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A scientometric study of greenhouse effect research output in India and China

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Abstract

This article discuses the greenhouse effect research output from India and China, 3776 records published by both countries during 2010 to 2019 which is Indexed in Scopus Database. It is observed that the main producers of research output in the greenhouse effect are The Chinese Academy of Sciences, Ministry of Education China, University of Chinese Academy of Sciences, Indian Institute of Technology Delhi, ICAR - Indian Agricultural Research Institute, New Delhi, Anna University and National Environmental Engineering Research Institute India. The most number of publications were in 2019 with 990 (26.2%) articles and Wang Y topped with 179 publications. The article measured the number of papers, Publication with Citations, Relative Growth Rate (RGR) and Doubling Time (DT) of Publications, Institutional affiliations, prolific authors and Zipf law.

Keywords: Greenhouse Effect, Year wise publications, Relative Growth Rate, Doubling Time, Document Types; Zipf Law; Prolific Authors.

1. Introduction:

Global warming and the greenhouse effect are two terms that are widely used by environmentalists. These two terms are linked to each other, but most of the time they are misunderstood. Both of these terms are significant and important because they play an important role in the sustainability of the environment. Global warming is the process by which the Earth warms from day to day, which is said to be the result of the phenomenon of global warming when the average temperature of the Earth warms. The greenhouse effect, on the

other hand, is a natural phenomenon each time the earth retains the heat and warmth of sunlight, the heat radiation from the sun is trapped by the earth's atmosphere, and they help keep the planet warm. It should be noted that global warming is a consequence of the greenhouse effect. Therefore keeping this analysis in view, we aim to carry out the scientometric study of greenhouse effect research output in India and China.

2. Objectives of the study

1. To examine the year wise growth of literature in the field of Greenhouse effect.

2. To analyse year wise citation received.

3. To analyse the document wise publications.

4. To identify the Relative Growth Rate (RGR) and Doubling Time (DT) of Greenhouse literature over the study period.

5. To analyse the implication of Zipf law

6. To find out most productive authors in greenhouse effect research.

7. To study the language wise distribution of Publications in greenhouse effect.

3. Methodology

The study used the scientometric approach of analysing the research output of greenhouse effect. The Scopus was used for retriving the relevant data and the search term used was ‘greenhouse effect’ during the research period of 2010-2019. A total of 3776 records were collected in the field of greenhouse effect and data were exported into MS Excel where the final analysis was done. The analysis was measured the number of papers, Publication with Citations, Relative Growth Rate (RGR) and Doubling Time (DT) of Publications, Institutional affiliations, prolific authors and Zipf law in order to mine out the coherent revelations and to infer the results.

4. Review of Literature

Sivasamy, K., & Vivekanandhan, S. (2020) analyzed the Leprosy Research during the year 2009-2018 with 6266 publications from the Scopus database and used scientometric tools such as frequency distribution, percentage analysis, relative growth rate and doubling time, degree of collaboration. The maximum number of publications published in 2015 was 675(10.77%). It is noticeably observed that the relative growth rate is identified as a decreasing trend and doubling time is an increasing trend from 2009 to 2018. The term leprosy research publications had been quantitatively dominated by India with 1522(24.29%) , followed by Brazil 1127(17.99%) and the United States with 1071(17.09%). The highest number of papers presented in Article (67.32%) followed by Review (13.58 %).

Kumara, T. A., & Kumar, K. S. (2020) evaluated 30485 records published by countries on different aspects of gravity during 2015 to 2019 as indexed by INSPEC database. The study pointed out the highest number of records 7562 (24.81%) were published in the year 2018 and the lowest number of records were 2012 (6.60%) in the year 2019. The top 10 countries listed from China to Switzerland contributed to 66.76% of total output of the literature, China topped the list with the highest share of documents (5567) followed by United States (4608), India (16363), and United Kingdom (1507) publications, etc.

