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Highly cited Articles in plant Sciences from Science citation index-Expanded: a scientometric analysis

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Highly cited Articles in plant Sciences: a scientometric analysis

This paper analyses the 239 publications with more than 1000 citations indexed in SCI-Expanded of Web of Science under research area plant sciences. These publications have been written by 600 authors and from 224 institutes and universities across the world. There are 52 periodicals with impact factor ranging from 0.687-18.918 which published these articles. The most number of highly cited articles were published in Annual Review of Plant Physiology And Plant Molecular Biology (34). Authorship pattern indicates that 25 % of highly cited publications (61) have been written by single author. Two author publications is most prevalent with 90 publications. It is also evident that one paper was written by as many as 42 authors. There are 148 papers in international collaboration and 61 papers without collaboration. Photosynthesis is the most frequent keyword used by authors.

Keywords: *Highly cited, scientometrics, plant sciences, bibliometrics.*

Introduction

Citations are Bibliographic references acknowledging important work previously done in a particular research area. Citedness of scholarly publication is the indicator of quality and impact of the publication. Eugene Garfield coined the term impact factor on the basis of Citation of articles published in a particular journal. On the basis of citation received Journal citation report is published every year by institute of Scientific Information, Philadelphia owned by Clarivate analytics (previously Thomson Reuters). Peer reviewed Journal having high impact factor publishes the best articles. In bibliometric analysis, evaluation of highly cited journal(s) and Author(s) have been broadly used. Research

publications in the field of plant sciences has grown exponentially from 529 publications in 1945 to 30187 publications in year 2018 as per web of science there are total 873663 records in research area "Plant sciences" .

Various bibliometric analysis of highly cited articles have been previously done by scholars. Eugene Garfield (1973) published an editorial of highly cited works in pure mathematics[1] and applied mathematics[2] during the period 1961-1972. Aversa (1985) analysed citation pattern of highly cited papers with relationship to literature ageing[3]. Paladugu et al (2002) reported one hundred citation classics in general surgical journals[4] Baltussen & Kindler (2004) anlaysed citation classics in critical care medicine[5]. Chuang et al (2011) analysed high impact paper in water resources from Essential science indicator[6]. Khan & Ho (2012) analysed top cited articles in the field of environment sciences[7]. Fu et al (2012) reported most frequently cited paper in adsorption research[8]. Ma et al analysed top cited articles in the wetland[9]. Ho (2014) analysed Classic articles on social work field[10] , materials science[11]. Hsu et al (2014) analysed Highly cited articles in health care sciences and services[12]. Highly cited publications output from specific contry/region have also been investigated by a number of researchers Similarly bibliometric evaluation of particular journals also analyses the highly cited artilcles from that journals. Pislyakov and Shukshina(2014) Measured highly cited papers from Russia leading institutions, patterns of national and international collaboration[13] Ho and Kahn (2014) investigated highly cited reviews in the Science Citation Index[14] , Azer(2015) analysed top-cited articles in medical education[15]. Fuand Ho(2015) reported top cited articles in thermodynamic research[16]. Chuang and Ho (2015) evaluated highly cited publications in Taiwan[17] and Canada [18]. Elango and Ho (2017) analysed highly cited papers from india[19]. Pathak & Bharati (2018) analysed Indian Journal of Traditional Knowledge on various scientometric indicators.[20]

The main objective of this paper is to analyze the highly cited articles in plant sciences, identify highly cited journals, authorship pattern, leading countries and organizations, highly cited authors, and document types.

