Australian Journal of Crop Science AJCS

Aust J Crop Sci. 19(04):429-435 (2025) | https://doi.org/10.21475/ajcs.25.19.04.p303 ISSN:1835-2707

Water deficit, fertigation, and bio-inputs in sugarcane cultivation: a scientometric review and practical recommendations

Bianca Soares Pierre[1], Derblai Casaroli*[2], José Alves Júnior[2], Adão Wagner Pêgo Evangelista[2], Rilner Alves Flores[3], Itamar Rosa Teixeira[4]

[1]Doutoranda no Programa de Pós-graduação em Agronomia, Clima e Recursos Hídricos, Universidade Federal de Goiás (UFG), Goiânia, GO, Brazil
[2]Department of Biosystems Engineering, Agrometeorology area, UFG, Goiânia, GO, Brazil
[3]Department of Soil, Plant Nutrition area, UFG, Goiânia, GO, Brazil
[4]Department of Agricultural Engineering, Production Technology area, UEG, Anápolis, GO, Brazil

Corresponding author: Derblai Casaroli
ORCID ID: https://orcid.org/0000-0001-8041-0066

Submitted: ***20/11/2024***

Revised: ***24/12/2024***

Accepted: ***20/02/2025***

Abstract: Brazil is the world's leading producer of sugarcane (FAO, 2020). However, certain production regions face periods of severe water deficit and are characterized by low-fertility soils. Research highlights the importance of irrigation and fertigation as effective strategies to improve growth and productivity. Simultaneously, bio-inputs have emerged as a sustainable alternative to conventional chemical fertilizers. This study aims to evaluate research trends on water deficit, fertigation, and bio-inputs in sugarcane cultivation, and to provide recommendations for optimal outcomes. A comprehensive search of the Scopus database was conducted using the following keywords: "water stress" OR "water deficit" AND "sugarcane"; sugarcane AND "fertirrigation*" OR "fertigation*"; sugarcane AND "fertirrigation*" OR "fertigation*" AND "water" AND "deficit*"; sugarcane AND "bioinputs". The scientometric analysis considered the year, journal, and geographic distribution of publications. Recommendations are based on articles published in the last decade, focusing on irrigation depth, fertilizer types and dosages, and bio-inputs. A notable rise in publications, particularly from Brazil and India, has been observed over time. High yields (≥100 Mg ha^{-1}) were reported even under water deficit conditions (50% ETc). The most recommended fertilizer rates were 60–120 kg ha^{-1} of nitrogen and 130–320 kg ha^{-1} of K_2O. One study on bio-inputs demonstrated a 10.7% increase in productivity compared to mineral fertilizers, with phosphate-solubilizing micro-fertilizers being the most commonly used bio-fertilizers.

Keywords: water requirements; plant nutrition; *Saccharum* spp.; sustainability; vinasse.
Abbreviations: Mg_megagrams; ha_hectares; ETc_Potential crop evapotranspiration; kg_kilograms; N_nitrogen; K_2O_potassium oxide.

Introduction

Global sugarcane production exceeds 1.6 billion of Mg annually (Silva et al., 2022). The largest producers are Brazil (757.1 million Mg), India (370.5 million Mg), China (108.1 million Mg), Pakistan (81.9 million Mg), Thailand (74.9 million Mg), Mexico (53.9 million Mg), and the United States (32.7 million Mg). Brazil alone is responsible for approximately 80% of the world's sugar production (FAO, 2020).

Since the 1980s, Brazil has significantly expanded its sugarcane cultivation area, increasing by 150% from 4 million to 10 million hectares (Cherubin et al., 2021). Notable growth occurred in Northeastern Brazil between 1970 and 1975, spurred by the "Proálcool" program (Silva et al., 2013). Currently, however, the agricultural frontier is expanding into the central region, particularly the "Cerrado" (Brazilian Savannah), which offers ideal conditions for sugarcane cultivation, including high light intensity and favorable air temperatures (Segato et al., 2006). In Goiás, one of Brazil's largest sugarcane-producing states in the "Cerrado", the projected yield is 78.8 Mg ha^{-1} (CONAB, 2023).

Despite this forecast, the region's production potential can reach up to 180 Mg ha^{-1} (Silva et al., 2019). However, yields are influenced by several factors, including management practices and adverse climatic conditions, particularly water deficits, which are more pronounced in Goiás than in traditional production areas such as São Paulo, Brazil's largest sugarcane-producing state. The crop requires 1,500 to 2,500 mm of water throughout its growth cycle (Doorenbos and Kassam, 1979), yet in Goiás, annual rainfall is often insufficient and irregular, ranging from 1,442 mm to 1,780 mm (Campos and Chaves, 2020). This underscores the critical role of irrigation in maintaining productivity (Silva et al., 2020).

In addition to water, proper plant nutrition is essential for achieving high yields. Nutrients are primarily absorbed from the soil, but often the soil cannot supply sufficient quantities. Consequently, fertilization and/or fertigation (the application of fertilizers through irrigation water) are required. Fertigation not only reduces fertilizer usage by 37.5% but also boosts yields by 28.4% (Coelho et al., 2018), particularly for key nutrients like nitrogen (N) and potassium (K) (Quaggio et al., 2022). Moreover, bio-inputs have emerged as a sustainable alternative to conventional agricultural inputs, including fertilizers and pesticides. Research suggests that bio-inputs hold significant promise as substitutes for chemical products in sugarcane cultivation (Goulet, 2021).

