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# The Allelopathic Effects of Aqueous Extracts from *Vachellia nilotica* On the Germination and development of *Citrullus lanatus* L

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**Abstract:** This study aims to evaluate the allelopathic effect of leaf extracts from the thorny acacia tree (*Vachellia nilotica*) on the germination and seedling growth of watermelon (*Citrullus lanatus* L). The experiment was conducted using three different concentrations of the aqueous extract of acacia leaves extract which are (0%, 20%, 40%, or 60%), in addition to a control group treated with distilled water. The effects of these extracts were assessed by measuring the parameters of Germination percentage, plumule and radicle length, seedling dry weight, and imbibition percentage. The results showed that the extracts at 40% and 60% concentrations enhanced the imbibition percentage compared to the control group, while for these concentrations (20%, and 60%) has no significant effect on the germination rate. Lower concentrations (20% and 40%) significantly stimulated plumule growth, whereas the highest concentration (60%) resulted in a reduction in plumule and radicle length. Moreover, the 60% concentration exhibited an inhibitory effect on radicle root growth, suggesting that the plant extracts may contain allelopathic compounds that influence seedling development. These findings confirm that the allelopathic effect of *V. nilotica* extracts is concentration-dependent (what are the allelopathic active compounds of *V. nilotica*), with a stimulatory effect at low doses and an inhibitory effect at higher doses. Further studies are needed to understand the mechanisms of allelopathic influence and its potential applications in mixed agricultural systems.
**Keywords:** Allelopathy; plumule and radicle length; Sustainable Agriculture; acacia tree.

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**التأثير الأليلوباثي للمستخلص المائي لنبات *Vachellia nilotica* في إنبات وقوة بادرات نبات البطيخ الأحمر *Citrullus lanatus***

**المستخلص:** تهدف هذه الدراسة إلى تقييم التأثير الأليلوباثي لمستخلصات أوراق شجرة السنط الشوكي *Vachellia nilotica* على إنبات ونمو بادرات البطيخ الأحمر *Citrullus lanatus* تم تنفيذ التجربة باستخدام اربعة تراكيز من ضمنها الكنترول (0%, 20%، 40%، 60%),حيث تم قياس تأثير هذه المستخلصات على صفات النبات والتي هي ( معدل الإنبات، طول الرويشة والجذير، الوزن الجاف للبادرات، ونسبة التشرب). أظهرت النتائج أن مستخلص نبات الاكاسيا عزز من نسبة التشرب المستخلصات عند التركيزين 40% و60% مقارنةً بمعاملة المقارنة, في حين لم يكن لها تأثير معنوي على نسبة الإنبات. كما تبين ان التراكيز (20% و40%) حفزت نمو الرويشة بشكل ملحوظ، بينما أدى التركيز الأعلى (60%) إلى انخفاض في طول الرويشة والجذير. علاوةً على ذلك، أظهر التركيز 60% تأثيرًا مثبطًا على نمو الجذور، مما يشير إلى إمكانية احتواء المستخلصات النباتية على مركبات أليلوباثية تؤثر على تطور البادرات. تؤكد هذه النتائج أن التأثير الأليلوباثي لمستخلصات *Vachellia nilotica*يعتمد على التركيز، حيث يمكن أن يكون له دور تحفيزي عند الجرعات المنخفضة وتأثير مثبط عند الجرعات العالية، مما يشير ذلك الى إجراء مزيد من الدراسات لفهم آليات التأثير الأليلوباثي وتطبيقاته المحتملة في النظم الزراعية المختلطة.
**الكلمات المفتاحية:** الأليلوباثي؛ طول الريشة والجذر الجنيني؛ الزراعة المستدامة؛ شجرة الأكاسيا.

