

THE RELATIONSHIP BETWEEN TIME OF CLUSTER DIFFERENTIATION AND PHENOLOGICAL STAGES WITH SPECIAL FOCUS ON ASSESSMENT OF BUD FERTILITY AND BUD NECROSIS AS MEANS FOR IMPROVING VINE PRODUCTIVITY OF SOME GRAPE CULTIVARS

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ABSTRACT

This study was carried out for three successive seasons (2006, 2007 and 2008) in a private vineyard located at El-Khatatba, Menoufiya governorate; to determinate the relationship between time of cluster differentiation and phenological stages of vine annual growth cycle with special focus on assessment of bud fertility and bud necrosis sensitivity of eight grape varieties; Flame Seedless, Superior, Beauty Seedless, Black Monukka, Rich Baba, Red Globe, Black Rose, and Ribier. The chosen vines were 10-year-old, grown in a sandy soil, spaced at 2 X 3 meters apart and irrigated by the drip irrigation system, cane-pruned and trellised by the Spanish Parron shape system.

The results showed that the time of cluster differentiation is closely correlated closely with phenological stages. However, cluster differentiation occurs just after full bloom time and continues almost until fruit harvest for all varieties in the three seasons of this study. It was noticed that, percentage of dissected bud fertility along 'Flame Seedless' shoots through the different phenological dates recorded the greatest values compared to the other varieties, followed by Beauty Seedless and Red Globe grape varieties. On the other hand, Black Monukka and Superior grape varieties gave the lowest percentage of dissected bud fertility along shoots through phenological dates in the three seasons of the study.

With respect to percentage of bud necrosis, data compiled from bud dissection analysis showed a significant difference in the levels of bud necrosis (BN) among varieties under investigation in the three seasons. In this respect, Flame Seedless and Black Monukka grape varieties had the highest incidence of BN followed by Superior, Beauty Seedless, Red Globe and Black Rose which were found to be intermediate in this respect. On the other hand, Ribier and Rich Baba grape varieties were the lowest during all seasons of this study.

INTRODUCTION

As one of the premises for crop yield, grapevine bud fruitfulness has been the focus of many studies, reviewed by several authors (Buttrose 1974, Srinivasan and Mullins 1981 and May 2000). Since productivity of cultivars may vary widely from year to year.

The low and erratic bud fruitfulness of table grape varieties is the single most significant problem. The poor bud fruitfulness and low cropping levels experienced during the few recent years have substantially reduced the economic feasibility of table grape production.

To improve bud fruitfulness, table grape growers should focus their efforts on this critical period and employ at the appropriate time management strategies (fertilizer, irrigation,...etc) as to be more effective in improving fruitfulness when cluster differentiation occurs through the phenological stages of the grapevine.

Vitis vinifera grapevines are phenologically distinct crop with the most important developmental stages being débourrement (budburst), floraison (flowering), veraison (color change and maturation nascent), and harvest (grape maturity). The time between these phenological stages varies greatly with grapevine variety, climate, and geographic location (Jones and Davis 2000).

Time of cluster differentiation of grapevine inflorescence primordia that make up the next year's crop in the compound bud begins around bloom time and continues almost until it is completed between veraison and harvest (May and Antcliff 1963; Swanepoel and Archer 1988 and Williams 2000). Therefore, the number of flower primordia per vine (and thus the potential yield) is determined during the previous year.

Bud necrosis (BN) of grapevines is a physiological disorder of the compound buds of grapevines resulting in the death of the primary bud (Bindra and Chohan, 1975; Hopping, 1977; Bains *et al.*, 1981; Lavee *et al.*, 1981; Naito *et al.*, 1986; Lavee, 1987; Morrison and Iodi, 1990; Perez and Kliever, 1990; Dry and Coombe, 1994; Wolf and Warren, 1995). The disorder usually affects the primary buds, but occasionally the secondary buds are also affected. Primary buds produce the fruiting shoots for the following season. When primary buds abort, the secondary buds undergo further development and produce the following year's fruiting shoots. Shoots that develop from secondary buds typically have smaller and fewer fruit clusters. Therefore, the crop yield of secondary shoots is lower than that of primary shoots.