Given these considerations, there is a need for studies that identify the main channels of scientific communication and present clear and conclusive information on this topic. Scientometric analyses and statistical techniques can be employed to quantify and classify research findings (Richardson, 1989), thereby addressing both the challenges and opportunities in this area (Parra et al., 2019). Accordingly, this study aims to examine research trends related to water deficit, fertigation, and bio-inputs in sugarcane cultivation. Additionally, it seeks to provide readers with recommendations based on the most successful outcomes reported in the literature.

Results and discussion

Scientometric analysis

The scientometric analysis revealed over 500 published works, including articles and other publications related to the topic. However, no results were found for the combined search terms "sugarcane, water deficit, fertigation, and bio-inputs." Instead, results were found for the following keyword combinations: "sugarcane + water deficit," "sugarcane + fertigation," "sugarcane + water deficit + fertigation," and "sugarcane + bio-inputs" (Table 1).

Using the keywords "sugarcane" and "water deficit," we identified 458 scientific articles published between 1969 and 2023 (Figure 1). A marked increase in publications occurred after 2008, with an average of seven articles per year, peaking in 2021 with 46 articles.

In terms of journals publishing articles on sugarcane and water deficit (Figure 2), Sugar Tech, an Indian journal with a B2 classification (Qualis-CAPES) and an impact factor (IF) of 1.87 (Web of Science), published the highest number of articles (33). The Brazilian journal Irriga (B1 classification, IF: 2.0) ranked next. A total of 158 journals contributed to this body of work, with 12 of them publishing at least seven articles, representing 33.65% of the total. The remaining 146 journals, classified as "others," collectively published 282 articles (66.35%).

In terms of geographical distribution, the analysis identified 54 countries involved in publishing on this topic. Twelve countries had more than seven publications, while the remaining 42 were grouped into the "other" category, accounting for a total of 89 articles (Figure 3). Brazil was the leading country, contributing 209 articles (33.7% of the total), followed by India (52 articles, 8.4%), China (45 articles, 7.2%), and the United States (42 articles, 6.8%). These findings align, in part, with the ranking of the world's largest sugarcane producers (FAO, 2020).

A search using the keywords "sugarcane AND fertigation* OR fertirrigation*" resulted in 167 articles published between 1999 and 2023, with a steady increase after 2016, averaging nine or more articles per year (Figure 4). The keyword combination "sugarcane and fertigation" yielded articles from 98 journals, with 36.5% of them concentrated in 11 journals. Sugar Tech published the most articles (13), followed by the Brazilian Journal of Agricultural and Environmental Engineering (Revista Brasileira de Engenharia Agrícola e Ambiental) with 11 articles (Figure 5).

Brazil also led in this category, accounting for 123 articles (73.6%), followed by India (21 articles, 12.6%), the United States (12 articles, 7.1%), and China (5 articles, 3%) (Figure 6). Six other countries, contributing only one article each, were classified as "others."

The combination of keywords "sugarcane, water deficit, and fertigation" resulted in a lower number of publications, with only 12 articles over the analyzed period (Figure 7). All of these articles were from Brazil, with Engenharia Agrícola publishing two of them. No further analysis by country was conducted due to Brazil's dominance in this search.

The search for "sugarcane and bio-inputs" produced a single article, published in 2011 in the Indian Journal of Agricultural Economics. Although this result highlights a lack of research in the area, the term "bio-inputs" was only formally adopted in Brazil in 2020, with the launch of the National Bio-Inputs Program by the Ministry of Agriculture, Livestock, and Supply (Goulet, 2021). Bio-inputs, such as vinasse, are widely used in sugarcane fields as biofertilizers (Flores et al., 2022; Oliveira et al., 2014). Other bio-inputs include P-solubilizers like *Pseudomonas* and *Bacillus* and plant growth stimulants such as *Azospirillum*.

Countries with the most publications also tend to be the largest sugarcane producers, and many journals publishing on this topic are based in these countries, particularly Brazil and India, which together produce over 50% of the world's sugarcane. The rise in publications since the 2000s may be linked to increased incentives for sugarcane production, aimed at reducing reliance on non-renewable fuels and increasing sugar exports (Yogitha et al., 2020).

Research trends are focusing on increasing crop yields under increasingly limiting conditions, particularly water deficit. Irregular and insufficient rainfall often fails to meet sugarcane's water needs, driving researchers to explore cost-effective solutions such as irrigation (Pereira et al., 2015).

Sugarcane water limiting

The response of different sugarcane varieties to water deficit and irrigation depths varies. For instance, varieties such as RB92579 and RB961003 reach optimal yields at water depths of 60-80% of ETc (crop evapotranspiration) (Oliveira and Braga, 2019). In trials conducted in Petrolina-PE, Brazil, the VAT90212 and RB92579

Table 1. Number of articles found on the Scopus platform using the following keywords. "water stress" OR "water deficit" AND "sugarcane"; sugarcane AND fertirrigation* OR fertigation*; Sugarcane AND fertigation* OR fertigation* AND water AND deficit*; sugarcane AND "bio inputs".

Type of work	Keywords			
	Sugarcane + Water deficit	Sugarcane + Fertigation	Sugarcane + Water deficit + Fertigation	Sugarcane + Bio-inputs
Published works	530	199	14	1
Scientific articles	458	167	12	1

Source: Scopus (2024).

