



State Level Model Regulatory Standard:

**Virus-Tested Certification Program for Strawberry
Nursery Stock Production Systems**

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The following section headings may be included in the regulation, if required by state certifying agency's legal counsel, who may supply standard language:

Review

Legislative Authority

Approval/Endorsement

Implementation

Distribution

Amendment Record

An accurate public record of amendments to this certification program should be maintained. Consult the certifying agency's legal staff on the possibility of posting the amendments on a persistent website that can be referenced within the body of the regulation.

Background

Since *Fragaria* crops are propagated vegetatively, systemic pathogens in mother plants can be spread rapidly to all progeny during the production of nursery stock. Commercial plantings of strawberry that are infected with viruses cannot be cured. However, plants free of targeted viruses can be obtained from infected plants by a combination of heat treatment and shoot tip culture; sometimes inhibitors of virus multiplication are used to reduce virus titer during this process. The only way to remove a virus from a planting or block of nursery plants is by destroying the infected plants and replanting with tested, clean plants in a sanitized site.

Clean stock programs for vegetatively propagated plants rely on several principal components: starting with plants that have been thoroughly tested and found free of targeted pathogens, defined production practices that minimize the risk of re-infection, and quality control to monitor plant health status. Plant production begins with plant material that is free of pests of concern (economically important and/or quarantine pests). This first level of material (G1) is then increased through one or more cycles (G2, G3, G4) to produce sufficient material for commercial production of the crop. G1 plants have the highest level of pest freedom, and each successive generation has its own standards for production and cleanliness. The certifying agency of the state where production of successive generations is carried out is responsible for ensuring that the plants meet the standards for cleanliness at that level.

This model regulatory standard is a systems-based approach for the certification of virus-tested *Fragaria* nursery stock, hereafter referred to in this document as the strawberry certification program. This program includes identification of risks (pathogens and their vectors), the critical control points for management of these risks, and the best management practices such as isolation distances, vector control, pathogen testing, and field inspection to minimize the risk of introduction and spread of the designated pathogens of strawberry. The quality control component ensures that the plant material produced in each generation of the clean stock program meets the rigorously defined standards for that generation. Procedures to determine that

plants are free from pathogens include visual inspection, testing with bio-indicators, and laboratory tests such as serology (ELISA) and/or molecular tests (polymerase chain reaction).

Participation in this program is voluntary. Any nursery stock produced in this program must also meet all other mandatory phytosanitary requirements, and must be maintained in a healthy state. A state or agency can certify strawberry plants for export to a country that has import requirements within the testing and production standards contained in this standard. To qualify for export, the stock must also meet the importing country's requirements for freedom from other regulated pests.

Scope

This standard describes the essential elements of virus-tested certification for strawberry nursery stock, hereafter in this document referred to as the strawberry certification program. Plant pests specifically dealt with in this standard are viruses (excluding those that are not graft transmissible), viroids, phytoplasmas, fastidious bacteria, and their vectors. The regulatory standard does not address other pests, abiotic disorders, or quality grades and standards. Trueness-to-cultivar is not part of this certification program; it is the responsibility of the nurseries. Strawberry plants or parts of these plants may be designated as G1, G2, G3 or G4, if they and the stock from which they were produced have been propagated, inspected, indexed, and tested in accordance with procedures and requirements outlined herein and found to be in compliance with all standards and requirements established here.

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Common Definitions, Abbreviations and Acronyms

APHIS – Animal and Plant Health Inspection Service within the United States Department of Agriculture

Audit – A systematic and independent examination to determine whether an auditee’s activities conform to a set of pre-specified standards of a program

Buffer zone – An area surrounding or adjacent to an area officially delimited for phytosanitary purposes in order to minimize the probability of spread of target pests or diseases into or out of the delimited area, and subject to phytosanitary or other control measures

Certification program – A comprehensive process established and authorized by a state or other governmental entity for virus-indexing and production of strawberry plants intended for further propagation or sale as described in this program. The regulations for each program define the program participation, plant production, plant identification and labeling, and quality assurance requirements.

Certifying agency – The official plant regulatory agency, or any entity approved by the state plant regulatory agency, that performs pathogen certification work as described in this standard

Certified – Having met the requirements and has been approved for certification under this program

Compliance agreement – Any written agreement between a person and a regulatory agency to achieve compliance with any set of requirements being enforced by the agency.

Crop seed –The seed or seedlike fruit of grain, beans, flax, beets, onions, or any other crop whether or not it is intended for planting purposes.

Cultivar – A variety or sub-variety of a plant species that is cultivated for a specific trait(s)

ELISA (Enzyme-Linked ImmunoSorbent Assay) – A serological test in which antibodies are used to detect plant pathogens

Endemic pest –Native (indigenous) pests or pests permanently established in a state.

G1 strawberry plants – A group of plants that have been tested for all viruses and other diseases and are maintained as described in this standard. These plants are used as sources for producing subsequent generations of plants.

G level – Signifies the degree to which plant stock is related to the original pathogen-tested plant material (G1 stock). Regulations developed by certification programs specify the conditions under which each G level must be maintained in order to qualify for the program.

Harmonization- the establishment, recognition and application by different countries or states of phytosanitary measures based on common standards.

Index –To test for systemic disease infection by making a graft with tissue from the plant to be tested to an indicator plant or by other means of inoculation.

Inspection – Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations

Meristem tip culture –Tissue culture in which the meristem tip of a plant is extracted from the shoot and placed in tissue culture

NAPPO – The North American Plant Protection Organization is a regional Plant Protection Organization of the International Plant Protection Convention. NAPPO coordinates the efforts among Canada, the United States and Mexico to protect their plant resources from the entry, establishment and spread of regulated plant pests and diseases, while facilitating intra/interregional trade.

National Clean Plant Network – A national network created to protect U.S. specialty crop agriculture and the environment from the spread of targeted plant diseases and pests that cause economic damage. The enabling legislation requires that the NCPN: (1) produce clean propagative material; and (2) maintain blocks of pathogen-tested material throughout the United States. <http://nationalcleanplantnetwork.org/>

National Berry Crop Certification Board – an 8-10 member board of representatives from traditional and tissue culture nurseries, researchers, and regulatory personnel with responsibility to regularly review and update the requirements and recommendations of the National Standards for Nursery Certification for Caneberry, Blueberry and Strawberry.

NCPN – B – National Clean Plant Network for Berries. A commodity committee of the National Clean Plant Network created to protect U.S. specialty crop agriculture and the environment from the spread of targeted plant diseases and pests of berry crops that cause economic damage.

Pathogen – An organism causing disease. Examples of pathogens include viruses, bacteria, fungi, etc.

Pest – Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products

Pest management plan – A written description of procedures and processes designed to control, suppress or eradicate pest populations to a level that meets the phytosanitary standards of this certification program

PCR (Polymerase Chain Reaction) – A laboratory detection technique for plant pathogens that amplifies a segment of DNA or RNA from the target organism (for example a virus) many times by using short segments of DNA (primers) that are complimentary to the target nucleic acid

Plugs or plug plants – Individual plants that are grown in trays containing large numbers of individual cells

Propagules – Any material that is used for the purpose of propagating an organism to the next stage in their life cycle

Rooted microshoots – Plants in tissue culture that have well-developed root systems

Quarantine – Official confinement of regulated articles for observation and research or for further inspection, testing, and/or treatment

Quarantine pest – A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled

Registered – A plant that has been enrolled in this strawberry certification program and meets all requirements to serve as a source of propagating material for pathogen-tested certified nursery stock, or a block that is enrolled in this program

Regulated pest – A quarantine pest or a regulated non-quarantine pest

Test – Official examination, other than visual, to determine if pests are present or to identify pests. This may include biological indexing, serological or molecular procedures, or any other method approved by the certifying agency.