Despite the widespread occurrence of BN, the principal cause is uncertain. High rates of shoot growth and large cane diameter (Lavee *et al.*, 1981; Lavee, 1987; Dry and Coombe, 1994 and Wolf and Warren, 1995), shading of buds (Perez and Kliever, 1990 and Wolf and Warren, 1995), excessive irrigation (Bindra and Chohan, 1975; Perez, 1991), low carbohydrate levels in bud tissues (Naito *et al.*, 1987), high gibberellinlike activity in buds (Ziv *et al.*, 1981 and Lavee, 1987) and mite infestation and fungal diseases (Rawnsley *et al.*, 2002) have all been associated with bud necrosis.

The incidence of BN appears to be cultivar-specific. Researches on BN and fruitfulness have been widely conducted on table grapes, such as Thompson seedless (Sultana) and Queen of Vineyard (Lavee *et al.*, 1981).

The time that BN develops is dependent on cultivar. It was reported that BN commences soon after flowering (Lavee *et al.*, 1981) and may develop up to 10 weeks after full bloom (Morrison and Iodi, 1990). Vineyards with BN often display vigorous shoot growth as a consequence of the unfruitful secondary shoots compensating for the loss of the primary bud. BN may also lead to development of two secondary shoots from the same node (Dry and Coombe, 1994), yet overall bunch number is reduced. Poor fruitfulness may indicate high levels of BN in the vineyard.

This survey cleared that grape growers should be aware of BN incidence as a potential vineyard problem, and as such, grape-growers have to change their management strategies to compensate for high levels of BN.

The objective of this study is to improve vineyard productivity through

determination of the relationship between time of cluster differentiation and phenological stages of vine annual growth cycle with special focus on assessment of bud fertility and bud necrosis sensitivity of eight grape varieties; Flame Seedless, Superior, Beauty Seedless, Black Monukka, Rich Baba, Red Globe, Black Rose, and Ribier.

MATERIALS AND METHODS

This study was carried out in a private vineyard located at El-Khatatba, Menoufiya governorate; to improve vineyard productivity through the determination of the relationship between time of cluster differentiation and phenological stages with special focus on the assessment of bud fertility and bud necrosis sensitivity of eight grape varieties; Flame Seedless, Superior, Beauty Seedless, Black Monukka, Rich Baba, Red Globe, Black Rose, and Ribier. The study extended for three successive seasons (2006, 2007 and 2008). The vines were 10-year-old, grown in a sandy soil, spaced at 2 X 3 meters apart, irrigated by the drip irrigation system, cane-pruned and trellised by the Spanish Parron shape system. The vines were pruned during the second week of January for the three seasons of the study so as to maintain a load of (10 canes X 12 buds/cane). Four replicates for each cultivar were taken where each replicate consisted of nine vines and subjected to the same cultural practices usually carried out for these cultivars.

The following parameters were measured to evaluate the tested varieties:-

1) Phenological data

The considered aspects: the 1st, date of bud burst, i.e. opening of 50% buds; the 2nd, date of full bloom: the vines were considered to reach full bloom when the calyptra had fallen from 70-80% of the flowers; the 3rd, date of fruit set: when the fertilized flower begins to be a berry; the 4th, date of veraison: when the berries start to soften as they build up sugars and acids begin to fall or the berries reach to the onset of colour stage; the 5th, date of harvesting: it takes place when the berries attain full colour stage and the TSS reach 16-17% according to Tourky *et al.*, (1995).

- a) Time of phenological dates (budburst, full bloom, fruit set, veraison and ripening) was estimated periodically.
- b) Number of days for phenological dates was calculated periodically by calendar year (Julian day).

