with additional skills and greater familiarity with market factors than would otherwise be the case in traditional classroom information delivery. Industry representatives were also impressed with the caliber of students from this class, particularly after answering the student's questions during laboratory tours. By the end of the school year, more than 20% of the students were hired as industry growers.

In summary, the use of a case study such as the Floratech Dilemma yielded positive results from the students, creating a more interactive educational setting. This developed the student's problem-solving skills to complement the knowledge derived from traditional production class education.

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Cultivar Trial Setup: A Case Study for Potted Plant Production Specialists

Neil O. Anderson

ADDITIONAL INDEX WORDS. *Cyclamen*, floriculture, *Primula*, teaching methodology

SUMMARY. A case study is presented for use as an active learning tool for students in a floriculture potted plant production class. This is the second case study developed for Floratech, a potted plant finisher. Students work together in small groups to solve the proposed problems; each student role-plays as a Potted Plant Production Specialist. A memorandum from the Board of Directors is delivered in their first month on the job at Floratech. Objectives of this case study are to determine the students' fluency in terminology and crop-specific cultural requirements for potted plant production of cyclamen (*Cyclamen persicum*) and primrose (*Primula* sp.) as well as their ability to setup a scientifically rigorous and unbiased cultivar trial for Floratech personnel and selected customers. Students research the latest commercial catalogs to determine which species, series, and cultivars are available, as well as their relative merits, prior to choosing the appropriate cultivars to include in the trial. The trial setup has a space limitation of 2,000 ft² (186 m²). This case study was tested with 20 undergraduate students during Fall Semester 1999. The case study demonstrated the students' fluency with terminology and crop-specific cultural requirements for both crops. Their ability to set up a scientifically rigorous trial varied widely, often with an inadequate sampling of cultivars and excessive replications (56 ± 37 cyclamen to 132 ± 65 primrose). A mean ± SD of 4 ± 1 cyclamen and 7 ± 3 primrose series were chosen. The

number of cultivars varied from 6 ± 2 cyclamen to 9 ± 4 primrose and the number of distributors was similar for the crops. Trial design and additional questions raised by the case study were discussed in class and applied in a cultivar trial in the lab. Unanswered questions were used as learning opportunities during class tours with local growers.

Almost half (49.1%) of large floriculture greenhouse operations in the U.S. (≥\$100,000 wholesale) produce flowering potted plants (USDA, 1999). After bedding/garden plants, flowering potted plants constitute the second largest segment of the floricultural industry with 19.7% of sales in 1998. While popular potted plant crops remain in annual production cycles, each year new cultivars and series are commercialized. A series is hereby defined as a group of cultivars within a crop that were bred and released to the market by a commercial breeder company. Each cultivar within a series shares one or more phenotypic traits (e.g., plant height, flowering time, flower type, etc.) that characterize the series. The cultivars in a series might, in some instances, share a common female parent, but would differ from each other by flower, fruit, or foliage colors. For example, alstroemeria (*Alstroemeria* × *hybrida*) 'Jazze Rose Frost', 'Jazze Deep Rose', and 'Jazze Purple Rose' are three cultivars within the Jazze series (PanAmerican Seed Co., 1999). Each cultivar differs from the others within the series by flower color. Potted plant growers conduct cultivar trials to determine which new series perform as good as or better than the industry standards in production.

Students need experience in this area to gain practical experience for industry positions. One important classroom and/or laboratory exercise for undergraduate students enrolled in a potted plant production class is to learn the basics of cultivar trialing. Of particular interest are the objectives of the trial, choice of cultivars and suppliers, consumer demand, crop market share, crop scheduling, and the important components of an unbiased trial that will provide scientific validity.

The cultivar trial setup case study was developed to test the students' comprehension of experimental design, trialing, and decision-making in the industry, after learning about crop-spe-

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Exhibit 1. Memorandum from the Floratech Board of Directors.

To: New Potted Plant Production Specialist
 From: The Board of Directors
 Re: Cultivar Trial Setup

We are seeking to expand our offering of flowering potted plants that are cool crops for winter production. Sales offerings would be primarily targeted in the north-central region of the U.S. We would like you to set up a cultivar trial of cool season crops that we are considering producing 1) cyclamen and 2) primrose for evaluations (peak flowering) during production week three of next year. Consult all of the distributor and breeder/producer company seed and vegetative catalogs in the library as references; in addition, contact all of our vendors. Do not hesitate to converse with sales representatives who could supply additional insight.