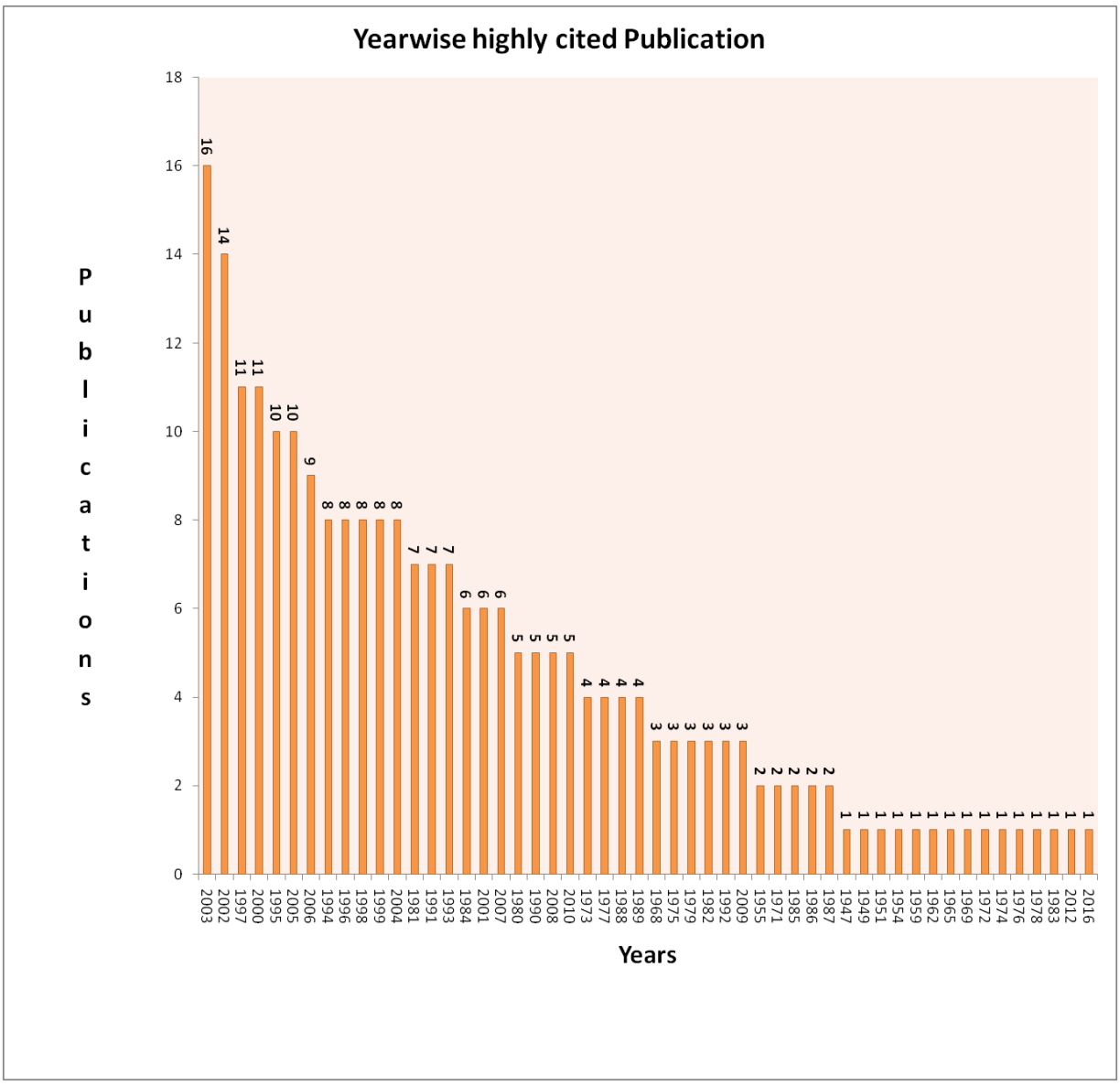
Methodology

Data for this study was collected from. Science Citation Index Expanded (SCI-E) database of Web of Science core collection from Clarivate analytics, using advanced search feature on 14 Auguststst 2019. Keyword used is Su=plant sciences and results thus obtained were sorted on the basis of citations received. Articles with 1000 or more citations were chosen for further analysis. Document under category of correction, reprint and retracted publication were excluded from the study. There were total 873663 publications under research category plant sciences. Out of which 239 publications have >=1000 citations All the results were downloaded in MS-excel for analysis. For data visualization software Vosviewer were used.

