A Comprehensive Analysis and Scientific Impact of ASHS Cross-commodity Publication Awards

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Established in 1985, the Cross-Commodity Publication Award recognizes authors of the most outstanding paper on horticultural cross-commodity research, including broadly applicable methodology, pre- and post-harvest physiology, genetics, anatomy, morphology, ecology, crop production systems, modeling, and management, published in the previous year's issues of the *Journal of the American Society for Horticultural Science* (JASHS), *HortScience*, or *HortTechnology*. Through the 39-year span (1985–2023), there were 38 papers that have been awarded (Table 1). Among all papers, two of them were published in *HortTechnology*, nine in *HortScience*, and 27 in the JASHS. Most of the awarded papers were basic research, which was aiming to understand the occurrence of a phenomenon and the response of plants; and applicable methodology, which was developed to facilitate efficient phenotyping or plant propagation and production. In addition, most of the studies were conducted under controlled environment and laboratory conditions, and there were several papers studying multiple crops spanning from fruits, vegetables, and ornamentals within one experimental set.

Analysis and approaches

The framework of this analysis for the winner papers published was constructed initially by a set of discrete questions that provided metrics such as authorship number, affiliation, and country of origin, journal type, crop category of single or combination of horticultural crops (e.g., fruits, vegetables, ornamentals), non-commodity specific (e.g., instrumentation, surveys), discipline, and major topics related to challenges in food systems (e.g., climate change, water use efficiency, sustainability, organics). We also explored interesting facts from the awarded papers, for example, what were the noun, adjective, or verb words that appeared more times from the title? For analysis we used the *udpipe* package in R (R Core Team 2023), which is a natural language processing toolkit that provides language-agnostic analysis, including annotating text genres (noun, adjective, verb, etc.) and counting the frequencies of term appearance.

Considering all the 38 papers, our primary review objective was to identify the central themes, their historical perspective, and their scientific impact in horticulture post-publication date. Following, we analyzed the contribution of selected key papers in a specific field of science and the prevalence in time post-publication date to determine if they served as a milestone in a specific theme and/or research area. To accomplish this objective, we used the Web of Science (Clarivate Analytics PLC, London, UK) as the database to find the citation reports for these awarded papers including titles, authorships, citations, institute/departments, and research areas. It is important to note that although Google Scholar (Google LLC, Mountain View, CA, USA) is another great database to search the information, compared with Web of Science, Google Scholar does not have a complete citation report, and it has inflated citation counts due to inclusion of all sources of documents including peer-reviewed journals, conference papers, theses and dissertations, extension publications, books, preprints, abstracts, technical reports, patents, and other online repositories. In addition, Google Scholar produced more irrelevant results when search because it cannot distinguish similar author names unless you have a Google Scholar profile.

Review for basic information

Researchers with affiliations from the US Department of Agriculture have won the most awards (18 individuals), followed by the University of California system (13 individuals), and the University of Wisconsin system (13 individuals). Interestingly, only two researchers have won this award twice, Jack E. Staub's papers that were published in 1996 (Staub et al. 1996) and 2011 (Gordon and Staub 2011), and Leslie H. Fuchigami's papers that were published in 1989 (Chalker-Scott et al. 1989) and 2009 (Ding et al. 2009). As the cross-commodity award, the 38

Jack Staub (1948–2019)

Marc W. van Iersel (1965–2023)

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We greatly appreciate the time and input received from authors Drs. L. Chalker-Scott, L. Fuchigami, and R. Ferrarezi on the significance of their paper awards and contribution to horticultural sciences and young professionals. This review honors the contribution of two giants in horticultural sciences, Dr. Jack Staub and Dr. Marc W. van Iersel.

25 Years of Publication Excellence Awards for ASHS Journals.

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Table 1. List of ASHS Cross-Commodity Publication Award papers followed by years and their category, study crops, study condition, and brief summary.

