

INTRODUCTION

Rice varieties with strong seedling vigor are desirable for crop establishment in the direct-seeded culture system and in temperate rice-growing areas where low temperature delays early seedling growth (Redoña et al., 1996). In California rice is established by sowing pre-germinated seeds in flooded fields. Seedlings emerge through 10 to 15 cm of water in 10 to 20 days, depending on the water temperature (Jones et al., 1976). The optimal water temperature range is 25 – 30°C and temperatures above or below this range can cause delays in growth and emergence of seedlings, resulting in reduced stands of rice plants. Although M-203 and M-206 were developed in the medium grain rice breeding program at the RES, we have observed differences in vigor under various growing conditions (Fig. 1).

OBJECTIVES

1. Characterize phenotypically the difference on seedling vigor observed between M-203 and M-206
2. Dissect the genetic basis of this difference using a genetic mapping population derived from these varieties.

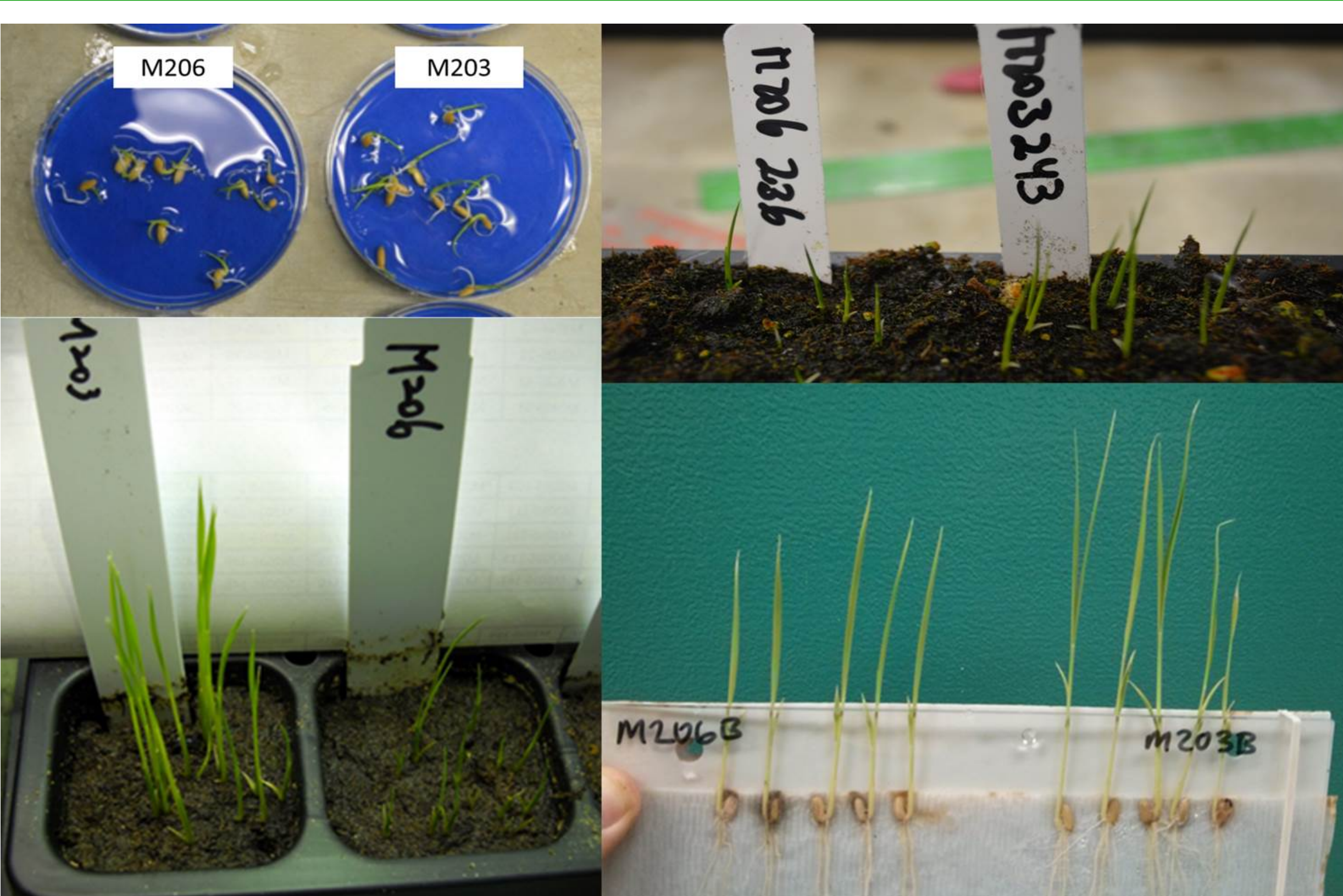


Fig. 1. Differences in seedling vigor between M-203 and M-206 under different growing conditions (petri dish, slant board and soil)