2) Time of cluster differentiation

Samples of primary bud along a 12-node current season shoots of at least 15 individual shoots for the eight grape varieties were collected periodically through dates of full bloom, fruit set, veraison, ripening and winter pruning during the seasons of the study. Samples were examined microscopically for the presence of floral primordia and calculated periodically by calendar year (Julian day). The method was conducted through the handling faster anatomy described by Ambika and pondey, (1969).

3) Bud fertility and bud necrosis

Number of predicted bud fertility and bud necrosis were estimated at

winter pruning time on dormant buds borne on 10 canes each of 12 buds for the eight grape varieties by microscope binocular. The method was conducted through the handling faster anatomy described by Ambika and pondey, (1969).

- a) Percentage of predicted bud fertility at different bud positions lengthwise the cane: This was calculated by dividing the total number of dissected fertile buds per vine by the total number of buds per vine at each bud position.
- b) Percentage of actual fruiting shoots in spring after bud burst at different bud positions lengthwise the cane: This was calculated by dividing the total number of fruit shoots per vine by the total number of buds per vine.
- c) Percentage of bud necrosis: It was calculated by dividing number of necrotic buds per vine by the total number of buds per vine.

- **Statistical analysis:**

The completely randomized design was carried out for this experiment. The statistical analysis of the present data was made according to Snedecor and Chocran (1972). Averages were compared using the new L.S.D. values at 5% level. Percentages were transformed by a certain equation prior to the statistical analysis.

RESULTS AND DISCUSSION

1) Phenological data

Data in (Table, 1 and Figure, 1) revealed that Flame Seedless and Superior grape were the earliest varieties with regard to the phenological dates (budburst, full bloom, fruit set, veraison and grape maturity) compared to the other varieties whereas, Red Globe, Black Rose, and Ribier grape varieties were the latest in this respect. On the other hand, Beauty Seedless, Black Monukka and Rich Baba Ribier grape varieties were intermediate in the three seasons.

Data concerning number of days by calendar year (Julian day) for phenological dates as shown in (Table, 2 and Figure, 2) revealed a remarkable variation among varieties under investigation. In this respect, Flame Seedless and Superior grape varieties had the lowest number of days as compared to the other varieties followed by Beauty Seedless, Black Monukka and Rich Baba grape varieties were found to be intermediate in this respect. On the other hand, Red Globe, Black Rose and Ribier grape varieties had the highest number of days in all seasons of the study.

The obtained results in this connection are in harmony with those mentioned by Abd-El-Fattah and Kasstor (1993a) on Beauty Seedless and Black Monukka grape varieties; Abd-El-Fattah and Kasstor (1993b) on Black Rose and Ribier grape varieties; Aisha *et al.*, (1998) on Black Monukka and Ribier grape varieties; Marwad (2002a) on Black Rose and Ribier grape varieties and Marwad (2002b) on Beauty Seedless and Black Monukka grape varieties.

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2) Time of cluster differentiation

Time of cluster differentiation within the compound bud in all studied varieties begins just after full bloom time and continues almost until fruit harvest along the 12-node shoot (Table, 3 and Figure, 3).

It is interesting to note that potential bud fruitfulness (dissected bud fertility %) showed a remarkable variation among varieties under investigation. In this respect, percentage of dissected bud fertility along 'Flame Seedless' shoots through phenological dates (full bloom, fruit set, veraison, harvest grape maturity and winter pruning) recorded the greatest values in comparison with the other varieties. The percentage was (16.7%) after 115 days of year at fruit set, (55.7%) after 133 days of year at veraison, (76.3%) after 163 days of year at fruit ripening and (77.9%) after 325 days of year at winter pruning, followed by Beauty Seedless and Red Globe grape varieties. On the other hand, Black Monukka and Superior grape varieties recorded the lowest percentage of dissected bud fertility along shoots through the phenological dates in the three seasons of the investigation.

It can be shown from the aforementioned data that definite relationships between phenological dates and time of cluster differentiation could be identified. Correlations illustrated in Figure (3) indicated that phenological dates are closely related to bud fruitfulness for the grape varieties under investigation.

