College of Agricultural, Consumer and Environmental Sciences

Fabian Garcia Research Center
&
Leyendecker Plant Science Center

Annual Progress Report 2017

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Annual Progress Report 2017

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INTRODUCTION

Mission

The mission of the Leyendecker Plant Science Research Center and the Fabian Garcia Science Center is to improve the lives of New Mexicans, the nation, and the world through research, teaching, and Extension. The Leyendecker Plant Science Research Center serves as the outdoor agronomic laboratory for researchers located on the NMSU main campus in Las Cruces; the Fabian Garcia Science Center is oriented toward horticultural research.

History

The first deed signed for Fabian Garcia Research Center was in 1906. Currently the center has 41.1 acres of land available. Fabian Garcia, professor of Horticulture from 1906-1945, was named the first director of the State Agricultural Experiment Station in 1913. He produced the first reliable chile pod, which was the beginning of the hot "Sandia" pepper. Pioneering New Mexico State University chile breeder Fabian Garcia has been inducted into the American Society for Horticultural Science Hall of Fame. During a five-decade career at NMSU. Garcia laid the foundation for the state's $400 million chile pepper industry.

New Mexico State University purchased the 203-acre in 1969. Projects occurring at the Leyendecker Plant Science Center include: hoop house project, cotton, chile, alfalfa and onion plant breeding, precision farming, pecan research, drip irrigation research, and a multitude of other projects and programs.

RESEARCH PROJECTS

Cotton Breeding and Genetics in New Mexico
Jinfa Zhang, Plant and Environmental Sciences

Cultivars Released:
The New Mexico Cotton Breeding Program was established in 1926 and has been led by five generations of breeders and geneticists. The program has released 37 Acala 1517 and one short-staple Upland cotton (*Gossypium hirsutum* L.) cultivars and numerous germplasm lines known for high fiber quality. Two Sea-Island *G. barbadense* L. cultivars were released for commercial production in the Mesilla Valley, NM. New Mexico cotton germplasm has contributed to development of 45% of the commercial cotton cultivars including almost all the Acala cultivars grown in California and much of the improvement in fiber length and strength in the U.S. Many Acala 1517 cultivars were tolerant or resistant to Verticillium wilt and bacterial blight. Among the most recent releases, one of the three transgenic Acala 1517 cultivars had some commercial production (7-14% cotton acreage in New Mexico in 2006-2007), while one conventional and two glandless Upland cultivars and one Sea-Island cultivar are being grown in New Mexico for special purposes such as organic cotton production.

Objectives in Research:
The current research program focuses on fiber and seed quality to develop elite germplasm with high-yields, superior fiber quality, glandless, resistance to Verticillium wilt, Fusarium wilt, thrips, bacterial blight, leaf spot and cotton rust, and tolerance to drought and salinity. Upland × Pima interspecific introgression breeding and genetics and development of the hybrid seed production system based on cytoplasmic male sterility (CMS), and the haploid-producing system based on semigamy are also important aspects in the program. There are extensive applications of genomic tools and approaches in the program. These efforts include DNA marker development, mapping population development, linkage map construction and quantitative trait locus (QTL) mapping, and functional genomics and its applications in marker development and gene identification.

Progress since 2002:

- 7 cultivars, >20 germplasm lines, & 1 genetic population.
- Publications: ~120 refereed papers; 50+ proceeding papers; & ~80 proceeding abstracts.

Example- Breeding and Genetic and Genomic Studies for Drought and Salt Tolerance in Cotton:

- Initiated in the mid-2000s.
- Screened >2300 cotton germplasm and breeding lines for salt tolerance in the greenhouse.
- Screened >2300 cotton germplasm and breeding lines for drought tolerance in the greenhouse or the field.
- Several drought tolerant breeding lines were developed.
- Several breeding populations were developed for genetic and genomic studies on drought and salt tolerance in cotton.
- >200 quantitative trait loci (QTL) for drought and salt tolerance were identified from these genetic mapping populations.
- A total of >700 salt-responsive genes were identified using a comparative microarray analysis.
- A total of 110 drought-responsive genes were identified in the drought tolerance cotton Acala 1517-99 under field stress conditions.

Extension Agronomy Projects

Researcher: John Idowu, Extension Plant Science, Plant and Environmental Sciences
Location: Leyendecker

1. **Impact of reduced tillage on cotton and corn**
   This project is evaluating the growth and the development of both cotton and corn under no-till, strip-till, conventional tillage and bed tillage. Cotton and corn trials are in the second year (Student MSc. Project).
2. **Cover crops for control of wind erosion in arid agroecosystem**
   This project is evaluating selected winter and summer cover crops on soil erosion by wind. Winter cover crops being tested are rye, winter wheat, barley and oats. The summer cover crops being tested are sorghum sudan, Japanese millet, brown top millet and pearl millet. This trial is in the second year (Student MSc. Project).
3. **Biochar impacts on pinto bean and sorghum sudan**
   This project is evaluating biochar at different rates on growth and yield of pinto bean and sorghum sudan. Rates of application for pinto bean are 0, 1 and 5 t/ac; while the rates for sorghum sudan are 0, 1.5 and 3.0 t/ac. The project is in the second year (Student MSc. Project).
4. **Variety evaluation of pinto beans in southern New Mexico**
   This project is focused on evaluation of different variety of pinto bean in southern New Mexico. Five pinto bean varieties are being evaluated which include Windbreaker, BillZ, UI 196, Longs Peak and Centennial. The project is in the second year.
5. **Performance of guayule under different moisture regimen**
   Guayule is a native desert plant that can be used for rubber production. This trial is focused on optimizing the water-use efficiency of guayule. Different levels of irrigation will be applied to the plots, and the performance of guayule will be evaluated. This trial is just beginning.
6. **Inoculant and phosphorus effects on growth and yield of guar**
   This trial is focused on evaluating a dry inoculum and five rates of phosphorus, on the performance of guar. Phosphorus rates applied are 0, 25,50, 75 and 100 Kg/ha. This is a new project that started this year.
7. **Potassium fertilizer influence on yield and fiber quality of cotton**
   Performance of four glandless cotton cultivars under different potassium rates is being evaluated in this trial. Glandless variety being evaluated are STV glandless, Acala-GLS, NM-13P1117 and Acala 1517-18 GLS. Potassium rate treatment are 0, 100 and 200 kg/ha. This is a new trial that started this year.

NMSU IR-4 Project

Investigator: Cary C.S. Hamilton; IR-4 Project-Field Research Director; Extension Plant Sciences

The following report outlines work conducted by the NMSU IR-4 Project at the Leyendecker Plant Science Research Center (PSRC) (still ongoing).

Since 1963, the IR-4 Project (IR-4) has been the primary entity in the United States to facilitate registrations of conventional pesticides and biopesticides on Specialty Food crops (fruits, vegetables, nuts, herbs, spices) and non-food Environmental Horticulture crops.

As IR-4 Director of the NMSU IR-4 Project and FRC, I provide two primary services to food and feed crop producers and processors in New Mexico. As State Liaison Representative (SLR), I support the interests of New Mexico farmers, growers, ranchers, and producers at the regional and national levels. As Field Research Director (FRD), I conduct Magnitude of Residue (MOR) field trials and efficacy trials which provide data for registering safer and effective pesticides on food and feed crops.

