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ORIGINAL ARTICLE

Highly Cited Articles in Science Citation Index Expanded – Subject Category of Horticulture: A Bibliometric Analysis

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Abstract In this paper, we have analyzed the characteristics of 781 highly cited articles in the Science Citation Index Expanded of category of horticulture published from 1961 to 2014. A total of 33 journals were grouped under Web of Science category of horticulture. Article has been cited more than 100 times being published since 1961 assessed in the terms of their distribution in the journals, and citation life cycle. Further, we have evaluated performance of authors, country and institutions. *The Journal Theoretical and Applied Genetics* and *American Journal of Enology and Viticulture* were more productive journals. Most of the highly cited articles published in 1990s and 2000s, respectively. Average authors per article also kept increasing from 1960s to 2000s, respectively. University of California, Davis and Cornell University in USA were the most productivity institutions and USA and the UK were the most contributing countries. The citation life cycles of the highly cited articles indicate that majority of the highly cited articles had received less citation in their publication decade, later started to receive good number of citations.

Keywords Highly cited articles · Horticulture · Bibliometric analysis · Web of Science · Y-Index

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Meistzitierte Artikel im Science Citation Index Expanded – Themenkategorie Gartenbau: Eine bibliometrische Analyse

Schlüsselwörter Meistzitierte Artikel · Gartenbau · Bibliometrische Analyse · Web of Science · Y-Index

Introduction

The term "horticulture" first appeared in written language in the seventeenth century. It is found mentioned in Peter Laurebmberg's treatise written in 1631 (Singh 2014). The word horticulture is derived from the Latin words "hortus" means garden and "cultura" means to cultivate (Subbarayudu and Sureshreddy 2015). Horticulture means garden cultivation (Singh 2014). Thus, horticulture is a part of plant agriculture which is concerned with cultivation of "garden crops" (Subbarayudu and Sureshreddy 2015). Garden crops conventionally include fruits, vegetables, spices, plantation, medicinal, flower, and aromatic crops (Singh 2014). The world population would attain 9.1 billion in 2050, which is 34 percent higher than today (Anonymous 2009). The population increase would occur more in developing countries than developed one (Anonymous 2009). At other end, Urbanization would also be accelerated its pace, and the 70 per cent of the world's population would reside in urban area compared to 49 percent today (Anonymous 2009). However, producing sufficient food for the world's population in 2050 would be easy but accomplishing it at an acceptable cost to the planet would depend on research into everything from high-tech seeds to low-tech farming practices (Anonymous 2010). Research on horticulture crops would provide an unique opportunity to feed the hunger and achieve food security in the coming days. In India, horti-

cultural crops form a noteworthy part of total agricultural produce in the country including of fruits and nuts, vegetables, root and tubers, flowers, ornamental plants, medicinal and aromatic plants, spices, condiments, plantation crops and mushrooms and contribute for 30.4 per cent of agricultural GDP (Ganeshamurthy and Satisha 2012).

Citations are important indicators of quality of research (Joint 2008). Recently, bibliometric studies had received foremost attention from the researchers and all of sudden, many researches all over the world started talking about impact of articles and journals. One reason for this move is certainly that science policy is increasingly interested in scientific excellence given its new public management tools (Aksnes 2003; Lamont 2012). "Many countries are moving towards research policies that highlight excellence; therefore; they develop evaluation systems to identify universities, research groups, and researchers that can be said to be 'excellent'" (Danell 2011).

A considerable number of bibliometric studies were reported in last decade on evaluation of research performance in particular subject, for example water resources journals (Wang et al. 2011a), comparison of universities' scientific performance (Wang et al. 2011b), ranking of knowledge management and intellectual capital academic journals (Serenko et al. 2010), Chinese superconductivity research (Zhu and Willett 2011), and computer science in Eastern Europe (Fiala and Willett 2015). There is common trend that the only few articles cited more frequently and remaining large number of articles found less cited or not cited (Ioannidis 2006). It is not fair to judge the impact of articles based on impact score of few articles (highly cited) such as the average impact of all articles published in a subject and journal (Singh et al. 2014). The highly cited papers are considered as all times "classic works," as they had maximum impact on the particular subject as well as researchers around the world (Fu and Ho 2015). Highly cited articles are very unlike from "ordinary" cited articles, typically, they are authored by a huge number of researchers, often involving international collaboration (Aksnes 2003). Compared to the least cited articles, the highly cited articles have higher average of authors, references, citations and page counts for each article (Kostoff 2007). Therefore, there is a considered necessary to look into the articles which are highly cited. Many researchers had been extensively conducted a study to reveal the characteristics of these highly cited articles in particular Web of Science subject categories, such as water resources (Chuang et al. 2011), orthopedics (Lefaivre et al. 2011), chemical engineering (Ho 2012), environmental sciences (Khan and Ho 2012), nursing (Wong et al. 2013), surgery (Long et al. 2014), health care sciences and services (Hsu and Ho 2014), social work (Ho 2014a), information science and library science (Ivanović and Ho 2016), and categories related to materials science (Ho 2014b).

In this paper, we present the bibliometric analysis of highly cited articles published in the journals listed in the Web of Science category of horticulture. This is the first kind of study, which would provide insight into characteristics of the highly cited articles in horticulture.

Methodology

The analysis provided in this study is based on the Science Citation Index Expanded (SCI-EXPANDED) database of Web of Science from Thomson Reuters (updated on 14 April 2016). There were 33 journals listed in Science Citation Index Expanded – subject category of horticulture in 2014 (Table 1). A total of 91,852 documents from 1961 to 2014 were found in SCI-EXPANDED. $TC_{2014} \geq 100$ were used as a filter to extract the highly cited documents (863 documents). TC_{2014} denotes the total citations from Web of Science Core Collection since publication of the article up to the end of 2014 (Wang et al. 2011b; Chuang et al. 2011). The advantage of this indicator is that it is an invariant parameter, thus ensuring repeatability, in comparison with the index of citation from Web of Science Core Collection, which has been updated from time to time (Fu et al. 2012). Therefore, 0.94% of the total documents published in SCI-EXPANDED – subject category of horticulture are regarded as the highly cited papers including articles (718 articles; 90% of 863 highly cited papers), reviews (76; 8.8%), proceedings papers (35; 4.1%), and notes (6; 0.70%). The 718 articles having $TC_{2014} \geq 100$ were retrieved as highly cited articles for further analysis. We chose articles for analysis because articles contain description of complete researches and results (Ho et al. 2010). Data about those articles and the total annual citations for each article were downloaded. All results were analyzed using Microsoft Excel 2013 (Li and Ho 2008).

