Productivity of Journals and the Applicability of Bradford's Law of Scattering in Hydroponics Literature

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Abstract:
This analysis provides a comprehensive exploration of the scientific publication landscape, highlighting the significance of various document types, languages, subjects, and journals in disseminating research. Articles dominate in volume (82.82%) and citations (90.59%), with a significant average impact (CPP 28.28). Reviews, although few (2.06%), have the highest influence (CPP 62.74), while conference papers, books, and other formats serve niche roles with lower impact. English is the dominant language, accounting for 91.82% of publications and 98.46% of citations, with a CPP of 27.72. Other languages like Chinese, Portuguese, and Spanish show regional relevance but lower global impact. Subject-wise, Agricultural and Biological Sciences lead (62.45%), followed by Environmental Science (27.92%) and Biochemistry, Genetics, and Molecular Biology (20.20%).Journal analysis reveals significant disparities in impact, with "Journal of Experimental Botany" (CPP 100.37) leading in influence. Applying Bradford's Law to hydroponics literature, 28 core journals produced 33.32% of articles. However, a high error margin (16.62%) suggests deviations from the law.

Keywords: Scientometrics, Hydroponics Literature, Publishing trend, Citations Per Paper (CPP), Authorship Pattern, Degree of Collaboration

1. Introduction

Scientometrics is a field dedicated to quantifying and analyzing scientific activities, offering valuable insights derived from data in scientific literature databases. This approach is utilized to assess research performance and compare scientific contributions across individuals, institutions, and nations, spanning local to global scales. In this study, Scientometric methods are employed to quantitatively and qualitatively examine Hydroponics Literature. Hydroponics is an innovative technique for cultivating plants without soil, where a nutrient-enriched water solution delivers essential nutrients directly to the plant roots. This method promotes faster growth, greater yields, and more efficient water usage. Plants are grown using substrates such as water, sand, or clay, with systems like Deep Water Culture and Nutrient Film Technique being commonly implemented. Hydroponics is particularly well-suited for urban agriculture and regions with inadequate soil quality or limited water resources.

2. Review of Literature

Ahmed, K. M., Gupta, B. M., & Gupta, R. (2018)[1] evaluated 5,351 publications on *Curcuma longa* indexed in Scopus from 1997 to 2016. The annual growth rate was 13.40%, with an average citation impact of 29.04 citations per paper. India contributed the largest share (31.04%) of publications, followed by the USA and China. Medicine accounted for the largest share of publications (37.38%), followed by pharmacology, toxicology, and pharmaceutics. The top 20 authors contributed 5.59% of global publications, while the top 20 organizations and journals made significant contributions to both publications and citations.

Anwar (2006)[2] conducted a bibliometric analysis of the literature on Phoenix Dactylifera L (date palm), focusing on publication growth, authorship patterns, and country and language distribution. The study found that date palm research grew rapidly from 1971, peaking in 1989 and stabilizing thereafter. The majority of publications were from agriculture, biological sciences, and chemistry. Most prolific institutions were located in Arab countries, with Iraq and Egypt leading in publication output. English was the dominant language, and a small number of core journals published the majority of the papers.

Balasubramani and Murugan (2011)[3] analyzed India's research performance on Tapioca from 1997 to 2010, focusing on global publication growth, share, and impact. The study examined international collaborations, productivity, and the impact of leading Indian institutions, as well as the characteristics of prolific authors and highly cited papers. Data from the Web of Science (SCI) were retrieved and analyzed using Histcite software. The research aimed to understand publication patterns and the role of key journals in Tapioca research. A total of 447 records were analyzed for the study.

Garg, K. C., Kumar, S., & Lal, K. (2006)[4] made an analysis of 16,891 publications by Indian scientists (1993–2002) indexed in the Science Citation Index Expanded shows a decline in agricultural science publications since 1998. Dairy and animal sciences, followed by veterinary sciences, make up the largest portion of India's agricultural research. Agricultural universities and ICAR institutes are the primary contributors to research

output. Most papers are published in domestic journals with low impact factors and citation rates. While productive institutions have many prolific authors, few highly cited authors come from these institutions.

