth/maturity timing, timing and size of panicle development, BMR and brachytic characteristics)*

Results: Forage and Grain Sorghum performance trials in 2022

Table 1. Various agronomic and yield characteristics for grain sorghum hybrids (averages for each site shown for 3 trial locations in California in 2021, Kearney, Westside, and UC Davis Farm locations.

Hybrid Information			Grain Yields bu -1		
Entry	**Company**	**Hybrid**	**Kearney**	**West side**	**UC Davis Farm**
1	Dyna-Gro	M59GN94	78.51	147.27	137.94
2	Dyna-Gro	M60GB31	75.22	142.86	115.64
3	Dyna-Gro	M63GB78	84.49	133.79	104.23
4	Dyna-Gro	M67GB87	98.63	162.05	99.82
5	Dyna-Gro	M71GR91	103.34	161.53	109.41
6	Dyna-Gro	M72GB71	81.36	134.05	117.19
7	S&W Seed	SP7715	53.82	174.49	109.41
8	S&W Seed	SP72M42	79.42	127.56	82.97
9	S&W Seed	SP78M42	89.1	145.2	144.94
10	S&W Seed	NK8828	68.87	123.93	102.67
11	S&W Seed	SPSD455	75.98	140.27	119.79
	Means		**79.85**	**143.51**	**114.21**
	CV		**18.85**	**14.54**	**22.42**

Table 2. Summary of key forage characteristics by type of forage grown at three locations, Kearney, West Side and Davis in 2022. Abbreviations are shown in the footnote.

Sorghum Type (number of cultivars)[1]	% Lodging @ Harvest[2]	Silage Yield (T/A) @65% Moist.[2]	% Crude Protein[2]	% ADF[2]	% NDF[2]	% Lignin[2]	% NDF D30[2]	% NDF D240[2]	Milk lbs/ton DM[2]	Relative Feed Quality (RFQ)[2]
PS (2)	0.28 c	33.78 a	6.32 b	40.79 a	62.97 a	5.12 a	49.05 b	66.40 a,b	2476.44 b	87.10 d
PS-BMR (7)	12.70 b,c	27.29 b	7.36 a	38.56 b	57.85 b	4.08 b	53.68 a	67.67 a	2556.13 b	105.11 c
FOR-NON (17)	24.62 a,b	26.37 b	7.31 a	33.68 c	50.52 c	4.14 b	47.38 b	63.54 c	2808.98 a	114.69 b
FFOR--BMR (9)	34.75 a	23.52 c	7.54 a	32.50 c	49.20 c	3.51 c	51.95 a	65.59 b	2870.64 a	126.74 a
Average	23.47	26.25	7.32	34.74	52.32	4.02	49.86	65.03	2756.27	114.3

[1]Number in parenthesis is the number of cultivars for each sorghum type. PS-BMR = Photoperiod-sensitive brown mid-rib; PS = Photoperiod sensitive; FOR-BMR=Forage brown mid-rib type; FOR-NON= forage type. [2]Means followed by the same letter do not significantly differ using LSD (P=0.05)

Table 3. Top yielding hybrids that yielded over 24.0 tons acre^{-1} averaged over the three sites for the University of CA Forage sorghum Trials in 2022.