In subsequent analysis, articles originating from England, Scotland, Northern Ireland, and Wales were classified as being from the United Kingdom (UK). Articles from Hong Kong before 1997 were classified as being from China. Articles from Federal Republic of Germany (Fed Rep Ger) and Germany were reclassified as being from Germany (Ho 2012); articles from Yugoslavia and Serbia were checked and reclassified as being from Serbia (Li et al. 2014). The contributions from institutions and countries were identified by the appearance of at least one author in the publications. Collaboration type was determined from the addresses of the authors. The articles were classified into six types based on the country and institution (Han and Ho 2011): (1) total article; (2) "single country article", if the researchers' addresses were from the same country; "single

Table 1 Characteristics of 33 journals in Science Citation Index Expanded – subject category of horticulture in 2014

Journal	IF_{2014}	Issues	*TP**	*TA**	*TP* (%)	*TA* (%)
Theoretical and Applied Genetics	3.79	Monthly	10,423	10,257	493 (4.7)	484 (4.7)
American Journal of Enology and Viticulture	1.388	Quarterly	3553	2400	62 (1.7)	50 (2.1)
Journal of the American Society for Horticultural Science	1.276	Bimonthly	7975	7863	42 (0.53)	42 (0.53)
Hortscience	0.902	Bimonthly	27,428	10,199	48 (0.18)	41 (0.40)
Postharvest Biology and Technology	2.223	Monthly	2649	2580	52 (2.0)	40 (1.6)
Euphytica	1.385	Semimonthly	8435	8133	49 (0.58)	38 (0.47)
Molecular Breeding	2.246	Monthly	1819	1751	36 (2.0)	29 (1.7)
European Journal of Plant Pathology	1.490	Monthly	2678	2576	27 (1.0)	22 (0.85)
Scientia Horticulturae	1.365	Monthly	6720	6453	26 (0.39)	13 (0.20)
Journal of Horticultural Science & Biotechnology	0.541	Bimonthly	2734	2635	7 (0.26)	7 (0.27)
Vitis	0.738	Quarterly	1393	1305	5 (0.36)	5 (0.38)
Seed Science and Technology	0.480	Tri-annual	2804	2728	6 (0.21)	4 (0.15)
Australian Journal of Grape and Wine Research	1.816	Tri-annual	474	440	6 (1.3)	3 (0.68)
Journal of the Professional Association for Cactus Development	0.300	Annual	145	138	1 (0.69)	1 (0.72)
Biological Agriculture & Horticulture	0.681	Quarterly	691	666	1 (0.14)	1 (0.15)
Tree Genetics & Genomes	2.451	Bimonthly	776	746	1 (0.13)	1 (0.13)
Horticulture Journal	N/A	Quarterly	N/A	N/A	N/A	N/A
New Zealand Journal of Crop and Horticultural Science	0.605	Quarterly	1135	1029	1 (0.088)	0 (0)
Acta Scientiarum Polonorum-Hortorum Cultus	0.552	Quarterly	531	530	0 (0)	0 (0)
Erwerbs-Obstbau	0.250	Quarterly	124	110	0 (0)	0 (0)
European Journal of Horticultural Science	0.302	Bimonthly	488	467	0 (0)	0 (0)
Fruits	0.883	Bimonthly	1096	1001	0 (0)	0 (0)
Horticultura Brasileira	0.335	Quarterly	826	798	0 (0)	0 (0)
Horticultural Science	0.586	Quarterly	196	192	0 (0)	0 (0)
Horticulture Environment and Biotechnology	0.725	Bimonthly	409	402	0 (0)	0 (0)
Horttechnology	0.681	Bimonthly	1759	1544	0 (0)	0 (0)
Indian Journal of Horticulture	0.134	Quarterly	905	899	0 (0)	0 (0)
Journal International Des Sciences De La Vigne Et Du Vin	0.625	Quarterly	364	345	0 (0)	0 (0)
Journal of the American Pomological Society	0.382	Quarterly	323	292	0 (0)	0 (0)
Korean Journal of Horticultural Science & Technology	0.339	Bimonthly	859	848	0 (0)	0 (0)
Mitteilungen Klosterneuburg	0.045	Bimonthly	396	357	0 (0)	0 (0)
Propagation of Ornamental Plants	0.346	Quarterly	318	302	0 (0)	0 (0)
Revista Brasileira De Fruticultura	0.414	Quarterly	1426	1387	0 (0)	0 (0)

IF_{2014} impact factor for 2014, *TP** total number of papers in subject category of horticulture from 1961 to 2014, *TA** total number of articles in subject category of horticulture, *TP* (%) total number of highly cited papers and percentage of 91,852 papers in subject category of horticulture, *TA* (%) total number of highly cited articles and percentage of 71,373 articles in subject category of horticulture, *N/A* not available; *Horticulture Journal* was listed in category of horticulture since 2015

institution article", if the researchers' addresses were from the same institution; (3) "internationally collaborative article", if the articles were coauthored by researchers from multiple countries (Chiu and Ho 2005); "inter-institutionally collaborative article", if authors were from different institutions; (4) "first author article", if the first author's address was from the certain country or institution for analysis; (5) "corresponding author article", if the corresponding author's address was from the certain country or institution for analysis; and (6) "single author article", if the article has only one author and the author was from the certain country or institution for analysis. *TP, IP, CP, FP, RP*, and *SP* are the number of "total article", "single country article" or "single institution article", "internationally collaborative article" o "inter-institutionally collaborative article", "first author article", "corresponding author article", and "single author article", respectively. In Web of Science, corresponding author is labeled as "reprint author"; however, the research shown in this paper uses the term "corresponding author" (Ho 2014a). The first author, corresponding author, and single author are not mutually exclusive classifications. In single author articles where authorship is unspecified, the single author is classified as the first author and as corresponding author (Ho 2014a). Analogous to this, in single institute articles, the single institute is classified as the first author institute and as the corresponding author institute (Ho 2014a).