Tissue culture – General term for the cultivation of plants (cells, tissues, organs) under aseptic conditions *in vitro*. The term also refers to the cultures themselves.

Outline of Requirements

The objectives of this standard are to:

- Prevent the introduction or spread of systemic pathogens in *Fragaria* production systems, and
- Facilitate trade of virus-tested *Fragaria* nursery stock.

This standard outlines the essential elements of a voluntary certification program for managing systemic pathogens and their vectors, achieved through a combination of best management practices and mandatory requirements. It outlines a systems-based approach for minimizing the risk of pathogen introductions associated with the production of *Fragaria* nursery stock. This standard references appendices designed to be maintained by the certifying agency; they contain details and requirements specific to the individual certifying agency's pathogen-tested certification program. The certifying agency will make the appendices available on a persistent website and through contact with the agency.

The certifying agency is not responsible for disease, genetic disorders, trueness to cultivar, failure of performance, or mislabeling in connection with this certification program. No grower, nursery dealer, government official, or other person is authorized to give any expressed or implied warranty, or to accept financial responsibility on behalf of the certification agency.

1. General Requirements

1.1 Regulated Commodities

This program includes the certification of *Fragaria* species that are being grown commercially.

Strawberry plant material may be moved into certification if produced under an official strawberry certification program that has been evaluated using this standard and approved by the certifying agency. The strawberry stock must originate from a recognized domestic pathogen certification program, or a foreign pathogen certification program that is also approved by USDA for import into the United States. The certifying agency must perform an audit inspection as outlined in this standard, including testing samples for the presence of pests listed in the strawberry certification program (Appendix 1). A certifying agency may disapprove a source that it determines could pose a pest risk to the certification system.

If no documentation of the origin or pathogen status of the plant material is available, the certifying agency must prohibit entry of the material into the state pathogen-tested certification program. This material may be submitted to a G1 facility for cleanup, testing and entry into the certification program.

1.2 Program Participation

The facility must be actively enrolled in state nursery registration/certification. The facility must also apply with the certifying agency for participation in this strawberry certification program.

1.3 Strawberry Pests

An exhaustive list of the systemic pathogens of strawberry covered in this program is given in Appendix 1.

The certifying agency has the responsibility to address the pathogen list in Appendix 1, but must adapt the list to reflect high risk pests of current concern in their state or region that are appropriately addressed through this certification program. Any changes to the list will be based on criteria to include:

- Credible published information on pathogen presence or absence in the state or surrounding area
- Patterns of nursery stock movement
- Reasonable testing criteria

1.4 Domestic Movement

Any plant material certified under this program being shipped domestically must include documentation that the shipping nursery maintains active state nursery certification or registration, and that the shipment complies with any applicable laws, regulations, and quarantines of the originating and destination locations. The shipment may also include documentation related to certification under this program, such as a statement declaring: “*State of Production Name* Certified Nursery Stock. The accompanying nursery stock is certified to have been produced in compliance with requirements of pathogen certification of *your state*.”

1.5 Application and Fees

An initial application for participation in the strawberry certification program shall be made on a form prescribed by the certifying agency. An application form template is available in Appendix 2. Upon receipt of the initial application, the certifying agency will begin a dialog with the facility that will result in a cooperative agreement, a pest management plan or compliance agreement, and an initial program entrance review of the facility. By applying, the facility is granting the certifying agency access to all production areas, records, and plant material for audit, inspection and testing purposes.

The certifying agency will establish and post fees for program participation and/or certification-related activities.

Except as otherwise provided, fees charged by the certifying agency for participation in the strawberry certification program are for the sole purpose of defraying expenses incurred by the certifying agency for implementation and documentation procedures provided for in this certification program, and for providing funds to the certifying agency to support appropriate plant pathogen surveys and related research. Payment thereof shall not be construed as granting any right or privilege to the applicant.

2. Specific Requirements

This standard deals specifically with essential elements of a certification program to mitigate the risk of viruses and other systemic pathogens listed in Appendix 1.

This strawberry certification program is carried out by or under the authority of the state certifying agency. The agency will be charged with the administration of program requirements such as terminology, testing, eligibility, nomenclature of certification levels, horticultural management, isolation and sanitation requirements, inspection and re-testing, documentation of test and audit results, identification and labeling of certified plants, quality assurance, noncompliance and corrective measures.

2.1 Program Administration

Responsibility for administration of the strawberry certification program resides with the certifying agency. While the certifying agency has oversight for all aspects of pathogen certification, it may establish a system of approval or accreditation for certification work to be performed by others. The certifying agency employs or accredits administrative, inspection and laboratory diagnostic personnel that have the appropriate training, experience, education and proficiency requirements necessary to implement the strawberry certification program. The agency will maintain records of this information, and allow for transparency of these records to all appropriate parties as allowable by state or federal law. Personnel training and staff responsibilities can be found in Appendix 3 and testing protocols and procedures can be found in Appendix 9. Testing protocols will be posted within the online pathogen database that is proposed for all NCPN specialty crops. Testing protocols will be posted within the online pathogen database that is proposed for all NCPN specialty crops.

Nurseries must submit application and renewal forms to the certifying agency. The nursery must maintain all other documents referenced in this regulation in paper or electronic format. Documents must be formatted to meet all required standards of the certifying agency, and the documents must be available for review by the certifying agency upon request. Nurseries should be aware that other information that is submitted voluntarily to the certifying agency may be subject to Freedom of Information requests.

2.2 Eligibility and Approvals

Eligibility of potential participants is conferred by the certifying agency upon fulfillment of the application process (see section 1.5) if the conditions of this certification program have been met.

All plant material to be enrolled in this certification program, and each site for planting of registered blocks, must be approved by the certifying agency.

2.3 Certification Levels

Certification levels represent a categorical measure of the pathogen-tested status of plants certified under this program. This certification program supports production of stock at certification levels appropriate for international and national commerce (G-levels).

2.3.1 G-level

The G-level, signifies the degree to which plant stock is related to the original, fully tested plant material entering a production system. G-levels represent levels of propagation from the original tested material as described in this standard, and have additional phytosanitary measures applied depending on the G-level. This certification program specifies the conditions under which each

G-level must be maintained in order to qualify for certification at that level, including testing specifications, regular inspections, isolation requirements, and other conditions under which the plants must be grown to prevent (re)infection.

2.3.1a. G1

G1 refers to the original plants that have been tested and found to be free of the systemic pathogens covered by this standard, and subsequently maintained in isolation to prevent (re)infection. G1 also refers to plants produced from the original sources of virus-tested plant material and maintained under equivalent conditions.

Production and maintenance of G1 material must be within a system approved by USDA-APHIS or its designee. All G1 material, whether of domestic or foreign origin, must meet the same testing criteria and requirements.

The certifying agency has the authority to review the systems used by a G1 producer. The certifying agency must approve a G1 producer before any of its G1 material may be accepted into this pathogen-tested certification program. A checklist that functions as a basis for approval can be found in Appendix 4.

2.3.1b G2

G2 plant material is propagated from G1 stock or, in the case of expanding a G2 block, from a G2 plant in the same block, and is maintained under specific conditions to prevent (re)infection. Propagation and maintenance of G2 plantings (including testing) is described in Appendix 5. G2 stock is frequently maintained by nurseries as source material for subsequent cycles of pathogen-tested certified nursery stock. Any vegetatively propagated material used for the production of a G2 plant must originate from G1 plants. G2 plants can be made available to nurseries and other plant improvement facilities for further propagation under restrictions that are specific to this level or may be sold to growers and exit the certification scheme. G2 plants used for further propagation are propagated under conditions appropriate for the G2 level.

