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Observations on the natural fall of the calyptra in clones of Picolit giallo with high and low productivity [1])

by

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Beobachtungen über das natürliche Abwerfen der Calyptra bei Klonen der Rebsorte Picolit giallo mit hoher und niedriger Ertragsleistung

Zusammenfassung. — Bei der Rebsorte Picolit giallo, die früheren Arbeiten zufolge selbststeril ist, wurde nach einem möglichen Zusammenhang zwischen der Art und Weise, in der die Calyptra abgeworfen wird, und der Ertragsleistung gesucht. Bei der normaltragenden Sorte Verduzzo (Kontrolle) ist das Abwerfen der Calyptra von untergeordneter Bedeutung, da diese Sorte selbstfertil ist; anders verhält es sich mit Picolit giallo, wo der Traubenertrag von einer Fremdbestäubung abhängt. Bei dem schwachtragenden Klon dieser Sorte wurde festgestellt, daß die Narbe frühzeitig degeneriert — noch während die Blütenknospe von einer grünen Calyptra bedeckt ist; bei dem normaltragenden Klon sind die Narben dagegen auch noch in den Knospen mit brauner Calyptra für Pollen empfänglich. Deshalb kann bei diesem Klon auch Fremdbestäubung jener Blüten erfolgen, die ihre gebräunte Calyptra nicht auf natürlichem Wege, sondern zufällig, z. B. durch Insekten oder Wind, verlieren.

Introduction

The low productivity of the main branches of some Picolit giallo clones is related to various factors. First of all, the pollen grains of Picolit giallo are always unable to germinate, although they appear viable: while their cellular inside shows normal ultrastructure, their sporopollenin wall is thick and continuous, unlike that of the pollen grains formed by other cultivars (LOMBARDO *et al.* 1976, 1978). Moreover, the absence of germinative pores seems to be a constant character of Picolit giallo, independent of rootstock and provenance (CARGNELLO *et al.* 1980).

Nevertheless, since some clones of Picolit giallo and the feathers of all the Picolit vines examined possess normal productivity, in spite of their acolporated pollen grains, we extended our research to the development of the embryo sac and to the length of the stigmatic receptivity of flowers that lost spontaneously their calyptra (CARRARO *et al.* 1979).

Besides, it seems that the amount of germinable pollen grains present in the air of the examined vineyards is related to their productivity (CARRARO *et al.* 1981); moreover, the pollen grains of Picolit, although unable to germinate, could at least induce the "pollen mass effect" towards normally tricolporated pollen grains adhering to the stigma. In Picolit giallo with low productivity, during the microsporogenesis of the main branches, the tapetal cells early degenerate and do not provide the pollen grains with the "pollen-stigma recognition proteins" that are usually formed by the tapetum and sent to the pollen grains during the synthesis of their walls (CARRARO *et al.* 1981).

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In the present work, we extended our investigations on the factors related to the low productivity of Picolit giallo and examined the calyptra of the flowers in order to detect a possible relationship between its fall and the fruit yield of two clones of Picolit with different productivity. As is known, in the mature inflorescence some flowers remain covered by the calyptra, which does not fall spontaneously, but progressively becomes brownish and finally decayes still adhering to the stigmatic papillae. Since Picolit is undoubtedly male-sterile and unable of self-fertilization, it seems to be of great interest to investigate the process of the calyptra fall in two clones of Picolit with different productivity.

