Phytotoxic effects of *Albizia lebbeck* (L.) Benth. Extracts on *Hordeum vulgare*, *Zea mays* and *Phaseolus vulgaris*

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Abstract

Albizia lebbeck (L.) *Benth* (A. lebbeck)*. is a large deciduous perennial tree widely prevalent in various tropical and subtropical areas. It is commonly cultivated in agricultural fields and alongside highways for purposes of fuel and shade. Therefore, this study aimed to assess the influence of* A. lebbeck *extracts and powder biomass on the growth and biochemical constituents of* Hordeum vulgare *(barley),* Zea mays *(maize), and* Phaseolus vulgaris *(bean). Fresh plant materials, such as bark and leaves were collected, shade dried and then the materials were ground into a powder for their utilization and to form the extracts. The aqueous extracts were prepared by soaking for 24, 48, and 72 hours using 5, 10, and 15 g of powder per 100 mL. The phytotoxic effects of these powder biomass and extracts on the seedling growth, and biochemical traits of barley, maize, and bean were assessed through aqueous bioassay and pot trials. All treatments significantly affected the plumule and radicle length, root numbers, fresh and dry biomass, shoot and root length of the above selected crops. Notable alterations were observed in physiological and biochemical indicators; such as proline content, chlorophyll a, and chlorophyll b. Proline levels increased, suggesting the presence of stress. Barley exhibited greater tolerance compared to bean and maize, which was identified as the most sensitive species among those studied. Increased extract content (15g) and soaking duration of bark and leaves of* A. lebbeck *resulted in more pronounced phytotoxic effects. Increased concentrations and extended soaking durations significantly influenced germination and seedling growth more than decreased concentrations and shorter soaking times. However, leaf extracts demonstrated a significant reduction in growth across all examined parameters when compared to bark extracts. In conclusion,* A. lebbeck *demonstrates significant phytotoxic effects that are influenced by dosage, duration, and the specific plant part, impacting the physiological traits, growth performance, and seed germination of key agricultural crops.*

Keyword*:* Phytotoxicity, *Albizia lebbeck*, Plant Growth, Physiological Processes.

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Introduction

Phytotoxicity refers to the negative impacts of chemically active compounds produced by plants on the sprouting, development, physiological processes, and metabolic activities of other plant species (Karatas et al., 2022). Phytotoxic interactions are crucial to interrelationships of plants and significantly influence crop production, changes in vegetation, and ecological stability. Plants release allelochemicals that can influence soil properties, seeds germination, plant development and yield, while also helping to suppress weeds and invasive plants (Kong et al., 2019; Valiño et al., 2023). A variety of plant species secondary metabolites reveal toxicity towards other plants (Madariaga-Mazón et al., 2019). Chemicals are necessary for plant defense, protection, effectiveness, and adaptability of chemical-stress, despite not having a direct influence on growth and metabolism. Phytotoxins include flavonoids, phenolic acids, coumarins, alkaloids, quinones, terpenoids, tannins and glycosides (Ohiagu et al., 2021; Chen et al., 2022). These chemical substances are synthesized by plants parts such seeds, bark, roots, stems and flowers. The quantity and composition of these chemical compounds are influenced by the plant species, growth, developmental stage, and environmental factors (Duke et al., 2000; Li et al., 2020). Climate change (Feng et al., 2022) also effect the phytotoxins, whereas these chemicals can impede seed sprouting, shoot and root development, absorption of nutrients, and critical physiological and biochemical processes in adjacent plant species upon release. *Albizia lebbeck* (L.) Benth (*A. lebbeck*) is a plant recognized for its therapeutic characteristics (Ackerman et al., 2003; Begum et al., 2021), with its active metabolites elucidating these medicinal capabilities. The pharmacological mechanisms and possible medicinal applications are being examined via preclinical studies and in silico analysis (Ahmad et al., 2024).

Root leaching, exudation of aerial plant components due to rainfall of irrigation, mulching, detritus decomposition, and the applications of plant extracts release phytotoxic chemical compounds (Prati & Bossdorf, 2004; Verma & Rao, 2006; Aleksieva & Marinov-Serafimov, 2008). Leaf leachates and plant extracts reveal induced phytotoxicity due to the maximum concentration of phytotoxins in leaf (Stinson et al., 2006), which have prolonged influence on plant growth, development in soil, influenced by several factors including soil texture, microbial action, moisture, and variability of temperatures (Farooq et al., 2009). Soil microbial communities (Shahid et al., 2026), which can induce toxicity or prolong their incidence through the modification of these phytotoxic chemicals (Bajaj et al., 2004). These substances have a variety of effects on plants, including the ability to adversely affect nucleic acids,

hormone and enzyme production, function, and cellular membranes, which might impede cell development and plant growth (Khan, 2025). Phytotoxicity consequences in decline elongation of plumules and radicles, induced chlorosis and necrosis, decline the surface area of leaf, impaired seeds sprouting, and decline fresh and dry biomass (Abrahim et al., 2000; Geetha, 2019). Phytotoxic chemicals can alter the pathways of electron transport, photorespiration, and photosynthesis, resulting in decline photosynthetic contents and reduced the efficiency of photosynthesis (Inderjit & Bhowmik, 2002). Plants experiencing phytotoxic chemical stress prove physiological processes including synthesis of proline, serving as an indicator of physiological and biochemical stress (Cvetnic & Vladimir-Knezevic, 2004). Plant phytotoxic research as a cause of natural pesticides has improved in recent years. The excessive use of synthetic herbicides presents distresses concerning effluence, the growth of herbicide conflict, and detrimental infancy on non-target organisms (Pfeifhoffer & Brantner, 2010). Subsequently, researchers are investigating plant-derived phytotoxic compounds for sustainable management of weed and induced crops development (Elzaki et al., 2012). Assessment of a plants phytotoxicity is critical for decisive its appropriateness for agro-ecosystems and evolving ecologically safe crop executive practices.

