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Research Article
Effect of Medicinal Plant Extracts on Seed Germination and Early Seedling Growth of Three Cucurbits

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Abstract

Background and Objective: Medicinal plants are beneficial for human and animal health but they could have a significant role on the flora also. Some studies suggested that medicinal plants can play the role of growth promotors/inhibitors also. To find useful available medicinal plants for native agricultural use, the present study was conducted and investigated the effects of 10 medicinal plant extracts on seed germination and growth of three cucurbitaceous crops namely cucumber (*Cucumis sativus*), pumpkin (*Cucurbita maxima*) and bottle gourd (*Lagenaria siceraria*). **Materials and Methods:** The 25 and 50% extracts of 10 medicinal plants, namely, Bougainvillea (*Bougainvillea spectabilis*), False daisy (*Eclipta alba*), Drumstick (*Moringa oleifera*), Sisso (*Dalbergia sissoo*), Mimosa (*Mimosa pudica*), Mint (*Mentha spicata*), Devil's cotton (*Abroma augusta*), Asthma plant (*Euphorbia hirta*), Ivy gourd (*Coccinia grandis*) and Royal poinciana (*Delonix regia*), were applied on the seeds. The effect of those medicinal plant extracts was compared for the germination percentage, the seedling root length, shoot length, fresh weight, dry weight and vigor index. **Results:** All treatments showed significant effects on tested seeds but royal poinciana performed very well to increase the germination and growth as well. **Conclusion:** This is the first experiment where royal poinciana was tested on seed germination and growth, indicating a good prospect for it to be used as a germination and growth regulator in the future.

Key words: Medicinal plant, aqueous extracts, seed germination, seedling growth, cucurbits

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Plants are the reservoir of different types of naturally occurring bio-organic compounds having a wide range of biological activities. Medicinal plants have historically proven their value as a source of molecules with therapeutic potential and nowadays still represent an important tool for the identification of novel drug leads. Different parts of plants and their extracts have been used for various purposes for a long time ago due to their chemical properties, availability and simple use without any side effects. Certain plant extracts were found to have cytotoxic effects[1], some showed antioxidant properties[2]. While a group of plant species effectively showed antimicrobial activities and reduced plant diseases like damping-off and wilt. Bio-insecticidal effects of plant extract from certain species were also reported[3]. Several reports were found on the effect of plant extracts as biopesticides and their toxicities toward different pests and diseases[4-6].

Medicinal plants are rich in secondary metabolites. Alkaloids, glycosides, coumarins, flavonoids, steroids, etc., are the secondary metabolites found in medicinal plants. These plants synthesized hundreds of chemicals that have allelopathic, insecticidal, antifungal, antimicrobial and antioxidant properties[7]. All these chemical properties help to increase seed germination, plant growth and development, also help to defend insects, pests and diseases etc. However, several observations reported that the leaf extract affected different seed germination, growth development of vegetables and crops. The leaf extract of bohera (*Terminalia bellirica*) increased germination of seeds and enhanced the shoot and root length of swamp cabbage (*Ipomoea aquatica*) and okra (*Hibiscus esculentus*) whereas, the aqueous extract of haritaki (*Terminalia chebula*) significantly reduced and delayed germination, shoot and root length of swamp cabbage[8]. The acalypha (*Acalypha indica*) extract showed the stimulatory effect on seed germination of brinjal (*Solanum melongena*)[9]. On the other hand leaf extract of neem (*Azadirachta indica*) and bougainvillea (*Bougainvillea spectabilis*) enhanced seed germination of tomato and bell pepper and also showed antiviral activities against pathogenic viruses of tomato[10].

In this study, the ten medicinal plants were selected to see the effect on cucumber germination and seedling development viz., bougainvillea, false daisy, drumstick, sisso, mimosa, mint, devil's cotton, asthma plant, ivy gourd and royal poinciana. Among them, the first five had proven them growth promoter or phytotoxic for plants and the other five were not tested before. However, Mint has larvicidal activities.

As know that leaf extracts of bougainvillea enhance the seed germination of bell pepper and induce tomato viruses[10]. False daisy leaf extract showed an inhibitory effect on seed germination and seedling growth of rice and mung bean[11]. The drumsticks widely cultivated for its young seed pods and leaves used as vegetables and for traditional herbal medicine. But the leaf extract increases the growth and yield of maize[12]. The fruit extract of sisso has molluscicidal properties[13] where the leaf enhanced the growth and production of wheat (*Triticum aestivum*)[14].

The leaf extracts of mimosa inhibited the seed germination of three cultivated species in Solanaceae namely brinjal (*Solanum melongena*), tomato (*Lycopersicum esculentum*), chilli (*Capsicum frutescens*)[15]. And the root extract of mimosa produced carbon disulfide, which prevents certain pathogenic and mycorrhizal fungi multiplication within the plant's rhizosphere and helps the formation of nodules on the roots of the plant, which fix atmospheric nitrogen and convert it into a form that is usable by the plant[16]. However, there is no study on mint affecting seed germination and growth. But the spearmint essential oil succeeds as a larvicide against mosquitoes[17].

On the other hand, devil's cotton, asthma plant, royal poinciana and ivy gourd are well-known for their medicinal value. But never tested on the plant before.

The leaves and bark of devil's cotton possess antimicrobial and antioxidant properties with anti-diabetic, analgesic, anti-inflammatory and anticancerous activity[18-20]. Asthma plant has many medicinal properties like a hypotensive, anticancer, tonic, exhibits anxiolytic, analgesic, antimalarial, antiasthmatic, antidiarrheal, antioxidant, antiamoebic, anti-inflammatory, antifungal, antibacterial, antiamoebic, antispasmodic etc. and the roots are also used for snake bites[21,22]. Asthma plant has potential use against dengue as it holds significant antiviral and platelet increasing activities[23]. Traditionally royal poinciana plant is used as anthelmintic, antimicrobial, anticancer, antirheumatic, antimalarial, antioxidant, hepatoprotective activity, antiulcer and anti-diabetic[24]. Ivy gourd also has a wide range of medicinal properties like analgesic, antipyretic, anti-inflammatory, antimicrobial, antiulcer, antidiabetic, antioxidant, hypoglycemic, hepatoprotective, antimalarial, antidyslipidemic, anticancer, antitussive and mutagenic[26].

The medicinal plant could be a growth promoter or growth inhibitor for other plants. Although there are not many investigations with these medicinal plants on seed germination and plant growth because of all the previous reports, it can be hypothesized that extract from the selected ten plants having some plant growth promoters, mineral

nutrients and vitamins in a naturally balanced composition, could be beneficial for seed germination, plant growth and development. If such happened, then the medicinal plants will have a good prospect in future organic cultivation.

To investigate the attributes of medical plants on seed germination and growth, the present study was undertaken with three major crops cucumber (*Cucumis sativus*), pumpkin (*Cucurbita maxima*) and bottle gourd (*Lagenaria siceraria*) from the cucurbitaceae family.

MATERIALS AND METHODS

Study area: The study was carried out at the Central Laboratory of the Department of Agriculture, Noakhali Science and Technology University, Noakhali, Bangladesh. The total duration of this was study was 6 months from July to December, 2019.

