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Plant Biology Research Output at Global Level: A Scientometric Study

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Abstract – **The paper analyses scientific output of plant biology discipline of Scopus databases during 1980-2013. The analysis indicates that highest number of journals and international collaboration, subject wise, top authorship pattern, year wise relative growth rate and doubling time of records in year wise and top most productive journals. The major research is focused on plant biotechnology, plant biology, agriculture plants, and plant science. A total number of 26111 records for 44 years between 1970 to 2013were retrieved from Scopus databases. The study explores the quantitative analysis of research performance of the plant biology research output in world level. The study aims to ascertain the growth of literature, top authors, relative growth rate, source wise publications identification of prolific authors, country wise, affiliation of research and core journals of plant biology.**

Keywords: **Scientometrics, plant biology, authorship pattern, Relative Growth Rate, Doubling Time**

I. Introduction

Job Satisfaction is the most valuable assets of any employees. Job Plant Biology is the science of Plant life and a branch of biology. In the 19th century new techniques were developed for the study of plants, including methods of optical microscopy and living cell imaging, electron microscopy, analysis of chromosome number, plant chemistry and the structure of enzymes and other proteins. In 20th century biology exploited the techniques of molecular genetics analysis DNA sequences to classify plants more accurately. 21st century. Plant science is molecular genetics and epigenetic, which are the mechanism and control of gene expression during differentiation of plant cells and tissues. In modern horticulture, agriculture and forestry, plant propagation, breeding and genetic modification in the synthesis of chemicals and raw materials for construction and energy production, in environment and the maintenance of biodiversity.

Modern botany construction upon the gene-chromosome theory of heredity that originated with Gregor Mendel (1822- 1884). Autust Weismann (1834-1914) proved that inheritance only takes place through gametes. No other cells can pass on inherited characters. In 20th century developments in plant biochemistry have been driven by modern techniques of organic chemical analysis, such as spectroscopy, chromatography and electrophoresis. With the rise of the related molecular-scale biological approached of molecular biology, genomics proteomics and metabolimics, the relationship between the plant genome and most aspects of the biochemistry, physiology morphology and behavior of plants can be subjected to detailed experimental analysis. Morphology recognizes a continuum between the major morphological categories of root, stem, leaf and trichome.

II. Review Of Literature

Garg et al (2011) analyzed 32574 papers published by five countries in plant genetics and breeding research during the 2005-2009. The research output of highest number of publications followed by USA and china. The total output of highest published article of USA UK, China, India Brazil and institutions wise, international level and shared of co authored papers in this study .

Srinivasa Ragavan, Surulinathi and Neelakandan 2012 depict the scientometric parameters for Medical

Plant research during the period 1973-2009, a total of 1265publications were published at national level.

Kirti Joshi, Avinash Kshitij, Garg 2010 studied the field of forest mycology indicates that the number of publications have increased significantly during the year 2004-2008. A total 3313 publications scattered 619 journals title from 50 countries and 839 institutions highest rate of annual growth of published articles.

Shri Ram 2011 defined Artemisia is a herb that yields a naturals component as Artemisinin used for the treatment of medicinal plants. The database indexed in the Pub Med Database for the period of 15 years (1996-2010. It has been found that publications on this subject grew to 712 percent in 2010 as compared to 1996. The most contributed journals of publications in the country of China. In India, Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh is a leading contributor of literature on Artemisia.

Harish Kumar Tripathi, Garg 2014 depicts that scientific output of India in the Discipline of crop science as reflected by the coverage of three different database i.e., Scopus, CAB, ISA during 2008-2010.The highest number of papers was published in the crop. Environment and Ecology, Indian Journal of Agricultural Sciences and research on Crops were most preferred journals used. The Research is focused on soil climate and environmental aspects and agronomic aspects. The authorship pattern reveals that co-authored papers accounted for 72% of total output.

III. Research Objectives

The purpose of this study was to investigate the demographic characteristics of the plant biology research output. It specifically focused on the following

1. To study the year wise distribution of papers growth rate literature of plant biology research output relative growth rate and doubling time.
2. To examine the authorship pattern distribution of contribution and ranking of authors
3. To analyze the country wise production of documents.
4. To studied the source wise documents of plant biology research output.
5. To analyze the subject wise distribution of articles.

IV. Methodology

The study is limited to all plants science for over all database were collected from Scopus. The Relative Growth Rate (RGR) is the increase in the number of articles / pages per unit of time. The overflow of papers represents one aspects of the general growth of scientific communication. Wooster (1970) has estimated the number of journals that existed in the world at any one time, where as some estimates of number of papers published annually.

