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RESEARCH PAPER

Scopus indexed scholarly publications of academics at the University of Agricultural Sciences, Dharwad: A Bibliometric analysis

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Abstract: The paper gives a thorough review of faculty research output from the University of Agricultural Sciences, Dharwad, as tracked by Scopus from 2002 to 2021.The Scopus database was used to retrieve the data for the study. To analyse the data, bibliometric techniques were used such as yearly distribution of publications, to calculate relative growth rate and doubling time of articles, authorship pattern, most prolific authors, most preferred journals etc. are studied. The analysis showed that, UAS, Dharwad had its most prolific year in 2014 with 116 publications (8.45%), totaling 658 citations, with the average article receiving at least 5.67 citations. The number of publications increased from 24 in 2002 to 1372 in 2021. The highest Doubling Time was found to be in the year 2019, with a value of 16.754. The author, Salimath P M of Genetics and Plant Breeding department was the most publishing author with 60 publications. The faculty preferred the journal "International Journal of Agricultural and Statistical Sciences," with a current impact factor of 0.278 as most popular journal to publish their papers. According to the study, UAS, Dharwad have made significant contributions to research publications in the fields of genetics, biochemistry, agricultural and biological sciences, and molecular biology.

Key words: Bibliometric, Doubling time, Relative growth rate, Research publications, Scholarly publications, Scopus

Introduction

The development of any country depends upon the research productivity of higher education institutions and research organizations. One of the main factors considered in the development of universities is the publications of faculty members (Bhui and Sahu, 2018). Through the development and use of multiple indicators like NAAS rating, Impact factor *etc.* citation analysis has become a more relevant and vital method of evaluating research excellence. One of the most crucial bibliometrics techniques is citation analysis, which considerably aids researchers in comprehending trends and instinctively recognising a study field's trend (Cobo *et al*., 2011). The field of bibliometrics involves a significant intersection and fusion of philology, information science, mathematics, and statistics in a particular area (He *et al*., 2017) and bibliometric indicators can be more effectively used to analyze the development of a certain study area. Publications are a means of disseminating innovative concepts and new knowledge. This study analyses the research publications published in Scopus data base by academics of University of Agricultural Sciences Dharwad.

University of Agricultural Sciences, Dharwad

The University of Agricultural Sciences, Dharwad, was established on October 1st, 1986. The University has 5 Colleges, 27 Research Stations, 6 Agriculture Extension Education Centres, 6 Krishi Vigyan Kendras and ATIC. The university has jurisdiction over Bagalkot, Belgaum, Vijayapur, Dharwad, Gadag, Haveri, and Uttar Kannada, seven districts in northern Karnataka. There is more variety in terms of soil types, climate, geography, cropping, and farming practices. The territory covered by the jurisdiction ranges from arid farming to areas with high rainfall. Significant crops farmed in the region include sorghum, cotton, rice, pulses, chillies, sugarcane, groundnuts, sunflower, wheat, and safflower. Numerous horticulture crops are raised there. This university has made considerable strides in the areas of extension, research and education (http:www.uasd.edu).

Objectives of the study

The primary goal of the present study is to determine the research productivity of the academics at the University of Agricultural Sciences. Dharwad as recorded in the Scopus database between 2002 and 2021. The analysis of the growth rate of research output aims the growth prospects of the authors of UAS, Dharwad. The rate of growth of publications of authors of UAS, Dharwad is determined by calculating relative growth rate and doubling time of articles productivity. The authors who contributed the most publications, their preferred journals and top ten most cited papers of authors of UAS, Dharwad listed in the scopus database were recognized. Co-authorship of authors of UAS, Dharwad and co-occurances of authors specified keywords were analysed by VOS viewer software.

Material and methods

This analysis is based on academic articles written by academics of University of Agricultural Sciences Dharwad, that were published between the years of 2002 and 2021. The data was retrieved from the Scopus database using affiliation listed individually on 4th June 2022. Totally 1372 articles were retrieved and used for analysis.

The data is analyzed using bibliometric analysis tools like Bibexcel (Persson and Schneider, 2009). While VOS viewer

(Perianes-Rodriguez *et al*., 2016) a visualization tool, is used for science mapping tasks including author co-authorship networks, and co-occurrences of author-specified keywords.

Data analysis

According to bibliometric analysis, the study's findings are reported in the following paragraphs.

Table 1 shows in terms of annual research publications of UAS, Dharwad and citation structure between 2002 and 2021. The table 1 revealed that a total of 1372 research articles were published during this period.

