Grant Project Final Report
For Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Development
Agricultural Development & Diversification Program (ADD)

Contract Number 17076

Nuna Beans: An Alternative Crop for Wisconsin

Project Being Date: July 1, 2002 Project End Date: Dec. 31, 2003
Amount of Funding Awarded: $23,000
Principal Contact Person: James Nienhuis
Address: 1575 Linden Drive Rm. 321A
Madison, WI 53706
Telephone: (608) 262-6975 Fax: (608) 262-4743
E-mail Address: nienhuis@calshp.cals.wisc.edu

Nuna beans, the Andean popping bean, have the potential of becoming a high value crop for Wisconsin. The goals of this grant were to continue with previous popping research, produce enough seed of advanced lines for commercial testing and to broaden the knowledge of nunas in general.

We used two approaches in the nuna breeding program; recurrent selection and pedigree selection. Pedigree selection was used to quickly provide adapted lines with desirable popping and agronomic properties and produce enough seed for commercial scale testing. Individual plants were selected from the best popping and yielding lines. Seed from these superior individual plants were planted out the following year and the best individuals were selected and this is being continued at present. The recurrent selection is being used to incorporated favorable traits to produce the future lines of nuna beans. The recurrent selection program also allows the exploration the genetic and environmental effects and their interaction. It is know the growing environment may play a role in nuna bean popping. We also wanted to understand how factors e.g. seed

moisture, popping temperature, and popping time were also measured to find the effect on popping.

Pedigree selection allowed us to quickly select nuna lines with high popping percentage and high yield. From the 2002 summer field trials, eight lines with high yield and popping percentage were selected. The eight lines were increased at the Walnut St. Greenhouses at the UW-Madison and in Davis, California in collaboration with ConAgra Foods. The greenhouse seed was planted out in summer 2003 under irrigation near Rock Falls, WI in collaboration with the Chippewa Valley Bean Co. The eight lines preformed differently in the field from what we saw in the greenhouse. Each line expressed a type I, II, or III growth habit and yields differed greatly among the lines. The top performing lines will be increased in Costa Rica. This increase is being funded through a $5,800 competitive grant submitted to the UW-Madison Graduate School.

Selection also continued in the field at the Arlington Agricultural Research Station, Arlington, WI. We experienced difficulty in the field this year due to the drought conditions giving us low seed yield and diminished stands.

Two rounds of recurrent selection were carried out under the funding period of the DATCP grant. One hundred lines were planted out in two randomized replicates with four blocks with in each replicate. The one hundred lines came from four Type 2 North Carolina Crossing Blocks with 25 lines coming from each. A North Carolina Crossing Block consists of an equal number of male and female parents that were randomly select from a population and crossed with each other. The plants from the trials were harvested in paper bags and burlap sacks and allowed to dry in greenhouse before thrashing. The seed was dried to a uniform seed moisture of 5% to eliminate variation in popping due to

seed moisture so that a better comparison could be made. The effect of moisture on popping can be seen in Figure 2. The popping data from this is currently being processed and will be submitted for publication to Hortscience.

To better understand nuna popping characteristics, a separate laboratory experiment was conducted. Three main factors were tested: moisture of the seed, time of popping, and temperature of the air in which the beans are popped were tested on the PB24 line of nunas using a factorial design experiment. To obtain seed sample of PB24 with a moisture range of 3% to 20% for the test moisture chambers were constructed from one gallon jars with lids. One kilogram of saturated salt solution was used in the bottom of seven of the jars. Saturated salt solutions provide an uniform relative humidity with in the sealed chamber. The dried seed was placed in each chamber and was allowed to equilibrate with the atmospheres of each chamber either losing moisture or as most often was the case gaining moisture. The seven different salt solutions provided a range of seed moistures from 2.57% to 19.77%.

