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Study the impact of *Tecoma stans* (L.) Juss. ex Kunth leaf extract on weed control and growth of ornamental plant *Gerbera jamesonii* B

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Abstract

One significant medicinal plant in the Bignoniaceae family is *Tecoma stans.* The study was carried out in the greenhouse of the National Research Centre, Giza, Egypt in two pot experiments. The experiments were to investigate the effect of aqueous fresh leaf extract of *Tecoma stans* plant on the two weeds *Amaranthus viridis* (broad leaf weed) and *Echinochloa colonum* (grassy weed) growth associated *Gerbera jamesonii* plants during 2022 and 2023. Spraying the leaf water extract of *T. stans* at concentrations 5, 10, 20 and 30% caused significant reduction in the fresh and dry weight of the two weeds. The reduction in fresh and dry weight of the two weeds reached maximum with spraying the leaf water extract of *T. stans* at 30%. The weed growth inhibitions were concomitant with increase in the growth and flowering of *Gerbera jamesonii.* Qualitative examination of *T. stans*' leaf extract for secondary metabolites revealed the presence of alkaloids, tannins, phenols, flavonoids, carbohydrates and saponins. When *T. stans* leaf extract was fractionated by sephadex LH-20 column and applied to TLC glass sheetsseven flavonoids and seven phenolic acids were separated. Our work plainly indicated that the water extract of *T. stans* can be a promising as bioherbicide for weed management and good effect on growth of ornamental plant *Gerbera jamesonii.*

Keywords: *Tecoma stans*, *Gerbera jamesonii*plant, *Amaranthus viridis and Echinochloa colonum* weeds, TLC chromatography (Thin Layer Chromatography), sephadex LH-20.

1. Introduction

The biggest family of blooming plants, it ranks fourth among cut flowers according to global floriculture trends and is one of the ten most popular cut flowers worldwide [1,2]. Because of its cut flower's lovely inflorescence, appealing colour, extended vase life, and suitability for long-distance transportation, gerbera (*Gerbera jamesonii*) is a high-value crop [3,4]. Gerbera flowers come in a wide variety of colours and shapes. When submerged in water, the sliced sprouts maintain their freshness for a fair amount of time. [5]. Due to its wide range of colours, this flowering plant is a popular choice for cut flowers because of its extended vase life and herbaceous borders, bedding, and pots in gardens [3, 4]. It is a popular cut flower in Holland, Germany, and the United States [2]. Grown in gardens, flower beds, pots, borders, dish gardens, and rock gardens are local and improved cultivars. Flowers come in solitary, semi-double, or double forms and come in a variety of colours, including white, cream, yellow, pink, orange, crimson, salmon, maroon, and brick red. Hence, expanding export and marketing [6]. Since *Gerbera jamesonii* is a valuable economic plant, weeds that hinder its growth must be controlled. So, increasing marketing and export [6]. From point of view, *Gerbera jamesonii* is important economic plant, so must control weeds that affect its production.

Serious problems that affect negatively economic crop yield are different weeds that associate these crops. These weeds compete for water, light, nutrient uptake. Efforts were made by researchers for overcoming these problems by controlling these weeds using herbicides [7] or alternative by natural compounds extracted from some plants [8].

Tecoma stans (L.) Juss. Ex Kunth is a species related to the Bignoniaceae family, known commonly as yellow bells, yellow elder, and trumpet flower. Several workers found that *Tecoma stans* has natural compounds that have biological activities [9,10,11]. Using herbicides for long time create herbicide-weed resistant beside unsafe environment [11]. So, alternative natural compounds (allelochemicals) that found in some plant extracts were used which called allelopathy [13].Cipriani *et al.*

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[14] reported that *Tecoma stans*' aqueous leaf extract significantly inhibited lettuce germination and decreased the root development of alfalfa and lettuce seedlings by 75% and 30%, respectively. It also resulted in modifications to the micromorphology of the root apex of the lettuce seedlings.