Results and Findings:

Yearwise publication

Analysis of Yearwise publication reveals that the earliest articles which received 1000 or more citations dates back to year 1947. The duration of publication year of highly cited articles ranges from 1947-2016. From 1947 to 1968 the highly cited articles growth is triannually i.e after three years gap there is one highly cited articles and from 1969 onwards there is at least one research publications which have received 1000 or more citations except year 2011.2013 2014 & 2015. Highest number of highly cited articles are from year 2003 with 16 publications followed by year 2002 with 14 publications, year 1997 & 2000 with 11 publication each (Fig 1).



Document Types

Document types identified by Web of Science was analyzed. From This analysis six document categories were found. The highest number of the highly cited documents are Reviews with 131 items (54.81%) followed by Articles with 101 items (42.25%), Book chapter (15, 6.27%), Proceeding

paper(6,2.5%) , note (5, 2.09%) and Editorial material(0.83%) respectively. (Fig-2). Proceeding papers, note and editorial matter has much lesser significant values in comparison to articles and reviews. (Fig-2)

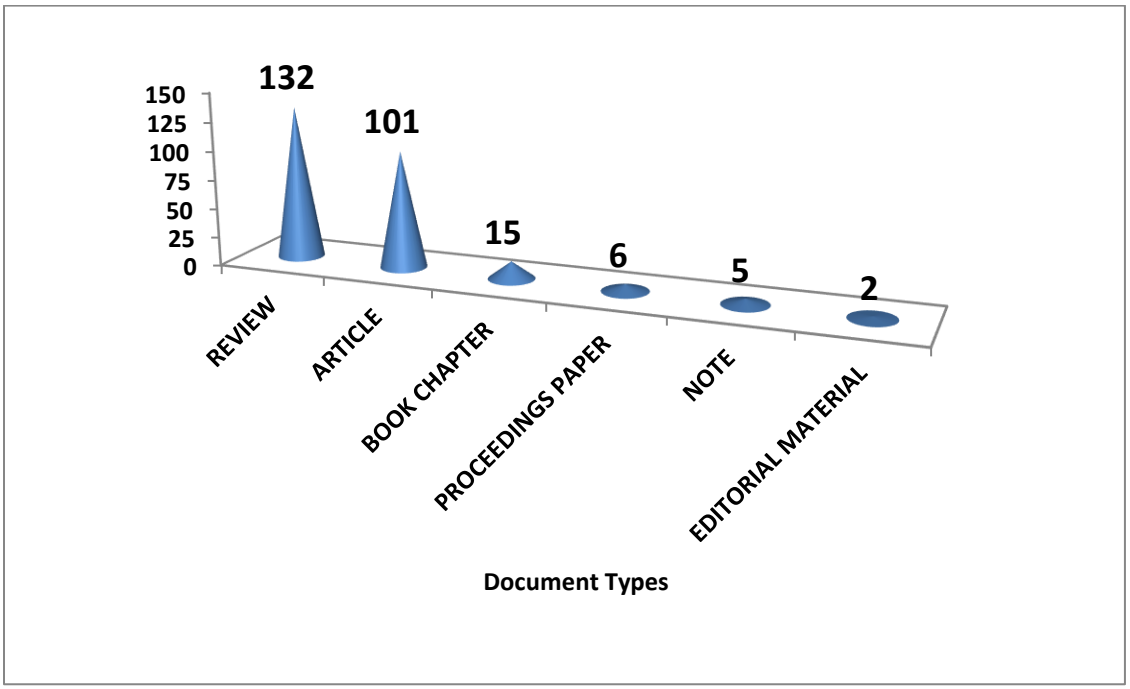


Figure-2 : Document Types

Organizations

These 239 highly cited articles in plant sciences have been contributed by total of 226 organizations across the globe. University of California System, USA is leading the list with 10 publications having 15138 citations, followed by University of Arizona & RIKEN with 9 publications each and received 14441 & 11404 citattions respectively. Commonwealth Scientific industrial Research organization (CSIRO), Japan International Research Center For Agricultural Sciences ,Max Planck Society having 8 publications each with 16946, 10347 & 12591 citations respectively. On the basis of impact of publications Australian National University is the most prolific organization with 18276 citations from 6 publications having 3046 average citations followed by Commonwealth Scientific industrial Research organization (CSIRO), with 16946 citations and 2118 citations per item. (Table1)