These results are in accordance with those obtained by (May and Antcliff 1963; Swanepoel and Archer 1988 and Williams 2000) who found that time of cluster differentiation of grapevine inflorescence primordia that make up the next year's crop in the compound bud begins around bloom time and continues almost until it is completed between veraison and harvest.

3) Prediction of bud fertility, actual fruiting shoots and bud necrosis

It is important to determine percentage of predicted bud fertility for each bud position as to help for the choice of the suitable pruning system for each cultivar.

With respect to percentage of predicted bud fertility at different bud positions lengthwise the cane, data in (Figure, 4) show that the first basal bud had the least percentage of bud fertility as compared to the subsequent buds. A remarkable increase attaining its maximum percentage occurred from the 2nd to the 4th bud for Flame Seedless grape variety, from the 3rd to the 5th bud for Beauty Seedless, Rich Baba, Red Globe, Black Rose and Ribier grape varieties. Black Monukka and Superior grape varieties recorded the highest percentage of bud fertility from the 5th to the 8th bud in three seasons.

As regards percentage of actual fruiting shoots lengthwise the cane, the results illustrated in (Figure, 4) revealed that, it exhibited a trend similar to that of the percentage of predicted bud fertility lengthwise the cane for all grape varieties under investigation. The similarity of the trend of both predicted and actual fruiting suggests that the forecasting through the examination of bud fertility during winter may be a reliable guide for winter-pruning and fruiting of the eight grape varieties in the following season.

The percentage of predicted bud fertility detected at dormancy period was approximately the same for the actual fruiting shoots at spring.

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However the percentage of predicted bud fertility was higher as compared to that of actual fruiting shoots for all grape varieties under investigation in the three seasons. This difference may be ascribed to the environmental factors and agricultural practices.

From the previously mentioned results, it can be recommended to prune Flame Seedless, Beauty Seedless, Rich Baba, Red Globe, Black Rose and Ribier grape varieties according to the spur pruning system while Black Monukka and Superior can be pruned according to the cane pruning system.

These results agree with the findings of Bessins (1965), Licul (1969), Monastra (1971), Abd El-Kawi and El-Yami (1992) and Aisha *et al.*, (1998) who found that the fruitfulness of buds increased from the basal sector to the distal bud position on the canes.

With respect to percentage of bud necrosis, data compiled from bud dissection analysis (Table, 4 and Figure, 5 & 6) showed significant differences in the levels of bud necrosis (BN) among the varieties under investigation in the three seasons. In this respect, Flame Seedless and Black Monukka grape varieties had the highest incidence of BN compared to other varieties followed by Superior, Beauty Seedless, Red Globe and Black Rose which were found to be intermediate in this respect. On the other hand, Ribier and Rich Baba grape varieties were the lowest in all seasons of the study.

Despite the widespread occurrence of BN, the principal cause is uncertain. High rates of shoot growth and large cane diameter (Lavee *et al.*, 1981; Lavee, 1987; Dry and Coombe, 1994 and Wolf and Warren, 1995), shading of buds (Perez and Kliwer, 1990 and Wolf and Warren, 1995), excessive irrigation (Bindra and Chohan, 1975; Perez, 1991), low carbohydrate levels in bud tissues (Naito *et al.*, 1987), high gibberellinlike activity in buds (Ziv *et al.*, 1981 and Lavee, 1987) and mite infestation and fungal diseases (Rawnsley *et al.*, 2002) have all been associated with bud necrosis.

The incidence of BN appears to be cultivar-specific. Researches on BN and fruitfulness have been widely conducted on table grapes, such as Thompson seedless (Sultana) and Queen of Vineyard (Lavee *et al.*, 1981).

The results highlighted that BN is a problem in most grape varieties under study, particularly in Flame Seedless, Black Monukka, Superior, Beauty Seedless, Red Globe and Black Rose grape varieties. It can be concluded from the results obtained that in this investigation grapegrowers should be aware of BN incidence as a potential vineyard problem, and as such, grape-growers have to change their management strategies to compensate for high levels of BN.

