Organic Crop Breeding Report

ORGANIC FARMING
RESEARCH FOUNDATION

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Introduction

Organic agriculture relies on varieties that have been bred by classical techniques for specific conditions. Many modern varieties have been selected to grow in high-input conditions that involve the use of fertilizers and pesticides prohibited for organic production. Such varieties do not always perform well in organic farming systems. A growing number of varieties are being introduced that have been genetically modified, and are thus excluded from organic production. Therefore, organic farmers need varieties that are improved, meaning that they perform optimally in organic farming systems and meet consumer demands for quality, flavor, and consistency. Breeding and selection for organic conditions is therefore a priority for organic farmers. Researchers at OARS presented on the selection of fava beans and lupins as cover crops; conventional breeding of tomatoes for insect resistance; and improving plant genetics for soil health and organic production. This research contributes to the field of knowledge by the breeding, selection and development of cultivated varieties suitable for organic farming conditions.

The Effect of Sowing Density on Biomass Production of Autumn Sown Fava Bean and Lupin: Opportunities for Improvement via Selection

Erik Landry (Presenter) and Jinguo Hu

The objectives over the research was to evaluate the biomass production of winter fava beans and lupin at three sowing densities; identify germplasm with superior winter hardiness and traits associated with biomass production; and transfer the improved germplasm for further testing and development of alternative cover crops in the Northern US. Organic farmers in the region have few options for winter cover crops because of the cold winters. The northern plains and prairies of North America have limited cool season nitrogen-fixing cover crop options that can withstand the long, cold winters. Researchers at the USDA-ARS Western Regional Plant Introduction Station planted fava beans, and white and blue lupin in September at three densities: 30, 60, and 90 plants /m^2 (approximately 120, 240 and 360 thousand plants per acre). Height, branch numbers, carbon (proxy for biomass), and nitrogen were measured in April and May. Weed pressure was also assessed. The lupins proved difficult to establish, uncompetitive against weeds and were not particularly winter hardy. Fava beans were more winter hardy. The 60 plants/m^2 density yielded the highest biomass. The 90 plants / m^2 density had the least weed pressure, but was not significantly better than the 60 plants / m^2. The additional cost of seed did not justify the higher density. Seed costs for fava beans are currently uncompetitive with winter pea or vetch. The varieties require further testing in multiple environments. The project has the potential to develop better cover crops for specific environmental conditions.

Conventional Breeding (non-GMO) of Tomato for Insect Resistance
John C. Snyder

Classical breeding can use the biodiversity found in wild relatives of domesticated crops to improve commercial organic crops. Selected insect resistant varieties can be grown without the use of pesticides. The objectives of the on-going project are to: (1) transfer the production of high levels of zingiberene, high type IV trichome density and other insect resistance factors from the wild tomato *Solanum habrochaites* to the cultivated tomato using conventional breeding methods; (2) evaluate the resistance of the tomatoes selected to spider mites and other arthropod species in the breeding population; and (3) identify genes associated with spider mite and whitefly resistance and with elevated zingiberene production and high type IV trichome density for use in marker assisted transfer of these characters from wild to cultivated tomato. Trichomes are small hairs on the leaf surface. These exude chemicals that repel or deter feeding by different known pests of the crop. Zingiberene is one such chemical that exhibits insect deterrent properties. While insect resistant varieties have been selected, these do not yet produce marketable fruit. Selections are being made for small stature, erect growth habit, high brix and good flavor. If commercial varieties are developed, organic farmers can produce undamaged tomatoes without pesticides.

Improving Plant Genetics for Soil Health and Organic Production
Mark Schonbeck

Organic farming systems require crop traits that are not necessarily found in modern varieties bred for production with high inputs. Breeding crops for soil health in the context of organic farming systems are expected to require selection of different traits than have been selected by modern breeding programs. The following traits were identified as possibly contributing to soil and water quality:

- Efficient uptake of nitrogen (N) and other nutrients from organic sources.
- Legumes selected for greater symbiotic N fixation
- Association with mycorrhizal fungi and other beneficial micro-organisms that assist nutrient uptake, promote tight nutrient cycling, and deter plant pathogens.
- Improved root development, with specific traits such as greater root biomass.
- Increased above ground growth that protects the soil surface and adds organic matter.
- Increased weed tolerance and weed competitiveness through rapid emergence and establishment, tall or dense canopy, or other traits.
- Ability to establish, thrive, and yield in cover crop based conservation tillage systems.
- Cover crops with high biomass, weed suppression, effective N fixation, efficient uptake of other available nutrients, winter hardiness, and ease of termination by mowing or roll-crimping.

Greater root development and more biomass directly increase soil organic matter and soil life. Regionally adapted cultivars that are competitive with weeds would reduce the need for tillage and cultivation. Organic farmers will benefit if more varieties are selected for organic farming conditions.

Conclusion

Classical plant breeding is a long-term endeavor that requires access to genetic material and the technology to select, improve, and develop varieties that are commercially viable. The study Taking Stock identified public crop cultivar development for organic farming systems as a priority, as well as farmer-participatory plant breeding and organic seed production networks. These endeavors will require a long-term investment. The researchers presenting at OARS provided useful models and valuable information about how breeding for organic conditions can be done.