PhD School on Agriculture, Environment and Bioenergy

(http://sites.unimi.it/dottorato_aab/)

(XXXVIII cycle, 2022-25)

Project draft

1.Field of interest

*Indicare **il/i** settore/i scientifico disciplinari: AGR03*

2.Project title

Study of the morphological and physiological adaptation of the root systems in conditions of water stress in *Vitis spp*.

3.Tutor

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- Eventually co-tutor/s:

4.Relevance of the topic and state of the art:

Drought is one of the main limiting factors in modern viticulture, affecting both yield and grape quality. The response of grapevine to drought involves several physiologic mechanisms, such as canopy regulation and transpiration control to reduce water loss or the expansion of root system to increase water availability. This adaptation mechanisms are strongly affected by the rootstock genotype, since grafting is worldwide used in viticulture (Zhang et al., 2016). Thus, the selection of tolerant rootstocks is a promising strategy to face drought conditions, becoming more frequent due to climate change. In the last years, rootstock control of transpiration has been largely investigated, whereas few studies focused on root system development, due to technical difficulties in accurate root phenotyping, especially under field conditions (Trachsel et al., 2011; Perkons et al., 2014; Wu and Guo, 2014). Recently, high-throughput root phenotyping platforms have been developed, allowing faster and more accurate analysis of root growth and morphology (Nagel et al., 2012). The aim of the project proposal well be to characterize the root system adaptation to drought of a grapevine core-collection, a breeding population and new American progenies under water deficit conditions, and to identify the related genetic regions in order to assist future breeding programs.

5.Layout of the project (draft)

5.1. Materials & Methods:

The Department of Agricultural and Environmental Sciences of the University of Milano disposes a large collection of grapevine rootstocks, composed by: i) a parental population of over 230 genotypes, including the largest part of current available rootstocks. The whole genetic diversity of the parental population is represented by a core-collection of 70 genotypes (Migliaro et al., 2019); ii) a new breeding population of about 140 genotypes obtained in a recent breeding program; iii) a total of about 60 new genotypes belonging to 12 American progenies never involved in breeding programs and provided by USDA-ARS National Clonal Germplasm Repository of UC Davis. The progenies belong to different species: *V. acerifolia, V. aestivalis, V. arizonica, V. champinii, V. cinerea, V. monticola, V. mustangensis* and *V. rotundifolia*.

Drought tolerance of the parental core-collection and the breeding population was recently characterized in terms of canopy growth, transpiration control and leaf turgor. In the project proposal, new drought related traits will be investigated on the core-collection, the breeding population, and American progenies. The experiment will be performed under controlled conditions using a high-throughput root phenotyping platform, which allows to assess the root system architecture traits (i.e. geotropic angle, root depth, root density). Root system development of each genotype will be monitored under different water availability conditions (well-watered, moderate and severe water deficit). Furthermore, other phenotypic traits will be measured, such as canopy growth, aerial/root biomass ratio and water extraction capacity.

Phenotypic data will be used along with the available genetic profiles (assessed using SNP markers) to identify the genetic regions related to each analyzed trait, using a genome wide association (GWA) approach.

5.2.Schedule and major steps (3 years):

The project proposal will be scheduled across three experimental years. Literature review and experimental set up are planned for the first year of the project. Phenotyping will be performed during the grapevine vegetative seasons of the first and the second years. The third year will be focused on GWA study. Data elaboration and statistical analysis will be performed each year of the project. Two scientific publications of results are expected in the end of the second and the third years, respectively. The following Gantt chart summarizes the main steps of the project.

Years of the project	1	2	3
Literature review	X		
experimental set up	X		
Phenotyping	X	X	
Data analysis	X	X	X
GWA study			X
Scientific publications		X	X

6. Available funds : source CTE_NAZPR18LBRAN_01; amount 5200,00

7. Literature:

Zhang, L., Marguerit, E., Rossdeutsch, L., Ollat, N., Gambetta, G.A., 2016. The influence of grapevine rootstocks on scion growth and drought resistance. Theor. Exp. Plant Physiol. 28, 143–157. https://doi.org/10.1007/s40626-016-0070-x

Trachsel S, Kaeppler SM, Brown KM, Lynch JP (2011) Shovelomics: high throughput phenotyping of maize (Zea mays L.) root architecture in the feld. Plant Soil 341:75–87. https://doi.org/10.1007/s11104-010-0623-8

Perkons U, Kautz T, Uteau D et al (2014) Root-length densities of various annual crops following crops with contrasting root systems. Soil Tillage Res 137:50–57. https://doi.org/10.1016/j.still.2013.11.005

Wu J, Guo Y (2014) An integrated method for quantifying root architecture of feld-grown maize. Ann Bot 114:841–851. https://doi.org/10.1093/aob/mcu009

Nagel KA, Putz A, Gilmer F et al (2012) GROWSCREEN-Rhizo is a novel phenotyping robot enabling simultaneous measurements of root and shoot growth for plants grown in soil-flled rhizotrons. Funct Plant Biol 39:891. https://doi.org/10.1071/FP12023

Migliaro, D., De Lorenzis, G., Di Lorenzo, G.S., De Nardi, B., Gardiman, M., Failla, O., Brancadoro, L., Crespan, M., 2019. Grapevine Non- Vinifera Genetic Diversity Assessed by SSR Markers as a Starting-Point for New Rootstock Breeding Programs. Am. J. Enol. Vitic. ajev.2019.18054. https://doi.org/10.5344/ajev.2019.18054