In terms of productivity, 2014 was the most productive year of UAS, Dharwad (TP:116 % TP:8.45) and total 658 citations with average article being cited at least 5.67 times, followed by 114 publications in 2011 and 2016 each (%TP:8.31) with total citations 797 and 224, respectively. It is found from the study that,according to citations, 2007 was the most influential year (CPP:14.52), followed by 2012 (11.14) and 2009 (10.07). A large number of publications found between 2011 and 2017 and fewer publications were between 2002 and 2009.

The increase in publications or pages per unit of time is known as the relative growth rate (RGR). According to Mahapatra's (1985) relative growth rate and doubling time equation, the growth rate of all publications has been computed.

The mean RGR is over the specific period ofinterval can be calculated from the following formula.

$$RGR = \frac{W_2 - W_1}{T_2 - T_1}$$

Table1.Year Wise Distribution of Research Articles Produced by UAS, Dharwad (2002-21)

Publication Year	TP	TC	%TP	CPP
2002	24	131	1.75	5.46
2003	31	160	2.26	5.16
2004	40	394	2.92	9.85
2005	24	111	1.75	4.63
2006	51	263	3.72	5.16
2007	46	668	3.35	14.52
2008	52	238	3.79	4.58
2009	45	453	3.28	10.07
2010	62	560	4.52	9.03
2011	114	797	8.31	6.99
2012	87	969	6.34	11.14
2013	100	599	7.29	5.99
2014	116	658	8.45	5.67
2015	102	427	7.43	4.19
2016	114	224	8.31	1.96
2017	106	397	7.73	3.75
2018	70	195	5.10	2.79
2019	50	184	3.64	3.68
2020	65	269	4.74	4.14
2021	73	85	5.32	1.16

Note: TP – Total Publications; TC – Total citations; CPP – Citations per Publications

Where,

RGR = Mean Relative Growth Rate over specific period of interval.

W_1 = Natural log of initial number of publications.

W_2 = Natural log of final number of articles after a specific period of interval.

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

Data on the relative growth rate and doubling time of articles published by academics of UAS, Dharwad are shown in Table 2. In 2002, the publications were just 24 and it increased to 1372 in the year 2021. A declining trend in the relative growth rate has been observed. The data shown in the table shows that its relative growth rate has gradually decreased from 0.829 in 2003 to 0.055 in 2021. The mean relative growth rate (Mean of RGR) of publications from 2002 to 2011 (first ten years) was higher (0.30) than the publications from 2012 to 2021 *i.e*. last ten years (0.10).

The Doubling time is the time required of publications to double size. As observed by Braford "Between Relative growth rate and doubling time there is a direct equivalence". According to Mahapatra (1985), to study doubling time ofpublications was calculated by the following formula.

$$\text{Doubling Time (DT)} = \frac{0.693}{RGR}$$

Table 2 was produced using the Doubling Time (DT). It was determined that the year 2019 had the highest DT, with a value of 16.754, and that the year 2020 had 11.79 came in second. Similar to this, the lowest DT ever recorded has a value of 0.836 and was recorded in 2003. Contrarily, mean of DT from 2.41 in 2011 to 8.57 in 2021, the doubling time for publications productivity of UAS, Dharwad has grown. On the whole, it was known to there was also variation in both Relative Growth Rate and Doubling Time during the study period.

Category-wise distribution of publications of UAS, Dharwad published between 2002 and 2021 was elucidated in Table 3. Maximum number of publications published under the category of article (1247, 90.89%), whereas 35 (2.55%) each papers published under the conference paper and book chapter categories. Very small number of publications were published under book, data paper and editorial category *i.e*. 1 (0.07%) each.

Totally 1372 articles were published by 500 individual authors during 2002 to 2021. Table 4 shows the top authors with more than or equal to 20 contributions between 2002 and 2021. It presents Salimath P M (TP: 60; 238 citations; %TP:4.37) of Genetics and Plant Breeding department was the most publishing author, followed by Bhat R S (TP:50; TC:655; %TP:3.64), Balikai R A (TP:46; TC:69; %TP:3.35) and others. However looking into citations Gowda M V C of Genetics and Plant Breeding department was the most influential author

Table 2. Relative Growth Rate and Doubling time of Articles Productivity of faculty of UAS, Dharwad