Hybrid	Company	Maturity	BMR	% Lodging	Ton ac^{-1} 65% Moist	240 hr NDFd	Milk Lbs ton-1	Rel. Forage Quality
A11003/F17300	Rooney	PS	NO	0.00 l	34.49 a	66.08 b-i	2542.9 j-m	92.30 n-q
TX08001	Rooney	PS	NO	0.56 l	33.08 a,b	66.73 b-g	2410.0 m,n	81.91 q
Fullgraze II	Dyna-Gro Seed	ML	NO	0.00 l	31.89 a-c	65.54 c-l	2501.7 k-m	86.52 o-q
Hybrid X54243	Scott Seed Co.	MED	NO	0.00 l	30.93 a-d	66.65 b-h	2477.2 l,m	84.66 p,q
SS405	S&W Seed	ML	NO	12.22 h-k	30.54 a-e	62.66 m-p	2777.8 d-i	103.96 k-n
Z-1310 PPS	Zinma Seed	PS	YES	7.78 i-l	29.47 b-f	67.44 a-d	2368.8 m,n	88.14 o-q
Fullgraze II BMR	Dyna-Gro Seed	ML	YES	17.78 f-i	28.87 b-g	66.70 b-h	2674.6 g-k	106.32 j-m
Super Sile 20	Dyna-Gro Seed	ML	NO	62.22 b,c	28.76 b-h	62.95 m-p	2649.9 h-l	101.91 l-n
Hybrid X50652	Scott Seed Co.	PS	YES	0.00 l	28.51 b-h	69.76 a	2387.7 m,n	101.24 l-n
SFS Star	Dyna-Gro Seed	E	NO	60.00 c	28.47 b-h	64.15 h-p	2767.8 d-i	109.43 i-l
Hybrid X50665	Scott Seed Co.	MED	YES	0.00 l	27.68 c-i	65.67 c-k	2869.7 b-e	131.91 b,c
Hybrid X52053	Scott Seed Co.	MED	NO	2.22 k,l	27.68 c-i	64.52 f-n	2896.0 b-e	122.74 c-h
SweetTon MS	Dyna-Gro Seed	ML	NO	26.67 e,f	27.43 c-j	65.18 c-m	2924.1 a-e	122.34 c-h
F72FS05	Dyna-Gro Seed	ME	NO	0.00 l	27.25 c-j	64.91 d-m	2819.4 d-h	115.79 g-k
Super Sweet 10	Dyna-Gro Seed	M	NO	26.11 e,f	27.20 c-j	61.96 n-p	2844.7 c-g	114.70 h-k
NK300	S&W Seed	ME	NO	20.56 f-h	27.11 c-j	61.59 p,q	2826.6 d-g	119.34 d-i
Super Sile 30	Dyna-Gro Seed	ME	NO	71.11 b	26.52 d-k	63.16 k-p	2632.7 i-l	98.81 l-o
SP3905 BD BMR 1	S&W Seed	ME	YES	2.78 k,l	26.48 d-k	63.09 l-p	3022.3 a,b	143.69 a,b
Danny Boy II BMR	Dyna-Gro Seed	PS	YES	63.33 b,c	26.24 d-l	68.62 a,b	2262.4 n	96.85 m-p
SPBD703	S&W Seed	E	YES	0.56 l	26.21 d-l	63.44 j-p	2941.7 a-d	129.59 c-e
Dynagraze II BMR	Dyna-Gro Seed	ME	YES	23.89 f,g	25.77 e-m	67.28 a-e	2919.6 a-e	120.15 c-i
SP1792 MS	S&W Seed	M	NO	36.67 d,e	24.76 f-n	64.52 f-n	2693.4 f-j	106.81 j-m
Z-1220 BMR	Zinma Seed	ML	YES	85.56 a	24.65 f-n	64.22 g-o	2754.9 e-i	116.65 f-j
SP3905 BD BMR 2	S&W Seed	ML	YES	0.00 l	24.18 g-n	67.73 a-c	2858.6 b-f	130.35 c,d
Hybrid X52265	Scott Seed Co.	MED	NO	1.11 l	24.05 h-n	64.40 f-o	2884.7 b-e	124.82 c-h

Hybrid information provided by seed companies. Under type, F=Forage sorghum. Under Maturity, E=Early, F=Full, ME=Medium Early, MF=medium Full, M=Medium, ML=Medium Late, L=Late, PS=Photoperiod Sensitive.

This and previous reports can be found at the sorghum website, www.sorghum.ucanr.edu

Improving agronomic and grain quality traits in sorghum, under well-watered and drought conditions

R. Dumanski, T. Bansal, S. Lo, J. Berlingeri, J. Pedraza, I. Mayanja, E. Maereka, G. Rendon, I. Matthews, R. Kawai, J. Dahlberg, M. Earles, B. Bailey, J. Sibiya, C. Diepenbrock (**chdiepenbrock@ucdavis.edu**).
A partnership between UC Davis, UC ANR, and Univ. KwaZulu-Natal, South Africa.

Background: Grain yield in sorghum is determined through the combination of grain size and grain number. Grain number is determined in the period leading up to flowering. Drought and limited-irrigation scenarios are relevant to sorghum production in the U.S. and worldwide, and grain composition is of interest for multiple end uses.

