

Sustainable Seed Production and Cover Crops

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Pioneer Hi-Bred focus on sustainable agriculture



Cover crop research in Hawaii, project leads John McHugh and Lynn Constantinides, Crop Care Hawaii, LLC. Photo: C. Goldstein.

Pioneer Hi-Bred International carries out research and development as well as seed multiplication with corn, soybeans, and sunflower on Oahu and Kauai. Sustainable agriculture practices are integrated into our agronomy programs and our goals for sustainable agriculture guide the direction of plant breeding programs to develop hybrids and varieties that help reduce agriculture's environmental footprint. Integrated Pest Management practices are utilized in our seed production operations, with extensive field scouting to manage seed production and use of biological control for insect pest management when possible.

Higher yields on the same number of acres, or fewer acres, is a goal for many of our plant breeding programs. Our goals for sustainable agriculture are driven by the need to feed a growing population on the same or fewer acres of land. Pioneer Hi-Bred is carrying out plant breeding work for genetic characteristics such as increased nitrogen use efficiency and drought tolerance that will allow the production of higher yielding crops on fewer acres with less water and lower nitrogen use.

Whether an agriculture producer uses organic or conventional farming methods, we all face similar challenges and seek solutions that are effective and sustainable. Research with cover crops and their adoption are important to Pioneer because cover crops are a sustainable agriculture practice that is of benefit to the seed industry and other Hawaii agriculture operations. Pioneer Hi-Bred has a long tradition of developing agronomic practices that benefit farmers and sharing that information to the benefit of everyone interested in producing crops.

Cover crops research - objectives and cooperators

While the first thing that may come to mind in discussing the use of a cover crop is the role these plants play in soil conservation and soil nutrition as nitrogen fixing cover crops, other long-term benefits for Hawaii agriculture were seen in these studies. Pioneer Hi-Bred International carried out cover crop research at our Waialua Parent Seed station on Oahu with Crop Care Hawaii, LLC. The goal of the project was to identify agronomic benefits of cover crops by establishing on-farm demonstration plantings and then promote the continued adoption of the practice. Once cover crops with the potential to benefit Hawaii's agriculture

producers were tested and identified, the second phase of the project was sharing information with farmers, researchers, state and federal agencies, and others that would benefit from this knowledge and that would in turn share it with others throughout the State of Hawaii.

This project was executed with a number of partners and included several agriculture cooperators around the state. Pioneer Hi-Bred was pleased to be able to include an educational component for high school students as part of this program, with Waialua High School students carrying out work as part time employees of Pioneer. Partners included the Oahu Resources Conservation and Development Council, USDA – Natural Resources Conservation Service, Hawaii Agriculture Research Center, University of Hawaii College of Tropical Agriculture and Human Resources, and Waialua High School and Intermediate.

A number of agriculture operations across the state participated in cover crop field tests. This allowed testing in different types of environments and helped with dissemination of information to a broader range of farmers in Hawaii. Cooperators included Mohala Farms (Mark Hamamoto), Hawaii Agriculture Research Center (Kunia and Maunawili), Pioneer Hi-Bred International, Inc., Dole Foods, Twin Bridge Farms, Inc., Kauai Coffee Company, George Mokuau (Molokai), Kapalua Farms (Maui), Alembic International, Inc. (Hamakua), Alberto Belmes and Randy Akao (Keaau), Orlando Manuel (Opihikao), Lorie Obra (Pahala) and Tommy Greenwell (Kona).



Oats, sunn hemp, and buckwheat at Twin Bridge Farms, Waialua. Photo: J. McHugh

Cover Crop Studies and Considerations

Agriculture operations often face the challenge of weed control no matter what crop is cultivated and cover crops can be one method that contributes to a good weed management strategy. Cover crops that fix nitrogen are often used to replenish nitrogen in soils, especially in rotation with a crop that may require larger amounts of nitrogen. Cover crops are often used as a green manure, returning nitrogen and sequestered carbon to the soil. Some of the cover crops tested had benefits that go beyond what we often think of for a cover crop. Nematode suppression is one of the positive

benefits associated with some cover crop species. One unexpected result was finding a cover crop that had a number of positive attributes that also served as a host plant for insect predators, benefiting our integrated pest management strategies for use of biological control agents.