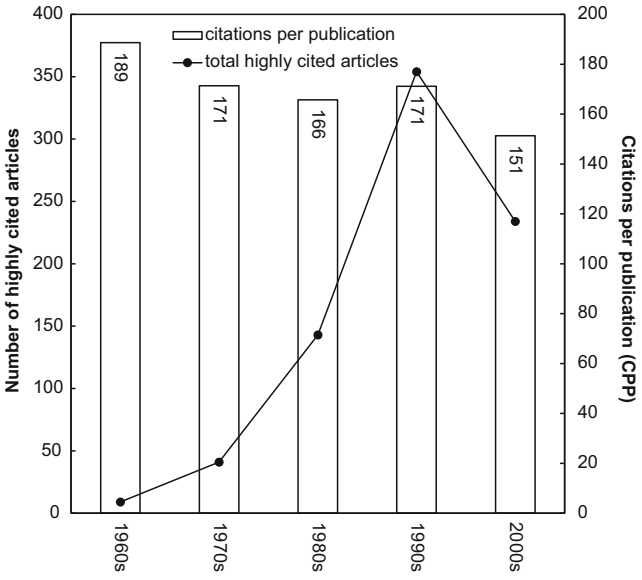

Fig. 1 Number of articles and citations per publication by decade

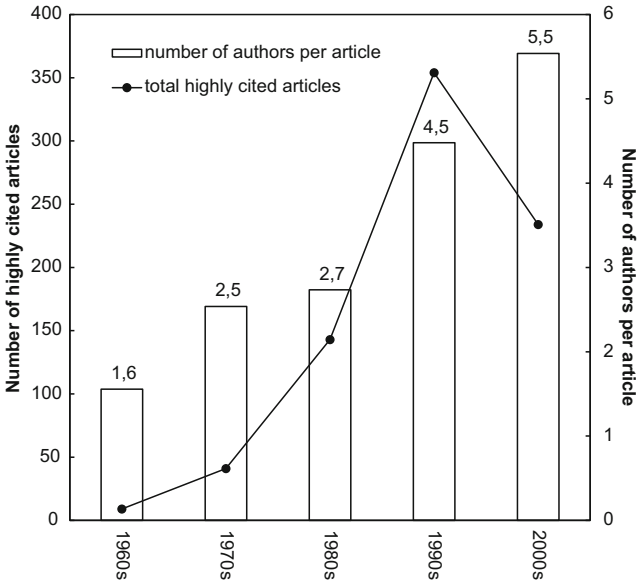

Fig. 2 Number of articles and number of authors per article by decade

Results and Discussion

Publication Year

Total citations for a paper from its publication date to the end of a recent year, was presented by Ho and co-workers as TC_{year} (Wang et al. 2011b; Chuang et al. 2011). This indicator was applied in recent years (Ho 2013; Ho and Kahn 2014). A total of 781 highly cited articles ($TC_{2014} \geq 100$) were published in the Web of Science category of horticulture in SCI-EXPANDED. The articles were published in 1961 to 2014. An average of 17 highly cited articles were published in each year. Minimum citation counts is 100 (TC_{2014}) and maximum is 1130 (TC_{2014}). Recently, Ho proposed a relationship between number of highly cited articles and their citations per publication ($CPP = TC_{year}/TP$) by decades for the top-cited articles in Web of Science category of chemical engineering (Ho 2012) and the classic articles on social work field (Ho 2014a) as well as by years for the top-cited research works in the SCI-EXPANDED (Ho 2013) and highly cited articles in materials science (Ho 2014b). Fig. 1 illustrates the distribution of these 781 highly cited articles over decades and their average citations per article ($CPP = TC_{2014}/TP$). No highly cited articles were published in the 2010s. As the articles need sufficient time to accumulate citations (Picknett and Davis 1999). The similar finding also found in the study of highly cited articles in the category of information science and library science in Social Science Citation Index (SSCI) (Ivanović and Ho 2016), top-cited articles in chemical engineering in SCI-EXPANDED (Ho 2012) and classic articles on the social work field in SSCI (Ho 2014a). Nine of the highly cited articles published in the 1960s and 45 and 30% of the highly cited articles were published in the 1990s and the 2000s respectively. This may be due to the increase in number of journals during the period and rapid increase in horticulture research. As the research helps to increase the yield and quality of horticulture crops, which is required to feed the hunger one. Articles published in the 1960s received *CPP* of 189, which is highest and lowest *CPP* value (151) was recorded to the articles published in the 2000s (Fig. 1).

Fig. 2 indicates the total highly cited articles with average authors per article in Web of Science category of horticulture. Average authors per article was also kept increasing in 1960s, 1.6 authors per article and in 2000s, it went to 5.5 authors per article, which is again one more indicator of quality of research in horticulture. The maximal value of authors in an article was 25 and the average value was 4.3 in horticulture, which again indicates the dominance of collaborative research in publication of highly cited articles in 1961–2014. Similar findings were found in the study of highly cited SARS research literature (Kostoff 2010) and the study conducted to find the characteristics of highly cited papers (Aksnes 2003).

Journals

A total of 33 journals were listed in the SCI-EXPANDED category of horticulture and all the journals with their details were provided in Table 1. As per the JCR 2014, value of the impact factor (IF_{2014}) for the 32 journals is ranged between 3.79, which is higher to the journal of *Theoretical and Applied Genetics* and lowest to *Mitteilungen Klosterneuburg* ($IF_{2014} = 0.045$). The articles published in *Horticulture Journal* can be found in SCI-EXPANDED since 2015. Of 33 journals, fourteen journals publication

frequency is quarterly, followed by ten journals bimonthly, five journals monthly, two journals tri-annual, and one semi-monthly and annually respectively. The highly cited articles were published by 16 journals of Web of Science category of horticulture. Remaining 17 journals had not published single highly cited article in 1960–2014. A total of 91,852 documents were published by these 32 journals with an average of 1701 documents per year from 1961 to 2014. A total of 71,373 articles were published by 32 journals with an average 2230 articles per year. *Theoretical and Applied Genetics*, a monthly journal, has contributed 484 highly cited articles with 4.7% of total 10,257 articles published by the journal, followed by *American Journal of Enology and Viticulture*, a quarterly journal (50 articles; 2.1% of 2400 articles), *Journal of the American Society for Horticultural Science*, a bimonthly journal (42; 0.53%), *Hortscience*, a bimonthly journal (41; 0.40%), and *Postharvest Biology and Technology*, a monthly journal (40; 1.6%) (Table 1).

Performance: Institutions, Countries, and Authors

Many researchers had made an effort to reveal the research performance of highly cited articles in a particular Web of Science subject category by institutions, countries, and authors, in environmental sciences (Khan and Ho 2012) and health care science and services (Hsu and Ho 2014). Table 2

Table 2 Characteristics of the 22 most productive institutions (*TP* ≥ 10)