Collection of study materials

Seed: Seeds of "Sheila" variety of cucumber, "Baromashi" variety of pumpkin and "Khet Lau" variety of bottle gourd was used in these experiments which were developed by Lal Teer Seed Ltd., Bangladesh. The seeds of these varieties were uniform in size and free from insects and disease infestation.

Medicinal plants: The ten medicinal plants were collected from Noakhali Science and Technology University, Bangladesh in Table 1. Mainly disease-free, clean, fresh and healthy leaves of those plants were collected.

Processing collected leaves: A total of 1 kg of fresh, healthy and disease-free raw leaves of each medicinal plant was collected expressed in Table 2. Then the leaves were washed properly by using distilled water and 70% ethanol. The clean leaves were air-dried at room temperature in the laboratory until they dried properly. After drying we ground the leaves with mortar and pastels to make leaf powder.

Preparation of plant extract: For preparing plant extracts, 10 g of leaf powder was taken in a beaker and 100 mL of distilled water was added. The leaf powder was mixed thoroughly to make the solution and left for 6 hrs to soak properly at room temperature. The solution was transferred to two 50 mL falcon tubes and centrifuged at 14000 rpm for 10 min by a centrifuge machine (Esco Micro, Changi, Singapore). The supernatant was collected with a micropipette very carefully. The supernatant was filtered using filter paper (Whatman International, Maidstone, England). The filtrates were considered as stock solutions and preserved at 4°C. From that stock, 25 and 50% were prepared before application.

Table 1: Medicinal plants used in the experiment

English name	Scientific name	Family	Parts used
Bougainvillea	*Bougainvillea spectabilis*	Nyctaginaceae	Leaf
False daisy	*Eclipta alba*	Asteraceae	Leaf
Drumstick	*Moringa oleifera*	Moringaceae	Leaf
Sisso	*Dalbergia sissoo*	Fabaceae	Leaf
Mimosa	*Mimosa pudica*	Fabaceae	Leaf
Mint	*Mentha spicata*	Lamiaceae	Leaf
Devil's cotton	*Abroma augusta*	Malvaceae	Leaf
Asthma plant	*Euphorbia hirta*	Euphorbiaceae	Leaf
Ivy gourd	*Coccinia grandis*	Cucurbitaceae	Leaf
Royal poinciana	*Delonix regia*	Fabaceae	Leaf

Table 2: Cucurbits seeds used in the experiment

English name	Scientific name	Variety	Parts used
Cucumber	*Cucumis sativus*	Sheila	Seed
Pumpkin	*Cucurbita maxima*	Baromashi	Seed
Bottle gourd	*Lagenaria siceraria*	Khet Lau	Seed

Setup the seeds in Petri dish: In a Petri dish (12 cm diameter), ten seeds were placed over a soaked tissue and 25 and 50% solutions (5 mL) were applied by hand sprayer. As a control, Distilled Water (DW) was applied. Then Petri dishes were kept in a seed germinator (Dasol scientific, Gyeonggi-do, South Korea) at 25±2°C. We used a hand water sprayer for watering the Petri dishes from the 3rd day after placing of seeds. Meanwhile, the DW was sprayed to keep the seeds moist when needed. Successful germination was considered when the first two leaves were grown. The experiment was replicated three times for each treatment.

Germination percentage: The number of seeds germinated was observed daily and the final data was recorded on the 7th day after treatment. The results obtained were converted into percentage germination. The germination percentage was computed using the following formula[25]:

$$\text{Germination}\ (\%) = \frac{\text{Number of seed germination}}{\text{Total number of seeds for test}} \times 100\%$$

Shoot and root length measurement: For cucumber, shoot and root length was recorded at 10 days after treatment and for pumpkin and bottle gourd at 12 days. All germinated seedlings were uprooted carefully and shoot length was measured from the root-shoot zone to tip. In the same way, root length was measured from the base to the top of the radicles of all germinated seedlings.

Fresh and dry weight measurement: After collecting seedlings from the Petri dish, they were left on the tissue for 30 min to remove the surface water. Then the fresh weight was measured by a digital weight scale (Sartorius Lab Instruments, Goettingen, Germany). For taking dry weight, the seedlings were kept in an oven machine at 60°C for 24 hrs to oven-dry properly. Then the dry weight had been taken in the same way.

Vigor Index calculation: The Vigour Index (VI) of the seedlings was estimated by the described formula[27]:

$$\text{Vigor index} = \text{Germination (\%)} \times (\text{Root length} + \text{Shoot length})$$

Statistical analysis: Collected data were recorded and compiled for germination percentage. Different growth parameters were also tabulated for statistical analysis. The data were analyzed statistically at a 5% level of significance with one-way ANOVA followed by Duncan's Multiple Range Test (DMRT)[28].

RESULTS

Effect of plant aqueous extracts on seed germination: The 25% aqueous extracts of the medicinal plants have significant effects on seed germination for all cucumber in Fig. 1a, pumpkin in Fig. 1b and bottle gourd in Fig. 1c ($p<0.001$). In cucumber, the maximum germination was observed for royal poinciana (100%) and devil's cotton (100%) followed by drumstick (96.67%), sisso (96.67%), asthma plant (96.67%), bougainvillea (93.33%), mint (90%) and ivy gourd (86.67%) and control (77.33%). For the pumpkin, royal poinciana (90%) showed maximum result followed by sisso showed (86.67%), bougainvillea (76.67%), asthma plant (76.67%), false daisy (70%), drumstick (70%) and ivy gourd (70%), mimosa (63.33%), control (60%) and devil's cotton (53.33%). For bottle gourd, royal poinciana (83.33%) also showed high germination followed by sisso (83.33%), bougainvillea (67.67%), devil's cotton (67.67%), ivy gourd (67.67%) mimosa (63.33%), mint (63.33%), control (60%), asthma plant (56.67%), drumstick (53.33%) and false daisy (50%). All 50% extracts also had a high significance ($p<0.001$) for all cucumber in Fig. 2a, pumpkin in Fig. 2b and bottle gourd Fig. 2c on the seed germination percentage. In cucumber, royal poinciana (100%) and sisso (100%) both resulted highest germination Ivy gourd (96.67%), bougainvillea (93.33%), devil's cotton (93.33%), drum stick (83.33%), asthma plant (83.33%), control (77.33%), mint (66.67%), false daisy (56.67%) and mimosa (56.67%). For the pumpkin, royal poinciana (80%) was maximum followed by bougainvillea (66.67%), drumstick (66.67%), sisso (66.67%), devil's cotton (66.67%), asthma plant (66.67%), ivy gourd (63.33%), mint (60%), control (60%), false daisy (56.67%),

