Retraction

Retraction: Analysis of research situation of domestic tomato irrigation and fertilization based on artificial intelligence technology (J. Phys.: Conf. Ser. 1852 032048)

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Analysis of research situation of domestic tomato irrigation and fertilization based on artificial intelligence technology

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Abstract. To fully grasp the development trend of research on tomato irrigation and fertilization in my country. This article uses CNKI journal database as the data source, using knowledge graph method, with the help of Excel, VOS viewer and other tools. A comprehensive analysis of the core scientific and technological journal papers of my country's tomato irrigation and fertilization research is carried out from the aspects of publication volume, institutions, authors, journals, frequency of citations, disciplines, topics, and fund distribution.

Keywords: Tomato, Irrigation And Fertilization, Situation Analysis, Cnki

China is the country with the largest tomato planting scale and the highest yield. Data show that in 2018, China's tomato production exceeded 50 million tons, and the planting area was about 1.11 million hectares [1]. Water and fertilizer are the key factors affecting the formation of crop yields. Water and nutrients together affect the growth and development of plants [2]. Irrigation fertilization is a fertilization method in which fertilizer is dissolved in irrigation water and applied to the soil with the irrigation water. These include sprinkler fertilization and drip fertilization. Different irrigation and fertilization methods will have different effects on tomato plant height, stem thickness, fruit diameter, yield and quality [3]. At this stage, the research on tomato irrigation and fertilization has attracted wide attention from scholars at home and abroad. But the specific research situation, what are the research hotspots and key points, what are the highly competitive institutions, authors, etc., are questions that should be answered at present. This has important practical significance for promoting the research and development of tomato irrigation and fertilization field.

1. Overview of data sources and research methods

1.1. Data source

CNKI is the Chinese database with the most abundant resources and the largest number of users in China. In this study, CNKI journal database is selected as the data source. In order to ensure the quality of papers, it is limited to core journals. By constructing a search formula and eliminating irrelevant documents from the search results, a total of 409 relevant Chinese core journal articles were obtained. The search date is August 4, 2020.
1.2. Research methods
Bibliometrics is a cross-science that uses mathematical and statistical methods to quantitatively analyze all knowledge carriers. Bibliometrics can objectively and quantitatively reflect the macro development trend of a certain discipline, and it has been adopted by many disciplines [4-5]. In recent years, bibliometrics has been widely used in chemistry, agriculture, biology, computer and other majors [6-8]. Bibliometrics reveals the distribution of disciplines, research hotspots, and development trends in various research fields from different angles, and has become an important auxiliary means of modern scientific research.

2. Results and analysis

2.1. Analysis of paper output

2.1.1. Analysis of the annual volume of papers
According to the statistics published in sections every 5 years, it can be seen from Figure 1 that the overall research on tomato irrigation and fertilization in China has shown an increasing trend. From 2006 to 2010, the growth rate was obvious and the speed was relatively fast. After 2016, the increase in the number of postings slowed down, which is related to the fact that the data for 2020 only reaches July.

![Figure 1. Distribution of annual document volume by segment](image)

2.1.2. Analysis of annual publications after 2010
It can be seen from Figure 2 that China’s research on tomato irrigation and fertilization is relatively stable, and the overall trend is fluctuating. In 2015, the number of published articles reached a peak of 37. Since 2010, the average annual publication volume has remained at around 30 articles, and the overall article has stabilized.

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2.2. Main research institutions

Table 1 shows the top 10 institutions that have published papers in the field of tomato irrigation and fertilization research. It includes 7 universities and 3 scientific research institutes. It can be seen that universities have a higher proportion in the field of tomato irrigation and fertilization research.

The top ten institutions published a total of 242 papers, accounting for 59.17% of the total. The average number of articles posted is 24.2, the average total citation frequency is 557, and the average citation frequency is 18.47. The top three institutions with publication volume are: Northwest Agriculture and Forestry University, Shenyang Agricultural University and China Agricultural University. These three institutions are also the top three institutions in terms of total citation frequency and article citation frequency respectively, indicating that these three institutions are highly competitive in the field of tomato irrigation and fertilization research in China.

Table 1. Top 10 research institutions in Chinese core publication volume

| Ranking | Organization                                                                 | Volume | Total citations | Times cited |
|---------|------------------------------------------------------------------------------|--------|-----------------|-------------|
| 1       | Northwest Agriculture and Forestry University                                | 77     | 2242            | 29.12       |
| 2       | Shenyang Agricultural University                                             | 41     | 1195            | 29.15       |
| 3       | China Agricultural University                                                | 29     | 704             | 24.28       |
| 4       | Shizheng University                                                          | 24     | 356             | 14.83       |
| 5       | Institute of Agricultural Resources and Agricultural Regional Planning, Chinese Academy of Agricultural Sciences | 15     | 305             | 20.33       |
| 6       | Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences | 14     | 269             | 19.21       |
| 7       | Ningxia University                                                           | 11     | 72              | 6.35        |
| 8       | Institute of Soil and Water Conservation, Chinese Academy of Sciences & Ministry of Water Resources | 11     | 163             | 14.82       |
| 9       | North China University of Water Resources and Electric Power                 | 10     | 82              | 8.20        |
| 10      | Inner Mongolia Agricultural University                                       | 10     | 182             | 18.20       |
|         | Average value                                                                | 24.2   | 557             | 18.47       |