Research questions:

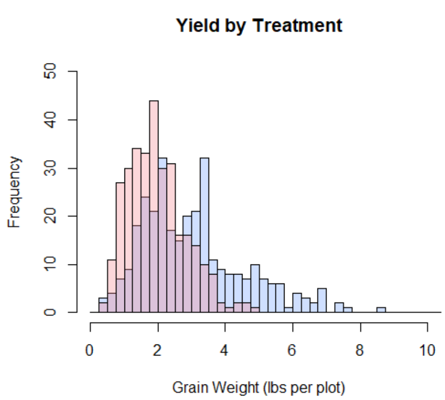
1) How are the following traits affected by pre-flowering drought vs. well-watered conditions?
    a. *Agronomic traits*: grain yield, plant height, flowering time, 100-seed weight, grain number, etc.
    b. *Grain compositional traits*: protein, lysine, fat, starch, moisture, ash, total phenolics, etc.
2) Which parts of the genome are relevant for these traits under one or both conditions? How well can we predict breeding values for these traits from DNA sequence information?
3) Which of the ~300 tested sorghum lines perform well in California?
4) To what extent can AI-enabled phenotyping help improve our trait predictions? How does variation in certain structural and functional traits (e.g., related to water use) relate to final yield?

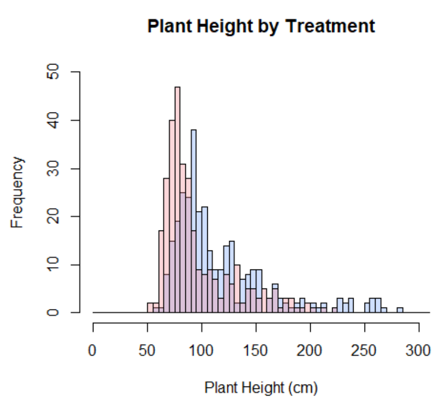
Experimental setup:

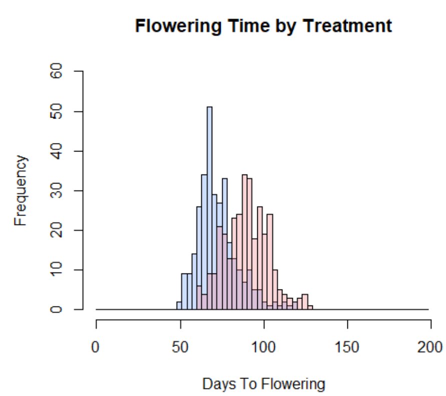
- 2020-2022: field trials of ~300 lines at the UC ANR West Side Research & Extension Center (REC), with thanks to the West Side REC and Kearney Ag. REC teams. Additional (smaller) field trial in Davis in 2022.
- Two replicate plots of each sorghum line per treatment per year; augmented design with two repeated check lines in each block of 15 or 16 plots (at West Side), randomized complete block design (in Davis).

Results:

- Reduced grain yield and plant height, and slower flowering time (along with higher grain moisture %) in pre-flowering drought (in pink below) vs. well-watered conditions (in blue below).







- Changes in grain compositional traits were substantially less than those for agronomic traits.
- On a 'per-line' basis, trait performance was moderately to highly correlated across treatments and years.
- Some of the lines evaluated in this study looked promising as parents for future crosses.

Video of our harvest workflow: 'Field to Flour' by Rebecca Dumanski, with thanks to Bryan Heyano: https://video.ucdavis.edu/media/1_8h4k7g8x.

Funding sources for these projects: USDA NIFA 2021-67013-33939; projectgemini.ucdavis.edu.

Use of Compost to Improve Soils in Alfalfa

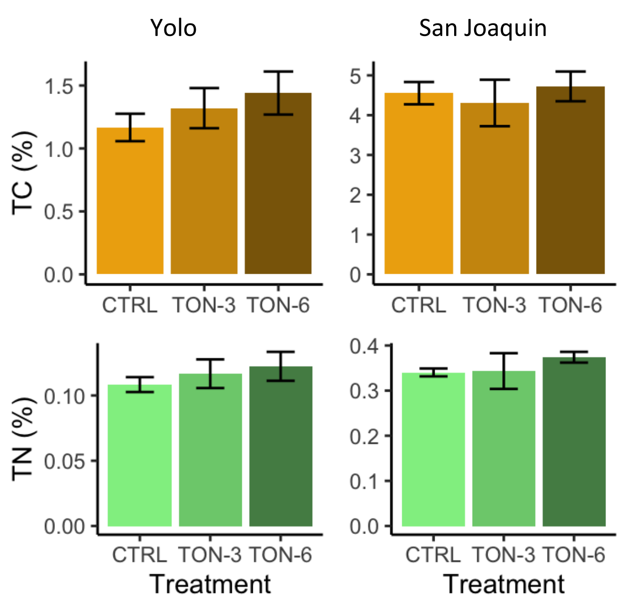
Michelle Leinfelder-Miles and Rachael Long, UCCE and Radomir Schmidt, UC Davis
UC Davis Alfalfa Field Day, May 11, 2023