SLR duties include: 1) interacting with growers and with regulatory, research, extension, industry and IR-4 personnel to determine important pest management needs and potential pesticide options to meet these needs, 2) submitting problems/selected options as Project Clearance Requests (PCRs), to IR-4 headquarters and, 3) representing NM interests while prioritizing projects at Regional and National conferences, workshops and webinars. In addition I provide supporting documentation for special pesticide registrations such as 24c's and Section 18's for our state and region when needed.

Once studies are selected for IR-4 action, trials are allocated among 11 Field Research Centers in the Western Region to conduct the field phases of Magnitude of Residue (MOR) research and efficacy testing. The IR-4 Project at NMSU was assigned13 trials for the 2017-2018 trial and research year. New Mexico is uniquely located due to the only state which consists of Three Crop Production Regions, which are Regions 8, 9, and 10.

IR-4 MOR research is required by law to be conducted following Good Laboratory Practice (GLP) standards. To maintain GLP Certification, NMSU FRC personnel participated in continuing education workshops, conferences, and webinars during the year.

To ensure GLP compliance, FRC facilities and critical phase procedures are audited several times each year by regional Quality Assurance (QA) personnel. So far four audits have been conducted throughout 2017-2018, and were passed with no significant findings.

Jujube cultivar trial at Leyendecker Plant Science Research Center
Researcher: Shengrui Yao, Plant and Environmental Sciences

Late frost is the number issue challenging fruit production in New Mexico. We are trying to find some alternative crops that are less affected by late frosts and can produce a reliable crop annually.

Jujubes, also called Chinese dates, leaf out 4-6 weeks later than most tree fruit species and can avoid most late frosts in New Mexico. We have been evaluating them at NMSU Sustainable Agriculture Science Center at Alcalde in northern New Mexico since 2010. After several years observation, jujubes have produced a reliable crop each year. But we also noticed the limitation of the Alcalde site- short growing season. The late frosts in the spring do not bother the jujube much but the early frosts in early October do terminate the fruit especially those late season cultivars. Jujube is a good alternative crop in northern New Mexico but its biggest potential would be in central and southern New Mexico with longer growing seasons than in northern New Mexico. Since 2015, we established cultivar trials at Alcalde and Los Lunas sites in April 2015, Tucumcari in 2016 and Leyendecker Plant Science Research Center in April 2017. The Leyendecker Center will provide a venue especially for those late maturing cultivars.

Jujubes are drought tolerant plants with nutritious fruit when they are established. After 5-10 years, we will recommend the top performing cultivars to growers and home gardeners for different purposes. Trees were planted in April 2017 in a randomized complete block design with 35+ with two trees per cultivar in each block. Trees have grown well and 95% of trees produced in the planting year. Yield varied from a few fruit to one pound of fruit per tree in 2017.

Comparing potential resistance to seed treatments for thrips in the Mesilla and Pecos Valleys
Researcher: Jane Breen Pierce; Entomology, Plant Pathology and Weed Science

In NM, optimal cotton production depends on managing pre-flowering insect pests including thrips Cotton damaged by these pests may have reduced photosynthesis capacity, attenuated growth, and plant death. Reductions in stand density, poor early-season crop growth, and delayed crop maturity can reduce lint quality and cotton yields.

Early-season pest management in US cotton has been primarily achieved with an in-furrow treatment of aldacarb (Temik®). In 2010, the Environmental Protection agency and Bayer CropScience reached an agreement to terminate production and use of aldacarb in the United States . Consequently, to achieve cotton production goals growers had to adopt alternative practices for early-season pest management. Neonicotinoid insecticide seed treatments have become the primary solution to managing early-season pests of cotton. Thiamethoxam and imidacloprid are two common systemic insecticide seed treatments applied to commercial cotton seed. Although the two insecticides belong to the same insecticide group, their physical and chemical properties vary and may affect mortality among target pests. Resistance to neonicotinoid seed treatments has been reported, particularly in the Southeastern US, thus it is important to evaluate efficacy in New Mexico. Some initial evaluations in Artesia with low thrip pressure have suggested that the seed treatments are effective but more years of field trials, higher thrip pressure and an evaluation in a very different geographic area are needed. The 2018 trials will include a second location in the Mesilla Valley where there is high thrip pressure. This research will provide information on current efficacy of neonicotinoid insecticide seed treatments to thrips and allow us to compare results in two different cotton growing areas of NM.

Cotton seeds will be treated with two different neonicotinoid insecticides (imidacloprid and thiamethoxam) with 2 formulations of each insecticide and a control for a total of 5 treatments replicated four times. This trial will be conducted at two locations in NM one at the NMSU ASC research farm in Artesia , the second at the NMSU Leyendecker research farm in Las Cruces.
Thrips will be collected at four different time period/growth periods; cotyledon, 2-leaf, 3-leaf, and 4-leaf stages.. Fourth leaf stage cotton plant height will be measured from 10 random plants per plot. In addition, 5 plants per plot (12 plots/location) will be measured for their root length and root vigor at 4-leaf stage to estimate the belowground effect of seed treatment. Later in the season, delays in plant maturity will be assessed by counting nodes above white flower (NAWF). Finally, each plot will be harvested and final seed-cotton yield will be compared among the treatments using appropriate statistical analysis.

Nut Tree Research Projects

Researcher: Richard Heerema, Extension Plant Sciences, Plant and Environmental Sciences

1) Partial Root Zone and Deficit Irrigation Drying for Greater Water Use Efficiency in Drip-Irrigated Pecans.

Graduate Student Research

Funding Source: National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2015-68007-23130

Location: Leyendecker

We are testing whether a technique called partial root zone drying (PRD) could be used to increase pecan orchard irrigation water use efficiency compared with conventional irrigation practices. Rather than irrigating a plant's full root zone, with PRD, irrigation water is placed on only one side of the plant, while the soil and roots on the other side of the plant are allowed to dry down for a defined time interval (often a few weeks). Then, with PRD, the irrigation water placement is switched to the dry side, and the previously irrigated side is allowed to dry down. With some crops, PRD has been shown to increase the amount of photosynthesis and production per unit volume of water used by the crop, but this has never been tested for pecan. Our experiment, initiated in 2017, will be conducted in a productive drip-irrigated 'Pawnee' pecan orchard where we will supply irrigation water to meet either 100% or 75% of orchard evapotranspiration (i.e., consumptive water use) requirement. In PRD treatments, the full irrigation supply will be made to only one side of tree rows, alternating on a 3-week cycle. Comparison will be made to a Control that is conventionally drip irrigated (i.e., on both sides of the tree row). We will test the treatment effects on photosynthesis and nut production.