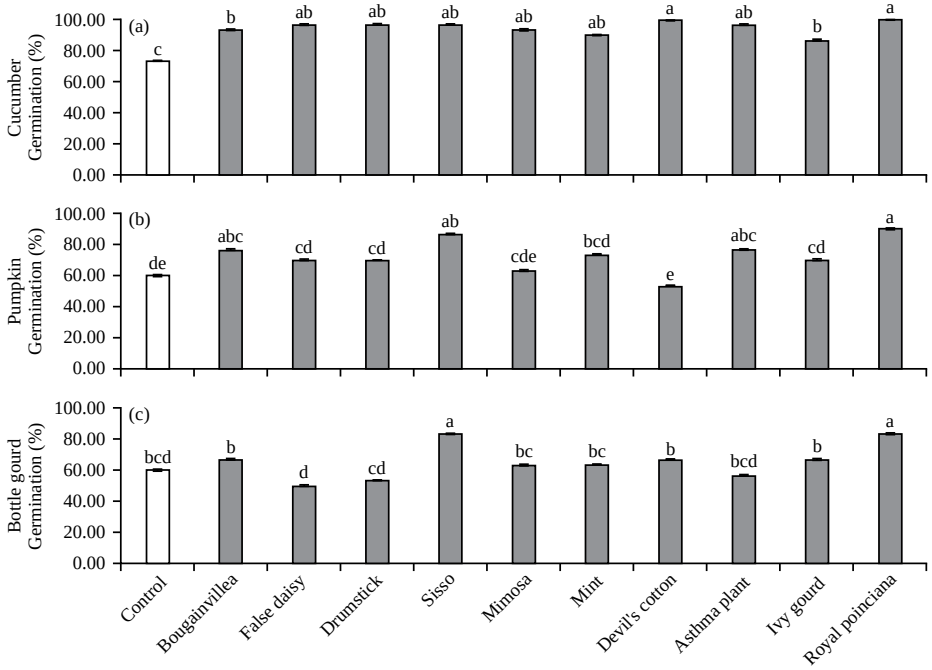

Fig. 1(a-c): Effect of 25% extracts of medicinal plants on the germination percentage, (a) Cucumber, (b) Pumpkin and (c) Bottle gourd

Bars labelled with different superscripts are significantly different ($p<0.05$) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

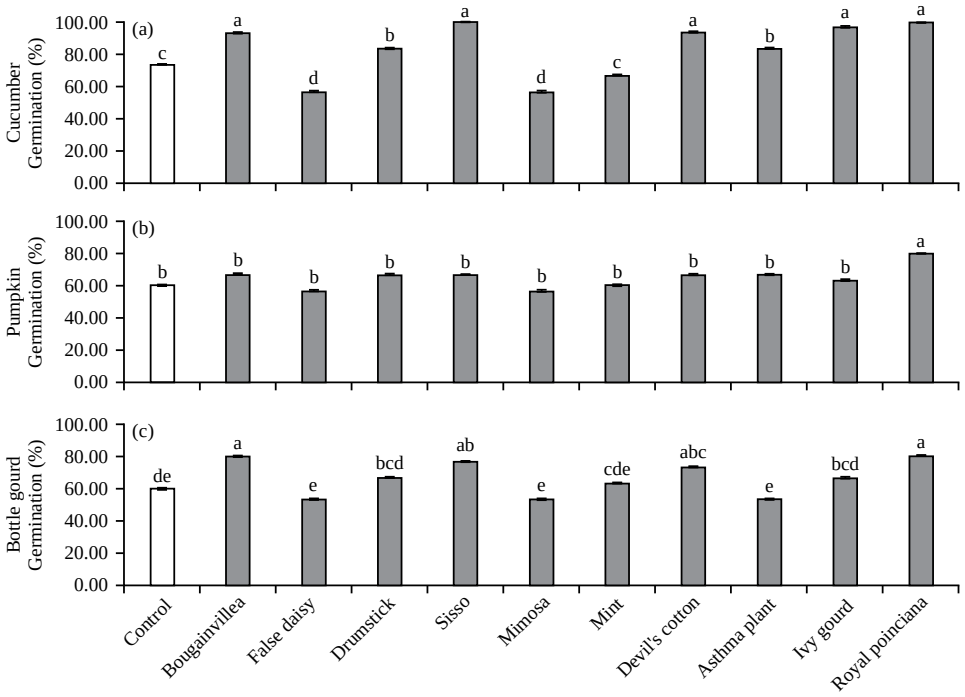

Fig. 2(a-c): Effect of 50% extracts of medicinal plants on the germination percentage, (a) Cucumber, (b) Pumpkin and (c) Bottle gourd

Bars labelled with different superscripts are significantly different ($p<0.05$) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

mimosa (56.67%). With bottle gourd, royal poinciana (80%) and bougainvillea (80%) was in first in the list followed by sisso (76.67%), devil's cotton (73.33%), drumstick (66.67%), ivy gourd (66.67%), mint (63.33%), control (60.00%), false daisy (53.33%), mimosa (53.33%) and asthma plant (53.33%).

Effect of plant aqueous extracts on shoot length: The shoot length of cucumber in Fig. 3a, pumpkin in Fig. 3b and bottle gourd in Fig. 3c was significantly affected by the 25% aqueous extracts of all ten medicinal plants ($p<0.001$). In cucumber, Ivy gourd (12.27 cm) showed maximum shoot length followed by mint (11.50 cm), mimosa (10.65 cm), royal poinciana (10.49 cm), issue (9.63 cm), asthma plant (8.82 cm), devil's cotton (8.56 cm), bougainvillea (8.56 cm), false daisy (7.68 cm), drumstick to (6.73 cm) and control (5.48 cm). In the case of pumpkin, ivy gourd (12.81 cm) showed maximum shoot length followed by royal poinciana (11.26 cm), sisso (10.04 cm), devil's cotton (9.95 cm), mint (9.62 cm), asthma plant (9.31 cm), false daisy (8.63 cm), bougainvillea (8.27 cm), mimosa (7.25 cm), drumstick (6.48 cm) and control (5.35 cm). For bottle gourd, most increased length was found for sisso (11.02 cm) followed by royal poinciana (10.63 cm), ivy gourd (10.22 cm), mint (9.92 cm), false daisy (8.76 cm), bougainvillea (7.97 cm), devil's cotton (7.89 cm), asthma plant (7.77 cm), mimosa (5.07 cm), drumstick (4.89) cm and control (3.79 cm).

The 50% solutions were also significantly influenced the shoot length of all three cucurbit seedlings ($p<0.001$) in Fig. 4a-c. For cucumber, the devil's cotton showed the highest shoot length (10.91 cm) followed by sisso (10.20 cm), bougainvillea (8.22 cm), royal poinciana (7.74 cm), drumstick (7.18 cm), mint (7.18 cm), false daisy (6.63 cm), ivy gourd (6.13 cm), control (5.48 cm), mimosa (4.19 cm) and asthma plant (3.78 cm). In pumpkin, highest length (9.03 cm) was found with devil's cotton, followed by royal poinciana (8.70 cm), ivy gourd (8.52 cm), false daisy (8.50 cm), asthma plant (7.84 cm), mimosa (7.54 cm), bougainvillea (7.41 cm), mint (6.92 cm), sisso (6.47 cm), drumstick (6.22 cm) and control (5.53 cm). For bottle gourd, the maximum shoot length (8.39 cm) was observed for royal poinciana followed by devil's cotton (6.33 cm), drumstick (6.02 cm) bougainvillea (6.00 cm), sisso (5.65 cm), mint (5.60 cm), mimosa (5.47 cm), ivy gourd (5.35 cm), asthma plant (4.75 cm), false daisy (3.37 cm) and control (3.79 cm).