Institute	*TP*	*TP R* (%)	*IP R* (%)	*CP R* (%)	*FP R* (%)	*RP R* (%)	*SP R* (%)
University of California, Davis, USA	81	1 (11)	1 (11)	2 (10)	1 (8.1)	1 (8.8)	1 (12)
Cornell University, USA	54	2 (7.1)	2 (4.1)	1 (10)	2 (4.8)	2 (4.6)	5 (3.4)
Institut National de la Recherche Agronomique, (INRA), France	40	3 (5.2)	3 (3.6)	4 (7.1)	3 (3.5)	3 (3.2)	N/A
United States Department of Agriculture, Agricultural Research Service (USDA ARS), USA	33	4 (4.3)	8 (1.7)	3 (7.4)	4 (2.4)	4 (2.5)	5 (3.4)
Agricultural Research Organization, Israel	19	5 (2.5)	15 (1.2)	5 (4.0)	10 (1.2)	10 (1.3)	8 (1.7)
University of Wisconsin, USA	19	5 (2.5)	5 (2.2)	12 (2.8)	5 (2.1)	6 (1.6)	N/A
Washington State University, USA	18	7 (2.4)	10 (1.5)	7 (3.4)	7 (1.6)	6 (1.6)	8 (1.7)
International Rice Research Institute (IRRI), Philippines	17	8 (2.2)	15 (1.2)	7 (3.4)	10 (1.2)	11 (1.2)	8 (1.7)
Agricultural University Wageningen, Netherlands	16	9 (2.1)	4 (2.9)	38 (1.1)	6 (1.8)	5 (1.9)	3 (5.2)
John Innes Centre for Plant Science Research, UK	16	9 (2.1)	8 (1.7)	14 (2.5)	8 (1.4)	6 (1.6)	8 (1.7)
Oregon State University, USA	16	9 (2.1)	15 (1.2)	9 (3.1)	10 (1.2)	11 (1.2)	N/A
Hebrew University of Jerusalem, Israel	15	12 (2.0)	33 (0.49)	6 (3.7)	19 (0.79)	22 (0.73)	N/A
Michigan State University, USA	15	12 (2.0)	5 (2.2)	22 (1.7)	9 (1.3)	9 (1.5)	2 (6.9)
North Carolina State University, USA	14	14 (1.8)	26 (0.73)	9 (3.1)	28 (0.65)	53 (0.29)	N/A
University of Adelaide, Australia	14	14 (1.8)	7 (1.9)	22 (1.7)	14 (1.0)	11 (1.2)	8 (1.7)
Agricultural Research Service (ARS), USA	13	16 (1.7)	33 (0.49)	9 (3.1)	19 (0.79)	22 (0.73)	8 (1.7)
Chinese Academy of Sciences, China	13	16 (1.7)	26 (0.73)	12 (2.8)	17 (0.92)	16 (0.88)	N/A
University of Florida, USA	13	16 (1.7)	10 (1.5)	17 (2.0)	19 (0.79)	16 (0.88)	3 (5.2)
Texas A&M University, USA	12	19 (1.6)	15 (1.2)	17 (2.0)	14 (1.0)	16 (0.88)	N/A
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia	11	20 (1.4)	10 (1.5)	28 (1.4)	17 (0.92)	22 (0.73)	N/A
Scottish Crop Research Institute, UK	11	20 (1.4)	10 (1.5)	28 (1.4)	10 (1.2)	11 (1.2)	N/A
University of Bristol, UK	10	22 (1.3)	33 (0.49)	15 (2.3)	34 (0.52)	36 (0.44)	8 (1.7)

TP total highly cited articles, *IP* single institution highly cited articles, *CP* inter-institutionally collaborative highly cited articles, *FP* first author highly cited articles, *RP* corresponding author highly cited articles, *SP* single author highly cited articles, *R* rank, *N/A* not available

provides the details about the top 22 most productive institutions, which published 10 or more highly cited articles in Web of Science subject category of horticulture. Of 22 institutions, eleven institutions were from USA, followed by three from UK, two from Israel, two from Australia, one from each of France, Philippines, Netherlands and China respectively. The majority of the institutions were based on the USA in case of studies which are concerned with highly cited articles on Web of Science categories of environmental sciences (Khan and Ho 2012) and health care science and services (Hsu and Ho 2014). This may be due to the budgetary provision available in the USA based institutions or else higher competency of USA based researcher. The highest contribution was from University of California, Davis in USA with 81 articles found 1st rank and also in single institution, corresponding, and single author highly cited articles respectively but in case of inter-institutionally collaborative highly cited articles the Cornell University in USA got first place. Michigan State University in USA is placed in 2nd ranked in case of single author highly cited articles and similarly, University of Florida in USA placed in 3rd place. Again one more interesting point is that all the institutions which placed in 1st and 2nd rank in total articles, single institution, corresponding author, inter-institutionally collaborative, first author, corresponding author, and single author highly cited articles were contributed by the institutions from the USA. The result is similar to the top cited ten intuitions in environmental sciences in SCI-EXPANDED (Khan and Ho 2012), the most frequently cited adsorption research articles in the Science Citation Index (Fu et al. 2012), the top-cited research works in the Science Citation Index Expanded (Ho 2013). Of 22 institutions, nine institutions do not have single author highly cited articles. University of Bristol in the UK has placed in 22nd rank in case of total papers, single institution (33rd rank), first author (34th rank), and corresponding author highly cited articles (36th rank). These 22 institutions had contributed 394 articles, which accounts for 52% of the 764 highly cited articles with authors' address in SCI-EXPANDED.

There were 17 highly cited articles without affiliations in Web of Science. Of 765 articles with author affiliations from 50 countries, 590 (77% of 765 articles) were single country articles from 35 countries and 174 (23%) were internationally collaborative articles from 44 countries. In last decade, Ho and co-workers proposed the six indicators such as total publications (*TP*), independent publications (*IP*), collaborative publications (*CP*), first authored publications (*FP*), corresponding authored publications (*RP*), and single authored publications (*SP*) to compare publications of countries and institutions respectively (Chiu and Ho 2005; Ho et al. 2010; Ho and Kahn 2014). Table 3 presents the all countries contributed highly cited articles to the Web of Sciences category of horticulture. USA has emerged as most contributing country with 352 highly cited articles, which accounts for 46% of the total articles found 1st rank in all six indicators. The similar result was found in the study on highly cited articles in library and information science category in Social Science Citation Index (Ivanović and Ho 2016) and materials science in Science Citation index expanded (Chuang and Ho 2014). UK was second most contributed country with 104 articles, which accounts for 14% of the total highly cited articles. Again, UK has secured 2nd rank in case of total articles, single country, internationally collaborative, first author, and corresponding author highly cited articles while Netherlands ranked 2nd in single author articles. Similar finding was found in the top-cited research works in the SCI-EXPANDED (Ho 2013), information science and library science category in Social Science Citation Index (Ivanović and Ho 2016), highly cited articles in biomass research (Chen and Ho 2015). In case of highly cited articles in health care sciences and services field in science citation index expanded, Canada found second leader place in the research performance (Hsu and Ho 2014). Among the 50 countries, 15 and 6 countries do not have single country and internationally collaborative highly cited articles respectively. Similarly, 13, 13, and 32 countries do not have first author, corresponding author, and single author highly cited articles respectively. Countries such as Chile, Cote Ivoire, Czech Republic, Iceland, Indonesia, Ireland, Jamaica, Kazakhstan, Mauritania, Morocco, Russia, Serbia, Taiwan, and Ukraine had contributed single highly cited article. Among these countries, only Ireland, Taiwan, and Ukraine have single country highly cited articles.

Bibliometric indicators such as total number of articles, first author articles, and corresponding author articles were applied to evaluate the publications of authors (Li and Ho 2008). Table 4 presents the name of the 22 most contributed authors who published six or more highly cited articles in Web of Science category of horticulture. The authorship list can be based on contribution, alphabetical order, or reverse seniority, but the approach most often used is ordering by contribution, especially for articles with few authors (Tscharntke et al. 2007). The first author has actually made the most contribution, and should receive a greater proportion of the credit (Riesenberg and Lundberg 1990; Marušić et al. 2004). S. D. Tanksley is the most productive author with 22 highly cited articles who belongs to Cornell University in USA. Similarly, K. M. Devos who contributed nine articles, who placed in 1st rank in case of first author (6 articles) and corresponding author (6 articles) highly cited articles. Of 22 authors, nine authors were belonging to institutions located in USA, three were from the UK, two from Philippines, one from Germany, one from Japan, one from Israel, and remaining five authors including M. D. Gale, R. Waugh, M.W. Ganal, C.N. Law, and K.W. Shepherd, do