2.3. Author analysis

The core author calculation formula \( M = 0.749 \times (N_{\text{max}})^{1/2} \) was proposed by Price. \( N_{\text{max}} \) in the
formula is the number of papers of the most productive author. And the core author means that the number of articles published is more than $M[9]$. It can be seen from Table 2 that the author with the largest number of articles is Zhang Yulong who has published 31 articles, that is, $N_{\text{max}} = 31$. Substituting into the calculation formula, $M = 4.17$, that is, the author with more than 5 articles is the core author. In the Chinese core literature related to tomato irrigation and fertilization, 1137 authors are involved, and 59 are core authors, accounting for 5.19% of the total.

### 2.3.1. Analysis of High Yield Authors

This study counts the top 10 high-yield authors according to the number of articles published (see Table 2). The 10 people come from 4 institutions, followed by Northwest Agriculture and Forestry University (4), Shenyang Agricultural University (3 persons), and Institute of Geography and Resources, Chinese Academy of Sciences (2 persons), China Agricultural University (1 person).

The top 10 Chinese authors in the field of tomato irrigation and fertilization research in China have published 150 articles, accounting for 36.67% of the total publication amount, with an average publication amount of 15.7 articles, an average total citation frequency of 355.4 times, and an average citation frequency of 22.69. Among them, Zhang Yulong and Yu Na are among the top three.

### 2.3.2. Author cooperation analysis

In this study, authors who have published more than 2 articles in Chinese (including 2 articles) are the research objects. Through their co-authoring relationships, a co-authoring relationship matrix is constructed to discover relevant domestic research teams and to study the structural characteristics of the team through social relationship diagrams. The status of team members can be known through the centrality analysis method of social network relationships. Actors with high centrality are more active than other actors in the network and have more relationships.

Figure 3 shows the author's co-authoring network relationship diagram excavated from Chinese core journal documents. You can find that there are 6 teams in the picture. Team 1 and Team 2 are composed of 9 and 11 people respectively. Among them, Zhang Yulong is the core member of Team 1, Yu Na and Zou Hongtao are the core members of Team 2. It is found that the main organization of these two teams is Shenyang Agricultural University. Team 3 and Team 4 consist of 11 and 10 members respectively. Among them, the core person of Team 3 is Cai Huanjie, and the core person of Team 4 is Zhang Fucang. The main institutions of these two teams are Northwest A&F University. Team 5 and Team 6 each consist of 6 members. Among them, the main institution of Team 5 is China Agricultural University, and the main institution of Team 6 is Liaoning Academy of Agricultural Sciences.
2.4. Journal distribution

It can be seen from Table 3 that the top 20 journals published a total of 307 papers, accounting for 75.06% of the published papers. Among them, *Water-saving Irrigation* has the largest number of articles, with 46 articles in total. *Chinese Vegetables* and *Journal of Irrigation and Drainage* published 37 articles and 34 articles respectively ranked second and third. This shows that the field of tomato irrigation and fertilization research is relatively concentrated, and relevant researchers can refer to the above journals for targeted literature and submission.

| Ranking | Publication name                                      | Number of documents | Ranking | Publication name                                      | Number of documents |
|---------|-------------------------------------------------------|---------------------|---------|-------------------------------------------------------|---------------------|
| 1       | Water Saving Irrigation                               | 46                  | 11      | Journal of Northwest A & F University(Natural Science Edition) | 10                  |
| 2       | China Vegetables                                      | 37                  | 12      | Chinese Journal of Soil Science                       | 9                   |
| 3       | Journal of Irrigation and Drainage                   | 34                  | 13      | Acta Agriculturae Boreali-occidentalis Sinica         | 7                   |
| 4       | Transactions of the Chinese Society of Agricultural Engineering | 30                  | 14      | Transactions of the Chinese Society for Agricultural Machinery | 7                   |
| 5       | Northern Horticulture                                | 27                  | 15      | Xinjiang Agricultural Sciences                       | 6                   |
| 6       | Agricultural Research in the Arid Areas              | 21                  | 16      | China Cucurbits and Vegetables                        | 6                   |
| 7       | Scientia Agricultura Sinica                          | 12                  | 17      | Acta Agriculturae Boreali-Sinica                     | 6                   |
| 8       | Journal of Plant Nutrition and Fertilizers           | 12                  | 18      | Chinese Journal of Eco-Agriculture                   | 5                   |
| 9       | Soil and Fertilizer Sciences in China                | 11                  | 19      | Journal of Soil and Water Conservation                | 5                   |
| 10      | China Rural Water and Hydropower                     | 11                  | 20      | Journal of Henan Agricultural Sciences                | 5                   |