A. lebbeck is a tree within the Fabaceae family, reveals leaf falling during the winter season. Larger tropical and subtropical regions in Australia, Africa, and Asia may reveal this phenomenon (Sesoltani, 2011; Verma et al., 2013). *A. lebbeck* is establish in road-sides, agricultural land, water channels, and streams. Common uses include agroforestry, shade provision, and aesthetic enhancement. The plants grow in damaged soils characterized by alkaline, saline, and acidic conditions, whereas the symbiotic nitrogen fixation has the potential to increase soil fertility (Gatti et al., 2004). *A. lebbeck* phytochemical analyses recognized the occurrence of tannins, phenols, alkaloids, flavonoids, glycosides, proteins and carbohydrates (Hussain et al., 2011), whereas several parts of plants also have therapeutic properties.

These secondary metabolites designate that the plant may influence neighboring plants; however, its impacts on agricultural plants and other plant species remain poorly understood. *A. lebbeck* is cultivated alongside crops in agro-forestry and mixed-cropping systems, potentially influencing crop germination, growth, and physiological performance. The phytotoxic potential of this species requires testing to evaluate its influence on crop growth and productivity. Therefore, the aim of this study is to assess the influence of *A. lebbeck* bark and leaf extracts and biomass

on seeds germination, growth and biochemical processes of barley, maize, and bean.

Materials and Methods

Preparation of A. lebbeck *Barks and Leaf Powder*

A. lebbeck bark and leaves were collected with local authorization from Tehsil Tangi, District Charsadda. Following collection, the plants were air-dried at room temperature (22–28°C) for duration of 15 days. Dry materials, including leaves and bark, were processed into a fine powder using an electric grinder. The estimated particle size ranged from approximately 0.4 to 1.0 mm, although sieve analysis was not performed. The bark and leaf powdered biomass were preserved in clean, labeled plastic bags at ambient temperature for subsequent utilization. The powdered material was applied to soil in pots at three treatment levels: 5g/kg, 10g/kg, and 15g/kg of soil.

Aqueous Bioassay

The aqueous extracts were evaluated at varying concentrations over different durations following the method of Minagawa et al. (2022). The 5g, 10g, and 15g powder material of the leaf and bark materials of *A. lebbeck* were combined with 100mL of distilled water. The mixture was agitated for a specified duration and subsequently allowed to rest for 24hrs with 5g, 48hrs/10g, and 72hrs with 15g. Following this period, the mixture was filtered using filter paper. The extracts were applied to various test crops, including barley, maize, and beans. The control plant seeds of the experimental crops underwent treatment with distilled water. Prior to the treatment, the Petri dishes were thoroughly washed and sterilized using an autoclave at 121°C for duration of 15 minutes. In each Petri plate, 10 viable seeds from each test species were placed. The extract was dispensed onto each Petri plate within a laminar flow environment. The Petri dishes containing seeds were maintained in an incubator for a duration of seven days at a temperature of 28°C. The treatment process was conducted daily over a span of seven days. After duration of seven days, the lengths of the plumule as well as radical were measured using a centimeter scale.

Pots Experiments

The uniform-sized pots were collected and thoroughly washed using distilled water. In every pot, the sterilized soil was measured and placed at equal intervals. *A. lebbeck* bark and leaves powder were mixed with sterilized soil at 5, 10, and 15g/kg of soil, whereas 10 healthy seeds of each test crop were sown in each pot with equal distance to minimize

the competition. Three replicates were used for each treatment such as control, 5, 10 and 15g. Although no chemical fertilizers were used throughout the experiment, the soil composition was sandy loam, with an electrical conductivity (EC) of 1.30 dS/m and a pH of 7.64. Moderate amounts of organic matter (1.6%), nitrogen (58.75 mg kg^{-1}), phosphorus (9.50 mg kg^{-1}), and potassium (110.34 mg kg^{-1}) were found in the nutrient analysis.

Following seven days of germination, a ruler was used to measure the plumule and radicle lengths of randomly chosen maize seedlings from each treatment (in cm). Key characteristics, such as leaf length, shoot length and root number and length and photosynthetic pigments of each test crop were calculated.

Photosynthesis Analyses

The content of chlorophyll a (Chl a), chlorophyll b (Chl b), and carotenoids in barley, maize, and bean leaves was assessed according to the protocol of Siyar et al. (2019). Fresh, fully expanded leaves were homogenized in 2 mL of 80% acetone, and the total volume was adjusted to 7 mL. Absorbance measurements were conducted with a UV spectrophotometer (Shimadzu-China; model UV-1780) at wavelengths of 480 nm, 510 nm, 645 nm, and 663 nm using the specified formulas.

$$Chlorophyll\ a.\left(\frac{mg}{g}\right) = \frac{12.3\ D663 - 0.86\ D645}{d\ x\ 1000\ x\ w}$$

$$Chlorophyll\ b.\left(\frac{mg}{g}\right) = \frac{19.3\ D645 - 0.86\ D663}{d\ x\ 1000\ x\ w}$$

$$Total\ Chlorophyll = Chl.a + Chl.b$$

$$Carotenoids = \frac{(1000\ A470 - 1.82\ Chl\ a - 85.02\ Chl\ b)}{198}$$

Proline Analysis

The assessment of proline levels in maize leaves was performed according to the methodology outlined by Ábrahám et al. (2010). Leaf samples (0.2g) were homogenized in 5 mL of 3% sulphosalicylic acid and incubated at 5°C for 24 hrs. The solution underwent centrifugation at 4000 rpm for 5min. 02mL of the supernatant were mixed with 2mL of acid ninhydrin reagent, composed of 6M phosphoric acid, glacial acetic acid, and 1.25g of ninhydrin. The mixture was heated in a water bath for 60min, then cooled and extracted with 4mL of toluene. The toluene layer was separated, and its absorbance was measured at 520nm. Toluene served as a control sample.