2) Almond Bud-break Timing Under Mesilla Valley Conditions

Location: Leyendecker

In recent years, tree nuts have become a profitable enterprise within the agricultural sector. In New Mexico, this has resulted in rapid expansion of the pecan industry, while other southwestern US states have also seen expansion of almond, walnut, and pistachio industries. Almonds are generally well adapted to the hot, dry environment of southern New Mexico, but the bud-break time of conventional almond varieties is too early (mid-February to early March) to avoid freeze related crop loss. Kaolin clay has a white color and, theoretically, clay films can reduce dormant plant tissue temperatures by reflecting solar radiation, thus delaying bud-break. Previous research conducted at NMSU has shown that such clay films can successfully delay bud-break of other tree species. Our objective will be to determine whether dormant season sprays of kaolin clay suspensions may also be used to delay almond tree bud-break sufficiently to avoid the period of high risk for freeze injury in southern New Mexico and allow for the planting of almonds as an alternative nut crop to pecan. Our research will be conducted in a small micro-sprinkler irrigated almond orchard planted in 2018.

3) Pecan Maternal Genotype: Implications for Nutrient Uptake in Alkaline Soils

Graduate Student Research

Funding Source: USDA-NIFA-SCRI 2016-51181-25408

Location: Fabian Garcia

In this study, we are investigating the effects of pecan seedling maternal genotype and soil lime content on nutrient uptake in alkaline soils. Eight maternal genotypes were grown in 18.5-liter pots under three soil lime treatments (30% lime, 15% lime, and no added lime ("Control")), which represent the range of soil lime content in the Southwest. Each genotype x lime content combination was replicated 6

times. Leaf tissue nutrient concentrations were measured 2015-2017. In 2018 rootstocks were grafted to the clonal scion ‘Pawnee’ and all plant tissue at 25cm above the soil line was removed for woody tissue nutrient analysis.

4) Pecan Rootstock Propagation Using Taproot Fragments

Graduate Student Research
Location: Fabian Garcia

We have designed a clonal propagation system that could allow production of large numbers of pecan rootstocks without the need for traditional tissue culture methods. This method does not require specialized facilities or equipment. To date, we have successfully cloned 15 ‘Burkett’ seedling trees using the root fragment technique in a greenhouse environment. We are currently investigating the effects of seedling age at cutting on clonal tree regrowth. We would now like to explore the possibilities of designing different pots, using growth enhancing plant hormones and looking at this cloning technique on other tree species like pistachio.

Optimizing fertilizer application and leaching under abiotic stresses within and below the Root Zone of Pecan Orchards
Reseracher: Manoj K Shukla, Professor of Soil Physics, Plant and Environmental Sciences
Location: Fabien Garcia (greenhouse experiments)

Optimizing fertilizer application and leaching under abiotic stresses within and below the Root Zone of Pecan Orchards
To the best of our knowledge, no simulation study has been done on N distributions within and below the root zone of an irrigated pecan orchards of southern New Mexico. Most studies done so far were only focused on modeling water fluxes in the root zone of a flood-irrigated Pecan tree (Deb et al., 2011; 2013). Therefore, the overall goal of the project is to setup a ready to use 2D/3D model calibrated for different soil types, irrigation systems, and irrigation water qualities. Such a model is needed as a decision support system for identifying leaching fraction for sustaining pecan production while maintaining groundwater quality in the valley. We aim to accomplish this goal by conducting a pilot study at two orchards in Mesilla and using already available data from some other orchards.

Increasing Chile Pepper Yields Using Brackish Groundwater and RO concentrate
The overall goal of the proposed project is to develop an efficient irrigation schedule using fresh, brackish groundwater and RO concentrate to sustain early grown flowers to increase overall chile pepper yields. The hypothesis of the proposed project is that yield of chile peppers would increase if RO concentrate were applied at the right time and in the right amount. Since RO is produced from the local groundwater aquifer, its application will not cause net increase in the groundwater salinity.

Pecan response to brackish water and RO concentrate
Pecan physiological, soil physical, chemical and biological properties are determined in this greenhouse experiments irrigated with brackish groundwater and RO concentrate.

Waste Utilization and Mineral Nutrition of New Mexico Plants
Fabien Garcia (greenhouse experiments)

Geno Picchioni, Plant and Environmental Sciences

Objective: Evaluate and compare growth, ion uptake, and seed germination responses of *Lepidium* species in saline solutions, and identify edaphic factors regulating invasiveness of the species.

Better understanding of site-specific factors that regulate weed encroachment is needed. Mesa pepperwort (*Lepidium alyssoides*), an indigenous plant species of the southwestern U.S., is known to aggressively occupy desert landscapes affected by high salinity, and to reduce plant species diversity by as much as six-fold. Recent research shows that this species is salt-adapted largely due to its tolerance of high leaf sodium and chloride accumulation. The findings add to a scarce database on soil-related factors governing plant invasiveness, and indicate that soil salinity assessment may be a cost-effective weed predictive and preventative measure for land managers.

Effect of Crop Load by Shoot Thinning on Yield and Berry Composition of Malbec

Investigator(s): G. Giese[1], and Ciro Velasco-Cruz[2]
[1]New Mexico State University, Agricultural Science Center at Los Lunas, NM 87031
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Potential impact(s):
Crop load, the ratio of yield to weight of one year wood removed by pruning during dormancy (Bravdo et al. 1984), is associated with the relationships between vegetative and reproductive weight (Jackson and Lombard, 1993). Crop load affects vine growth, berry composition and resultant wine quality (Chapman et al. 2004, Geller and Kurtural 2013, and Kliewer and Weaver, 1971). A vine carrying more fruit than it can ripen for its intended use is overcropped (Jordan 2005). Some of the detrimental impacts of over cropping include undesired changes in berry chemistry that impacts wine aroma and flavor by which wine quality is determined. Environmental conditions especially excessive heat and light can negatively impact fruit composition and quality (Jackson and Lombard, 1993, Main and Morris, 2004). When, how and level of crop load vines are adjusted to can impact berry composition and wine quality (Chapman et al. 2004, Kliewer and Dokoozlian, 2005). Winegrowers worldwide, inclusive of New Mexico growers, seek to optimize crop load and consequently berry composition and wine quality. However, to our knowledge, no systematic investigation of appropriate crop loads for New Mexico vineyards exists.

We aim to quantitatively evaluate the effects of various crop loads imposed by shoot thinning the cultivar, Malbec (*V. vinifera L*.) under the hot climate conditions of southern New Mexico. This information will help growers adjust crop load and optimize berry composition, vine sustainability and winery profits.

Methods:
Four crop level treatments arranged in a RCBD: 16 shoots/32 clusters/vine, 16 shoots/16 clusters/vine, 12 shoots/12 clusters/vine and 8 shoots/8 clusters/vine imposed via shoot thinning when shoots reached 10 cm length with 5 leaves separated and inflorescence clear (modified E-L stage 12, Coombe 1995) and cluster thinning imposed at E-L stage 27 (fruit set) (Figure 1) were applied to an established Malbec (*Vitis vinifera* L. grafted to 101-14 *V. riparia* x *V. rupestris* rootstock) vineyard located at the Fabian Garcia ASC in Las Cruces, NM. The vineyard was planted in 2009 and trained to a modified VSP (vertical shoot positioned) trellis with a single pair of catch wires. Data collected will include fruit yield, cluster and berry weight and composition (primary chemistry and total phenolics) and dormant pruning weights.