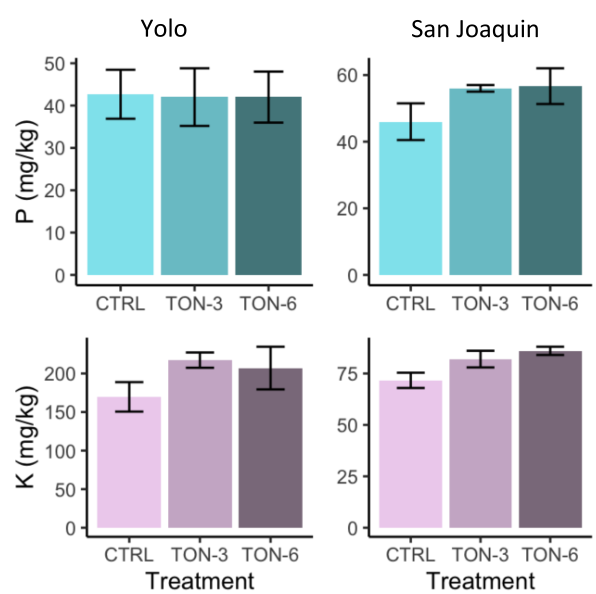
We have been evaluating the use of green waste compost on established alfalfa. Questions of interest include:

- Does green waste compost application to alfalfa fields improve soil carbon and nitrogen storage or other soil quality characteristics?
- Does compost application improve alfalfa yield or quality?
- How does compost application affect greenhouse gas emissions?

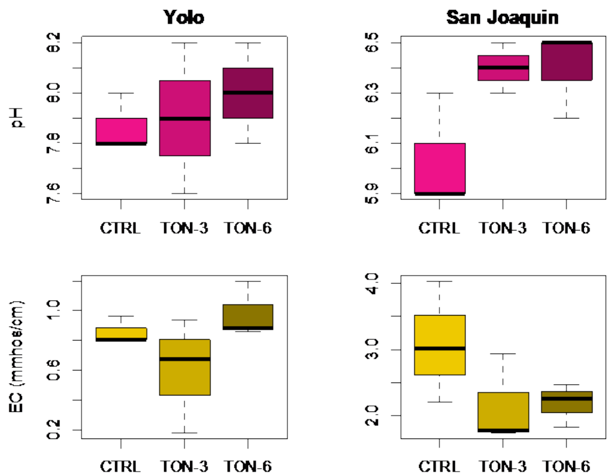
Methods: The project is on commercial farms in Yolo and San Joaquin (SJ) counties. The Yolo site is a mineral soil with high clay content, and the SJ soil is a mucky clay with high organic matter. We are comparing two green waste compost rates (3 and 6 t/a) to the untreated control. Compost applications were annually (2020-2022) surface-applied in the fall/winter ahead of rain.

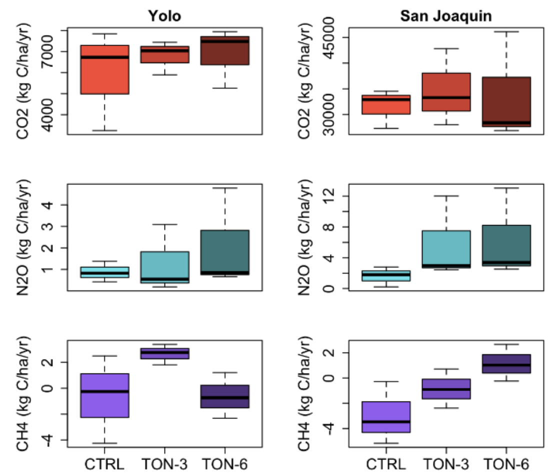
Preliminary results: There have been no significant differences in total carbon and nitrogen among treatments (Fig. 1, below left), but there is a trend for compost to increase carbon and nitrogen at the Yolo site, which has low organic matter. We have observed an increase in phosphorus and a statistically significant increase in potassium at the SJ site, where soil potassium is inherently low (Fig. 2, below right).



