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MULTI-MODAL APPROACH TO PROMOTE BEST MANAGEMENT PRACTICES IN NEW JERSEY VINEYARDS.

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ABSTRACT

Four crucial viticultural challenges that affect the economic sustainability of New Jersey's fledging wine industry are: 1) Poor preplant decisions at the time of vineyard establishment; 2) viral diseases, spread by contaminated planting materials; 3) cold damage during harsh winters, and 4) high humidity and excess precipitation causing high disease pressure. The Vineyard Best Management Practice (BMP) program was developed to educate New Jersey's wine grape growers to manage these stressors. Educational programs were delivered through a variety of platforms such as twilight meetings, symposiums, demonstration workshops, field visits, fact sheets, and blog as well as newsletter articles. Survey results indicated substantial knowledge gain in vineyard establishment, pruning and canopy management. Growers' responses showed rapid adoption of planting advanced, certified grapevines. A substantial number of growers showed increased preparedness to mitigate cold damage by integrating strategies, such as hilling-up and retaining multiple canes. A series of educational field meetings helped growers with pre- and post-bloom pest management. Overall, the Vineyard BMP program resulted in healthier vineyards which assure enhanced economic sustainability.

INTRODUCTION

The Wine Grape industry has been one of the fastest growing agricultural sectors in New Jersey during the past decade (USDA- NASS, 2002; 2017). Given the popularity of wine, agro-tourism, and supporting local agriculture, it is not surprising that many vineyard owners are first generation growers transitioning into agriculture with limited experience. These novice growers require unique educational support to assist them in avoiding costly mistakes with this perennial crop. Also, New Jersey is uniquely suited to produce high-quality wine grapes. Its varied climates create an opportunity for producing a rich and varied suite of wines. However, major biotic and abiotic stresses affect the sustainability of this production system (Centinari et al., 2016; Wolf, 2008). In addition to vineyard establishment, three main challenges that affect the economic sustainability of the wine industry are; viral diseases, caused by infected planting material sourced from the non-certified nurseries (Sudarshana et et., 2015); unpredictable harsh winters leading to cold injury and subsequent scourge of crown gall disease (Gohil and Ward, 2017); high humidity causing high disease pressure, and excess precipitation causing excess canopy growth. Excess precipitation for grape vines during the growing season is very common in New Jersey (Wolf, 2008). It causes vigorous vegetative growth, poor light penetration, reduced air circulation, and increased disease pressure, none of which is good for quality fruit or wine. There are several other factors aggravating the problem, including inexperience of beginners; lack of understanding of the cold damage occurrence; inability to spot disease symptoms and employing limited strategies to mitigate the problem (Gohil et al., 2016a, Gohil et al., 2016b, Gohil et al., 2017). Considering these factors, there was a need for developing a curriculum and implementing a Best Management Practices (BMP) program in wine grape production.

PROGRAMS AND CURRICULA

Educational programs were designed specific to four broad objectives: 1) assist beginning growers in making right decisions during the early years of vineyard establishment; 2) promote clean plant material; 3) promote integrated cold-damage management strategies to mitigate cold-damge and; 4) promote integrated pest management in vineyards. Educational programs were delivered through a variety of platforms such as twilight meetings, symposiums, demonstration workshops, vineyard visits, fact sheets, and blog as well as newsletter articles.

1. Beginning Grape Growers Workshops

There is an ever-increasing volume of inquiries, from the basic to advanced aspects of grape production. In response to this need, a curriculum was developed to educate beginning grape growers (0-5 years of experience) on the aspects of grape cultivation. Three teaching modules were developed, focusing on vineyard establishment, winter pruning and canopy management.

Vineyard Establishment workshops: Wine grapes are a perennial crop. Decisions made at the time of vineyard establishment could affect the crop for the next 20 to 40 years. Mistakes at this stage can be very costly and difficult to undo over time. An annual, one-day workshop on vineyard establishment was developed to assist beginning growers in deciding if wine grape growing is the right choice for them. If so, what should they know about vineyard establishment before and after? The curriculum included:

Should you be growing grapes
Things to remember before ordering your vines
Site preparation for your vineyard
Vineyard economics
Suitable avrieties for northeastern regions
Case study: What worked and what did not (progressive established grower)

Vineyard Winter Pruning Workshops: This module taught practical, hands-on training to improve their winter pruning skills for beginners. This module consisted of a 3-hour workshop comprising an hour of lectures followed by an hour-long demonstration of pruning using props. The workshop concluded in the third hour with a hands-on practicum in the vineyard by the participants. The curriculum included:

Spur and cane pruning methods (demonstration)
Pruning strategies for managing cold-damaged vines
Tools: Types of pruners, loppers and saws used in pruning
Balanced pruning using Ravaz index

Canopy Management Workshops: The canopy management training module was designed to educate beginners on incorporating practices that reduce excessively vigorous growth. Two demonstrations were organized. The curriculum included:

How to perform hedging, leaf thinning, and fruit thinning
Growth habits of high cordon and low cordon hybrid varieties
Training grapevines during the first and the second years
Tools for canopy management
Mechanized canopy management

2. Clean Planting Material

Certified planting material can protect growers from importing a virus into the vineyard from infected cuttings, a common cause of virus diseases in vineyards. Also, the latest survey (Sudarshana et al., 2015) has confirmed spreading of the highly damaging red blotch virus in north eastern U.S. vineyards, including New Jersey. In response to these needs of both beginner and advanced growers, we developed a curriculum that included the following modules. A teaching module was developed to help growers adopt cutting-edge technology based planting material such as the 2010 Protocol-based, which provides the cleanest scions and rootstocks. The module also provides a method for cost-benefit analysis and information on the agencies involved, such as Foundation Plant Services and the National Clean Plant Network, the process of certification and sourcing certified planting material. The curriculum included:

Certified plant material- the best strategy to prevent virus diseases in the vineyard
Detailed inspection of planting material before planting grapevines (Gohil et al., 2016a)
2010 protocol-based planting material

3. Integrated Cold Injury Management (ICIM)

Cold damage and resulting crown gall disease is the scourge of cool climate wine grape production. For example, according to our survey, 85% of NJ's vineyards suffered cold damage from the harsh winters of 2013-14, and after the following winter, 70% reported similar damage, resultin in a substantial loss of crop and income. Centinari et al. (2015) reported that more than 80% of growers in all the regions of Pennsylvania reported injury at least once in the last five years. The Vineyard Cold Injury Mitigation Practices program was designed to address the above challenges using the following curriculum:

Variety and clonal selection for cold climate viticulture
2010 protocol-based certified planting material
Hilling-up and other practices to mitigate winter damage (Gohil et al., 2017)
Cordon renewal strategies for declining Merlot vineyards (Gohil et al., 2018)

4. Integrated Pest Management

Effective pest management requires monitoring, identification of symptoms, adoption of preventive practices and mitigation using minimal pesticides. A series of twilight meetings were held where Rutgers University wine grape experts provided preseason updates on pest scouting and pest management. Often symptoms of biotic and abiotic stresses overlap, which may result in growers spending money on unnecessary diagnostic tests. The program for the identification of biotic (virus, bacterial and fungal diseases) and abiotic stresses (nutritional deficiencies and cold damage management) in vineyards and how to address those challenges, included:

Integrated Pest Management (Rutgers experts and invited speakers)
Red leaves in the vineyard: Biotic and abiotic Causes (Gohil et al. 2016b.)
Monitoring vineyard nutritional status to determine nutritional deficiency at bloom and its early mitigation

OUTPUTS AND OUTCOMES

For each program outputs were reported in terms of number of participants attended or the number of people receiving educational material as a hard copy or digital. Number of people receiving or downloading digital material such as fact sheets and blog articles were gathered from Rutgers office of communications. The outcome of each program was measured to understand the gain in knowledge, attitude, skill or intention to adopt the practices.This was accomplished by conducting pre- and post-event surveys, specific to each program.

1. Beginners Grape Growers Workshops

Vineyard Establishment: A total of 88 beginners were educated during four annual workshops conducted from 2015 to 2018. This workshop answers some of the basic questions related to wine grape production in New Jersey. Following beginner grape grower workshops at Atlantic City in 2016 and 2017, beginners (growers with 0 to 5 years of grape growing experience) were surveyed for their increase in knowledge and if the workshop helped in resolving any of their vineyard-related problems (n= 42).

- 90% agreed that this workshop helped resolve some of their vineyard establishment related questions.
- 100% indicated that after this program they would test their soil pH and amend it before planting a new vineyard.
- 80% learned or improved their understanding that ‘site suitability should be considered before buying or selecting land for a vineyard’.
- 80% learned or improved their understanding that ‘varieties should be trained differently depending on its growth pattern.’
- 70% learned or improved their understanding that ‘there is a difference in growth habits of different varieties.’
- 80% learned to improve their understanding that ‘buying certified plant material can help prevent the introduction of virus diseases.’