Cover crops tested in these studies included sunn hemp (*Crotalaria juncea*), buckwheat, winter wheat, oats, barley, sudex, lana vetch, and mung beans. In some of the research plots two cover crops, sunn hemp and one of the other species, were combined and evaluated.

Bareground fallow was used as a control for experiments. No irrigation, fertilization, or pest control were used in the cover crop plots. As the project progressed, planting protocols were modified to manage the crops during drought periods. To achieve good vegetative cover for soil erosion management and production of green manure, management practices such as only disking ground to be planted in one day, and incorporating seed with planting equipment immediately following disking were included in the planting protocol.

Sustainable weed control practices are a topic of active research and use of cover crops for suppression of weeds is not a new topic of investigation. Cover crops were found to be very effective for weed suppression in these field tests. Plantings with sunn hemp plus buckwheat, and sunn hemp plus oats were found to be the most effective at suppressing weeds. Sunn hemp plus oats gave good vegetative cover and decreased soil erosion was observed.

One criteria for evaluating the effectiveness of a cover crop is how well weeds are suppressed as the crop germinates, emerges, and seedlings develop. The cover crop species were evaluated for ability to give good overall weed control throughout the life cycle of the cultivated crop. Research involved not only selection of species to test for effectiveness of weed control, but the pattern of establishment of the cover crop. A cover crop might give good control of weeds initially, but may only give good control as the crop is first established and become less effective as the production cycle of the cultivated crop progresses. This was the case for mung bean which did in fact germinate at high rates and establish a good cover, but longer term suppression of weeds during the growth cycle of the cultivated crop was not achieved. Buckwheat was slightly better than mung bean for weed control, with good early weed control, but less effective as the experiments progressed. Mung bean, winter wheat, barley, and oats were more effective at suppressing weeds than a bareground fallow practice.

While a cover crop may thrive and work well for soil conservation purposes, some cover crops can become established in a field and set seed at high enough rates to become a weedy species. Awareness of the potential for a cover crop to become an invasive species should be top of mind for anyone considering a new cover crop for Hawaii. Care should be taken that selected cover crops are not potential invasive species. Another critical factor to observe in determining the usefulness of a cover crop is whether the cover crop is so successful after the first growth cycle as a cover crop that it becomes a weedy plant in a cultivated field. This has



Buckwheat in coffee, Ka 'u. Photo: J. McHugh



Oats in coffee, Ka 'u. Photo: J. McHugh

been the case for oats which can be an effective cover crop, but has aggressive tillers which may exhibit rapid growth.

Once a cover crop has become well established and has shown benefits, it is important to observe the growth pattern of the plants and determine when to stop the growth cycle and turn the crop back into the soil. It is often desirable to do this prior to the cover crop setting seed. A cover crop such as sunn hemp can quickly go from an herbaceous cover crop to a woody shrub and substantial tap root growth may occur. Close observation of the growth habit and developmental cycle of the cover crop is essential when establishing best management practices for a cover crop.



Sunn hemp and buckwheat at Twin Bridges Farm, Waialua. Photo: John McHugh

Cost and availability of seed are two practical aspects of selecting a cover crop. In any agriculture operation where profits and cost of production are factors in the operation, cost of cover crop seeds must be considered. The amount of seed that will be needed to give good vegetative cover and the cost of that seed must be taken into account in choosing which cover crop to utilize. Relative costs may vary from year-to-year with changes in supply and demand. Mung bean seed and oat seed were the least expensive, buckwheat seed was about twice the cost, and sunn hemp seed was the most expensive at about 5 times the cost of mung bean seed. When cost per acre was calculated, winter wheat was the lowest cost, and very close to the cost of mung bean and oat seed. Buckwheat was about twice the cost per acre and sunn hemp was about 2.5x higher than the cost per acre planted for winter wheat, oats and mung bean.



