Perspectives on Organic Vegetable Legumes: Current Status and Breeding for the Future

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Introduction:

This panel seeks to highlight current work in breeding organic vegetable legumes and initiate a discussion about current and future varietal needs, while tying the discussion to a larger stakeholder needs assessment. Previously, crops such as snap beans and garden peas have received only minor attention, being combined with the field crop forms of these species. Traits of importance for organic production are potentially different between field and vegetable crops.

To explore these demands further, our panelists will expand on personal topics of expertise, including bush and pole snap beans, snap and shelling peas, pea shoots and sprouts, as well as industry trends in a variety of vegetable legumes. James Myers, Vegetable Breeder at Oregon State University, will present on bush-habit snap beans with a discussion of valuable traits for both organic beans intended for the fresh market and processing market. Michael Mazourek, Vegetable Breeder at Cornell University, will discuss the value of pole beans on diversified, organic vegetable farms and his collaborative work to develop 10 multi-use pole bean cultivars intended for use on such farms. Additionally, he will discuss his ongoing work to incorporate colorful flavonoids into snap peas. Rebecca McGee, Research Geneticist at the USDA-ARS station in Pullman, will discuss breeding objectives for a variety of pea crops including shelling types, shoot and sprout types, and field peas. Linda Fenstermaker, West Coast Sales Representative from Osborne Quality Seeds, will be presenting on trends in legume seeds in the organic farm industry.

Snap beans (bush-habit):

Snap beans are the vegetable cousin to dry beans and share the same basic biology. There are differences; nutritionally, snap beans have lower protein and carbohydrates but possess certain vitamins that dry beans lack. Snap beans share common origins with dry beans, and research problems overlap, but many aspects of snap bean breeding and genetics related to their use as a vegetable are unique to the crop. Among others, they have been selected for low fiber, stringlessness, and thick, succulent pods. Yield is more complex than for dry beans because of the need to balance yield with quality. Snap beans fall into two main types: Those used for processing and those grown for fresh market. The two types have different requirements – for example pod fiber levels can be much higher in fresh market types compared to processing types. Processing types have additional requirements such as round pod cross-sections, white seed, and concentrated

pod set. Much of the breeding effort for the crop has been on disease resistance (viruses, anthracnose, rust, bacterial brown spot, common bacterial blight, halo blight, white mold, root rots). Additional research has been focused on quality traits (pod color, fiber, texture, etc.), taste, flavor, and human nutrition (sugars, calcium, flavor volatiles and phenolics). Some research activities have concentrated on improving plant architecture and yield for processing varieties, but this type of work has not been carried out for fresh market snap beans. Snap beans are valuable in crop rotation on organic farms because they are a legume and can potentially add nitrogen to the soil. However, the needs of organic growers have not been assessed to determine whether contemporary cultivars are well adapted, and what traits might be incorporated that would be useful to organic growers, markets, and consumers. One trait of value to organic production that is not necessarily important to conventional production, is that of biological nitrogen fixation. In conventional agriculture, snap beans are managed as if they do not have the ability to fix their own nitrogen, mainly because the crop rapidly reaches harvest maturity before the symbiotic process has time to establish and contribute nitrogen in any quantity to plant growth. The situation is somewhat alarming because we are beginning to see snap bean cultivars bred in fertilizer-intensive conventional production systems that completely lack the ability to form nodules and fix atmospheric nitrogen. Breeding for snap beans that establish symbioses early and rapidly fix nitrogen could be an objective of breeding for organic production.

Are there other traits that would enhance organic production? This is where input from the organic community is needed to establish the goals of breeding snap beans for organic systems.