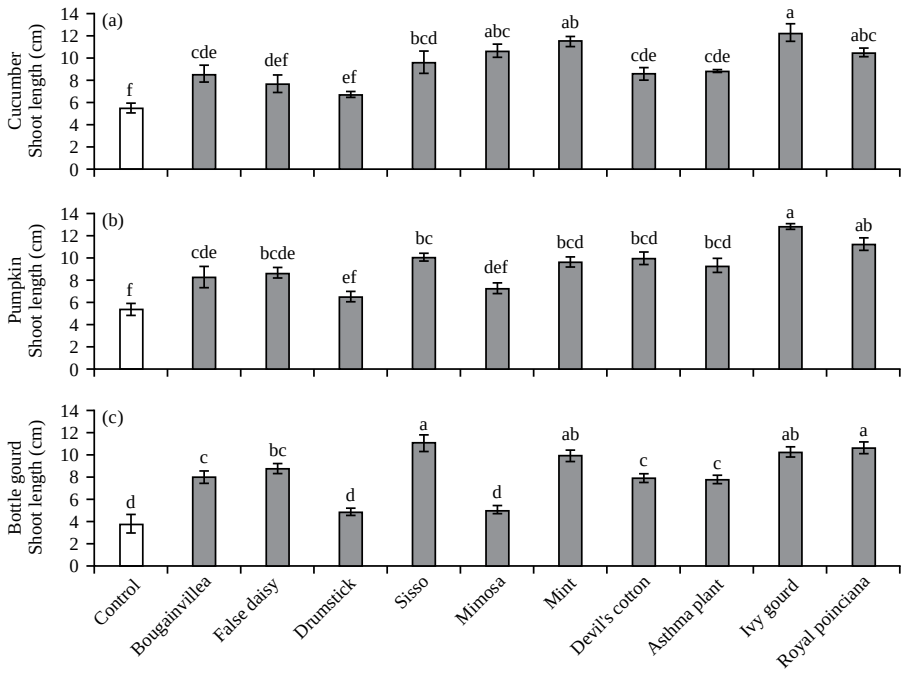

Fig. 3(a-c): Effect of 25% extracts of medicinal plants on the shoot length (cm), (a) Cucumber, (b) Pumpkin and (c) Bottle gourd
Bars labelled with different superscripts are significantly different (p<0.05) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

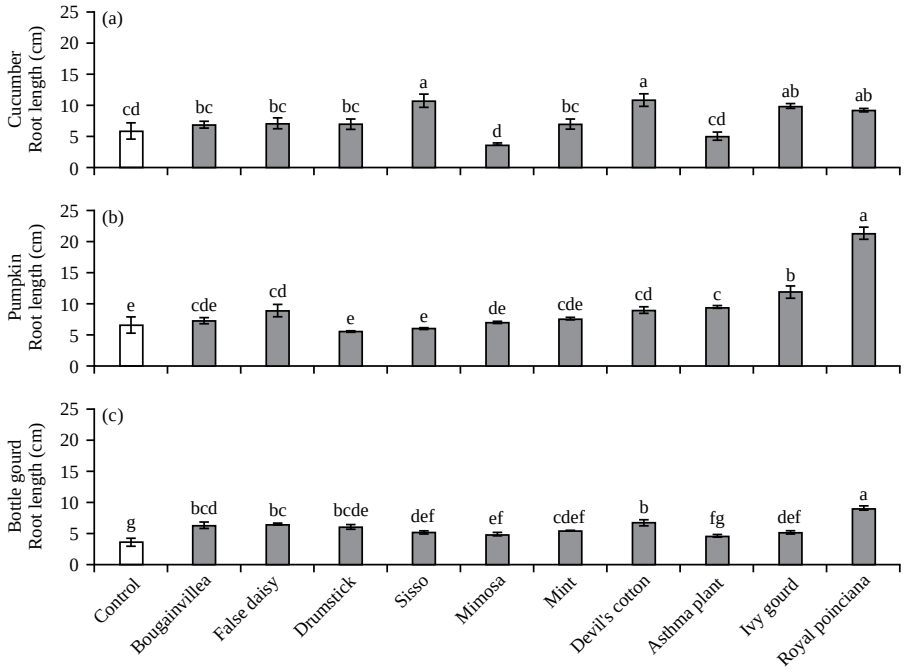

Fig. 4(a-c): Effect of 50% extracts of medicinal plants on the shoot length (cm) , (a) Cucumber, (b) Pumpkin and (c) Bottle gourd
Bars labelled with different superscripts are significantly different (p<0.05) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

Effect of plant aqueous extracts on root length: The roof length of three cucurbits was significantly affected by all 25% medicinal plant extracts, (p<0.001) in Fig. 5a-c. In cucumber, the highest root growth (8.56 cm) was observed for mimosa followed by drumstick (8.75 cm), royal poinciana (8.56 cm), ivy gourd (8.15 cm), bougainvillea (8.04 cm), mint (7.87 cm), sisso

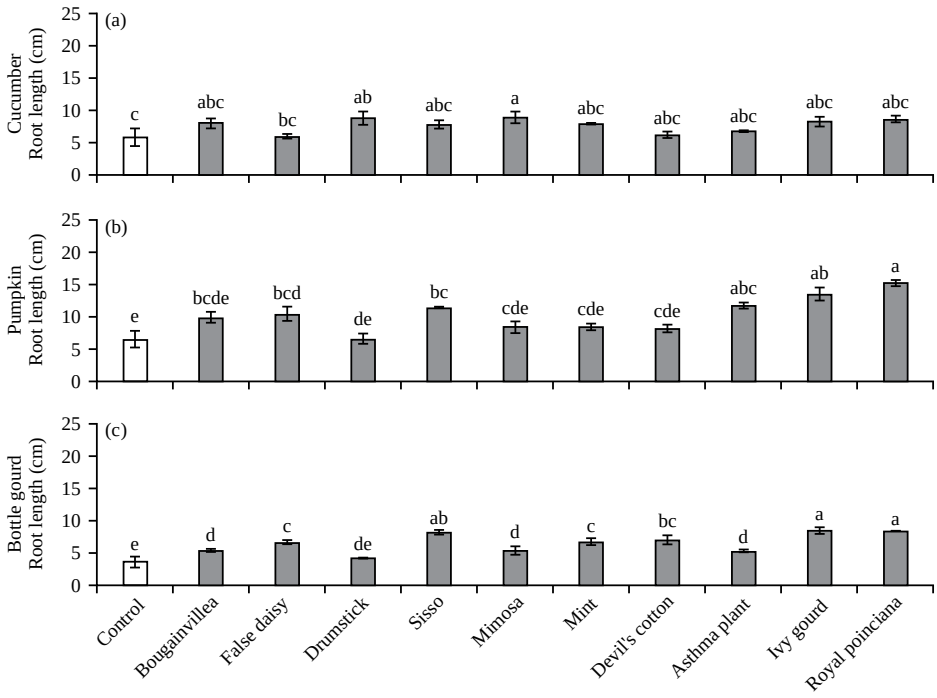

Fig. 5(a-c): Effect of 25% extracts of medicinal plants on the root length (cm), (a) Cucumber, (b) Pumpkin and (c) Bottle gourd
Bars labelled with different superscripts are significantly different ($p<0.05$) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

(7.80 cm), asthma plant (6.75 cm), devil's cotton (6.12 cm), false daisy (5.90 cm) and control (5.77 cm). In pumpkin, the royal poinciana gave the highest root length (15.17 cm), ivy gourd (13.45 cm), asthma plant (11.69 cm), sisso (11.38 cm), false daisy (10.44 cm), bougainvillea (9.81 cm), mint (8.35 cm), mimosa (8.34 cm), devil's cotton (8.15 cm), drumstick (6.56 cm) and control (6.48 cm). The bottle gourd seedlings showed the highest root length (8.44 cm) for ivy gourd followed by royal poinciana (8.78 cm), followed by sisso (8.19 cm), devil's cotton (7.03 cm), mint (6.73 cm), false daisy (6.62 cm), bougainvillea (5.36 cm), mimosa (5.33 cm), asthma plant (5.25 cm), drumstick (4.19 cm) and control (3.54 cm).