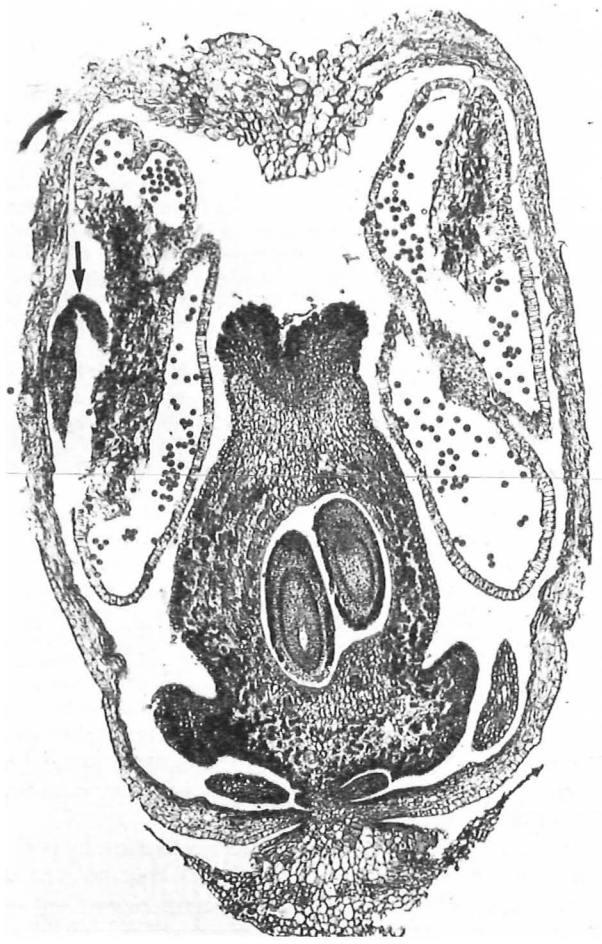

Fig. 1: Bud of Verduzzo with green calyptra. The calyptra appears firmly inserted on the receptacle. The pistil possesses well developed stigmatic papillae and normally formed ovules. The anthers whose filaments appear clearly bent (arrow) contain many pollen grains. × 50.

Knospe von Verduzzo mit grüner Calyptra. Diese ist fest mit dem Receptaculum verbunden. Der Stempel besitzt wohlentwickelte Narbenpapillen und Samenanlagen. Die Antheren, deren Filamente deutlich gekrümmt sind (Pfeil), enthalten zahlreiche Pollenkörner. 50 ×.

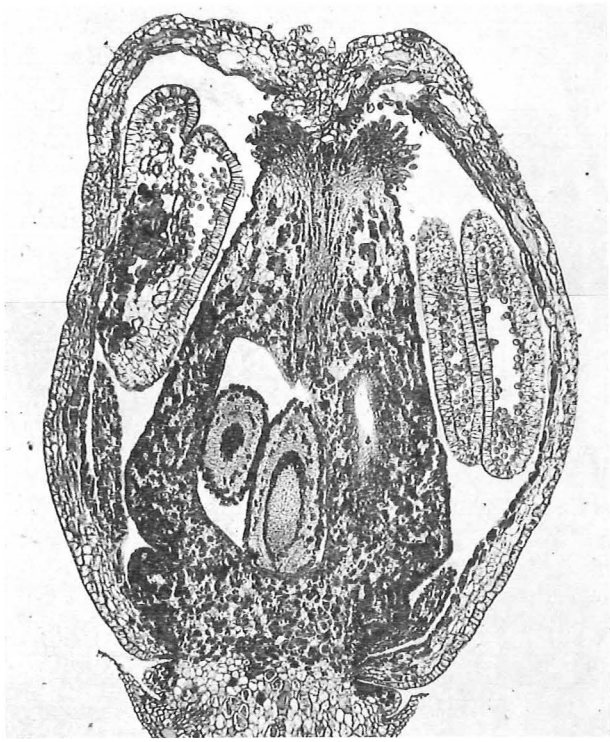

Fig. 2: Longitudinal section of a Picolit 31 AAU bud with green calyptra. The calyptra is firmly inserted on the receptacle and its apical portion leans on the stigmatic papillae which appear well developed. An ovule with compact nucellus is clearly visible in the ovary cavity. The anthers contain a remarkable amount of mature roundish pollen grains. × 45.

Längsschnitt durch eine Knospe von Picolit 31 AAU mit grüner Calyptra. Diese ist fest mit dem Receptaculum verbunden und ruht mit ihrem oberen Teil auf den wohlentwickelten Narbenpapillen. Eine Samenanlage mit kompaktem Nucellus ist deutlich sichtbar. Die Antheren enthalten zahlreiche rundliche reife Pollenkörner. 45 ×.

Material and methods

Flowers of the main branches of Verduzzo, Picolit 31 AAU [2]) and Picolit F [2]), still provided with their calyptra, were fixed and embedded following procedures of light microscopy previously described (CARRARO *et al.* 1979). The flowers were divided into three groups according to the colour of their calyptra: flowers with green, with brownish and with dark calyptra.

[2]) Picolit 31 AAU, characterized by high productivity, derives from the clone 31 AA and is cultivated in the wine farm G.B. Cragnolini near Cividale del Friuli (Udine). Picolit F, characterized by low productivity, grows in the wine farm L. Felluga near Oleis (Udine) (see LOMBARDO *et al.* 1978).