Table 3 Characteristics of the all contributing countries

Country	*TP*	*TP R* (%)	*IP R* (%)	*CP R* (%)	*FP R* (%)	*RP R* (%)	*SP R* (%)
USA	352	1 (46)	1 (43)	1 (57)	1 (41)	1 (39)	1 (50)
UK	104	2 (14)	2 (10)	2 (25)	2 (10)	2 (11)	3 (5.2)
France	69	3 (9.0)	3 (5.9)	3 (20)	3 (6.5)	3 (6.6)	N/A
Australia	48	4 (6.3)	4 (5.4)	7 (9.2)	4 (5.1)	4 (5.1)	7 (1.7)
Germany	48	4 (6.3)	7 (4.2)	4 (13)	6 (4.1)	6 (4.3)	4 (3.4)
Netherlands	41	6 (5.4)	5 (4.7)	10 (7.5)	5 (4.6)	5 (4.7)	2 (14)
Italy	37	7 (4.8)	11 (2.4)	4 (13)	10 (2.6)	9 (2.8)	7 (1.7)
Japan	37	7 (4.8)	6 (4.4)	13 (6.3)	7 (3.8)	7 (4.0)	7 (1.7)
China	34	9 (4.5)	9 (2.9)	6 (10)	8 (3.0)	8 (3.1)	N/A
Israel	34	9 (4.5)	8 (3.1)	7 (9.2)	9 (2.7)	10 (2.6)	7 (1.7)
Spain	30	11 (3.9)	11 (2.4)	7 (9.2)	11 (2.5)	12 (2.5)	7 (1.7)
Canada	26	12 (3.4)	10 (2.5)	13 (6.3)	11 (2.5)	10 (2.6)	N/A
Philippines	18	13 (2.4)	13 (1.0)	11 (6.9)	14 (1.3)	15 (1.3)	7 (1.7)
India	16	14 (2.1)	17 (0.68)	11 (6.9)	14 (1.3)	14 (1.5)	N/A
Switzerland	15	15 (2.0)	15 (0.85)	15 (5.7)	13 (1.7)	13 (1.8)	N/A
New Zealand	10	16 (1.3)	13 (1.0)	21 (2.3)	16 (1.0)	16 (1.2)	7 (1.7)
Belgium	9	17 (1.2)	15 (0.85)	21 (2.3)	17 (0.65)	18 (0.59)	7 (1.7)
Brazil	8	18 (1.0)	20 (0.34)	16 (3.4)	20 (0.39)	19 (0.44)	N/A
Austria	6	19 (0.79)	26 (0.17)	17 (2.9)	17 (0.65)	17 (0.73)	7 (1.7)
Colombia	6	19 (0.79)	26 (0.17)	17 (2.9)	25 (0.26)	24 (0.29)	N/A
Hungary	6	19 (0.79)	26 (0.17)	17 (2.9)	25 (0.26)	28 (0.15)	N/A
Mexico	6	19 (0.79)	20 (0.34)	21 (2.3)	20 (0.39)	24 (0.29)	N/A
Argentina	5	23 (0.65)	N/A	17 (2.9)	N/A	N/A	N/A
Greece	5	23 (0.65)	20 (0.34)	26 (1.7)	20 (0.39)	19 (0.44)	N/A
Finland	4	25 (0.52)	18 (0.51)	30 (0.57)	19 (0.52)	19 (0.44)	4 (3.4)
Poland	4	25 (0.52)	N/A	21 (2.3)	29 (0.13)	28 (0.15)	N/A
Portugal	4	25 (0.52)	26 (0.17)	26 (1.7)	29 (0.13)	28 (0.15)	N/A
South Korea	4	25 (0.52)	26 (0.17)	26 (1.7)	29 (0.13)	28 (0.15)	7 (1.7)
Thailand	4	25 (0.52)	N/A	21 (2.3)	29 (0.13)	28 (0.15)	N/A
Croatia	3	30 (0.39)	N/A	26 (1.7)	N/A	N/A	N/A
Denmark	3	30 (0.39)	18 (0.51)	N/A	20 (0.39)	19 (0.44)	7 (1.7)
Syria	3	30 (0.39)	20 (0.34)	30 (0.57)	20 (0.39)	19 (0.44)	4 (3.4)
Norway	2	33 (0.26)	26 (0.17)	30 (0.57)	29 (0.13)	28 (0.15)	N/A
Pakistan	2	33 (0.26)	26 (0.17)	30 (0.57)	29 (0.13)	28 (0.15)	N/A
South Africa	2	33 (0.26)	20 (0.34)	N/A	25 (0.26)	24 (0.29)	N/A
Sweden	2	33 (0.26)	20 (0.34)	N/A	25 (0.26)	24 (0.29)	N/A
Chile	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Cote Ivoire	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Czech Republic	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Iceland	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Indonesia	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Ireland	1	37 (0.13)	26 (0.17)	N/A	29 (0.13)	28 (0.15)	N/A
Jamaica	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Kazakhstan	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Mauritania	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Morocco	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Russia	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A
Serbia	1	37 (0.13)	N/A	30 (0.57)	N/A	N/A	N/A

Table 3 Characteristics of the all contributing countries (Continued)

Country	*TP*	*TP R* (%)	*IP R* (%)	*CP R* (%)	*FP R* (%)	*RP R* (%)	*SP R* (%)
Taiwan	1	37 (0.13)	26 (0.17)	N/A	29 (0.13)	28 (0.15)	N/A
Ukraine	1	37 (0.13)	26 (0.17)	N/A	29 (0.13)	28 (0.15)	7 (1.7)

TP total highly cited articles, *IP* single country highly cited articles, *CP* internationally collaborative highly cited articles, *FP* first author highly cited articles, *RP* corresponding author highly cited articles, *SP* single author highly cited articles, *R* rank, *N/A* not available

Table 4 Top 22 most prolific authors

Author	Institution	Rank (*TP*)	Rank (*FP*)	Rank (*RP*)
S.D. Tanksley	Cornell University, USA	1 (22)	2 (4)	3 (5)
M.D. Gale	N/A	2 (13)	N/A	N/A
S.R. McCouch	Cornell University, USA	3 (12)	84 (1)	1 (6)
N. Huang	International Rice Research Institute (IRRI), Philippines	4 (10)	16 (2)	88 (1)
G.S. Khush	International Rice Research Institute (IRRI), Philippines	5 (9)	N/A	88 (1)
T.C. Osborn	Atlantic Richfield Company (ARCO), USA	6 (8)	84 (1)	N/A
W. Powell	DuPont Company Inc., USA	6 (8)	84 (1)	N/A
R. Waugh	N/A	6 (8)	N/A	N/A
P.B. Cregan	United States Department of Agriculture, Agricultural Research Service (USDA ARS), USA	9 (7)	N/A	7 (3)
K.M. Devos	John Innes Institute, UK	9 (7)	1 (6)	1 (6)
K.J. Edwards	University of Bristol, UK	9 (7)	N/A	88 (1)
M.S. Roder	Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany	9 (7)	N/A	88 (1)
J. Dvorak	University of California, Davis, USA	13 (6)	84 (1)	88 (1)
M.W. Ganal	N/A	13 (6)	N/A	N/A
P.M. Hayes	Oregon State University, USA	13 (6)	84 (1)	88 (1)
S. Kresovich	University of Georgia, USA	13 (6)	16 (2)	19 (2)
C.N. Law	N/A	13 (6)	N/A	N/A
C.P. Meredith	University of California, Davis, USA	13 (6)	N/A	19 (2)
K.W. Shepherd	N/A	13 (6)	N/A	N/A
M. Soller	Hebrew University of Jerusalem, Israel	13 (6)	16 (2)	88 (1)
A.J. Worland	John Innes Centre for Plant Science Research, UK	13 (6)	16 (2)	19 (2)
M. Yano	National Institute of Agrobiological Resources (NIAR), Japan	13 (6)	84 (1)	4 (4)