Hualin Xie. et al. (2020) performed a study of scientometric analysis of the research literature output on Land Ecosystem Service. The requirenment of data for the study was downloaded from the Web of Science database and 840 records retrieved this research period of 20 years (2000 to 2019). China (187) accounted for the largest output of Land Ecosystem Service literature.

5. Data Analysis and Interpretation

5.1 Year wise analysis and Citation Structure of Greenhouse Effect

Figure 1 depicts the growth of research publications published in the field of Greenhouse effect literature during the study period 2010-2019. The highest number of 990 records were published during the year 2019. Overall of 3776 articles were published at this stage of research period. The highest count of articles, 990 (26.22%) were published by the year 2019

and least count of research articles, 122 (3.23%) were published by the year 2010. The second highest count of articles, 868 were published in the year of 2018 (22.99%). Approximately 58% of the overall Greenhouse effect publications were accounted during the research period of 2017–2019. There is a linear growth found in research output from 2010 to 2019.

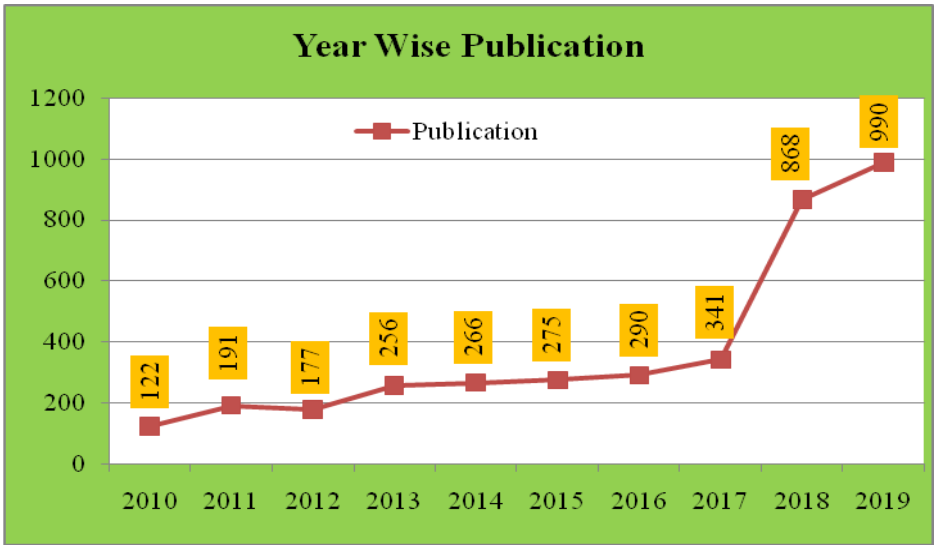

Figure 1: Greenhouse Effect (GHE) Year Wise Publications

Figure 2 reflects the distribution of citations of greenhouse effect documents during the years (2010–2019), with sum of 79,612 citations. Fascinatingly, the year 2010 shows only 8234 citations with a sum of 122 documents. The most number of citations were in the year 2018, with a sum of 12638 and least number of citations were found in the year of 2011, with a sum 4395 citations.