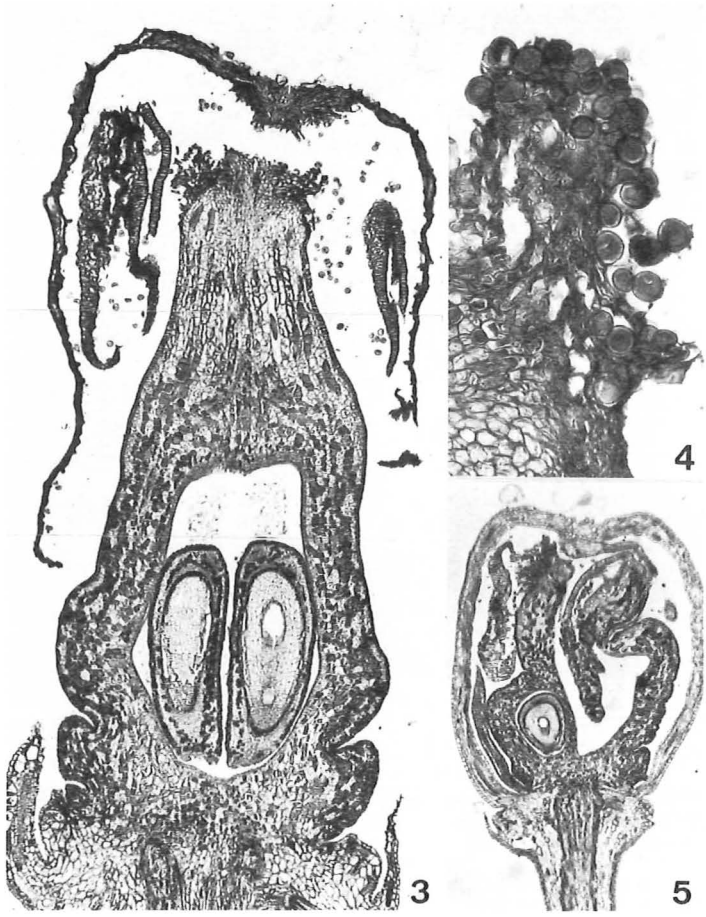

Fig. 3: Bud of Picolit 31 AAU with brownish calyptra. The calyptra appears detached from the receptacle and its apical remainders are dried up. One of the two ovules contains a well developed embryo sac. The anther walls are widely interrupted and the pollen grains are free in proximity of the stigma. × 30.

Fig. 4: Stigmatic papillae of Picolit 31 AAU at the stage of brownish calyptra. Many pollen grains adhere to them. × 155.

Fig. 5: Bud of Picolit F with green calyptra firmly inserted on the receptacle. The pistil shows evident morphology anomalies. × 20.

Abb. 3: Knospe von Picolit 31 AAU mit brauner Calyptra. Diese hat sich vom Receptaculum abgelöst und ist vertrocknet; eine der beiden Samenanlagen enthält einen wohlentwickelten Embryosack. Die Wand der Antheren ist aufgerissen, und die Pollenkörner befinden sich frei in der Nähe der Narbe. 30 ×.

Abb. 4: Narbenpapillen von Picolit 31 AAU mit brauner Calyptra; an den Papillen haften zahlreiche Pollenkörner. 155 ×.

Abb. 5: Knospe von Picolit F mit grüner Calyptra; diese ist fest mit dem Receptaculum verbunden. Der Stempel zeigt deutliche morphologische Anomalien. 20 ×.

Results

Ve r d u z z o : In all the examined buds with a green calyptra, this appears firmly inserted on the receptacle.