Reference	Category	Study crops	Study condition	Summary
Akers et al. 1985	Applicable method	'Rutgers' tomato (*Solanum lycopersicum*)	Controlled environment	Develop a minitron system for precisely growing small plants
Hosoki et al. 1986	Applicable method	Gladiolus (*Gladiolus ×tubergenii*)	Controlled environment	Use extracts from garlic and horseradish paste to break gladiolus corm dormancy
Tomlinson and Lovatt 1987	Basic research	Citrus (*Citrus sinensis* × *Poncirus trifoliata*)	Laboratory	Assess the capacity of anabolic and catabolic pathways of purine and pyrimidine nucleotide metabolism in orange
Goldy et al. 1988	Breeding	Grape (*Vitis* sp.)	Laboratory	Use embryo culture to produce hybrids between grape species
Chalker-Scott et al. 1989	Applicable method	'Jean Marie de Montague' rhododendron (*Rhododendron*)	Laboratory	Use spectrophotometric measurement to indicate freeze damage of rhododendron leaf
Corey and Tan 1990	Basic research	Tomato (*Solanum lycopersicum*), pepper (*Capsicum annuum*), apple (*Malus domestics*), carrot (*Daucus carota*), witloof chicory (*Cichorium intybus*), rhubarb (*Rheum rhabarbarum*), pokeweed (*Phytolacca americana*)	Laboratory	Explore the total gas pressure gradients in bulky plant organs
Warrington and Norton 1991	Management	Chrysanthemum (*Chrysanthemum indicum*), radish (*Raphanus sativus*), corn (*Zea mays*), cucumber (*Cucumis sativus*)	Controlled environment	Evaluate the effects of daily light integrals on plant growth
Serres et al. 1992	Genetics	Cranberry (*Vaccinium macrocarpon*)	Laboratory	Develop an electric discharge particle acceleration system for the genetic transformation of cranberry
Levi et al. 1993	Genetics	Blueberry (*Vaccinium cyanococcus*), peach (*Prunus persica*), apple, pear (*Pyrus communis*)	Laboratory	Produce randomly amplified polymorphic DNA (RAPD) markers from woody plants
Cappiello and Kling 1994	Basic research	Red osier dogwood (*Cornus sericea*)	Controlled environment	Analyze plant biochemical changes during cold storage and emergence from dormancy
Liptay et al. 1995	Applicable method	Corn	Laboratory	Use optical flow system to measure corn seeding growth
Staub et al. 1996	Basic research	Cucumber	Laboratory	Assess sources of errors in RAPD analysis
Tao et al. 1997	Genetics	'Jiro' persimmon (*Diospyros kaki*)	Laboratory	Transform a gene to persimmon that could induce insect resistance
Beaulieu et al. 1998	Basic research	Tomato, apple	Laboratory	Understand the role of acetaldehyde and pH in ethylene biosynthesis
Workmaster et al. 1999	Basic research	Cranberry	Controlled environment	Use infrared video thermography to understand ice nucleation and propagation in plants

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Table 1. (*Continued*)