Scientific growth has involved not only increase in manpower and finance. The flood of papers represents one aspect of the general growth of scientific communication. Growth analysis is used analytical tool for

The mean Relative Growth Rate (R) over the specific period of interval can be calculated from the following formula:

$$1\text{-}2R = \frac{\text{Log}_{e2} W - \log_{e1} W}{T_2 - T_1}$$

Whereas

1 -2 R = mean relative growth over the specific period of interval

$\log_{e1} W$ = Log of initial number of articles

$\text{Log}_{e2} W$ = log of final number of articles after a specific period of interval

$T_2 - T_1 =$ the unit difference between the initial time and the final time

The year can be taken here as the unit of time. The RGR for articles is calculated

Therefore

1-2R (aa-1 year -1) can represent the mean relative growth rate per unit of articles per unit of year over a specific period of interval.

Doubling Time (Dt)

There exists a direct equivalence between the relative growth rate and the doubling time. If the number of articles / pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be logarithms of number 2. If natural logarithms is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the formul a:

$$\text{Doubling time (Dt)} = \frac{0.693}{R}$$

Therefore,

$$\text{Doubling time For articles Dt (a)} = \frac{0.693}{1 - 2\ R\ (aa^{-1}\ year^{-1})}$$

Table 1 Year Wise Relative Growth Rate Literature in Plant Biology

YEAR	Publication Output	Cumulative No. of Output	W_1	W_2	$R = (aa^{-1}\ year^{-1})$	Doubling Time Dt=0.693 / R(a)	Mean Dt(a)
1970	10	10	0	2.302	2.302	0.030	
1971	12	22	2.302	2.484	0.182	0.381	
1972	16	38	2.484	2.772	0.288	0.241	
1973	18	56	2.772	2.890	0.118	0.587	
1974	22	78	2.890	3.091	0.201	0.345	
1975	25	103	3.091	3.218	0.127	0.546	0.603
1976	29	132	3.218	3.367	0.149	0.465	
1977	32	164	3.367	3.465	0.098	0.707	
1978	35	199	3.465	3.555	0.090	0.770	
1979	37	236	3.555	3.610	0.055	1.260	
1980	39	275	3.610	3.663	0.053	1.308	
1981	43	318	3.663	3.761	0.098	0.707	
1982	47	365	3.761	3.850	0.089	0.779	
1983	51	416	3.850	3.931	0.081	0.856	
1984	52	468	3.931	3.951	0.020	3.465	
1985	55	523	3.951	4.007	0.056	1.238	
1986	58	581	4.007	4.060	0.053	1.308	1.189
1987	60	641	4.060	4.094	0.034	2.038	
1988	65	706	4.094	4.174	0.080	0.866	
1989	70	776	4.174	4.248	0.074	0.936	
1990	115	891	4.248	4.744	0.496	0.140	
1991	126	1017	4.744	4.836	0.092	0.753	
1992	151	1168	4.836	5.017	0.181	0.383	
1993	172	1340	5.017	5.147	0.130	0.533	
1994	177	1517	5.147	5.176	0.029	2.390	
1995	186	1703	5.176	5.225	0.049	1.414	
1996	291	1994	5.225	5.673	0.448	0.155	
1997	320	2314	5.673	5.768	0.095	0.729	0.811
1998	456	2770	5.768	6.122	0.354	0.196	
1999	486	3256	6.122	6.186	0.064	1.083	
2000	529	3785	6.186	6.270	0.084	0.825	
2001	705	4490	6.270	6.558	0.288	0.241	
2002	757	5247	6.558	6.629	0.071	0.976	
2003	901	6148	6.629	6.803	0.174	0.398	
2004	986	7134	6.803	6.893	0.090	0.770	
2005	1630	8764	6.893	7.396	0.503	0.138	
2006	1698	10462	7.396	7.437	0.041	1.690	
2007	1808	12270	7.437	7.499	0.062	1.118	
2008	1886	14156	7.499	7.542	0.043	1.612	1.03
2009	2096	16252	7.542	7.647	0.105	0.660	
2010	2252	18504	7.647	7.719	0.072	0.962	
2011	2424	20298	7.719	7.793	0.074	0.936	
2012	2508	23436	7.793	7.827	0.034	2.038	
2013	2675	26111	7.827	7.892	0.065	1.066	
	26111		7.892		0.179		

V. Analysis and Interpretation

Table 1 indicates that the year wise research output from 1970 to 2013. Totally 26111 scholarly contributions of papers published with all over the country for 44 years. Highest percentage of paper was published in the year 2012 and 2013 respectively. In the year 2013 the publications percentage.