The pistil appears normally formed with well developed stigmatic papillae. Its length reaches little more than half of the whole bud length, so that the calyptra never

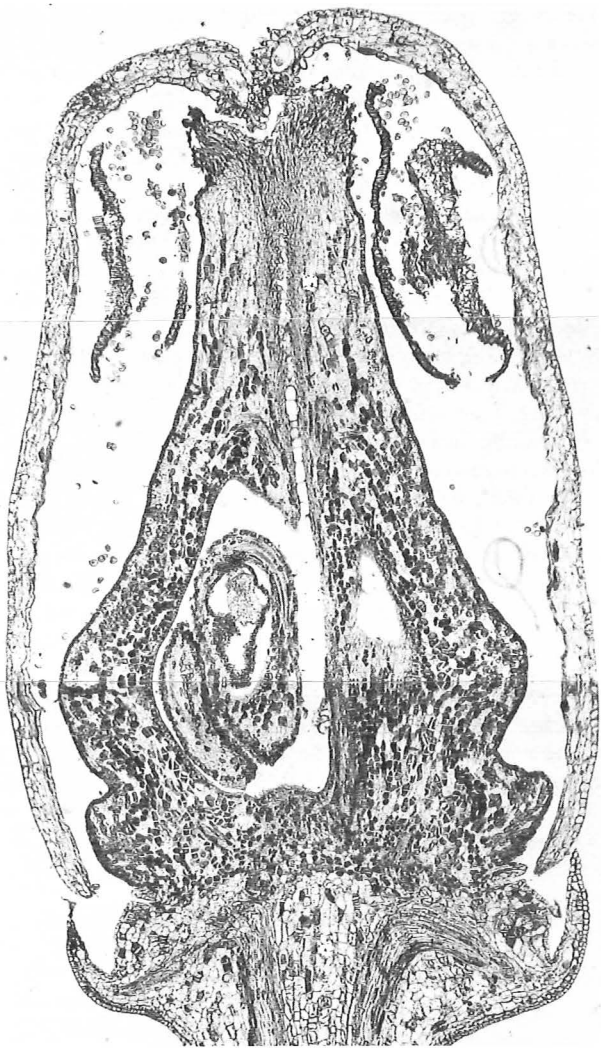

Fig. 6: Bud of Picolit F with green calyptra. The ovules and the stigmatic papillae appear degenerated; the anthers are completely broken and some roundish pollen grains are free in the bud cavity. × 45.

Knospe von Picolit F mit grüner Calyptra. Die Samenanlagen und die Narbenpapillen wirken degeneriert; die Antheren sind vollständig zerbrochen, und einige rundliche Pollenkörner befinden sich frei in der Knospenhöhlung. 45 ×.

leans on the stigmatic papillae. The ovules contain evident embryo sacs. In the mature anthers, supported by extroflexed filaments, the sterile wall is widely interrupted and some pollen grains adhere to the stigmatic papillae (Fig. 1).

Most of the pollen grains present in the bud cavity or still enclosed in the anthers show evident furrows and germinative pores and sometimes a beginning of pollen tube emission.

Picolit 31 AAU: In all the buds showing a green calyptra, this envelops completely all the fertile organs (Fig. 2). At its basis, the calyptra appears firmly inserted on the receptacle and in this portion its cells appear smaller and with thin wall. At its top, the calyptra shows a more or less evident depression and seems to lean on the axile portion of the stigmatic papillae.

The pistil possesses a stigma with well formed papillae and its ovules are in different developmental stages: in some ovules the nucellus is still compact, while in others the embryo sac begins to form. The stamina filaments are extroflexed and the anthers contain a remarkable amount of mature pollen grains. Sometimes the anther wall appears broken and many pollen grains are free in the bud cavity.

In the buds with brownish calyptra (Fig. 3), the stigma appears degenerated in its axile portion, on which previously leaned the calyptra; on the contrary, the papillae of the peripheral stigmatic portion appear well formed and a great amount of acolporated pollen grains adhere to them (Fig. 4). The ovules are mature and contain well developed embryo sacs.

In the buds with dark calyptra, anthers and pistils are completely degenerated.

Picolit F: The green calyptra envelops completely all the fertile organs; at its basis it appears partially inserted on the receptacle and at its top it shows a light depression and seems to lean on the stigmatic papillae.

As regards the pistil, we noticed different situations in the numerous buds we examined. Some pistils show normal aspect: the stigmatic papillae are well developed and the ovules contain an evident embryo sac. In other buds, the pistils are in an advanced stage of degradation (Fig. 6): the stigmatic papillae appear partially degenerated, contracted and enclosed in a dark matrix. The ovules are highly degenerated; nucellus or embryo sac remainders are no more detectable. In few other buds, the pistil shows remarkable shape anomalies (Fig. 5), so that the number of ovules and the stigmatic surface appear reduced. In all the buds examined, independently on the pistil situation, the stamina filaments are extroflexed and the anthers appear quite empty (Fig. 5) or completely broken (Fig. 6). The pollen grains are mainly roundish, while some of them appear highly compressed.