Germination and radicle length of green gram were reduced by the dry leaf extract of *Tecoma stans* at different concentrations [15]. The authors also cited significant reduction in activities of protein, the enzymes, amylase, invertase and protease and the reduction increased with increasing dry leaf extract concentrations. *T. stans* contain alkaloids, amino acids, phytosterols, monoterpenes, triterpenes, glycosides, phenols, tannins, saponins, and flavonoids, in leaves, roots, flowers, fruits, bark and seeds [16, 17, 18, 19, 20].

In continuous work on the natural plant extracts for controlling weeds associated target plants, the current study aimed to evaluate the effect of natural extract of *Tecoma stans* on the weeds associated *Gerbera jamesonii* and its effect on its growth.

2. Material and Methods

At the National Research Center in Cairo, Egypt, the experiment was conducted over the course of two consecutive seasons, 2022 and 2023, which started in March 2023 and finished in August of the same year. Commercial nurseries at the Horticulture Research Institute, Agriculture Research Center, Giza, provided the gerbera seedlings. Plant seedlings grown in 60 cm diameter plastic pots were planted in 10 kg of weed-infested loamy sand soil [21]. There was one gerbera plant in each pot. Every 21 days after planting, 3 g of krystalone (NPK at 18:18:18) fertilizer was added to the soil three times. After removing any additional weeds that might have been present, it was discovered that *Amaranthus viridis*, a broad leaf weed, and *Echinochloa colonum*, a grassy weed, predominated.

Soil properties physical and chemical analysis of the experimental soil according to Jackson [22].The experiment consisted of six treatments including healthy plants (weed free), unweeded plants and the fresh leaf extract of *Tecoma stans* at 5, 10,20 and 30% concentrations. The experimental design was arranged in a complete randomized block design (CRBD) contained three replicates as each replicate consisted of three pots. The fresh leaf extract of *Tecoma stans* at the different concentrations was sprayed two times 15 and 22 days after Gerbera planting.

2.1 Plant material

2.1.1 Preparation of the extracts

The collected leaves of *Tecoma stans* were washed then dried. 20 g amount of plant material was extracted by deionized water. Also 10 g amount of plant material was extracted by 80% v/v methanol: water. The resulting extracts were pulled and concentrated using rotary evaporator at 70°C done under pressure. The extracts were freeze-dried to obtain the powdered form of the *Tecoma stans* leaves. Preparing *Tecoma .stans* leaf extract concentration at 5, 10 , 20 and 30 % was done.

2.1.2 Chemical analysis and qualitative phytochemicals screening

Secondary metabolites such as alkaloids, carbohydrates, tannins. saponins, flavonoids and phenolic compounds in aqueous and methanolic leaves extracts of *T. stans* were tested through the preliminary phytochemical studies using different standard tests [23]**.**

a. Determination of total phenolic content

With slight adjustments, the Folin-Ciocalteu (FC) method [24] was used to determine the total phenolic content. 0.5 ml of *Tecoma*stans leaf extract and 0.5 ml of Folin-Ciocalteu reagent were combined. After 7 mins, 2ml of a 7.5% sodium carbonate solution were added. The absorbance was measured at 725 nm after 30 mins. The standard utilized was gallic acid

b. Determination of total flavonoid content

The aluminium chloride colorimetric assay method according to Chang*et al*. [25]. Four milliliters of distilled water were mixed with one hundred microliters of extract. 0.3 millilitre of 5% sodium nitrite was then added. 0.3 ml of 10% aluminium chloride was added after 5 minutes. After 6 minutes, 2 millilitres of 1 M sodium hydroxide were added to the blend. At 510 nm, the absorbance was measured. The extract's total flavonoid content was reported as mg/g catechin equivalents per gram of material.

c. Scavenging of hydrogen peroxide

Ruch *et al*. technique [26] was used to assess the scavenging properties of hydrogen peroxide in the methanol and water extracts of *Tecoma stans* leaves. A hydrogen peroxide solution (40 mM) was made in phosphate buffer (pH 7.4). In distilled water, extracts (100 µg/mL) were added to a 0.6 mL, 40 mM hydrogen peroxide solution. Ten minutes later, the absorbance of hydrogen peroxide at 230 nm was measured against a blank.