Gautam, M., & Shilpa, U. (2021)[5] analyzed the scientometric aspects of the *Indian Journal of Horticulture* from 2011 to 2019, focusing on year-wise distributions, authorship patterns, and growth metrics. A total of 1,085 articles were analyzed, with a peak in publications in 2016 (123 articles). Most papers (56.58%) had three authors, and 97.78% were multi-authored. The study found a decreasing growth rate over the years, from 0.69 in 2011 to 0.11 in 2019. The mean relative growth rate was 0.2188, and the mean doubling time for total output was 3.0955.

Gupta, B. M., & Ahmed, K. M. (2018)[6] analysed 4900 publications on Azadirachta indica during the periond 1997–2016. Gupta and Ahmed (2018) analyzed 4,900 publications on *Azadirachta indica* (1997–2016) using Scopus, reporting an annual growth rate of 7.61% and an average of 13.91 citations per paper. The top three countries with the highest relative citation index were the UK (1.95), USA (1.71), and Germany (1.42). Agricultural and Biological Sciences dominated publication share (48.41%), followed by Pharmacology and Toxicology (22.04%). A total of 848 institutions and 1,589 authors contributed globally, with the top 25 institutions and authors accounting for 20.65% and 8.92% of publications, respectively. The study identified 78 highly cited papers, averaging 237.15 citations each.

Gupta, B. M., Ahmed, K. M., Dhawan, S. M., & Gupta, R. (2018)[7] analyzed global Aloe Vera research publications from 2007 to 2016, retrieving 1,988 records from Scopus. The annual growth rate was 3.91%, with an average citation impact of 9.57 citations per paper. India contributed the largest share of publications (32.55%), followed by the USA and Iran. Medicine accounted for the highest share of publications (40.90%), and the top 20 organizations and authors contributed significant shares to global publications and citations. Eighteen highly cited papers accounted for 2,656 citations, with an average of 147.55 citations per paper.

Rajendran, L. (2018)[8] analyzed the growth of Paddy (Oryza Sativa) crop research in India from 1951 to 2017, based on 1,80,675 papers indexed in the CAB Direct Database. India leads global agricultural research with 29,038 papers (15.9% of global output), followed by China with 17,266 papers (9.4%). The most published journals are the International Rice Research Newsletter and the Chinese Journal of Rice Science. India ranks highest in paddy production globally, with Tamil Nadu standing out among the top contributors. The study emphasizes India's dominance in agricultural research, particularly in paddy crop analysis.

Suresh, C., Hema, R., & Sankarasubramaniam, N. (2015)[9] analyzed the publication output of the *Indian Journal of Horticulture* from 2010 to 2014, covering 714 articles. It examines year-wise distribution, authorship patterns, growth rates, and geographical distribution of research. Most papers were published by multiple authors, with India contributing 96.35% of the articles. The study found the highest degree of collaboration in 2011 and 2013. The Indian Agricultural Research Institute was the most productive institution, with 22.26% of the publications.

Suresh, N., & Thanuskodi, S. (2019)[10] analyzed the research output of ICAR-IIHR, Bangalore, from 1989 to 2018 using data from the Web of Science. A total of 1,095 publications were studied, revealing exponential growth in literature. Journal articles were the dominant publication type, with the *Indian Journal of Agricultural Sciences* and *Current Science* being the leading journals. Agriculture and plant sciences were the primary subject areas, with significant collaboration, particularly with the United States and Horticultural Experiment Station. The study provides a comprehensive overview of ICAR-IIHR's research performance.

Yuan, B. Z., Bie, Z. L., & Sun, J. (2021)[11] analyzed 2,030 articles and review papers on cucumber research from the horticulture category in the Web of Science. The articles were mainly in English, authored by 5,630 researchers from 80 countries and published in 46 journals. The top journals included *Scientia Horticulturae*, *HortScience*, and the *Journal of the American Society for Horticultural Science*. The leading countries were the U.S., China, Japan, South Korea, and India, with prominent institutions like the University of Wisconsin and North Carolina State University. The research identified eight clusters of keywords, offering insights for future research directions.