Publication Year	TP	Cumulative TP	W_1	W_2	RGR (W_2-W_1)	Mean of RGR	DT	Mean of DT
2002	24	24	-	3.178	-		-	
2003	31	55	3.178	4.007	0.829		0.836	
2004	40	95	4.007	4.554	0.547		1.268	
2005	24	119	4.554	4.779	0.225		3.077	
2006	51	170	4.779	5.136	0.357		1.943	
2007	46	216	5.136	5.375	0.239	0.30	2.894	2.41
2008	52	268	5.375	5.591	0.216		3.213	
2009	45	313	5.591	5.746	0.155		4.465	
2010	62	375	5.746	5.927	0.181		3.835	
2011	114	489	5.927	6.192	0.265		2.611	
2012	87	576	6.192	6.356	0.164	0.10	4.232	8.57
2013	100	676	6.356	6.516	0.160		4.329	
2014	116	792	6.516	6.675	0.158		4.376	
2015	102	894	6.675	6.796	0.121		5.720	
2016	114	1008	6.796	6.916	0.120		5.774	
2017	106	1114	6.916	7.016	0.100		6.931	
2018	70	1184	7.016	7.077	0.061		11.372	
2019	50	1234	7.077	7.118	0.041		16.754	
2020	65	1299	7.118	7.169	0.051		13.500	
2021	73	1372	7.169	7.224	0.055		12.675	

Note: TP – Total Publications

Table 3. Category-wise distribution of publications

Category	TP	%TP
Article	1247	90.89
Conference Paper	35	2.55
Book Chapter	35	2.55
Review	23	1.68
Letter	12	0.87
Note	11	0.80
Erratum	4	0.29
Short Survey	2	0.15
Book	1	0.07
Data Paper	1	0.07
Editorial	1	0.07

Note: TP – Total Publications

(TC:1148; CPP:27.30) followed by Bhat R S (TC:655; CPP:13.10) of Department of Biotechnology, Katageri I S (TC:530; CPP22.08) and Nadaf H L (TC:489; CPP:11.93) of Department of Genetics and Plant Breeding. This demonstrates that the writers of the Genetics and Plant Breeding and Biotechnology departments' papers received the most citations.

The number of single and multiple authorships was determined by analyzing the authorship pattern in Table 5. According to this information, the author sample included 5160 authors who published 1372 papers between them from 2002 to 2021. Out of which 34 (%TP:2.48) articles are contributed by a single author, 287 (%TP:2.92) articles are contributed by two authors, and 372 (%TP:27.11) papers are contributed by three authors. Contributions by four authors (251 articles) are next, followed by five authors with 136 articles and more than five

Table 4. Authors with highest number (≥ 20) of contributions during 2002 - 2021

Name of the Authors	TP	TC	%TP	CPP	Department
Salimath P M	60	238	4.37	3.97	Genetics and Plant Breeding
Bhat R S	50	655	3.64	13.10	Biotechnology
Balikai R A	46	69	3.35	1.50	Agricultural Entomology
Krishnaraj P U	44	317	3.21	7.20	Agricultural Microbiology
Gowda M V C	42	1148	3.06	27.33	Genetics and Plant Breeding
Nadaf H L	41	489	2.99	11.93	Genetics and Plant Breeding
Mahale G	28	47	2.04	1.68	Textile and Apparel Designing
Fakrudin B	27	486	1.97	18.00	Biotechnology
Jahagirdar S	25	24	1.82	0.96	Plant Pathology
Katageri I S	24	530	1.75	22.08	Genetics and Plant Breeding
Khadi B M	24	137	1.75	5.71	Genetics and Plant Breeding
Vasudeva R	24	82	1.75	3.42	Forestry/Biochemistry
Nargund V B	23	204	1.68	8.87	Plant Pathology
Kulkarni S	22	63	1.60	2.86	Plant Pathology
Kuruvinashetti M S	22	295	1.60	13.41	Genetics and Plant Breeding
Byadgi A S	20	179	1.46	8.95	Plant Pathology
Ravikumar R L	20	92	1.46	4.60	Genetics and Plant Breeding

Note: TP – Total Publications; TC – Total citations; CPP – Citations per Publications

Table 5. Authorship pattern

Authorship Pattern	TP	%TP	Total Authors
Single Author	34	2.48	34
Two Authors	287	20.92	574
Three Authors	372	27.11	1116
Four Authors	251	18.29	1004
Five Authors	136	9.91	680
More than Five Authors	292	21.28	1752
Total	1372	100.00	5160

Note: TP – Total Publications

authors are with 292 publications. It also reveals that majority of publications are in the form of collaborative work. The table also includes the total number of authors.