Reference	Category	Study crops	Study condition	Summary
Brumfield et al. 2000	Economics	Tomato, 'Saccharada' sweet corn (*Zea mays*), pumpkin (*Cucurbita pepo*)	Field	Analyze cost and return among conventional, integrated crop management, and organic cropping systems
Zheng et al. 2001	Genetics	Chrysanthemum	Laboratory	Transform a gene to chrysanthemum could alter plant architecture
Beyer and Knoche 2002	Basic research	Sweet cherry (*Prunus avium*)	Laboratory	Analyze conductance in water uptake through the fruit surface and its potential relevance for fruit cracking
Li et al. 2003	Basic research	Citrus (*Citrus sinensis*)	Laboratory	Understand the involvement of phytohormones in postbloom fruit drop caused by fungal infection
Anderson and Padhye 2004	Basic research	'Little Bright Eye' vinca (*Catharanthus roseus*), 'Explorer Mix' sweet pea (*Lathyrus odoratus*)	Controlled environment	Examine plant thermotolerance from hydrogen peroxide defense systems and radical scavenging capacity
Etxeberria et al. 2005	Basic research	Mandarin (*Citrus reticulata*)	Laboratory	Investigate the mechanisms of sucrose transport and its accumulation in citrus
Wood et al. 2006	Applicable method	Pecan (*Carya illinoinensis*)	Controlled environment	Use metal hyperaccumulators (*Alyssum*) extract to correct and prevent nickel deficiency in pecan
Leatherwood et al. 2007	Basic research	Celery (*Apium graveolens*), 'Golden Acre' cabbage (*Brassica oleracea*), tobacco (*Nicotiana tabacum*), arabidopsis (*Arabidopsis thaliana*)	Controlled environment	Understand effects of salt stress on seed germination performance and carbohydrate content changes
Barb et al. 2008	Basic research	Stokes aster (*Stokesia laevis*)	Laboratory	Explore the genetic and biochemical pathway for flavonoid biosynthesis in stokes aster
Ding et al. 2009	Applicable method	Almond (*Prunus dulcis*), poplar (*Populus trichocarpa* × *Populus deltoides*), apple	Protected environment	Develop a nondestructive assessment of chlorophyll in fresh leaves using spectral reflectance
Lopez-Granados et al. 2010	Applicable method	Garlic (*Allium sativum*), onion (*Allium cepa*), sunflower (*Helianthus annuus*), bean (*Vicia faba*), maize (*Zea mays*), potato (*Solanum tuberosum*), winter wheat (*Triticum aestivum*), melon (*Cucumis melo*), watermelon (*Citrillus lanatus*), cotton (*Gossypium hirsutum*), alfalfa (*Medicago sativa*), asparagus (*Asparagus officinalis*), plum (*Prunus* sp.), citrus (*Citrus* sp.), olive (*Olea europaea*)	Field	Use multispectral reflectance to classify irrigated crops with discriminant analysis and neural networks

(Continued on next page)

Table 1. (*Continued*)

Reference	Category	Study crops	Study condition	Summary
Gordon and Staub 2011	Basic research	Cucumber	Controlled environment	Understand plastidic and nuclear genetic effects on chilling responses in cucumber
Merk et al. 2012	Basic research	Tomato	Field	Understand economically important traits variation in regionally adapted tomato germplasm
Nveawiah-Yoho et al. 2013	Basic research	Tomato	Controlled environment	Identify proteins for salt tolerance in tomato roots
Shan and Seaton 2014	Applicable method	Grapevine (*Vitis vinifera*)	Controlled environment	Establish a rapid propagation method for grapevines using immature cuttings
Lordan et al. 2015	Applicable method	'Saturn' peach (*Prunus persica*)	Field	Develop an image-based method to estimate the tree canopy and pruning biomass
van Iersel et al. 2016	Applicable method	Lettuce (*Lactuca sativa*), pothos (*Epipremnum aureum*), sweetpotato (*Ipomoea batatas*)	Controlled environment	Develop a chlorophyll fluorescence-based biofeedback system to control photosynthetic lighting
Lv et al. 2017	Basic research	Apple	Laboratory	Understand the regulating roles of ethylene on the jasmonate pathway during fruit ripening and senescence
Brennan 2018	Applicable method	Spearmint (*Mentha spicata*), creeping thyme (*Thymus serpyllum*), sweet alyssum (*Lobularia maritima*), purslane (*Portulaca oleracea*), grain amaranth (*Amaranthus tricolor*), chives (*Allium schoenoprasum*), basil (*Ocimum basilicum*), Chinese chives (*Allium tuberosum*)	Laboratory	Develop a slide hammer seeder for the precise seeding of raw seeds of small-seeded plants
Bielenberg and Gasic 2019	Applicable method	Peach, sunflower	Controlled environment	Develop lost-cost temperature controllers for floral budbreak and seed germination
Lattier and Contreras 2020	Basic research	Althea (*Hibiscus syriacus*)	Controlled environment	Understand segregation patterns in flower color and eyespot in althea
Reva et al. 2021	Management	Tomato, pepper, cucumber	Controlled environment	Use arbuscular mycorrhizal inoculant for alleviating severe heat stress
Atkins and Boldt 2022	Management	'Superbells Lemon Slice' calibrachoa (*Calibrachoa* ×*hybrida*), 'Supertunia Mini Strawberry Pink Veined' petunia (*Petunia* ×*hybrida*), 'Superbena Royale Whitecap' verbena (*Verbena* ×*hybrida*), 'Maverick Red' geranium (*Pelargonium* ×*hortorum*), 'California Wonder' pepper (*Capsicum annuum*), 'Pacino Gold' sunflower (*Helianthus annuus*)	Controlled environment	Test plant photosynthetic responses under different supplemental lightings, temperatures, CO_2 enrichments

