# Identification of genomic regions associated with root respiration rate during post-harvest cold storage

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## Introduction

Sugarbeet (*Beta vulgaris* L. ssp. *vulgaris* Doell.) is primarily grown for sucrose production. Sugarbeet roots are often stored in piles at outdoor under cold up to six months before processing. A significant sucrose loss during root storage occurs due to root respiration (Fig. 1). This study uses sugarbeet lines along with few fodder and table beet genotypes to test root respiration rates during stored at 5˚C from one to three months. A genome-wide association study (GWAS) will be conducted in next to identify genomic regions associated with respiration rates in different genotypes and the changes of the respiration rate during cold storage. This research will not only identify genotypes for developing germplasm with lower storage respiration rate, but also the genetic information about respiration rate, both are critical for breeding varieties to lower respiration rate during cold storage.

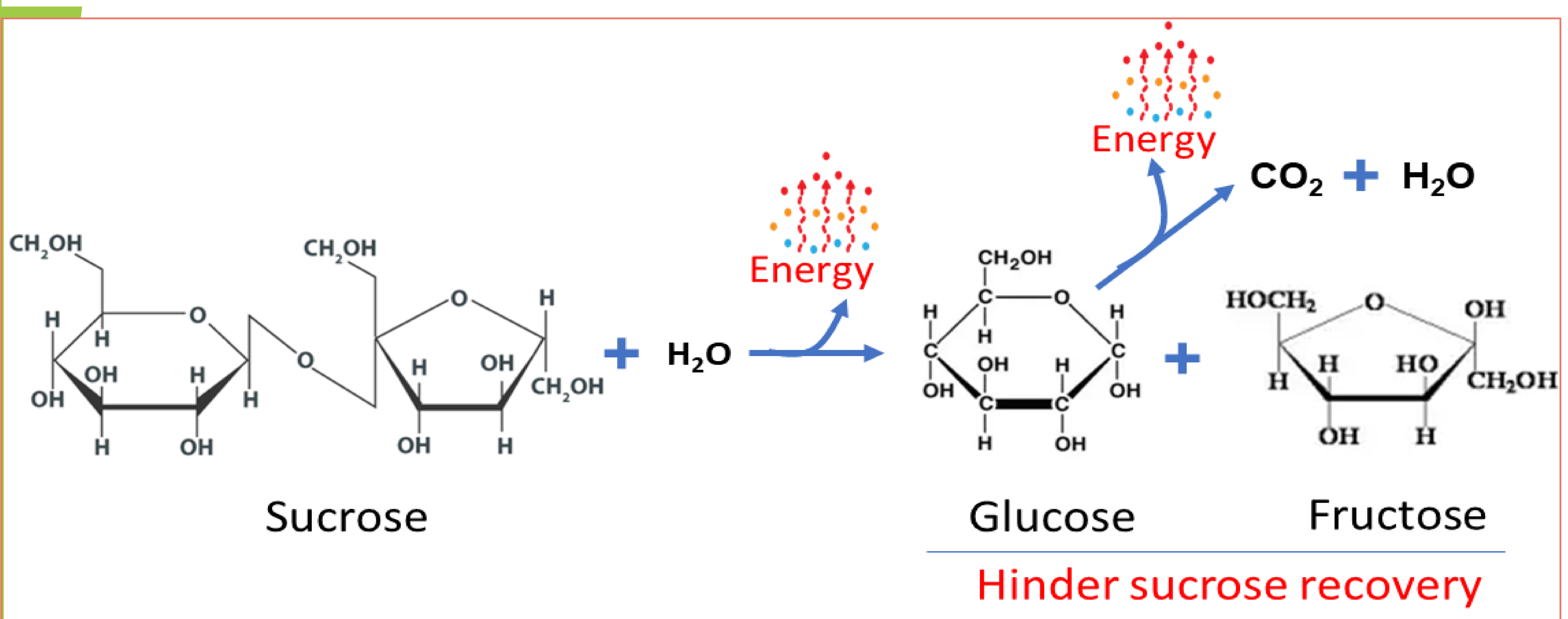


**Fig. 1**. Sucrose was converted to glucose and fructose during respiration.

## Materials and Methods

A set of 336 sugarbeet genotypes were selected based on genetic diversity study in Tehseen et al. (2023), and those lines were originated from 50 countries with plenty variations on roots (Fig. 2). The germplasm lines were originally obtained from NPGS, followed by three rounds of purification selection to remove off-types. Uniformities of roots in each genotype were greatly improved after line purification.