Table 1- Prolific organizations

Sl No	Organization(s)	Publication (>5)	Citation	Impact(C/p)
1.	University of California System	10	15138	1513
2.	Univ Arizona	9	14441	1604.5
3.	RIKEN, Japan	9	11404	1267.1
4.	COMMONWEALTH SCIENTIFIC INDUSTRIAL RESEARCH ORGANISATION CSIRO	8	16946	2118.25
5.	JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES	8	10347	1293.8
6.	MAX PLANCK SOCIETY	8	12591	1573.8
7.	INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE INRA	7	9849	1407
8.	UNIVERSITY OF WISCONSIN SYSTEM	7	10427	1489.5
9.	AUSTRALIAN NATIONAL UNIVERSITY	6	18276	3046

Countries

Country wise analysis indicates that these highly cited articles involves 32 countries among which USA is leading country with 110 publications which is 46% of total highly cited publications. USA is followed by England, Australia, Germany, Japan, France and Canada with 31, 22, 21,14, 11 & 10 Publications respectively. There are 9 countries namely Argentina, Barbados, Bulgaria, Finland, Hungary, Morocco, Nigeria, Philippines and Scotland with single publication. Top 5 countries contribute more than 83 % publications. (Table 2)

Table-2: Countrywise distribution of highly cited papers

Sl.No	Countries	TP	%age of global Output	IP	%age	CP	%age
1.	USA	110	46.03	81	73.64	29	26.36
2.	ENGLAND	31	13.39	11	35.48	11	35.48
3.	AUSTRALIA	22	9.21	17	77.27	5	22.73
4.	GERMANY	21	8.79	14	66.67	7	33.33
5.	JAPAN	14	5.86	13	92.86	1	7.14
6.	CANADA	10	4.18	5	50.00	5	50.00
7.	FRANCE	11	4.18	4	36.36	7	63.64
8.	SWITZERLAND	7	2.93	3	42.86	4	57.14
9.	NETHERLANDS	6	2.51	4	66.67	2	33.33
10.	BELGIUM	5	2.09	2	40.00	3	60.00
11.	ISRAEL	5	2.09	3	60.00	2	40.00
12.	SWEDEN	5	2.09	1	20.00	4	80.00
13.	DENMARK	3	1.26	0	0.00	3	100.00
14.	INDIA	3	1.26	3	100.00	0	0.00
15.	ITALY	3	1.26	2	66.67	1	33.33
16.	SOUTH AFRICA	3	1.26	1	33.33	2	66.67
17.	SPAIN	3	1.26	0	0.00	3	100.00
18.	WALES	3	1.26	1	33.33	2	66.67
19.	AUSTRIA	2	0.84	0	0.00	2	100.00
20.	FED REP GER	2	0.84	1	50.00	1	50.00
21.	PAKISTAN	2	0.84	0	0.00	2	100.00
22.	PEOPLES R CHINA	2	0.84	0	0.00	2	100.00

23.	PORTUGAL	2	0.84	1	50.00	1	50.00
24.	ARGENTINA	1	0.42	0	0.00	1	100.00
25.	BARBADOS	1	0.42	0	0.00	1	100.00
26.	BULGARIA	1	0.42	0	0.00	1	100.00
27.	FINLAND	1	0.42	1	100.00	0	0.00
28.	HUNGARY	1	0.42	0	0.00	1	100.00
29.	MOROCCO	1	0.42	0	0.00	1	100.00
30.	NIGERIA	1	0.42	0	0.00	1	100.00
31.	PHILIPPINES	1	0.42	0	0.00	1	100.00
32.	SCOTLAND	1	0.42	1	100.00	0	0.00