The following formula was used to estimatethe percentage of scavenging H_2O_2 in the both extracts aqueous and methanolic extracts.

As a percentage of H_2O_2, % (H_2O_2) = $[(A_0 - A1)/A_0 \times 100]$, where A_0 represents the control absorbance and A1 represents the *Tecoma stans* extract absorbance. For every batch, samples were run in triplicate and averaged.

d. Fractionation of methanolic extract of *Tecoma stans* leaves by sephadex LH-20.
Fractionation of methanolic extract of *T. stans* leaves over sephadex LH-20 column (1.5 X 30 cm) was done by using ethanol (80%) as eluates tannins adsorbed to the sephadex LH-20 beads, [27] and phenolic compounds (phenolic acids and flavonoids) were filtered and collected in fractions.

f. Thin-layer chromatography
On TLC glass sheets covered with 0.25 mm layers of silica gel 60 F_{254}, TLC was carried out. following the application of standard solutions (phenolic acids and flavonoids) and isolated fractions. Spraying the sheets with 1% methanolic diphenylboryloxyethylamine and then 5% ethanoic polyethylene glycol 4000 allowed the flavonoids and phenolic acids to be visible. Under UV illumination at l=366 nm, the chromatograms were assessed; flavonoids showed up as orange-yellow bands and phenolic acids as blue, fluorescent bands [28].

2.2. Data recorded

a. Weeds

Associated weeds, *Amaranthus viridis* (broad leaf weed) and *Echinochloa colonum* (grassy weed) were collected from each pot at the end of the season (Gerbera flowering), the fresh and dry weight of grown weeds were recorded.

b. *Gerbera jamesonii* growth and flowering
Growth parameters were recorded asplant height (cm), numbers of leaves/plant, fresh and dry weights of leaves (g/plant) and roots (g/plant), flowering measurements were taken at the end of the season for the following parameters: 1- number of flowers/plants, length of flower stalk (cm), flowers diameter (cm), flower stalk thickness (mm),fresh weight of flower and stalk (g/plant).

2.3.Chemical analysis of *Gerbera jamesonii* leaves

a-Photosynthetic pigments
Chlorophylls a, b and carotenoids were estimated in aqueous fresh leaves (mg/g) at flowering stage according to the producer described by Moran [29].

b- Total carbohydrate content
Carbohydrate content was determined in finely ground leaves (powdered) at flowering stage according to Dubois et al. [30].

c. Macro- and microelements content
The standard and customized methods of analysis were used to determine the macro and micro components present in dried leaves during the flowering stage [31].

d. Determination of antioxidant enzymes activity
Enzyme extraction was done in fresh leaves as described by Mukherjee and Choudhuri [32]. Kar and Mishra technique [33] was used to calculate the catalase (CAT) activity. By tracking the drop in absorbance at 240 nm in 50 mM phosphate buffer (pH 7.5) with 20 mM H_2O_2, the CAT activity was determined. The quantity of enzyme that consumed 1 µmol H_2O_2 min^{-1} was the definition of one unit of CAT activity. Marklund method [34] was used to measure superoxide dismutase activity (SOD) by measuring the enzyme's reduction in the optical density of nitro-blue tetrazolium dye. At 560 nm, the absorbance was measured. The amount of enzyme that caused the absorbance reading to drop to 50% was determined to be one unit of enzyme activity. Guaiacol peroxidase (GPX) activity was measured according to the Bell *et al*. [35] method. The rise in absorbance at 470 nm for 70 s was used to measure the activity of GPX enzyme. The reaction mixture included 100µl plant extract, 25mM guaiacol, 10mM H_2O_2, and 50mM potassium buffer (pH 7.0).

2.4. Statistical analysis
The obtained data were statistically analysed according to Snedecor and Chochran [36] using the L.S.D. values at 5% level and averages were compared between means.

