

# Replicated clonal selection for improving forage yield of alfalfa – Preliminary Report. J. Hansen, J. Crawford, C. Brummer, R. Michaud, A. Claessens, S. Acharya, Y. Papadopoulos, J. Lamb, C. Sheaffer, D. Viands.

## Introduction

Recurrent phenotypic selection has not been very effective for increasing yield potential of alfalfa germplasm adapted to North America. Rumbaugh et al. (1988) mentions replicated clonal line selection as one approach to eliminating escapes. The research objective is to determine if replicated clonal evaluation across multiple environments is effective in selecting genotypes for improved alfalfa forage yield.

## Materials and Methods (Figure 1)

One genetically broad alfalfa population was created through cross pollination of three populations and then randomly mating for two generations. Two hundred plants were randomly chosen to initiate the clonal evaluation (0358-Cycle 0). Rooted stem cuttings from each of these 200 genotypes were sent to four collaborators for Cycle 1 (Table 1). Three replicates of three ramets per replicate of each genotype were established in field nurseries. At the end of the second production year, the highest yielding 10% (20 genotypes) across locations were intercrossed to produce Cycle 1 seed. Cuttings of the Cycle 1 population (200 plants) were sent to three cooperators for a second cycle using the same methods as for the first cycle. The populations developed were: multiple location clonal selection (1222), and clonal selection based on the NY yields (1221-cycle1 multiple environments, cycle 2 NY). The genotype rankings by locations for each cycle of selection were not highly correlated. Thus the selected plants were the best ones over locations, but were not the best ones at each location. In NY, a population was developed by mass selection (1210 cycle 2). Syn. 2 seed of the populations was produced for trials. In 2013-14, yield trials were established at 6 locations, three in Canada and three in USA. The trial entries were the three parent populations, Cycle 0 (0358), Cycle 2 across locations (1222), Cycle 2 NY selection (1221), and Cycle 2 mass selection (1210). Three trials have been harvested for 2 production years and three trials have been harvested for 1 production year. Yield data were summed over harvests and years (total yield).