The 50% solutions also significantly influenced the root length of cucumber in Fig. 6a, in pumpkin Fig. 6b and bottle gourd in Fig. 6c ($p<0.001$). For cucumber, the devil's cotton (10.82 cm) was in the highest position followed by sisso (0.67 cm), ivy gourd (9.86 cm), royal poinciana (9.21 cm), false daisy (7.04 cm), drumstick (6.89 cm), control (5.77 cm), asthma plants (4.99 cm) and mimosa (3.58 cm). In the case of pumpkin seedlings, with royal poinciana, the highest root length (21.31 cm) was resulted followed by ivy gourd (11.86 cm), asthma plant (9.42 cm), devil's cotton (8.95 cm), false daisy (8.85 cm), mint (7.59 cm), bougainvillea (7.29 cm), mimosa (7.02 cm), control (6.51 cm), sisso (5.99 cm) and drumstick (5.50 cm). For bottle gourd, the maximum observed root length (8.99 cm) was found for royal poinciana followed by devils cotton (6.67 cm), false daisy (6.46 cm), bougainvillea (6.25 cm), drumstick (6.97 cm), mint (5.37 cm), sisso (5.15 cm), ivy gourd (5.08 cm), mimosa (4.83 cm), asthma plant (4.53 cm) and control (3.34 cm).

Effects of plant aqueous extracts on seedling vigour index: Plant aqueous extracts of 25% concentrations have a significant influence on the vigour index of cucumber in Fig. 7a, pumpkin in Fig. 7b and bottle gourd in Fig. 7c, seedlings ($p<0.001$). In cucumber, among 25% extracts, royal poinciana (1905) was performed followed by mimosa (1821), ivy gourd (1770), mint (1744), sisso (1685), bougainvillea (1549), asthma plant (1505), drumstick (1496), devil's cotton (1469), false daisy (1313) and control (824.7). For the pumpkin, royal poinciana (1028) was best consequently ivy gourd (910.2), sisso (881.6), asthma plant (725.5), bougainvillea (643.9), false daisy (614.6), mimosa (467.3), mint (467.3), drumstick (460.4) and control (327.5).

Cucumber seedling showed the highest vigour index with sisso (1601) succeeded by royal poinciana (1584), ivy gourd (1244), mint (1055), devil's cotton (994.6), bougainvillea (888.7), false daisy (769), asthma plant (737.7), mimosa (658.5), drumstick (484.1) and control (439.7).

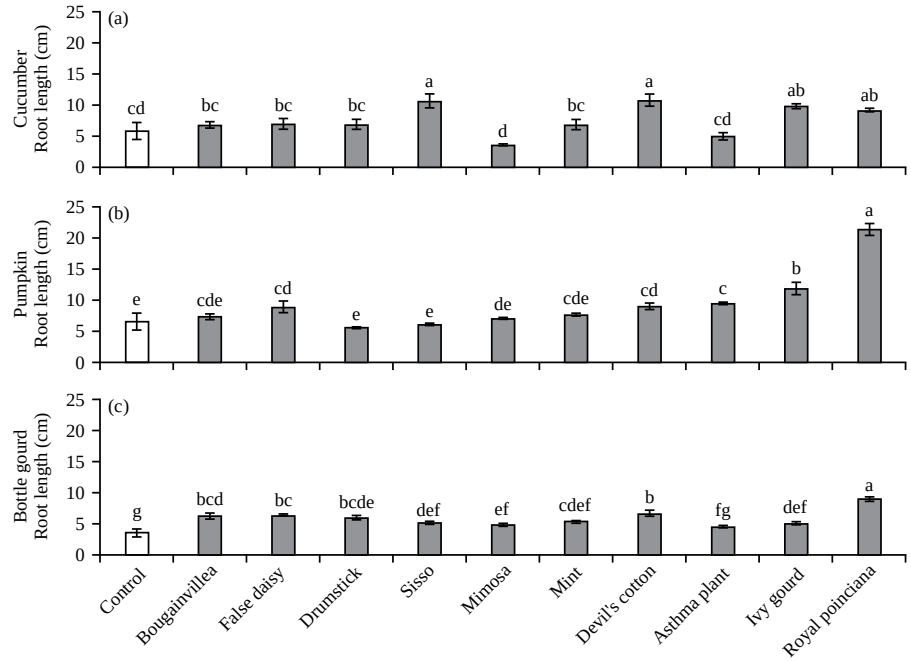

Fig. 6(a-c): Effect of 50% extracts of medicinal plants on the root length (cm), (a) Cucumber, (b) Pumpkin and (c) Bottle gourd
Bars labelled with different superscripts are significantly different ($p<0.05$) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

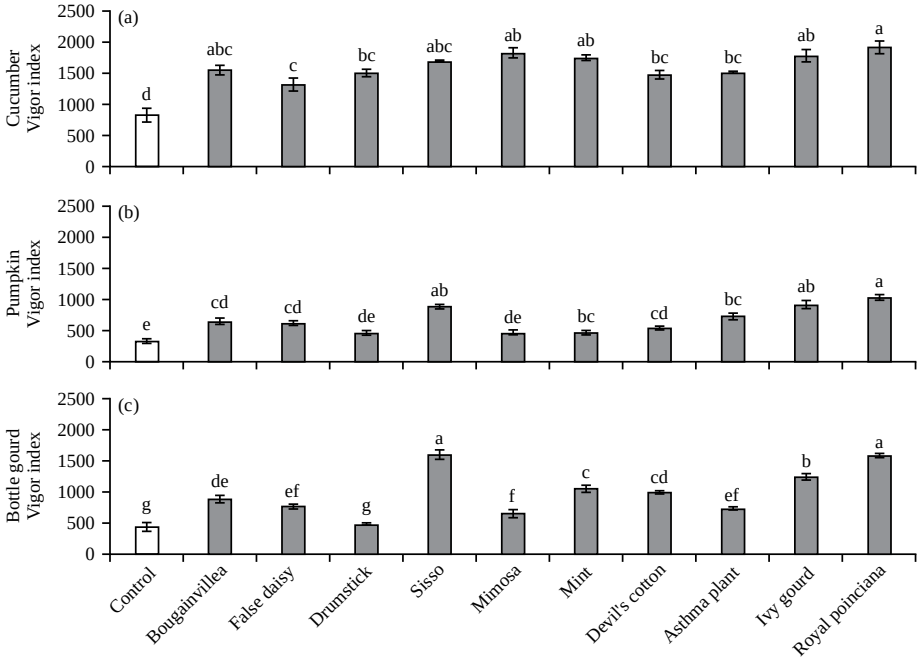

Fig. 7(a-c): Effect of 25% extracts of medicinal plants on the vigour index, (a) Cucumber, (b) Pumpkin and (c) Bottle gourd
Bars labelled with different superscripts are significantly different ($p<0.05$) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