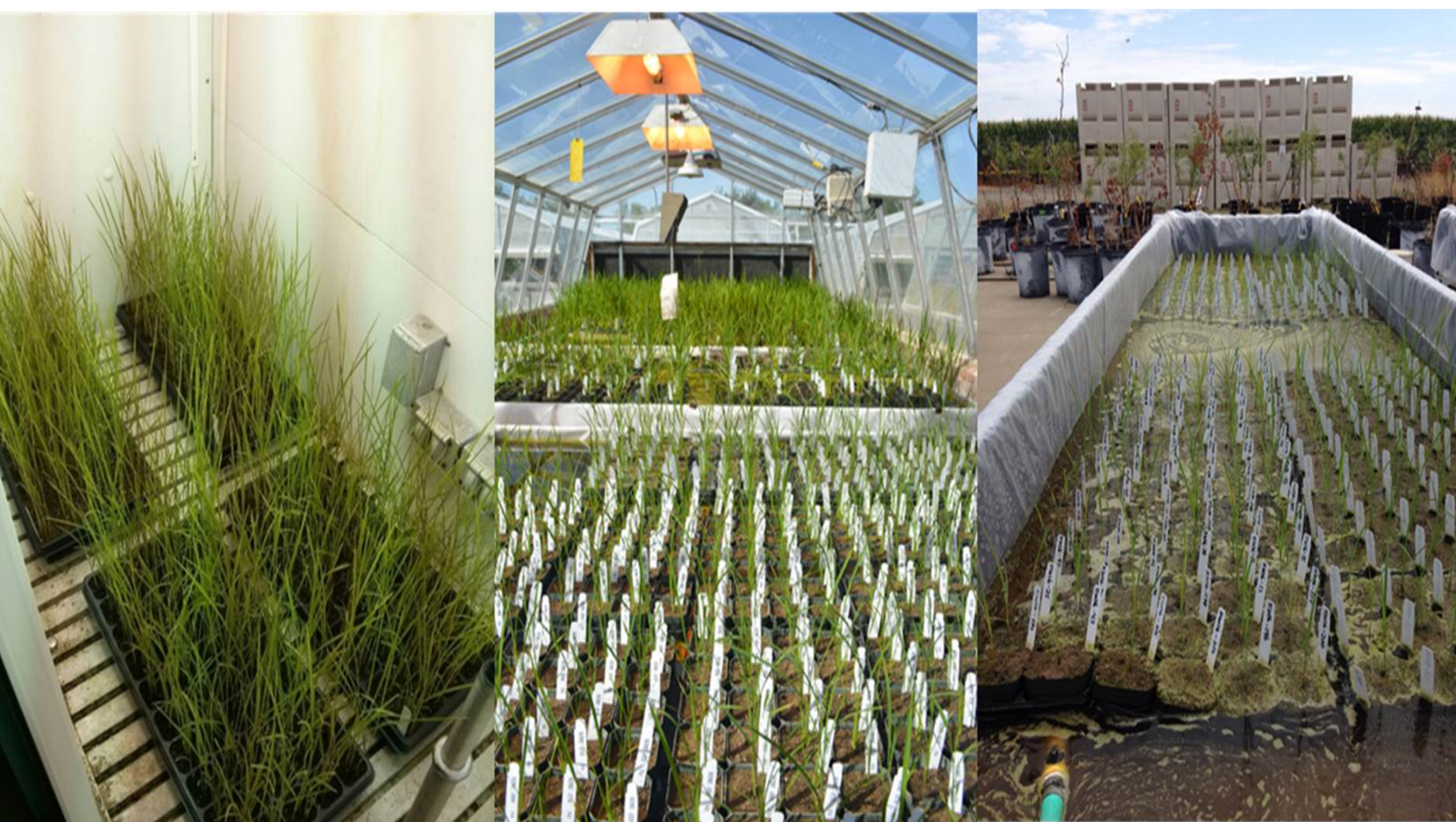


Fig. 2. M2036 RIL population growing in three different environments (left growth chamber, middle greenhouse and right outdoor basins)

MATERIALS AND METHODS

Mapping population: A recombinant inbred line mapping population (designated the M2036 population, F7; n = 178) was developed by single seed descent from a cross between two California medium grain rice varieties, M-203 and M-206.