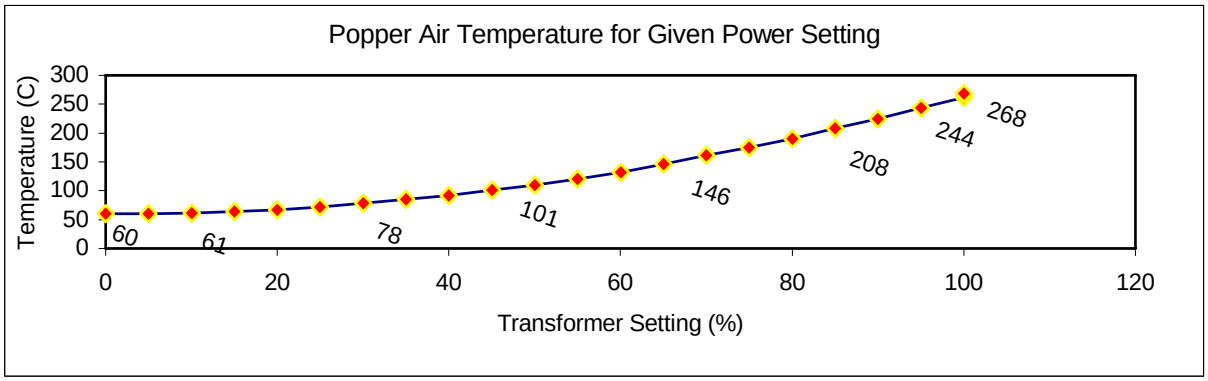
Table 1. Seed moisture and relative humidity within moisture chambers.

Saturated Salt Solution	Relative Humidity*	% Seed Moisture
Control	NA**	2.57
LiCl	11.30	3.08
$MgCl_2$	32.78	5.71
K_2CO_3	43.20	6.67
$Mg(NO_3)_2$	52.89	7.69
NaCl	75.29	12.36
KCl	84.34	15.13
K_2SO_4	97.30	19.77

*Relative humidities are reference values (CRC Press)
**no measured value

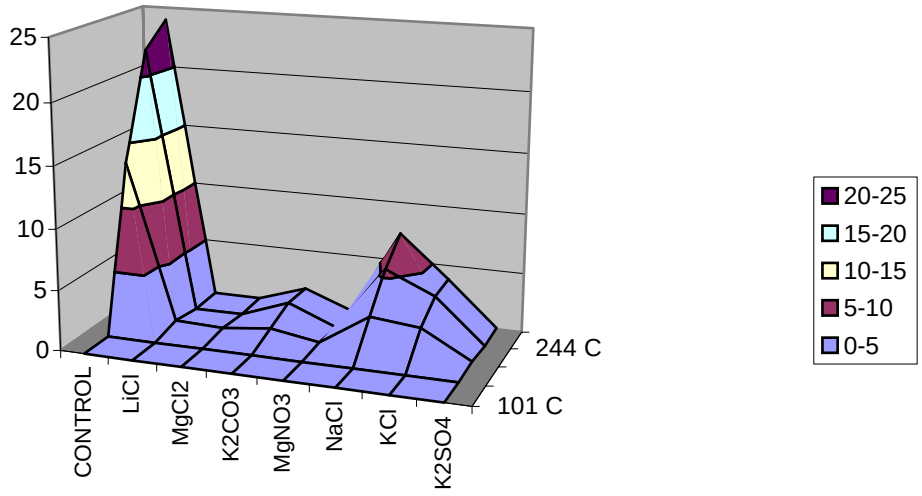
To obtain the necessary range of hot air temperatures a Presto Hot Air Popper, the same type of popper that was used for popping the uniform seed moisture trials, was modified placing a variable transformer in line with the main heating coil of the hot air popper. This configuration allowed us to produce a range of temperatures from 60 C to 268 C (Fig. 1). We used eight levels of seed moisture, five levels of popping temperature and three popping times

Figure 1. Temperatures produced at different power settings of the variable popper.



A better understanding of the factors influencing popping was gained. We found that seed moisture and popping temperature are the main factors that effect the popping of nuna beans. Nuna popping percentages were much lower at moistures above 6% total seed moisture. We also found that temperatures above 200 Celsius were necessary for popping (Fig 2). The highest percentage of popping was found temperatures of 201, 244, and 268 C, though scorching of the popped bean were seen at the temperatures of 244 and 268 C for times of 1.5 minutes and 2 minutes. The best popping at these temperatures was seen at the seed with the lowest seed moisture. The relationship between temperature and number of seed popped per 25 seed sample can be seen (Fig. 2).

Figure 2. Average number of fully popped seeds per 25 seed sample.



The newness of this product to North American markets and the lack of familiarity with nuna beans hindered its marketing to larger companies. The potential of the product has been acknowledged by snack-food companies that we have contacted. Partnership is needed to take this product to the shelves of grocery stores to study consumer reactions.

We are continuing selection for improved nuna lines, increasing seed, as well as meeting with companies willing to market the nuna bean.