Yuan, B. Z., & Sun, J. (2021)[12] analyzed 2,640 articles and reviews on strawberry research from the Web of Science database, focusing on horticulture. The research mainly comes from 6,807 authors across 77 countries, published in 57 journals, with *Hortscience* and *Scientia Horticulturae* being the top journals. The USA, China, Japan, South Korea, and Brazil were the leading countries in strawberry research, while top institutions included the University of Florida and Michigan State University. The study identifies key authors and research topics through bibliometric mapping. The findings offer insights for future research and guide students and researchers in selecting journals and institutions.

3. Objectives

1. Analyze publication patterns and the roles of various document types.
2. Examine the impact of language on scientific dissemination, with a focus on English and regional languages.

3. Quantify subject contributions, highlighting key disciplines like Agricultural Sciences and Environmental Science.
4. Evaluate journal performance based on publication count, citations, and impact.
5. Test the applicability of Bradford's Law in hydroponics literature.

4. Methodology

The data on Hydroponics Literature were taken from SCOPUS online database for the year 1999-2023.The collected data were analysed with MS office Execl Spreadsheet and presented the findings in the form of Tables and Graphs.

5. Result and Discussions

Document Type-wise distribution in Hydroponics Literature

Table 1: Document Type-wise distribution in Hydroponics Literature

S. No	Documet Type	Count	% of Publications	Citations	% of Citations	CPP
1	Article	13749	82.82	388756	90.59	28.28
2	Conference paper	2076	12.51	14210	3.31	6.84
3	Review	342	2.06	21458	5.00	62.74
4	Book chapter	307	1.85	2716	0.63	8.85
5	Book	33	0.20	1063	0.25	32.21
6	Note	30	0.18	165	0.04	5.50
7	Erratum	18	0.11	7	0.00	0.39
8	Editorial	14	0.08	275	0.06	19.64
9	Retracted	11	0.07	151	0.04	13.73
10	Letter	9	0.05	40	0.01	4.44
11	Data paper	7	0.04	49	0.01	7.00
12	Short survey	5	0.03	254	0.06	50.80
	Total	**16601**	**100**	**429144**	**100**	**25.85**

This analysis reveals a structured publication landscape, where articles serve as the primary medium for disseminating research, reviews provide critical synthesis, and specialized formats (e.g., books, short surveys) deliver targeted impact. The diversity of document types reflects the varied needs of researchers and the broader scientific community. Articles are the most prevalent document type, making up 82.82% of all publications. They contribute a massive 90.59% of total citations, reflecting their central role in scientific communication. With a CPP of 28.28, articles have a significant average impact, indicating that they are widely referenced and influential. Conference papers account for 12.51% of publications, making them the second-largest category by volume. However, they contribute only 3.31% of citations, with a CPP of 6.84, indicating lower average influence compared to articles. These papers may primarily serve to present early-stage research or discussions rather than definitive findings. Reviews represent just 2.06% of publications but attract 5.00% of citations, underscoring their importance in summarizing and synthesizing knowledge. With a CPP of 62.74, reviews are the most impactful on average, as they often serve as key references for researchers in a field. The dataset includes 16,601 publications with 429,144 citations, yielding an average CPP of 25.85 across all types. Articles dominate in both volume and impact, reviews stand out for their high average influence, and books and short surveys contribute disproportionately to their volume. Other document types, while limited in count and influence, fulfill specific roles in the scientific ecosystem. Document types such as notes, errata, letters, and data papers collectively account for a small fraction of publications and citations.These typically serve specific purposes, like corrections, brief communications, or data sharing, with lower average impact (CPP ranging from 0.39 to 7.00).