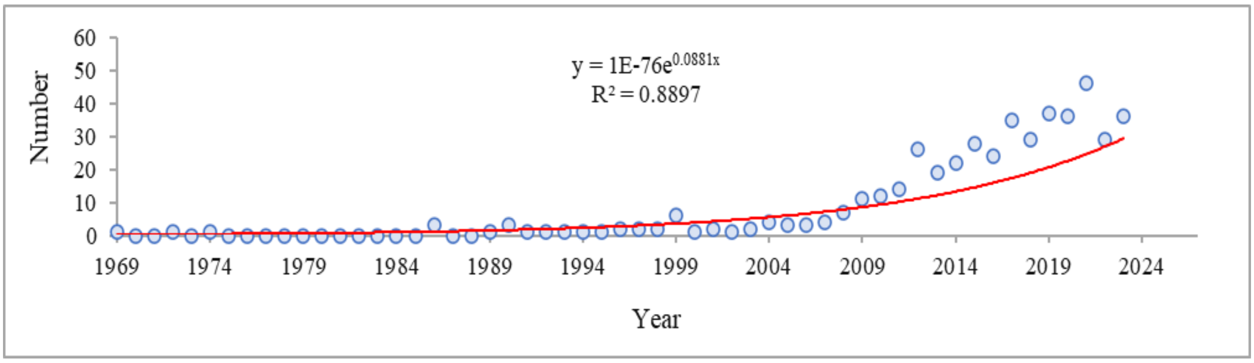

Fig 1. Number of articles by year of publication on sugarcane and water deficit from 1969 to 2023, totaling 458 scientific articles. The trend line represents an exponential fit, excluding years with zero publications.

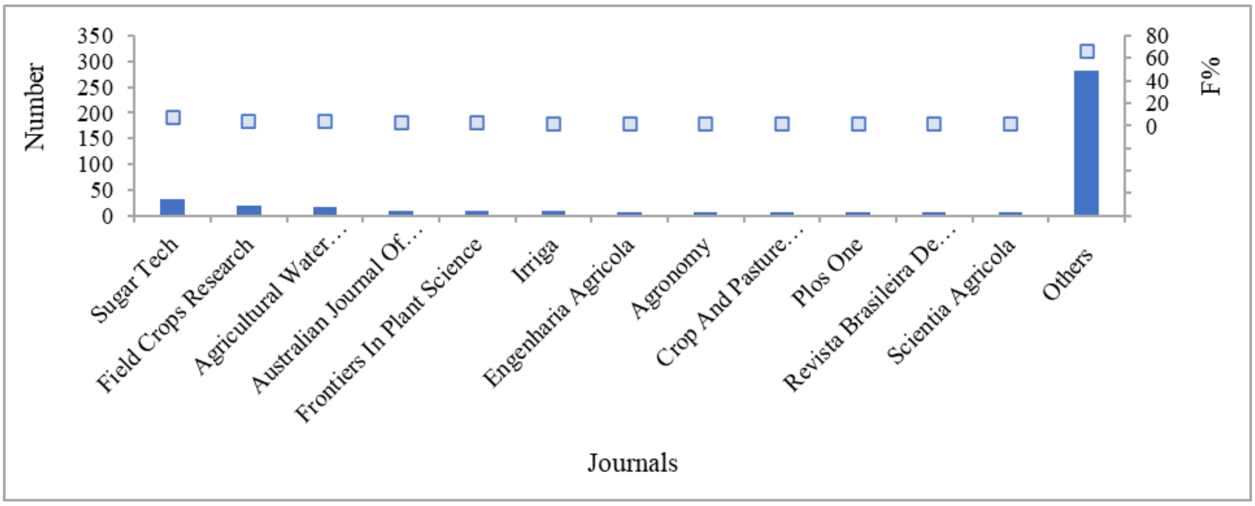

Fig 2. Number of articles by journal name (columns) and their respective percentages (F%; squares), based on the search for sugarcane and water deficit.

varieties showed high yields under varying irrigation depths, while RB012018 exhibited similar yields across irrigation levels. Such studies underscore the importance of selecting drought-resistant varieties to optimize water use and minimize costs.

Research in Northeastern Brazil (Teresina-PI) further demonstrated the yield potential of different varieties under limited irrigation. For example, the RB935744 variety achieved maximum yields (255.2 Mg ha^{-1}) with 110% ETc irrigation, while the RB92579 variety performed well under both 50% and 80% ETc conditions (Silva et al., 2019).

In the "Cerrado" region of Goiás, studies recommend supplying at least 40% ETc for sugarcane cultivation, with full irrigation during the growth phase yielding the highest returns (Antunes Júnior et al., 2021). Economic analyses support the feasibility of irrigation in this region, with a benefit/cost ratio exceeding 1.0. Full irrigation provides significantly higher returns than deficit or rescue irrigation over a 30-year investment horizon (Pereira et al., 2015).

Fertigation in sugarcane: nutrients and recommended doses

When considering fertigation, several studies highlight its role in optimizing sugarcane nutrition. The application of vinasse, for instance, can boost sugarcane yields by up to 35 Mg ha^{-1} (Flores et al., 2022). The Integrated Diagnosis and Recommendation System (DRIS) for soil nutrients has also identified the benefits of using fertigation to address nutrient deficiencies and increase productivity.

Sugarcane yields (plant cane) (Carpina-PE) subjected to different irrigation rates (rainfall + fertigation) (1498, 1614, 1739, and 1854 mm) and nitrogen doses (0, 20, 40, 80, and 120 kg ha^{-1}) were higher when applying 1854 mm with the dose of 80 kg ha^{-1} (sugar: 28.9 Mg ha^{-1} and stalks: 191.97 Mg ha^{-1}). We used urea, simple superphosphate, and potassium chloride as NPK sources, respectively (Costa et al., 2019).