Root were stored at 5˚C after root were cleaned. At each of the time that roots were stored in cold for about one, two and three months, around ten roots per genotype were randomly selected and put into a sealed 5-gallon bucket, followed by using a 40-chanel root respirometry system to test the carbon dioxide ($CO_2$) concentration in each bucket over night (Fig. 3), and the reading were convert to respiration rate based on the air flow rate and mass of roots that expressed as mg of $CO_2$ from one Kg of root in one hour (mg·Kg$^{-1}$·h$^{-1}$).

**Fig. 2**. Picture of roots from part of 336 sugarbeet germplasm lines

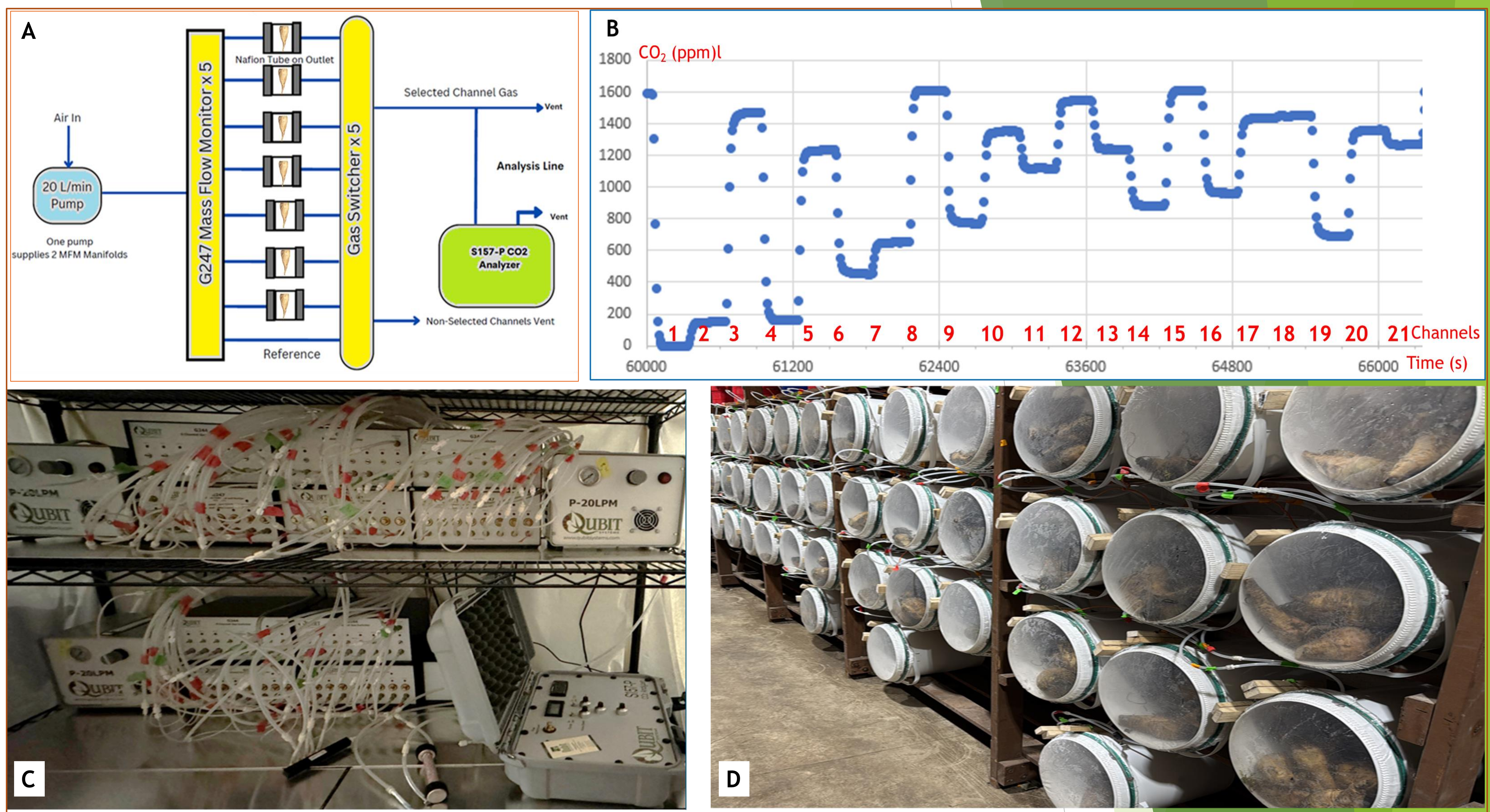


**Fig. 3**. The 40-chanel root respirometry system with $CO_2$ analyzer. (A) diagram of the system. (B) part of readings in a test recorded from channel 1 (reference) to 21.(C) pump, channel switch and $CO_2$ analyzer. (D) roots are under testing.

## Results

### Variation of respiration rate in the germplasm lines

As roots stored in cold for one month, respiration rates showed a wide range variation in 336 genotypes with the highest to be 30 and the lowest to be 5 mg·Kg$^{-1}$·h$^{-1}$ (Fig. 4). Among all genotypes, 160 had respiration rate between 10 to 15 