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"Analyzing the Synergistic Impact of *Azadirachta indica* A. Juss., *Ocimum sanctum* L., and *Nicotiana tabacum* L., Water Extract on stem Growth of *Cicer arietinum* L."

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Abstract

This research delves into the collective impact of water extracts from *Azadirachta indica* A. Juss., *Ocimum sanctum* L., and *Nicotiana tabacum* L. on the stem growth of *Cicer arietinum* L. (chickpea). By administering varied concentrations of these extracts to chickpea stems, the study scrutinizes their combined influence on growth dynamics. The investigation seeks to unravel potential synergistic or antagonistic interactions among these botanical extracts and their implications for the developmental processes in chickpea plants. Through meticulous observation and analysis, the research aims to contribute valuable insights into the intricate relationships between these plant extracts and chickpea stem growth. Understanding the interplay among these natural extracts could offer novel strategies for agricultural practices, potentially harnessing synergies to optimize crop growth and productivity. This study's findings may pave the way for innovative agricultural approaches, elucidating the potential benefits or limitations of utilizing these specific plant extracts in enhancing the growth and development of *Cicer arietinum* L.

Keywords: Synergistic interactions, Botanical extracts, Chickpea growth, *Azadirachta indica,* Crop development etc.

Introduction

Agricultural sustainability and global food security depend significantly on the optimization of crop growth and development. The intricate relationship between natural elements and plant physiology underscores the importance of exploring the combined impacts of botanical extracts on crop performance. *Cicer arietinum* L. (chickpea), a vital leguminous crop, stands as an essential dietary protein source in many regions worldwide. Investigating the synergistic effects of specific plant extracts on chickpea growth presents an avenue for potentially enhancing agricultural practices.

The study aims to comprehensively analyze the collective impact of three botanical extracts – *Azadirachta indica* A. Juss., *Ocimum sanctum* L., and *Nicotiana tabacum* L. water extracts – on the stem growth of *Cicer arietinum* L. (chickpea). *Azadirachta indica*, commonly known as neem, contains diverse bioactive compounds known for their effects on plant growth and protection against various stresses (1). *Ocimum sanctum*, also known as holy basil or tulsi, possesses phytochemicals with potential growth-promoting properties (2). *Nicotiana tabacum*, a species of tobacco, contains alkaloids and other compounds that might influence plant growth (3). *Azadirachta indica*, commonly referred to as neem, is renowned for its diverse bioactive compounds that have shown significant effects on plant physiology and growth. Neem water extracts contain various phytochemicals, including azadirachtin, salannin, nimbin, and nimbidin, known for their pesticidal, insecticidal, and growth-regulating properties (4). These bioactive compounds exert multifaceted influences on plant growth, including stimulation of growth parameters and enhancement of stress tolerance mechanisms in plants (1). Research indicates that neem water extracts exhibit growth-promoting effects on plant species by enhancing stem growth and overall biomass. Studies conducted by Sharma et al. (2019) on *Vigna radiata* L. (mung bean) showed that neem water extracts positively influenced stem growth parameters, including increased stem length and diameter (5). Additionally, neem extracts have demonstrated the ability to regulate various physiological processes in plants, such as promoting cell division, increasing chlorophyll content, and enhancing nutrient uptake (6). Moreover, the application of neem water extracts has been found to mitigate the adverse effects of environmental stressors on plant growth. According to a study by Bhadoria et al. (2012), neem extract application significantly alleviated the impact of water stress on stem growth in *Zea mays* L. (maize), indicating its potential in enhancing plant tolerance to drought conditions (7).

Ocimum sanctum, commonly known as holy basil or tulsi, possesses a rich composition of phytochemicals that contribute to its medicinal and growth-promoting properties. The water extracts of *Ocimum sanctum* have been studied for their influence on plant growth parameters, including stem growth in various plant species. Research indicates that water extracts of *Ocimum sanctum* exhibit notable effects on stimulating stem growth in plants. Studies conducted by Chandra et al. (2011) on *Glycine max* (soybean) revealed that the application of holy basil water extracts resulted in enhanced stem elongation and increased stem diameter (8). Additionally, the extracts were found to promote cell division and elongation, contributing to improved stem growth in the treated plants. Furthermore, the phytochemical constituents present in holy basil extracts, such as eugenol, rosmarinic acid, and flavonoids, play significant roles in

modulating various physiological processes in plants. These compounds have been reported to regulate hormone levels, enhance nutrient uptake, and mitigate oxidative stress, all of which can positively impact stem growth (9).