With RB 855453 (Rio Verde-GO), nitrogen in the applied doses (0 and 100 kg ha^{-1}) was not significant ($p<0.01$ and 0.05) (Silva et al., 2015). With sugarcane (Paraíba Region), on two fertilization treatments (1 - mineral fertilization with 350 kg ha^{-1}, plus four 30 mm vinasse

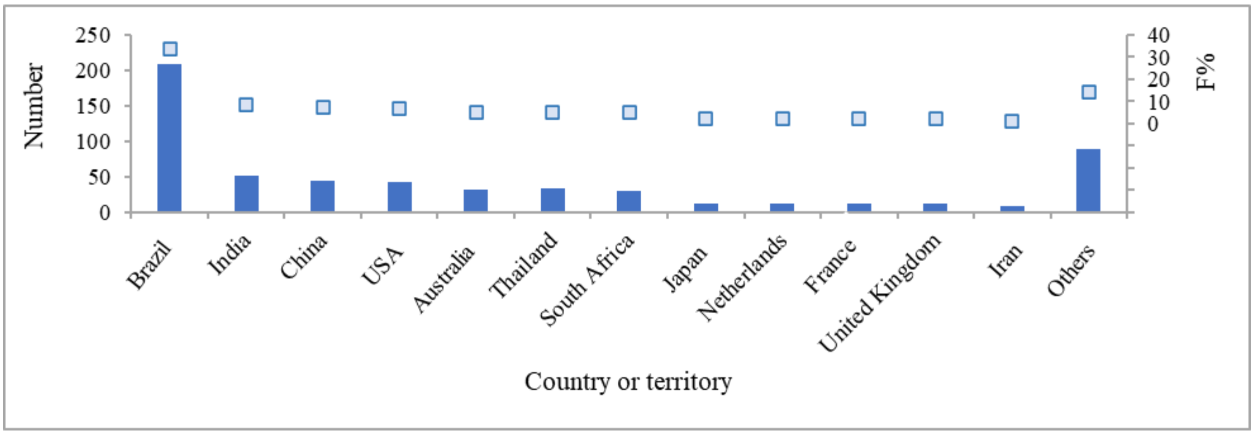

Fig 3. Number of articles by country or territory (columns) and their respective percentages (F%; squares) related to sugarcane and water deficit research.

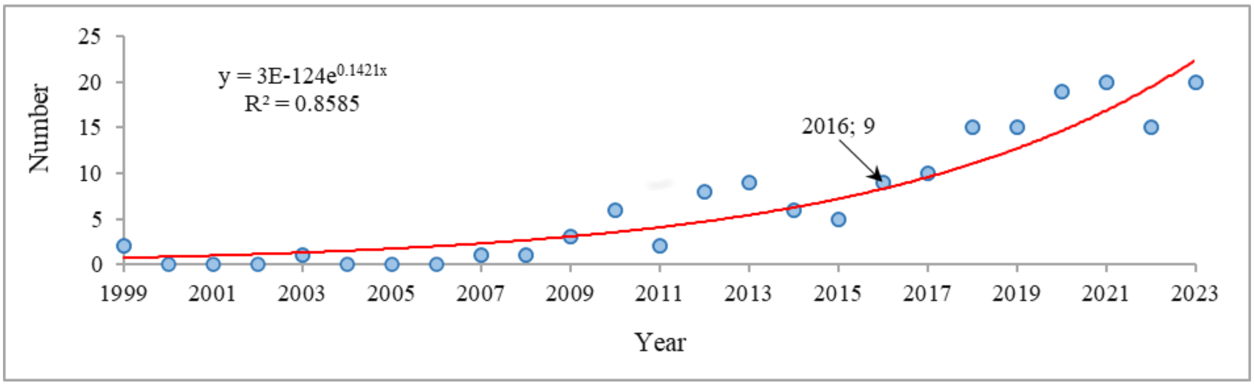

Fig 4. Number of articles by year of publication (1999-2023) related to sugarcane and fertigation. The trend line is an exponential fit, with zero values removed (red line).

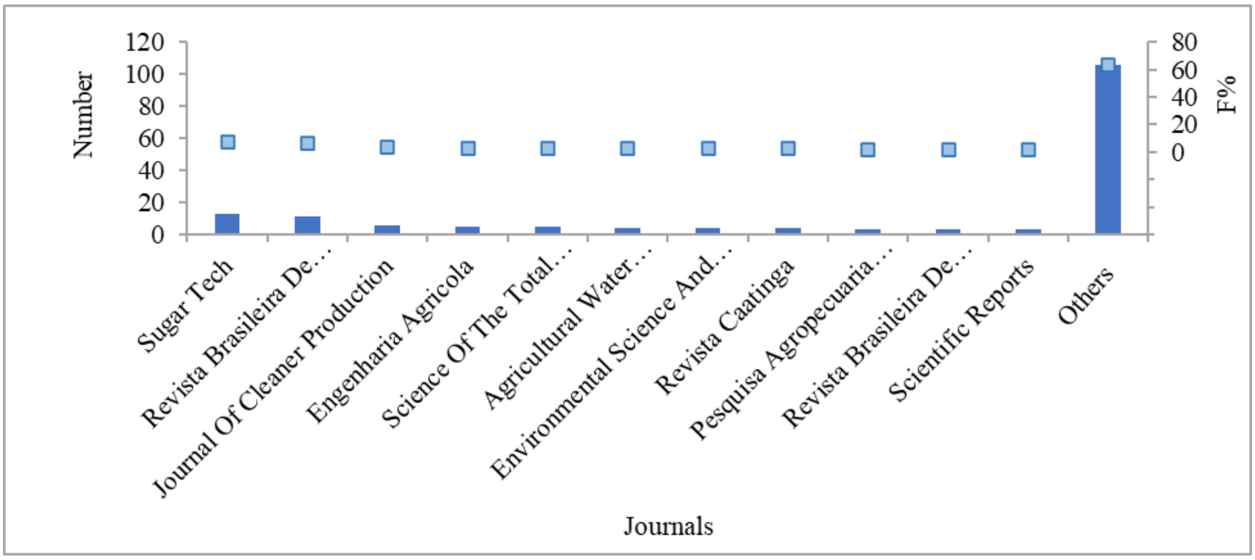

Fig 5. Number of articles by scientific journal (columns) and their respective percentages (F%; squares). The "others" category includes journals with two or fewer articles.