mg·Kg$^{-1}$·h$^{-1}$ and 130 between 15 to 20 mg·Kg$^{-1}$·h$^{-1}$. A set of 10 genotypes had respiration rate less than 15 mg·Kg$^{-1}$·h$^{-1}$, indicating respiration rate in cold is genotype-dependent.

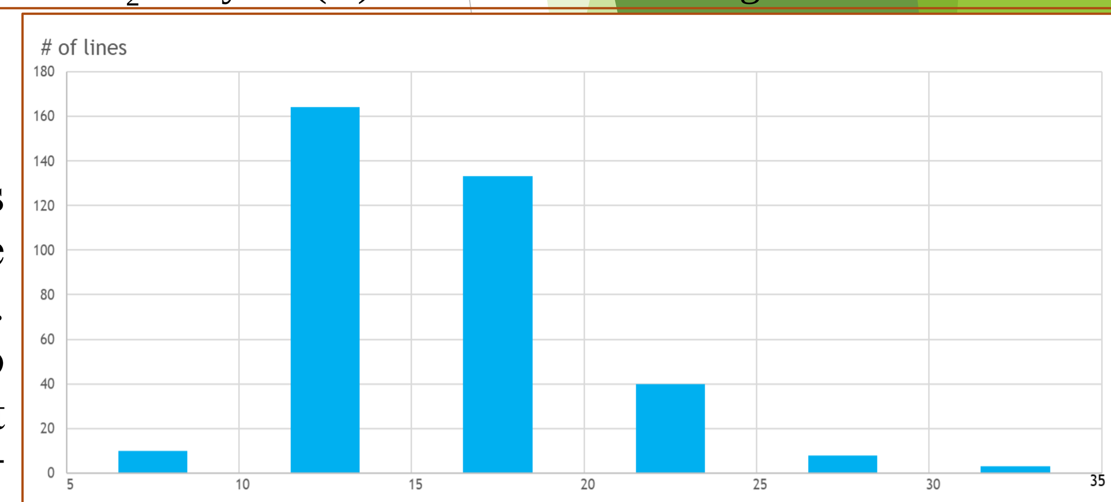


**Fig. 4**. Distribution of respiration rates in 336 genotypes tested when root cold stored for a month

### Respiration rate change during cold storage in the 2nd and 3rd month

Tests after roots stored in cold for two months found respiration rate about a half of the genotypes significantly decreased (Fig 5A&B), indicated that respiration caused by wound healing mainly occurred in the first month and the cold temperature helps reducing respiration rate in the second month.

Tests in the third month showed about 70% of genotypes had respiration rate significantly increased (Fig. 5A&C), this is largely due to sprouts started to vigorously grow in this period as we kept the root crawn part to grow plants later for seed production. Therefore, keeping the crawn part may increase respiration rate when roots stored in cold longer.

Additionally, respiration rate during root cold storage is loosely but positively associated with root tissue firmness (see Jolene et al., 2025 Poster #11).