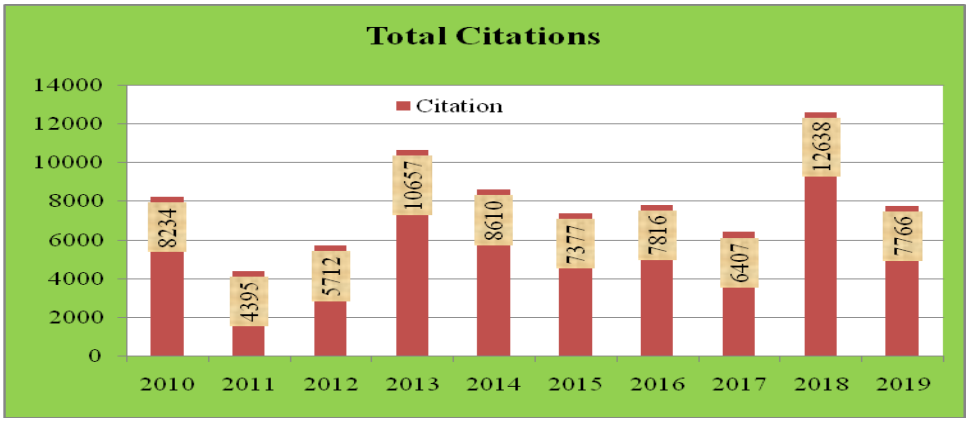

Figure 2: Total Citations of GHE (Greenhouse Effect)

The diversity observed in the total number of citations with respect to the total number of documents over the years is represented in Figure 2. There has been a standard increase in the citations over the year. In 2010 it reach a maximum records with a value of CPP 67.49 and it is followed by the records in the years 2013 and 2012 with CPP of 41.63 and 32.27 respectively. This can also be credited to the actuality that a most of records in these years have attracted a good number of citations. In contrast, the citations per paper count has degraded in the last few years as represented in Figure 3.

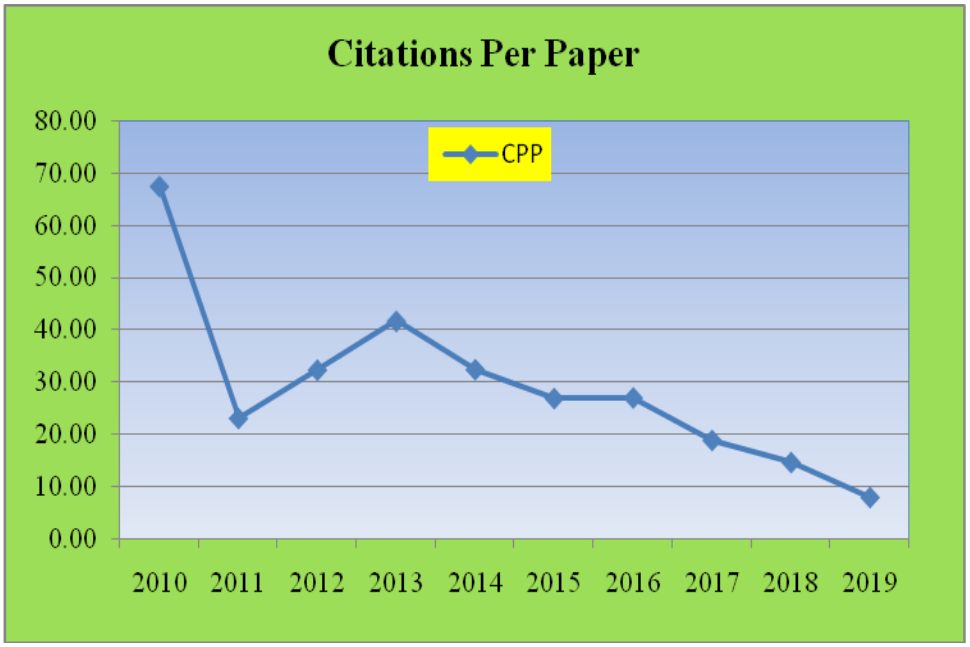

Figure 3: Citations Per Paper of GHE (Greenhouse Effect)

5.2 Document Type wise Distribution of Publications

From Table 1 Document type wise distribution of publications of Greenhouse effect literature was observed. With reference to the analysis, there were 10 types of documents classified. “Article” with 3172 (84%) publications was the most preferred document type by the researchers followed by “Conference Paper” with 314 (8.32%) publications and the “Review” with 176 (4.66%) publications. Hence, 97% of total publications were occupied by the above mentioned three document types.