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## INTRODUCTION

Allelopathy is a natural ecological process in which interactions among plants significantly contribute to the stability of agroforestry ecosystems. It involves the effect of one plant or associated microorganisms on the growth and development of neighboring plants through the release of chemical compounds into the environment (Alshareef & M. A. A., 2019). Agricultural crops are significantly affected by windbreaks planted in their vicinity, leading to reduced yields due to direct competition for essential resources such as water, minerals, and light. In addition to physical competition, windbreaks also release allelopathic compounds that inhibit crop growth, thereby exacerbating the damage to agricultural production (Yanar & Kadioglu, 2004; Abu-Romman, 2016; Kluthe et al., 2018). However, these effects are visibly manifested through several symptoms, including general stunted growth, leaf wilting and yellowing, root browning, and the absence of root hair development. In some cases, this may lead to partial or complete plant desiccation (Appleton et al., 2000). Furthermore, these allelopathic compounds are secondary metabolites produced by various plant parts, including leaves, roots, stems, flowers, and seeds, with leaves being the primary source (Kumari et al., 2016). Acacia species are known to produce a wide range of secondary metabolites, including amines, alkaloids, cyanogenic glycosides, cyclitols, fatty acids, seed oils, fluoroacetic acid, gums, non-protein amino acids, and various types of terpenes such as essential oils, diterpenes, phytosterols, triterpenes, and saponins, in addition to hydrolyzable tannins, flavonoids, and condensed tannins (Seigler, 2003). According to Alshareef and Alaib (2018), *Vachellia nilotica* (commonly known as thorny acacia) exhibits strong allelopathic effects on squash seed germination and seedling growth. Similarly, findings were reported by Al-Wakeel et al., (2007), who observed that aqueous extracts of *V. nilotica* reduced fresh and dry weight, plant height, chlorophyll content, and Nitrogen and phosphorus levels in peas. According to (Mohamed Bogelil et al. 2024), watermelon is a primary summer crop in the Al-Fataeh agricultural region. Watermelon (*Citrullus lanatus*) is one of the most important agricultural crops of the Cucurbitaceae family. It is widely cultivated worldwide due to its refreshing taste, particularly during the summer season. Given the extensive use of *Vachellia nilotica* trees as windbreaks in this area, it is essential to investigate their impact on watermelon cultivation. Therefore, this study aims to analyze the effects of aqueous extracts from *V. nilotica* on the germination and seedling vigor of watermelon (*Citrullus lanatus*) using filter paper as a germination medium.

## MATERIALS AND METHODS

The study was conducted in the laboratory of the Department of Plant Production Techniques at the Higher Institute of Agricultural Technologies Derna, during the 2024 season. Its primary aim was to investigate the effect of aqueous extracts from *Vachellia nilotica* leaves on the germination and vigor of watermelon (*Citrullus lanatus*) seeds of the Germa F1 cultivar. To achieve this, three distinct concentrations of the extract (20%, 40%, and 60%) were prepared and tested. Each treatment was replicated three times, along with a control treatment using distilled water. For the preparation of the extract, leaves exhibiting healthy morphological characteristics were carefully selected. The leaves were initially washed with tap water, then thoroughly rinsed again with distilled water. Subsequently, the leaves were left to dry in the shade under natural conditions. Once dried, they were ground using an electric grinder. The extraction process followed the protocol outlined by Masoud et al, (2022). Specifically, an initial stock extract at 100% was prepared by mixing 100 grams of dried leaf powder with 500 mL of distilled water in a 1-liter flask. This mixture was stirred on a shaker for 24 hours. The resulting extract was first filtered through three layers of sterile gauze to

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remove solid residues, and then further filtered using Whatman filter paper No. 1. Finally, the filter was centrifuged at 2000 rpm for 15 minutes to produce a 100% stock extract. From this concentrated stock, working concentrations were prepared by dilution with distilled water. Germination tests were conducted using 10 cm diameter Petri dishes, with a total of twelve dishes, including the control. For each treatment, five seeds were weighed to determine their initial dry weight, placed in Petri dishes, and treated with 20 mL of the appropriate aqueous plant; distilled water was used for the control. Seeds were soaked for 24 hours, then blotted dry with clean filter paper and weighed again to calculate water absorption percentage. Subsequently, the seeds were placed on two layers of moistened filter paper inside Petri dishes, which were re-moistened with the corresponding extract as needed to prevent drying out (Othman et al., 2018). The filter paper was replaced every 48 hours to prevent seed rot. Seeds were considered germinated when the radicle length reached 2 mm, and daily germination counts continued until a stable germination rate was achieved (Murray et al., 1979). In this experiment, this period lasted for two weeks. Various growth parameters were calculated as follows:

• **Water absorption percentage:** Calculated using the formula: Water absorption percentage = [(Weight after soaking – Weight before soaking) / Weight before soaking) × 100 (Ban & Hussain, 2022].