Over the years 2002 to 2021, the academic output of UAS, Dharwad was published in 325 scholarly journals. Table 6 lists the periodicals in which the faculty at UAS, Dharwad have published their research articles. Table no. 6 represents the journals with more than twenty publications. The top journal used by authors from UAS, Dharwad to publish their articles is the "International Journal of Agricultural and Statistical Sciences," with a current impact factor of 0.278 (TP:89; %TP:6.49). This is followed by the journal "Plant Achieves," with an impact factor of 0.272, which was used to publish their research papers (TP:84; %TP:6.12). More than fifty research articles were published in the journals "Indian Journal of Genetics and Plant Breeding" (TP:55), "Legume Research" (TP:51), and "Research on Crops" (TP:50). The table also shows that the lowest articles (TP:22; %TP:1.60) by authors from UAS, Dharwad were published in the journal "Euphytica," which had the highest impact factor (2.13) and highest h-index (110).

According to academics at UAS, Dharwad, Table 7 listed the top ten works that had received the most citations. The publication by Chen Z J *et.al.* which included the author Katageri I S of UAS Dharwad, titled "Toward sequencing cotton (*Gossypium*) genomes" published in the journal Plant Physiology in 2007 found most cited with 290 citations, followed by the title "Development of genic-SSR markers by deep transcriptome sequencing in pigeonpea [*Cajanus cajan* (L.) Millspaugh]" by Datta S, which included the author Fakrudin B of UAS Dharwad published in journal BMC Plant Biology in 2011 has 216 citations. The only title "Pigeonpea genomics initiative (PGI): An international effort to improve crop productivity of pigeonpea (*Cajanus cajan* L.)" by Varshney R K with Fakrudin B published in journal Molecular Breeding in 2010 has the citations less than 100. This table also demonstrates that the authors Gowda M V C and Fakrudin B are well-known writers in the Genetics and Plant Breeding department at UAS Dharwad, as evidenced by the number of citations their publications have received in the list of the most frequently cited works published by UAS, Dharwad academics in Scopus

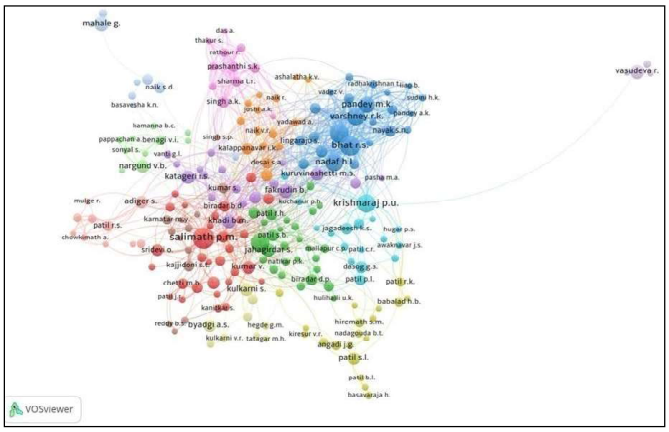

Fig 1. Co-authorship of authors of UAS Dharwad between 2002 and 2021

Figure 1 depicts the co-authorship network of UAS, Dharwad authors who published at least five co-authored articles between 2002 and 2021, with 14 clusters and 983 links.Co-authorship illustrates the intellectual links between academics from various institutions (Donthu et.al., 2021). The strongest co-authorship cluster is made up of Bhat R S and Gowda M V C with total link strengths of 294, 251 and 50, 42 documents, respectively.

Table 6. Most preferred journals used by academics of UAS, Dharwad to publish their research papers

Name of the Journals	TP	Impact Factor	h-Index	%TP
International Journal of Agricultural and Statistical Sciences	89	0.278	14	6.49
Plant Archives	84	0.272	10	6.12
Biochemical and Cellular Archives	59	0.244	11	4.30
Indian Journal of Genetics and Plant Breeding	55	0.77	17	4.01
Legume Research	51	0.589	16	3.72
Research on Crops	50	1.06	15	3.64
Acta Horticulturae	49	0.29	11	3.57
Journal of Pure and Applied Microbiology	46	0.483	20	3.35
Indian Journal of Agricultural Sciences	40	0.371	29	2.92
Electronic Journal of Plant Breeding	35	0.51	11	2.55
Pestology	34	0.132	12	2.48
Current Science	34	1.102	62	2.48
Indian Journal of Agronomy	24	0.226	23	1.75
Annals of Biology	22	1.24	7	1.60
Euphytica	22	2.13	110	1.60