winner papers covered diverse research areas including genetics, heredity, biochemistry, molecular biology, environmental science, ecology, biotechnology, applied microbiology, pathology, anatomy morphology, food science technology, entomology, agricultural economics, computational biology, etc. The most occurring nouns in awarded paper titles were fruit and analysis (six times), followed by growth (five times), system, plants, temperature, gene, transport, and salt (three times) (Fig. 1A); the most occurring adjective in awarded paper titles was comparative (three times), followed by small, polymorphic, genetic, sweet, and photosynthetic (two times) (Fig. 1B); the most occurring verb in awarded paper titles was using (eight times), followed by controlled, based (three times), and amplified (two times) (Fig. 1C).

Impact and contribution to horticultural sciences

To date, the total citations (accessed 24 Oct 2023) for these papers were 879, with 23 average citations per year. Papers with the top three citations are Staub et al. (1996) (97 citations), Levi et al. (1993) (62 citations), and Merk et al. (2012) (61 citations); and papers with the top three average citations per year are Merk et al. (2012) (5 citations/year), Staub et al. (1996) (3.5 citations/year), and van Iersel et al. (2016) (3.1 citations/year).

To answer priority questions related to the scientific impact and to whether a particular paper serves as a milestone for a specific research area, we needed to identify all the papers that have cited the awarded papers, as well as their specific research areas, and the evolution of the specific research area over years. To accomplish that we use a software, CiteSpace (Chen 2016), which can generate visualizing patterns and trends in scientific papers based on their citation and cocitation interactions. For example, if a paper 1 cites a paper A, and paper 2 and paper 3 also cite the paper A, then this paper A is cocited, and could become an important paper for a specific research area, and this specific area can be "documented" with some keywords generated by CiteSpace based on the appeared frequency from title, abstract, keyword, etc. After we know the year published for the paper A, we could also reveal the research trend over the years.