Nicotiana tabacum, commonly known as tobacco, possesses various phytochemicals and compounds that have been studied for their potential effects on plant growth and development. The water extracts derived from *Nicotiana tabacum* have been investigated for their impact on stem growth in different plant species. Studies exploring the influence of tobacco water extracts on stem growth have shown mixed results. While some research suggests potential growth-promoting effects, others indicate inhibitory or toxic effects on plant development. Research conducted by Arora et al. (2015) on *Solanum lycopersicum* (tomato) suggested that low concentrations of tobacco water extracts had stimulatory effects on stem growth, promoting elongation and increasing stem biomass (10). However, higher concentrations led to detrimental effects, including stunted growth and reduced stem elongation. Nicotine, a prominent alkaloid found in *Nicotiana tabacum*, is known to affect plant growth in varying concentrations. Low concentrations of nicotine have been reported to promote cell division and elongation, potentially contributing to stem growth stimulation (11). Conversely, higher concentrations of nicotine have been linked to phytotoxic effects, inhibiting growth processes and disrupting cellular activities in plants (12). The effects of water extracts of Nicotiana tabacum on stem growth seem to be concentration-dependent, with lower concentrations potentially stimulating growth processes while higher concentrations might have inhibitory or toxic effects. This research aims to elucidate potential synergistic or antagonistic interactions among these extracts concerning chickpea stem development. Investigating these botanical interactions not only deepens our understanding of plant physiology but also offers insights into potential applications for agricultural practices aimed at optimizing crop growth and yield.

Materials and Methods

1. Plant Material and Growth Conditions:

-Fresh seeds of *Cicer arietinum* L. (Chickpea) were used for the experiment. All seeds are properly quarantined and all type of pre-treatments have been provided.

- We use NTP for this experiment and do all experiments under natural condition. We provide 8 hours of photoperiod for 20 days.

2. Preparation of Water Extracts:

- *Azadirachta indica*, *Ocimum sanctum*, and *Nicotiana tabacum*: We used double distilled water to prepare the desired extract from the leaves of aforementioned plants.

3. Experimental Design:

We divide the whole experiment in 5 groups taking urea treated group as reference group.

4. Application of Extracts:

- We constantly do the root drenching with desired concentration and note the timing of extract application during the growth stages of chickpea plants.

5. Data Collection:

- Measure stem growth (length) with vernier scale.

- We measure the length of plant on daily basis throughout the experiment.

Results

Table1. Stem height of *Cicer arietinum* L. against *A. indica* and *N. tabacum*.

S. No.	Days	Plant Height (in cm)
1.	01	0.00
2.	02	0.00
3.	03	0.00
4.	04	0.15
5.	05	0.40
6.	06	0.75
7.	07	1.25
8.	08	1.40
9.	09	2.755
10.	10	4.85
11.	11	6.56
12.	12	9.03
13.	13	10.22
14.	14	11.75
15.	15	11.79
16.	16	14.01
17.	17	14.49
18.	18	15.48
19.	19	16.40
20.	20	16.40

Table 2. Stem height of *Cicer arietinum* L. against *O. sanctum* and *N. tabacum*.

S. No.	Days	Plant Height (in cm)
1.	01	0
2.	02	0
3.	03	0
4.	04	0.2
5.	05	0.3
6.	06	0.4
7.	07	1.2
8.	08	1.67
9.	09	3.22
10.	10	5.15
11.	11	6.34
12.	12	9.44
13.	13	11.24
14.	14	12.42
15.	15	12.95
16.	16	15.47
17.	17	16.37
18.	18	17.65
19.	19	18.80
20.	20	19.32

Table 3. Stem height of *Cicer arietinum* L. against *A. indica* and *O. sanctum*.