Note: TP – Total Publications

Table 7. Top 10 most cited papers published in Scopus by academics of UAS, Dharwad

Rank	Authors	Title	Year	Source title	TC
1	Chen Z J, *et al.* (Katageri I S)*	Toward sequencing cotton (*Gossypium*) genomes	2007	Plant Physiology	290
2	Dutta S, *et al.* (Fakrudin B)*	Development of genic-SSR markers by deep transcriptome sequencing in pigeonpea [*Cajanus cajan* (L.) Millspaugh]	2011	BMC Plant Biology	216
3	Gan Y, *et al.* (Angadi V V)*	Canola and mustard response to short periods of temperature and water stress at different developmental stages	2004	Canadian Journal of Plant Science	157
4	Ravi K, *et al* (Gowda M V C)*	Identification of several small main-effect QTLs and a large number of epistatic QTLs for drought tolerance related traits in groundnut (*Arachis hypogaea* L.)	2011	Theoretical and Applied Genetics	139
5	Khedikar Y P, *et al.* (Gowda M V C)*	A QTL study on late leaf spot and rust revealed one major QTL for molecular breeding for rust resistance in groundnut (*Arachis hypogaea* L.)	2010	Theoretical and Applied Genetics	133
6	Singh N K, *et al* (Fakrudin B)*	The first draft of the pigeonpea genome sequence	2012	Journal of Plant Biochemistry and Biotechnology	127
7	Patil J R, *et al*	Bioactive compounds from mexican lime (*Citrus aurantifolia*) juice induce apoptosis in human pancreatic cells	2009	Journal of Agricultural and Food Chemistry	117
8	Sujay V, *et al* (Gowda M V C)*	Quantitative trait locus analysis and construction of consensus genetic map for foliar disease resistance based on two recombinant inbred line populations in cultivated groundnut (*Arachis hypogaea* L.)	2012	Molecular Breeding	116
9	Varshney R K, *et al.* (Gowda M V C)*	Marker assisted introgression of a QTL region to improve rust resistance in three elite and popular varieties of peanut (*Arachis hypogaea* L.)	2014	Theoretical and Applied Genetics	106
10	Varshney R K, *et al* (Fakrudin B)*	Pigeonpea genomics initiative (PGI): An international effort to improve crop productivity of pigeonpea (*Cajanus cajan* L.)	2010	Molecular Breeding	98

Note: TC – Total citations, *- Authors of UAS, Dharwad

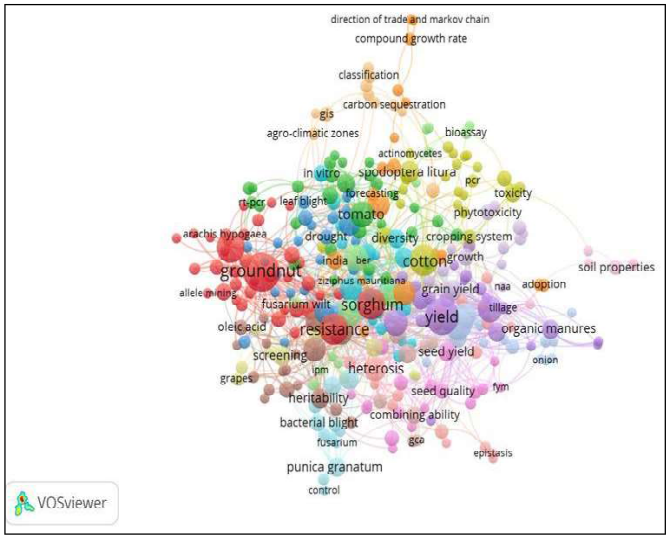

Fig 2. Co-occurrences of author specified keywords of UAS, Dharwad authors' publications from 2002 to 2021Fig. 2 presents the co-occurrence of the most discussed author specified keywords at least 25 times by academics of UAS, Dharwad between 2002 and 2021.349 keywords total appeared in all clusters. Stronger connections and more frequent co-occurrences are shown by the term "groundnut," (49 times) which is followed by the words "yield" (42 times) and "maize" (28 times).However, "cotton", "resistance" and "sorghum" occurred 29 times each.

Results and discussion

It is presented some facts, conclusions, or study results that are as follows after analyzing the academics at UAS, Dharwad's publications data obtained from Scopus for the years 2002 to 2021.