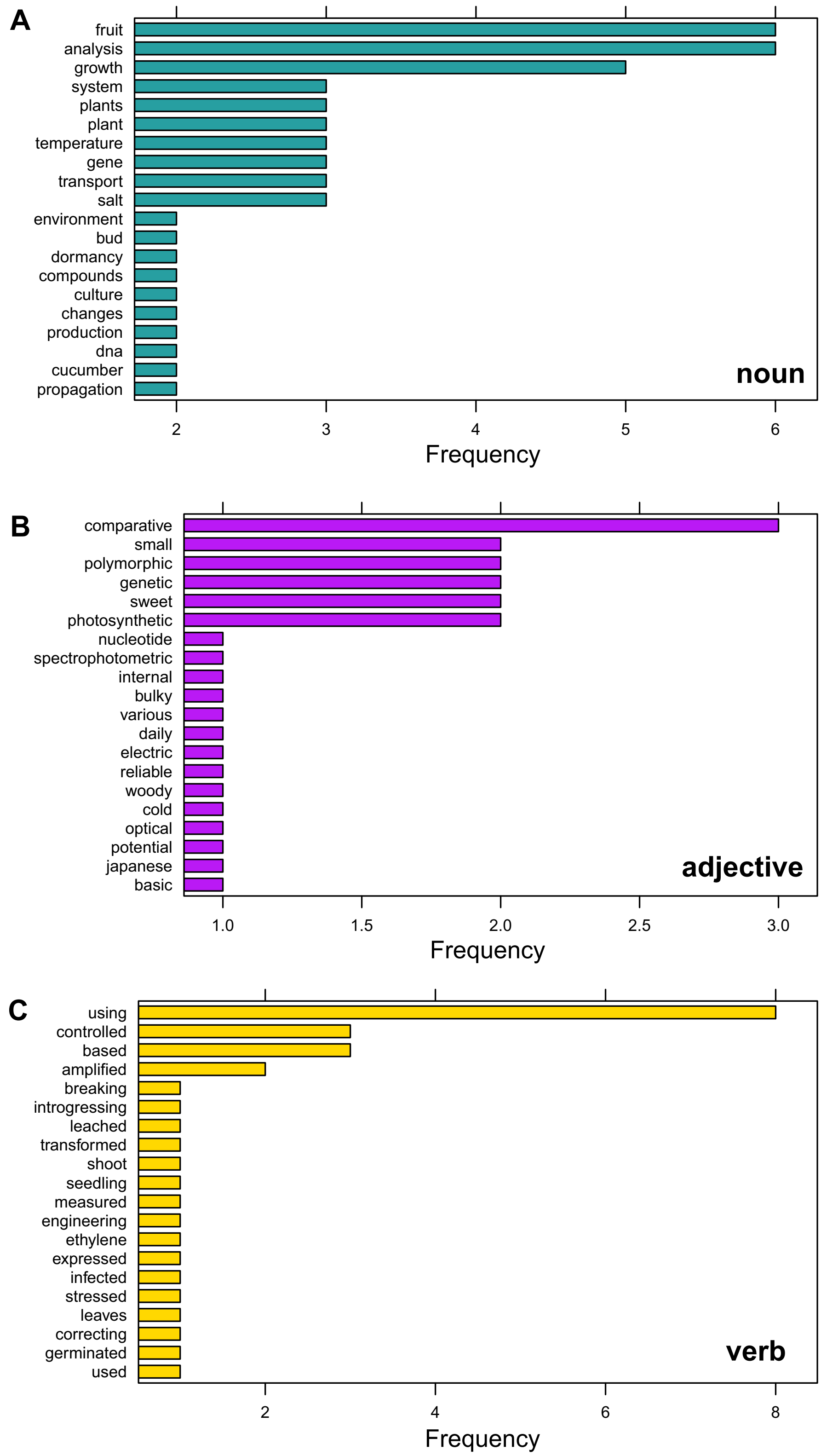

Fig. 1. Most occurring nouns (A), adjectives (B), and verbs (C) by frequency (times) in ASHS Cross-Commodity Publication Award paper titles from 1985 to 2023.

We have selected three papers to do this deeper analysis. The first one was Staub et al. (1996). Staub et al. (1996) has been cited by 97 other papers, and these 97 papers cited many other papers, and overall, we

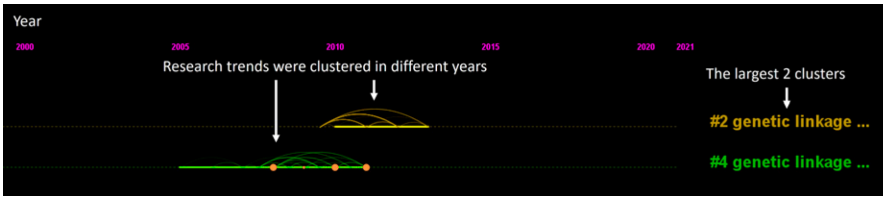

Fig. 2. Research trend of the 97 papers that cited Staub et al. (1996) (received ASHS Cross-Commodity Publication Award in 1997), which are grouped into two main clusters (green and yellow). Both clusters are related to interspecific genetic maps but are centered in different years (2008 for the green cluster and 2011 for the yellow cluster).