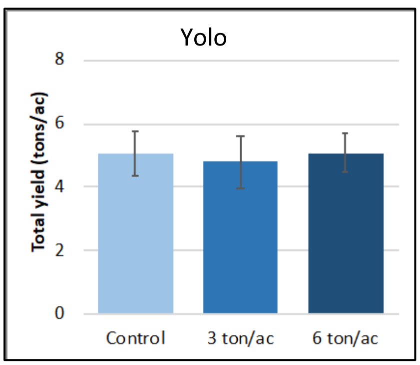


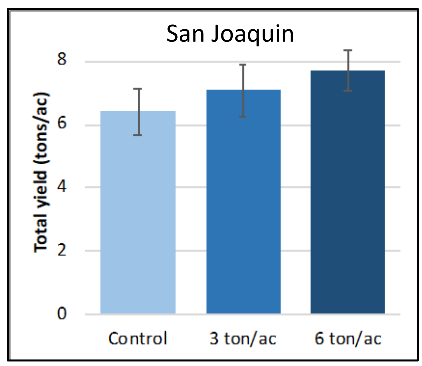
We have also observed improvements to soil pH (i.e. rising) and salinity (i.e. lowering) at the SJ site (Fig. 3, below left). We need to further explore these results, but we hypothesize that these are occurring due to changes in soil biological composition and improvements in soil physical characteristics, like aggregation and infiltration. Greenhouse gas emissions have not differed among treatments (Fig. 4, below right), indicating that the carbon that is added is not being respired from the system. Higher CO_2 emissions at the SJ site are attributed to the inherently higher carbon of the soil.





We have not observed statistically significant improvements to alfalfa yield, though there has been a trend for compost to improve yield at the SJ site. We will continue monitoring soil characteristics, greenhouse gas emissions, and yield at both sites in 2023.





Other considerations:

- **Compost type:** Compost is decomposed organic matter from plants or animals. Plant-derived composts have a high carbon-to-nitrogen ratio (C:N), which is the relative amount of carbon and nitrogen in the material. Animal-derived composts have a low C:N. The ratio is important because it affects microbial metabolic functioning and plant-available nitrogen. The green waste compost that was applied to this trial has a high C:N. We would not expect it to supply nutrients to sustain crop production, but over time, the addition of carbon can help improve nutrient retention and soil functioning.
- **Cost:** It may take years before soil health and yield benefits from compost are realized, and this can inhibit adoption. Additionally, costs for material plus hauling runs $27/ton and spreading $10/ton, totaling $37/ton (2021 prices). To help offset compost costs, CDFA's Healthy Soils Program provides funding to farmers to implement soil conservation practices, like compost applications. For more information, please see https://www.cdfa.ca.gov/oefi/healthysoils/

Teff as an Alternative Summer Forage Crop

Michelle Leinfelder-Miles, UCCE Farm Advisor, Chris DeBen & Dan Putnam, UC Davis
UC Davis Alfalfa Field Day, May 11, 2023

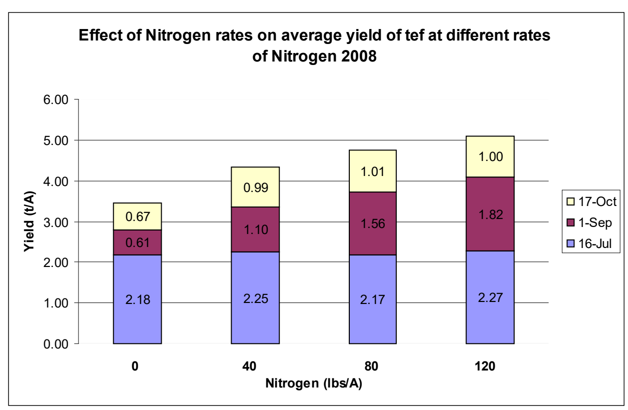
Teff (Eragrostis tef) is a warm-season grass that may be grown for grain, forage, or as a cover crop. Native to Ethiopia, teff was originally grown for grain. As a forage, teff is palatable to livestock, has high yield and quality, and may be baled for hay, grazed, or ensiled. As a cover crop, teff has fibrous roots that can prevent erosion, with a thick canopy.