2.3.1c G3

G3 plant material is propagated from G1 or G2 stock, or, in the case of expanding a G3 block, from a G3 plant in the same block, and grown in accordance with the propagation and maintenance requirements in Appendix 6. G3 stock is frequently maintained by nurseries to increase the amount of available source material for the production of virus tested certified nursery stock. G3 plants may be sold directly to growers and exit the certification scheme. G3 plants used for further propagation are propagated under conditions appropriate for the G3 level.

2.3.1d G4

G4 stock is commonly grown in certified nursery blocks, and is the material distributed for sale for fruit production. Any vegetatively propagated material used for G4 production shall have originated from a registered G1, G2, or G3 source. Propagation and maintenance (including testing) are described in Appendix 7. G2 plants and G3 plants that are grown for sale for fruit production are considered G4 plants for testing purposes and can only be sold as G4 plants.

2.4 Horticultural Management of Strawberry Plants at All Certification Levels

All plants in the certification program should be kept in good horticultural condition by following recommended horticultural practices for their region.

2.4.1 Screened Greenhouse Plantings

Screened greenhouses/screenhouses must be located, constructed and maintained to minimize the introduction of pathogens transmitted by aerial and soil-borne vectors from the surrounding area. The growing media and containers must introduce no pest risks of concern for this certification program. Overlap between cultivars must be avoided.

Screened greenhouses that are not initially approved may be re-evaluated if the facility undertakes corrective measures as approved by the certifying agency.

2.4.2 Field Plantings

Planting sites must be selected to minimize the introduction of pathogens transmitted by aerial and soil-borne vectors from the surrounding land through drainage, flooding, irrigation, or other means.

G2, G3 and G4 blocks must only be planted on land that has been free from non-certified strawberry plants and other non-certified *Fragaria* species for a time period as specified in Appendices 5, 6 and 7, respectively. G2, G3 and G4 blocks must be planted on land that has been free of known hosts for nematode-transmitted viruses that affect strawberries for a period of time as specified in Appendices 5, 6 or 7, or, alternatively for G4 level blocks, the entire site must be treated prior to planting. Certified nursery blocks must be located a specified distance from any noncertified strawberry plants or strawberry plants at lower certification levels as specified in this standard for their respective G-level.

Sites that are not initially approved may be re-evaluated if the facility undertakes corrective measures as approved by the certifying agency.

Expansion or addition of new material to an existing registered block is possible upon request to the certifying agency. All requirements that must be met for a new block will also be required for expansion of a registered block.

2.4.3 Tissue Culture

Growers may use tissue culture techniques to multiply plants prior to planting them in a screened greenhouse/screenhouse or field if the following conditions are met: (1) the tissue culture facility is approved by the certifying agency and the nursery follows their approved pest management plan, and (2) the tissue culture plants are isolated at all times from other *Fragaria* plants, except those that have been indexed and found to be free of the pathogens specified in this standard, and (3) a representative plant(s) are taken out of tissue culture and established in a greenhouse for at least 12-weeks before testing as described for registered *Fragaria* plants at the equivalent G-level.

2.5 Isolation, Pest Management and Sanitation

2.5.1 Isolation Requirements

The isolation requirements of the certification program will vary according to the certification level and should be based on the biology of the pests and their vectors present in the certification area. Buffer zones are necessary to reduce the chance of infection by pollen-borne and vectored pathogens. Isolation requirements for each G-level can be found in Appendices 4-7.

2.5.2 Sanitation and Pest Management

The participating facilities will produce and implement a pest management plan or enter into a compliance agreement that addresses the measures they apply to prevent systemic pathogen introduction into their certified plantings. A pest management plan is a detailed, written description of procedures or processes designed to eradicate, control, or suppress pest populations to a level that meets this pathogen certification standard (as dictated by regional differences). The pest management plan will address the following critical control points:

- a) source material procurement
- b) site selection processes
- c) production processes

A pest management plan template is available in Appendix 9 and a compliance agreement template in Appendix 10. A facility's pest management plan or compliance agreement must be reviewed and approved by the certifying agency; major revisions to a plan must also be submitted for approval.

General pest management practices, while not directly related to this certification program, may impact the status of the certified material. While the pest management plan or compliance agreement produced under this program specifically deals with the critical control points listed above, the certifying agency has the authority to require any additional practice or documentation it deems necessary for the verification of certification status. All materials should, besides the diseases mentioned here, meet any other pest quarantine requirements as dictated by the certifying agency for the region or state within which the plants are grown.

2.6 Inspection and Testing

Strawberry plants entered in the strawberry certification program will be inspected during the growing season at times appropriate for the detection of disease symptoms and presence of insects or other pest vectors according to accepted survey patterns. Inspection and testing is also required for candidate sites. The inspectors will follow the protocols established in the inspection and testing guidelines maintained in Appendix 9. These guidelines address the following considerations:

- a) frequency and timing of inspection and testing necessary to address perceived risks
- b) sampling and testing procedures
- c) process to be undertaken upon suspicion or confirmation of pest presence

2.7 Documentation, Identification and Tagging

The primary purpose of the records required in this section is to document the pathogen-tested

status and maintain the identity of the material being produced and sold under this program. These records include documentation of plant production and pest management practices to verify that the nursery has implemented the regulations as described for this certification program. All material used in the production of G4-level certified pathogen-tested nursery stock must be traceable to approved G1 through G3 sources.

Records must be kept in a organized manner on the nursery premises and must be made available to inspectors on request. The nursery must maintain records on its premises for a period of time (established by the certifying agency) from the date of propagation for G1, G2, G3 and G4 plants.

2.7.1 Certifying Agency Responsibilities

The certifying agency will document inspection, certification and testing activities undertaken in compliance with this standard to ensure the eligibility and status of the plant material, production sites, participants and all certification levels of the strawberry plants. These documents will be available, upon request, to the USDA or other certifying agencies for audit, trace-out and other regulatory purposes.

2.7.2 Nursery Responsibilities

The nursery must document and identify plants during growth, post-harvest, and at sale to ensure traceability. The facility must maintain records on its premises for a period of time established by the certifying agency, and must update critical records within a time frame agreed upon with the certifying agency. The facility must make these records available to the agency upon request. Record-keeping requirements for each G-level can be found in Appendices 4-9.

2.7.3 Identifying Marks

The certifying agency and the nursery manager must agree upon appropriate labels, tags or signs to properly identify all certification levels of virus-tested material at the facility. The labels must be weather-resistant and must distinguish material grown under the pathogen-tested certification program from non-certified material. Labeling may be by any clearly identifiable unit as described in Appendices 4-7. The nursery manager must notify the certifying agency in advance if the nursery wishes to modify the labeling system. Failure to properly label and identify certified plant material will result in the removal of that material from certification, and may jeopardize the certification status of adjacent material.

2.8 Nursery Evaluation

Nursery evaluations continually monitor and verify the status of the nursery's plant material, records, and administrative procedures to ensure conformity with this certification program. Nursery evaluations determine whether the facility has the resources, infrastructure, and staff in place to successfully implement the procedures outlined for acceptance into this certification program.

The certifying agency will conduct an initial program entrance evaluation upon application. After a nursery has entered into a cooperative agreement, the certifying agency will conduct at least one evaluation per year in addition to the inspections that fulfill the requirements of section

2.6 Inspection and Testing. Any nursery evaluation may include inspection and/or testing of records, plants or sites, especially in reference to ongoing, new, or perceived risks. The certifying agency may adjust the frequency of nursery evaluations as necessary.