S. No.	Days	Plant Height (in cm)
1.	01	0.0
2.	02	0.0
3.	03	0.0
4.	04	0.0
5.	05	0.0
6.	06	0.46
7.	07	0.78

8.	08	1.04
9.	09	1.46
10.	10	2.14
11.	11	2.52
12.	12	3.84
13.	13	4.54
14.	14	7.12
15.	15	9.34
16.	16	11.49
17.	17	12.12
18.	18	13.74
19.	19	15.24
20.	20	16.26

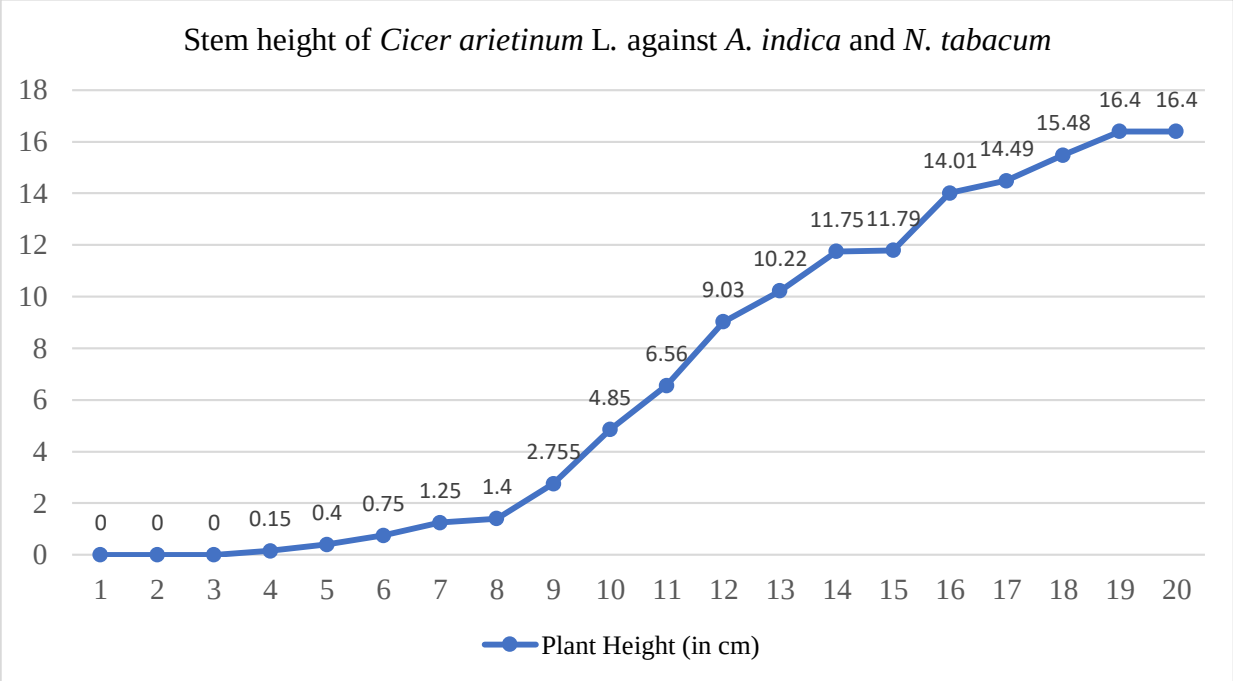
Table 4. Stem height of *Cicer arietinum* L. against *A. indica, N. tabacum* and *O. sanctum*.