• **Germination percentage (GP):** Expressed as the percentage of germinated seeds relative to the total seeds. The final germination percentage was calculated by dividing the number of germinated seeds by the total number of seeds and multiplying by 100 (Yousif et al., 2020).

• **Radicle and plumule length (cm):** The length of the radicle and plumule was measured in centimeters for each seedling in each Petri dish after the germination period. The average lengths were calculated using a ruler (Abdulhussein, 2016).

• **Seedling dry weight (mg):** The seedlings used for measuring length were also placed in perforated bags and dried in an electric oven at 80°C for 24 hours. After drying, their dry weights were recorded, and the average dry weight was determined (Ahsyee et al., 2021).

• **Statistical analysis**: Data from all measured traits were analyzed statistically using a Completely Randomized DESIGN (CRD). Treatment differences were evaluated using analysis of variance (ANOVA) at a significance level of 5%, and means were compared using Tukey's Honestly Significant Difference (HSD) test through the SPSS software package.

## RESULTS AND DISCUSSION

**Imbibition Rate :**The results in Table 1 showed that treating watermelon seeds with aqueous extract of the Acacia prickly plant in concentrations of 40% and 60% led to a significant increase in the rate of imbibition compared to the control treatment. This may be attributed to the increased diffusion potential and attractive forces between water molecules and adsorbent molecules, as indicated by a previous study (Ahsyee et al., 2021). However, no significant difference was observed between the 20% concentration and the control treatment, indicating equal potency and effectiveness in imbibitions**.**

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**Table:(1).** Impact of various concentrations of the aqueous extract of acacia prickly leaves on the rate of imbibition of watermelon seeds.

| Aqueous extract concentrations (%) | Imbibition rate (%) |
|---|---|
| Control | 12a ± 0.57 |
| 20 | 11a ± 0.01 |
| 40 | 23b ± 0.33 |
| 60 | 14c ± 0.33 |

Means followed by the same letter are not significantly different by Tukey's HSD test at 5% level.

**Germination Percentage:** The results presented in Table 2 showed that aqueous extracts of acacia leaves do not significantly affect the germination percentage. All concentrations had an approximately similar effect, with no stimulating or inhibitory effect on germination compared to controls. These results confirm the observations of Saeed et al. (2013), who revealed that wheat germination was not significantly affected by the aqueous extract of (*Syzygium cumini* L.) leaves.

**Table: (2).** Impact of various concentrations of the aqueous extract of acacia prickly leaves on the germination percentage of watermelon seeds.

| Aqueous extract concentrations (%) | Germination rate percentage (%) |
|---|---|
| Control | 100.0 ±0.01 |
| 20 | 93.3 ± 6.7 |
| 40 | 86.7 ± 6.7 |
| 60 | 100.0 ±0.01 |

Means followed by the same letter are not significantly different by Tukey's HSD test at 5% level.

**Plumule Length:** Table 3 shows that the low concentration of aqueous extract from acacia prickly leaves stimulated the growth of the plumule length, but the high concentration of the extract (60%) led to a significant decrease compared to 20%. This indicates that the stimulatory or inhibitory action is concentration-dependent (Saxena, 1996). Similarly, Reigosa et al. (1999) found that certain allelochemicals may either stimulate or fail to affect various plant species when applied at low concentrations. Supporting these observations, Khan et al.,(2005) also reported that bark extracts exhibited similar behavior. Promoted the germination of *Asphodelus tenuifolius*. On the other hand, our outcomes differ from those of Mehmood et al. (2011), who noted that the aqueous bark extract of *Acacia nilotica* improved germination and shoot and root growth across various concentrations, except at 20%, where it had an inhibitory effect.