Table 1 indicates that the relative growth rates for plant biology research output decreased in the year 1986 0.53 RGR and 0.34 in 1987. The overall study period of has witnessed a mean relative growth of 0.179. Contrastingly, the doubling time for the publication of all sources of plant biology research output has increased from 3.465 in 1984 to 2.390in 1994. The mean of doubling time for contributions for the periods of 1970 -1980, 1981-1992, 1992-2002, 2003-2013 are 0.603, 1.189, 0.811, and 1.03 respectively. The highest period of doubling time mean value from 1981-1992 1.189 means value.

Table II Author Productivity

Name of the Authors	No. of Articles Published	Ranking Authors
Barrett, S.C.H.	45	1
Kiss, J.Z.	45	1
Lewis, N.G.	39	2
Fernie, A.R.	38	3
Sack, F.D.	35	4
Saito, K.	34	5
Shinozaki, K.	33	6
Evans, M.L.	32	7
Roux, S.J.	31	8
Hasenstein, K.H.	30	9
Shibata, D.	30	9
Cosgrove, D.J.	29	10
Kamada, H.	29	10
Poovaiah, B.W.	27	11
Rieseberg, L.H.	27	11
Soltis, P.S.	26	12
Reski, R.	26	12
Benfey, P.N.	26	12
Weigel, D.	25	13
Davin, L.B.	25	13

Table 2 depict ranking of authors by number of contribution of publications. The first rank of the top Authors Barrett and Kiss J.Z published highest number of articles for the study period with 45 records. Second ranking author Lewis 39 records, Third rank of Authors 38 records.

It is found that plant biology research is being conducted in 8312 institutions in worldwide. Table shows the list the top 25 organizations which contributed more than 200 publications each.

Table 6 shows that university of UC Davis 471 (8.53%) , University of Florida 412, Cornell University 358 , CNRS Centre National de la Research Scientific 339 and UC Berkeley, University of Wisconsin Madison 318 and 302 are the top contributors in plant biology research output. Most of the organizations which contributed more than 200 publications other countries belong to USA.

The research of plant biology as majority of publications came major countries of USA 11410 (43.70%), UK 3203 (12.27%), China 2948 (11.29%) Germany 2912 (11.15%), France 2326 (8.91%), Japan 2215 (6.68%) and followed by India 1538 (5.89%), Spain, 1243 (4.76%) Switzer land 423 (1.54%).

Table III Highly Productive Affiliation

S.No.	AFFILITATION	RECORDS	PERCENTAGE
1	UC Davis	471	8.53
2	University of Florida	412	7.47
3	Cornell University	358	6.46
4	CNRS Centre National de la Recherche Scientifique	339	6.14
5	UC Berkeley	318	5.76
6	University of Wisconsin Madison	302	5.47
7	Michigan State University	289	5.24
8	USDA Agricultural Research Service, Washington DC	278	5.04
9	Chinese Academy of Sciences	268	4.86
10	Kyoto University	242	4.38
11	Pennsylvania State University	237	4.29
12	University of Arizona	237	4.29
13	University of Queensland	235	4.26
14	University of California, Riverside	233	4.22
15	University of Toronto	228	4.13
16	Ohio State University	216	3.91
17	Iowa State University	215	3.90
18	University of Cambridge	215	3.90
19	John Innes Centre	214	3.88
20	Purdue University	212	3.84
			100.00

Table IV Country Wise Production of Documents on Plant Biology Research

S.No.	COUNTRY	PUBLICATIONS	PERCENTAGE
1	United States	11410	43.70
2	United Kingdom	3203	12.27
3	China	2948	11.29
4	Germany	2912	11.25
5	France	2326	8.91
6	Japan	2215	8.48
7	Canada	1744	6.68
8	Australia	1657	6.35
9	India	1538	5.89
10	Spain	1243	4.76
11	Switzerland	423	1.62
12	Italy	403	1.54
13	Netherlands	386	1.48
14	Sweden	325	1.24
15	Belgium	283	1.08
16	Brazil	282	1.08
17	SouthaKorea	273	1.05
18	Mexico	244	0.93
19	Austria	219	0.84
20	Isrel	208	0.80