The correlation between high BN levels and low fruitfulness is important in terms of crop forecasting to meet target yields (Lavee *et al.*, 1981; Dry and Coombe, 1994). It has been suggested that factors leading to a reduced number of inflorescences also contribute to the process leading to BN incidence (Lavee *et al.*, 1981). The high degree of variability found between different vineyards indicate that it would be difficult to estimate BN regionally and may be more reliant on other factors.

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This implies that each vineyard would need to be managed on a case-by-case basis and factors such as seasonal changes and block variability would need to be considered to accurately estimate BN levels.

The following are the possible recommendations which could be given according to the obtained results:-

- Horticultural practices should be applied at the appropriate time and with the required accuracy so as to prepare the vine for the proper floral bud differentiation of cluster primordia especially after full bloom time and continues almost until fruit harvest.
- It is required to raise vine bud load during winter pruning in accordance with percentage of bud necrosis detected through the microscopically examination of buds.

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**العلاقة بين توقيت التخليق الزهري والمراحل الفينولوجية مع إلقاء الضوء على
تقييم خصوبة وموت البراعم كوسائل لتحسين الإنتاجية في بعض أصناف العنب
محفوظ محمد الموجي ، محمد عبد العزيز عبد الوهاب و جيهان حسين صبرى
قسم العنب - معهد بحوث البساتين - مركز البحوث الزراعية بالجيزة - مصر**

أجرى هذا البحث لمدة ثلاثة مواسم متتالية (٢٠٠٦، ٢٠٠٧، ٢٠٠٨) بأحد المزارع الخاصة بمنطقة الخطاطبة (محافظة المنوفية) بهدف محاولة تحسين إنتاجية مزارع العنب من خلال تحديد العلاقة بين توقيت التخليق الزهري والمراحل الفينولوجية لدورة النمو السنوية مع إلقاء الضوء على تقييم خصوبة وموت البراعم لثمانية أصناف من العنب وهى: فليم سيدلس، سوبيريور، بيوتى سيدلس، بلاك مونوكا، ريش بابا، ريد جلوب، بلاك روز، ريبيير. وكان عمر الكرمات ١٠ سنوات نامية فى تربة طميية رملية، على مسافة ٢ X ٣ متر، وتروى بنظام الري بالتنقيط. تم تقليم الكرمات تقليماً قصيباً تحت نظام تدعيم التكعيب الأسبانية.

وقد أوضحت نتائج الدراسة أن توقيت التخليق الزهري يرتبط ارتباطاً وثيقاً بالمراحل الفينولوجية حيث تبدأ عملية التخليق الزهري بعد قمة التزهير مباشرة وتستمر غالباً حتى مرحلة الحصاد وذلك لكل الأصناف خلال الثلاثة مواسم من الدراسة. حيث لوحظ أن خصوبة البراعم لصنف العنب الفليم سيدلس خلال المراحل الفينولوجية المختلفة سجلت أعلى نسبة مئوية مقارنة بباقي الأصناف الأخرى يليها أصناف عنب البيوتى سيدلس، ريد جلوب. بينما سجل أصناف عنب بلاك مونوكا، السوبيريور أقل نسبة مئوية من خصوبة البراعم خلال المراحل الفينولوجية للثلاث مواسم من الدراسة.

كما أشارت النتائج المتعلقة بالنسبة المئوية لموت البراعم من خلال بيانات تشريح البراعم أن هناك فروقاً معنوية فى درجة موت البراعم بين الأصناف المدروسة خلال الثلاثة مواسم. حيث لوحظ أن أصناف عنب الفليم سيدلس، البلاك مونوكا كانت أعلى الأصناف فيما يتعلق بالنسبة المئوية لموت البراعم مقارنة بباقي الأصناف الأخرى يليها أصناف عنب السوبيريور، بيوتى سيدلس، ريد جلوب، بلاك روز بينما سجلت أصناف عنب الريبيير، ريش بابا أقل نسبة مئوية من موت البراعم خلال المواسم الثلاثة من الدراسة.