Authorship pattern

The Average no of Authors per article is 2.51. These 239 publications were written by total 600 authors either in collaboration or in individual capacity. Of the 239 publications 61 articles (25.5%) has been written by individual researcher that also indicates that 178 articles are written in collaboration either inter-instituional, intra-institutional , national or International collaboration. 90 articles (37.65%) were written by 2 authors, 45 articles(18.82%) by 3 authors, 20 (8.36%) by 4 authors,5 articles (2.09%) by 5 authors. There are 11 publications (7.53%) which were written by more than 5 authors. Authorship pattern also indicates hyper-authorship as one article has been written by 42 authors. (figure 3)

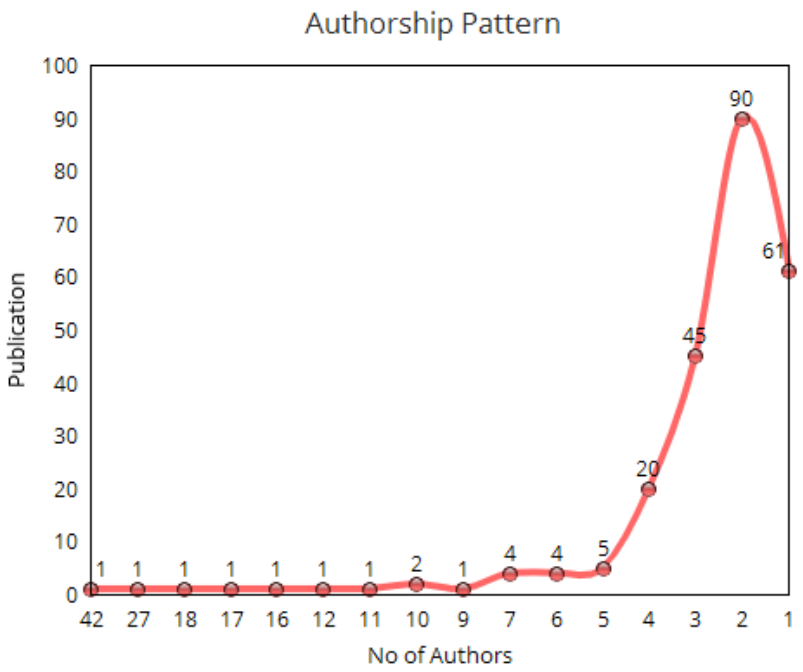


Figure 3 – Authorship pattern of highly cited artilcles

Authors

There are total 600 authors from 226 research institutes and universities across the world who have contributed these 239 highly cited articles in plant sciences. Kazuo Shinozaki from RIKEN Japan is leading the list of top 5 authors with 8 publication having 10347 citations followed by Yamaguchi-Shinozaki, Kazuko 7 publications with 8993 citations, FARQUHAR, GD (6 publications, 18276 citation), Zhu, JK (6, 10416) Soltis, Douglas E. from University of North Carolina (5, 9142) on the basis of citations Farquhar, GD is most cited author followed by Zhu, JK and Kazuo Shinozaki. (Table 3)

Table-3: Most productive authors

Sl. No	Authors	Organization	Publication	Citation
1.	Shinozaki, Kazuo	RIKEN, Plant Sci Ctr, Yokohama, Kanagawa 2300045, Japan	8	10347
2.	Yamaguchi-Shinozaki, Kazuko	Univ Tokyo, Grad Sch Agr & Life Sci, Lab Plant Mol Physiol, Tokyo 1138657, Japan	7	8993
3.	FARQUHAR, GD	AUSTRALIAN NATL UNIV,RES SCH BIOL SCI,DEPT ENVIRONM BIOL,CANBERRA,ACT 2601,AUSTRA	6	18276
4.	Zhu, JK	Univ Arizona, Dept Plant Sci, Tucson, AZ 85721 USA.	6	10416
5.	Soltis, Douglas E.	UNIV N CAROLINA,DEPT BIOL,CHAPEL HILL,NC 27514, USA.	5	9142