TP total highly cited articles, *FP* first author highly cited articles, *RP* corresponding author highly cited articles, *N/A* not available

not have first author and corresponding author highly cited articles. Similarly, G.S. Khush, P.B. Cregan, K.J. Edwards, M.S. Roder, and C.P. Meredith do not have any first author highly cited articles and W. Powell and T.C. Osborn also do not have their corresponding highly cited article. Six authors had a single highly cited article to their credits and seven authors had a single highly cited article as corresponding author respectively. A.J. Worland was the only one who published single author highly cited article in Table 4. In addition, S. Ceccarelli, J.E. Parlevliet, M. E. Saltveit, and S.F. Yang were authors who published two single author highly cited articles. Articles entitled "Reporting of objective color measurements" (McGuire 1992) by McGuire from U.S. Department of Agriculture-Agricultural Research Service was the most frequently cited single author articles with TC_{2014} of 935 ranked 3rd and C_{2014} of 84 ranked 5th.

In an era of increasing multiple-authorship when the contribution of authors is diluted, further study was concentrated on only the first and corresponding author publications (Hsu and Ho 2014). Ho proposed a new bibliometric indicator that the Y-index (*j, h*) is related to numbers of first author publications (*FP*) and corresponding author publications (*RP*), and already be applied to evaluate authors, institutions, and countries, as defined (Ho 2012, 2013, 2014b):

$$j = FP + RP \tag{1}$$

$$h = tan^{-1}\left(\frac{RP}{FP}\right) \tag{2}$$

where, j is publication performance, which is a constant related to publication quantity, and h is publication characteristics, which can describe the proportion of *RP* to *FP*. j is the sum of *FP* and *RP*. The greater j is, the more contribution the analyzed unit makes. Different values of h stand

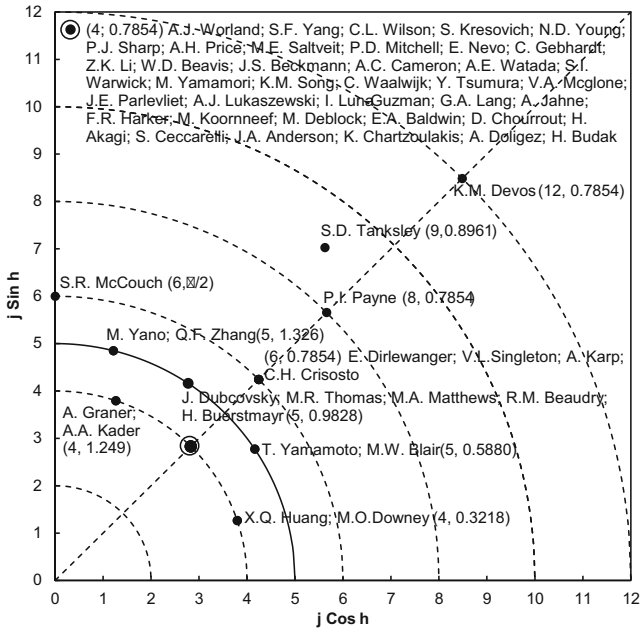

Fig. 3 Top 59 authors with Y-index ($j \geq 4$)

for different proportions of *RP* to *FP*. $h > 0.7854$ means more *RP*; $h = 0.7854$ means the same quantity of *FP* and *RP*; $0 < h < 0.7854$ means more *FP*. When $h = 0$, j = number of first author articles and when $h = \pi/2$, j = number of corresponding author articles (Ho 2014b).

The Y-index provides a single index that identifies important characteristics related to the first and corresponding author that cannot be obtained by other traditional indicators (Fu and Ho 2013). Of the 781 highly cited articles in horticulture field, 623 articles had both first author and corresponding author information in SCI-EXPANDED and were used to calculate a Y-index for individual authors. The fact that only articles with both first author and corresponding author information could be considered is a limitation of this indicator. In SCI-EXPANDED database, the corresponding author is labeled as the "reprint author", and this study uses the term "corresponding author". In a single author article where authorship is not specified, the single author is classified as the first author and the corresponding author (Ho 2013). Fig. 3 shows the top 59 authors with by value of the j parameter of Y-index ($j > 3$) ($j\ Cos\ h$ and $j\ Sin\ h$ is chosen as the x and y coordinates axes). Distance of point from coordinate beginning is directly proportional to the value of Y-index j parameter of a certain author. The parameter j is proportional to the total number of first and corresponding author articles, and parameter h differentiates the nature of the leadership role: first or corresponding author role. If the point of the author is above (below) the line $y = x$, value of Y-index h parameter is greater (smaller) than 0.7854, number of highly cited articles where the certain author is the first author is lower (higher) than number of highly cited articles where the author is corresponding author (Ho 2012, 2014b). The highest values of j parameter of Y-index have researchers such as K.M. Devos ($j = 12$), S.D. Tanksley ($j = 9$), P.I. Payne ($j = 8$), E. Dirlewanger, V.L. Singleton, A. Karp, and C.H. Crisosto ($j = 6$). Points which represent researchers K.M. Devos with $h = 0.7854$ which means he has equal number of highly cited articles as *RP* and *FP* and S.D. Tanksley with $h = 0.8961$, which indicates he has more corresponding author highly cited articles than *FP*. The advantages of the Y-index are presented in the figure. The distribution of authors by Y-index clearly shows that when one had larger j, it could be found one's Y-index located far away from original of the polar coordinates, that means the author published more first and corresponding author papers; when one had larger h it could be found one's Y-index closed to y-axis, that means the author published more corresponding author articles than first author articles (Ho 2012, 2014b). Most authors published the same number of first and corresponding author highly cited articles with h of 0.7854. S.R. McCouch published only six corresponding author articles but no first author article ($6, \pi/2$). M. Yano, Q.F. Zhang, J. Dubcovsky, M.R. Thomas, M.A. Matthews, R.M. Beaudry, H. Buerstmayr, T. Yamamoto, and M.W. Blair located in the same arc ($j = 5$). They published the same numbers of total first author and corresponding author articles. However they have different publication characteristics. Yano and Zhang published more corresponding author articles with Y-index of (5, 1.326) then Dubcovsky, Thomas, Matthews, Beaudry, and Buerstmayr with Y-index of (5, 0.9828) while Yamamoto and Blair published more first author articles with Y-index of (5, 0.5880). In addition, X.Q. Huang and M.O. Downey were also published more first author articles then corresponding author articles with Y-index of (4, 0.3218).