Results: Although dormant pruning weights were collected in winter of 2017 (Table 1) to establish baseline pruning weights, the experimental treatments were initiated in the spring of 2018. Therefore, the first completed set of data will be collected during and after the 2018 growing season.

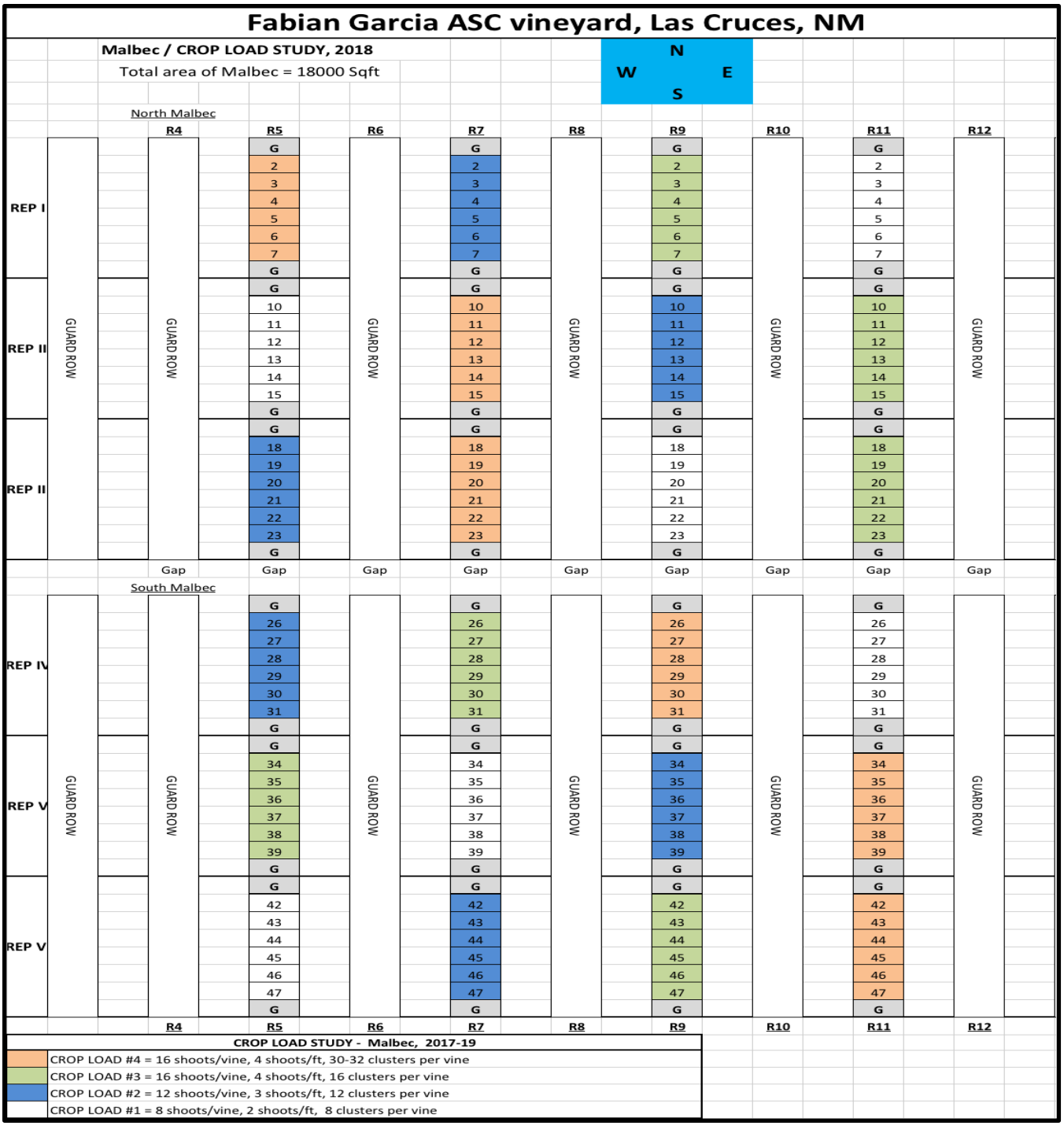

Figure 1. Experimental design (RCBD) with six replications of each crop load treatment imposed by various levels of shoot thinning, Fabian Garcia ASC, Las Cruces, NM, 2018.

	Average of Avg. Cane Wt. (g)	Average of Canes/vine	Average of Pruning Wt./Vine (kg)
Crop Load #1	0.026	32.08	0.83
Crop Load #2	0.033	32.42	1.04
Crop Load #3	0.028	33.69	0.90
Crop Load #4	0.033	31.00	1.00

Table 1. Dormant pruning weights (kg), cane weight (g) and number of canes per vine in experimental vineayard block, Fabian Garcia ASC, Las Cruces, NM, 2017.

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Onion Research at the Fabian Garcia Science Center (FGSC)
Researcher: Christopher Cramer

1. Onion genetic improvement.

New Mexico has an onion industry that is valued at $80-90 million annually, is economically significant to New Mexico, and is highly competitive within the U.S. Continued development and release of high-yielding, high-quality, well-adapted, pest-resistant, disease-resistant, short- and intermediate-day open-pollinated and hybrid cultivars with varying maturities and scale colors is needed to support industry growth in New Mexico. At the FGSC, onion breeding lines are being screened for disease resistance, bulb yield and quality, maturity dates, and bulb color. Phenotypic and genotypic recurrent selection is being used to develop short- and intermediate-day onion cultivars for production in New Mexico. Cultivar and observational trials are being performed on breeding lines from direct seeding in pink root infested soil in replicated plantings.

2. Measuring selection progress for resistance to Fusarium basal rot.

Fusarium basal rot (FBR) is a devastating soil-borne disease of onion caused by *Fusarium oxysporum* f. sp. *cepae* (FOC). This pathogen is prevalent in all onion-growing regions in the US and the world. FBR ranks the second most important disease in terms of economic loss in the state of New Mexico. The disease causes a disintegration of the onion bulb basal plate (compressed stem) thus killing a plant growing in the field. Once a bulb becomes infected with the pathogen, the disease and the resulting decay it causes cannot be halted. FBR-resistant cultivars currently do not exist and complete resistance is limited in all onion germplasm pools. Populations have been developed for FBR resistance using an artificial inoculation of mature bulbs screening method. Seeds of original, intermediate, and advanced FBR-selected populations and one resistant and one susceptible check cultivar are being grown and evaluated at the FGSC for their FBR susceptibility.

3. Herbaceous Ornamental Plant Species Evaluation for Onion Seed Production Improvement

Breeding programs improving cross-pollinated plant species must use some form of plant isolation during the seed production process to prevent genetic contamination. When space is limited, seed production is often accomplished using isolation cages that confine the utilized pollinator while restricting plant access to any external pollinators. Seed production in this fashion limits the pollinator to foraging on a single plant species for a period of time. This single species foraging is often detrimental to the health of the pollinator as the floral resources are not sufficient for sustained growth. In the case of honeybees (*Apis mellifera*), hive reserves are used to maintain the hive colony. Previous research work demonstrated a hive-weight reduction of up to 33% when honeybees were placed in a captive cross-pollination event with onions solely. Pollination success is one factor that influences onion seed yield. It may be possible to reduce pollinator stress by incorporating another flowering plant species in this captive pollination method. Currently, 11 herbaceous ornamental plant species are being evaluated for their ease of culture, flowering time relative to onion, plant height relative to onion seedstalk height, and attractiveness to honeybees when these plant species are intercropped with onions under a captive pollination scenario.