Seedling vigor phenotyping: Seedling vigor was evaluated in three growing environments (growth chamber, greenhouse, and outdoor basins) under a normal temperature range (Fig. 2). For the growth chamber evaluation, eight seeds from each of the 178 RILs and parents were planted in a RBCD with three replications in 50 cell trays using Sunshine Mix #1 soil and the temperature was held at 28°C with a 12-hour photoperiod. Height, fresh weight of aboveground biomass, and growth rate were measured. For the greenhouse evaluation, a subset of 50 RILs representing the most and least vigorous lines based on the growth chamber experiment were evaluated during January 2015 using the same experimental design. For evaluation in outdoor basins, a single plant from each of the 178 RILs (and parents) was germinated and grown in a 3.5” pot containing UC Davis rice soil (80:20 mix). Plants were arranged in a RBCD with three replications per line and traits were evaluated 12 and 19 days after sowing.

Marker genotyping: Preliminary genotyping was performed using 24 single nucleotide polymorphism (SNP) markers designed from sequence data from M-203 and M-206 (Kim and Tai, 2013). SNP marker data were generated using the Fluidigm EP1 genotyping platform.

RESULTS

Differences in height, fresh weight and growth rate were found among the different M2036RIL lines used in the three different environments under study. Transgressive segregation was also observed for all traits analyzed (Table 1, Fig. 3 and 4).

Table 1. Phenotypic analyses of seedling vigor traits under different environments

Environment/Trait	M203 Mean ± SD	M206 Mean ± SD	RIL population	
			Mean ± SD	Range
Growth Chamber	Height 7 (days after sowing)	7.8 ± 1.2	9.8 ± 1.1	6.1 - 12.8
	Height 14 (days after sowing)	37.9 ± 4.2	41.2 ± 3.1	32.8 - 48
	Fresh weight (grams)	1.21 ± 0.2	1.55 ± 0.1	1.10 - 1.91
	Growth rate (cm/day)	4.3 ± 0.2	4.5 ± 0.4	3.4 - 5.5
Greenhouse	Height 7 (days after sowing)	3.3 ± 0.4	3.3 ± 0.6	1.5 - 4.4
	Height 14 (days after sowing)	11.8 ± 0.4	13.3 ± 1.7	10.2 - 16.2
	Fresh weight (grams)	0.34 ± 0.1	0.38 ± 0.05	0.27 - 0.50
	Growth rate (cm/day)	1.35 ± 0.09	1.43 ± 0.2	1.11 - 1.72
Outdoor basins	Height 7 (days after sowing)	5.8 ± 1.2	6.8 ± 1.3	3.3 - 10.5
	Height 14 (days after sowing)	13.5 ± 1.06	13.3 ± 2.1	6.7 - 18.3
	Growth rate (cm/day)	1.08 ± 0.1	0.9 ± 0.2	0.5 - 1.5