Production Methods: Teff is adapted to many soil types. Planting should occur in late spring when the soil temperatures reaches at least 65°F. Teff seed is very small and should be planted 1/8 to 1/4" deep into a very firm seed bed. **Management.** The seeding rate for raw seed is usually 5 to 7 lb./ac, for coated seed is 8 to 10 lb./ac. May be broadcasted or drilled with firm packing. Sprinkler irrigation helps provide the best stand. Some varieties are better suited to forage and others to grain. Teff is a drought-tolerant crop, thrives in heat; 18- 24" irrigation will optimize forage yield over multiple cuttings. Teff requires low nitrogen inputs, approximately 50 to 120 lb./a of available N in split applications. **Pests.** Herbicide options are limited, so weed management is achieved with pre-plant cultivation and good stand establishment. Teff is not known to have many insect or disease pests, although we've observed some pests in California. **Harvest.** Harvested 2-3 x/year. First cutting occurs 45 to 55 days after seeding. For the best regrowth, keep stubble height at about 4"

Teff as a Forage:

- Fast-growing summer forage
- Moderate yields, high quality
- Yields 3-7 t/acre depending
- Palatable to horses, cattle, others
- Hay crop, but can be grazed
- Less nitrate concern/prussic acid
- Heat Tolerant
- 2-3 cuts
- Requires N fertility for high yield
- Low input

Teff Crude Protein Results (%)			
N-rate	Season	Season	Season
lbs/A	2006	2007	2008
0	12.5	11.5	8
40	15.7	16.5	9.6
80	17.6	19.6	12.5
120	18.3	21.9	14
Nrate	**	***	*
variety	ns	ns	ns
Nrate * var	ns	ns	ns



Alfalfa Strategies for Coping with California's Water Future: Flexibility is the Key

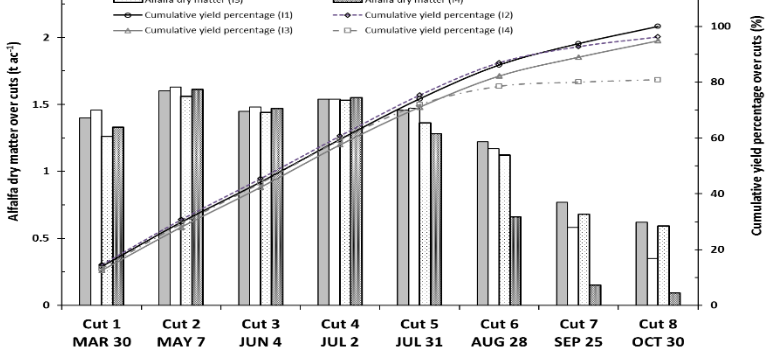
Dan Putnam, Forage Extension Specialist, UC Davis

It is tempting on the part of policy makers and journalists to point to high water-using crops like alfalfa during drought periods, and target them for elimination (fallowing). It is clear that California (and indeed the whole West) faces mammoth challenges with periodic droughts, sometimes followed by floods as in 2023. However, water use should be balanced with productivity, economic return, and food production. Alfalfa is a major food producing crop, in partnership with dairies and other livestock. A more important consideration is the resiliency of agricultural food-producing systems given the certain variation in water supply which is a current and future reality. Alfalfa has a key role to play in a water-uncertain future due to its high flexibility during times of insufficient water, in addition to environmental benefits to soils and wildlife habitat, and protecting soil losses during droughts.

Alfalfa – the best crop to have in a drought. This statement may appear counter-intuitive, since alfalfa is a major water user. However, its water demand is mostly due to its year-long growth habit. Under drought, alfalfa offers considerable flexibility and has major biological advantages when faced with water shortages. and even water excesses. These are:

- Alfalfa has very **deep roots** which allow the use of residual moisture
- Alfalfa has **High Yield** and high water-use efficiency
- Alfalfa can be **deficit irrigated** and generally survives during late summer drought
- **Long season** –takes advantage of solar radiation year long
- As a perennial, no **need to re-establish** each year as per annuals.
- Multiple harvests can give **partial economic yields** when irrigation ceases
- Alfalfa roots survive summer dry-downs, and **regrows when re-watered**
- **High salinity tolerance** (even greater than 6-8 dS/m).
- Alfalfa can be (carefully) **winter-flooded (**e.g. 6-12 feet) to charge aquifers