Result and Discussion

Impacts of A. lebbeck *Leaf Aqueous Extracts on Plumule Length of Selected Crops*

In comparison to the control, the leaf aqueous extract of *A. lebbeck* reduced the plumule length of all studied species, including barley, maize, and bean (Table 1). The effect was contingent upon the amount and duration of contact. The maximum plumule lengths recorded were 10.1 ± 1.17 cm for corn, 8.9 ± 0.56 cm for barley, and 8.3 ± 0.21 cm for beans. All of these lengths were believed to indicate a growth of 100%. The plumule's length was noticeably reduced after an exposure period of 24 hrs to 5 g/100 mL AE. The highest blocking level was 59.5% for barley, 64.3% for maize, and 73.4% for beans. In all species, the plumule lengths decreased when the soaking time was extended from 24 to 72 hrs at the same concentration. The length of the plumule gradually decreased as the concentration increased (10 and 15 g/100 mL). After exposure to 15 g/100 mL AE for 72 hrs, the plumule lengths decreased to 3.2 ± 0.43 cm (35.9%) in barley, 3.3 ± 0.51 cm (32.6%) in maize, and 4.3 ± 0.22 cm (51.8%) in beans. Compared to maize and barley, beans were less affected by the aqueous extracts of leaves of *A. lebbeck*; still, all techniques produced longer plumules.

Table 1: Impact of* A. lebbeck *leaf aqueous extracts on plumule length (PL).

Treatments (Aqueous extract)	Test species					
	Barley		Maize		Bean	
	PL (Cm)	% of PL	PL (Cm)	% of PL	PL (Cm)	% of PL
Control	08.90 ± 00.56	100	10.10 ± 01.17	100	08.30 ± 00.21	100
5g/24hrs	05.30 ± 00.27	59.5	06.50 ±0 0.49	64.3	06.10 ± 00.30	73.4
5g/48hrs	05.00 ± 00.24	56.1	06.20 ± 00.24	61.3	05.80 ± 00.50	69.8
5g/72hrs	04.80 ±00.24	53.9	05.90 ± 00.38	58.4	05.60 ± 00.52	67.4
10g/24hrs	04.60 ± 00.35	51.6	05.70 ± 00.20	56.4	05.50 ± 00.28	66.2
10g/48hrs	04.40 ± 00.31	49.4	05.40 ± 00.48	53.4	05.30 ± 00.32	63.8
10g/72hrs	04.10 ± 00.25	46	05.20 ± 00.39	51.4	05.10 ± 00.24	61.4
15g/24hrs	03.80 ± 00.27	42.6	03.90 ± 00.47	38.6	04.80 ± 00.22	57.8
15g/48hrs	03.50 ±00.21	39.3	03.60 ± 00.35	35.6	04.60 ± 00.36	55.4
15g/72hrs	03.20 ± 00.43	35.9	03.30 ± 00.51	32.6	04.30 ± 00.22	51.8

This study shows the effect *A. lebbeck* leaf aqueous extract phytotoxically and allelopathically affects barley, maize, and bean seedlings. Increased extract concentration and longer soaking times reduce plumule length, demonstrating the dose-dependent allelopathic effects of leaf-derived inhibitory chemicals on seedling growth. Phenolics, flavonoids, tannins, and alkaloids in *A. lebbeck* may limit plumule elongation. In early germination, these chemicals disturb hormone balance, enzyme activity, cell division, and cell elongation, inhibiting shoot development (Yan et al., 2024). Barley and maize respond more to

allelopathic stress than beans, demonstrating species-specific responses. Beans' better detoxification and flexible metabolic pathways diminish allelochemical effects and increase tolerance. Allelopathy research reveals crop species respond uniformly. Extended soaking increases phytotoxic component leaching and extract buildup, inhibiting action. Seed storage mobilization, photosynthetic establishment, and plumule meristematic activity may decrease with prolonged exposure, causing physiological stress (Adetunji et al., 2021).

Impact of A. lebbeck *Leaf Extracts on Radical Length*

Barley, maize, and beans have decreased radicle lengths after exposure to *A. lebbeck* leaf AE. The effects varied with concentration and duration (Table 2). In control treatments, maize grew the greatest (8.6 ± 1.71 cm), followed by barley (6.48 ± 0.37 cm) and beans (5.8 ± 0.84 cm). All were 100% growth. Barley, maize, and beans had 81%, 84.8%, and 86.2% control growth rates after 24 hours of 5 g/100 mL AE exposure. Radicle length was considerably reduced. Radicle elongation slowed after 72 hours of soaking at the same dosage. This shows phytotoxicity worsens with time. As extract concentration and treatment time rose at 10 and 15 g/100 mL, the radicle length decreased. After 72 hours of 15 g/100 mL AE exposure, barley radicle length decreased to 3.7 ± 0.34 cm (57.8%), maize to 5.9 ± 0.51 cm (68.6%), and beans to 3.7 ± 0.22 cm (63.7%). Barley was most sensitive, then beans. However, maize resisted aqueous leaf extract better.

Table 2: Effect of* A. lebbeck *leaf aqueous extracts on Radical Length (RL).