The 50% concentrations also showed a significant effect on the vigour index of cucumber in Fig. 8a, pumpkin in Fig. 8b, and bottle gourd in Fig. 8c, seedlings ($p<0.001$). In cucumber, among 50% plant extracts, the sequential arrangement of vigour index starts from sisso (2087) followed by devil's cotton (2029), royal poinciana (1695), ivy gourd (1547), bougainvillea

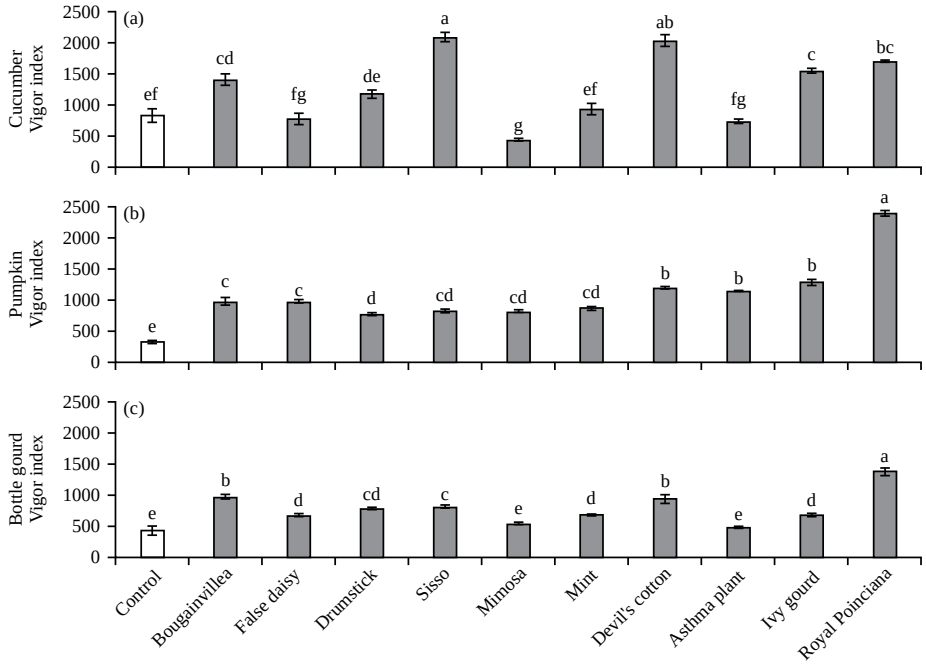

Fig. 8(a-c): Effect of 50% extracts of medicinal plants on the vigour index, (a) Cucumber, (b) Pumpkin and (c) Bottle gourd
Bars labelled with different superscripts are significantly different ($p<0.05$) according to Duncan's New Multiple Range Test, each bar represents the Mean±SE of 3 replicates

(1403), drumstick (1173), mint (938.2), control (824.7), false daisy (774.9), asthma plant (731.6), mimosa (440.5). In pumpkin, the highest most was observed for royal poinciana (2401) followed by ivy gourd (1290), devil's cotton (1199), asthma plant (1151), false daisy (983), bougainvillea (981), mint (870.6), sisso (831.1), mimosa (825.4), drumstick (781.2) and control (327.5). For cucumber, topmost vigour index observed for royal poinciana (1391) subsequently bougainvillea (980), devil's cotton (953.3), sisso (828.7), drumstick (799.7), mint (695.2), ivy gourd (695.2), false daisy (684.3), mimosa (549.7), asthma plant (495) and control (439.7).

Effect of aqueous extracts on shoot and root weight

Shoot fresh weight: All 25% plant extracts significantly affected the shoot fresh weight of all three cucurbit seedlings ($p<0.001$) in Table 3. In cucumber seedlings, royal poinciana (2.62 g) showed the highest fresh weight followed by mimosa (2.54 g), ivy gourd (2.07 g), mint (1.71 g), bougainvillea (1.67 g), asthma plant (1.64 g), sisso (1.45 g), drumstick (1.43 g), devil's cotton (1.33 g), false daisy (1.25 g) and control (0.93 g). For the pumpkin, sisso (6.64 g) gave higher weight consequently royal poinciana (6.56 g), ivy gourd (6.48 g), mint (5.44 g), bougainvillea (4.04 g), mimosa (4.03 g), asthma plant (3.99 g), devil's cotton (3.09 g), drumstick (3.00 g), false daisy (3.82 g) and control (2.84 g). In bottle gourd, 25% extracts, increased fresh weight resulted from royal poinciana (6.39 g) followed by asthma plant (6.32 g), sisso (6.24 g), false daisy (5.68 g), devil's cotton (5.53 g), ivy gourd (5.53 g), bougainvillea (4.76 g), mint (3.61 g), mimosa (2.09 g), control (1.65 g) and drumstick (1.48 g).

All 50% plant extracts also significantly affected the shoot fresh weight of cucumber, pumpkin and bottle gourd seedlings ($p<0.001$) (Table 3). For cucumber, the top performed devil's cotton (2.17 g) was following that drumstick (2.13 g), royal poinciana (2.07 g), bougainvillea (1.84 g), sisso (1.83 g), mint (1.81 g), ivy gourd (1.68 g), asthma plant (1.38 g), mimosa (1.12 g), false daisy (1.00 g) and control (0.93 g). For the pumpkin, royal poinciana (4.22 g) was on top followed by ivy gourd (3.68 g), bougainvillea (3.46 g), drumstick (3.26 g), sisso (3.04 g), mint (3.03 g), asthma plant (3.02 g), mimosa (2.93 g), false daisy (2.92 g), devil's cotton (2.89 g) and control (2.83 g). In bottle gourd, royal poinciana (4.19 g) ranked first by leaving bougainvillea (2.83 g), asthma plant (2.83 g), devil's cotton (2.60 g), mint (2.57 g), drumstick (2.51 g), ivy gourd (2.51 g), sisso (2.18 g), mimosa (2.05 g), false daisy (1.93 g) and control (1.65 g) back.