2.8.1 Initial Program Entrance and Systems Evaluations

Nursery evaluations are systematic examinations of the organizational structure, procedures, processes, and resources used within the participating nursery to implement this certification program. The objective of a nursery evaluation is to align the nursery's production system, including its pest management plan, with the standards of this certification program.

The initial program entrance and annual nursery evaluations will assess all elements of this program using the checklists in Appendix 10 or certifying agency equivalents.

The annual nursery evaluation will take place at a time agreed to by the certifying agency and the approved facility.

2.8.2 Surveillance Evaluations (Inspections)

Surveillance evaluations supplement the annual nursery evaluations by targeting one aspect of the implementation of the certification program at the nursery. All program requirements defined in section *2.6 Inspection and Testing* may be addressed in surveillance evaluations; additional surveillance evaluations may be performed if deemed necessary by the certifying agency. Surveillance evaluations shall be directed by the certifying agency.

2.9 Non-compliance and Corrective Measures

2.9.1 Non-Compliance

System elements that are not in compliance may be detected by the certifying agency or the nursery. If detected by the certifying agency, the nursery will be informed in writing of the corrective actions required for compliance. The nursery must make corrections promptly, within a timeline at the discretion of the certifying agency. If detected by the nursery, the certifying agency may require notification and/or documentation of any actions the nursery took to correct the non-compliance. Failure to follow the protocol may result in denial of certification status by the certifying agency.

The number and type of non-compliance issues found determine the status of the nursery and the subsequent auditing frequency. Appendix 10 provides guidelines for classification of non-compliance; however, the certifying agency may modify classification in a situation, based on an evaluation of the associated risk and whether the integrity of the certification program has been compromised.

A template for a corrective action request form can be found in Appendix 10. Each corrective action request includes a detailed description of the measures that the certified nursery will implement to prevent recurrences of the non-conformance and a timeframe for completing the corrective actions. Failure to follow the prescribed actions may result in suspension of the nursery from the certification program.

2.9.2 Suspension or Cancellation of Registration

Non-compliance with program requirements may result in cancellation or suspension of the certification status of the nursery, block, or strawberry plants managed by the nursery. The certifying agency will specify the consequences of non-compliance, which may vary depending on the nature and severity of the infraction. The corrective measures to enable a suspended or de-certified participant, production area, or variety to become eligible for reinstatement or re-certification will be determined on a case-by-case basis by the certifying agency.

Registration of the facility may be canceled if pathogen-tested certification claims are misused or misrepresented. Program participation may be suspended if program fees are not paid. Following suspension or cancellation of registration, a facility must re-apply to be evaluated for reinstatement into the virus-tested certification program.

3. Evaluation of External Sources and Cooperation with Other Certifying Agencies

The certifying agency may periodically audit/review approved certification programs to ensure they continue to meet all certification standards and requirements. Detection of targeted systemic pathogens or vectors controlled under this certification program or deficiencies of documentation may indicate that the integrity of the certification system is compromised.

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Appendix 1. Strawberry Pathogen List

All graft-transmissible pests must be considered at the level of importation of plant material into the U.S. or entrance of domestic or foreign material into G1 certification. The list of all known agents for inclusion at that level of virus certification is outside the scope of this document, but is maintained by the Center for Environmental and Regulatory Information Systems (CERIS) located at Purdue University (<http://pest.ceris.purdue.edu/>).

For state-level certification programs, the assumption is that G1 material is free of all graft-transmissible agents, so certification activity should focus on detection of viruses and other graft-transmissible agents (phytoplasmas) that are known to occur in the state and that can spread naturally in the field. Secondly, certification programs may monitor for viruses that occur in the state but are not known to spread naturally, as a means to identify infected source materials entering the certification stream. Finally, the certification agency may incorporate any inspection or testing component required by trading partners. Since inspection and testing of source materials for virus certification is an efficient means of surveillance for exotic invading pests, education on exotic pest detection and occasional survey for such pests is encouraged, although not required and always subject to availability of funds.

A matrix of pests that should be considered in a pathogen-tested strawberry certification program, along with the rationale for inclusion in this program, is provided below (Table 1). Each state may adjust the list and level of surveillance based on the distribution of the pathogen in their state or region (Table 2), the availability of reasonable inspection or testing protocols, and the trading needs of the program. All material should, besides the diseases and pathogens listed here, also be checked for the presence of other pathogens, which can be transmitted on propagation material.

Table 1. List of viruses, bacteria and phytoplasma of concern and acceptable diagnostic tests.

Pathogen	Acceptable diagnostic assays		
	Indicator	Herbaceous hosts ^a	Laboratory assays
<i>Virus</i>			
Apple mosaic	<i>Fragaria vesca</i>	A, B, C	ELISA, RT-PCR
Arabis mosaic		A, B, C	ELISA, RT-PCR
Beet pseudo-yellows	UC 10/11		RT-PCR
Cucumber mosaic		B, C	ELISA, RT-PCR
<i>Fragaria chiloensis</i> latent			ELISA, RT-PCR
Raspberry ringspot		B, C	ELISA, RT-PCR
Strawberry chlorotic fleck	UC 4/5/Alpine		RT-PCR
Strawberry crinkle	UC 4/5/Alpine		RT-PCR
Strawberry latent C	UC 5, <i>F. vesca</i> ‘EMC’		
Strawberry latent ringspot		B, C	ELISA, RT-PCR
Strawberry leaf curl	UC 4/5/Alpine		PCR
Strawberry mild yellow edge	UC 4/5/Alpine		ELISA, RT-PCR
Strawberry mottle	UC 4/5/Alpine		RT-PCR
Strawberry necrotic shock	<i>F. vesca</i>	B	ELISA, RT-PCR
Strawberry pallidosis	UC 10/11		RT-PCR
Strawberry polerovirus 1			RT-PCR
Strawberry pseudo mild	UC 4/5/Alpine		

yellow edge

Strawberry vein banding	UC 4/5/Alpine		PCR
Tobacco necrosis D		B	ELISA, RT-PCR
Tobacco streak	<i>F. vesca</i>	B	ELISA, RT-PCR
Tomato black ring		B, C	ELISA, RT-PCR
Tomato ringspot		A, B, C	ELISA, RT-PCR
Phytoplasmas			PCR
Green petal			
Aster yellows			
Witches broom			
Marginal chlorosis			

^a Herbaceous hosts: A = Cucumber Straight 8; B = *Chenopodium quinoa*; C = *Chenopodium amaranticolor*.

Table 2. Viruses detected in major strawberry production areas of the United States and Canada (Data from Martin, R.R., and I.E. Tzanetakis, 2013, Plant Disease 97(10), 1358-1362).

Virus	Symptomless plants (CA)	Declining plants (CA)	Pacific Northwest	Midwest	Southeast ^a	Northeast ^a
Apple mosaic	0/104	0/24	0/90	0/52	0/67	0/34
Beet pseudo-yellows	6/104	15/24	0/90	2/52	6/67	13/72
Fragaria chiloensis latent	0/104	0/24	0/90	5/52	0/67	0/34
Strawberry chlorotic fleck	0/104	0/24	0/90	0/52	0/67	0/34
Strawberry crinkle	7/104	5/24	33/90	3/52	2/122	0/72
Strawberry mottle	8/104	6/24	62/90	6/52	64/122	36/72
Strawberry mild yellow edge	12/104	8/24	48/90	2/52	48/122	49/72
Strawberry necrotic shock	5/104	0/24	3/90	1/52	1/122	1/72
Strawberry pallidosis	11/104	18/24	1/90	19/52	13/67	7/72
Strawberry veinbanding	11/104	4/24	43/90	3/52	2/122	1/72

^a Viruses with a greater number of assays completed were due to sampling in autumn 2012 in response to plant decline in Nova Scotia and fruiting fields in the southeast.