Table 1:

Document Wise Publications of Greenhouse Effect

S. No	Document Type	Publications	Percentage
1	Article	3172	84.00
2	Conference Paper	314	8.32
3	Review	176	4.66
4	Book Chapter	34	0.90
5	Note	24	0.64
6	Letter	22	0.58
7	Short Survey	15	0.40
8	Editorial	13	0.34
9	Book	4	0.11
10	Retracted	1	0.03
11	Undefined	1	0.03
Total		**3776**	

5.3 Relative Growth Rate and Doubling Time of Publications

Table 2 and Figure 4 represented the Relative Growth Rate (RGR) of Greenhouse effect literature for the 2012 with the value of 0.45. Similarly, the lowest value reported in the year 2016 and 2017 with the value of 0.20 respectively. Table 2 and Figure 5 concerned with the Doubling Time (DT). In the year 2017 maximum DT with the value of 3.54 , followed by the year 2016 with the value of 3.41 was observed. Similarly, the lowest DT reported in the year 2011 with the value of 0.74. A linear fall in Relative Growth Rate and linear growth in Doubling Time was observed during the research period.

Table 2:

Relative Growth Rate and Doubling Time of Greenhouse effect publications

S. No	Year	Publication	Cumulative	W1	W2	RGR	DT
1	2010	122	122		4.80		
2	2011	191	313	4.80	5.75	0.94	0.74
3	2012	177	490	5.75	6.19	0.45	1.55
4	2013	256	746	6.19	6.61	0.42	1.65
5	2014	266	1012	6.61	6.92	0.30	2.27

S. No	Year	Publication	Cumulative	W1	W2	RGR	DT
6	2015	275	1287	6.92	7.16	0.24	2.88
7	2016	290	1577	7.16	7.36	0.20	3.41
8	2017	341	1918	7.36	7.56	0.20	3.54
9	2018	868	2786	7.56	7.93	0.37	1.86
10	2019	990	3776	7.93	8.24	0.30	2.28
Total		**3776**					