depths; and 2 - fertigation with vinasse), mineral fertilization (NPK) with vinasse provided lower yields and sugar content (48.09 Mg ha^{-1} and 20.2% Brix) than vinasse alone (49.98 Mg ha^{-1} and 20.4% Brix) (Oliveira et al., 2014).

With fertigation, RB 92579 (Juazeiro-BA), at five doses of nitrogen (0, 40, 80, 160, and 320 kg ha^{-1} with urea), five doses of potassium (0, 60, 120, 240, and 480 kg ha^{-1} of K_2O), and three cycles (plant cane and 1st and 2nd ratoon), the doses of 60 kg ha^{-1} of N and 200 kg ha^{-1} of K_2O showed the highest percentage of Brix at 22.9% (Simões et al., 2023). The RB92579 variety (Teresina-PI), in the first ratoon, obtained the highest percentage of Brix (20.0%) with 60 kg ha^{-1} N and 180 kg ha^{-1} K_2O, with an estimated yield of 210 Mg ha^{-1}. The maximum yield of stalks (217.5 Mg ha^{-1}) was obtained with the application of 180 kg ha^{-1} N and 60 kg ha^{-1} K_2O, with around 19% Brix (Nascimento et al., 2018), which was higher than what is industrially desired (18%) (CONSECANA, 2006).

Costa et al. (2023), in fertigation with silicon (Si), studied two water deficit conditions (presence: 35%, and absence: 70% water retention) combined with the absence (0.0 mmol L^{-1}) and presence of Si fertigation (1.8 mmol L^{-1}) in three tropical soils (Quartzarenic Neosol, Eutrophic Red Latosol, and Dystrophic Red Latosol) from the state of São Paulo. The application of Si via fertigation

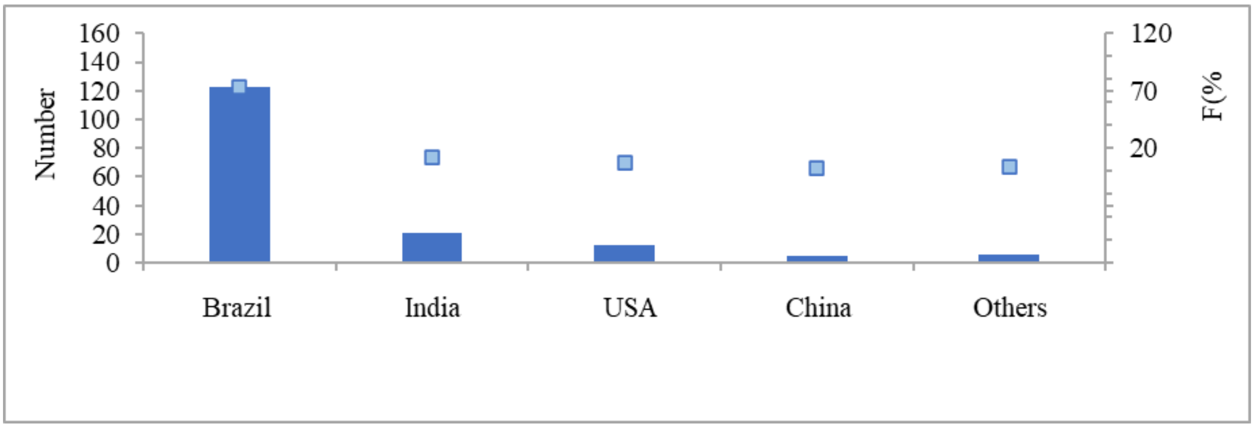

Fig 6. Number of articles by country or territory (columns) and their respective percentages (F%; square) based on the search for sugarcane and fertigation.