Treatments (Aqueous extract)	Selected crops					
	Barley		Maize		Bean	
	RL (cm)	% of RL	RL (cm)	% of RL	RL (cm)	% of RL
Control	06.48 ± 00.37	100	08.60 ± 01.71	100	05.80 ± 00.84	100
5g/24hrs	05.20 ± 00.33	81	07.30 ± 00.25	84.8	05.00 ± 00.25	86.2
5g/48hrs	05.00 ± 00.21	78	07.10 ± 00.41	82.5	04.90 ± 00.35	84.4
5g/72hrs	04.80 ± 00.13	74	06.90 ± 00.57	80.2	04.70 ± 00.28	81
10g/24hrs	04.60 ± 00.33	71	06.70 ± 00.32	77.9	04.60 ± 00.33	79.3
10g/48hrs	04.50 ± 00.25	70	06.60 ± 00.62	76.7	04.40 ± 00.29	75.8
10g/72hrs	04.30 ± 00.25	67.1	06.40 ± 00.56	74.4	04.20 ± 00.25	72.4
15g/24hrs	04.10 ± 00.23	64	06.20 ± 00.37	72	04.10 ± 00.21	70.6
15g/48hrs	03.90 ± 00.50	61	06.00 ± 00.29	69.7	03.9 ± 00.24	67.2
15g/72hrs	03.70 ± 00.34	57.8	05.90 ± 00.51	68.6	03.70 ± 00.22	63.7

The significant reduction in radicle development suggests that a water-soluble phytotoxic compound in *A. lebbeck* leaves impact early root formation. Radicles are more sensitive to allelochemicals than plumules because they contact the growing medium. They are susceptible to cell division, membrane integrity, and nutrient absorption issues. Phenolic substances and other secondary metabolites in *A. lebbeck* may impede root

meristem expansion by inhibiting mitotic activity. Allelochemicals reduce radicle length by solubilizing and increasing the accessibility of inhibitory compounds in the extract during extended soaking. To cope with stress, certain crops alter their metabolism, detoxify, and increase the permeability of their seed coverings. *A. lebbeck* leaf water extract strongly phytotoxic and allelopathically affects crop seedling radicle development (Lal & Biswas, 2023).

Influence of A. lebbeck *Bark AE on Plumule Length*

The aqueous bark extract of *A. lebbeck* significantly reduced barley, maize, and bean plumule length compared to the control group (Table 3). Untreated seedlings showed maize had the longest plumules (10.1 ± 1.17 cm), followed by barley (8.9 ± 0.56 cm) and beans (8.3 ± 0.21 cm). Bark AE slowed plumule growth concentration-dependently. Prolonged exposure at 5 g/100 mL reduced plumule length, suggesting plant damage. High extract concentrations (10 and 15 g/100 ml) reduced all crop development. Compared to the control group, barley, maize, and beans plummule length fell by 41.5%, 52.4%, and 60.2% after 72 hours of 15 g/100 mL suppression. Barley and maize were most sensitive to bark extract, whereas beans were more resistant. This suggests that *A. lebbeck* bark includes phytotoxic compounds that affect diverse species. Phenolics and other water-soluble inhibitory chemicals in the bark may reduce plumule length during seedling development by slowing cell proliferation and metabolic activities (Garnett et al., 2004). Longer soaking times increase inhibition, making phytotoxic chemicals easier to drain (Cui et al., 2023).

Table 3: Impact of* A. lebbeck *bark aqueous extracts on plumule length (PL).

Treatments (Aqueous extract)	Barley		Maize		Bean	
	PL (Cm)	% of PL	PL (Cm)	% of PL	PL (Cm)	% of PL
Control	08.90 ± 00.56	100	10.01 ± 01.17	100%	08.30 ± 00.21	100
5g/24hrs	05.90 ± 00.65	66.2	07.30 ± 00.24	72.2	06.70 ± 00.26	80.7
5g/48hrs	05.60 ± 00.36	62.9	07.10 ± 00.64	70.2	06.50 ± 00.21	78.3
5g/72hrs	05.40 ± 00.47	60.6	06.90 ± 00.41	68.3	06.30 ± 00.24	75.9
10g/24hrs	05.20 ± 00.32	58.4	06.70 ± 00.23	66.3	06.10 ± 00.37	73.4
10g/48hrs	04.90 ± 00.68	55	06.50 ± 00.62	64.3	05.90 ± 00.51	71
10g/72hrs	04.60 ± 00.28	51.6	06.20 ± 00.28	61.3	05.70 ± 00.32	68.6
15g/24hrs	04.30 ± 00.33	48.3	05.90 ± 00.73	58.4	05.50 ± 00.36	66.2
15g/48hrs	04.00 ± 00.30	44.9	05.60 ± 00.61	55.4	05.20 ± 00.23	62.6
15g/72hrs	03.70 ± 00.48	41.5	05.30 ± 00.27	52.4	05.00 ± 00.23	60.2

Impact of A. lebbeck *Bark Aqueous Extract on Radicle Length*

The aqueous bark extracts of *A. lebbeck* gradually, dose-dependently reduced barley, maize, and bean radicle length compared to the untreated group (Table 4). The longest radicles in untreated seedlings were seen in maize (8.6 ± 1.71 cm), barley (6.4 ± 0.37 cm), and beans (5.8

± 0.84 cm). All extracts dramatically slowed radicle growth. With prolonged exposure at 5 g/100 mL, root length decreased somewhat, suggesting phytotoxic effects. All crops showed higher radicle inhibition at 10 and 15 g/100 mL. After 72 hours at 15 g/100 mL, barley, maize, and beans had 64.8%, 76.7%, and 79.3% shorter radicles than the control group. Bark aqueous extract treatments worked best on barley, followed by maize. Beans tolerated more than other plants. Phytotoxins may directly affect radicle cell proliferation, elongation, and nutrient absorption during seedling growth. The radicle length decreases as concentration and soaking time increase, indicating that the water-soluble inhibitory compounds in *A. lebbeck* bark become more accessible. Due to their phytotoxicity, *A. lebbeck* bark residues or leachates may impede field crops' early root development (Liu et al., 2024).

Table 4: Impact of an aqueous bark extract from* A. lebbeck *on the radicale length (RL).