Appendix 2: Pathogen-Tested Certification Program Application Form Templates

1. Initial Application for Participation

Instructions:

This application must be completed and signed by a designated representative of the applying nursery. The signature indicates that the nursery understands and is willing and able to comply with the requirements of this program including, but not limited to:

- Granting the certifying agency access to all production areas, records, and plant materials for audit, inspection, and testing purposes;
- Developing and implementing a written pest management plan that fulfills all requirements specified by the program;
- Providing maps of the geographic location of blocks, and planting records that indicate the location of plants under consideration for registration;
- Maintaining all documentation, identification and tagging requirements of the program.

Upon receipt of the signed application, the certifying agency will enter into a dialog with the applying nursery. During this dialog, the certifying agency will conduct an initial program entrance review of the nursery. The review consists of a systems evaluation of the nursery facility, the development of a written pest management plan, and the confirmation of a cooperative agreement between the certifying agency and the nursery.

Please return application form to:

Nursery Certification Officer
Certifying Agency Address

Application for year _____

Business Name	Certification Manager
Street Address	City, State, Zip
Phone Fax	E-mail
Alternative Nursery Representative Name Title	Street Address City, State, Zip

Phone	
E-mail	
Signature, Authorized Nursery Representative	

<i>Regulatory Review and Approval</i>	<i>Department Use Only</i>
Initial program entrance review completed	Signature of certifying agency representative Date
<input type="checkbox"/> Approved for participation	Signature of certifying agency representative Date
<input type="checkbox"/> Not approved	Signature of certifying agency representative Date
Comments:	

2. Annual Continuation of Participation and Notification of Changes

Instructions:

This completed form must be signed by an authorized representative of the participating nursery. The signature indicates that any changes made to specific requirements of the pathogen-tested certification program have been reported to the certifying agency. The certifying agency will follow-up with the primary nursery contact to gather information and record the changes. By completing this form and cooperating with the updating process, participation in the pathogen-tested certification program is continued for another year. If you wish to withdraw from the program, you must notify the certifying agency in writing.

Check those that apply.

Have there been CHANGES:

- In nursery personnel who are responsible parties in the administration of the pathogen-tested certification program? *Please use the form on the back to record personnel changes, attach additional pages if needed.*
- To locations and/or planting records of certified sites that require changes to maps?
- To identification and tagging methods?
- To the production or procurement processes listed in the Pest Management Plan?
- To best management practices or standard operating procedures, or any other change affecting the nursery's Pest Management Plan?
- There have been NO CHANGES in the year 20__.

Please return renewal form to:

Certification Officer

Appendix 3 – Certifying Agency Personnel Training and Staff Responsibilities

1. Certifying Official

The Certifying Official is an employee of the certifying agency vested with the authority and responsibility to approve facilities that meet the requirements of this certification program and approve or reject plantings/stock enrolled in certification. The Certifying Official may designate qualified personnel to assist in the implementation of different components of the program such as audit, inspection, sampling, or testing of nursery stock. The Certifying Official may only delegate those tasks for which there is a trained, competent, and qualified individual available.

2. Training

The certifying agency should maintain training records for those working with the program including, but not limited to:

- Training in program regulations
- Training in field programs and field safety
- Training in laboratory programs and lab safety

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Appendix 4. G1 Propagation and Maintenance

G1 strawberry plants are the foundation of the clean stock program, where each plant has tested negative for all the pathogens listed in Appendix 1 according to approved methods. All G1 material, whether of domestic or foreign origin, will meet the same testing criteria and requirements. Production and maintenance of G1 material must be within a system approved by the certifying official. These plants must be maintained in an approved facility in a protected environment in a prescribed manner to minimize the possibility of infection.

1. Source Material

A candidate plant must be tested twice following establishment for pathogens on the National *Fragaria* Certification Pathogen List (Appendix 1) and found to be free of these pathogens before they can be designated as G1 plants. Until fully tested, these candidate plants must be held separately from other G1 plants. Plants must be held as designated below in order to maintain G1 status.

Plants propagated in a screened greenhouse from existing G1 block plants will be eligible for planting in the same G1 block. Newly established G1 blocks must be completely tested for pathogens listed in the National *Fragaria* Certification Pathogen List (Appendix 1) prior to entry into the program. All plants in G1 blocks must be tested at least every two years for viruses and other pathogens that are listed in the National *Fragaria* Certification Pathogen List (Appendix 1).

The state certifying agency or their designee has the authority to review the systems used by a G1 producer. The state certifying agency or their designee must approve a G1 producer before any of its G1 material may be accepted into the state's virus-tested certification program.

2. Location Requirements

- G1 plants must be grown in a screenhouse/screened greenhouse that has been inspected and approved for this purpose.
- The screened greenhouse housing G1 plants must be designed and constructed to preclude pressure from virus-vectoring arthropods and nematodes and should:
 - Have a double door to the outside;
 - Have screens of a mesh size that will prevent entry of thrips (mesh size of 0.037 inches or smaller);
 - Have a footbath or other approved method at entry points to the screened greenhouse to prevent introduction of soil-borne contaminants. The disinfectant in footbaths must be changed regularly;
- Contain only G1 plants. Candidate G1 plants must be housed separately;
- Have lockable doors with restricted access (recommended);
- Have floors kept clean, free of debris, soil and weeds;
- Have appropriately labeled greenhouse compartments to indicate status of material;
- Have a system to provide positive air pressure to entry points to screened greenhouses to minimize entry of insects and pathogens (recommended);

- Be constructed to avoid direct contact of plants with the soil;
- Have an uncontaminated water supply or effectively decontaminated water supply;
- Be surrounded by a 10-foot zone free of undesirable (non-cultivated) plants and weeds around the entire perimeter, which may serve as sources for virus or virus vectors.
- Equipment used in the propagation and maintenance of G1 stock must be dedicated or effectively sanitized prior to usage within the G1 material.
- Every plant in the registered G1 block(s) must bear permanent individual identification.
- Roadways, receiving areas, media and container storage facilities, propagation, production, and shipping areas and parking areas should be constructed and maintained in such a way that minimizes contact with soil.

3. Maintenance Requirements

G1 plants must be maintained in a greenhouse/screened greenhouse in an approved manner.

Maintenance requirements for G1 blocks are:

- Disinfection of materials, hands, and tools before each operation.
- Workers must start with the blocks that have the most stringent certification level requirements and proceed downwards through the lower levels.
- Use of soil- media, new or sterilized.
- Use of new or disinfected packaging material for transporting plants.
- Cultivars or clones should be clearly separated from each other.
- Recommended horticultural practices should be used to maintain health and vigor of G1 plantings.
- Regular, sustained pest monitoring and control (including pathogens, arthropods and weeds).
- Removal of flowers before opening.
- Avoidance of splashing water during watering (recommended).

4. Inspection, Testing, and Labeling

4.1 Inspection Requirements

Each registered G1 plant must be visually inspected by the certifying agency at least twice annually; once in the spring during rapid growth of the plants, and once at another season of the year. Any off-type, diseased, or unusual growth must be recorded and investigated to assure no issues related to the certification program are apparent.

4.2 Testing Requirements

To be eligible for G1 block status and maintaining that status, each G1 plant must be tested at least every two years at the specified times and have been found free of all organisms specified in the National *Fragaria* Certification Pathogen List (Appendix 1).

4.3 Labeling and Mapping Requirements

Each individual G1 plant must be labeled with the cultivar name, and a unique number that corresponds to a written record for this plant. The nursery must provide a map or GPS coordinates showing the location of the G1 plants within the nursery.