3. Results

3.1. Weeds
Table (1) reveals significant inhibition in the fresh and dry weight of *Amaranthus viridis* and *Echinochloa colonum* in comparison to the control with using *T*ecoma *stans* aqueous leaf extract at the applied concentrations (5, 10, 20 and 30%). The inhibition in both two weed growth increased with the concentration increase. Therefore, the reduction in*A. viridis* and *E. colonum*in pots sprayed with 30% *T. stans* extract recorded the highest significant reduction in comparison to the untreated control. The reduction in *A. viridis* and *E. colonum* reached 45.87 and 45.38% of untreated control. It is worthy to mention that reduction in the two weed dry weight caused by spraying 20% of *T. stans* was non-significant with that caused by 30%.

Table 1: Effect of *Tecoma stans* leaf extract on the fresh and dry weight of *Amaranthus viridis* (broadleaf weed) and *Echinochloa colonum* (grassy weed) [Average of the two seasons] .

Treatments	F.W. Narrow(g/pot)	D.W. Narrow (g/pot)	F.W. Broad (g/pot)	D.W. Broad (g/pot)
Weed Free plants	0.00 e	0.00 d	0.00 e	0.00 e
Unweeded	20.56 a	6.61 a	57.26 a	11.75 a
5%	16.11 b	5.01 b	40.26 b	9.56 b
10%	13.40 c	4.19 c	31.72 c	7.63 c
20%	11.65 d	3.74 c	26.22 d	6.65 d
30%	11.00 d	3.61 c	24.74 d	6.36 d
LSD at 5%	1.46	0.58	2.65	0.66

3.2. *Gerbera jamesonii*

3.2.1Vegetative growth

The results in Table (2) recorded significant increase in plant height of *G. jamesonii* due to spraying *T. stans* leaf extract at all concentrations (5, 10, 20 and 30%) as compared to the unwedded control reaching maximum value at 30%. Similar trends were recorded in number of leaves/plant, fresh and dry weight of leaves/plant. The least significant difference was found with spraying 5% *T. stans* leaf extract. Both the fresh and dry weight of the root/plant recorded the highest significant increase by 30% of *T. stans* treatment.

Table 2: Effect of *Tecoma stans* leaf extract on the different morphological characters of *G. jamesonii* (Average of the two seasons).

Treatments	Plant height (cm)	No. leaves	Fresh wt. leaves (g/plant)	Dry wt. leaves (g/plant)	Fresh wt. root(g/plant)	Dry wt. of root(g/plant)
Weed Free plants	39.32 ab	24.40 ab	96.91 b	28.45 b	28.30 b	7.58 c
Unweeded	30.13e	13.67e	24.50d	5.21d	15.25c	4.63c
5%	33.80d	16.67d	35.83c	10.53c	19.35d	4.81c
10%	35.33cd	20.33c	45.51c	13.42bc	24.41c	7.08b
20%	37.33bc	23.00b	60.33b	16.82b	27.35b	8.99a
30%	40.50a	25.33a	101.53a	30.60a	30.40a	14.74ab
LSD at 5%	2.64	2.03	9.94	3.44	1.97	1.83

3.2.2 Flowering

Table (3) show that the number of flowers increased significantly over unweeded controls with spraying 30% *T. stans* leaf extract, the increase caused by 5, 10 and 20% was non-significant. The thickness of flower stalk showed significant increase over unweeded control at both concentrations 20 and 30% of *T.stans* leaf extract. In addition, the results reveal significant increases in length of flower stalk, flower diameter, fresh weight of flower and stalk over their corresponding unweeded controls with all concentrations of *T. stans* leaf extract. The increase was maximum at 30%.

3.2.3. Chemical analysis of *Gerbera jamesonii*

a. Photosynthetic pigment contents

Table (4) show that chlorophyll a in leaves of *G. jamesonii* increased over the unweeded control by spraying *T. stans* leaf extract at 10-30% reaching maximum content with 30%. Chlorophyll b and carotenoids increased significantly over the unweeded control with using 20 and 30% of the tested extract.