S. No.	Days	Plant Height (in cm)
1.	01	0.0
2.	02	0.0
3.	03	0.0
4.	04	0.0
5.	05	0.0
6.	06	0.12
7.	07	0.35
8.	08	0.76
9.	09	1.12
10.	10	1.36
11.	11	1.75
12.	12	2.01
13.	13	4.47
14.	14	6.26
15.	15	7.80
16.	16	8.50
17.	17	9.20
18.	18	10.50
19.	19	11.20
20.	20	12.00

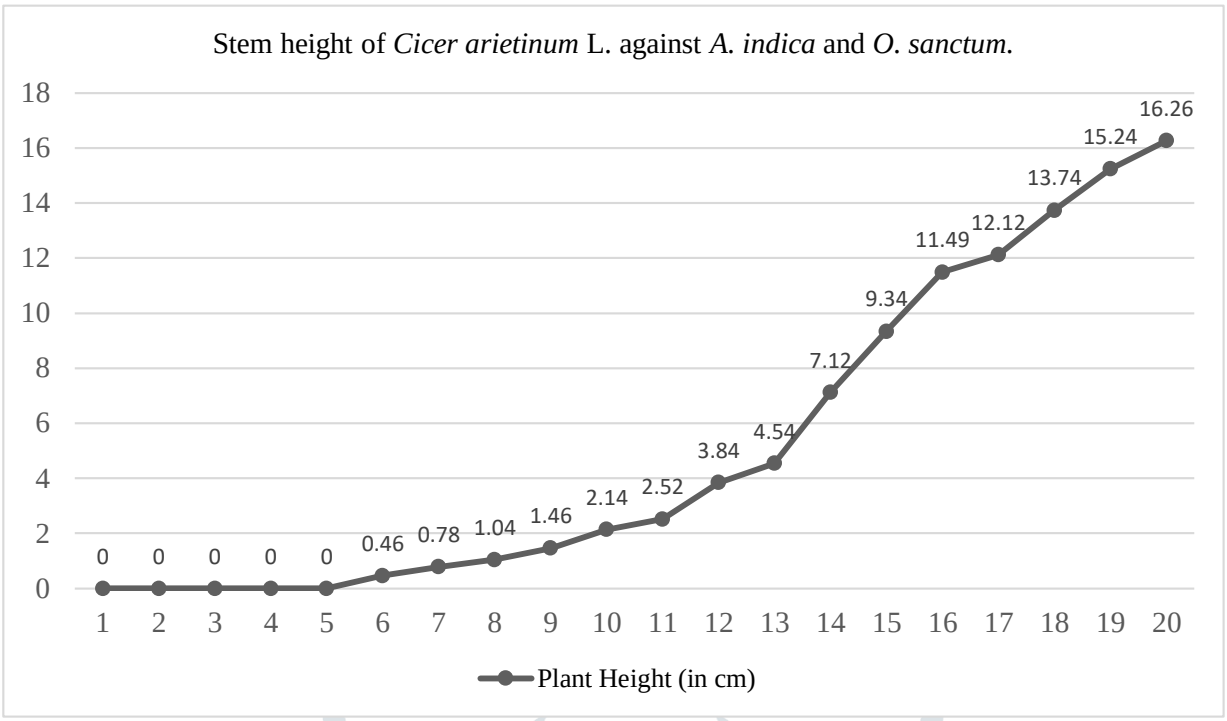
Table 5. Stem height of *Cicer arietinum* L. against urea.