5. Recordkeeping Requirements:

Records must include:

- An inventory of all registered plants in the G1 blocks. See Appendix 12 for suggested format for record keeping.
- A list of all plants removed from the G1 block or from registration including the specific row and plant location and reason for the removal.
- Records showing that tests and inspections have been completed in accordance with the provisions of this standard.
- An inventory showing all of the G2 stock that was distributed from the G1 block. The report shall include the names and addresses of recipients, quantity shipped, date, cultivar, and clone or selection number of the G1 source plants, and should be retained for at least 2-years.
- Records documenting fumigation, treatments and tests for G1 blocks must be kept for at least 2-years or as required by state law and made available upon request.

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Appendix 5 – G2 Propagation and Maintenance

G2 plant material is propagated from G1 stock or, in the case of expanding a G2 block, from a G2 plant in the same block, and is maintained under specific conditions to prevent (re)infection.

1. Source Material

Only stock material from G1 sources approved by the certifying agency will be eligible in certified G2 blocks. Prior to planting new material in a certified G2 block, the nursery shall provide the certifying agency with a list of plants to be introduced, bearing the botanical (genus and species) and common names and cultivar identities of the plants. The nursery must maintain records of origin of source materials used in the establishment or expansion of a G2 block for the life of the block.

1.1 Candidate G2 plants

Candidate plants would only be propagated as a specific agreement between the approving agency, Clean Plant Center, the breeder and nursery, and such an agreement would be done on a case-by-case basis. The certifying agency may approve planting of “Candidate G2 plants” under the following special provisions:

- A candidate G1 plant may be identified but not yet eligible for G1 status pending official testing results.
- In the period that virus testing is ongoing, propagation material may be taken from the candidate G1 plant and propagated in tissue culture after agreement by the approving agency, with consultation of the certification agency and the nursery.
- If, at the end of testing, the candidate G1 plant qualifies for G1 status, all progeny plants produced from it are also immediately qualified as G2.
- If the candidate G1 plant is found to be infected with a target pathogen during the completion of the testing program, all G2 plants derived from the candidate G1 plant will be removed from the certification program.

2. Location Requirements

G2 material may be maintained in tissue culture or screenhouse/screened greenhouse as long as all specified conditions are met.

2.1 General requirements

- G2 stock maintained in a screenhouse/screened greenhouse must be tested at least every 3-years and G2 stock maintained in field plantings must be tested every year for viruses that are known to spread in the geographic region where the nursery is located (see Appendix 1).
- Appropriate measures and precautions must be taken to prevent the presence of virus vectors in greenhouse/screened greenhouse culture of G2 stock and in field plantings of G2 stock.
- Screenhouses/screened greenhouses must be isolated from field plantings to minimize the risk of introducing pollen and virus-vectoring organisms. Planting media must be free of soil-borne vectors of plant viruses. Tools and supplies must be maintained in a way to

prevent mechanical transmission of pathogens into the certified material from uncertified materials.

- G2 field plantings must be isolated from non-certified or lower certification level *Fragaria* species by a buffer zone. G2 field plantings must be free from soil-borne vectors of plant viruses prior to planting. Tools and supplies must be maintained in a way to prevent mechanical transmission of pathogens into the certified material from uncertified materials.
- The selected field planting site plus a buffer zone must be on land that has not been used for growing non-certified strawberry species for at least the last season. The selected planting site plus a buffer zone must be on land that has not had plants such as potatoes, tomatoes, or other solanaceous plants (known hosts of viruses that infect strawberry) within the last 2-years. The land must be treated with an approved method to eliminate soil-borne vectors within 1-year prior to planting.
- Non-certified strawberry plants or less stringent G level plants must not exist within the G2 level screenhouse/screened greenhouse or field planting.

2.2 Buffer Zones

- Undesirable (non-cultivated) weeds must be controlled within 10 feet of the perimeter of the G2 screenhouse/screened greenhouse.
- Undesirable (non-cultivated) weeds must be controlled within at least 10-ft of the perimeter of the G2 field planting.
- Non-certified *Fragaria* species may not be grown within at least 650-ft of the G2 field planting.

3. Maintenance Requirements

- In screenhouses/screened greenhouses or field plantings, G2 plants shall be labeled with cultivar name and lot number (if applicable).
- Flowering must be prevented by removing blossoms before they open.
- Planting media or soil beds must be free of pathogens.
- Recommended horticultural practices should be followed to maintain the health and vigor of G2 blocks.
- Regular, sustained pest monitoring (including pathogens, arthropods and weeds) should be conducted within screenhouses/screened greenhouses or field plantings (including buffer zones), and appropriate control measures must be applied as described in the nursery's pest management plan.

4. Inspection, Testing, and Labeling

4.1 Inspection Requirements

Each registered G2 plant must be visually inspected by the certifying agency at least twice annually; once in the spring during rapid growth of the plants, and once at another season of the year. Any off-type, diseased, or unusual growth must be recorded and investigated to assure no issues related to the certification program are apparent.

4.2 Testing Requirements

To be eligible for G2 block status and maintaining that status, each G2 clone must be tested at the prescribed times and manner and have been found free of the organisms in the National Strawberry Certification Pathogen List (Appendix1) that are present and spread in the area of production.

4.3 Labeling and Mapping Requirements

Each individual G2 clone must be labeled with the variety name, and a unique number that corresponds to a written record for this plant. The nursery must provide a map or GPS coordinates showing the location of the G2 plants within the nursery.

5. Recordkeeping Requirements

Records must include:

- An inventory of all registered plants in the G2 blocks. See Appendix 12 for suggested format for record keeping.
- A list of all plants removed from the G2 block or from registration including the specific row and plant location and reason for the removal.
- Records showing that tests and inspections have been completed in accordance with the provisions of this standard.
- An inventory showing all of the G3 stock that was distributed from the G2 block. The report shall include the names and addresses of recipients, quantity shipped, date, cultivar, and clone or selection number of the G1 source plants, and should be retained for at least 2-years from the time of propagation.
- Records documenting fumigation, treatments and tests for G2 blocks must be kept for at least 2-years from date of application or as required by state law and made available upon request.

Appendix 6 – G3 Propagation and Maintenance

1. Source Material

G3 plant material is propagated from G1 or G2 stock and is maintained under conditions specified in this standard for G3 stock to prevent (re)infection.

2. Location Requirements

G3 stock may be maintained in screenhouse/screened greenhouse, or in the field. The guidelines for maintaining G3 stock in a screenhouse/screened greenhouse are the same as those for G2 plant material (see Appendix 5).

2.1 General requirements

G3 stock may be grown and maintained in the field under the following conditions:

- Field plantings must be isolated from non-certified strawberry plantings or separated from blocks of strawberry stock at lower G levels to minimize the risk of introducing virus through pollen and virus vectoring organisms.
- Planting sites must be selected to minimize the introduction of soil-borne viruses from the surrounding land via soil-borne vectors through drainage, flooding, irrigation or other means;
- Planting sites must be treated for soil-borne vectors by an approved method within one year prior of planting;
- The selected planting site, including a 30-foot buffer zone, must be on land that has not been used for growing non-certified strawberry species for at least the last season. The selected planting site plus a 30-foot buffer zone must be on land that has not had plants such as potatoes, tomatoes, or other solanaceous plants (known hosts of viruses that infect strawberry) within the last 2-years.
- Weeds within the planting site and the buffer zone must be controlled using an approved.
- G3 stock maintained in the field must be tested every year for the most common viruses known to spread in the geographic region where the nursery is located (Appendix 1 and 11).
- The facility must notify the certifying agency in writing prior to relocating a G3 block for any reason.