Root-knot Nematode Host Suitability Recommendations for Ornamental Plants
Researchers: Jacqueline Beacham & Steve Thomas, Entomology, Plant Pathology and Weed Science
Undergrad interns: Abriel Gonzalez; Andrew Cruse; Stephen Cooke-Grado; Julian Martinez
Location: Fabian Garcia Ag Science Center

New Mexico homeowners and Master Gardeners who lose perennial landscape plants due to parasitism by root-knot nematodes face the frustrating and disappointing realization that no information is available on the susceptibility of most ornamentals to this common pest. Because much residential development in southern NM occurs on land that was previously farmed, the incidence of root-knot nematode infestation in home landscapes reflects what occurs in agricultural land – which is 60% infestation. Unlike farmers, most homeowners are unfamiliar with soilborne nematodes and unknowingly plant into root-knot infested soil. Plants are rapidly infected, and nematodes develop to damaging levels over a 3-5 year period (more rapidly in xeriscape environments). In response to requests from Master Gardeners and nursery wholesalers, a study was initiated at the Faubian Garcia Ag Science Center to determine the susceptibility of 21 species of perennial plants recommended for xeriscape use in the Southwest to the southern root-knot nematode (*Meloidogyne incognita*).

In early summer 2016, 60 cylindrical plots, each 3 ft in diameter, were infested with a known quantity of root-knot nematodes and planted with three or four different species of potted perennials obtained from regional nurseries. These 2 ft deep, open-ended cylinders permit us to exclude nematodes from surrounding soil while controlling the number of nematodes added to each plot. Doing so allowed us to determine and quantify the relative rate of nematode reproduction on the 21 different candidate species. An advantage of conducting the research at the Fabian Garcia Ag Science Center, which is located in a suburban environment, was the high public visibility of the study. Without the infrastructure provided by the Science Center (availability of semi-permanent cylindrical plots and underground drip irrigation system) the study could not have been conducted.

Results from study, which was harvested in fall 2017, provided the first classification of root-knot nematode susceptibility for the plants examined. Notably, the commonly-planted perennials desert broom, Russian sage, turpentine bush, agave, prickly pear, and rock penstemon were all good hosts for southern root-knot nematode. Plants including Mexican redbud, blue grama, pistachio, blackfoot daisy, NM evening primrose, Arizona rosewood, and pink muhlenbergia were all nonhosts. These results allow homeowners and landscape professionals to make more informed decisions about plant usage in residential xeriscapes.

Adapting New Chemistry to Manage Root-knot Nematode Damage to Chile in NM
Researchers: Jacqueline Beacham & Steve Thomas, Entomology, Plant Pathology and Weed Science
Undergrad interns: Abriel Gonzalez; Andrew Cruse; Stephen Cooke-Grado; Julian Martinez
Location: Leyendecker Plant Science Research Center

Southern root-knot nematode (*Meloidogyne incognita*; SRKN) is a serious pest of chile grown in lighter-textured (sandier) soils in southern NM, often resulting in yield reductions of 40% or more when left unmanaged (Lindsey and Clayschulte - 1982, Journal of Nematology 14:353-358; Thomas et al - 1995, Plant Disease 79:557-559; Thomas - 1994, Journal of Nematology 26S:683-689; Goldberg - 2001, NM Cooperative Extension Service Circular 549). Surveys of 20% of the chile acreage in Doña Ana, Luna, and Hidalgo Counties showed approximately 60% of fields were infested with SRKN. Due to the wide range of crop and weed hosts of SRKN, once a field is infested it remains infested - permanently. A two-year research project is underway to provide growers with the following information: 1) can Nimitz®, the first new tool for nematode suppression in vegetables like chile in more than 40 years, be adapted for use in the furrow-irrigated production systems of the Rio Grande Valley; 2) compare nematode suppression and crop response using Nimitz with that achieved using Telone II®, the only nematicide currently available for use on chile in New Mexico.

Fluensulfone (Nimitz®; ADAMA North America) was developed as an alternative to the soil fumigant 1,3-dichloropropene (Telone II®; Dow AgroScience) and is easier to apply and safer to humans and the environment than fumigant chemistry. ADAMA supports expanding the product label to permit Nimitz use in furrow-irrigated crops, as does the grower-funded NM Chile Commission. Both companies and the Chile Commission provide funding to the NMSU Nematology Program to compare performance of the two products under New Mexico growing conditions and present objective finding to chile growers. To insure these findings are relevant, such research is conducted using standard farming practices and commercial application equipment in 72 small, randomized and repeated plots (a plot for each treatment is typically 50 ft long and 4 rows wide). On a fee recovery basis, the Leyendecker Ag Science Center provides the 2 acres of land, farming equipment, and skilled operators needed to apply the products and grow the crop throughout the season. Such research is too disruptive to be conducted in collaboration with private growers.

Preliminary results from 2107 showed the new chemistry appears compatible with furrow irrigation and regional farming practices. No reductions in plant density or foliar phytotoxicity were observed with any treatment. Plant heights were greater with 3.5 pt/A and 5.0 pt/A rates of NIMITZ than in untreated control plots in both broadcast and banded applications. Though not significant statistically, all chile yield parameters tended to decrease with increasing rates of NIMITZ, suggesting that lower rates may be preferable to higher ones. Root-knot nematode numbers were lower than anticipated in all plots. Nematode populations at the end of the season were greater in plots that received the banded applications (only the seeded row was treated) than those that received broadcast applications (rows and furrows were both treated), as would be expected.

Developing Management Tools for Root-knot Nematode Damage to Pinto Beans in NM
Researchers: Jacqueline Beacham & Steve Thomas, Entomology, Plant Pathology and Weed Science
Undergrad interns: Abriel Gonzalez; Andrew Cruse; Stephen Cooke-Grado; Julian Martinez
Location: Leyendecker Plant Science Research Center

New Mexico pinto bean producers face yield losses as high as 50% due to damage from two plant-parasitic nematodes: root-knot and root lesion nematodes. Both are widespread throughout the state, can feed and reproduce on most crops rotated with pinto bean, and cannot be eliminated from fields where they occur. The only management tool currently available to growers is a soil fumigant that must be applied by a custom applicator using specialized equipment. Treatment costs about $200/acre and is not economically viable at the current market value of this crop.

Two new products recently registered by US EPA for suppression of these nematodes in other crops – fluensulfone (Nimitz®; ADAMA North America) and fluopyram (Velum I ®; Bayer CropScience) – are being examined for their potential use in pinto bean. Both companies support the expansion of product labels to allow such use, and contract with us to determine how their products perform under New Mexico growing conditions for suppressing nematode numbers, restoring crop yield potential, and if early-season plant injury occurs due to product application. **Because neither product is currently registered for use in New Mexico, the treated pinto bean crop must be destroyed at the end of the season.** To conduct such research requires the security afforded by the Leyendecker Ag Science Center so proper crop destruction is guaranteed and no treated beans accidentally end up in the food chain. This guarantee is nearly impossible to achieve when conducting on-farm research in collaboration with private growers who must prevent unintentional harvesting or consumption of the treated crop before and after harvest.