Shoot dry weight: All medicinal plant extracts of 25% concentrations significantly affected the shoot dry weight of cucumber, pumpkin and bottle gourd seedlings ($p<0.001$) in Table 4. In cucumber, among 25% extracts the royal poinciana

Table 3: Effect of 25 and 50% extracts of medicinal plants on the shoot fresh weight (g) of cucumber, pumpkin and bottle gourd, respectively

	Shoot fresh weight (g)					
	25% aqueous extract			50% aqueous extract		
Name of the treatments	Cucumber	Pumpkin	Bottle gourd	Cucumber	Pumpkin	Bottle gourd
Control	0.93±0.18^{d}	2.84±0.19^{c}	1.65±0.36^{e}	0.93±0.18^{f}	2.83±0.13^{c}	1.65±0.36^{e}
Bougainvillea	1.67±0.11^{bc}	4.04±0.24^{bc}	4.76±0.17^{c}	1.84±0.07^{abc}	3.46±0.14^{bc}	2.83±0.08^{b}
False daisy	1.25±0.15^{cd}	3.82±0.03^{bc}	5.68±0.16^{ab}	1.00±0.12^{f}	2.92±0.07^{c}	1.93±0.1^{de}
Drumstick	1.43±0.14^{cd}	3.00±0.1^{c}	1.48±0.25^{e}	2.13±0.13^{ab}	3.26±0.21^{bc}	2.51±0.19^{bcd}
Sisso	1.45±0.16^{cd}	6.64±0.21^{a}	6.24±0.1^{ab}	1.83±0.02^{abc}	3.04±0.08^{bc}	2.18±0.09^{cde}
Mimosa	2.54±0.15^{a}	4.03±0.11^{bc}	2.09±0.09^{e}	1.12±0.06^{ef}	2.93±0.03^{c}	2.05±0.06^{cde}
Mint	1.71±0.08^{bc}	5.44±0.17^{ab}	3.61±0.08^{d}	1.81±0.04^{bc}	3.03±0.08^{bc}	2.57±0.14^{bc}
Devil's cotton	1.33±0.14^{cd}	3.09±0.19^{c}	5.53±0.05^{bc}	2.17±0.05^{a}	2.89±0.06^{c}	2.60±0.04^{bc}
Asthma plant	1.64±0.11^{bc}	3.99±0.25^{bc}	6.32±0.4^{ab}	1.38±0.06^{de}	3.02±0.02^{bc}	2.38±0.24^{bcd}
Ivy gourd	2.07±0.17^{ab}	6.48±0.18^{a}	5.53±0.08^{bc}	1.68±0.08^{cd}	3.68±0.07^{ab}	2.51±0.28^{bcd}
Royal poinciana	2.62±0.11^{a}	6.56±0.28^{a}	6.39±0.04^{a}	2.07±0.03^{ab}	4.22±0.14^{a}	4.19±0.16^{a}
LSD	0.53	1.55	0.84	0.35	0.66	0.54
CV (%)	18.49	20.07	11.02	12.67	12.20	12.83

Data are presented as Mean±SE of 3 replicates, Means followed by same letters are not significantly different within a single column, based on one-way ANOVA and DMRT ($p<0.05$)

Table 4: Effect of 25 and 50% extracts of medicinal plants on the shoot dry weight (g) of cucumber, pumpkin and bottle gourd, respectively

	Shoot dry weight (g)					
	25% aqueous extract			50% aqueous extract		
Name of the treatments	Cucumber	Pumpkin	Bottle gourd	Cucumber	Pumpkin	Bottle gourd
Control	0.08±0.01^{d}	0.32±0.06^{c}	0.18±0.02^{f}	0.08±0.02^{f}	0.32±0.02^{e}	0.18±0.04^{e}
Bougainvillea	0.12±0.01^{bcd}	0.44±0.03^{bc}	0.33±0.03^{cd}	0.23±0.01^{b}	0.62±0.03^{ab}	0.45±0.02^{b}
False daisy	0.14±0.02^{abc}	0.50±0.03^{bc}	0.37±0.03^{bcd}	0.13±0.01^{de}	0.47±0.03^{cd}	0.47±0.03^{b}
Drumstick	0.13±0.01^{abc}	0.40±0.01^{c}	0.24±0.03^{ef}	0.17±0.01^{cd}	0.63±0.03^{a}	0.43±0.07^{b}
Sisso	0.10±0.015^{cd}	0.65±0.03^{ab}	0.52±0.01^{a}	0.17±0.02^{cd}	0.51±0.05^{bc}	0.46±0.04^{b}
Mimosa	0.16±0.02^{ab}	0.44±0.01^{bc}	0.42±0.02^{b}	0.11±0.01^{ef}	0.39±0.02^{cde}	0.26±0.02^{de}
Mint	0.13±0.01^{abc}	0.48±0.03^{bc}	0.31±0.00^{de}	0.21±0.04^{bc}	0.40±0.02^{cde}	0.31±0.01^{cd}
Devil's cotton	0.10±0.02^{cd}	0.42±0.04^{bc}	0.33±0.02^{cd}	0.18±0.01^{bcd}	0.49±0.06^{cd}	0.37±0.02^{bc}
Asthma plant	0.10±0.00^{cd}	0.49±0.07^{bc}	0.51±0.04^{a}	0.17±0.01^{cd}	0.44±0.03^{cd}	0.48±0.01^{b}
Ivy gourd	0.11±0.02^{bcd}	0.47±0.02^{bc}	0.40±0.02^{bc}	0.21±0.03^{bc}	0.37±0.05^{de}	0.40±0.01^{bc}
Royal poinciana	0.18±0.02^{a}	0.75±0.07^{a}	0.56±0.02^{a}	0.41±0.01^{a}	0.703±0.02^{a}	0.58±0.03^{a}
LSD	0.043	0.213	0.068	0.048	0.111	0.087
CV (%)	20.75	25.77	10.66	15.83	13.47	13.06

Data are presented as Mean±SE of 3 replicates, Means followed by same letters are not significantly different within a single column, based on one-way ANOVA and DMRT ($p<0.05$)

(0.18 g) performed best followed by mimosa (0.16 g), false daisy (0.14 g), drumstick (0.13 g), mint (0.13 g), bougainvillea (0.12 g), ivy gourd (0.11 g), sisso (0.10 g), devil's cotton (0.10 g), asthma plant (0.10 g) and control (0.08 g). For pumpkin, royal poinciana (0.75 g) also was in top position subsequently sisso (0.65 g), false daisy (0.50 g), asthma plant (0.49 g), mint (0.48 g), ivy gourd (0.47 g), mimosa (0.44 g), bougainvillea (0.44 g), devil's cotton (0.42 g), drumstick (0.40 g) and control (0.32 g). The bottle gourd showed the highest dry weight with sisso (0.52 g) hereafter asthma plant (0.51 g), mimosa (0.42 g), royal poinciana (0.41 g), ivy gourd (0.40 g), false daisy (0.37 g), bougainvillea (0.33 g), devil's cotton (0.33 g), mint (0.31 g), drumstick (0.24 g) and control (0.18 g).

The 50% concentrations also showed a significant effect on the shoot dry weight of cucumber, pumpkin and bottle gourd seedlings ($p<0.001$) (Table 4). The royal poinciana (0.41g) performed better with cucumber seedlings afterwards bougainvillea (0.23 g), ivy gourd (0.21 g), mint (0.21 g), devil's cotton (0.18 g), drumstick (0.17 g), sisso (0.17 g), asthma plant (0.17 g), false daisy (0.13 g), mimosa (0.11 g) and control (0.08 g). For pumpkin, royal poinciana (0.70 g) also performed better followed by drumstick (0.63 g), bougainvillea (0.62 g), sisso (0.51 g), devil's cotton (0.49 g), false daisy (0.47 g), asthma plant (0.44 g), mint (0.40 g), mimosa (0.39 g), ivy gourd (0.37 g) and control (0.32 g). In bottle gourd, here also royal poinciana (0.58 g) showed highest dry weight following that asthma plant (0.48 g), false daisy (0.47 g), sisso (0.46 g), bougainvillea (0.45 g), drumstick (0.43 g), ivy gourd (0.40 g), devil's cotton (0.37 g), mint (0.31 g), mimosa (0.26 g) and control (0.18 g).