2.2 Buffer Zones

- G3 field plantings must be separated from non-certified strawberry plantings or plantings certified at a less stringent level by a distance of at least 30 feet.
- The ground in and around G3 field plantings shall be kept either clean cultivated for an isolation distance of 30 feet.

3. Maintenance Requirements

- G3 field blocks shall be planted and maintained in a manner, and/or at sufficient distances, so that roots runners of different blocks do not intermingle.

- Flowering should be prevented. Blossoms must be removed before they open.
- Recommended horticultural practices should be followed to maintain the health and vigor of G3 blocks.
- Regular, sustained pest monitoring (including pathogens, insects and weeds) should be conducted in field blocks (including buffer zones), and appropriate control measures should be applied as described in the nursery's pest management plan.

4. Inspection, Testing, and Labeling

4.1 Inspection Requirements

Each registered G3 block must be visually inspected by the certifying agency at least twice annually; once in the spring during rapid growth of the plants, and once at another season of the year. Any off-type, diseased, or unusual growth must be recorded and investigated to assure no issues related to the certification program are apparent.

4.2 Testing Requirements

To be eligible for G3 block status and maintaining that status, G3 blocks must be tested at the prescribed times and manner and have been found free of the most common organisms in the National Strawberry Certification Pathogen List (Appendix 1 and 11) that are present and spread in the area of production.

4.3 Labeling and Mapping Requirements

Each G3 nursery block must be labeled with the variety name, and a unique number that corresponds to a written record for this nursery block. The nursery must provide a map or GPS coordinates showing the location of the G3 plants within the nursery.

5. Recordkeeping Requirements

Records must include:

- An inventory of all registered plants in the G3 blocks. See Appendix 12 for suggested format for record keeping.
- A list of all plants removed from each G3 block with date and reason for the removal.
- Records showing that tests and inspections have been completed in accordance with the provisions of this Standard.
- An inventory showing all of the G3 or G4 stock that was distributed from the G3 block. The report shall include the names and addresses of recipients, quantity shipped, date, and cultivar, and should be retained for at least 2-years from the time of propagation.
- Records documenting fumigation, treatments and tests for G3 blocks must be kept for at least 2-years or as required by state law from date of application and made available upon request.

Appendix 7 – G4 Propagation and Maintenance

1. Source Material

- Only stock material from G1, G2 or G3 sources approved by the certifying agency will be eligible for planting in certified G4 blocks.
- The nursery shall maintain a list of plants in the G4 block including the source of plants and the common names and cultivar identities of the plants.
- If G1, G2, G3 stock for use in G4 production is being supplied by a third party, the nursery must provide documentation from the third party's certifying agency that supports the certification status for all source material obtained.

2. Location Requirements

2.1 General requirements

- The site should be isolated from uncertified *Fragaria* species (including wild species) by at least 30-feet.
- The selected planting site, including a buffer zone, must be on land that has not been used for growing non-certified strawberry species for at least the last season. The selected planting site plus a buffer zone must be on land that has not had plants such as potatoes, tomatoes, or other solanaceous plants (known hosts of viruses that infect strawberry) within the last 2-years.
- Weeds must be controlled within the site and a 10-foot buffer zone. Clean cropping is an option.
- Planting sites must be selected to minimize the introduction of soil-borne vectors and pathogens from the surrounding land through drainage, flooding, irrigation or other means;
- The soil should be tested for soil-borne vectors and, if necessary, treated using an approved method within 1-year prior to planting.

2.2 Buffer Zones

- G4 field blocks shall be separated by 30-feet from all non-certified *Fragaria* species.
- For G4 field blocks, the ground ~~in and~~ around a G4 block shall be kept clean-cultivated (recommended) or weeds controlled for an isolation distance of at least 10 feet.
- G4 field blocks shall be planted and maintained in a manner, and/or at sufficient distances, so that runners of different cultivars do not intermingle.

3. Maintenance Requirements

- Recommended horticultural practices should be followed to maintain the health and vigor of G4 blocks.
- Regular, sustained pest monitoring (including pathogens, insects and weeds) should be conducted, and appropriate control measures should be applied.

4. Inspection and Testing

4.1 Inspection Requirements

Each registered G4 block must be visually inspected by the certifying agency at least twice annually; once in the spring during rapid growth of the plants, and once at another season of the year. Any off-type, diseased, or unusual growth must be recorded and investigated to assure no issues related to the certification program are apparent.

4.2 Testing Requirements

To be eligible for G4 status, G4 blocks must be tested at the prescribed times and manner and have been found free of the most common organisms in the National Strawberry Certification Pathogen List (Appendix 1 and 11) that are present and spread in the area of production.

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Appendix 8- Transferring Plants Between Facilities

1. Requirements

To transfer plants between different facilities both growers must agree to meet the requirements listed in the standard for each G-Level. If both growers do not meet these requirements then the plants will be moved to a lower certification level or will become uncertified stock.

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Appendix 9. Pest Management Plan: Nursery Sanitation and Pest Management

1. General considerations

The participating facilities will produce and implement a pest management plan that addresses the measures they apply to prevent pathogen introduction into their certified plantings. A pest management plan is a written description of procedures or processes designed to eradicate, control, or suppress pest populations to a level that meets this pathogen-certification standard.

Just as the risk of certain viruses varies due to geographical differences affecting vectors and conditions of virus transmission, so too will each facility's pest management plan vary due to regional differences. A facility's pest management plan will include procedures for the removal and destruction of plants that are diseased or deemed at risk by the certifying agency. A pest management plan must be reviewed and approved by the certifying agency; major revisions to a plan must also be submitted for approval.

General pest management practices, while not directly related to this pathogen-tested certification program, may impact the status of the certified material. While the pest management plan produced under this program specifically deals with the critical control points listed above, the certifying agency has the authority to require any additional practice or documentation it deems necessary for the verification of certification status.

2. Pest Management Plan

The pest management plan will address the following critical control points and describe the best management practices and standard operation procedures that will be employed to meet the standard:

2.1 Source material procurement

This section must include a flow diagram or written description of the nursery's procurement process for incoming nursery stock of the listed genera for inclusion in this certification program. For auditing purposes, the auditor will need to access original records from the procurement process. Original records may differ depending upon the G-level of the nursery stock. However, to protect potential confidential business information, a summary of the procurement process is adequate for purposes of the pest management manual.

The points that must be addressed for this critical control point include:

- Selection procedures for the source of stock for inclusion in the program and anticipated certification level.
- The system used to track stock of different certification levels as they are received until planting.
- Tracking of certified material of the listed genera in the establishment to maintain identity through production, packing, and distribution of certified stock to customers.

2.2 Site selection process for plantings registered in the certification program

The certifying agency must approve each site prior to planting. The following factors will be considered in the site review process and must be addressed or the information included in the pest management plan.

The points that must be addressed for this critical control point include:

- Site drainage evaluation
- History of previous crops
- Isolation distances from non-certified plants in the same genus, including commercial and landscape plantings
- Presence and management of soil-borne nematode vectors

2.3 Production processes (including propagation) for nursery stock

This section must include a flow diagram or written description of the nursery's production processes for the listed genera. This section must address measures to prevent introduction of viruses into the certified material. For auditing purposes, the auditor may need access to original records of the production processes.

The points that must be addressed for this critical control point include:

- Weed control program
- Movement of tools, equipment, and personnel among registered plantings
- Movement of soil, insect and nematode vectors, pollen, or virus itself via mechanical transmission

2.4 Additional potential pathways

Each nursery may identify additional potential pathways in the procurement or production processes where virus could be introduced. Each additional potential pathway should be noted in the pest management plan and best management practices or standard operating procedures to address the pathway should be included in the pest management plan.