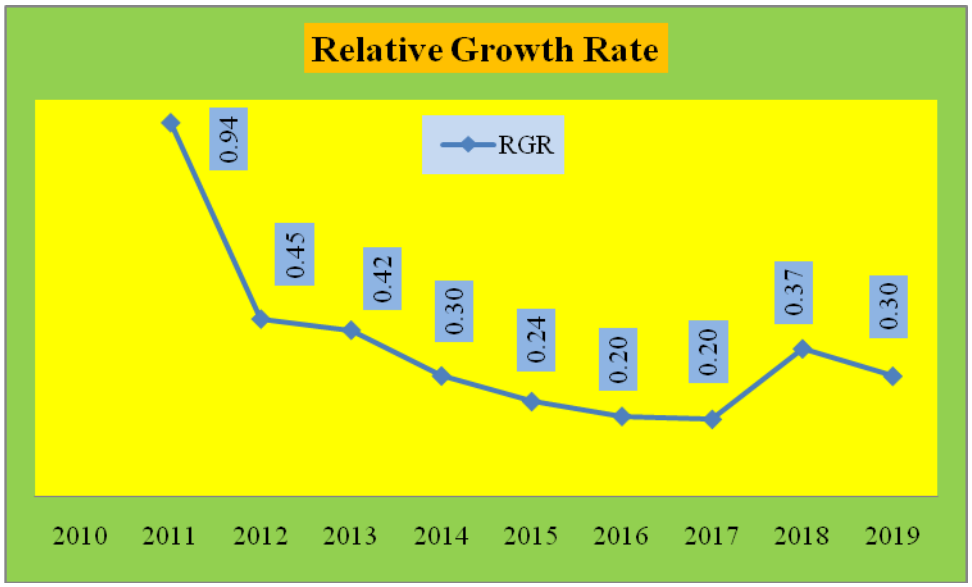

Figure 4. Relative Growth Rate of Greenhouse Effect publications

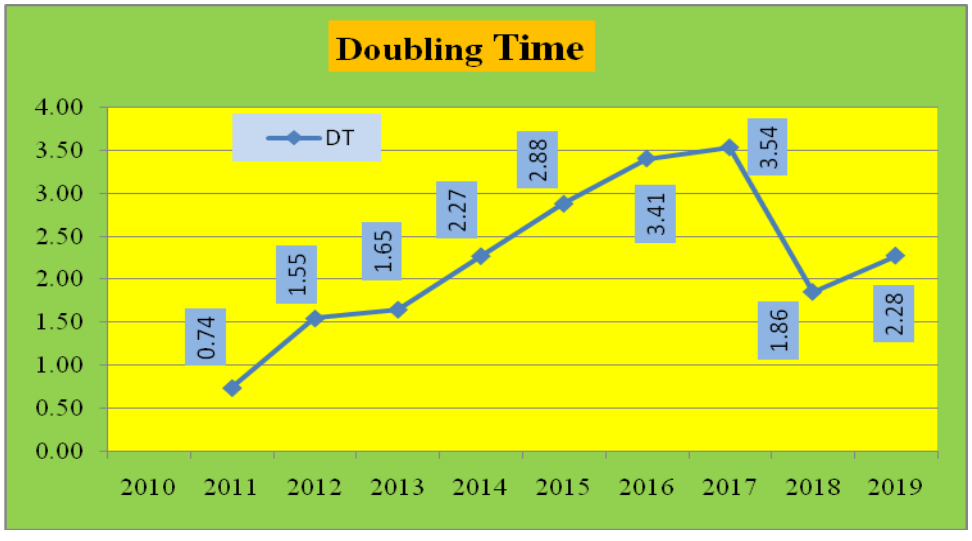

Figure 5. Doubling Time of Greenhouse Effect publications

5.4 Source Title wise Distribution of Publications

Table 3 illustrated the Source title wise distribution of publications in the field of Greenhouse effect research. There were 159 source titles/journals which contributed to the Greenhouse effect research. It was identified that the Science Of the total Environment published by Elsevier was at top position with 169 (4.48%) publications, followed by Plos One published by Public Library of Science with 127 (3.36%) publications and Nongye Gongcheng Xuebao Transactions Of The Chinese Society Of Agricultural Engineering published by Chinese Society of Agricultural Engineering with 96 (2.54%) publications.

Table 3:

Top 10 Source Title wise Distributions of Publications

Sl. No	Source Title	Publications	% of 3776
1	Science Of The Total Environment	169	4.48
2	Plos One	127	3.36
3	Nongye Gongcheng Xuebao Transactions Of The Chinese Society Of Agricultural Engineering	96	2.54
4	Scientific Reports	75	1.99
5	Environmental Science And Technology	69	1.83
6	Chinese Journal Of Applied Ecology	67	1.77
7	Atmospheric Environment	63	1.67
8	Environmental Science And Pollution Research	57	1.51
9	Huanjing Kexue Environmental Science	45	1.19
10	Proceedings Of The National Academy Of Sciences Of The United States Of America	44	1.17

5.5 Implication of Zipf Law

From the Table 4 it is observed that the terms like Greenhouse Effect (2520), Article (1147), Global Warming (952), Carbon Dioxide (889), China (770) and Climate Change (553) are the most frequently used keywords during this research period. In 1990s G.K Zipf in progress a work on the phenomena of word frequency. He analysed the changes of phonetics in languages and tried to recognize the frequency of use of words and their phonetically changes over a long time period. Zipf's law gives us a connection of words frequency and its rank.

According to Zipf's law rf=c

Where r=rank of words

F=frequency of occurrence of words.