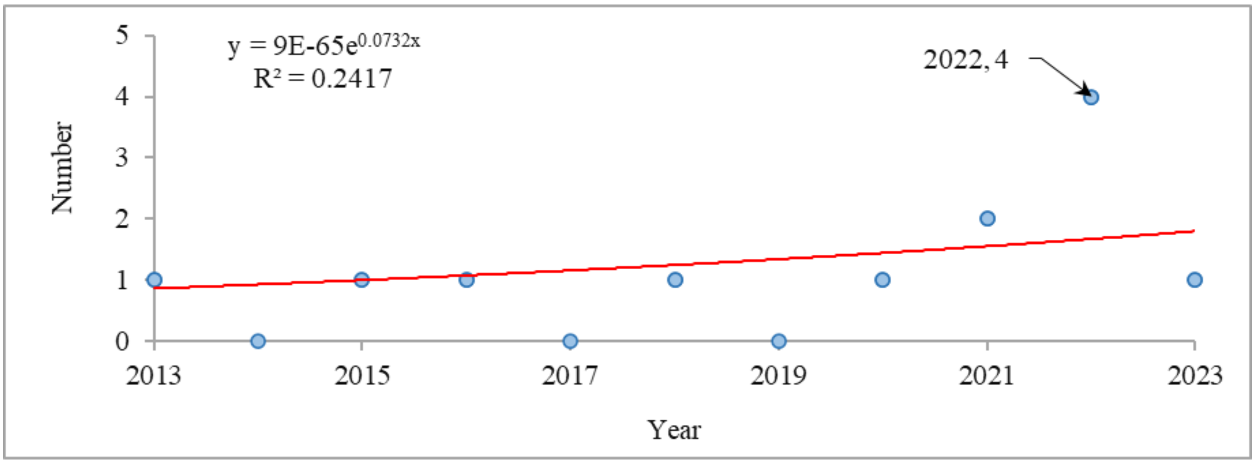

Fig 7. Number of articles by year of publication (2013–2023) related to the search for “sugarcane, fertigation, and water deficit” (2013-2023). An exponential fit was applied, excluding zero values.

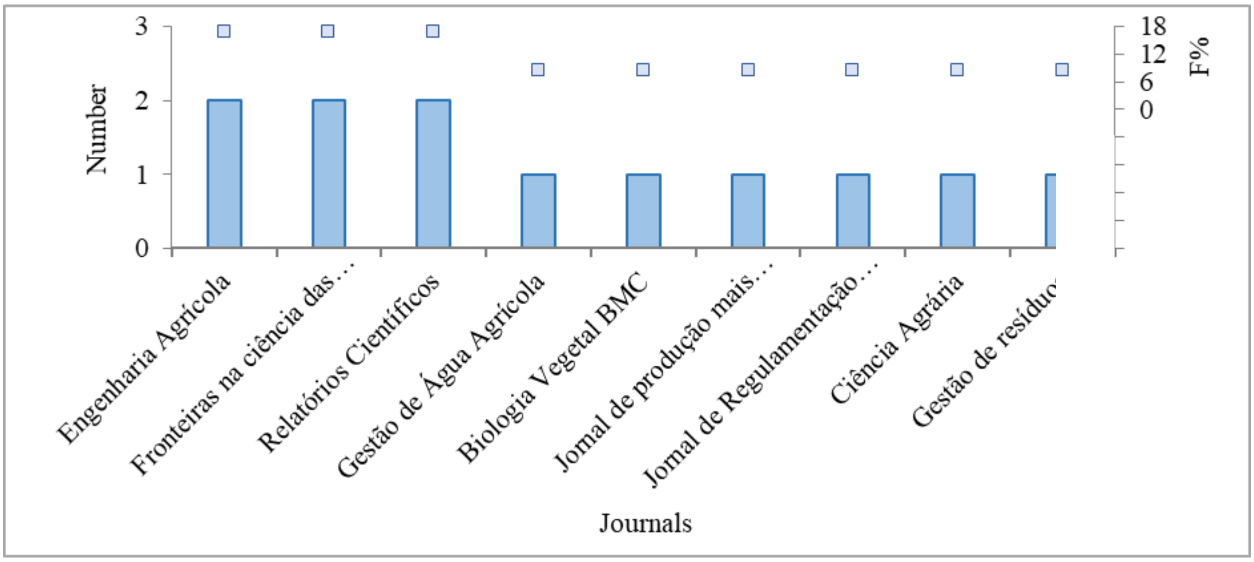

Fig 8. Number of articles by journal name, based on the search for “sugarcane, fertigation, and water deficit”; as well as their frequencies (F%).

increased the accumulation and use efficiency of C, N, and P, and reduced the biological damage caused by water deficit. In the Quartzarenic Neosol soil, there was an increase in the N content of up to 19.2% in the presence of water deficit and the absence of Si, with no significant differences between the treatments during water deficit. In a Quartzarenic Neosol, there is naturally low available Si content (São Paulo-SP). Thus, the application of Si via fertigation mitigates water deficit effects by improving physiological aspects and modifying the C:N:P stoichiometry, inducing an increase in nutrient use efficiency, as observed in conventional sugarcane (variety-RB 966928) and energy cane (variety-VX2) (Oliveira Filho et al., 2021). Therefore, Si fertilization also becomes an option when growing under severe water deficit, as its supply partially reduces losses and can increase the dry mass of leaves, stalks, and shoots by 28, 78, and 48% in sugar cane, and by 30, 52, and 45% in energy cane, respectively (Teixeira et al., 2022).

Bio-inputs

Bio-inputs are emerging as a sustainable alternative to traditional chemical inputs. In South America, countries like Brazil, Argentina, and Colombia are leading this shift, driven by national programs that promote environmentally friendly agricultural practices (Goulet, 2021). The use of bio-inputs, such as phosphate-solubilizing microorganisms, has the potential to significantly improve crop performance, particularly in crops like sugarcane, coffee, and cotton data from 2020 show that Brazilian farmers on average use less than two products classified as bio-inputs per crop year, with the rest comprising chemical inputs, which represents an enormous potential for expansion. Thus, between 2020 and 2025, the global market is expected to exceed 11 billion dollars in biocontrol sales (Goulet, 2021).

The only study found on scientometrics was conducted in India by Thennarasu and Banumathy (2011) to calculate the costs and returns associated with sugarcane cultivation and identify the factors determining the adoption of bio-inputs. They found that it depends on subsidies, tax exemptions on bio-inputs, institutional credit and insurance, and prizes/rewards for farmers who adopt bio-inputs, whether it influences their adoption. Overall, the total cost of cultivation per hectare was 2.35% higher on farms adopting bio-inputs than on farms not adopting bio-inputs. However, income on farms adopting bio-inputs was 10.74% higher due to higher yields.

