Reuniting the Three Sisters: Native American Intercropping, Seed Saving, and Plant Health

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Recent food and seed sovereignty movements within Native American communities have ushered in a revitalization of cultural growing practices. Crucial to this work are efforts to revive knowledge and practices surrounding seed saving, which allow for future plantings of culturally significant crops. This research project, which exists in collaboration with Native Tribes throughout the Midwest, has undertaken efforts to conserve and share valued Indigenous varieties. In a Three Sisters garden plot located at the Horticultural Research Station rare varieties of corn, bean, squash, and sunflower have been grown out for amplification and rematriation.

Rematriation is a rising process within Indigenous seedkeeping networks. This movement, which provides a feminine reframing of repatriation work, seeks to identify cultural seeds from within the collections of non-Native institutions and reunite them with their home communities. For this research to be respectful of the Indigenous methodology utilized by the overarching research project, a decision was made to grow Native varieties in the garden plot. A culturally appropriate and ethical way to make use of all crops grown for this research was to rematriate the seeds to their home communities.

Therefore, a component of the research at this field site is plant health and yield as it relates to seed production. As a continuation of this project from last season, the research considers the effects of the Three Sisters Intercropping of corn, bean, and squash, when compared with each of the crops in monoculture.

Materials and Methods

This project is in its second field season and uses many of the methods from the previous season. Experiment layout consisted of a randomized complete block design, with four replications of each treatment [3-sister (3SI), Corn, Bean, Squash]. Each treatment plot was 20 ft. × 20 ft. Each plot contained 16 mounds, approximately 3 ft. wide in diameter, per traditional Native gardening methods. Each mound was spaced 5 ft. apart (center to center). Mounds were constructed by hand, piling soil into the center of raised beds. Before planting, an aggregate soil sample from each of the treatments was collected to create a baseline soil nutrient and health profile. For the second year (2021) research, a three-year crop rotation was developed for all monoculture treatments: Corn→Squash→Bean→Corn. The 3SI treatment remained in the same research block to allow for analysis of a multi-year treatment effect. Figure 1 and 2 show a 3SI mound and a plot overview, respectively.

Figure 1. Example of a complete Three Sisters mound.

Prior to planting, Sustane® Natural Fertilizer (4-6-4), Inc. (Cannon Falls, Minnesota) was applied directly to the growing mounds at a rate of 60 lbs. per acre. Planting configurations also followed the same protocol as the previous growing season, with a border of sunflowers around the perimeter of the experiment and plants always placed in the same position within each mound, regardless of whether the treatment was a monoculture or the complete intercropping. One adaptation to this year's methods, however, was a reduction in the number of squash planted. Due to competition from plant vigor in the 2020 season, which negatively impacted the bean crop, only one squash plant was included in each of the perimeter mounds within a treatment, and always on the south side of the mound. Within the inside four mounds, two plants were maintained to allow for comparison between growing seasons.

This year's planting relied upon the same suite of sisters utilized last growing season, and all seeds came from seed production in the previous season. The varieties used in this research are Turtle Mountain White Corn, Hidatsa Red Bean, Algonquin Long Pie Pumpkin, and Arikara Sunflower. All crops were direct seeded this season, with corn planted first May 13, 2021. Beans were seeded June 1, and squash June 15, following the timing of Indigenous protocol. Overheard irrigation was not installed due to smut infection the previous season, as foliar moisture and water droplets can exacerbate infection in growing plants. Instead, the plot relied on drip irrigation. In the bean monoculture treatments, trellis support was created using wooden stakes in an A-frame to mimic the structural support of corn in the Three Sisters treatment.

During this season, seed saving again was a priority, given the project's aim to produce seeds for rematriation. Sunflower heads were bagged and hand-pollinated to protect against outcrossing with wild plants. Additional corn varieties were grown at the plot this season for a mini trial on smut infection. These varieties were bagged and hand pollinated to prevent cross-pollination with the Turtle Mountain White. Beans, being mostly inbreeding, were left to open pollinate. Squash, given their tendency to cross with plants within the same field, and given adequate distance between *C. pepo* plants at the farm, also were allowed to open pollinate.

Corn silking began June 25, about a week earlier than expected. Corn smut reappeared as an issue around this same time, first affecting corn tassels. To protect corn yield, the team began removing young smut galls by hand to prevent their growth and from breaking open and spreading fungal spores when mature.

Figure 2. Bean monoculture in the bottom left, with the Three Sisters treatment to the right, and the sunflower perimeter visible in the back.

Despite these efforts, many ears still were lost to the fungus. Beans began flowering July 7, and squash on July 21. The plot experienced substantial damage from squash bugs and corn rootworm beetles this season, necessitating organic insecticide applications (Safer Soap, Pyganic, M-Pede, and Di-Pel) frequently during the height of the growing season.

Results and Discussion

This season, while more successful than the previous, was not without its challenges. Smut infection, while anticipated and managed for, still impacted corn health and yield. An unforeseen development at the plot this season was the appearance of bacterial leaf spot in the pumpkin crop, caused by the bacterial pathogen Xanthomonas cucurbitae. This disease is one of the most significant concerns to the cucurbit industry, causing up to 100% yield losses in some instances. Disease severity at the research plot was significant, with approximately 95% of the yield lost to this disease across the experiment. Between the two treatments, disease impact was more severe in the monoculture treatment, with 51% of produce affected.

Comparatively, 43% of the crop was impacted by the disease in the Three Sisters treatment (Table 1). Bacterial leaf spot has been reported as a seedborne pathogen, being carried both within and on the seedcoat. Any pumpkins with symptoms during the growing season transmit the disease to the next generation through its seeds. Due to concerns about passing this disease on to collaborating communities, it was not possible to save seeds for rematriation this season.

Corn yields across the two treatments were similar. Beans, however, were significantly more productive in the monoculture system. Despite efforts to control squash vigor in this growing season by limiting the number of plants per treatment, the squash crop still was too competitive. Three Sisters mounds were again overgrown by the pumpkin plants, and beans may have been too shaded to perform well.

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Table 1. Average yield (count and weight) of marketable and non-marketable corn, bean, and squash grown at the ISU Horticultural Research Station.

	Monoculture				Three Sisters			
	Marketable		Non-marketable		Marketable		Non-marketable	
Crop	Count†	Weight (kg)	Count	Weight (kg)	Count†	Weight (kg)	Count	Weight(kg)
Corn	88	5.57	26	0.47	82	5.80	25	0.70
Bean	3,486	4.57	54	0.03	908	1.25	37	0.02
Squash	50	78.93	53	61.47	45	74.70	33	39.31

† Bean count depicts the number of pods.