During the 2017 workshop, after the presentation on vineyard economics, a survey was conducted where growers (n=14) were asked to indicate which profit enhancing strategies they would use. Ninety percent indicated that they would seek to choose an excellent site; 80% indicated that they would minimize equipment expenditure; 80% indicated that they would minimize borrowing of money; 90% indicated that they would maximize crop quality and value; and 70% indicated that they would plant vineyards large enough to justify efficient equipment.

These workshops were followed by more than 80 hours of consultation (on-site, one-on-one and follow-up visits) which saved an estimated $16,000 (at the commercial rate of $200/hr.) in private consulting charges. Also, more than 90% of the beginning grape growers attended at least one of the beginning grape grower workshops. These resulted in 28 beginning growers establishing (planning or planted) 136 new acres of wine grapes with estimated annual revenue of more than a million dollars, from selling grapes, or more though wine sales, once it comes to full production. Twenty-eight beginners made at least 2 to 3 critical decisions, such as site evaluation (e.g., soil testing), certified planting material, varieties, rootstocks or clones selection, based on information received at these meetings, twilight or personal visits.

Pruning Workshops: A total of 102 growers were educated during three pruning workshops from 2016-2017, held at Rutgers Agriculture Research and Extension Center (RAREC, Bridgeton, NJ) and a grower's vineyard. An evaluation was conducted after the winter pruning workshop held at RAREC in 2016. Based on the responses of 38 growers:

- 56% increased their knowledge of pruning tools;
- 84% increased their knowledge of spur and cane pruning;
- 100% increased their knowledge of pruning methods.

An evaluation conducted after the pruning workshop in 2017 at Bellview Vineyards (n=30 responses) indicated that:

- 66% increased their knowledge of balanced pruning (BP) from none/fair to either good, very good or excellent; 23% increased their knowledge of BP from fair to either good, very good or excellent; and 23% increased their knowledge of BP from good to very good or excellent.
- 80% increased their knowledge of mechanized pruning (MP) from none/fair to either good, very good or excellent; 10% increased their knowledge of (MP) from fair to good to very good or excellent.
- 27% indicated ‘now I know’; 50% indicated now I know more, and 23% indicated ‘already know’ about ‘plan on pruning cold hardiest varieties first and finish with least hardiest.'
- 50% indicated ‘now I know’; 23% indicated now I know more, and 30% indicated ‘already know’ about ‘pruning can be delayed till bud swell.'

A pre- and post-event evaluation was conducted in 2018, following the workshop held at RAREC. Participants were sent a Google Forms-based digital survey link (*https://docs.google.com/forms/d/12kYDH94cyhbOFLZF8iysgC3ZQzlv5oxBlHzipU8xiEI/edit)* to rate their knowledge increase from before and after participating in the program, using the rating scale of 1 to 5, where 5 = Excellent (n=22 responses).

	Before	After
Tools and Techniques in pruning young vines	2.5	4.2
Tools and techniques in assessing bud injury	1.0	4.8
Difference between the dead bud and live bud	1.8	4.0
Tools and techniques in training young vines	2.4	3.0
How to perform cane and spur pruning	3.0	4.0

Canopy Management: A total of 66 growers were educated during two workshops held at RAREC and a grower’s vineyard. A pre- and post-event evaluation was conducted in 2017 where participants were asked to rate their knowledge increase from before and after participating in the program using the rating scale of 1 to 5, where 5 = Excellent (n=21 responses).

	Before	After
High Cordon and Low Cordon Training System	2.0	4.0
Growth Habits of 'Regents,' 'Marquette' and 'Arandell'	1.5	3.8
Grapevine Disease Identification	2.3	4.2
Sampling for Virus	1.6	3.2
Testing Sprayer Effectiveness	1.8	3.6

Did you learn anything new about training systems that you would use in new or existing planting? 100% yes.

Based on today's demonstration will you test the effectiveness of your sprayer using spray cards? 96% yes and 4% No.

2. Clean Plant Material

A total of 88 growers directly received education on clean plant material. A total of 670 accessed the fact sheet FS1252 (Gohil et al., 2016a), while 880 read the blog post on a detailed inspection of planting material, indicating successful outreach to growers beyond New Jersey. At the end of a presentation in May, 2016, a survey of participants (n=20) showed:

70% responded 'now I know' virus cannot be cured in the vineyard

85% responded 'now I know' certified material can prevent virus diseases that otherwise could have originated from the nursery

100% increased their knowledge about 'certified' planting material while 85% increased their awareness about the 2010 protocol-based material, compared to before the program

60% responded they would 'always' buy certified or clean plant material

A survey was conducted in the fall of 2017 to determine the current level of adoption or the intention to order certified planting material. A Google Forms-based survey link was sent (*https://docs.google.com/forms/d/1Y5ubOROHdp5AxWgO4ZukD2mbyFuTzli3MlYfYHu5TaM/edit)*. Based on 26 responses (157 acres), 90% of new vineyards, used certified planting material, of which 52 acres were of 2010 protocol-based (the most advanced technology) material. That showed a 30% increase, compared to the previous year, indicating rapid adoption of 2010 protocol-based material.