Every year, the total number of publications varies, and the number of publications ascended year after year until 2017. However, there were fewer publications from 2018 to 2021 than in 2017. According to the citation, the most influential year was 2007 (TC: 668; CPP: 14.52), followed by 2012 (TC: 969; CPP:11.14) and 2009 (CPP:10.07). The relative growth rate of publications has been discovered to be decreasing. According to the data, its relative growth rate has continuously decreased from 0.829 in 2003 to 0.055 in 2021. The mean relative growth rate (Mean of RGR) for the first ten years of publications from 2002 to 2011 was larger (0.30) than for the last ten years of publications from 2012 to 2021 (0.10). The year 2019 was discovered to have the

largest DT with a rating of 16.754, with the year 2020 following in second with a number of 11.79. Similarly, the lowest DT ever measured, which occurred in 2003, has a value of 0.836. On the other hand, the doubling time for publications output at UAS, Dharwad has increased, from a mean of 2.41 in 2011 to 8.57 in 2021.

Between 2002 and 2021, the most publications from UAS, Dharwad were in the category of articles (1247 or 90.89%), while 35 (2.55%) were in the category of conference papers and book chapters. It reveals that the vast majority of academics are eager to publish their work as journal articles. From 2002 through 2021, 500 different authors collaborated on 1372 papers. Salimath P M (TP: 60; 238 citations; percent TP:4.37) from the Genetics and Plant Breeding department has the most publications, followed by Bhat R S (TP:50; TC:655; percent TP:3.64) and Balikai R A (TP:46; TC:69; percent TP:3.35). The writers of works from the department of Genetics and Plant Breeding received the most citations in this category. According to citation analysis, Gowda M V C of the Genetics and Plant Breeding department had the greatest impact, followed by Bhat R S (TC:655; CPP:13.10) of the Biotechnology department, Katageri I S (TC:530; CPP22.08) and Nadaf H L (TC:489; CPP:11.93) of the Genetics and Plant Breeding department. By this data, the author sample included 5160 writers who collaborated on 1372 works between 2002 and 2021. 34 (TP:2.48) of those articles were written by a single author, while 1338 were co-authored.

The academic output of UAS, Dharwad was published in 325 scholarly publications. The "International Journal of Agricultural and Statistical Sciences" is the most popular journal for authors from UAS, Dharwad, with an impact factor of 0.278. (TP = 89; percent TP = 6.49). The authors of UAS, Dharwad chose "Plant Achieves" as their second preferred journal for publishing their research papers. The journal "Euphytica" has the fewest articles (TP:22; percent TP:1.60) written by UAS, Dharwad writers, yet the highest impact factor (2.13) and h-index (110). Considering the top cited, "Towards sequencing cotton (*Gossypium*) genomes" by Chen Z J *et al.,* which also featured Katageri I S of UAS, Dharwad, was one of the most cited articles. It was published in the journal Plant Physiology in 2007 and received 290 citations. and S Datta with Fakrudin B's article "Development of genic-SSR markers by deep transcriptome sequencing in pigeonpea [*Cajanus cajan* (L.) Millspaugh]" published in the journal BMC Plant Biology in 2011 has 216 citations. The authors Gowda M V C, Katageri I S, Fakrudin B and Bhat R S are well-known authors in the department of Genetics, Plant Breeding, and Biotechnology at UAS, Dharwad, according to the number of citations their papers have received in the list of the most frequently cited works published by UAS, Dharwad academics in Scopus.

Bhat R S and Gowda M V C have the maximum number of link strengths in VOS viewer, with 294, 251 and 50, 42 documents, respectively. Between 2002 and 2021, VOS viewer displayed the co-occurrence of the most discussed author-specified terms at least 25 times by UAS, Dharwad professors. There were 349 keywords in total across all clusters. The keyword "groundnut" (49 times) and the word "yield" (42 times) suggest stronger links and more frequent co-occurrences.

Conclusion

Bibliometrics helps to understand the analysis of scientific results in the form of publications of particular institution and predicting the potential of a field. According to the study's findings, compared to other subjects, there is a lot of research being done in the fields of agriculture and allied sciences. The study's findings showed that from 2002 to 2021, the University of Agricultural Sciences Dharwad's research output significantly increased. Further, to enhance research trend in the university, UAS, Dharwad is encouraging the faculty members to publish their research publications in Scopus listed journals. In order to address this issue, the university needs to implement a number of strategies, including an incentive policy, funding for authors to publish their work, compiling and publishing an annual compendium of research publications that includes abstracts of academic publications, and conducting workshops on how to write and publish research articles. The results also give agricultural and related scientists a strong foundation on which to advance, sustain, and support future research.

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