Each spring, beginning in 2016, six combinations of treatments including different rates of Nimitz, one rate of Velum I, and presence or absence of root-knot nematodes were applied to 3 ft diameter cylindrical plots in a field containing sandy loam soil at Leyendecker PSRC. All treatments were repeated seven times, for a total of 42 plots. These 2 ft deep, open-ended cylinders permit us to exclude nematodes from some plots while controlling the number of nematodes added to other plots. Doing so allows us to determine the relative effect of nematode levels and their suppression using the new chemistries above on pinto bean growth and yield. Such comparisons are not possible under normal field conditions where nematode populations cannot be excluded or adjusted. The controlled conditions afforded by these semi-permanent cylinders located at at Leyendecker PSRC allows a more accurate assessment of product efficacy and crop response. The results provide growers with information needed to evaluate the management potential of these new nematicides and could not be developed without the use of Leyendecker PSRC facilities.

Results from 2016 and 2017 show that neither product injures emerging pinto beans at any of the rates tested. Two of the three rates of Nimitz and the Velum I significantly reduced root-knot nematode infection in bean roots. Yields from plants with reduced numbers of nematodes trended higher than those from untreated plants. Both products show promise for managing root-knot nematodes in pinto beans in New Mexico, are much less toxic to agricultural workers and the environment than soil fumigation, and are potentially viable economically.
Cover Crops for Weed Management and Soil Quality in Flood-Furrow Irrigation

NMSU Alfalfa Breeding and Genetics Research Program Summaries
Researcher: Ian Ray, Plant and Environmental Sciences

Fabian Garcia Science Center Projects:

Molecular and conventional breeding to improve alfalfa drought resilience.

Summary:
The NMSU alfalfa breeding and genetics program maintains hundreds of plants in greenhouses at the Fabian Garcia Science Center to provide core germplasm for conducting drought tolerance improvement research projects. Many plants are used to provide tissue for laboratory-based DNA marker analysis projects. Genetic marker data from these plants are linked to field-based projects conducted at the Leyendecker Plant Science Research Center, where families derived from each plant are evaluated for forage productivity during drought stress. Integrated analyses of the DNA marker and forage yield data from these families are conducted to identify specific DNA markers that are associated with alfalfa drought resilience. Subsequently, we use these markers for selection to develop new alfalfa lines with improved productivity in water-limited environments. In other research, hundreds of vigorous plants identified in drought-stressed field research plots are excavated from the field and transferred to the greenhouse, where they are screened for resistance to key pathogens. Surviving plants are then mated to generate seed for advanced breeding lines. These lines are subsequently evaluated for their performance in deficit-irrigated field trials to identify superior materials for developing drought-resilient cultivars.

Leyendecker Plant Science Research Center Projects:

Molecular and conventional breeding to improve alfalfa drought resilience.

Summary:
The NMSU alfalfa breeding and genetics program has developed 30 elite populations using traditional selection methods for DNA markers associated with drought-resilience. These populations are being evaluated at the Leyendecker Plant Science Research Center in replicated field plots (200 plots) under deficit irrigation management for three years. Results from this study will be used to validate the usefulness of the targeted DNA markers that were used in the selection process, and to identify superior populations with enhanced forage productivity during drought-stress. A second project has been designed to evaluate two new DNA marker assisted breeding methods, including association mapping and genomic selection, for their potential to accelerate development of drought-resilient alfalfa varieties. In this study, 220 elite families have been genetically characterized for several thousand DNA markers. These families are also being evaluated in replicated field plots (920 plots) under deficit irrigation management for three years. Integrated analyses of the DNA marker and biomass data will be conducted using association mapping and genomic selection modeling to identify plants with the greatest genetic potential to improve alfalfa drought resilience. Subsequent field validation studies will characterize advanced populations developed by these two new selection methods for their performance relative to conventionally developed breeding lines in drought-stressed field conditions. In all studies each field plot is harvested three to seven times per year, depending upon the irrigation management regime.

Chile Pepper Breeding and Genetics Program
Researcher: Paul Bosland, Plant and Environmental Sciences

The Fabian Garcia Science Center (FGSC) houses the Chile Pepper Institute Teaching Garden and the Chile Pepper Breeding and Genetics Program's research greenhouse. The Garden is a unique environment created to present the wonders of chile peppers in a garden setting. The Garden is an educational facility operated in partnership with the NMSU Chile Pepper Breeding and Genetics Program. It is the world's only garden dedicated exclusively to chile peppers. It is a living classroom where students, researchers, and the public learn about the science, history and versatility of chile peppers. We have delivered lessons to more than 100,000 students since the Garden was first opened to the public. In addition to students, it is visited by gardening groups and researchers from around the world. Most years in excess of 1,500 visitors come to the Garden to learn about chile pepper science. The Garden teaches concepts ranging from disease prevention to a chile pepper's heat profile.

In the greenhouse and shadehouse at the FGSC, we are developing a new class of chile peppers. These chile peppers are for container growing, which is becoming an important category of vegetables for city dwellers. Additionally, we have breeding populations of compact jalapeno types with high-yield and superior pod characteristics, and a cayenne type with high-yields and superior plant and pod characteristics.

The new ornamental chile pepper cultivars are being developed in the greenhouse. Ornamental chile pepper cultivars satisfy a unique industry niche of which several NMSU cultivars have become very popular for the greenhouse and nursery industry. The current research in ornamental cultivars focuses on dwarf plants that are more easily transported, do not require chemicals to keep them compact and have unique and showy plant and pod characteristics that are desired by the market.

Other research programs in the greenhouse include screening for disease resistance. This is the first stage in evaluating phytophthora resistance in chile peppers and is a crucial part of the process. Carotenoid research where two yellow natural pigments, lutein and zeaxanthin, strong anti-oxidants that protect against macular degeneration and aid in cognitive thinking, are being studied. Additionally, we are determining the inheritance of capsaicin vesicles on fruit walls. Our program was the first to discover that super-hot varieties of chile peppers develop capsaicin vesicles not only on the placenta, as other species do, but on the walls, as well.

Turfgrass weed management under reduced potable irrigation
Researcher: Goss, R.M., Plant and Environmental Sciences, and J. Powers (Master's Student)

Purpose of Study: Drought is one of the most pressing management issues turfgrass managers face in the desert southwest. Political responses from local and state governments have further restricted water use for non-essential uses like golf courses and athletic fields. If these conditions persist, there will be a higher appearance of drought-stressed turfgrass on golf courses, home lawns, and other public turfgrass systems. Drought-stressed turfgrass will not be able to provide environmental benefits like increased oxygen production, ambient temperature reduction, or provide acceptable low-cost playing surfaces that greatly improve quality of life in the desert southwest. Herbicides are the primary management practice to reduce difficult to control weeds in turfgrass stands. The purpose of this study is to determine the interaction between decreasing water applications and severity of herbicide turfgrass phytotoxicity and determine the effect of decreasing water applications on herbicide efficacy.