Citation Life Cycles of Highly Cited Articles

The studies on citations life cycles of highly cited articles in particular subject was investigated for example in wetland research in Science Citation Index Expanded (Ma et al. 2013) and classic articles in social work in Social Science Citation Index (Ho 2014a). Table 5 presents the top 10 articles cited at least 563 times ($TC_{2014} \geq 563$). Among these, two articles published in the 1993, two articles in the 1996, one in each of 1977, 1988, 1992, 2000, 2003, and 2004, respectively. Only four articles had at least one or more citations in the publication year ($C_0 \geq 1$). Of 10 articles, seven were concerned with plant breeding and crop improvement and remaining three with post-harvest technology. Plant breeding involved in increasing yield, often based on resistance to biotic and non-biotic stress (Janick 2005). Five articles were written by more than three au-

Table 5 Ten most frequently cited articles in Web of Science category of horticulture

Rank (TC_{2014})	Rank (C_{2014})	Rank (C_0)	Rank (*TCPY*)	Title	References
1 (1130)	1 (152)	259 (0)	12 (30)	Total phenol analysis: Automation and comparison with manual methods	Slinkard and Singleton (1977)
2 (1114)	6 (71)	259 (0)	2 (59)	The comparison of RFLP, RAPD, AFLP and SSR (microsatellite) markers for germplasm analysis	Powell et al. (1996)
3 (935)	5 (84)	259 (0)	4 (41)	Reporting of objective color measurements	McGuire (1992)
4 (844)	45 (25)	15 (4)	6 (38)	Development of reliable PCR-based markers linked to downy mildew resistance genes in lettuce	Paran and Michelmore (1993)
5 (802)	2 (112)	259 (0)	1 (73)	A high-density microsatellite consensus map for bread wheat (*Triticum aestivum* L.)	Somers et al. (2004)
6 (773)	7 (70)	112 (1)	4 (41)	High level of genetic differentiation for allelic richness among populations of the argan tree (*Argania spinosa* (L) Skeels) endemic to Morocco	El Mousadik and Petit (1996)
7 (730)	164 (13)	259 (0)	16 (27)	Molecular mapping of rice chromosomes	McCouch et al. (1988)
8 (603)	3 (86)	25 (3)	3 (50)	Exploiting EST databases for the development and characterization of gene-derived SSR-markers in barley (*Hordeum vulgare* L.)	Thiel et al. (2003)
8 (603)	62 (22)	112 (1)	16 (27)	RAPD variation within and among natural populations of outcrossing buffalograss (*Buchloëdactyloides* (Nutt.) Engelm.)	Huff et al. (1993)
10 (563)	8 (69)	259 (0)	6 (38)	Preharvest and postharvest factors influencing vitamin C content of horticultural crops	Lee and Kader (2000)

TC_{2014} number of citations till 2014, C_{2014} number of citations in 2014, C_0 number of citations in publication year, *TCPY* TC_{2014} per year

thors, four by two authors, and remaining one by single author. Article contributed by Somers et al. (2004) had received 73 citations which is highest rate of TC_{2014} per year (*TCPY*) among them and ranked as 1st and one more article contributed by Powell et al. (1996) also received 59 citations per year since its publication and took 2nd rank. Six articles were published in *Theoretical and Applied Genetics*, one in each of *American Journal of Enology and Viticulture*, *Molecular Breeding*, *Hortscience*, and *Postharvest Biology and Technology* respectively. Five articles were contributed by independent USA based authors Lee and Kader (2000), McCouch et al. (1988), McGuire (1992), Paran and Michelmore (1993), and Slinkard and Singleton (1977), one by authors from Germany (Thiel et al. 2003), one article published in collaboration with authors from USA, UK, Canada, and Italy (Powell et al. 1996), one by authors from UK and Canada (Somers et al. 2004), one article by authors from France and Morocco (El Mousadik and Petit 1996), and one by Australia and USA (Huff et al. 1993) based authors respectively. Four articles which are related to breeding aspects are written in collaboration with authors from different countries.

The article titled as "Total phenol analysis: Automation and comparison with manual methods" (Slinkard and Singleton 1977) has the highest value of TC_{2014} (1130) and C_{2014} (152) among the highly cited articles in Web of Science Category of horticulture. The article was about the comparison of manual and automated method for analysis for total phenols in wine and other plant extracts, which is found to be very useful to the researchers while deciding method for analysis of phenols in wine (Slinkard and Singleton 1977). Similarly, highly cited articles in biomass research, the most cited articles was on extraction method for measuring soil microbial biomass (Chen and Ho 2015). The correspondingly, articles titled as "The comparison of RFLP, RAPD, AFLP, and SSR (microsatellite) markers for germplasm analysis" (Powell et al. 1996) also has second highest TC_{2014} (1114), which takes the 2nd rank in horticulture field. The articles indicates that comparison involved both cultivated (*Glycine max*) and wild soybean (*Glycine soja*) accessions, estimates based on RFLPs, AFLPs and SSRs are greatly correlated, demonstrating congruence between these assays but correlations of RAPD marker data with those obtained using other marker systems were lower (Powell et al. 1996) The article titled as "Reporting of objective color measurements" is third most highly cited articles with TC_{2014} 935. This is concerned with post-harvest technology aspect and published in *Hortscience* (McGuire 1992). The article receives an average of 41 citations per year since its publication and it has no citations in its publication year. This takes the 4th rank in citations (*TCPY*) among the ten most frequently cited articles. Article contributed by Paran and Michelmore (1993) was the 4th most frequently cited article in horticulture with TC_{2014} value of 844. The article receives 4 citations in its publication year and 25 citations in 2014. The article found that the amplified fragment contained no obvious repeated sequences beyond the primer sequence (Paran and Michelmore 1993). Article entitled