Language-wise Distribution in Hydroponics Literature

Table 2: Language-wise Distribution in Hydroponics Literature

S. No	Language	Publicatons	% of Publications	Citations	% of Citations	CPP
1	English	15243	91.82	422530	98.46	27.72
2	Chinese	832	5.01	3284	0.77	3.95
3	Portuguese	219	1.32	2212	0.52	10.10
4	Spanish	138	0.83	571	0.13	4.14

5	Korean	54	0.33	104	0.02	1.93
6	Japanese	42	0.25	191	0.04	4.55
7	Russian	27	0.16	78	0.02	2.89
8	German	12	0.07	27	0.01	2.25
9	French	9	0.05	67	0.02	7.44
10	Persian	5	0.03	1	0.00	0.20
11	Turkish	5	0.03	48	0.01	9.60
12	Arabic	4	0.02	4	0.00	1.00
13	Polish	3	0.02	4	0.00	1.33
14	Czech	2	0.01	3	0.00	1.50
15	Bulgarian	1	0.01	0	0.00	0.00
16	Croatian	1	0.01	3	0.00	3.00
17	Dutch	1	0.01	2	0.00	2.00
18	Indonesian	1	0.01	1	0.00	1.00
19	Italian	1	0.01	0	0.00	0.00
20	Slovak	1	0.01	14	0.00	14.00
	Total	**16601**	**100**	**429144**	**100**	**25.85**

This table provides a comprehensive breakdown of scientific publications by language, detailing their count, percentage of total publications, citation impact, and citations per publication (CPP). The table highlights the central role of English as the global language of science, accounting for the vast majority of publications and citations. Regional languages like Chinese, Portuguese, and Spanish make notable contributions but face challenges in achieving broader impact. Smaller and niche languages exhibit limited representation, emphasizing the importance of language accessibility in disseminating scientific knowledge globally. English is the predominant language for publications, accounting for 91.82% of total publications. English publications attract an overwhelming 98.46% of total citations, reflecting their global accessibility and reach. The CPP for English-language publications is 27.72, indicating a high average impact per publication. Chinese constitutes 5.01% of publications, the second-highest after English. Citations make up only 0.77% of the total, with a relatively low CPP of 3.95, possibly reflecting limited global accessibility or niche subject areas. Portuguese accounts for 1.32% of publications with 0.52% of citations. A CPP of 10.10 suggests moderate impact, likely focused on specific regions or communities. Spanish Represents 0.83% of publications with 0.13% of citations. The CPP of 4.14 is low compared to English but slightly higher than Chinese.

Subject-wise Distribution in Hydroponics Literature

Table 3: Subject-wise Distribution in Hydroponics Literature

S. No	Subject	Publications	% of Publications
1	Agricultural and Biological Sciences	10368	62.45
2	Environmental Science	4635	27.92
3	Biochemistry, Genetics and Molecular Biology	3353	20.20
4	Engineering	1432	8.63
5	Chemistry	1058	6.37
6	Medicine	957	5.76
7	Computer Science	926	5.58
8	Earth and Planetary Sciences	567	3.42
9	Chemical Engineering	542	3.26
10	Immunology and Microbiology	492	2.96
11	Energy	485	2.92
12	Pharmacology, Toxicology and Pharmaceutics	473	2.85
13	Physics and Astronomy	449	2.70
14	Social Sciences	387	2.33

15	Multidisciplinary	376	2.26
16	Materials Science	344	2.07
17	Mathematics	246	1.48
18	Veterinary	198	1.19
19	Decision Sciences	169	1.02
20	Business, Management and Accounting	142	0.86
21	Nursing	105	0.63
22	Neuroscience	55	0.33
23	Economics, Econometrics and Finance	48	0.29
24	Health Professions	38	0.23
25	Arts and Humanities	31	0.19
26	Dentistry	8	0.05
27	Psychology	8	0.05

This table categorizes scientific publications by subject, showing their volume and percentage of total publications. It highlights the prominence of certain disciplines and their contribution to overall research output. Below is a comprehensive interpretation: It also highlights the growing importance of interdisciplinary research and the valuable contributions of niche fields. Together, these subjects reflect global research priorities addressing challenges like sustainability, health, and technological advancement. Major contribution is from the subject Agricultural and Biological Sciences with 10368 (62.45%) of total publications. Second Major contribution is from the subject Environmental Science with 4635 (27.92%) of publications. Third major contribution were from Biochemistry, Genetics, and Molecular Biology with 3353 (20.20%) of publications.