**Table: (3).** Impact of various concentrations of the aqueous extract of acacia prickly leaves on the plumule length of watermelon seeds.

| Aqueous extract concentrations (%) | Plumule length (cm) |
|---|---|
| Control | 1.42a ±0.20 |
| 20 | 10.47b ±0.17 |
| 40 | 10.95b ±0.28 |
| 60 | 8.33c ±0.19 |

Means followed by the same letter are not significantly different by Tukey's HSD test at 5% level.

**Radicle Length:** In Table 4 the results show the radicle length of the red watermelon plant using different concentrations of the aqueous extract of the acacia prickly plant. The inhibitory effect of leaf filtration on the radicle length of the seedling was observed, as the of 20% and 40% did not show any significant effect compared to the control. However, which indicates that these concentrations of the extract did not significantly affect the length of the radicles. However, which indicates that these concentrations of the extract did not significantly affect the length of the radicles. In contrast, the 60% concentration caused to a significant decrease in radicle length compared to the control. This result is consistent with previous studies that showed that increasing the concentration of plant extracts often leads to radicle growth inhibition, as pointed out by Javaid and Shah (2007), Roots are the first part of the plant to come into contact with the soil and its chemicals, so they are

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particularly vulnerable to the effects of plant extracts.A study by Djurdjevic et al. (2004), showed that *Acacia nilotica* extracts rich in phenolic compounds such as gallic acid and catechin can inhibit root growth. These compounds are believed to inhibit vital processes within the cell, such as cellular respiration, which leads to obstructing root growth (Abrahim et al., 2000).

**Table:(4).** Impact of various concentrations of the aqueous extract of acacia prickly leaves on the radicle length of watermelon seeds.

| Aqueous extract concentrations (%) | Radicle length (cm) |
|---|---|
| Control | 4.30 ±0.30 |
| 20 | 4.30 ±0.30 |
| 40 | 4.56 ±0.19 |
| 60 | 3.76 ±0.27 |

Means followed by the same letter are not significantly different by Tukey's HSD test at 5% level.

**Dry Weight of Seedlings:**Table 5 shows the results of the dry seedling weight of red watermelon plants using different concentrations of aqueous extract of the acacia prickly plant. The dry seedling weight was significantly higher at concentrations of 20% and 40% compared to the control, and significantly lower at the 60% concentration. Meanwhile, the results obtained are consistent with those of Tripathi et al. (1998). This consistency may be attributed to the biphasic response phenomenon, also known as hormesis, where low doses stimulate growth and high doses inhibit it. This effect is attributed to the allelopathic compounds, such as tannins and phenolics, present in the extract (Saleha et al., 2018).

**Table: (5).** Impact of various concentrations of the aqueous extract of acacia prickly leaves on the dry weight of watermelon seedlings.

| Aqueous extract concentrations (%) | Dry weight of seedlings (g) |
|---|---|
| Control | 0.03a ±0.01 |
| 20 | 0.82b ±0.01 |
| 40 | 0.09b ±0.01 |
| 60 | 0.03a ±0.01 |

Means followed by the same letter are not significantly different by Tukey's HSD test at 5% level.

## CONCLUSION

In this study, an applicable that the aqueous extracts of *Vachellia nilotica* leaves exhibit a variable allelopathic effect on the germination and early growth of Citrullus lanatus seedlings, primarily depending on the extract concentration. The results indicated that low concentrations (20% and 40%) did not significantly affect germination percentage but stimulated shoot growth and increased seedling dry weight, suggesting a positive influence on early developmental stages. In contrast, the higher concentration (60%) resulted in a significant reduction in shoot and root length, reflecting an inhibitory effect on root growth. This suppression may be attributed to allelopathic compounds in the extract that interfere with cell division or nutrient uptake essential for growth. Furthermore, higher concentrations (40% and 60%) enhanced seed imbibition compared to the control group, which may be linked to alterations in seed membrane permeability due to bioactive compounds present in the extract. Based on these findings, it is evident that the allelopathic effect of plant extracts is dose-dependent, exerting a stimulatory effect at lower concentrations and an inhibitory effect at higher concentrations. These results open new avenues for exploring the bioactive chemical constituents of *V. Nilotica* and their mechanisms of action, potentially contributing to the development of agricultural strategies that leverage allelopathy for weed management and sustainable crop production systems.

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