The buds with brownish and dark calyptra always possess pistils whose stigmatic papillae and ovules show evident symptoms of degeneration.

Discussion

In the normal producing cv. Verduzzo, the floral morphology allows an early pollination even in buds enveloped by the calyptra. The pistil appears quite short compared with the whole bud length; consequently, the stigma is in a favourable position to be pollinated by the pollen grains formed in the anthers of the same bud. Actually, many tricolporated pollen grains ready for germination often adhere to the stigmatic papillae. The ovules and the stigmatic papillae appear well developed and receptive, so that self-pollination and self-fertilization can occur also in buds still provided with the calyptra, allowing the development of berries (Fig. 1).

In the cv. Picolit giallo, the calyptra leans on the stigmatic papillae and partially covers them, thus reducing the surface for pollination. Moreover, the stigma (unlike in Verduzzo) occupies a higher position than the anthers: therefore, self-pollination seems very difficult or completely hindered. Since the cv. Picolit giallo is male-sterile, this observation could be of little importance, but would become of great significance if such pollen grains — even if not germinable — would be able to give the "pollen mass effect" towards normally tricolporated pollen grains coming from other cultivars (CARRARO *et al.* 1981). Besides, the male-sterility of Picolit makes cross-pollination absolutely necessary for the development of berries; such pollination can only occur after the fall of the calyptra. Consequently, in this cv. the time and way of falling of the calyptra and the receptivity length of stigma and ovules seem to be of great importance.

The buds provided with green calyptra, probably in early stages of development, show different situations of the fertile apparata in the two examined clones with different productivity.

In the high producing clone 31 AAU, the ovules contain young embryo sacs or compact nucelli (Fig. 2) and probably will still remain receptive for a long period. Actually, buds provided with brownish calyptra and consequently in a more advanced ripening stage contain normally conformed female apparata (Fig. 3). This extended receptivity could allow the possibility of cross-pollinations also for quite long periods. This fact seems to represent a remarkable advantage for those buds that do not lose their calyptra spontaneously. In this case, the calyptra becomes brownish still covering the flower and successively falls accidentally (by means of insects or wind) delivering female apparata still receptive and able to give fruits (provided that cross-pollination occurred).

In Picolit F, unlike what observed in Picolit 31 AAU, the morphology of the buds agrees with the reduced productivity. In fact, only some pistils contain ovules of apparently normal aspect, showing course and time of maturation similar to those observed in Picolit 31 AAU (Fig. 2); most pistils, however, possess ovules in advanced degeneration stages (Fig. 6) or even with morphological anomalies leading to their numerical decrease (Fig. 5). Also the stigmatic papillae of those degenerated or anomalous buds, still enveloped by a green calyptra, show evident degeneration symptoms, or their receptive surface appears extremely reduced (Fig. 5). In this last case, also the style shows anatomical anomalies probably leading to difficulties in the growth of the pollen tube.

Besides, in the buds of Picolit F provided with brownish calyptra the female apparatus always appears highly degenerated with regard to the ovules and to the stigmatic papillae. Therefore, dissimilar to Picolit 31 AAU, if such brownish calyptrae should accidentally fall (and also some of the green ones), they would deliver female apparata no more receptive to any cross-pollination. Even if the amount of these buds is not very high, their impossibility to give fruits could affect quite remarkably the productivity of this cultivar that is always very low. This situation of the buds still provided with calyptra could therefore represent an other of the numerous factors related to the low productivity of this clone.

Summary

We tried to determine a possible relationship between the way of falling of the calyptra and the productivity of the cv. Picolit giallo, whose male-sterility has been demonstrated in previous works.

Whereas in the cv. Verduzzo (choosed as a test cv.) the problem of the calyptra fall seems to be of little importance, because of the self-fertility of this cv., in Picolit giallo the fruit yield is always due to cross-pollination. In the low producing Picolit giallo, we observed an early degeneration of the fertile organs in buds with still green calyptra, while in the high producing Picolit giallo the fertile organs appear receptive in all the buds with green calyptra and in a remarkable percentage of those with brownish calyptra. In this clone, cross-pollination could then occur also for those flowers that do not loose spontaneously their calyptrae, which become brownish and fall accidentally by means of insects or wind.

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