PhD School on Agriculture, Environment and Bioenergy

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

(XXXIV cycle, 2018-20)

Project draft

1.Field of interest

General arboriculture and tree crops (AGR/03)

2.Project title

Grapevine rootstock phenotyping for drought resistance.

3.Tutor (membro del Collegio dei Docenti)

Osvaldo Failla

- Eventually: co-tutor/s

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

Vitis vinifera, one of the most important economic fruit species in the modern world, is usually grafted on rootstocks (American *Vitis* spp.) due to its susceptibility to phylloxera attack, a homopteran insect (*Daktulosphaira vitifoliae* Fitch) that feeds on the *V. vinifera* roots leading to the vine death. Rootstocks are worldwide used, and a more effective role in the adaptation to limiting soil and climate conditions appear to be a key strategy for more sustainable viticultural models in terms of grape quality, yield/growth vine balance, adaptation to drought conditions and calcareous soils (Vršič et al. 2005).

Water availability is a major environmental factor limiting the development of sustainable viticulture, because most of the world's wine-producing regions are threatened by seasonal drought decreasing viticulture production. Generally, drought is associated with many morphological and physiological changes in plants, such as reduced expansion of aerial organs (Cramer et al. 2007), decrease in transpiration and photosynthesis (Chaves et al. 2002), accumulation of osmotic compounds and ions (Cramer et al. 2007), activation of detoxifying processes. Also, drought stress negatively influences root development, although to a lesser extent than shoot, resulting in a decrease in the shoot/root mass ratio (Blum 1996).

In this scenario, the selection and development of new grapevine rootstock genotypes resistance to drought is an essential goal to face with the global warming and a sustainable viticulture. The objective to achieve the project proposal is to phenoty the behavior of four grapevine rootstock full-sib progenies and a core population composed of unrelated genotypes (for a total of 500 genotypes) under water-limiting conditions, in order to select new rootstock genotypes showing resistance/tolerance to drought.

5. Layout of the project (draft)

5.1. Materials & Methods:

Recently, the researcher of the Department of Agricultural and Environmental Sciences (University of Milan) developed a breeding program aimed to select novel genotypes to be used as rootstock in viticulture to cope with some of the major concerns affecting Mediterranean viticulture, such as drought, salinity, lime-induced iron chlorosis, temperature, phylloxera and nematodes. A number of progenies have been developed so far. For this project, a set of 116 unrelated grapevine rootstock individuals, called the parental population, and four full-sib rootstock families (384 F1 genotypes), called the breeding population, will be used in this study. The genotypes of parental population are genotypes included in a core collection, representing the whole genetic diversity of an original collection comprising 232 different molecular profiles, genotyped by microsatellites. These include grapevine rootstocks and non-*vinifera* genotypes. The breeding population was derived from the following four crosses: i) M1 x V. berlandieri cultivar Thyers; ii) M1 x V. vinifera cultivar Sangiovese; iii) M1 x M3 (Kober 5BB x Teleki 5C); iv) M1 x Teleki 5C. The parental genotypes were chosen for their resistance to iron chlorosis (M1 and Sangiovese) and drought (M3 and Teleki 5C) and were included in the parental population. The crosses for breeding population were performed in 2012 and plants of both parental and breeding populations were planted on field in the ampelographic Riccagioia's collection of the Università degli Studi di Milano (Torrazza Coste, Pavia, Italy).

The evaluation of resistance/susceptibility to drought will be evaluated on plants grown on 3.5 L plots filled with a standard substrate with no limitation of water and mineral nutrition, in open air under a net shelter. Water stress will be gradually imposed to plants showing 16 leaves separated, corresponding at stage 19 of the Eichhorn-Lorenz phenological stages (Coombe 1995), by decreasing the water availability in pots from 80% to 30% of the field capacity. During this period the following parameters will be estimated: aboveground biomass evolution, colour indices, canopy density, canopy temperature depression (Grant et al. 2006), canopy geometry, vigour and spectral indices (Caruso et al. 2017). The time of bud burst and early vigour of the shoot will be also estimated. Moreover, chlorophyll florescence and canopy temperature depression will be detected by portable chlorophyll fluorimeter and infrared camera. At the end of the water stress period, a shovelomic approach will be used to phenotype root architecture (Trachsel et al. 2011). Some destructive methods will be applied at the end of experiment: leaf morphometric (Chitwood et al. 2014) and xylem vessel analysis (Tombesi et al. 2011).

5.2. Schedule and major steps (3 years):

The work program is expected to take three years. The phenotyping will be held overall the first two years of the project. Statistical analysis will be performed year-by-year after each phenotypic data collection and during the third year on the two-year data.

6. Available funds (source and amount)

Financial support by liberal contribution from Winegraft company: 10,000.00 € / year

7. Literature: max 10 citazioni

Blum (1996). Plant Growth Regulation, 20:135-148.
Caruso et al. (2017). Vitis, 56:63-70.
Chaves et al. (2002). Annals of Botany, 89:907-916.
Chitwood et al. (2014). Plant Physiology, 164:259-272.
Coombe (1995). Australian Journal of Grape and Wine Research, 1:100-110.
Cramer et al. (2007). Functional and Integrative Genomics, 7:111-134.

Grant et al. (2006) Physiologia Plantarum, 127:507-518.
Tombesi et al. (2011). Scientia Horticulturae, 127:353-357.
Trachsel et al. (2011). Plant and Soil 341:75-87.
Vršič S et al. (2005). Scientia Horticulturae, 181:168-173.