*Indicates significant differences at level of p < 0.05, LSD

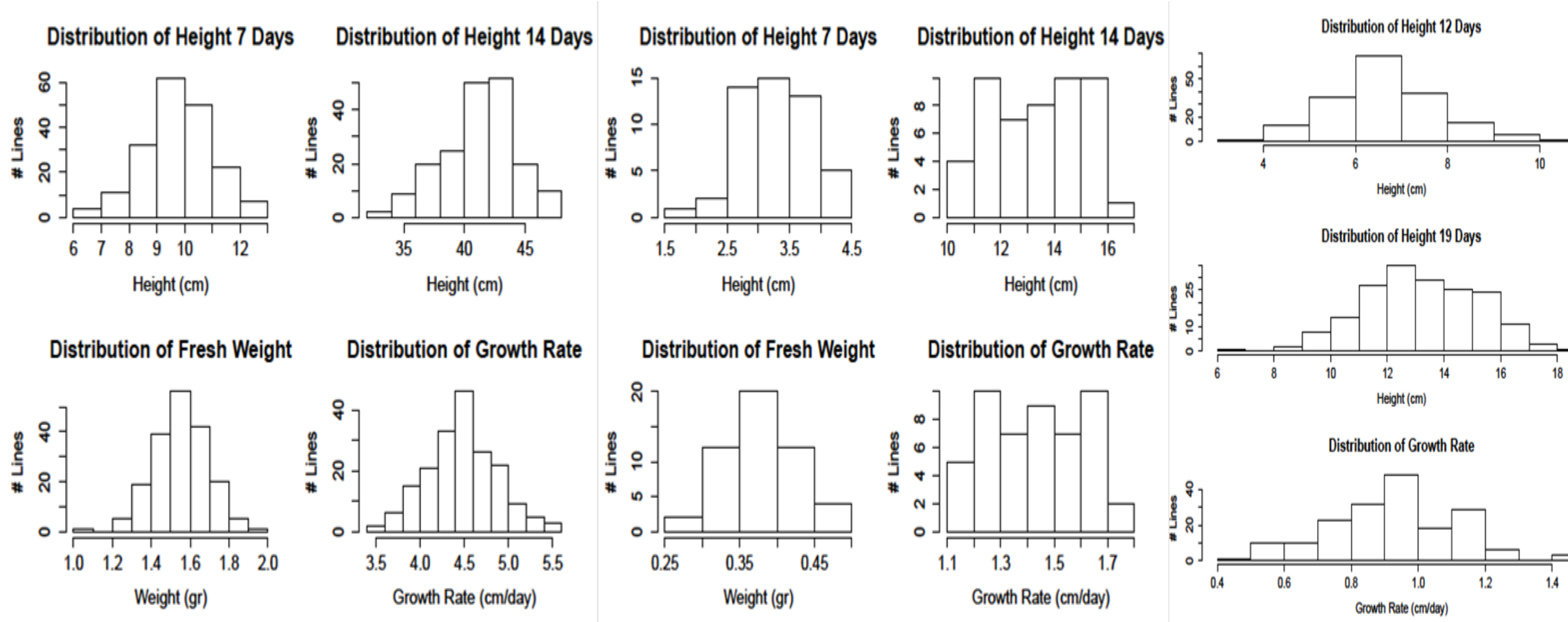


Fig. 3. Trait distributions in the M2036 population in the three different environments (growth chamber, greenhouse and outdoor basins from left to right)

RESULTS

Six lines showed a better performance in seedling vigor related traits (Table 2) than the best parent (M-203) across the three environments under study

Table 2. Phenotypic analyses of seedling vigor traits of the parental and six best lines

Trait/Growing environment	Line RIL population							
	M203 Mean ± SD	M206 Mean ± SD	25 Mean ± SD	138 Mean ± SD	149 Mean ± SD	187 Mean ± SD	196 Mean ± SD	231 Mean ± SD
Height 7 (days after sowing)	11.5 ± 0.8*	7.8 ± 1.2	10.9 ± 1.5*	9.5 ± 1.4*	10.5 ± 2.1*	10.4 ± 1.7*	12.1 ± 0.5*	11.0 ± 1.8
	4.3 ± 0.1*	3.3 ± 0.4	3.7 ± 0.3	3.7 ± 0.6	3.7 ± 0.2	4.2 ± 0.6*	3.8 ± 0.1	4.2 ± 0.8*
	7.5 ± 1.3*	5.8 ± 1.2	9.2 ± 3.3*	8.7 ± 1.5*	9.5 ± 2.8*	8.8 ± 2.4*	9.7 ± 0.8*	8.5 ± 3.0*
Height 14 (days after sowing)	43.3 ± 1.0*	37.9 ± 4.2	45.4 ± 2.1*	47.2 ± 4.8*	47.1 ± 0.8*	47.9 ± 3.4*	44.6 ± 0.3*	45.9 ± 2.6*
	15.1 ± 1.2*	11.8 ± 0.4	15.2 ± 0.9*	15.7 ± 0.5*	15.2 ± 0.4*	16.2 ± 0.9*	14.3 ± 0.5	15.5 ± 1.1*
	14.5 ± 1.2	13.5 ± 1.06	15.7 ± 5.3	16.7 ± 4.5	17.3 ± 3.5*	16.0 ± 5.2	16.5 ± 2.6	15.0 ± 2.2
Fresh weight (grams)	1.68 ± 0.1*	1.21 ± 0.2*	1.68 ± 0.1*	1.77 ± 0.3*	1.76 ± 0.1*	1.78 ± 0.2*	1.84 ± 0.1*	1.59 ± 0.1*
	0.41 ± 0.08	0.34 ± 0.1	0.39 ± 0.0	0.38 ± 0.1	0.48 ± 0.0	0.43 ± 0.0	0.40 ± 0.1	0.42 ± 0.1
Growth rate (cm/day)	4.6 ± 0.1	4.3 ± 0.2	4.9 ± 0.4	5.4 ± 0.7*	5.2 ± 0.4*	5.4 ± 0.4*	4.6 ± 0.1*	5.0 ± 0.4*
	1.64 ± 0.01	1.35 ± 0.09	1.63 ± 0.1	1.72 ± 0.1	1.65 ± 0.1	1.72 ± 0.2	1.50 ± 0.1	1.61 ± 0.0
	1.0 ± 1.1	1.08 ± 0.1	0.9 ± 0.3	1.1 ± 0.5	1.1 ± 0.1	1.0 ± 0.4	1.0 ± 0.4	0.9 ± 0.3