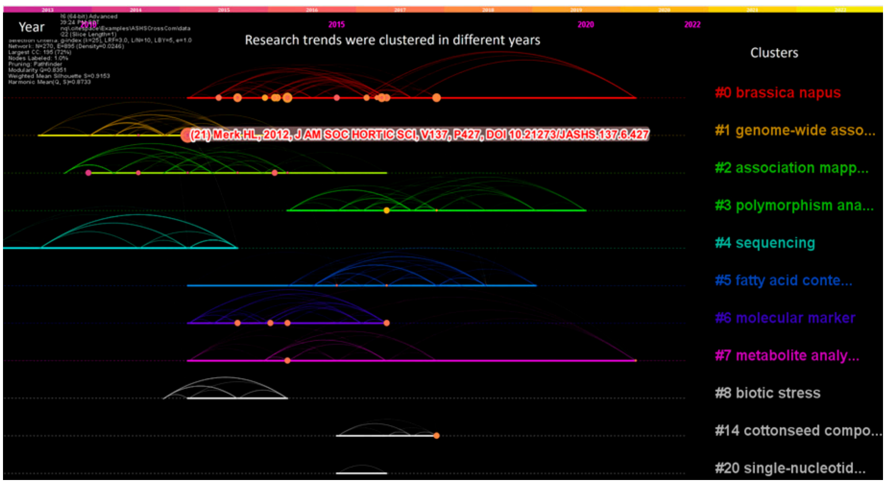

Fig. 3. Research trend of the 61 papers that cited Merk et al. (2012) (received ASHS Cross-Commodity Publication Award in 2013), which are grouped into several clusters, showing Merk et al. (2012) is having both direct and indirect effects on these research trends, especially with the keyword "genome-wide association."

found that there are two major theme clusters (or groups) that are all related to the genetic linkage map (Fig. 2). The difference between these two clusters is due to each having different key papers (like the paper A), which is reflected by the circle size (bigger means more important or that has been cited more times), but regardless, they all lead to interspecific "genetic map" research.

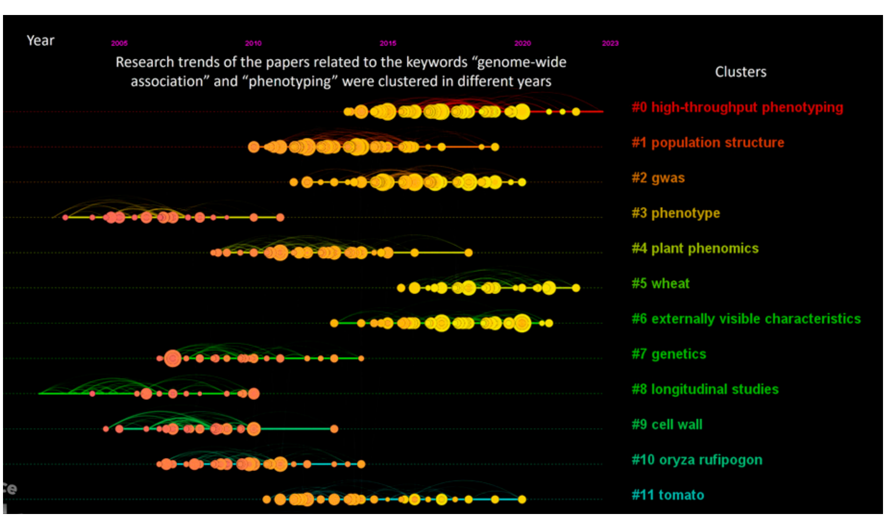

Fig. 4. Research trend of the papers related to the keywords "genome-wide association" and "phenotyping" that are generated from Merk et al. (2012).