The average consumption of biofertilizers in India is 0.04 kg ha^{-1}. On farms that adopt bio-inputs, the share of fertilizer costs in the total cost was only 5% compared to farms that only use mineral fertilizers, with 14.71%. Among bio-inputs, there is a large use of phosphate-solubilizing micro-fertilizers, organisms that account for around 45% of total bio-fertilizer production. The variables determining the adoption of bio-inputs include experience in handling bio-inputs, the age of the interviewee, the farm size, and the interviewee's income (Thennarasu and Banumathy, 2011).

In conclusion, scientific research on water deficit and fertigation in sugarcane has expanded significantly over the years. However, there remains a need for further research on bio-inputs. It is evident that irrigation at depths lower than 100% ETc can reduce yields, but strategic irrigation timing, especially during periods of high biomass and sucrose accumulation, can still achieve high yields with resistant cultivars. Fertigation strategies, including the use of vinasse and bio-inputs, show promise in enhancing both yield and sustainability in sugarcane cultivation.

Materials and methods

Literature search

Scientometric study involved a comprehensive search for articles on the Scopus platform, covering the entire historical series from 1969 to 2023. We employed the following keywords: sugarcane, water deficit, fertigation, and bio-inputs. The search was conducted in English, following the format of the Scopus platform. Example search queries include: "sugarcane" AND "water stress" OR "water deficit"; sugarcane AND fertirrigation* OR fertigation*; sugarcane AND fertigation* OR fertigation* AND water AND deficit*; and sugarcane AND "bio inputs."

We evaluated the following parameters to obtain and quantify the publications: i) Year of publication; ii) Name of the journal; iii) Journal's country of publication; iv) Journal's Qualis-CAPES classification, retrieved from the Sucupira Platform (https://sucupira.capes.gov.br/), for the 2017-2020 quadrennium in the area of Agricultural Sciences; and v) Impact factor, obtained from the Clarivate platform (https://mjl.clarivate.com/home).

Bibliographical review

Additionally, we compiled and described the results related to water deficit, fertigation, and bio-inputs, which are considered optimal for ensuring good sugarcane yields. This bibliographical review and description were based on experimental research conducted primarily in Brazil, focusing on the Center-South and Northeast regions. We prioritized articles published in the most representative journals with the highest number of publications over the past 10 years.

Acknowledgements

This work was supported by the Coordination for the Improvement of Higher Education Personnel (CAPES) and the Federal University of Goiás. Authors 2, 3, 4, 5, and 6 received Research Productivity Grants from the National Council for Scientific and Technological Development (CNPq).

Contributions

The authors declare the following contributions: Author 1: Data collection, organization, and manuscript editing; Author 2: Study conception, design, and supervision; Author 3: Preparation of tables and figures; Author 4: Contribution to the discussion of results; Author 5: Manuscript review and suggestions for improvement; Author 6: Critical manuscript review and participation in discussions.

References

Antunes Júnior EJ, Alves Júnior J, Sena CCR, Casaroli D, Evangelista AWP, Battisti R (2021) Responses of different varieties of sugarcane to irrigation levels in the Cerrado. Aust J Crop Sci. 15: 1110-1118.

Campos JO, Chaves HML (2020) Tendências e Variabilidades nas Séries Históricas de Precipitação Mensal e Anual no Bioma Cerrado no Período 1977-2010. Revista Brasileira de Meteorologia 35: 157-169.

Cherubin MR, Bordonal RO, Castioni GA, Guimarães EM, Lisboa IP, Moraes LAA, Menandro LMS, Tenelli S, Cerri CEP, Karlen DL, Carvalho, JLN (2021) Soil health response to sugarcane straw removal in Brazil. Industrial Crops and Production 163: 113315.

Clarivate (2023) Navegue, pesquise e explore periódicos indexados na Web of Science. <https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/>. Accessed at Nov. 12 2023.

Coelho AP, Dalri AB, Landell EPA, Faria RT, Palaretti, LF (2018) Produtividade inicial e eficiência no uso da água de cultivares de cana-de-açúcar fertirrigadas e