Field and greenhouse experiments are underway to meet the objectives of this research. The field experiment is being conducted at Fabian Garcia Research Science Center in Las Cruces, NM. A Linear Gradient Irrigation System (LGIS) will be used to create drought conditions and determine the interaction of precise water statuses and herbicide application responses. A LGIS is a single row of sprinkler heads arranged to provide an irrigation gradient from none to excessive applied-water. Each plot will be irrigated on a gradient of applied water through LGIS and will receive a combination of different herbicide applications commonly used in the Las Cruces area. Four commonly grown ornamental turfgrasses, Bermudagrass, and a combination of Kentucky bluegrass, tall fescue, and perennial ryegrass will be grown in two separate plots. Plots will be visually rated for turfgrass phytotoxicity, quality, color, density and uniformity on 1-foot (0.3m) intervals along irrigation gradient monthly throughout the experiment.

The greenhouse experiment will be conducted at Fabian Garcia Research Science Center in Las Cruces, NM. Bermudagrass and Kentucky bluegrass will be grown to maturity in pots with uniform irrigation. After maturity, plants will be exposed to 4 decreasing water contents and then sprayed with 3 of the same herbicides from the field experiment at a 2x maximum label rate to mimic overlapping of herbicides. Pots will be visually rated for turfgrass phytotoxicity, quality, color, and density for approximately 30 days.

The research proposed here will likely determine the minimum water application needed for effective herbicide use in turfgrass. Having results that show the minimum water application needed for effective herbicide use will ensure turfgrass quality will not diminish even under drought conditions and undesired weeds will not overtake these systems. Homeowners will be able to determine when they can apply herbicides to their lawns under water restrictions. Athletic fields like golf course and football/soccer fields will maintain their playing quality by reducing the appearance of unwanted weeds. Ultimately this research will ensure that the environmental benefits turfgrass provides will not diminish under the drought conditions seen in New Mexico.

Extension Vegetable Program - Development of New Vegetable Cultivars through Traditional Breeding - Leyendecker Plant Science Research Center (2017)

Investigators: S.J. Walker and I.S. Joukhadar, Extension Plant Science

Potential Impact:

NM Green Chile: Commercial acreage of NM-type green chile is threatened due to inconsistent labor availability and the relatively high labor expense compared to competing countries. Mechanizing the harvest of green chile in NM would reduce the need for hand labor and is essential to maintaining large-scale, profitable production of this crop. Success in mechanizing NM green chile is anticipated to stop the loss and spur an increase in acres planted in NM. Each acre grown is worth approximately $7,000 in gross income to NM farmers, and just a 10% increase in the current level of acreage would result in more than a $3 million annual increase in NM farm receipts.

Heat Tolerant Tomatoes: Tomatoes are the favorite vegetable for home gardeners in New Mexico, however the high summer temperatures experienced in much of the state reduces pollination, and therefore fruit set, during this critical growth period. A variety trial was conducted in 2018 at the Leyendecker PSRC to identify tomato cultivars that exhibited a higher tolerance to the heat. The goal of the project is to identify the best varieties for gardeners in New Mexico. We're particularly interested in ability of the plants to set fruit during the hottest part of the summer (yield), but quality attributes are also critical and were considered.

Method:

NM Green Chile: This program has conducted long-term efforts to develop new NM green chile cultivars efficient for mechanization, a critical component towards mechanizing harvest of the crop. Since 2010, breeding lines have been established at the Leyendecker Plant Science Research Center (PSRC) for evaluation of plant and fruit structure. Traits, including taller plants, fewer basal branches, higher primary branch angle heights, and thicker main stem diameters, were used as selection criteria in the development of advanced breeding lines. Seed increases using large seed cages were made on promising NM green chile lines so that ample seed was available to plant mechanical harvest trials.

Heat Tolerant Tomatoes: Using donated seed and seed saved from breeding lines in development, Master Gardeners and other interested participants around the state planted tomatoes from the trial and provided feedback on their relative performance at the end of the season. Three plants from each cultivar were also planted in the lathe house at the Leyendecker PSRC.

Results:

NM Green Chile: Self-pollinated seed was collected from 13 exceptional NM green chile advanced lines 6W17-18W17. Breeding line seed will be planted in Los Lunas mechanical harvest trials in 2018. Field evaluation was limited due to severe Curly Top Virus disease pressure.

Heat Tolerant Tomatoes:

The results of gardener participants and plants grown at the research center were compiled and averaged (Table 1).

Table 1. Tomato Cultivar Survey Results (best in the category are highlighted) - 2017

Access #	**Cultivar**	**Yield Ranking (1 highest to 17 lowest)**	**Taste Rating Average (1 = best to 5 = worst)**	**Visual Appearance Rating Average (1 = best to 5 = worst)**
27W17	Breeding Line 119W16	7	4.2	2.8
28W17	Breeding Line 118W16	4	2.0	2.9
29W17	Breeding Line 119W16 x 118W16	12	3.0	2.2
30W17	Breeding Line 118W16 x 119W16	1	3.6	2.8
31W17	Big Beef	2	3.2	2.8
32W17	Siletz	3	2.8	2.8
33W17	Legend	6	2.2	1.2
39W17	Cherokee Purple	13	3.6	3.6
40W17	Mortgage Lifter	17	Not rated	Not rated
41W17	Black	8	2.6	2.3
42W17	Ananas Noire	15	2.7	2.8
43W17	Kellogg's Breakfast	16	2.0	2.4
44W17	Pineapple	9	3.4	2.9
45W17	German	10	3.0	3.3
46W17	Rutgers	5	Not rated	Not rated
47W17	Down Home	14	Not rated	Not rated
48W17	Pink Berkley Tie Dye	11	2.8	2.8

General observation include:
-Breeding line 28W17 performed very well for a line in development.
-'Legend' was favorably rated for taste and appearance; yield was also on the high side. Unfortunately, two respondents noted that the fruit were 'mushy'.
-'Siletz' provided high yield; taste and appearance were mid-range. Two respondents noted an off or bitter taste.
-'Cherokee Purple', an heirloom tomato that has been cited as a selection that performs well in NM, was one of the worst performers in this trial. Two respondents noted it to be mushy or off-taste.

Extension Vegetable Program Development of New Chile Cultivars through Traditional Breeding – Fabian Garcia Science Center (2017)

Investigators: S.J. Walker and I.S. Joukhadar, Extension Plant Science

Potential Impact:

The development of new, high yielding, high quality, open-pollinated chile pepper cultivars is critical to support and ensure the long-term economic viability of the crop in New Mexico. Ongoing production pressures, including labor issues, diseases, and increasing input costs threaten commercial production in the state. New cultivars must be developed that have improved yield, flavor, key quality attributes, and are highly efficient for mechanical harvest. Adoption of mechanical harvest of the green chile crop in New Mexico could potentially increase crop revenues by more than $3 million for each 10% increase in acreage.