Treatments (Aqueous extract)	Barley		Maize		Bean	
	RL (cm)	% of RL	RL (cm)	% of RL	RL (cm)	% of RL
Control	06.40 ± 00.37	100	08.60 ± 01.71	100	05.80 ± 00.84	100
5g/24hrs	05.90 ± 00.33	91	08.00 ± 00.33	93	05.60 ± 00.23	96.5
5g/48hrs	05.70 ± 00.33	87.9	07.90 ± 00.31	91.8	05.50 ± 00.32	94.8
5g/72hrs	05.40 ± 00.49	83.3	07.80 ± 00.44	90.6	05.40 ± 00.16	93.3
10g/24hrs	05.20 ± 00.24	80.2	07.60 ± 00.49	88.3	05.30 ± 00.26	91.3
10g/48hrs	05.00 ± 00.48	77.1	07.40 ± 00.45	86	05.10 ± 00.30	87.9
10g/72hrs	04.90 ± 00.20	75.6	07.30 ± 00.20	84.8	05.00 ± 00.26	86.2
15g/24hrs	04.70 ± 00.30	72.53	07.10 ± 00.38	82.5	04.90 ± 00.28	84.4
15g/48hrs	04.50 ± 00.36	69.4	06.90 ± 00.29	80.2	04.80 ± 00.40	82.7
15g/72hrs	04.20 ± 00.30	64.8	06.60 ± 00.20	76.7	04. 60 ± 00.24	79.3

Impact of* A. lebbeck *Leaf Powdered Biomass on Stem and Root Length

The stem length of barley, maize, and beans is reduced to 09.70 (73.40%), 11.30 (76.30%), and 09.90 cm (79.20%) by a 5g dosage of *A. lebbeck* leaf powder. The stem height of beans was 09.70cm (77.6%), maize was 11.10cm (75.00%), and barley was 09.50cm (71.90%) at 10g. The rate of stem height inhibition accelerated at 15g. Barley stem development is limited to 09.30cm (70.40%), maize to 10.90cm (73.60%), and beans to 09.50cm (76.00%) when 15g of leaf powder is applied (Figure 1).

5g leaf powder reduced the length of barley roots by 09.10cm (81.20%), maize by 11.10cm (84.0%), and beans by 09.30cm (86.10%). At 10 g, the root length of barley was 09.00cm (80.30%), maize measured 10.90cm (82.50%), and beans reached 09.10cm (84.20%). At a concentration of 15g, the root length of barley was decline to 08.80cm (78.5%), 10.70cm (81.00%) maize, and bean root to 08.90cm (82.40%) (Figure 1). These findings showed that the test crop's stem and root length decreased as the dosage concentration increased, with barley being the

most successful crop, subsequent to maize and beans. The A. trifida was examined in relation to wheat crops in pot experiments. The analysis indicated that this weed generates various allelochemicals that negatively impact the plant development and dry weigh of the wheat plant (Kong et al., 2007).

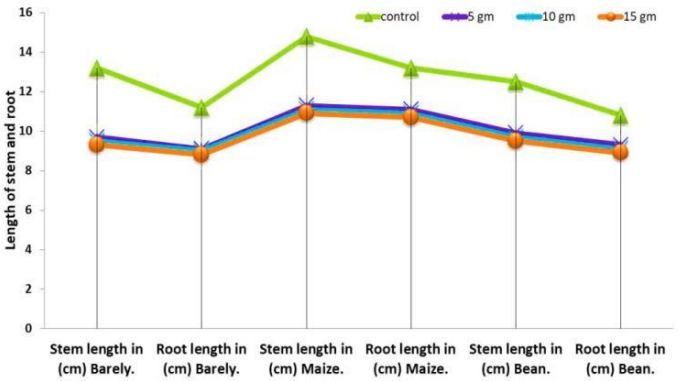

Figure 1: Effect of* A. lebbeck *leaf powder on test crop stem and root length.

Impacts of A. Lebbeck *Leaf and Bark Powder Biomass on Number of Roots*

A. lebbeck leaf powder declines the overall number of roots in barley to 08.90 (79.40%), in maize to 10.50 (83.30%), and in beans to 9.00 (86.50%). Barley's root number dropped to 08.70 (77.60%), maize to 10.30 (81.70%), and beans to 08.80 (84.60%) at 10g. For the investigated species, 15g reduces the total number of roots to 08.50 (75.80%), beans to 08.60 (82.60%), and maize to 10.10 (80.10%). The findings showed that although a lower concentration of powdered leaves has less of an impact; a larger concentration has a considerable impact on the quantity of roots. Barley was the most damaged crop, with maize and beans coming in second and third, respectively (Figure 2).

Effect of A. lebbeck *Leaf Powder Biomass on the Dry and Fresh Weight*

5g of *A. lebbeck* leaf powder reduces the fresh weight of beans to 08.03g, maize to 08.46g, and barley to 07.61g. The fresh weight of barley, maize, and beans is reduced by 10g to 07.45, 08.27, and 07.91g, respectively. Barley weighed 07.28g, maize weighed 07.91g, and beans weighed 07.74g at a dose of 15g.

The dry biomass of beans is decline to 06.41g, maize to 06.70g, and barley to 05.90g with 5g of leaf powder. 10g affects the dry weight of beans to 06.27g, barley to 05.71g, and maize to 06.54g. The dry biomass of beans dropped to 06.11g, maize to 06.23g, and barley to 05.56g with

15g. Figure 3 show that 15g of leaf powder has a stronger inhibitory impact than 5g and 10g.

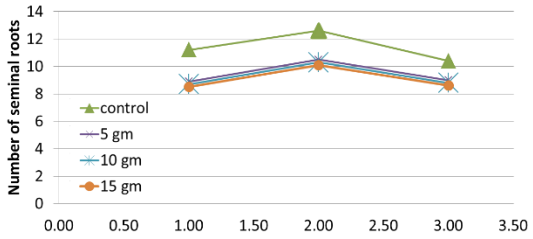

Figure 2: Impact of* A. lebbeck *leaf powder on the root number of selected crops.