Although Staub et al. (1996) does not show as a key paper to directly affect this research area probably because Staub et al. (1996) was published decades ago and there were relatively few comparable papers published during that period, Staub et al. (1996) has indirectly inspired these 97 papers that focused on research in genetic maps even after 15 years (1996–2011).

The second paper is Merk et al. (2012). Unlike Staub et al. (1996), Merk et al. (2012) has served as an important paper to guide a major research trend. Merk et al. (2012) directly inspired the research in genome-wide association studies, as is evident by the major cluster, representing major impact in this field (Fig. 3, yellow line). Merk et al. (2012) also indirectly inspired the research in many other diverse aspects and crop commodities; and these research areas are still active at the current date (Fig. 3, for #0, #3 and #7 clusters, represented by red, green, and purple lines). Because Merk et al. (2012) has directly inspired the research in genome-wide association studies and phenotyping, we searched all the papers related to these two keywords and explored their research trends (Fig. 4). We found these two keywords have extended their research trend to high-throughput phenotyping, wheat (*Triticum aestivum*), tomato (*Solanum lycopersicum*), externally visible characteristics, etc. Some studies are recent, and some are from old research. Although in this case, Merk et al. (2012) is hard to identify (not an important paper anymore because the paper pool is too big), but we can see the importance of cross-commodity studies using different types of plant species.

The third paper is van Iersel et al. (2016). As a recently published paper, van Iersel et al. (2016) has relatively higher average citations per year, showing his paper directly inspired the research in quantum yield of photochemical reaction studies, as evident by the biggest impact on that cluster, and this research is still very active at the current date (Fig. 5, second yellow line). van Iersel et al. (2016) also indirectly inspired the research in many other thematic-related areas such as supplemental light, light quality, leafy greens, etc. These areas currently constitute hot topics in controlled environment agriculture (CEA) production

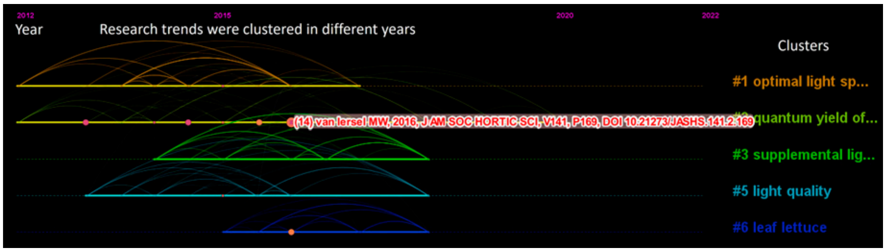

Fig. 5. Research trend of the 22 papers that cited van Iersel et al. (2016), which are grouped into several clusters, showing van Iersel et al. (2016) (second line in yellow) is having both direct and indirect effects on the research trend.

(Resh 2022). Again, since van Iersel et al. (2016) has directly inspired the research in CEA, light, and photosynthesis studies, we searched all the papers related to these keywords and explored their research trends (Fig. 6). A similar explanation as before, but in this case, the research trend is more related to multiple research themes focusing on physiology, phenotyping, and production, instead of multiple crops.

Taking into account the three highly cited papers (Figs. 2–4) we can infer that compared with the older awarded papers, the newer awarded papers have impacts on more diverse research themes or topics.

Future directions for cross-commodity publications

As can clearly be seen, papers honored in the cross-commodity award have continuous impacts on defining, developing, and inspiring areas of research. Multidisciplinary, multiple research focus (physiology, phenotyping, production), and multiple crops or commodities have become key aspects for the award selection. Future directions will continuously focus on basic research aimed to a) understand plant responses under global environmental changes; b) applicable methodology with the incorporated application of advanced technology, artificial intelligence, data-driven, and cost-effective solutions; and c) management practices to sustainably improve plant production and quality in pre- and postharvest processing stages under various cropping systems and environments.