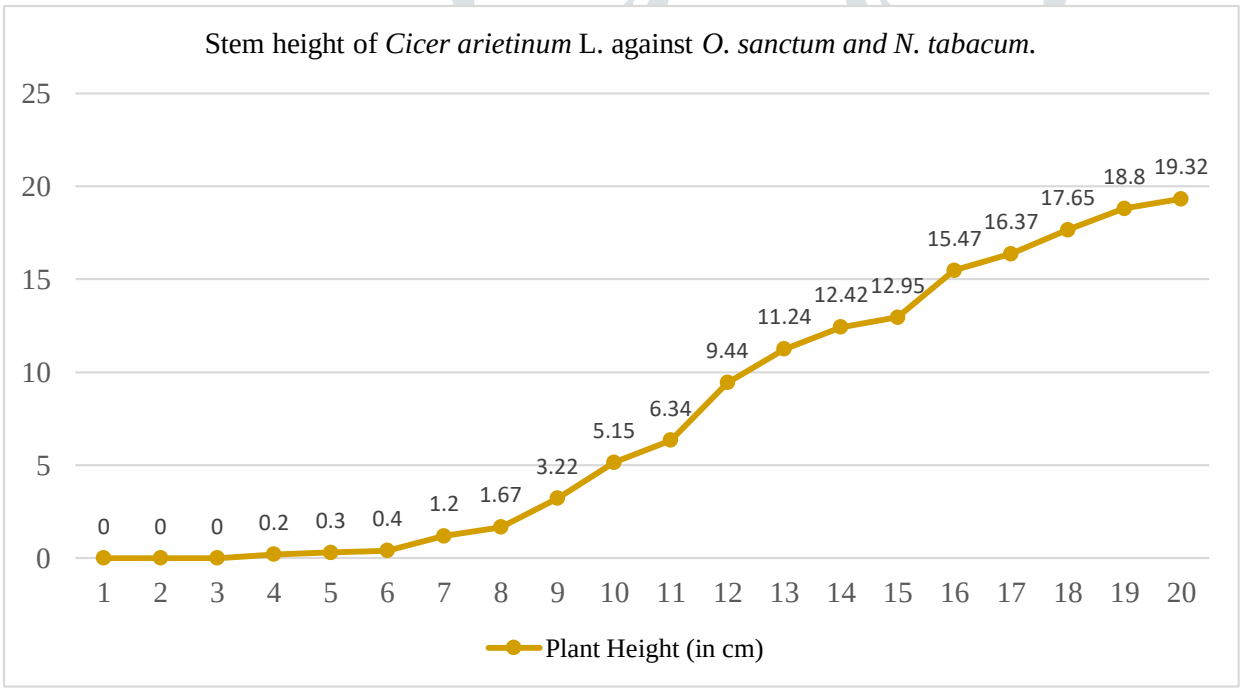
S. No.	Days	Plant height (in cm)
1.	01	0.0
2.	02	0.0
3.	03	0.0
4.	04	0.0
5.	05	0.46
6.	06	0.46

7.	07	1.68
8.	08	1.83
9.	09	2.04
10.	10	2.08
11.	11	2.9
12.	12	3.08
13.	13	3.38
14.	14	3.68
15.	15	3.86
16.	16	4.16
17.	17	4.56
18.	18	4.76
19.	19	5.12
20.	20	5.15



Graph 1. Graphical representation of growth of stem height against extracts of *A. indica* and *N. tabacum*.