Table 3: Effect of *Tecoma stans* leaf extract on flowering components (Average of the two seasons)

Treatments	No flowers	Flower diameter (cm)	Flower stalk thickness (mm)	Flower stalk length (mm)	F. W. of flowers and stalk/plant (g/plant)
Weed Free plants	3.87a	9.22a	4.34a	50.67a	10.26 c
Unweeded	1.67b	6.77c	3.37b	32.43c	7.83 d
5%	1.33b	5.00d	3.37b	36.67bc	11.04 bc
10%	1.33b	6.50cd	3.90b	38.53b	11.51 ab
20%	2.00b	9.27b	3.67b	39.53b	11.83 ab
30%	4.67a	11.85a	6.87a	53.47a	12.23 a
LSD at 5%	1.49	1.64	0.73	5.38	0.83

b. Carbohydrates content

The results in Table (4) indicate increasing in carbohydrates content in leaves of *G. jamesonii* with using all concentration of *T. stans* leaf extract as compared to the unweeded control. This increase was observable at 30% of the extract.

Table 4: Effect of *Tecoma stans* leaf extract on photosynthetic pigment contents in leaves of *G. jamesonii*

Treatments	Chlorophyll-a (mg /g F.W)	Chlorophyll- b (mg /g F.W)	Carotenoids (mg /g F.W)	Carbohydrate %
Weed Free plants	0.933 a	0.273 a	1.613 c	29.633 b
Unweeded	0.664 b	0.235 a	1.572 c	22.336 f
5%	0.688 b	0.252 a	1.633 bc	25.086 e
10%	0.892 ab	0.260 a	1.656 bc	27.726 d
20%	0.932 a	0.268 a	1.816 ab	28.693 c
30%	1.003 a	0.272	1.890 a	31.580 a
LSD at 5%	0.218	0.028	0.174	0.709

c. Macro- and micro-elements content

Spraying water leaf extract of *Tecoma stans*at 5-30% increased the content of Fe, Mn, Cu, Zn, P and K in leaves of *G. jamesonii*over that of unweeded plants (Table 5). Microelement content (Fe, Mn, Cu, Zn) was accumulated mostly in leaves of *Gerbera jamesonii* sprayed with leaf water extracts of *T. stans* (30%) ascompared to the unweeded plants. In addition, marked increase in microelements (P and K) was measured in leaves of *G. jamesonii* over that in the unweeded control with using leaf extract of *T*ecoma *stans* at 30%.

Table 5: Effect of *Tecoma stans* leaf extract on micro and macro nutrient contents in leaves of *G. jamesonii*

Treatments	Microelements			Macroelements		
	Fe%	Mn%	Cu%	Zn%	P%	K%
weed free Plant	90.0	82.0	8.5	17.0	0.99	1..84
Unweeded	66.0	43.5	5.0	12.8	0.86	1.54
5%	99.0	67.2	8.2	14.1	0.96	2.23
10%	75.0	59.2	6.2	13.0	0.49	3.31
20%	93.0	62.3	8.0	15.2	0.68	2.22
30%	157.3	82.5	9.0	17.1	1.01	1.99

d. Antioxidant enzymes activity

Determination of antioxidant enzymes,GPX (guaiacol peroxidase), SOD (superoxide dismutase) and catalase in *G. jamesonii* leaves reveal increase in these enzyme activities over that of unweeded control with spraying *T. stans* leaf extract. Marked increases were determined with using 30% of the *T. stans* leaf extract (Table 6).

Table 6:Effect of *Tecoma stans* leaf extract on some antioxidant enzymes in *G. jamesonii*

Treatments	Enzymes		
	GPX (mU/ml)	SOD (U/mi)	Catalase (U/L)
Free	0.23	71.97	1.93
Unweeded	0.05	50.33	0.57
5%	0.06	59.31	0.68
10	0.05	75.97	0.94
20%	0.06	77.81	1.29
30%	0.10	83.33	2.58

3.3. Qualitative phytochemical analysis of the leaf extract of *Tecoma stans*

Qualitative estimation of the aqueous and methanolic leaf extracts of *T. stans* reveal the presence of alkaloids, flavonoids, tannins, phenols, coumarin and carbohydrates in both aqueous and methanolic extracts. The results reveal the presence of saponins in the methanolic extract (Table 7).