plantadas por mudas pré-brotadas. Scientia Agraria 19: 57-64.
CONAB. Companhia Brasileira de Abastecimento (2023). <https://www.conab.gov.br/info-agro/safras/cana>. Accessed at Nov. 30 2023.
CONSECANA (2006) Regulamento dos negócios de compra e venda de cana-de-açúcar no Estado de São Paulo: Manual de Instruções, Piracicaba, Brasil. 16 p.
Costa ARFC, Rolim MM, Simões Neto DE, Silva MM, Silva GF, Pedrosa EMR (2019) Produtividade e qualidade tecnológica da cana-de-açúcar submetida a diferentes lâminas de irrigação e doses de nitrogênio. Irriga 24: 38-53.
Costa MG, Prado RM, Sarah MMS, Palaretti LF, Piccolo MC, Souza Júnior JP (2023) New approaches to the efects of Si on sugarcane ratoon under irrigation in Quartzipsamments, Eutrophic Red Oxisol, and Dystrophic Red Oxisol. BMC Plant Biol. 23: 1-20.
Doorenbos J, Kassam AH (1979) Yield response to water. FAO, Rome. 197 p.
FAO. Food and Agriculture Organization of the United Nations. 2020. <https://www.fao.org/faostat/en/#home>. Accessed at Nov. 07 2023.
Flores RA, Carvalho AS, Bueno AM, Martins C, Andrade AF, Xavier MFN, Mesquita M, Santos GG, Casaroli D, Leandro WM (2022) Establishment of DRIS Standards and Indices for Ratoon Cane Production in the Southern Region of Goiás, Brazil. Sugar Tech 24: 1710–1727.
Goulet F (2021) Biological inputs and agricultural policies in South America: between disruptive innovation and continuity. Perspective 1:1-4.
Nascimento FN, Andrade Júnior ASA, Bastos EA, Ribeiro VQ, Lopes AS (2018) Agro-industry production of sugarcane grown using subsurface drip fertigation with nitrogen and potassium. Pesqui Agropecu Bras. 53: 1346-1354.
Oliveira AR, Brag MB (2019) Variedades de cana-de-açúcar submetidas a diferentes lâminas de reposição hídrica por gotejamento subsuperficial. Energ Agr. 34: 350-363.
Oliveira WS, Brito MEB, Alves RAB, Souza AS, Silva EG (2014) Cultivo da cana-de-açúcar sob fertirrigação com vinhaça e adubação mineral. Revista Verde 9: 01-05.
Oliveira Filho ASB, Prado RM, Teixeira GCM, Rocha AMS, Souza Junior JP, Piccolo, MC (2021) Silicon attenuates the effects of water deficit in sugarcane by modifying physiological aspects and C:N:P stoichiometry and its use efficiency. Agr Water Manage. 255: 107006.
Parra MR, Coutinho RX, Pessano EFC (2019) Um breve olhar sobre a cienciometria: origem, evolução, tendências e sua contribuição para o ensino de ciências. Editora Unijuí. 34: 126-141.
Pereira RM, Alves Júnior J, Casaroli D, Sales DL, Rodriguez WDM, Souza JMF (2015) Viabilidade econômica da irrigação de cana-de-açúcar no Cerrado brasileiro. Irriga 1: 149–157.
PLATAFORMA SUCUPIRA. Qualis periódicos (2023). <https://sucupira.capes.gov.br/>. Accessed at Feb. 10 2024.
Quaggio JA, Cantarella H, van Raij B, Otto R, Penatti CP, Rossetto R, Vitti GC, Korndörfer GH, Trivelin PCO, Mellis EV, Franco HCJ, Gava GJC, Vitti AC, Dias FLF (2022) Cana-de-açúcar. In: Cantarella H, Quaggio JÁ, Mattos-Junior D, Boaretto RM, van Raij B (Org.). Boletim 100: Recomendações de adubação e calagem para o Estado de São Paulo. 5th ed. Campinas: Instituto Agronômico de Campinas 1: 177-186.
Richardson RJ (1989) Pesquisa social: métodos e técnicas. Atlas, São Paulo, Brasil. 27 p.
SCOPUS. Elsevier (2024). <https://www.scopus.com/search/>. Accessed at Feb. 10 2024.
Segato SV, Mattiuz CFM, Mozambani AE (2006) Aspectos fenológicos da cana-de-açúcar. In: Segato SV, Pinto AS, Jendiroba E. Atualização em produção de cana-de-açúcar. Livroceres, Piracicaba, Brasil. 19-36.
Silva VPR, Oliveira SD, Santos CAC, Silva MT (2013) Risco climático da cana-de-açúcar cultivada na região Nordeste do Brasil. Revista Brasileira de Engenharia Agrícola e Ambiental 17: 180–189.
Silva NF, Cunha FN, Teixeira MB, Soares FAL, Moura LC (2015) Crescimento vegetativo da cana-de-açúcar submetida a lâminas de irrigação e fertirrigação nitrogenada via gotejamento subsuperficial. Revista Brasileira de Agricultura Irrigada 9: 79-90.
Silva EMP, Andrade Júnior AS, Bastos EA, Ribeiro VQ (2019) Produtividade de colmos e eficiência o uso da água em cana-de-açúcar irrigada por gotejamento subsuperficial. Irriga 24: 162–176.
Silva NF, Cunha FN, Teixeira MB, Soares FAL (2020) Crescimento e rendimento da cana-de-açúcar irrigada submetida a diferentes reposições hídricas e nitrogênio. Revista Brasileira De Agricultura Irrigada 14: 792-802.
Silva JHB, Almeida LJM, Araújo JRES, Guimarães HS, Dantas EA, Silva DAM, Pereira Neto F, Lima JPVMF, Lima JMG, Alves EMC, Gomes EM, Silva AM, Toledo LCM, Fernandes RGS, Oliveira AB, Silva ES (2022) Variabilidade temporal (2000 – 2020) da produção de cana-de-açúcar em Alagoa Nova, Brejo Paraibano. Scientific Electronic Archives 15: 1-7.
Simões WL, Oliveira CPM, Salviano AM, Silva JS, Teixeira Filho MCM, Torres Júnior VG, Sobral YRA, Barbosa IM (2023) Impactos da fertirrigação nitrogenada e potássica no rendimento agroindustrial da cana-de-açúcar. Delos 16: 897-909.
Teixeira GCM, Prado RM, Rocha AMS, Oliveira Filho ASB, Sousa Junior GS, Lupino Gratão P (2022) Action of silicon on the activity of antioxidant enzymes and on physiological mechanisms mitigates water deficit in sugarcane and energy cane plants. Sci Rep-uk. 12: 1-18.
Thennarasu R, Banumathy V (2011) Economics of sugarcane production using ecofriendly technology in Cuddalore District, Tamil Nadu. Ind. Jn. of Agri. Econ. 66: 88-96.
Yogitha B, Karthikeyan M, Muni Reddy MG (2020) Progress of sugarcane bagasse ash applications in production of Eco-Friendly concrete – Review. Mater Today-Proc. 33: 695-699.