Journals

Table 4 shows that 239 highly cited articles appeared in 52 distinct source titles. On the basis of publication output journal Annual Review Of Plant Physiology And Plant Molecular Biology (IF 17.372) is the most productive journal with 34 publications (14.23 %) having 59207 citations followed by plant cell (IF 8.631)with 19 publications (7.95%) having 25352 citations, Annual review of plant Biology (IF 18.918) with 17 publications (7.11%) &31203 Citations. There are 20 periodicals with single publications, 7 journals with 2 & 3 publications each, one journal with 4 & 8 number of publications, 2 journals with 5 publications, 3 journals with 6 ,7 &10 number of publications. The impact factor (JCR 2018) varies from .753 to 18.918 which indicates that these publications have appeared in high impact

journals. 69 publications have been published in journal having more than 10 impact factor. Only two articles are published in journal having less than 1 impact factor. 34 articles have been published in journal within impact factor range of 1-5 and 9 articles published in journal with impact actor range of 5-10.

Table 4- List of journals

Sl. No	**Journals**	**Publicaitons**	**%age**	**Citation**	**Impact Factor (JCR 2018)**	**Rank in Plant sciences journal category JCR 2018**
1.	ANNUAL REVIEW OF PLANT PHYSIOLOGY AND PLANT MOLECULAR BIOLOGY	34	14.23	59207	17.372	1
2.	PLANT CELL	19	7.95	25352	8.631	6
3.	ANNUAL REVIEW OF PLANT BIOLOGY	17	7.11	31203	18.918	1
4.	PLANT PHYSIOLOGY	14	5.86	33774	6.305	10
5.	PLANT JOURNAL	10	4.18	19807	5.726	11
6.	TRENDS IN PLANT SCIENCE	10	4.18	27539	14.006	2
7.	PHYTOCHEMISTRY	10	4.18	12833	2.905	52
8.	NEW PHYTOLOGIST	9	3.77	14270	7.299	8
9.	ANNUAL REVIEW OF	8	3.35	11183	10.2	5

	PHYTOPATHOLOGY					
10	PLANTA	7	2.93	13452	3.06	45
11	JOURNAL OF EXPERIMENTAL BOTANY	7	2.93	14341	5.36	14
12	PLANT AND SOIL	7	2.93	17809	3.259	41
13	PLANT MOLECULAR BIOLOGY	6	2.51	8134	3.928	24
14	JOURNAL OF ECOLOGY	6	2.51	10696	5.687	12
15	ANNALS OF BOTANY	6	2.51	8555	3.454	36
16	JOURNAL OF NATURAL PRODUCTS	5	2.09	10788	4.257	16
17	AMERICAN JOURNAL OF BOTANY	5	2.09	6497	2.841	53
18	THEORETICAL AND APPLIED GENETICS	4	1.67	5319	3.926	25
19	PHYSIOLOGIA PLANTARUM	3	1.26	3139	3	48
20	BOTANICAL JOURNAL OF THE LINNEAN SOCIETY	3	1.26	4139	3.057	46
21	VEGETATIO	3	1.26	6358	1.225	42
22	AUSTRALIAN JOURNAL OF PLANT PHYSIOLOGY	3	1.26	47316	2.398	18
23	PLANTA MEDICA	3	1.26	4312	2.746	56
24	ENVIRONMENTAL AND EXPERIMENTAL BOTANY	3	1.26	5005	3.712	29
25	CURRENT OPINION IN PLANT BIOLOGY	3	1.26	5342	7.508	7
26	COMMUNICATIONS IN SOIL	2	0.84	3906	0.687	197