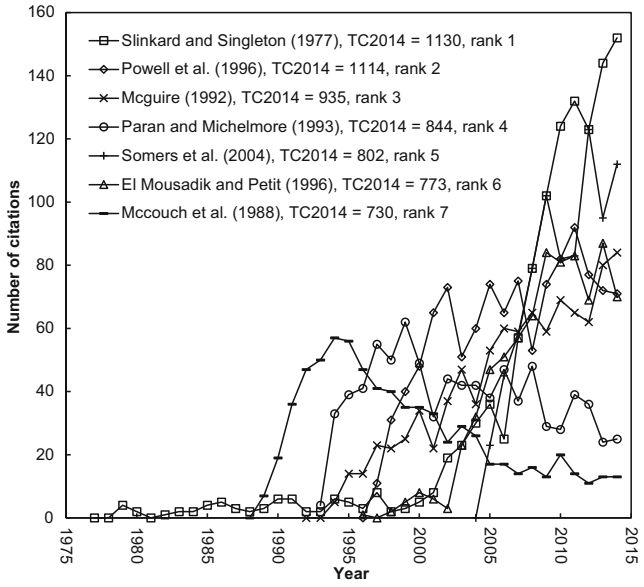

Fig. 4 Citation life cycles of the top seven articles ($TC_{2014} \geq 730$)

as "A high-density microsatellite consensus map for bread wheat (*Triticum aestivum* L.)" has TC_{2014} value of 844 and ranked 5th. The article has received considerable number of citations over years since its publication. The article is ranked 2nd in C_{2014} (112). It has no citations in its publication year and ranked 1st in *TCPY* (73). The article published in more productive journal *Theoretical and Applied Genetics* in the Web of Science category of horticulture. The consensus map here in described provides a more complete coverage of the durum wheat genome compared with earlier developed maps (Somers et al. 2004). We expect this to receive more citation in future. El Mousadik and Petit (1996) had contributed article titled as "High level of genetic differentiation for allelic richness among populations of the argan tree (*Argania spinosa* (L) Skeels) endemic to Morocco" which takes the 6th rank among the ten most frequently cited articles. The article receives the 1 citations in the publication year and takes the 112th position among the articles and in 2014, it has received 41 citations ranking 4th in ten articles. The consensus map developed which represents the highest-density public microsatellite map of wheat and is accompanied by an allele database showing the parent allele sizes for each marker mapped (El Mousadik and Petit 1996). The article published in 1988 titled as "Molecular mapping of rice chromosomes" (McCouch et al. 1988) takes the 7th place (TC_{2014} = 730) in most frequently cited articles and it has received maximum citations in the beginning in exponential manner and later some slight decline is observed. The findings reported in the article were included that rice DNA is less C-methylated than tomato or maize DNA and the notion that a large fraction of the rice genome (approximately 50%) is single copy (McCouch et al. 1988).

Thiel et al. (2003) also had published article in the Web of Science category of horticulture, which ranked 8th in most frequently cited articles. The article had received 3 citations (C_0 = 3) in its publication year and ranked 3rd (*TCPY* = 50) in average citations per year. A software tool was developed for the identification of simple sequence repeats (SSRs) in barley (*Hordeum vulgare* L.) EST (expressed sequence tag) database comprising 24,595 sequences (Thiel et al. 2003). Similarly, article titled as "RAPD variation within and among natural-populations of outcrossing buffalo grass (buchloe-dactyloides (NUTT) engelm)" was also one among the most frequently cited articles, which takes the 8th rank (TC_{2014} = 603) and the article reports the results on variation of RAPD markers within and among natural-populations of outcrossing buffalo grass (Huff et al. 1993). The article contributed by Lee and Kader (2000) was the 10th most frequently cited article, which receives an average of 33 citations per years since its publication (*TCPY* = 33). The article reports the result of preharvest and postharvest factors that influence vitamin c content in the horticultural crops (Lee and Kader 2000). Genotypic differences, preharvest climatic conditions and cultural practices, maturity and harvesting methods, and postharvest handling procedures are the major influencing factors (Lee and Kader 2000; Table 5).

Fig. 4 provides citation life cycle of top seven most frequently cited articles $TC_{2014} \geq 730$. Many researchers had studied the citation life cycle of the top cited articles to reveal their features (Avramescu 1979; Cano and Lind 1991; Ho 2012). The article by Slinkard and Singleton (1977) has received less citations and in last decade (after 2005), later it has received maximum citations. The article did not have any citation in its publication year (C_0 = 0), later it has started receiving maximum citations up to 2010, again some fall in number of citations were observed. This finding is agreement with result found in the study of citations life cycle of ten classic works, five in medicine and five in biochemistry (Cano and Lind 1991). The similar result was found in the study of citation lifecycle of papers with delayed recognition (Lachance and Larivière 2014). The article contributed by Powell et al. (1996) has received maximum citations and later some decline was observed since its publication.

The highly cited articles might not always be high impact or visibility after publication (Ho 2014b; Ho and Kahn 2014). Impact of a highly cited article in recent year was discussed by C_{year} (Ho 2014a, 2014b). Fig. 5 presents the seven most cited articles in recent year with $C_{2014} \geq 70$. The article contributed by Slinkard and Singleton (1977) has highest value of C_{2014} with 152 citations. It again gives the clue that later it may receive good number of citations. This article may be called as "Sleeping Beauty" (van Raan 2004) as it has attracted more citations in recent years (Lachance

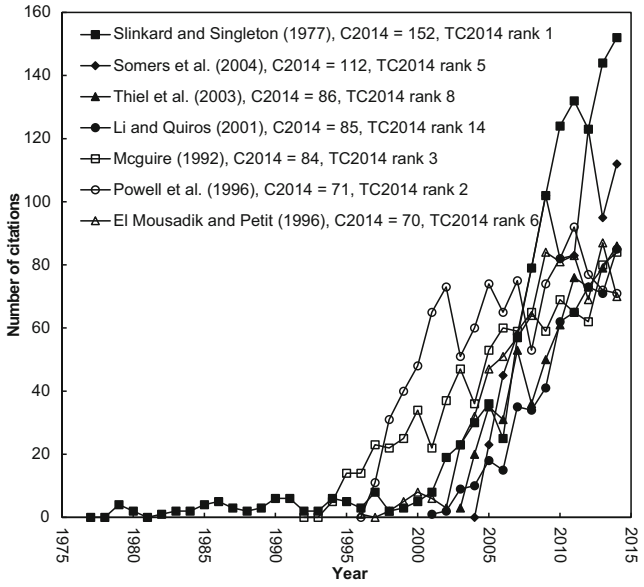

Fig. 5 Citation life cycles of the top seven articles ($C_{2014} \geq 70$)

and Larivière 2014). The methodology might be more appropriate so that number of authors had started using the article for their research design in recent years (Antonakis et al. 2014). The article has been ranked 1st in indicator of highest in both TC_{2014} (1130) and C_{2014} (152). Second article with second highest value of C_{2014} (112) is contributed by Somers et al. (2004) published in most recently (2004) and ranked in 5th article in indicator of TC_{2014}. One more article contributed by Powell et al. (1996) is placed as 2nd article with highest TC_{2014} value and has received 71 citations in 2014.

Conclusion

In this study, we did analyze the 781 highly cited articles characteristics and attributes published in 33 journals listed in Web of Science category of horticulture from 1961–2014. Most of the highly cited articles were published in *Theoretical and Applied Genetics* and *American Journal of Enology and Viticulture*, respectively. An average of 17 highly cited articles published in each year. Majority of the highly cited articles published in 1990s and 2000s, respectively. Articles published in 1960s has received highest citation rate per article. Average authors per article also kept increasing from 1960s to 2000s, respectively. University of California, Davis in USA and Cornell University were the most productivity institutions respectively. USA and UK were the most contributing countries. The citation life cycles of the highly cited articles indicate that majority of the highly cited articles had received less citation in their publication decade, later started to receive good number of citations.

Conflict of interest S. R. Kolle, T. H. Shankarappa and Y.-S. Ho declare that they have no competing interests.

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