3. Integrated Cold-Injury Management

One hundred seventy-four growers were directly educated though presentations on various methods of ICM. The fact sheet FS 1264 (Gohil et al., 2017), on the topic of hilling-up, has been viewed and downloaded by more than 830 people. The plant and pest advisory newsletter article on this topic https://plant-pest-advisory.rutgers.edu/time-to-hill-up-your-grapevines-is-now/ has been viewed by more than 110 times, while the article on cool climate chardonnay clones https://plant-pest-advisory.rutgers.edu/cool-climate-chardonnay-clones/ was viewed by 89 growers.

To determine if the growers understood the methods of cold injury prevention, a survey was conducted in March, 2017 (n = 34).

19% indicated that they would increase monitoring for trunk injuries at the onset of the season

26% indicated that they would choose suitable sites for cold tender and hardy varieties for their new plantings

30% indicated that they would choose suitable varieties for their site for their new plantings

33% indicated that they would hill-up their vineyard to protect the graft union against winter injury

37% indicated that they would retain multiple canes or suckers as insurance in case the main trunk gets damaged due to cold injuries

52% indicated that they would plant or order 2010 protocol certified material

A Google Forms-based survey link was sent in fall 2017 to determine the current level of adoption (*https://docs.google.com/forms/d/1QGdyoxbgfri5tOBWDc0ChSJ9RGsyIwdzyfX3khg06Rs/edit)*. Based on 34 responses, out of 382 acres planted, a total of 288 acres were managed using improved winter damage prevention strategies; 57% of growers integrated hilling-up on 227 acres; 63% of growers integrated retaining multiple canes on 265 acres; 41% integrated site/slope selection on 123 acres; and 35% growers changed pruning strategies on 144 acres. These indicate increased preparedness to mitigate cold damage using an integrated approach.

4. Integrated Pest Management in the Vineyard

During eight wine grape twilight extension meetings in four years from 2015 to 2018, a total of 186 growers were directly educated on various aspects of pest management in the vineyard, and a total of 2380 pesticide recertification credits were provided. Since 2016, FS 1260, Red Leaves in the Vineyard (Gohil et al., 2016b) was accessed and downloaded by more than 4239 people, indicating outreach well beyond New Jersey and the United States.

A survey was conducted in the fall of 2017 to determine the effectiveness of the twilight extension meetings on pest management. Based on 20 responses (196 acres); 80% of growers (161 acres) changed their disease management practices after attending twilight meetings; 90% of growers (180 acres) indicated that twilight meetings helped them develop better disease management programs; and 95% of growers (190 acres) indicated the twilight meetings helped with identifying the pest and insect damage symptoms at the early stage of development. More than 90% of growers agreed that twilight meetings helped them develop better disease management programs and 95% of growers (150 acres) indicated that twilight meetings provided adequate pesticide re-certification credits.

A survey of adoption of soil pH management and grapevine nutritional deficiencies was conducted in the fall 2017. A Google Forms-based digital survey link (*https://docs.google.com/forms/d/1iI0teFR_wBOxT956ng6w77Mzv59Cb_c0SMLLRzoAbTs/edit)* was sent. Based on 20 responses (196 acres), 85% of growers (143 acres) identified grapevine nutritional deficiencies; 75% of growers (147 acres) amended nutritional deficiencies; 55% of growers (113 acres)

improved soil and leaf petiole sampling skills; 35% of growers (39 acres) increased frequency of pH and nutritional status monitoring and; 60% of growers (145 acres) corrected grapevine or vineyard nutritional deficiencies.

CONCLUSIONS

Wine grape growers of New Jersey were educated using various educational platforms to address some of the crucial challenges to the industry. Methods such as demonstration and workshops were more effective for the beginner growers while fact sheets, blogs and newsletters could reach out to growers in NJ and beyond. The results of all different surveys indicated overwhelmingly positive outcomes of this multi-modal approach to the BMP program for growers with different levels of experience growing grapes. Our results suggest that a similar approach can be used to promote BMPs for any specialty crop in any region, however an extension agent may need to perform a needs assessment and prioritize programming areas. Programs will need to be executed with coordinated and collaborative efforts from a team of crop specific experts at the state and regional level.

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