	SCIENCE AND PLANT ANALYSIS					
27	PLANT CELL AND ENVIRONMENT	2	0.84	2199	5.624	13
28	PHOTOSYNTHESIS RESEARCH	2	0.84	3825	3.057	46
29	JOURNAL OF PHYCOLOGY	2	0.84	2951	2.831	54
30	ANNALS OF THE MISSOURI BOTANICAL GARDEN	2	0.84	2884	2.933	51
31	PLANT PATHOLOGY	2	0.84	2323	2.493	64
32	PHYTOPATHOLOGY	2	0.84	4503	3.264	40
33	WEED RESEARCH	1	0.42	3216	1.857	93
34	PLANT AND CELL PHYSIOLOGY	1	0.42	1758	3.929	23
35	BIOCHEMIE UND PHYSIOLOGIE DER PFLANZEN	1	0.42	1510	NA	NA
36	PLANT PHYSIOLOGY AND BIOCHEMISTRY	1	0.42	1179	3.404	38
37	JOURNAL OF PLANT PHYSIOLOGY	1	0.42	1157	2.825	55
38	AUSTRALIAN JOURNAL OF BOTANY	1	0.42	4548	1.164	143
39	PLANT DISEASE REPORTER	1	0.42	1292	NA	NA
40	FUNCTIONAL PLANT BIOLOGY	1	0.42	1041	2.327	73
41	MOLECULAR BREEDING	1	0.42	3239	1.862	92
42	PHYCOLOGIA	1	0.42	2015	1.976	88
43	CANADIAN JOURNAL OF BOTANY	1	0.42	1053	NA	NA
44	CANADIAN JOURNAL OF BOTANY-REVUE CANADIENNE DE BOTANIQUE	1	0.42	1581	0	76

45	PLANT SCIENCE	1	0.42	1518	3.785	28
46	AMERICAN FERN JOURNAL	1	0.42	1521	1.067	153
47	ADVANCES IN ECOLOGICAL RESEARCH, VOL 25	1	0.42	5714	5.724	NA
48	JOURNAL OF PLANT NUTRITION	1	0.42	1131	0.753	189
49	CRITICAL REVIEWS IN PLANT SCIENCES	1	0.42	1477	4.189	18
50	PHYSIOLOGICAL AND MOLECULAR PLANT PATHOLOGY	1	0.42	1776	1.678	101
51	BOTANICAL REVIEW	1	0.42	1225	2.536	61
52	JOURNAL OF ETHNOPHARMACOLOGY	1	0.42	1165	3.41	37

Keyword

Analysis of Author keywords reveals that there are total 459 keywords provided by authors with average 1.92 keywords per publications. Document types note, Editorial do not contain any keywords, hence they were excluded from this study. Keyword “Photosynthesis” has the highest frequency with 10 occurrences, followed by Photoinhibition(7), Oxidative Stress (6), Gene Expression (5), Stress Tolerance (5). There are 401 keywords with single occurrence, 43 keywords with 2 occurrences, 8 keywords with 3 occurrences and 3 keywords with 4 occurrences. Figure 4 & 5 describes author keywords and keyword plus network visualization.