Journal Productivity in Hydroponics Literature

Table 4: Journal Productivity in Hydroponics Literature

S.No	Publications	Publications	% of Publication	Citations	CPP	Rank
1	Acta Horticulturae	1028	6.19	5823	5.66	1
2	Plant and Soil	316	1.90	18487	58.50	2
3	Journal of Plant Nutrition	307	1.85	5811	18.93	3
4	Environmental Science and Pollution Research	280	1.69	8335	29.77	4
5	Frontiers in Plant Science	267	1.61	7052	26.41	5
6	Scientia Horticulturae	254	1.53	10142	39.93	6
7	Chemosphere	231	1.39	11847	51.29	7
8	Ecotoxicology and Environmental Safety	222	1.34	9780	44.05	8
9	Plant Physiology and Biochemistry	188	1.13	8577	45.62	9
10	Environmental and Experimental Botany	185	1.11	11570	62.54	10
11	Agronomy	184	1.11	3446	18.73	11
12	Science of the Total Environment	178	1.07	6730	37.81	12
13	IOP Conference Series: Earth and Environmental Science	167	1.01	371	2.22	13
14	Journal of Hazardous Materials	162	0.98	10270	63.40	14
15	Plants	162	0.98	2405	14.85	14
16	International Journal of Phytoremediation	156	0.94	4508	28.90	15
17	Environmental Pollution	150	0.90	8126	54.17	16
18	HortScience	142	0.86	2825	19.89	17
19	Horticulturae	140	0.84	1798	12.84	18
20	PLoS ONE	139	0.84	5507	39.62	19
21	Environmental Science and Technology	128	0.77	11190	87.42	20
22	Journal of Experimental Botany	112	0.67	11241	100.37	21

23	Journal of Agricultural and Food Chemistry	95	0.57	4347	45.76	22
24	Acta Physiologiae Plantarum	92	0.55	2839	30.86	23
25	International Journal of Molecular Sciences	91	0.55	1894	20.81	24

This table provides an overview of scholarly publications in different journals, summarizing their publication count, percentage of total publications, citation count, citationper-publication (CPP), and rank based on citation impact. Here's a detailed breakdown and interpretation. Journal titled "*Acta Horticultura"* dominate in publication count 1028 (6.19%) but have lower CPP (5.66), indicating broader but less impactful research. Journals titled
"*Journal of Experimental Botany"* has the highest CPP 100.37.*Environmental Science and Technology* with the CPP value of 87.42 publish fewer articles but with significantly higher impact. Journals in environmental sciences show consistently high CPP, reflecting the critical relevance of this field.

Bradford Law in Hydroponics Literature

Table 5: Bradford Law in Hydroponics Literature

S. No	No. of Journals	No. of Articles	Total No. of Articles	Cumulative
1	1	1028	1028	1028
2	1	316	316	1344
3	1	307	307	1651
4	1	280	280	1931
5	1	267	267	2198
6	1	254	254	2452
7	1	231	231	2683
8	1	222	222	2905
9	1	188	188	3093
10	1	185	185	3278
11	1	184	184	3462
12	1	178	178	3640
13	1	167	167	3807
14	2	162	324	4131
15	1	156	156	4287
16	1	150	150	4437
17	1	142	142	4579
18	1	140	140	4719
19	1	139	139	4858
20	1	128	128	4986
21	1	112	112	5098
22	1	95	95	5193
23	1	92	92	5285
24	1	91	91	5376
25	1	83	83	5459
26	2	79	158	5617
27	1	72	72	5689
28	1	69	69	5758
29	1	68	68	5826
30	1	65	65	5891
31	1	64	64	5955
32	1	62	62	6017
33	1	60	60	6077