Conclusive remarks from awarded authors

We were excited to have interviewed three authors of two awarded papers (Chalker-Scott et al. 1989; van Iersel et al. 2016) on the perspectives and significance of their research topics and findings. Dr. Leslie H. Fuchigami, Emeritus Professor at the Department of Horticulture, Oregon State University (Corvallis, OR, USA) emphasized the importance of sublethal stress (above freezing) and the role of high pH in precipitation of phenolics through the formation of reactive oxygen species. This was the framework for his student—now Dr. Linda Chalker-Scott, Professor and Extension Urban Horticulturist at Washington State University, Puyallup Research and Extension Center (WSU PREC), Puyallup, WA, USA—to develop a handy and simple objective method to measure phenolics in leachates as an indicator of freeze damage, a technique that can be used presently. Dr. Rhuanito Ferrarezi, coauthor of the CEA influential paper by van Iersel et al. (2016), described that their manuscript was highly theoretical with a fascinating topic and the potential for application but not thinking it would have such an impact on the industry by simply connecting a serial output in the MINI-PAM II (Heinz Walz GmbH, Effeltrich, Germany) to a serial reader of a CR1000 datalogger (Campbell Scientific Inc, Logan, UT, USA). At the closing interviews, we asked them how significant these awards were. Leslie humbly expressed "*… students*

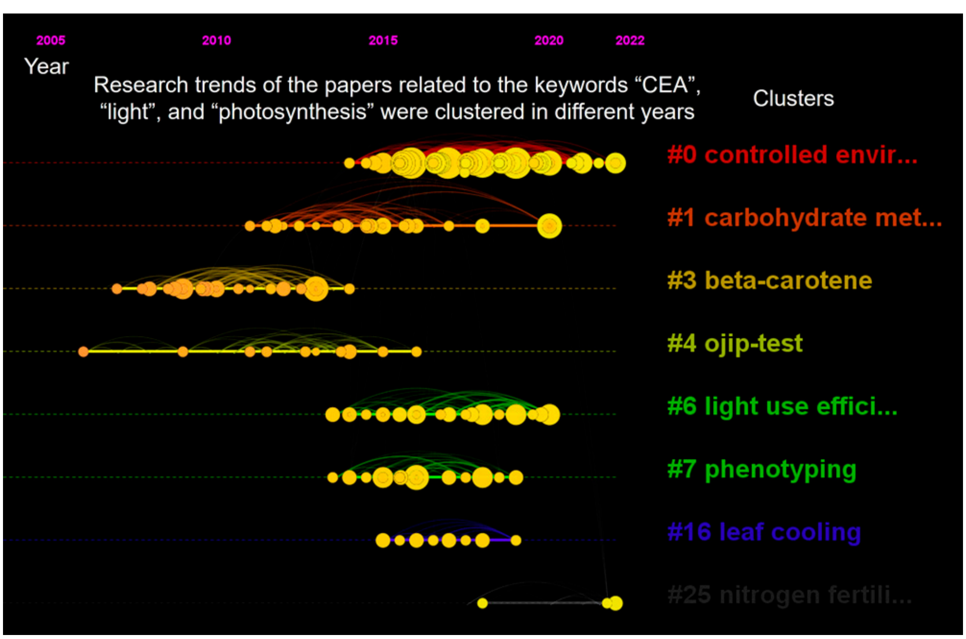

Fig. 6. Research trend of the papers related to the keywords "controlled environment agriculture (CEA)," "light," and "photosynthesis" that are generated from van Iersel et al. (2016).

deserve all the credits for these awards," his student Linda added "… *these awards validate yourself as scientist and increase self-confidence*," and Rhuanito shared "… *the academic environment is suitable to foster and nurture young minds, bringing the ability to interact beyond the conference rooms in tours and coffee breaks.*"

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