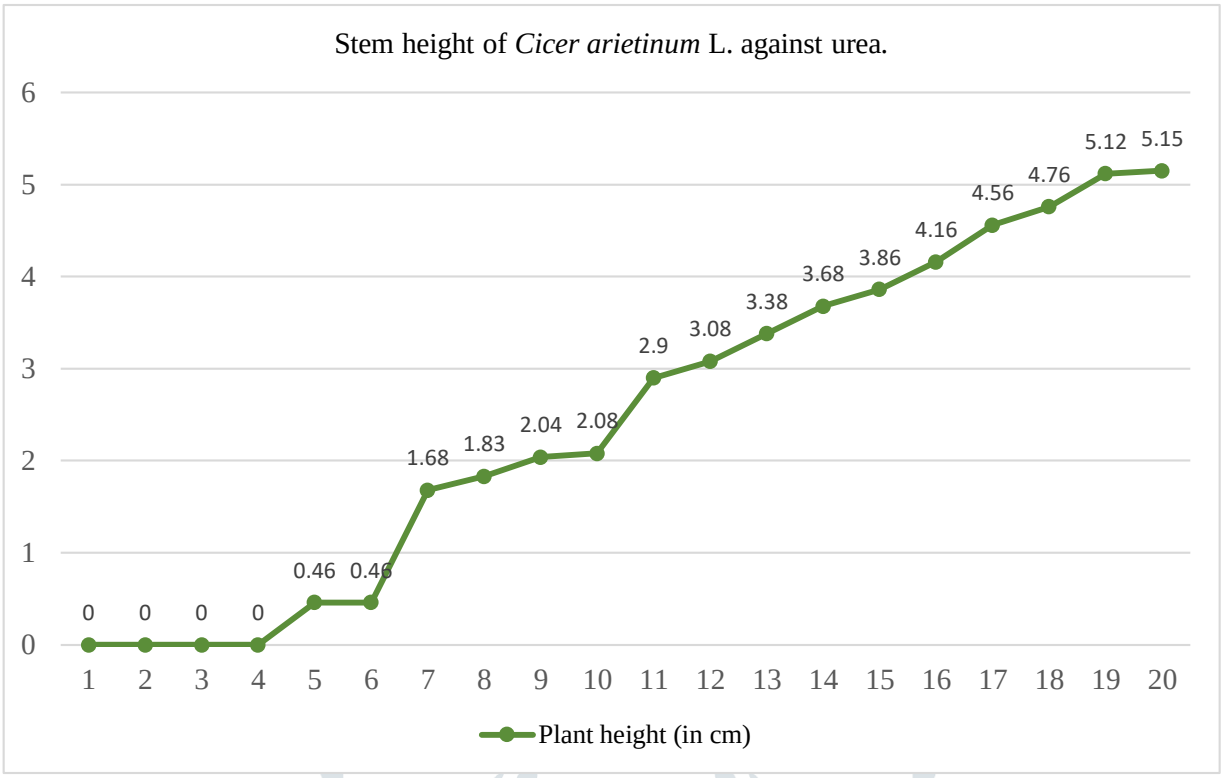


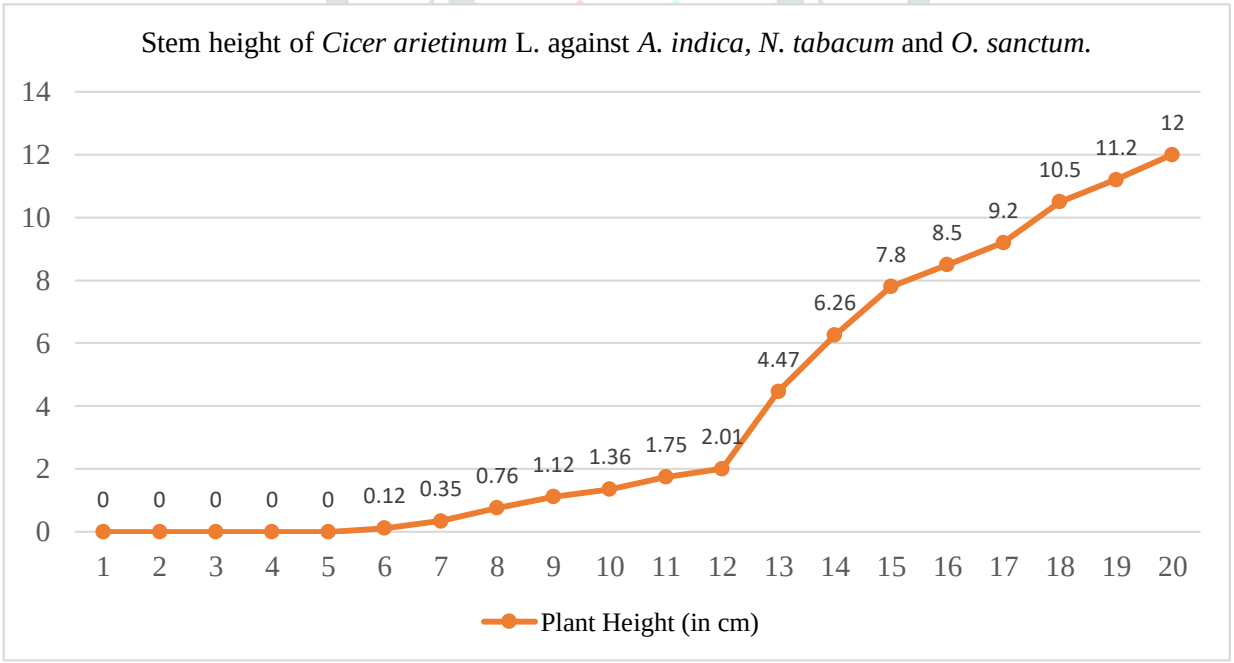


Graph 2. Graphical representation of growth of stem height against extracts of *O. sanctum* and *N. tabacum.*

Graph 3. Graphical representation of growth of stem height against extracts of *A. indica* and *O. sanctum*.