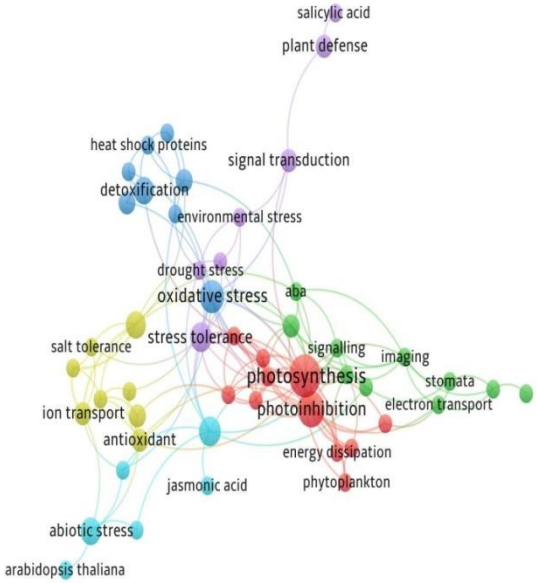


Figure 4- Author Keyword networks

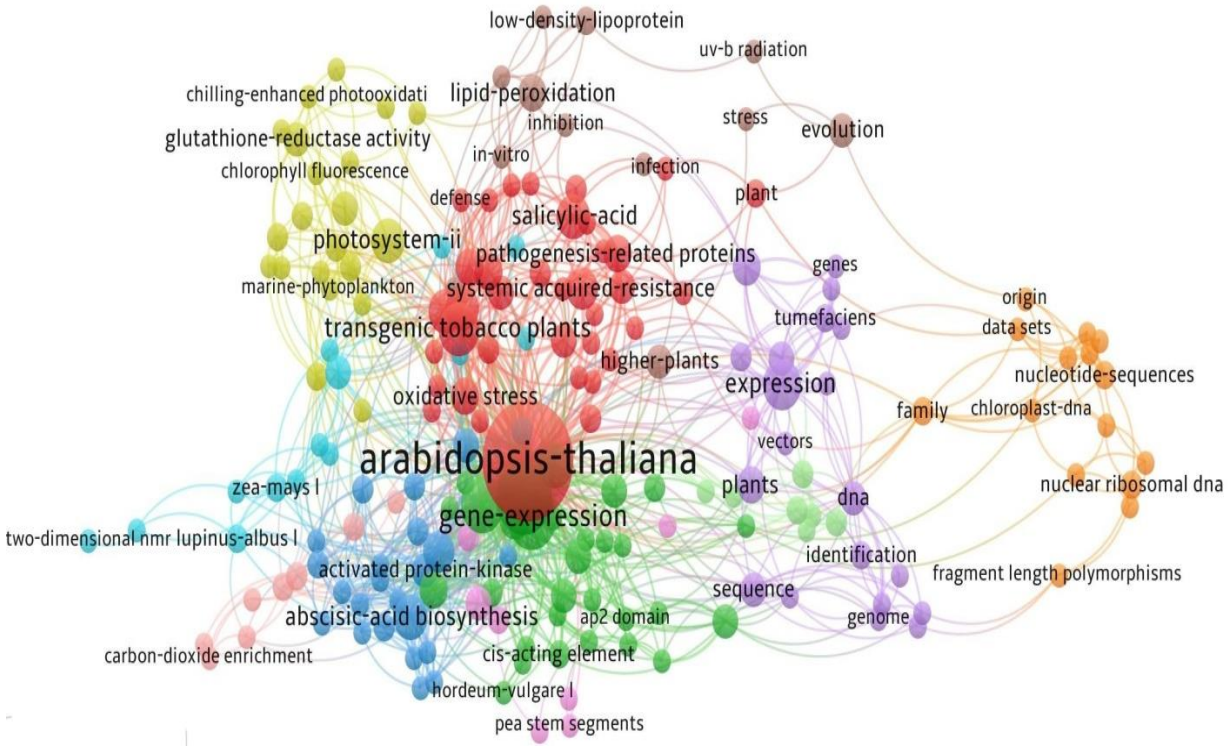


Figure 5- Keyword plus networks

Conclusion

It can be concluded that highly cited publications have been published in high impact journals. USA is the leading country in receiving highest number of highly cited papers. It also leads the list of publication originated from individual countries without any international collaboration and most prolific organizations. As of 9 highly cited organizations 3 are from USA. Authors from Japan & USA are most cited authors with 2 authors from each country among top 5 highly cited authors. In document types it is evident that Review articles are most frequently cited in comparison to other document types. The most

highly cited articles published in 1962 by Murashige & Skoog in journal *Physiologia plantarum* having 42826 citations. 7 numbers of articles were funded National Institute of General Medical Sciences. (NIH HHS) and rest of the funding agencies have only one publication in highly cited list

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