You may trial as many cultivars as you like, being sure to choose a representative sampling of cultivars for all crops to be included. You must assemble the sowings or vegetative propagation and supervise the grower staff to ensure that everything proceeds on schedule for the trial date. At Floratech, we pride ourselves in conducting rigorous and meaningful cultivar trials for all company representatives to inspect, including the following divisions: sales, executives and upper management, seed technology, operations, production, and customer service. Select Floratech customers will also be invited to view and participate in the trial. During week three of next year, all personnel will be walking the trial to evaluate each crop for their market potential, as well as potential series and cultivars to be included in the Floratech product offering, should the decision be made to carry any or all of these crops. You must assemble a trial rating form for each person to use when evaluating the trial. Please consult the sample bedding plant pack trial books on file in the library to serve as examples. Be sure to include all data that has been collected up to this point in the trial, including germination, yield potential, realized crop losses, etc.

The trial will be conducted in Zone 3 of the production facility next to the administrative offices. You may use as much space within Zone 3 as you need [2,000 ft² (186 m²) maximum]. You must decide the following: whether to sow seeds or root cuttings versus purchasing plugs, day/night temperatures (during all production phases), sowing or propagation dates, fertilization and pest control applications, growth regulator applications (if any), final pot size, and spacing. Be sure to include a sufficient number of replications. If you decide to sow seeds on site, the maximum that can be sown per cultivar is the standard seed number contained within a sample packet, i.e., 300 seeds. If you do not use all replications in the trial, do not show only the best plants of a cultivar. Rather, ensure that the level of crop variation is fairly represented. In the trial, group each crop and flower color within species together, replicates of each cultivar are blocked within adjacent rows, as well as clearly labeling each cultivar (scientific name, common name, series, cultivar, source). Some considerations for the trial include negative perceptions of these crops by the industry, sales differences and customer preferences between Europe and North America. Our industry sources tell us that the competitors lose money on cyclamen. How could we change this? Primrose has low germination; consider how to resolve this.

cific production practices. Case studies are interactive learning tools, based on hypothetical situations that enable students to focus on scenarios from the inside-out rather than as hands-off critics (Simmons, et al., 1992). A few case studies have been published for horticulture classes (Davis, 1992a, 1992b; Foulk and Hoover, 1997; Hoover, 1993; Meyer and Allen, 1994) and fewer yet for floriculture classes (Engeikyoku and Hanakika, 1983; Kuehny and McMahon, 1998; Anderson, 2001).

The use of group activities, such as case studies, offers many strategic advantages to students during the educational process (Anderson, 2001). The cultivar trial setup is the second case study from the Floratech Company for use by floriculture students enrolled in potted plant production classes. The Floratech Dilemma (Anderson, 2001) was written for use on the first day of class whereas the Cultivar Trial Setup is meant to be provided 1 month later in the course.

The cultivar trial setup

A memorandum from the Board of Directors at Floratech Company is provided to all students (Exhibit 1).

Students have already worked on The Floratech Dilemma case study; the Cultivar Trial Setup continues their role-playing as Potted Plant Production Specialists for Floratech. This company specializes as a finisher of potted plants (Anderson, 2001).

The memorandum includes a detailed description of the cultivar trial to be setup, including the trial objectives and crop species, target week for peak flowering during which all company-wide evaluations will be conducted, trial rating forms to be created, data collection, experimental setup, and specific crop problems that could be addressed (Exhibit 1). Students work together in groups (3-4 students/group) and decide on the series and cultivars to be included, the number of replications, source(s), whether to sow their own seeds or root cuttings versus purchasing liners or plugs, flower colors, crop-specific production target dates for each phase (germination, vegetative growth, flower bud initiation/development, etc.), final spacing and pot sizes, and trial setup, to ensure that the trial provides Floratech and its customers a representative sampling of the variability on the market. Some considerations

students need to conceptualize include the negative perceptions of the crops within sectors of the industry and potential sales differences for series, plant forms, or flower colors. They are also encouraged to think of innovative ways of circumventing crop opportunities such as low germination rates in primrose and low profit margins with some cyclamen.