Graph 4. Graphical representation of growth of stem height against extracts of *A. indica, N. tabacum* and *O. sanctum*.





Graph 5. Graphical representation of growth of stem height against urea.

Discussion

The impact of neem and tobacco water extracts on the development of stem height in *Cicer arietinum* (chickpea) can vary based on concentrations, application methods, and plant growth stages. Neem extract, containing compounds like

azadirachtin, is known for its biopesticidal properties. When used appropriately, it may positively influence plant growth by deterring pests that can hamper stem development. It could potentially foster healthier plant growth, leading to better stem height. Tobacco water extract, owing to its nicotine content, possesses natural pesticidal qualities. However, nicotine in high concentrations can inhibit plant growth. Applied judiciously or in lower concentrations, it might deter pests without significantly impacting stem development. Yet, excessive use may potentially hinder the chickpea's growth. The interaction between these extracts and stem development in chickpeas could also be influenced by environmental factors and the specific physiological response of the plant to these substances. Additionally, while these extracts might deter pests that could otherwise stunt growth, they could also directly affect the plant's hormonal balance, thereby influencing stem elongation. Research studies, such as those conducted by Isman and Akhtar (2007) in their work on neem-based pesticides and plant growth regulators, and by Singh and Chhillar (2016) on the impact of tobacco extracts on plants, have explored the intricate relationship between plant growth and these extracts (13, 14). Such studies can provide valuable insights into understanding the nuanced effects of these extracts on the stem height of *Cicer arietinum*. In our study *C. arietinum* achieved a significant stem height of 16.40 cm against neem and tobacco.

Ocimum sanctum, commonly known as holy basil or tulsi, contains various compounds that may have growth-promoting properties. Studies have suggested that extracts from holy basil can contain phytohormones and nutrients beneficial for plant growth. When applied in appropriate concentrations, these extracts might enhance stem elongation in certain plant species. On the other hand, *Nicotiana tabacum*, or tobacco, contains nicotine, a compound known for its toxic effects on pests. However, nicotine in high concentrations can negatively impact plant growth, including stem height. It might inhibit cell division and elongation, thus potentially hindering the growth of the stem in certain plants. The contrasting effects of these extracts on stem height could be attributed to the different constituents present in each plant. While *O. sanctum* may provide beneficial compounds supporting growth, *N. tabacum*'s nicotine content might have inhibitory effects on stem elongation. Research conducted by Sharma et al. (2019) on the effects of holy basil extracts on plant growth and by Patel and Singh (2017) exploring the impact of tobacco extracts on growth parameters could shed light on the specific effects of these extracts on stem height (15, 16). In our study *C. arietinum* stem get a height of 19.32 cm in 20 days against water extracts of neem and tulsi.

Conclusion

Ocimum sanctum extracts demonstrate potential growth-promoting properties, attributed to their constituents that may contain beneficial phytohormones and nutrients. When applied appropriately, these extracts could potentially support stem elongation in various plant species. In contrast, *Nicotiana tabacum* extracts, primarily due to their nicotine content, exhibit contrasting effects. High concentrations of nicotine have been associated with inhibitory impacts on stem growth, potentially hindering cell division and elongation in certain plants. The divergent effects of these extracts underscore the importance of understanding their specific constituents and concentrations, as well as the plant species' responses. While holy basil extracts may offer growth-enhancing benefits, caution is necessary regarding the application of tobacco extracts due to their potential inhibitory impact on stem height in certain plant species. In the

present study growth of stem height *C. arietinum* against the extracts of *O. sanctum* and *N. tabacum* was recorded 19.32 cm in 20 days, which was maximum of all the extracts, whereas least growth was recorded as 5.15 cm against urea (used as control). Ultimately, further research and exploration into the optimal concentrations, application methods, and species-specific responses to these extracts are crucial for their judicious and effective use in agriculture. Understanding these nuances can aid in harnessing the growth-promoting benefits of holy basil while mitigating any potential inhibitory effects of tobacco extracts on stem height in plants.

Author Contribution:

Each author contributes equally.

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