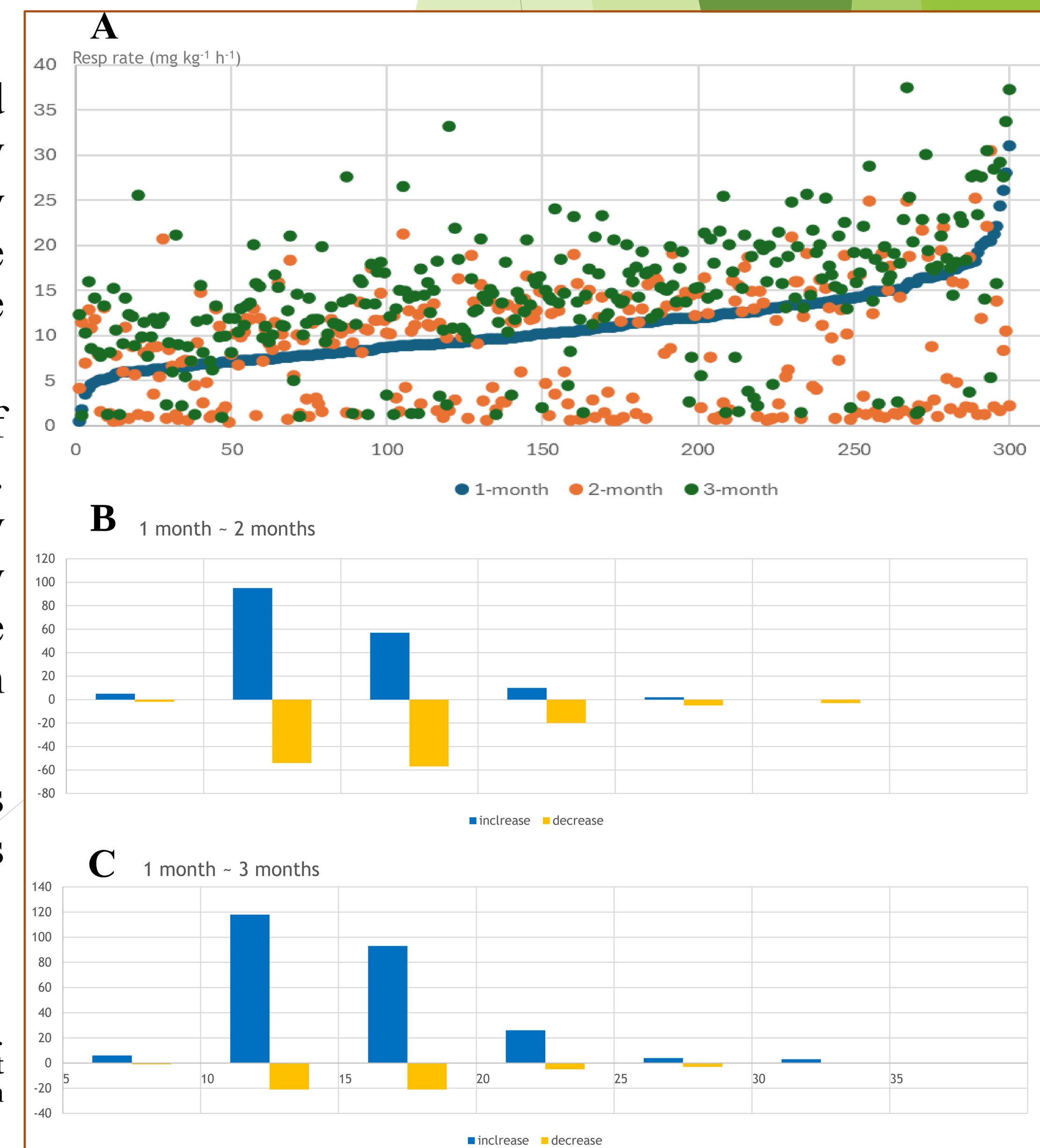


**Fig. 5**. Change of respiration rate two and three months after root cold stored. (A) combining diagram of three tests. (B) comparison between tests at one and two months. (C) comparison between tests at one and three months.

## Acknowledgement

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## References

Tehseen et al. (2023). Potential of publicly available Beta vulgaris germplasm for sustainable sugarbeet improvement indicated by combining analysis of genetic diversity and historic resistance evaluation. Crop Science, 63, 2255–2273. https://doi.org/10.1002/csc2.20978

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