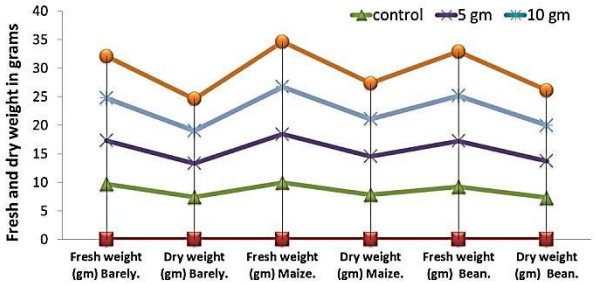

Figure 3: Impact of* A. lebbeck *leaf powder on the dry and fresh biomass of test crops.

Effect of* A. lebbeck *Bark Powder Biomass on Stem and Root Growth

5g of *A. lebbeck* bark biomass reduces the height of barley stem to 10.10cm, maize to 11.90cm, and bean to 10.50cm. At 10g, the barley stem height was 09.90cm, the maize stem height was 11.70cm, and the bean stem height was 10.30cm. The application of bark powder of 15g restricts the growth of barley stems to a maximum length of 09.70cm, maize to 11.40cm, and beans to 10.1cm. 5g of bark powder reduced the length of barley roots by 09.50cm, maize by 11.50cm and bean by 09.80cm. At 10 g, the root length of barley was 09.30cm, maize was 11.30cm, and bean reached 09.60cm. At 15g, the barley root length decreased to 09.10cm, maize to 11.20cm, and bean root to 09.40cm (Figure 4). The results indicated that an increase in dose concentration led to a reduction in the root and stem length of the selected plants (Rajala & Peltonen-Sainio, 2001), however, the most productive crop was barley, which was followed by maize and beans.

Influence of A. lebbeck *Bark Biomass on Number of Roots*

Application of *A. lebbeck* 5g bark biomass reduced the root numbers to 09.10 in barley, 11.10 in maize, and 09.50 in beans. At 10g, the root numbers in barley declined to 08.90, 10.90 maize, and beans to 09.30. Similarly, the influence of 15g induced, whereas the root numbers were decline up to 08.70, 10.70 for maize, and 09.10 for beans. The results indicated that a maximum bark dose has significantly affects the root number compared to a lower dose. The most affected crops were barley, followed closely by bean and maize (Figure 5). The impact of A. nilotica leaves were examined in field experiments on P. sativum, showed the results indicate that A. nilotica synthesis a phenolic compound that affects length of plumule, root quantity, chlorophyll content, and sugar levels (Al-Wakeel et al., 2007).

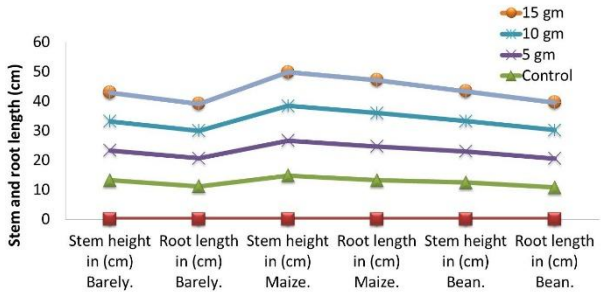

Figure 4: Impact of* A. lebbeck *bark powder on the stem and root lengths of tested crops.

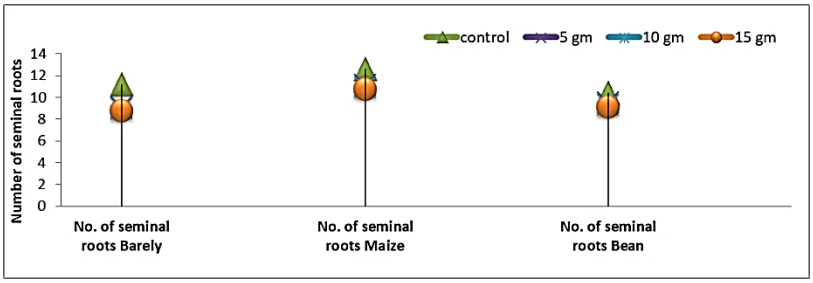

Figure 5: Impact of* A. lebbeck *bark powder on the quantity of seminal roots in test crops.

Effect of A. lebbeck *Bark Biomass on Fresh and Dry Biomass*

5g of *A. lebbeck* bark powder diminishes the fresh biomass of barley to 07.96g, maize to 08.81g, and beans to 08.44g. A dosage of 10g declines the fresh biomass of barley to 07.86g, maize to 08.64g, and beans to 08.26g. At 15g, the fresh biomass of barley is 07.63g, maize is 08.35g,

and beans are 08.11g. 5g of bark powder also decline the dry biomass of barley to 06.05g; maize is decline to 06.92g, and beans to 06.68g. A 10g application lowers the dry biomass of barley to 05.97g; maize is decline to 06.77g, and beans to 06.52g. With 15g, the dry biomass of barley is decline to 05.76g, maize is to 06.50g, and beans are reduced to 06.39g. The inhibitory effect of 15g bark powder surpasses that of 5g and 10g (Figure 6).

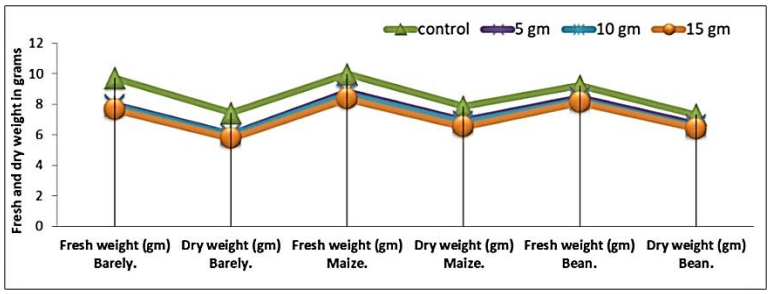

Figure 6: Impact of* A. lebbeck *bark powder on the fresh and dry weights of test crops.