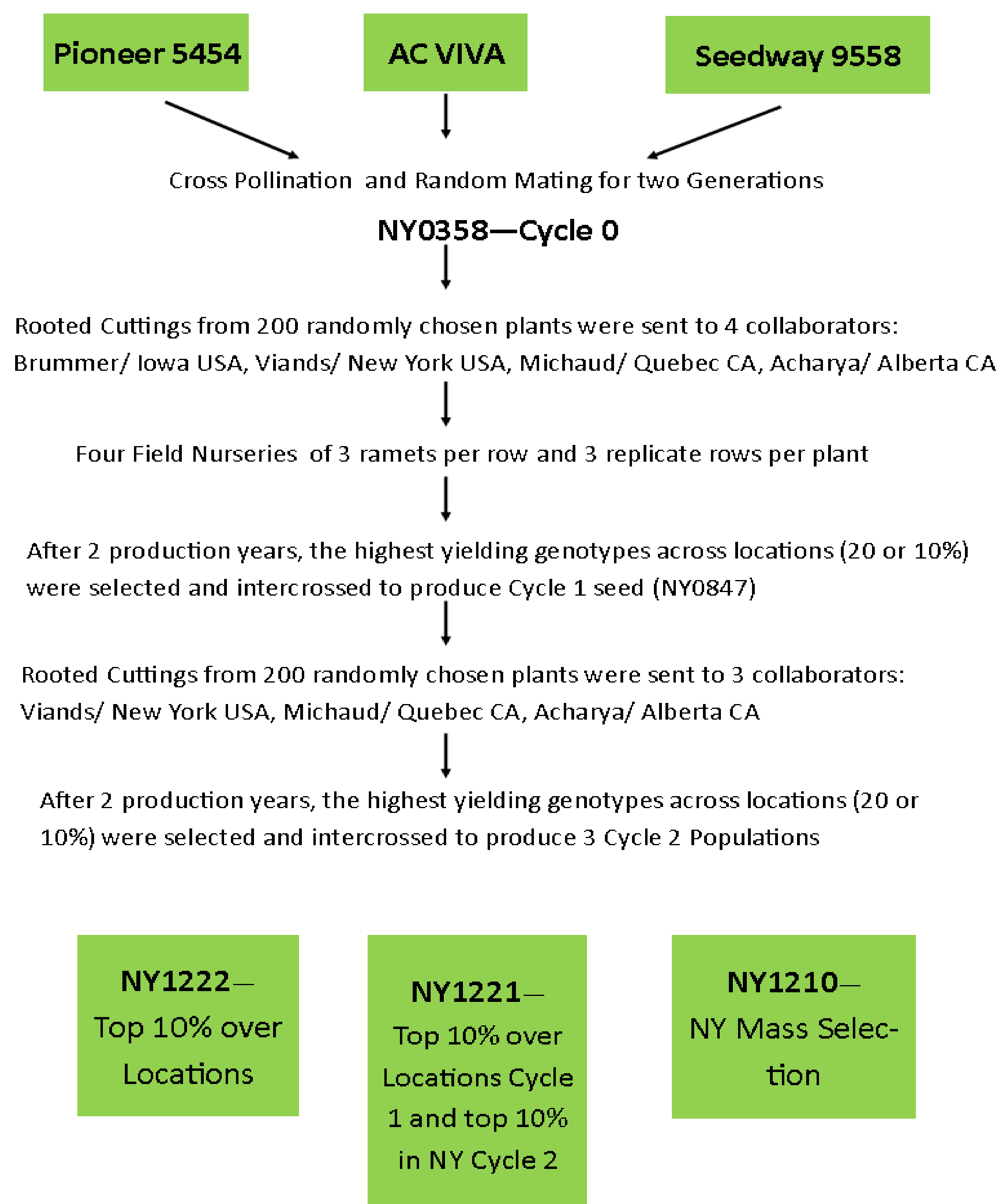


Figure 1: Breeding methods for developing populations selected based on clonal evaluation.

Table 1: Data from each Location that were compiled for selecting 20 genotypes each cycle.

Location	Cycle 1	Cycle 2
Alberta, Canada	Visual score - 2 Har., 1 Yr.	Visual score -1 Har.; Yield-1 Har., 1 Yr.
Quebec, Canada	Yield - 3 Har., 2 Yr.	Yield - 3 Har., 1 Yr.
Iowa, USA	Yield – 6 Har., 2 Yr.	-
New York, USA	Yield – 6 Har., 2 Yr.	Yield – 6 Har., 2 Yr.

Table 2: Yield trial preliminary results of the clonal evaluation experiment to date.

Alfalfa Population	Canadian Locations			USA Locations			Avg over Locations
	Alberta	Nova Scotia	Quebec	Minn	NY-S4	NY-H3	
				<b>kg/ha</b>			
5454	27457	13551	16803	21405	23886	13280	19397
AC VIVA	27808	13950	17415	21743	25083	12010	19668
Seedway 9558	26646	14323	17510	20019	23492	12443	19072
<b>Average of Parents</b>	<b>27304</b>	<b>13941</b>	<b>17243</b>	<b>21056</b>	<b>24154</b>	<b>12578</b>	<b>19379</b>
NY0358 - Cycle 0	28689	14078	17472	21338	25398	13949	20154
NY1210 - Mass Selection	25725	12954	16677	20794	25038	13386	19096
NY1221 - 4 Loc/ NY	29887	14805	17029	21611	25522	13618	20412
NY1222 - 4 Loc/ 3 Loc	26478	13471	16655	22549	25548	12957	19610
<b>Overall Average</b>	<b>27527</b>	<b>13876</b>	<b>17080</b>	<b>21351</b>	<b>24852</b>	<b>13092</b>	<b>19630</b>
Number of harvests	2 in '14; 3 in '15	1 in '13; 2 in '14	3 in '14	4 in '14; 4 in '15	2 in '14; 3 in '15	3 in '15	
LSD (0.05)	2656	1392	1392	1603	1396	895	
Pvalue entries	0.067	0.311	0.688	0.146	0.006	0.001	0.000
reps	8	8	6	8	8	5	
error df	56	56	45	56	76	44	222

Alfalfa Population	Canadian Locations			USA Locations			Avg over Locations
	Alberta	Nova Scotia	Quebec	Minn	NY-S4	NY-H3	
				<b>% of Trial Mean</b>			
5454	100	98	98	100	96	101	99
AC VIVA	101	101	102	102	101	92	100
Seedway 9558	97	103	103	94	95	95	98
<b>Average of Parents</b>	<b>99</b>	<b>100</b>	<b>101</b>	<b>99</b>	<b>97</b>	<b>96</b>	<b>99</b>
NY0358 - Cycle 0	104	101	102	100	102	107	103
NY1210 - Mass Selection	93	93	98	97	101	102	97
NY1221 - 4 Loc/ NY	109	107	100	101	103	104	104
NY1222 - 4 Loc/ 3 Loc	96	97	98	106	103	99	100

## Preliminary Results

The average yield of the three parent populations over locations (99%) was lower than the Cycle 0 yield (103%), thus the Cycle 0 population had hybrid vigor for yield.

The Cycle 2 NY selection (1221) yielded more than the Cycle 0 (0358) at four out of six locations, and more than the parent population average at five locations.

The Cycle 2 across locations (1222) yielded more than the Cycle 0 at two locations and more than the parent average at three locations.

The Cycle 2 mass selection (1210) yielded less than the Cycle 0 at all six locations and yielded more than the parent average at two locations.

Preliminary results indicate that clonal selection over diverse locations was less effective at improving yield than maximizing heterosis. Clonal selection at one location for the second cycle resulted in a population that yielded more than the initial populations. Yield trials that are evaluating these populations are ongoing at four of the six locations.

Reference Cited: Rumbaugh M.D., J.L. Caddel, D.E. Rowe. 1988. Breeding and Quantitative Genetics. P 777-808. In A.A. Hanson (ed.) Alfalfa and Alfalfa Improvement. ASA, CSSA, and SSSA, Madison, WI.

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