*Indicates significant differences at level of p < 0.05, LSD

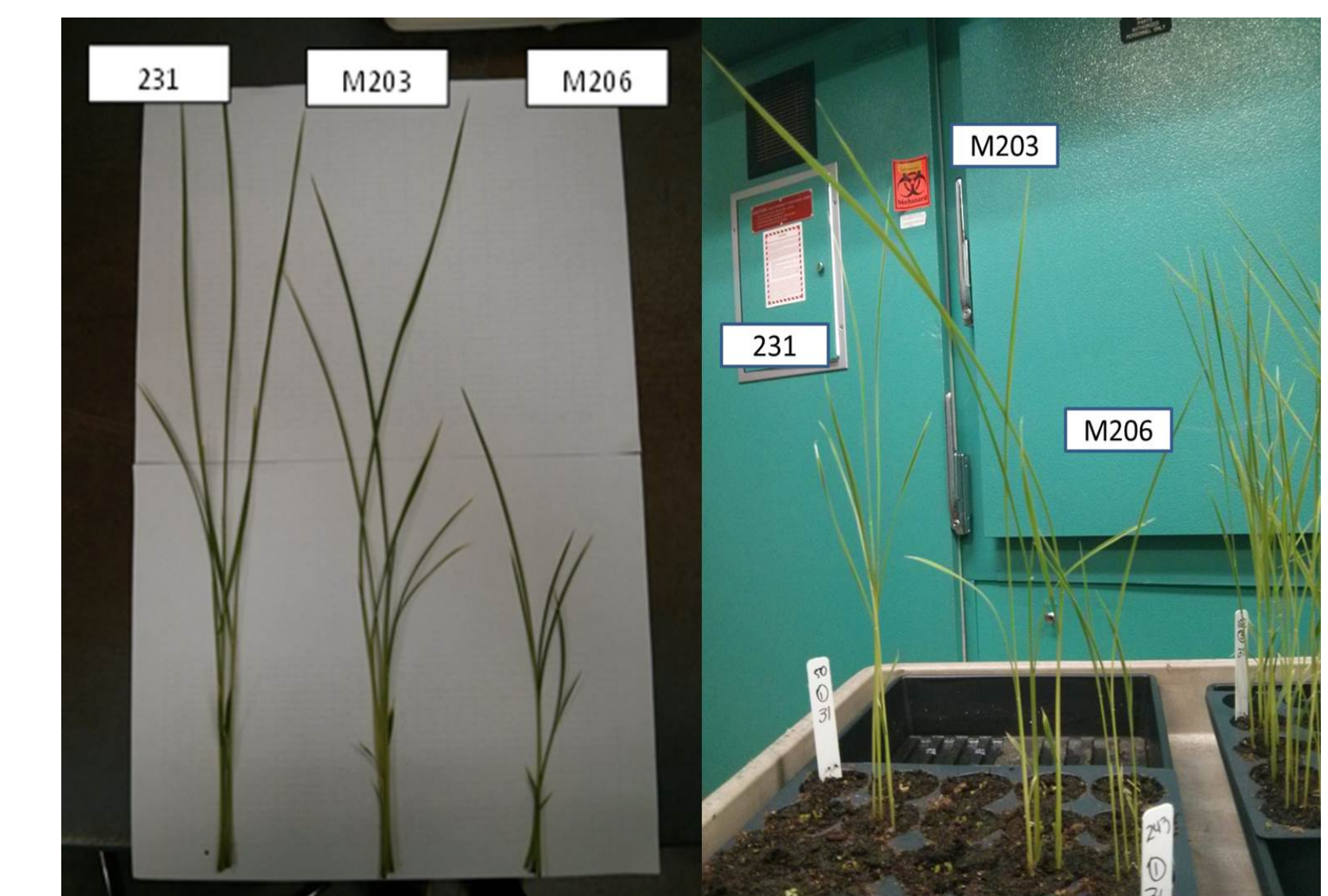


Fig. 4. Transgressive segregation exhibited by the RIL #231 under growth chamber conditions.

RESULTS

It was observed that these six lines were genetically different from parental lines after the Fluidigm SNP analyses (Fig 5)

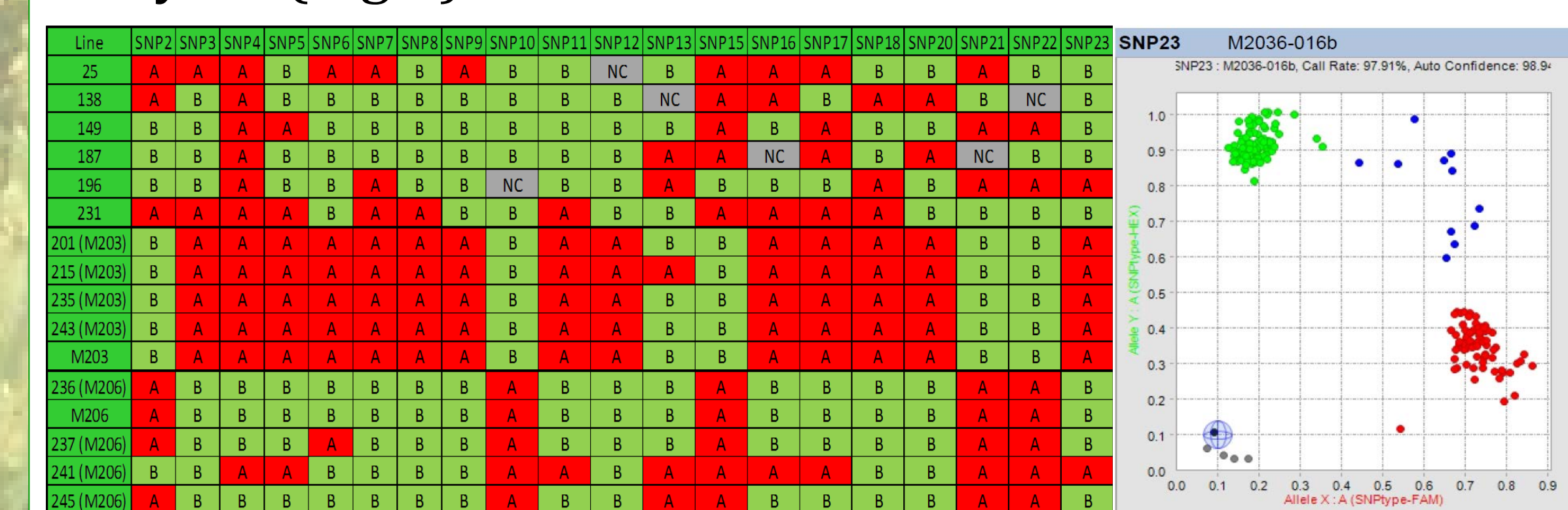


Fig. 5. SNP genotyping analysis using Fluidigm platform. (A : allele 1 and B allele 2, NC: no call)

CONCLUSIONS AND FUTURE WORK

- Our results revealed that there was phenotypic variation in seedling vigor related traits between parental lines M-203 and M-206 and among lines from the M2036 RIL population.
- RILs that showed significantly better seedling vigor than the best parent were identified and may be used to develop breeding lines.
- Initial genotyping will be extended to increase the number of markers and include the entire M2036 population to facilitate determining the genetic basis for the differences in seedling vigor traits we observed.

ACKNOWLEDGMENTS

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