Impacts of A. lebbeck *on Leaf and Bark Biomass on Chlorophyll a Content*

A 5g dose of *A. lebbeck* leaf biomass decline the chlorophyll "a" content to 01.73 mg/mL for the leaf, 02.68 mg/mL for maize, and 02.13 mg/mL for bean. *A.lebbeck* 10g of leaf powder decline chlorophyll a content to 01.56 mg/mL, maize to 02.51 mg/mL, and bean to 02.05 mg/mL. 15g of leaf decline chlorophyll a content in barley to 01.39 mg/mL, in maize to 02.28 mg/mL, and in bean to 01.97 mg/mL. The findings showed that, in comparison to lower concentrations, a greater leaf doses significantly impacted the quantity of chlorophyll a (Figure 7). In test crops including wheat and maize, leaf extracts from guava, eucalyptus, and litchi had a negative influence on length of radical, plumule size, and seed germination. Compared to the other two species, eucalyptus has a greater allelopathic potential. As extract concentrations rise, the inhibitory impact intensifies (Zhao et al., 2019; Ahmad et al., 2023).

A. lebbeck bark powder (5g) declines the quantity of chlorophyll an in barley to 10.98, corn to 3.00, and beans to 02.45 mg/mL. Chlorophyll a concentration was lowered by 10g of *A. lebbeck* bark to 01.86 in maize, 2.86 in beans, and 2.33 in beans. Chlorophyll a concentration was decline by 15g of bark to 01.79 in barley, 02.72 in maize, and 02.23 in beans. The findings showed that, in comparison to a lower concentration, a greater leaf concentration had a substantial impact on chlorophyll a content (Figure 8).

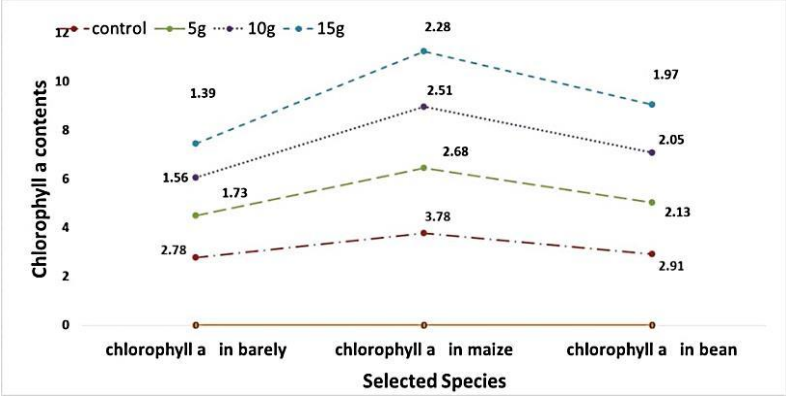

Figure 7: Influence of leaf powder of A. lebbeck on chlorophyll a content of test crop species.

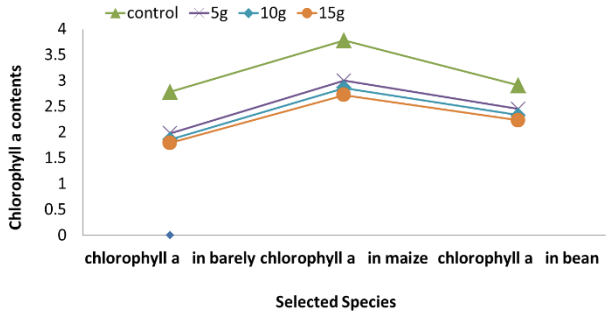

Figure 8: Impact of* A. lebbeck *bark powder on chlorophyll a level in crop species.

Effect of Leaf and Bark Powder Biomass of A. lebbeck *on Chlorophyll b Contents*

A 5g dose of leaf powder from *A. lebbeck* resulted in a chlorophyll b content of 01.99 in the control group, 02.90 in maize, and 2.41 mg/mL in beans. 10g of *A. lebbeck* leaves decline chlorophyll b content to 01.82 in maize, 02.76, and 2.32 mg/mL in beans. The chlorophyll b content in 15g of leaf was measured at 01.73 for the leaf sample, 02.55 for maize, and 02.15 mg/mL for bean. The results indicated that a maximum dose of leaf had a greater influence on chlorophyll b compared to a lower dose (Figure 9). Extracts of P. oleracea were isolated from both root and leaf tissues. The extracts were analyzed for their influence on C. pepo. The extracts and rhizoshperic fungi demonstrated inhibitory effects on protein, chlorophyll a, chlorophyll b, and carotenoids (Shahid et al., 2026). Additional research indicates that leaf extracts exhibit a greater effect than root extracts (Voko et al., 2022).

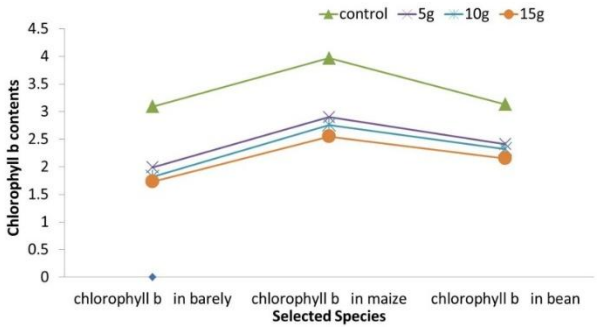

Figure 9: Impact of* A. lebbeck *leaf powder on chlorophyll b levels in test crop species.