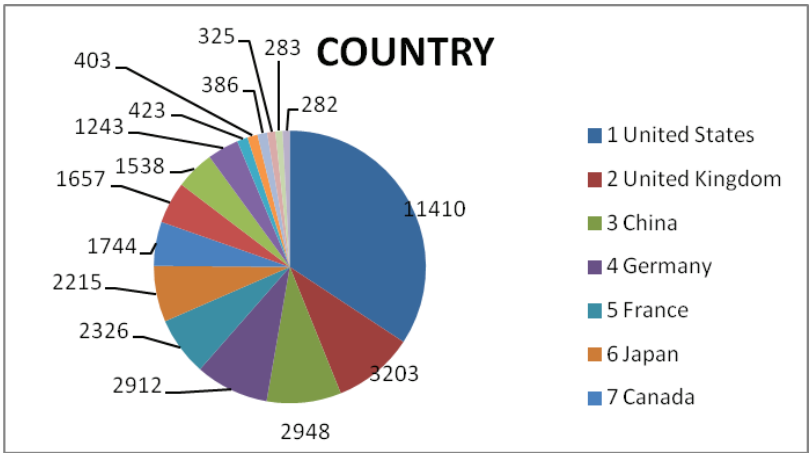

Fig.1 Country Wise Production of Documents

Table 4 reveals that the plant biology research of top 20 countries during the period from 1970 to 2013. The top country of United States of America was published the 11310 (43.70%) contribution of publications and second rank of United Kingdom contributed to 3203 (12.27) records. Among world countries the analysis shows India, Spain Switzerland is in the middle, and the bottom of Australia and Israel.

Table 5 indicates the top ranking journals of biological chemistry published articles 1860 (7.12%), second journal of experimental botany 913 (3.50%), minimum articles of In Vitro Cellular and Developmental Biology Plant, Plant biology, Plant Biotechnology articles published from 400-500. Annals of Botany, Plant Biotechnology Journals, Proceedings of the national Academy of Science of the United States of America. Science, Nature, Plant Journals, Conservation Biology Molecular and Evolution and Journal of Evolutionary Biology are above 200 to 300 Journals published.

TABLE V RANKING OF JOURNALS IN PLANT BIOLOGY RESEARCH OUTPUT

RANKING JOURNALS	JOURNAL NAME	PUBLICATION	PERCENTAGE
1	Journal of Biological Chemistry	1860	7.12
2	Journal of Experimental Botany	913	3.50
3	Plant Biotechnology	478	1.83
4	In Vitro Cellular and Developmental Biology Plant	445	1.70
5	Plant Physiology	424	1.62
6	New Phytologist	347	1.33
7	American Journal of Botany	323	1.24
8	Plos One	309	1.18
9	Plant Molecular Biology	304	1.16
10	Annals of Botany	286	1.10
11	Plant Biotechnology Journal	279	1.07
12	Proceedings of the National Academy of Sciences of the United States of America	242	0.93
13	Science	242	0.93
14	Nature	223	0.85
15	Plant Journal	221	0.85
16	Conservation Biology	211	0.81
17	Molecular Biology and Evolution	206	0.79
18	Journal of Evolutionary Biology	205	0.79
19	Evolution	189	0.72
20	Current Opinion in Plant Biology	173	0.66