34	1	58	58	6135
35	1	57	57	6192
36	4	55	220	6412
37	3	53	159	6571
38	3	52	156	6727
39	2	51	102	6829
40	2	50	100	6929
41	3	49	147	7076
42	1	48	48	7124
43	2	47	94	7218
44	1	45	45	7263
45	4	44	176	7439
46	2	43	86	7525
47	2	42	84	7609
48	4	40	160	7769
49	1	39	39	7808
50	2	38	76	7884
51	3	37	111	7995
52	1	36	36	8031
53	1	35	35	8066
54	2	34	68	8134
55	2	33	66	8200
56	5	32	160	8360
57	4	31	124	8484
58	4	30	120	8604
59	3	29	87	8691
60	8	28	224	8915
61	2	27	54	8969
62	6	26	156	9125
63	3	25	75	9200
64	1	24	24	9224
65	4	23	92	9316
66	8	22	176	9492
67	7	21	147	9639
68	7	20	140	9779
69	6	19	114	9893
70	4	18	72	9965
71	8	17	136	10101
72	9	16	144	10245
73	17	15	255	10500
74	15	14	210	10710
75	9	13	117	10827
76	26	12	312	11139
77	17	11	187	11326

78	28	10	280	11606
79	32	9	288	11894
80	26	8	208	12102
81	62	7	434	12536
82	55	6	330	12866
83	80	5	400	13266
84	127	4	508	13774
85	190	3	570	14344
86	381	2	762	15106
87	1495	1	1495	16601
Total	**2731**		**16601**	

Table 6: Bradford's Distribution of Journals in Zones in Phytochemistry Literature

Zone	No. of Journals	No. of Articles	Bradford Multiplier
1	28	5533	
2	184	5294	6.57
3	2519	5774	13.69
Total	**2731**	**16601**	**10.13**

This Table shows the Bradford's Law of Scattering in Hydroponics Literature. Bradford Law of Scattering describes a quantitative relationship between journals and the papers they publish. According to the Bradford law "only a little number of core journals will contribute the nucleus of papers on a given topic which accounts for a significant percentage (1/3) of the articles. This will be followed by a second larger group of journals that account for another significant percentage (1/3) of the articles, while a much larger group of journals account for another significant percentage (1/3) of the articles. It was observed from Table that small number of 28 journals was identified with the core zone representing 1.02 % of the journals covered 5533 (33.32%) articles. The second small number of 184 (6.73%) journals provides 5294 (31.88 %) of the articles and the third largest zone of 2519 (92.23 %) journals covered 5774 (34.78%) articles. The Bradford multiplier between the zone 1 and zone 2 is 6.57 while it is 13.69 between zone 2 and 3. The average multiplier value is 10.13. In Bradford's journal distribution, the relationship between the zones is 1: n: n^2. In contrast the relationship in each of the present study is 28:184:2519. Here, 28 is the number of journals in the nucleus zone and mean Bradford's multiplier is 10.13. Hence, 28: 28*10.13: 28*$(10.13)^2$
28: 283.64: 2,873.27
28+283.64+2,873.27= 3,184.91
Percentage of Error = (3,184.91-2731/2731)×100= 16.62%. The Percentage of error is high (16.62%) and therefore Bradford's law does not fit the above data.

6. Conclusion

In conclusion, this analysis reveals the intricate dynamics of the scientific publication ecosystem, highlighting the dominance of articles in both volume and impact, the critical synthesis provided by reviews, and the specialized roles of other document types. The overwhelming prevalence of English as the global language of science underscores its importance in research dissemination, while regional languages face challenges in achieving broader influence. Subject areas like Agricultural and Biological Sciences, Environmental Science, and Biochemistry, Genetics, and Molecular Biology reflect global research priorities, addressing critical issues such as sustainability and technological advancement. Journal analysis demonstrates variability in impact, with certain high-CPP journals playing pivotal roles despite lower publication volumes. The application of Bradford's Law of Scattering to hydroponics literature identifies core journals contributing significantly to the field. However, deviations from the expected distribution highlight unique characteristics of this dataset. These findings underscore the structured yet diverse nature of the scientific publication landscape, emphasizing the importance of understanding publication patterns to optimize knowledge dissemination and impact.

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