Varietal thiols, especially 3-mercaptomethyl-2-oxazolidone (3MH) and 3-mercaptopropylglycine (3MGA), are desirable aroma compounds identified in white, rosé and red wines made from several cultivars. These fruity compounds are linked to the plant nitrogen (N) uptake (1) and sulfur (S) metabolism by its S-cysteine and S-glutathione conjugates described as aroma precursor (2). Between 2005 and 2011, several experiments were conducted to assess the impact of foliar applications of nitrogen (formulated forms of urea, organic fertilizers) combined or not with sulfur on several cultivars.

Material and Methods

1. Conditions of spraying: To allow sufficient dilution of the fertilizer and avoid toxicity, foliar sprayings were carried out at 400 L/ha and divided into two applications (onset of veraison and full veraison).

2. 1st experiment on white and rosé wines: A formulated form of urea (Folur, Tradecorp, Belgium) was applied through foliar way at the rate of 10, 15 and 20 kg N/ha. These applications were combined or not with elemental soluble sulfur (Microthiol, Cereslagri, France) at reduced doses (from 5 to 10 kg S/ha). Sprayings were tested on Colombard B, Gros Manseng B, Nérette N, Sauvignon B, Melon B and Sauvignon B between 2005 and 2008.

3. 2nd experiment with organic fertilizers: 3 commercial products obtained from enzymatic digestion of animal (Aminovital, Biofa, Germany), vegetal (Diaglutin, Biofa, Germany) and marin (Liquiplant B336, Plantin, France) proteins were tested at 10 kg N/ha in 2010 on Sauvignon B grown in the South West of France.

4. 3rd experiment on red wines: A formulated form of urea (Azofol SR, Agronutrition, France) was applied in 2011 at 20 kg N/ha without sulfur due to the risk of developing reductive off-flavours, on Fer N and Carignan N.

Winemaking and analyses: For all the experiments, wines were elaborated at pilot scale (30 L). Grapes were processed under a strict non-oxidative protocol for white and rosé wines. For red wines, fermentation and maceration took place at 25°C for 8 days. Nitrogen in must was determined as the sum of ammonia and amino-acid concentrations. Wines were analyzed for their aroma composition, especially for their concentration of varietal thiols.

Results and discussion

A large impact on the nitrogen content of the must and the aroma composition of white and rosé wines

The gain in nitrogen induced by the foliar application was linear: 50% and 100% increases were noticed for 10 and 20kg N/ha applications respectively. In comparison with controls, nitrogen and sulfur sprayings induced a three to four-fold gain in varietal thiols. This increase was observed even for control wines with high concentrations in thiols (from 10 to 40 nM/L). When performing sensory analysis, wines from the N and S treatment were judged more intense and presented higher scores for grapefruit and tropical fruit attributes. No undesirable sulfur/reductive notes were perceived at tasting.

Can the technique be adapted to organic viticulture?

Our results showed that organic fertilizers can be assimilated by grapevine through foliar way. The gain obtained for Aminovital reaching 48%, was equivalent to the increase expected for a urea-based application (50%). Concentrations in varietal thiols measured in wines were very weak and foliar sprayings had a depressive impact on the quantity of molecules. No differences were found between the four wines at tasting. Severe burn damages, particularly marked for the Liquiplant B336 and Diaglutin treatments, were noticed on the foliage at harvest. This phytotoxicity can be mainly explained by the concentration of nitrogen in the organic fertilizers that doesn’t allow sufficient dilution. The cost of this product also poses a serious threat to the development of the technique.

Is the technique also suitable for the production of red wines?

Red wines from the foliar treatment had lower Total Phenol Index (TPI) which is not completely unexpected as it has been shown that biosynthesis pathways of proanthocyanidins were down-regulated by an excessive nitrogen uptake (3). Surprisingly, despite average gains of 25% and 30% in glutathione and cysteine precursors of 3MH respectively, concentrations in 3MH were not impacted in finished wines. Red winemaking conditions (higher temperature and turbidity) are less favourable to the release of 3MH (4) and the absence of nitrogen/sulfur combination in this experiment might also have played a role (5).

From a sensory point of view, wines from the nitrogen treatment had marked reductive off-flavours which can be explained by the higher concentration in hydrogen sulphide found in wines.

Conclusions

The application of sulfur and nitrogen through foliar way at veraison is a powerful viticultural technique to over-express the varietal character of white and rosé wines without undesirable side effects. The technique cannot be yet adapted to organic viticulture and its interest is limited when making red wines.

References