The dosage of chlorophyll b in barley, maize, and beans decreased to 02.23, 03.18 (80.1%), and 02.66 mg/mL at treatment of 5g of *A. lebbeck* bark powder was added. In maize, the amount of chlorophyll b is reduced to 02.11, 03.02, and 02.55 mg/mL at treatment of 10g of *A. lebbeck* bark. 15g of bark declined the quantity of chlorophyll b in barley to 2.00 of control, in maize to 02.87, and in beans to 02.41 mg/mL. The results demonstrated that higher amounts of bark had a stronger impact on the quantity of chlorophyll b than did lesser amounts (Figure 10).

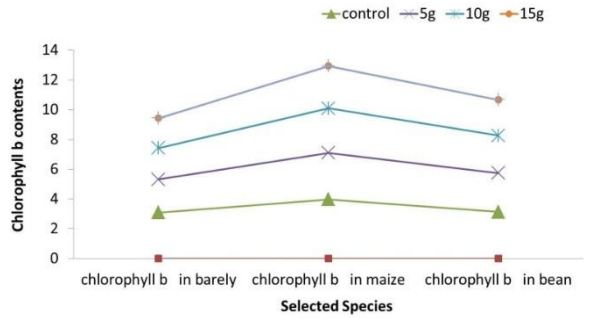

Figure 10: Impact of* A. lebbeck *bark powder on chlorophyll b levels in test crop species.

Influence of A. lebbeck *Leaf and Bark Biomass on Proline Concentrations*

The application of 5g *A. lebbeck* leaf biomass induced the proline level of 01.03 in barley, 01.53 in maize, and 01.42 mg/mL in beans. The proline content measured in 10g of *A. lebbeck* leaf was 1.21 mg/mL, while maize exhibited a level of 1.69 mg/mL, and beans recorded 1.59 mg/mL. The proline content increased to 1.39 mg/mL in leaf samples of 15g, while maize reached 1.87 mg/mL and beans attained 1.75 mg/mL. The findings

showed that proline concentration was more affected by a higher leaf treatment than by a lower one (Figure 11). *N. plumbaginifolia* leaf extracts were made and evaluated against *S. viridis*, *C. album*, *S. sophera*, and *S. tora*. *N. plumbaginifolia* has antagonistic properties against particular weeds in the field, as shown by the extracts' reduction of chlorophyll, protein, carbohydrate, and proline concentration (Mushtaq et al., 2020).

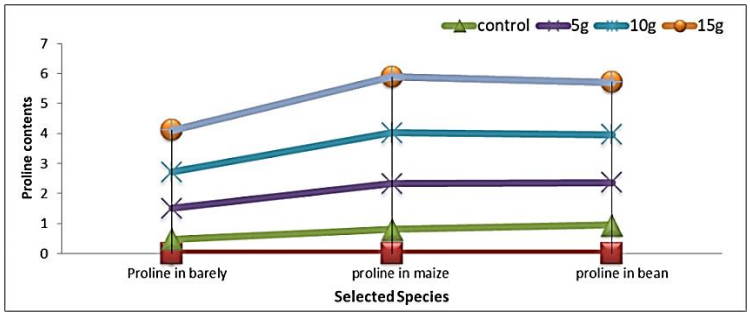

Figure 11: Impact of* A. lebbeck *leaf powder on proline levels in test crop species.

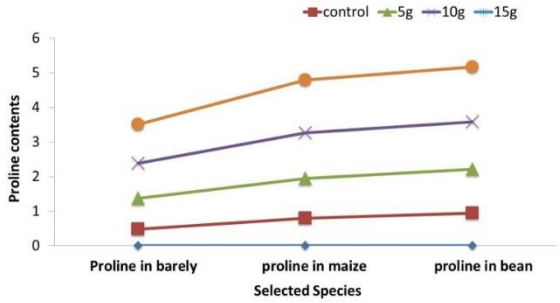

Figure 12: Impact of* A. lebbeck *bark powder on proline levels in test crop species.

The application of 5g of bark powder from *A. lebbeck* resulted in proline content increases of 0.71 mg/mL in maize, 0.97 mg/mL in beans, and 1.13 mg/mL in other legumes. 10g of *A. lebbeck* bark elevated proline content to 0.90 mg/mL in maize and 1.12 mg/mL in beans, reaching 1.21 mg/mL. The application of 15g of bark resulted in a proline content increase to 1.01 mg/mL in maize, 1.27 mg/mL in beans, and 1.44 mg/mL in other legumes. The findings showed that proline content was more significantly impacted by greater bark concentration than by lower levels (Figure 12 above). The impact of S. arvensis aqueous extracts on the B. napus plant was investigated. According to the research, this plant generated allelochemicals that raise proline levels while decreasing

carbohydrate, protein, and chlorophyll a and b levels (Hadadchi & Masoudi, 2006; Chen et al., 2015).

Conclusion

The pots experiments showed that *A. lebbeck* aqueous extracts and powder biomass has adversely affected the plumule, radicale, number of roots, shoot length, root length, fresh and dry biomass of barley, maize, and bean. Lower dosages and shorter soaking intervals are also regarded to have less allelopathic potential, whereas greater extract levels and longer soaking times boost effectiveness. *A. lebbeck* leaf, root, and bark extracts impact proline and chlorophyll a and b in barley, maize, and bean, whereas the leaf extract boosted proline concentration more than the bark extracts, although it had a stronger effect on chlorophyll a and b. *A. lebbeck* tree plantings near or within field crops should be avoided, according to this study, and it's crucial to understand the allelochemicals and their mechanisms of action. Further research is required to determine the allelochemicals and mode of action of the *A. lebbeck* tree. It is also essential to examine how *A. lebbeck* affects different types of agronomic crops. In order to boost agricultural productivity, it is also essential to assess all crops that show resistance to the allelochemicals of the *A. lebbeck* plant.

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