C= constant (1)

Zipf's law generally refers the above equation but according to Wyllys(1981) Zipf's law can also be written in graphic representation as log r f=log c

Or log r+ log f=log c

In the present study, rank, frequency and their log has been calculated in table 5.3.1. From the graph it is clear that the Constant value for all keywords listed here is aproximately 3.40

Table 4: Frequency log and rank log table

S. No	Keyword	Keyword Frequency	Rank	Log of Keyword	Log of Rank	C=Log F+Log R
1	Greenhouse Effect	2520	1	3.40	0.00	3.40
2	Article	1147	2	3.06	0.30	3.36
3	Global Warming	952	3	2.98	0.48	3.46
4	Carbon Dioxide	889	4	2.95	0.60	3.55
5	China	770	5	2.89	0.70	3.59
6	Climate Change	553	6	2.74	0.78	3.52
7	Greenhouse Gas	512	7	2.71	0.85	3.55
8	Greenhouse Gases	507	8	2.71	0.90	3.61
9	Priority Journal	488	9	2.69	0.95	3.64

S. No	Keyword	Keyword Frequency	Rank	Log of Keyword	Log of Rank	C=Log F+Log R
10	Nonhuman	451	10	2.65	1.00	3.65
11	Methane	396	11	2.60	1.04	3.64
12	Controlled Study	391	12	2.59	1.08	3.67
13	Temperature	360	13	2.56	1.11	3.67
14	Carbon	356	14	2.55	1.15	3.70
15	Chemistry	316	15	2.50	1.18	3.68
16	Soil	310	16	2.49	1.20	3.70
17	Carbon Footprint	296	17	2.47	1.23	3.70
18	Nitrous Oxide	294	18	2.47	1.26	3.72
19	Nitrogen	275	19	2.44	1.28	3.72
20	Human	267	20	2.43	1.30	3.73
21	Agriculture	264	21	2.42	1.32	3.74
22	Greenhouses	253	22	2.40	1.34	3.75
23	Gas Emissions	242	23	2.38	1.36	3.75
24	Environmental Monitoring	235	24	2.37	1.38	3.75
25	Environmental Impact	213	25	2.33	1.40	3.73

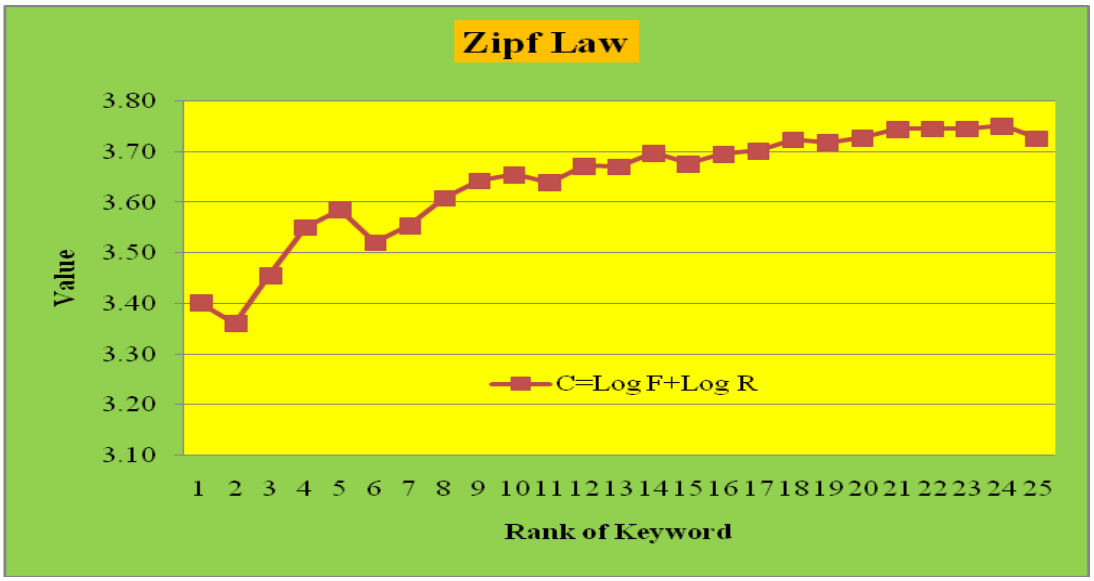

Figure 6. Frequency and rank log

5.6 Top Prolific Authors

The top 25 authors are listed below in Table 5. It revealed that out of 3776 articles, a total number of 2441 articles (64.65%) were written during 2010 to 2019 by top 25 authors. Some of these articles are the result of joint authors and some of them are by single authors. It was exciting to know who the top prolific authors during the period. Findings disclosed that Wang, Y. with 179 articles was the most productive scientist in greenhouse effect literature. As can be understood from Table 1, Liu, Y and Li, Y each with 160, 149 articles appeared in the second and third positions, respectively.