3. Visual Inspection of Plants

3.1 Procedure

Procedure for inspecting strawberry stock in the greenhouse/screened greenhouse or field:

- The grower will regularly inspect plants. All plants that are symptomatic will be removed and destroyed. The grower must keep a logbook recording the cultivar and number of plants destroyed and reason for plant removal.
- The certifying agency will do at least 2 inspection(s) during the growing period when the plants are likely to express symptoms of infection by the pathogens covered in this standard.
- All plants that are exhibiting symptoms will be flagged by the certifying agency, and samples will be taken and tested if symptoms are suggestive of virus infection. If sampled plants are infected, this will trigger additional testing by the certifying agency. The grower will remove all flagged plants immediately after inspection.
- All plants will be inspected by the certifying agency for insect vectors; if found, the certifying agency will notify the nursery of the need for a pest management treatment.

- The certifying agency may conduct additional inspections.

3.2 Potential reasons for inspection refusal or suspension

- Planting is in such poor condition that an adequate inspection cannot be made.
- Previously condemned plants have not been destroyed.
- Plants are not grown under conditions specified in this standard (for example inadequate isolation distances from non-certified strawberry plants, broad-leaf weeds not controlled, plants are flowering, etc.).
- Other reasons as determined by the certifying agency (e.g, safety issues, re-entry intervals, etc.).

INSERT- template for a corrective action request form

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Appendix 10. Sampling and Diagnostic Procedures for Strawberry Certification

1. Sampling procedure

- Samples must be identified in a manner that enables trace-back to the specific block, clone, or plant from which they were collected.
- Samples must be collected by the certifying agency in a manner that assures appropriate chain of custody from the nursery to the laboratory and traceability to the individual plant or clone in the screenhouse/screened greenhouse or field.
- Samples must be protected during collection, transport, and storage from conditions that might interfere with pathogen detection or sample integrity, and sent as soon as possible to an officially approved laboratory for analysis.

2. Diagnostic Tests for Strawberry Pathogens

Appropriate tests for strawberry pathogens include the following:

- Herbaceous Indexing
- Graft Indexing
- ELISA
- PCR

3. Testing Schedule Based on G-Level

G Level	Culture type	Schedule for testing	# plants tested	% plants tested	Pathogen tests	Time of testing
G1 ^a	SH/SGH	At least every 2-years	All	100%	All on pathogen list (Appendix 1)	Varies depending upon pathogen
G2 ^b	SH/SGH Field	Twice Annually, Clones must be tested every 3-years	All	100%	All pathogens on list that are present in the region of production	Once during the spring when rapid growth occurs, once during another season.
G3	Field	Twice Annually	Varies ^c	95% confidence level for 1% disease incidence	All pathogens on list that are present in the region of production	Once during the spring when rapid growth occurs, once during another season.
G4	Field	Twice Annually	Varies ^c	95% confidence level for 5% disease incidence	Canary viruses	Once during the spring when rapid growth occurs, once during another season.

^a G1 plants must be tested at least every other year for all listed pathogens in Appendix 1.

^b G2 clones must be tested every 3-yr for all common pathogens in the region if in a screenhouse or greenhouse; if in the field, they must be tested every year. For each clone, a minimum of 2% of the plants must be tested annually.

^c G3 and G4 blocks must be tested annually for the most common virus(es) in the region. The total number of samples collected for testing will be done according to the ISPM No. 31 (Table 1, p. 16) at the detection rate specified in the table. Minimum number of samples collected for 95% and 99% confidence levels will vary according to lot size and hypergeometric distribution.

Example 1: G4 at 95% confidence level for 5% infection if samples from 5 plants can be bulked for ELISA tests:

- 10,000 plants will require 59 samples, and with bulking of samples, 12 ELISA tests.
- 1,000 plants will require 57 samples, and with bulking of samples, 12 ELISA tests.
- 100 plants will require 45 samples, and with bulking of samples, 9 ELISA tests.

Example 2: G3 at 95% confidence level for 1% infection:

- 10,000 plants will require 294 samples, and with bulking of samples, 59 ELISA tests
- 1000 plants will require 258 samples, and with bulking of samples, 52 ELISA tests
- 100 plants will require 95 samples, and with bulking of samples, 19 ELISA test

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Appendix 11: Nursery Field Map and Inventory List Guidelines

There are many formats that convey all the necessary information. These can be legibly hand-drawn, computer generated, or entered into a software program for nursery inventory management.

1. For field maps include

- Field location and orientation
- Nearby roads and adjacent fields (for orientation)
- Grounds maintained (mowed, weeds removed, clean cultivated)
- Rows labeled
- GPS Coordinates (Recommended)

2. For inventory lists include

- New plants added
- Quantity of plants in each cultivar
- Row length or bed sizes
- GPS Coordinates (Recommended)

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Appendix 12. Nursery Evaluation Checklists and Forms

Nurseries should be able to see and use the nursery evaluation checklist themselves, to make sure they are prepared for a nursery evaluation.

- Records indicating botanical (genus and species) and cultivar names, certification level, date of introduction of stock to the facility, field name, nursery row planting and accession number. Facilities are encouraged to develop systems that would allow identification of sources for strawberry plants that would trace back to individual source plants, or smaller groups of plants.
- Copies of certification of virus-testing received with incoming plant material.
- Data collected from monitoring, control or eradication of disease and surveillance activities and dates.
- The facility's written pest management plan or compliance agreement and any records generated through implementation of the plan.
- Maps or planting records of the facility indicating the geographical location of blocks, and the location of certified strawberry plants within the blocks. Guidance on the creation of facility maps is located in.
- Records of sale and purchaser's identity, for all wholesale or commercial sales.
- Records maintained for other regulatory purposes (e.g. general phytosanitary documents, pesticide records) must be available for inspection and audit if the certifying agency deems it necessary to ensure pathogen status of material.

Appendix 13. Aspects of virus transmission to strawberries from internal or external sources in the nursery setting

Virus	Vector	Vector movement	Seed transmission	Transmitted by pollen	Alternate hosts
Arabis Mosaic	Nematode	In the soil, on machinery	Yes	Possibly for hops	Hops, Raspberry, <i>Vitis</i> spp.
Raspberry Ringspot	Nematode	In the soil, on machinery	Yes	Yes	Cherries, Gooseberries, Grapes
Strawberry Latent Ringspot	Nematode	In the soil, on machinery	Yes	Yes	Raspberries blackberries, black currants, red currants, cherries, grapes, plums, peaches
Tobacco ringspot	Nematode	In the soil, on machinery	Yes, in many weed and crop hosts	Yes, to seed in some hosts	Many alternate weed and crop hosts such as dandelion, grapes, etc.
Tomato ringspot	Nematode	In the soil, on machinery	Yes, in many weed and crop hosts	Yes, to seed in some hosts	Many alternate weed and crop hosts such as dandelion, grapes, cherries, etc.
Strawberry Crinkle	Aphid	Aerial	No	No evidence for	Some wild strawberry species
Strawberry Mottle	Aphid	Aerial	No	No	Some wild strawberry species
Strawberry Mild Yellow Edge	Aphid	Aerial	No	No	Some wild strawberry species
Strawberry Vein Banding	Aphid	Aerial	No	No	Some wild strawberry species
Strawberry pallidosis	Aphid	Aerial	No		Some wild strawberry species
Strawberry polerovirus I	Unknown	Unknown	Unknown		Some wild strawberry species
Strawberry Latent C	Aphid	Aerial, Grafted	No	No	Some Weeds

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