Method:

The Extension Vegetable Program's research greenhouse is housed at the Fabian Garcia Horticulture Farm. The enclosed, temperature controlled greenhouse is a critical component in the traditional breeding of new chile pepper cultivars. Tradition chile pepper breeding begins with determining the long-term goals, including which traits will be incorporated or improved in the new cultivar, then identifying and selecting parental lines accordingly. Chile pepper flowers readily self-pollinate; however, if bees or other pollinating insects are in proximity they will visit the chile flowers, easily transfer pollen, and result in cross-pollination events. Pollinating insects are excluded from the greenhouse, making controlled pollination and breeding efforts straightforward.

The following operations take place in the research greenhouse:

-Parental plants for new breeding line development are grown and reciprocally cross-pollinated in the protected structure.

-Seed from the first generation of these parental crosses (F1 plants) is grown in the greenhouse to produce second and third generation (F2 and F3) self-pollinated seed. The F2 and F3 seed is then planted in the field to evaluate segregating plants so that exceptional plants exhibiting the improved, desired traits can be selected and brought forward in the breeding process.

-Chile pepper transplants for the field are first grown in the program greenhouse. There is only a small amount of seed available during the early stages of new cultivar development. (Larger scale seed increases are time consuming and costly, so new lines will not be increased until field evaluations confirm high potential.) Compared to direct seeding in the field, a large number of plants can be grown from a small amount of seed when a field is established from transplants.

-Seed increases are also made in the greenhouse for exceptional advanced breeding lines to ensure adequate seed is available for planting in case of crop failure with seed cages in the field.

Results:

In 2017, transplants were grown for a research field at the Leyendecker Plant Science Research Center. Transplanted material included seed cages for advanced green chile breeding lines developed for mechanical harvest efficiency, as well as observational breeding lines selected for mechanical harvest attributes.

Advancing NM Green Chile Mechanization in New Mexico through Cultivar Development

Investigators: S.J. Walker, I. Joukhadar, P. Funk, C. Havlik
Extension Plant Sciences, USDA-ARS, Plant and Environmental Sciences

Potential Impact:

Commercial acreage of NM-type green chile is threatened due to inconsistent labor availability and the relatively high labor expense compared to competing countries. Mechanizing the harvest of green chile in NM would reduce the need for hand labor and is essential to maintaining large-scale, profitable production of this crop. This program has conducted long-term efforts to develop new NM green chile cultivars efficient for mechanization, a critical component towards mechanizing harvest of the crop. Success in mechanizing NM green chile is anticipated to stop the loss and spur an increase in acres planted in NM. Each acre grown is worth approximately $7,000 in gross income to NM farmers, so a 10% increase in the current level of acreage would result in more than a $3 million annual increase in NM farm receipts.

Method:

Previous research efforts by this program identified the Moses 1010 Etgar chile harvester (Bet Dagan, Israel) as the most efficient machine tested for harvesting NM type green chile with minimal fruit breakage. A one row, small plot model of this machine was used in the NM green chile mechanical harvest trial. In addition, previous trials established plant attributes that contribute to mechanical harvest efficiency in NM green chile. These traits, including taller plants, fewer basal branches, higher primary branch angle heights, and thicker main stem diameters, were used as breeding objectives in development of the advanced breeding lines evaluated in 2017.

Six advanced breeding lines (54W17, 55W17, 57W17, 58W17, 60W17, and 61W17) developed for mechanical harvest efficiency were evaluated in 2017 at New Mexico State University's Los Lunas ASC. 'NuMex Joe E. Parker' (JEP), identified as the best commercially available NM-type green chile cultivar for mechanical harvest and 'AZ-1904' (AZ1904) provided by Curry Chile and Seed Company (Pearce, AZ), the most widely grown green chile cultivar in NM, were planted as standard controls. The field was direct seeded in a randomized complete block design on April 4, 2017 with seven replications, then managed according to standard production practices. On August 28, 2017, plant measurements were taken on six random plants per plot (Table 1). The field was mechanically harvested on August 29, 2017. All harvested material from 30' plots was collected, sorted and weighed. Following harvest, chile fruit remaining on the plants and knocked to the ground were gathered and weighed to assess field loss.

Results (2017):

Breeding line 54W17 provided the highest mechanically harvested, marketable yield, although the difference was not significant compared to JEP or breeding line 60W17. AZ1904 had significantly more ground fall losses and unharvested fruit remaining on plants compared to the breeding lines. JEP and AZ1904 both left significantly more chile fruit in the field (ground and plant loss) compared to 54W17 (Table 2). We found breeding line 54W17 to be most suitable for mechanical harvest in this trial compared to commercially available cultivars based on overall mechanical harvest efficiency and plant architecture traits.

Table 1. Plant dimension average measured on August 28, 2017.

Accession	Plant Height (cm)	Plant Width (cm)	Height to Bifurcation (cm)	Stem Diameter (mm)	Basal Branches (#)
54W17	48.3 *ab*[x]	42.4 *bc*	20.3 *a*	11.95 *a*	0.2 *cd*
55W17	50.3 *a*	42.2 *bc*	19.1 *ab*	11.79 *ab*	0.1 *d*
57W17	46.2 *bc*	43.1 *abc*	16.9 *cd*	11.81 *ab*	0.6 *bc*
58W17	44.4 *c*	40.9 *bc*	17.1 *cd*	10.76 *cd*	0.3 *cd*
60W17	45.6 *c*	42.3 *bc*	17.4 *c*	11.16 *bc*	0.7 *ab*
61W17	48.7 *ab*	43.7 *ab*	15.6 *e*	10.31 *d*	1.0 *a*
JEP	50.1 *a*	45.8 *a*	18.8 *b*	11.70 *ab*	0.8 *ab*
AZ1904	41.3 *d*	40.7 *c*	15.8 de	10.79 *cd*	0.2 *cd*

[x]Means followed by the same letter within columns are not significantly different (*P*=0.05; Least Significant Difference Test).

Table 2. Mechanically harvested NM green chile, damaged fruit, trash and fruit left in the field after harvest, 08/29/17.

Accession	Marketable Green Fruit (kg/plot)	Damaged Green Fruit (kg/plot)	Trash (kg/plot)	Unharvested Remaining on Branches (kg/plot)	Ground Fall Losses (kg/plot)
54W17	6.0 *a*[x]	1.0 *b*	1.3 *a*	0.1 *d*	0.3 *d*
55W17	5.0 *abc*	1.0 *b*	1.3 *a*	0.1 *d*	0.4 *cd*
57W17	4.5 *bc*	0.9 *bc*	1.0 *ab*	0.3 *cd*	0.5 *bcd*
58W17	2.5 *d*	0.6 *c*	0.4 *c*	0.4 *c*	0.3 *cd*
60W17	5.3 *ab*	1.0 *b*	1.2 *ab*	0.3 *cd*	0.6 *bc*
61W17	2.6 *d*	0.6 *bc*	0.8 *bc*	0.7 *b*	0.4 *cd*
JEP	5.8 *ab*	1.1 *ab*	1.1 *ab*	0.5 *bc*	0.7 *ab*
AZ1904	3.8 *cd*	1.4 *a*	0.9 *ab*	0.9 *a*	1.0 *a*

[x]Means followed by the same letter within columns are not significantly different (*P*=0.05; Least Significant Difference Test).