Table 5: Top Prolific Authors

S. No	Author	Publication	Rank
1	Wang Y	179	1
2	Liu Y	160	2
3	Li Y	149	3
4	Wang J	142	4
5	Wang X	140	5
6	Li X	133	6
7	Zhang Y	125	7
8	Li J	110	8
9	Zhang X	110	8
10	Zhang J	98	9
11	Zhang Z	92	10
12	Liu X	84	11
13	Wang H	84	11
14	Chen J	81	12
15	Zhang H	78	13
16	Zhang L	77	14
17	Wang L	73	15
18	Li Z	71	16
19	Wang Z	69	17
20	Chen Y	68	18
21	Liu J	67	19
22	Li S	64	20
23	Wang S	64	20
24	Zhang Q	63	21
25	Li L	60	22

5.7 Institutions-wise Distribution of Publications

Table 7 represented the Institutions-wise distribution of publications of greenhouse effect literature at India and China. Of the top 05 productive institutions listed in China, Chinese Academy of Sciences contributed 545 publications followed by Ministry of Education China contributed 209 publications, University of Chinese Academy of Sciences with 176 publications, China Agricultural University with 95 publications and Tsinghua University with 86 publications. In India, Indian Institute of Technology Delhi with 13 publications, ICAR - Indian Agricultural Research Institute, New Delhi with 12 publications, Anna University with 12 publications, National Environmental Engineering Research Institute India with 10 publications and Indian Council of Agricultural Research with 10 publications.

Table 7:

Institutions-wise Distribution of Publications

S.No	China	Publications	Rank	India	Publications	Rank
1	Chinese Academy of Sciences	545	1	Indian Institute of Technology Delhi	13	1
2	Ministry of Education China	209	2	ICAR - Indian Agricultural Research Institute, New Delhi	12	2
3	University of Chinese Academy of Sciences	176	3	Anna University	12	2
4	China Agricultural University	95	4	National Environmental Engineering Research Institute India	10	3
5	Tsinghua University	86	5	Indian Council of Agricultural Research	10	3

5.8 Language-wise Distribution of Publications

Table 8 illustrated the Language-wise distribution of Greenhouse effect literature. Globally contributions were made in 4 languages. English language was noticed as the predominant language of communication with 3326 (88.08%) publications. Nextly, Chinese language received 448 (11.86%) publications then French language received 64 (0.454%) publications followed by Croatian and French with 01 publications respectively.

Table 8:

Language-wise Distribution of Publications

S.No	Language	Publications	Percentage
1	English	3326	88.08
2	Chinese	448	11.86
3	Croatian	1	0.03
4	French	1	0.03
Total		**3776**	**100**

6. Conclusion:

The present study predicts that there will be a rapid growth in the number of scientific publications related to Greenhouse effect research. The results also shows that Chinese Academy of Sciences contributed 545 publications ranked first in China and Indian Institute of Technology Delhi contributed 13 publications ranked first in India. It is observed that the terms like Greenhouse Effect (2520), Article (1147), Global Warming (952), Carbon Dioxide (889), China (770) and Climate Change (553) are the most frequently used keywords during this research period. Regarding prolific authors concern, Wang, Y. from China became the topper amongst all the authors. Hence it can be suggested that the Indian researchers of Greenhouse effect should concentrate on more research.

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CONFLICT OF INTEREST

I have no conflicts of interest to declare for this study.

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