Deficit Irrigation Strategies for drought. Alfalfa has proved to be highly flexible and resilient in surviving droughts while sustaining productivity, even when as little as ½ the water requirement is applied. Data from Davis and other locations indications that between 60-95% of full yields can be realized when irrigation is cut back 25-50% during the season (see graph). In most of the studies on deficit irrigation, alfalfa has mostly recovered from late-summer droughts and come back to yield normally the following year. Contrary to superficial thinking on crop choice concerning water supply, alfalfa, with its high flexibility, is an important component to adjust to a water uncertain future.



Technologies for Improving Water Use Efficiency in Alfalfa with Overhead Irrigation

Isaya Kisekka, Umair Gull and Daniel H. Putnam, UC Davis

Prevailing droughts in the Western US have underscored the need for high-efficiency irrigation systems. Recent advances in overhead irrigation systems has resulted in systems that water apply with more than 95% application efficiency coupled with automation. Low Elevation Spray Application (LESA), Low Energy Precision Application (LEPA) and Mobile Drip Irrigation (MDI) with closer spacings. all have advantages over older methods.

Overhead vs. Surface Irrigation: Overhead sprinkler applications have the advantage of more closely following water demand by the crop, since small amounts of water can be applied. Not possible with check-flood. Flexibility in rotation across row crops and forages. Automation, fertigation and chemigation and site-specific applications possible. Especially important on sandy soil types or on heavy soils when infiltration is poor. However, flood irrigation may do a better job at filling deep soil profiles and rodent damage can be greater with sprinklers.

System	Advantages	Disadvantages
Mid- or Top Elevation Spray Application (wide spacings)	Low cost, older system, less cost for tubing, sprinklers, setup.	Often poor Distribution uniformity, inability to fill profile. Low application efficiency. High wind losses. Requires high pressure
Low Elevation Spray Application (LESA) (close spacings)	Better Distribution Uniformity, soil water penetration, lower pressure requirements/low energy, low wind loss, use of bubblers for water penetration.	Expense of tubing/sprinklers. Tend to high application rates (runoff)
Low Energy Precision Application (LEPA) (close)	Reduced energy requirement, excellent distribution uniformity, low wind loss, use of bubblers. Ability to site-specific applications.	Expense of tubing/sprinklers. Tend to high application rates (runoff)
Mobile Drip Irrigation (MDI) close spacings	Greatly reduced energy requirement, near zero wind loss, low erosion. High application efficiency, better infiltration, little runoff, excellent for slopes.	Expense of drip lines, requirement for filtration, maintenance.

Deficit Irrigation Studies. In a study conducted at Davis (2019-2020) we grew alfalfa with LESA and MDI, and imposed water deficits (100% of ET_c, 60% ET_c-summer cutoff, 60% ET_c- gradual deficit, and 40% ET_c- gradual deficits). We concluded that both LESA or MDI both can successfully be utilized, including with deficits. MDI was better able to store more water in the deep soil profile that may have sustained production during longer periods of drought. As expected reductions in yield were observed in the deficit irrigation treatments, but these yield reductions were not as great as the amount of water saved (see graph). During the last year, we did winter flooding on selected plots which greatly improved production in that drought year.

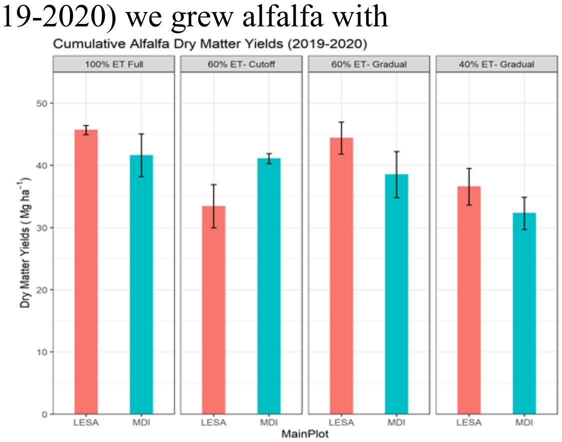


Figure 1. Alfalfa cumulative dry matter yields for two years 2019 and 2020.