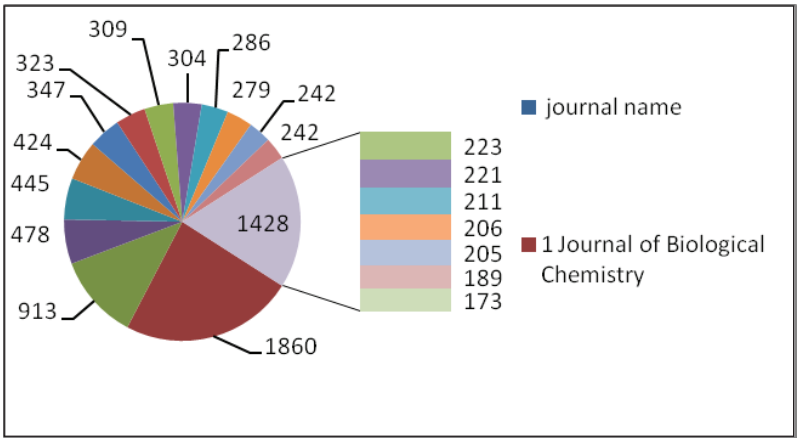

Fig.2 Ranking of Journals in Plant Biology

Table VI Subject Wise Distribution of Plant Biology

S.No.	SUBJECT AREA	RECORDS	PERCENTAGE
1	Agricultural and Biological Sciences	14283	34.14
2	Biochemistry, Genetics and Molecular Biology	12606	30.13
3	Environmental Science	3426	8.19
4	Medicine	2852	6.82
5	Immunology and Microbiology	1624	3.88
6	Chemistry	877	2.10
7	Earth and Planetary Sciences	867	2.07
8	Multidisciplinary	805	1.92
9	Pharmacology, Toxicology and Pharmaceutics	741	1.77
10	Engineering	631	1.51
11	Chemical Engineering	583	1.39
12	Computer Science	521	1.25
13	Mathematics	472	1.13
14	Neuroscience	304	0.73
15	Physics and Astronomy	285	0.68
16	Social Sciences	276	0.66
17	Materials Science	200	0.48
18	Energy	100	0.24
19	Arts and Humanities	98	0.23
20	Decision Science	69	0.16
21	Psychology	58	0.14
22	Health Professions	44	0.11
23	Veterinary	43	0.10
24	Nursing	28	0.07
25	Business, Management and Accounting	19	0.05
26	Dentistry	14	0.03
27	Economics, Econometrics and Finance	8	0.02
28	Undefined	8	0.02
			100.00

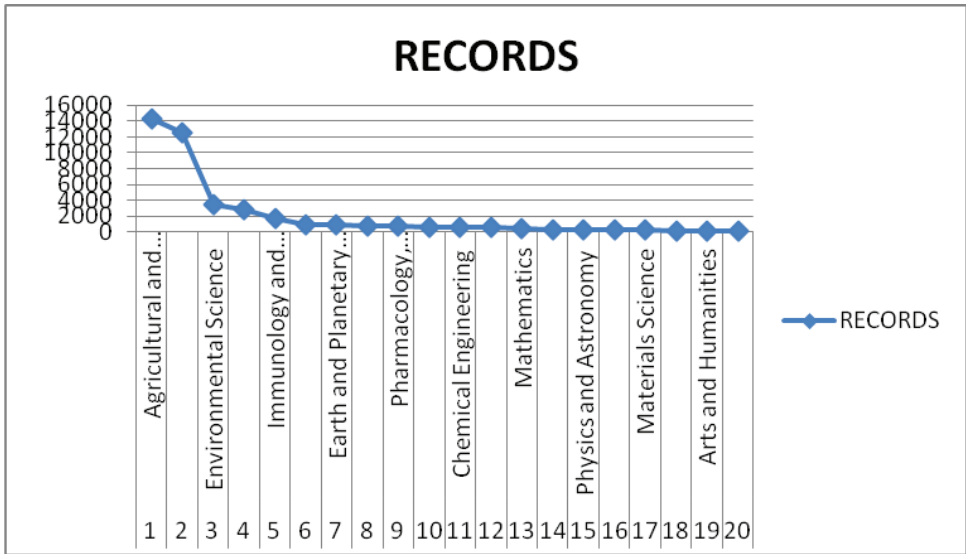

Fig.3 Subject Wise Distribution of Plant Biology

Shown in table 6 the subject classification gives some idea of newly –developed specialized branches of plant biology research during 1970 -2013. The table 6 indicates the majority of contributions appeared under Agricultural and Biological Sciences 14283 (34.14%), Biochemistry, Genetics and Molecular Biology 12606 (30.13%), Environmental Science 3426 (8.19%) , medicine 2852 (6.82%), Immunology and Microbiology 1624 (3.88%) and Chemistry of Below 1000 publications and Mathematics 472 (1.13%) .

VI. Conclusion

This study deals with the scientometric analysis of plant biology research output (26111 records) as reported in SCOPUS Database during this period from 1970 -2013. The study shows that plant biology Relative Growth Rate decreased in the year 1986 (0.53) RGR (0.34) in 1987. The overall Study period increased from period of 1994 (3.465) and 1984 (2.390). The highest period of doubling time mean value from 1981-1992 1.189 means value. The top Authors Barrett and Kiss J.Z published highest number of articles for the study period with 45 each records. The Affiliation of organizations which contributed more than 200 publications other countries belong to USA and to country of USA published 11410 records. The department wise published articles from Agriculture and biological Science, Genetics and Molecular Biology of most articles published. Journals published in biological science and experimental biology published most of articles contributed. Maximum number of articles published in Biological Science.

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