Students first research the available distributor and breeder/producer seed and vegetative catalogs to learn about the series, color, and plant habit variability in current market offerings. Catalogs are provided by the class instructor and students are also encouraged to search the web for on-line catalogs. Then they are directed to contact the Floratech vendors as well as other personnel who could supply additional insight, e.g., sales personnel for commercial distributors, local growers (customers). As the potted plant class tours local growing operations in laboratory field trips they can pose questions to the growers directly for information. The case study task and guidelines are specified in Exhibit 2. A written and oral presentation of the cultivar selections, series, colors, sources, productions

Exhibit 2. The task and guidelines.

The task

In your first year on the job as a potted plant production specialist, it is essential that you learn the important components of cultivar trials. You will need to continually interact with all of the Floratech staff, our suppliers, breeder/producer companies, and customers to ensure proper trial setup. Please report back to the Board of Directors 1 month from today with your cultivar selections, series, colors, production schedules, and trial evaluation forms. Be sure to include any industry intelligence on these crops that might influence our decision, the trial setup, or potential product positioning in the market.

Guidelines

Begin the assignment by conferring with the other potted plant production specialists in your group at this Floratech location. Other members of your group have the same assignment and may have different opinions regarding any or all of the parameters in the trial setup. After examining the facts, all of the members within your group must agree on the chosen parameters.

1. You are encouraged to use tables and figures in your report to the Board of Directors.
 2. A five-page (maximum), typed summary for your group (due one month from today) should include all of the required information, as well as the reasoning behind your choices.
 3. Hand in your written summary to the Board of Directors (your instructor) with all of the group members' names included.
 4. Your group will also make an oral presentation that summarizes your cultivar trial.
-

schedules, and trial evaluation forms are due from each group in one month.

Additional class discussion

After the groups' oral presentations, students vote for the best cultivar trial. A discussion session follows during the next class period to consider the insights and questions posed by the presentations, as well as those from the Board of Directors (Exhibits 1–3). Particular emphasis is placed on the design of the trial experiment(s), insurance percentages (crop overage), number of replications, as well as the number of series, cultivars, and flower colors included. Information from this exercise is then incorporated into a class experiment for an actual trial with a potted crop.

Interpretive or teaching note

The Cultivar Trial Setup case study covers many of the important factors that influence the reliability and accu-

racy of actual trials. This case study is useful to provoke in-depth, critical thinking and decision-making required in planning and executing a rigorous, scientific trial. All students, regardless of their emphasis within the horticulture curriculum can benefit from this case study. The diversity of student backgrounds, experience, and scientific training will enhance trial formulation and subsequent discussions (Davis, 1992b; Meyer and Allen, 1994).

This case study was first used with 20 students (divided into seven groups) enrolled in HORT 4051 (Potted Plants), during Fall 1999 semester. Student groups were consistent for the number of series chosen, i.e., 4 ± 1 (mean $\pm$ SD) cyclamen and 7 ± 3 primrose series were included in each trial. The number of cultivars varied from 6 ± 2 cyclamen to 9 ± 4 primrose, a small fraction of those commercially available. The instructor stressed the importance of including as many series/cultivars as possible to ensure that each trial provided a representative sampling of the genetic variability

for each crop. While no optimal figures are possible, due to space and cost constraints, an ideal trial would seek to include as many cultivars as possible. Similar results were found with the number of distributors chosen, i.e., 2 ± 0.7 (cyclamen) and 2 ± 0.9 (primrose). Final pot sizes and spacings were fairly consistent between the proposed trials with mini cyclamen grown in 4-inch (10-cm) pots at 10×10 -inch (25-cm) spacing, 5-inch (12.5-cm) pots at 12×12 -inch (30-cm) spacing for midis, and 6 inch (15 cm) pots at 15×15 inch (37.5 cm) for maxis. Primrose were grown primarily in 4 inch pots at a 6×6 inch spacing. Crop overproduction or percent insurance (for crop losses) was $40\% \pm 9\%$ for cyclamen and $36\% \pm 7\%$, higher than industry averages of 10% to 15%.

The largest variation between trials occurred with the number of replications (blocks) of each cultivar, ranging from 56 ± 37 (cyclamen) to 132 ± 65 (primrose). In-class discussions focused on the minimal numbers of repli-

Exhibit 3. Follow-up items to consider after the cultivar trial presentations.

Followup items

Have the potted plant production specialists consider the following questions after the classroom presentations.

