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Factors Responsible for Differences in Yield Among Lowbush Blueberry Clones

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Project Title: FACTORS RESPONSIBLE FOR DIFFERENCES IN YIELD AMONG LOWBUSH BLUEBERRY CLONES

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Project No: 1275-21000-185-01S Accession No: 0412884
SY(s): ROWLAND, LISA

Location: PLANT SCIENCES INSTITUTE
GENETIC IMPROVEMENT FOR FRUITS AND VEGETABLES LABORATORY

1a. Objectives (from AD-416):
Identify factors that explain differences in yield among lowbush blueberry clones. Compare high yielding clones to low yielding clones for several factors. Factors include average genetic similarity with neighbors and effects of relationship of parents in controlled crosses on fruit set, synchrony of flowering time with neighbors, freezing tolerance of closed flower buds and open flowers, floral morphological and physiological differences (nectar amounts) that might be more attractive to bees, signs of disease, etc.

1b. Approach (from AD-416):
Studies will focus on comparing high yielding clones to low yielding clones for several factors. Because V. angustifolium is predominantly outcrossing and self-fertility is poor due to early-acting inbreeding depression, one of the factors that will be investigated is genetic relationship with neighboring clones. EST-PCR markers will be used to genotype clones and determine relationship (genetic similarity) to other clones. Crosses will be made between high yielding clones and other clones in the field that have clearly different similarity values. The same will be done with low yielding clones. In this way, it will be determined if genetic relationship affects yield. In addition, 4-5 clones in the immediate vicinity of each high and low yielder will be genotyped. The average similarity value between each focal high and low yielder and its neighbors will be determined and compared. Other factors will be compared between high and low yielding clones including synchrony of flowering time with neighbors, freezing tolerance of closed flower buds and open flowers, flower morphology, signs of disease, etc.

3. FINAL Report:
Introductory Statement
This report documents research conducted under a Specific Cooperative Agreement between ARS and the UNIVERSITY OF MAINE. Additional details for the research can be found in the report for the parent project 1275-21000-185-00D, ENHANCEMENT OF BLUEBERRY, STRAWBERRY, AND BRAMBLES THROUGH MOLECULAR APPROACHES.

About 1/3 of commercial blueberry production is from managed, wild fields of lowbush blueberry (V. angustifolium). Lowbush blueberry grows in a patchwork or mosaic pattern of individual plants referred to as clones. Variation among clones is very high with adjacent clones showing as much as 12-15 fold differences in berry yield. The focus of this research has been to identify genetic factors responsible for these yield differences. It has been hypothesized that, if the distribution of individuals in fields is such that closely related individuals tend to cluster together in patches, then crosses between these plants could result in low yields due to inbreeding depression. In this project, we have tested this hypothesis in several ways. First, we investigated the spatial genetic structure (or patterns of genetic relationship) of plants within fields using DNA markers. On the finest local scale, we sampled 100 touching clones within a single field. We found that most of the individuals were not highly related to their near neighbors with a few exceptions. We also began a study on gene flow in lowbush blueberry. Lowbush blueberry is pollinated by rented honey bees, which tend to fly short distances, thus it is thought that plants would most likely be pollinated by themselves or by near neighbors. Here we collected open pollinated fruit from two lowbush clones, extracted the seed, and germinated the seedlings. The seedlings were fingerprinted, as well as the mother plants and the surrounding 5-6 nearest neighbors. Initial results from a paternity analysis of the seedlings suggested that none resulted from self-crosses (probably due to lack of germination of seed from self crosses) and that about 85% of the seedlings appeared to have been sired by a plant outside of the near neighbor group. Therefore, the patches of genetically similar individuals we found in the local scale study probably cannot explain the yield differences seen in lowbush blueberry, as the highly related patches are few in number and bees are moving pollen further than expected from observations on foraging habits. This project relates to objective 3 of the in-house parent project, identifying germplasm and developing molecular markers and genetic maps useful for conferring traits of horticultural value, such as cold tolerance in blueberry, disease resistance in strawberry, and repeat flowering in strawberry, raspberry, and blackberry. This information will help scientists make recommendations to growers on ways to improve yields in lowbush blueberry.

Publications:

Bell, D.J., L.J. Rowland, J.J. Polashock, and F.A. Drummond. 2008. Suitability of EST-PCR markers developed in highbush blueberry for genetic fingerprinting and relationship studies in lowbush blueberry and related species. J. Amer. Soc. Hort. Sci. 133: 631-722.

Bell, D.J., L.J. Rowland, J. Smagula, and F.A. Drummond. 2009. Recent Advances in the Biology and Genetics of Lowbush Blueberry. Maine Agric. For. Exp. Stn., University of Maine, Orono. Tech. Bull. 36 pp.

Bell, D.J., L.J. Rowland, D. Zhang, and F.A. Drummond. 2009. Spatial genetic structure of lowbush blueberry, *Vaccinium angustifolium*, in four fields in Maine. Botany 87: 932-946.

Bell, D.J., L. J. Rowland, J. Stommel, and F.A. Drummond. 2010. Yield variation among clones of lowbush blueberry as a function of kinship and self-compatibility. J. Hort Sci. 135 (3): 1-12.

Bell, D.J., F.A. Drummond, and J.L. Rowland. 2012. Evidence of functional gender polymorphisms in a population of the hermaphroditic lowbush blueberry (*Vaccinium angustifolium* Ait.). Botany 90(5): 393-399.

Rowland, L.J., F.A. Drummond, J. Graham, N. Alkharouf, E.J. Buck, J.F. Hancock, N.V. Bassil, C.E. Finn, and J.W. Olmstead. 2012. Generating genomic tools for blueberry improvement. Intl. J. Fruit Sci. 12(1-3): 276-287.

Bell, D.J., L.J. Rowland, and F.A. Drummond. 2012. Does pollen neighborhood affect berry yield in lowbush blueberry (*Vaccinium angustifolium* Ait.)? Intl. J. Fruit Sci. 12(1-3): 65-74.

Bell, D.J., L.J. Rowland, and F.A. Drummond. 2012. Fine-scale spatial genetic structure associated with *Vaccinium angustifolium* Aiton (Ericaceae). Intl. J. Bot. 2(4): 72-82.

Manuscripts in Progress:

1) Genetic variation of lowbush blueberry across its range

2) Bloom phenology of lowbush blueberry clones and their relationship to self-compatibility

3) Pollen movement in lowbush blueberries by honey bees determined by molecular markers

4) A simulation model of pollination of lowbush blueberry

ARS PI monitoring activities to evaluate research progress included:

Email communications

Phone calls/ Conference calls