Table 7: Phytochemical evaluation of powdered aqueous and methanolic leaf extracts of *Tecoma stans*

Allelochemicals / Tecoma extract	**Alkaloids**	**Flavonoids**	**Saponins**	**Tannins**	**Phenols**	**coumarin**	**Carbohydrates**
Aqueous	+	++	-	+	++	+	++
Methanol	++	+++	++	++	+++	+	++

+++ Strong; ++ medium; + poor; - absence.

a. Quantitative estimation of total phenolic and flavonoids contents and their antioxidant activity (TAA%).

Table (8) show that the leaf of both aqueous and methanolic extracts contain phenolic acids, flavonoids that were higher in methanolic extract. Also antioxidant activity was higher in methanolic extract.

Table 8: Totalphenolic and flavonoid contents of aqueous and methanolic leaf extracts of *Tecoma stans* and their antioxidant activity as TAA%.

Extract	Total phenolic acid	Total flavonoids	TAA%
Aqueous	30.2 ± 0.4	19.6 ± 0.3	46.59±1.9
Methanolic	60.5 ± 0.52	35.5 ± 0.22	80.9±1.2%

All values are mean ± SD of three replicates; GAE: Gallic acid equivalents;CE: (+)-catechin equivalent and TAA%, total antioxidant activity.

b. Fractionation of methanolic extract of *Tecoma stans* leaves by sephadex LH-20.

Fractions were eluted from sephadex LH-20 column.Three ml of eluents were collected in 30 test tubes. First 30 ml was discarded, and then the rest of eluents divided into three fractions and qualitatively tested for presence of flavonoids and phenolic acids (Table 9).

Table 9: Qualitative screening of phenolic compound in three fractions

Fractions	Polyphenolic compounds
I	++
II	+++
III	+++

+++ Strong; ++ medium

c. TLC analysis (Thin Layer Chromatography)

Data set of *Rf* values of flavonoids and phenolic acids identified in the methanolic leaf extract of *Tecoma stans* fractionated by sephadex LH-20 column, Fig (1) and Table (10).

Seven flavonoids and seven phenolic acids were identified in the three separated fractions. Seven phenolic acids were identified as ferulic acid, caffeic acid and chlorogenic acid, gallic acid, vanillic acid, cinnamic acid and p-coumaric acid, while the investigated flavonoids were catechin, rutin, hesperidin, kaempferol, naringin, apegenin and quercetin.

Studies on the plant leaves, roots, flowers, seeds and fruits of *T. stans* have been indicated to have chemical components such as alkaloids, amino acids, phytosterols, monoterpenes, triterpenes, glycosides, phenols, tannins, saponins, and flavonoids [37]. These chemical components were proved by many workers to have allelopathic properties [38, 39, 40, 41, 42].

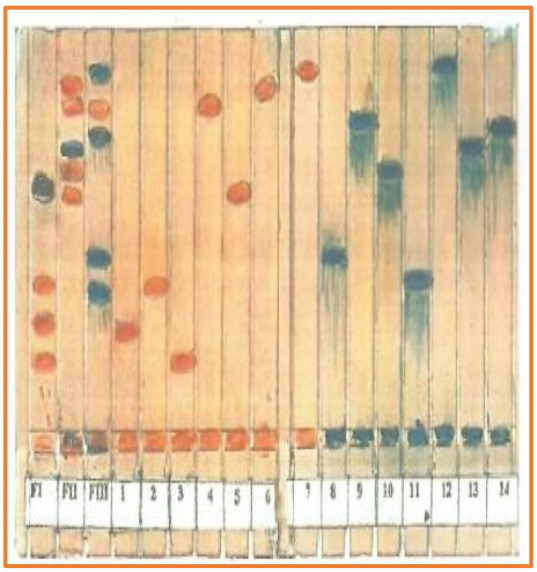

Fig. 1. TLC chromatogram of the investigated three fractions of the leaf methanolic extract of *Tecoma stans* eluted from sephadex LH-20.