Snap beans (vining-habit):

Pole beans can be a better fit than bush beans for diversified farms. While bush beans are self-supporting, their short stature, concentrated pod set, and maturity are ideal for mechanized harvest. Pole beans are ergonomic for hand harvest, are easy to work into crop rotations with single plantings instead of succession plantings, and continue producing when harvests are missed or skipped. Pole beans also break the cycles of disease that accumulate when growing the same crop every summer or every other summer. As a nitrogen fixing legume, they reduce the need for fertilizer and therefore salt buildup in the high tunnel soil. This has the potential to extend the duration a high tunnel can stay in production without being moved or having the plastic removed for rain to wash out accumulated salts. With the welcoming support of Zaid and Haifa Kurdieh at Norwich Meadows Farm, and cross-pollination pairings by John Hart (now Earthworks Seeds) we began a collaborative breeding project. Seed multiplication was integrated into the production farm by reviewing the crop before the first harvest to make selections. A couple pods on each selected plant were labeled with red mesh sleeve bags to allow market harvest to happen while we saved seed. We developed ten new pole bean cultivars for multiple use as snap, fresh shelling, and dry bean use. We were guided with harvest trait input from the growers on the farm, flavor critiques from Zaid and Haifa, and lab genotyping that confirmed seed transmitted virus resistance.

Peas (snap/edible pods):

As we domesticate plants from the wild, they become more practical to grow but lose their resistances and phytochemistry. The peas we grow tend to have Mendel's white flowers to avoid bitterness and astringency of the associated flavonoids in wildtype, purple flowered plants. We are exploring the benefits for plant and person of restoring colorful flavonoids to peas.

Peas (shelling, sprouts, shoots, and field):

Peas, *Pisum sativum*, are grown and consumed either as a vegetable or as a dry, pulse crop. Vegetable peas have traditionally been consumed as immature seeds, either canned, frozen, or fresh and are frequently referred to as garden peas, shelling peas, or English peas. In the 1970's edible pod peas, ones in which the pod as well as seeds are consumed, became popular. In recent years, pea sprouts and shoots have become a third vegetable pea product. English peas typically have dark green, wrinkled seeds, and white flowers (all Mendelian traits). Breeding efforts have focused on resistance to biotic stress (primarily aphid vectored virus diseases, foliar fungal pathogens, soil-borne pathogens), end-product quality (flavor, texture, color, appearance) and, of course, yield. As with most legumes, English peas can form a symbiotic relationship with Rhizobium and fix atmospheric nitrogen, much of which is left for subsequent crops. For organic production, some issues of concern include pea seed weevil, fast germination and stand establishment, and maturity timing. Pea shoots and sprouts are relatively new. Sprouting peas are typically Maple peas and are usually grown in controlled conditions. Sprouting peas have long internodes, pigmented flowers, and normal leaves. They are typically consumed as a vegetable or garnish when they are about 15 cm tall. Pea shoots are also used as a garnish or vegetable and are grown either in fields or controlled conditions. In this class, the leaflets have been converted to tendrils with a leaflet on the end of each tendril. Breeding objectives for both pea shoots and sprouts include rapid germination, flavor, and texture. Field peas are considered a pulse crop as they are harvested when the seed is physiologically mature. They have either green or yellow cotyledons, white flowers, and are typically semi-leafless. They are sold as either a whole food, dry (e.g., split peas) or re-hydrated and canned (e.g., mushy peas), or are further processed and used as an ingredient. There is growing interest in plant-based proteins and field peas are a crop of choice because they are high protein (25%), have no allergen issues, and are non-GMO. Breeding efforts have focused on resistance to biotic and abiotic stresses, nutritional quality (protein and mineral concentrations), and processing attributes.

Input is sought on additional agronomic and quality traits that are important to organic growers of English peas, pea sprouts and shoots, and field peas.

Industry perspective:

Linda Fenstermaker, West Coast Sales Representative from Osborne Quality Seeds, will be presenting on trends in legume seeds in the organic farm industry. Through her

experience working with organic farmers and as an organic farmer herself, she will describe popular varieties of beans and peas, as well as general consumer trends in these crops. A few areas of focus include colorful peas, common beans, and fava beans. She will also identify areas of growth for increased organic seed use within the industry.

Needs Assessment:

We hope you'll join us for a meaningful conversation among our panelists and the audience, as we seek to define the path forward for breeding work on a suite of vegetable legume crops. A needs assessment will be available during the conference via Qualtrics (see QR code), where we encourage those of you who work with any vegetable legumes to lend your voice to the discussion as well.

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