Field day to share results of cover crops research with local farmers, held at Pioneer Hi-Bred, Waialua Oahu. Photo: C. Goldstein.

While some seed is easily sourced, such as mung bean, oat and wheat seed, other cover crops that may be well suited for Hawaii may be difficult to find from a commercial source. Sunn hemp has been shown to have many positive attributes as a cover crop for Hawaii, but availability of seed has been a bottle neck for wide spread implementation by agriculture producers that want to use sunn hemp as a cover crop. Production of an ample supply of sunn hemp seed has been a challenge. Rainfall patterns for establishment of a planting are important. Seed should be planted at a time when rainfall is expected to allow good germination and establishment of plants. When planting sunn hemp for on-farm seed production it is recommended that planting

occur from mid-September through the end of December. Plant growth and development has not been the most significant challenge, but following harvest, threshing seed has proved to be quite difficult. Specialized equipment modified for sunn hemp has made threshing easier and improved efficiency. An International Harvester combine with a John Deere seed head has been used successfully to harvest the sunn hemp seed.

Additional considerations for use of sunn hemp as a cover crop should include an understanding of the release of nitrogen. Nitrogen release from green manures can be a slow process. Not all nitrogen will be available immediately after disk or plow down. Decomposition of incorporated organic matter and release of Nitrogen occur after soil moisture is applied.

Cover Crop Studies and Results

Results of the studies carried out by Pioneer Hi-Bred International, Inc., with Crop Care Hawaii, LLC and Hawaii Agriculture Research Center showed sunn hemp (*Crotalaria juncea*) to be very effective as a cover crop for weed suppression and soil erosion control. Vegetative cover was significantly greater in plots with sunn hemp alone or sunn hemp in combination with oats or in combination with mung bean. Sunn hemp alone or in combination with other cover crops provided excellent weed suppression. Sunn hemp alone or in combination with other cover crops can potentially enhance soil nitrate due to nitrogen fixation capabilities, increase soil nutrients, and increase soil organic matter. Sunn hemp was also observed to contribute to root knot nematode suppression and an unexpected result was that sunn hemp was found to be a host for beneficial insects important for integrated pest management practices.

Pioneer Hi-Bred Implementation of Sustainable Agriculture Practices

Pioneer Hi-Bred International, Inc., has adopted sustainable agriculture cover crop practices based on findings of this research. Sunn hemp was shown to be the best cover crop for our seed production needs. We rely on naturally occurring rainfall, planting in the fall to take advantage of late fall and winter rains. Sunn hemp is seeded in small field plots following seed production cycles and continues to be effective for soil erosion control. With low rainfall patterns, strips of sunn hemp seed were prepared which germinated following rainfall and slowed down water movement when heavier rains began. We have also planted sunn hemp as a refuge for an insect biological control program for the parasitic wasp species *Trichogramma*, for biocontrol of corn ear worm.



Sunn hemp field planting. Pioneer Hi-Bred has adopted sunn hemp as a suitable cover crop for seed production. Photo: C. Goldstein.

Additional Resources - Sustainable Agriculture and Cover Crops

Use of sunn hemp as a best management practice for sustainable agriculture is not new. These studies confirmed that sunn hemp is a beneficial cover crop for use in our seed production operations in Hawaii. The UH CTAHR publication '[Tropic Sun' Sunn Hemp](#), extension bulletin SA-GM-11 provides practical information for use of sunn hemp as a cover crop in Hawaii.

Another helpful reference is Managing Cover Crops Profitably, www.sare.org/publications/covercrops/covercrops.pdf

A link with more information about the field tests and results can be found at the Oahu RC&D website. The link includes information on benefits, the field trials, and photos.

<http://www.oahurcd.org/projects/conservation-planning/adoption-of-cover-crop-technology/>

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