Table 10. *Rf* and color of spots of the investigated fractions

Spots	*Rf*	UV light at l=366 nm	Compound
Fraction I	0.22	Yellow-orange band	Catechin
	0.3	Yellow-orange band	Rutin
	0.4	Yellow-orange band	Hesperidin
	0.64	Blue fluorescent band	Chlorogenic acid
Fraction II	0.87	Yellow-orange band	Kampefrol
	0.62	Yellow-orange band	Naringin
	0.88	Yellow-orange band	Apegenin
	0.92	Yellow-orange band	Quercetin
Fraction III	0.74	Blue fluorescent band	p-Coumaric acid
	0.48	Blue fluorescent band	Ferulic acid
	0.79	Blue fluorescent band	Caffeic acid
	0.4	Blue fluorescent band	Gallic acid
	0.98	Blue fluorescent band	Vanillic acid
	0.7	Blue fluorescent band	Cinnamic acid

4. Discussion

In this study *T*ecoma *stans* leaf extract caused high significant reduction in the fresh and dry weight of *A. viridis* and *E. colonum* as compared to the unweeded control (Table 2). The reduction in plant growth by *T. stans* was documented by Cipriani *et al*. [14] on lettuce, Bhat and Yogamoorthi [15] on greengram. Analysis of leaf extracts of *T. stans* indicated the presence of flavonoids, phenols, alkaloids, saponins, tannins, coumarin (Table 8). Thus, these chemicals may be the reason of the weed growth reduction of both *A. viridis* and *E. colonum*. Similar results were documented [7, 41,43]. El-Rokiek *et al*. [44] reported that *Aloe vera* leaf water extract caused high significant reduction in *Sonchus oleracea* weed and returned that reduction to flavonoids, phenols, alkaloids, saponins, tannins in the extract, so, confirmed our results. The results of TLC analysis indicated the presence of seven phenolic acids i.e. ferulic, caffeic, gallic, chlorogenic, vanillic, cinnamic and p-coumaric a and seven flavonoids i.e rutin, hesperidin, catechin, kampefrol, naringin, apegenin and quercetin (Fig 1). In this connection, Ahmed *et al*. [45] obtained similar results, so explained the reduction in *Teucrium royleanum* (Labiatae). In addition, El-Rokiek [46] recorded high significant reduction in *Betavulgaris* and *avena fatua* by using cinnamic, benzoic acids alone or both. El-Rokiek *et al*. [47] obtained similar phenolic acids in mango leaf extract and returned the reduction in *Cyperus rotundus* by leaf extract to these acids. Ghimire*et al*. [48] attributed the reduction in growth of *Commelina communis*, *Artemisia princepsvar. orientalis*, *Bidens frondosa* and *Oenothera* biennis weeds by *Miscanthus sacchariferous* water extract to chlorogenic acid as well as rutin that found in the extract. These results were confirmed by El-Rokiek *et al.*[41] who obtained similar results. Weeds produced the highest potential loss (34%) [49]. So, the reduction in weed growth was accompanied by increase in *G.jamesonii* growth and flowering, these results may be due to controlling weeds, so less competition between weeds and *G.jamesonii* resulted. Several documented results confirmed this suggestion [8, 43, 44]. The results also reveal increase in different metabolic activity, as photosynthetic pigments and carbohydrates. The increase in growth also was accompanied by increase in micro and macroelement contents [50] as well as antioxidant enzymes (Table 6). The antioxidant enzymes not only protect the plant from cell damage by transformation of free oxygen (O) to safe O_2 but also participating in growth and development [51]. The results in *G. jamesonii* growth and flowering are close to weed free control that can indicate the increase in growth related to stimulation in addition to weed control [43].

5. Conclusion

Weeds have a detrimental impact on plant growth, development, and crop productivity. The aqueous extract of medicinal plants, particularly Tecoma stans, plays a crucial role in biological control by enhancing the activity of plant oxidation

enzymes. This extract effectively targets weeds like *Amaranthus viridis* and *Echinochloa colonum*, which compete with ornamental plants such as *Gerbera jamesonii*. Oxidative enzymes are vital for essential processes like chemical synthesis, energy production, detoxification, and other metabolic functions, all of which directly influence plant growth and flowering. *Tecoma stans* contains bioactive secondary metabolites, including alkaloids and polyphenolic compounds, that not only inhibit weed growth but also stimulate the growth and blooming of the plant itself.

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