- Are there apparent flower color differences between the proposed trials? What are the advantages or disadvantages of using straight colors versus mixes?
 - What is an appropriate number of replications, given the production space constraints?
 - Would there be any strategic advantage to include > one distributor for the same or different series of a crop?
 - Were the most popular selling cultivars included in the trials?
 - How would the realized germination and yield potential in the trial compare with the published values for each seed lot?
 - What additional production information could be included on the trial evaluation forms that would be useful?
 - Did any trial include novelty cultivars? Why or why not?
 - Which distributors were chosen? Why?
 - Were the trial objectives met in each case?
 - Did all trials include an overage for insurance against crop losses during production? If so, were these adequate, based on industry standards?
 - Is there a difference between a cultivar trial and a variety trial?
-

cations required, e.g., 5 to 10 replications per cultivar for most studies, and whether any information would be derived from additional replications. No background information had been supplied to the students on experimental design and students had varying amounts of statistical training. Subsequent class discussions refined each group's experimental design (blocking types, statistical significance) to minimize replications. For additional clarification, students were encouraged to read published articles on trialing, particularly Harkess (1999) and Batschke (2000).

Students also chose to include one to seven different flower color classes in both crops. Color choices varied, depending on whether the trial of the crops was meant to target specific holidays, e.g., red/scarlet and white for Christmas, or to present unique color offerings (e.g., blue primrose).

Results also varied for sow dates (i.e., staggered depending on production time), replicated sowings, or demonstration of series differences for flowering earliness or plant habit. Early cultivars were commonly selected to reduce production time and cost, providing a strategic advantage for Floratech. Series and suppliers were compared to test product performance under Floratech growing conditions. Additional crop features for cyclamen, such as fragrance, disease susceptibility differences, and flowering period duration made particular cultivars or series exceptional. All groups constructed cultivar trials with F_1 hybrid rather than open-pollinated cyclamen. Several groups questioned the use of comparisons in a commercial cultivar trial. They wanted to know why Floratech had not recommended any cyclamen or primrose series that were the market standards for comparison with other series/cultivars. The instructor presented the differences between public or All-America Selections trials (where the comparisons are predetermined and included in the trial list) versus private company trials (where the comparisons are chosen, based on the company's knowledge of the market). Students had not found standard comparisons in their catalog searches but proposed that local growers could be an informational source.

Information presented for the trial evaluations included the requested data, as well as selling price information, markup potential, and profitability analyses. Students also wrestled with the

option of growing both crops from seed versus purchasing pre-started plugs and how this might affect Floratech's current standing as a finisher company.

Many cultivar/series choices and production treatments were proposed to eliminate the anticipated primrose germination problems. These included asexual propagation of selected, top-rated genotypes after the conclusion of the cultivar trial. This engendered lengthy discussions of ethical and legal issues, as well as disease certification and feasibility for both crops. Early investigative research by several groups found which cultivars are problematic for growers, particularly older cultivars (e.g., 'Super Trophy') that have low germination. The recommendations in this instance were to grow newer and improved types, e.g., Danova and Dania series (Daehnfeldt, 1999). One group recommended germination testing all seeds lots upon arrival—if germination was lower than the published standard, seed lots were to be returned. If the germination met the standard but was still under the profit margin, then multi-sowing with subsequent singulation was recommended. Other treatments, e.g., adding potassium nitrate to the soil medium for german primrose (*P. obconica*) or soaking seeds in nicotinic acid or $GA_{3,4,7}$ for other primrose species, were proposed (Dole and Wilkins, 1999).

The class then considered the follow-up questions, if they had not already surfaced (Exhibit 3). Additional discussion points focused on the critical number of replications, acceptable % overproduction, the value of multiple sources, perils connected with few flower colors included in the trials, comparison of results and production costs for > one pot size and realized profits. Other questions surfaced later in the class, including: Whether germination percentages be significantly improved with the proposed treatments? Which cultivar produces the highest percentage of a salable crop? Why are no vegetative sources available for cyclamen and primrose?

Students felt this case study provided additional learning opportunities about industry trials that surpassed lecture and textbook education. They enthusiastically engaged in discussions within their group and in class. The majority of students (>80%) had never seen nor heard of a cultivar trial prior to this case study and even more (>95%) had never visited the annual California

or European Pack Trials. Participants felt that this case study provided experiential training in commercial trialing and greater familiarity with the industry than would otherwise be the case in traditional classroom information delivery. Industry representatives were also impressed with the caliber of students from this class, particularly after answering the students' questions during laboratory tours, and hired >20% of the students as industry growers by the end of the school year.

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