2.5. Subject analysis

Based on 409 Chinese core journal papers, classified according to the *Chinese Library Classification* (Figure 4). Among them, there are at most 308 articles on vegetable subjects, accounting for 75% of all papers. Followed by gardening with 167 articles, accounting for 41% of all papers. 47 agricultural engineering articles, accounting for 11% of all papers (Note: An article may involve multiple disciplines, so the sum of the literature of each discipline is greater than 409).
2.6. Thematic analysis

By extracting keywords from 409 Chinese core documents in the field of tomato irrigation and fertilization, 61 effective keywords were obtained (frequency ≥ 5 times). Using the method of social network analysis, the keyword co-occurrence matrix is calculated. As shown in Figure 5, the size of the node represents the word frequency of the topic word, which can indicate the importance and popularity of the topic word. The thickness of the connection between nodes represents the frequency of co-occurrence between the topic words, and can indicate the closeness of the relationship between the topic words. From Figure 5, it can be found that the research in the field of tomato irrigation and fertilization mainly focuses on three aspects:

1. Study on Irrigation Mode of Greenhouse Tomato. Hot subject words include: Tomato (190 times), greenhouse (30 times), irrigation (22 times), underground drip irrigation (16 times), soil moisture (10 times), etc.

2. Effects of Different Irrigation and Fertilization Methods on Tomato Yield. Hot subject words include: Yield (118 times), drip irrigation (84 times), quality (59 times), drip irrigation under mulch (39 times), water use efficiency (39 times), processed tomatoes (36 times), water and fertilizer coupling (28 times), greenhouse tomatoes (22 times) etc.

3. Study on water-saving irrigation and fertilization of tomato in sunlight green house. Hot topic words include: Solar greenhouse (50 times), irrigation volume (31 times), cherry tomatoes (14 times), drip irrigation (12 times), economic benefits (11 times), water and fertilizer integration (10 times), etc.
2.7. Fund project funding

A total of 339 of the 409 Chinese core journal papers have been supported by the fund, and the fund support rate has reached 82.89%. At present, there are 39 fund topics involved in tomato irrigation and fertilization research papers. The top 5 are the National Natural Science Foundation of China (108 articles), the National High-Tech Research and Development Plan (863 Project) (56 articles), the National Science and Technology Support Plan (47 articles), the National Key R&D Program (13 articles), and the Liaoning Province Science and Technology Fund (11 articles).

The 39 types of funds are classified and summarized, including 11 national-level topics, 11 provincial-level topics, 7 municipal and department-level topics, 8 college-level topics, and 2 other-level topics. The number of papers published by each level of project funding is shown in Figure 5. National-level projects funded 246 papers, accounting for 73% of the total, and 45 papers were funded by provincial-level projects, accounting for 13%. The project sponsored the publication of 13 papers, accounting for 4%. The university-level project published 27 papers, accounting for 8%, and the other types of projects funded the publication of 8 papers, accounting for 2%.

The funding status of a research field can reflect the degree of concern in that field. Through statistics of the fund support in the field of tomato irrigation and fertilization research, it can be seen that the research funds in this field have a wide range of sources and are highly valued by the country. In addition, research funding in this field comes from provincial fund projects. Among them, Liaoning Province has a total of 5 types of funding for the publication of 25 papers. In addition, Henan Province and Shaanxi Province have funded 2 types of projects respectively, with 10 and 6 papers each. It can be seen that the above several provinces pay more attention to and value the research in the field of tomato fertilization and irrigation.

Figure 5. Topic analysis based on high-frequency keywords (term frequency ≥ 5, co-occurrence> 1)
3. Conclusion
This research is based on the Chinese core journal papers published in the field of tomato fertilization and irrigation research in CNKI, using the bibliometric analysis method to comprehensively analyze the current research status in this field, and discuss the research hotspots and priorities in this field. The main conclusions obtained are:

From a long-term perspective, the overall research on tomato fertilization and irrigation in my country has shown an upward trend and the development trend is good. In recent years, the number of related publications has remained at around 30, and research has stabilized.

Three institutions, Northwest A&F University, Shenyang Agricultural University and China Agricultural University have done more research in this field, and the literature output and frequency of citations are all ranked in the top three. The core authors in this field are mainly from Northwest A&F University and Shenyang Agricultural University.

The research focus of this research field can be seen from the subject categories involved in the literature research. The research on tomato fertilization and irrigation in my country is mainly concentrated in vegetables, horticulture and agricultural engineering.

Tomato fertilization and irrigation research hotspots are very extensive. Among them, the research on greenhouse tomato irrigation mode, the research on the influence of different irrigation and fertilization methods on tomato yield, and the research on tomato water-saving irrigation and fertilization in solar greenhouse have attracted more attention.

Various funds support research in the field of tomato fertilization and irrigation, focusing on the National Natural Science Foundation, the National High-Tech Research and Development Program (863 Program), and the National Science and Technology Support Program. In addition, Liaoning Province, Henan Province and Shaanxi Province pay more attention to research in this field.

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