Table 5: Effect of 25 and 50% extracts of medicinal plants on the root fresh weight (g) of cucumber, pumpkin and bottle gourd, respectively

	Root fresh weight (g)					
	25% aqueous extract			50% aqueous extract		
Name of the treatments	Cucumber	Pumpkin	Bottle gourd	Cucumber	Pumpkin	Bottle gourd
Control	0.23±0.06^{e}	0.73±0.09^{g}	0.98±0.12^{e}	0.23±0.06^{c}	0.73±0.09^{b}	0.98±0.11^{c}
Bougainvillea	0.35±0.04^{cde}	1.30±0.05^{ef}	2.32±0.07^{b}	0.31±0.02^{c}	0.98±0.12^{b}	1.25±0.13^{bc}
False daisy	0.28±0.02^{cde}	1.43±0.08^{ef}	2.02±0.07^{c}	0.38±0.05^{c}	0.99±0.06^{b}	1.42±0.33^{b}
Drumstick	0.38±0.04^{cd}	0.79±0.03^{g}	1.22±0.07^{e}	0.29±0.02^{c}	0.90±0.05^{b}	1.05±0.05^{bc}
Sisso	0.35±0.03^{cde}	2.08±0.09^{b}	2.27±0.02^{b}	0.51±0.03^{bc}	1.03±0.15^{b}	1.27±0.08^{bc}
Mimosa	0.55±0.03^{ab}	1.17±0.03^{f}	1.20±0.07^{e}	0.27±0.01^{c}	0.83±0.03^{b}	1.20±0.07^{bc}
Mint	0.53±0.05^{ab}	1.76±0.06^{cd}	1.55±0.08^{d}	0.42±0.18^{c}	0.99±0.09^{b}	1.12±0.1^{bc}
Devil's cotton	0.24±0.05^{de}	1.21±0.11^{f}	2.40±0.08^{b}	0.31±0.01^{c}	0.84±0.03^{b}	1.16±0.08^{bc}
Asthma plant	0.41±0.05^{bc}	1.58±0.12^{de}	2.96±0.04^{a}	0.42±0.04^{c}	0.83±0.08^{b}	1.06±0.04^{bc}
Ivy gourd	0.58±0.03^{a}	1.93±0.07^{bc}	2.39±0.08^{b}	0.88±0.17^{a}	0.91±0.07^{b}	1.39±0.08^{bc}
Royal poinciana	0.59±0.02^{a}	2.76±0.03^{a}	3.07±0.07^{a}	0.72±0.11^{ab}	1.33±0.05^{a}	2.07±0.07^{a}
LSD	0.14	0.302	0.24	0.25	0.28	0.37
CV (%)	19.65	11.71	6.88	34.90	17.25	16.92

Data are presented as Mean±SE of 3 replicates, Means followed by same letters are not significantly different within a single column, based on one-way ANOVA and DMRT ($p<0.05$)

Table 6: Effect of 25 and 50% extracts of medicinal plants on the root dry weight (g) of cucumber, pumpkin and bottle gourd, respectively

	Root dry weight (g)					
	25% aqueous extract			50% aqueous extract		
Name of the treatments	Cucumber	Pumpkin	Bottle gourd	Cucumber	Pumpkin	Bottle gourd
Control	0.01±0.002^{d}	0.03±0.01^{d}	0.04±0.015^{e}	0.01±0.002^{f}	0.03±0.007^{e}	0.04±0.013^{e}
Bougainvillea	0.02±0.00^{cd}	0.10±0.01^{bcd}	0.14±0.01^{ab}	0.02±0.00^{ef}	0.08±0.01^{bcd}	0.09±0.01^{abc}
False daisy	0.02±0.00^{bc}	0.10±0.00^{bcd}	0.09±0.00^{cd}	0.02±0.01^{def}	0.08±0.02^{bcd}	0.10±0.01^{ab}
Drumstick	0.04±0.00^{a}	0.08±0.01^{cd}	0.08±0.01^{d}	0.02±0.00^{bcde}	0.09±0.01^{bc}	0.09±0.00^{abcd}
Sisso	0.04±0.00^{a}	0.13±0.01^{b}	0.11±0.00^{abcd}	0.04±0.00^{a}	0.11±0.00^{b}	0.10±0.01^{ab}
Mimosa	0.04±0.00^{ab}	0.10±0.01^{bcd}	0.10±0.01^{bcd}	0.02±0.00^{cde}	0.04±0.00^{de}	0.06±0.01^{de}
Mint	0.04±0.002^{a}	0.10±0.01^{bcd}	0.10±0.01^{abcd}	0.03±0.00^{abcd}	0.08±0.01^{bcd}	0.08±0.01^{bcd}
Devil's cotton	0.04±0.00^{a}	0.07±0.00^{cd}	0.13±0.01^{abc}	0.02±0.00^{bcde}	0.07±0.02^{cde}	0.06±0.01^{cde}
Asthma plant	0.03±0.00^{abc}	0.13±0.01^{b}	0.13±0.01^{abc}	0.03±0.00^{abc}	0.10±0.01^{bc}	0.09±0.01^{abc}
Ivy gourd	0.04±0.00^{a}	0.11±0.01^{bc}	0.11±0.01^{abcd}	0.04±0.00^{ab}	0.08±0.009^{bcd}	0.08±0.01^{bcd}
Royal poinciana	0.05±0.00^{a}	0.19±0.01^{a}	0.14±0.01^{a}	0.05±0.00^{a}	0.16±0.01^{a}	0.11±0.00^{a}
LSD	0.012	0.038	0.037	0.013	0.037	0.028
CV (%)	23.06	21.52	20.67	29.53	26.34	20.52

Data are presented as Mean±SE of 3 replicates, Means followed by same letters are not significantly different within a single column, based on one-way ANOVA and DMRT ($p<0.05$)

Root fresh weight: The roof fresh weight of three cucurbits was significantly affected by all 25% medicinal plant extracts, ($p<0.001$) in Table 5. In cucumber, the highest root fresh weight was found for royal poinciana (0.59 g) followed by ivy gourd (0.58 g), mimosa (0.55 g), mint (0.53 g), asthma plant (0.41 g), drumstick (0.38 g), bougainvillea (0.35 g), sisso (0.35 g), false daisy (0.28 g), devil's cotton (0.24 g) and control (0.23 g). For pumpkin, top most weight was observed for royal poinciana (2.76 g) followed by sisso (2.08 g), ivy gourd (1.93 g), asthma plant (1.58 g), mint (1.76 g), false daisy (1.43 g), bougainvillea (1.30 g), devil's cotton (1.21 g), mimosa (1.17 g), drumstick (0.79 g) and control (0.73 g). For bottle gourd, royal poinciana (3.07 g) also showed maximum weight followed by asthma plant (2.96 g), devil's cotton (2.40 g), ivy gourd (2.39 g), bougainvillea (2.32 g), sisso (2.27 g), drumstick (1.22 g), false daisy (2.02 g), mint (1.55 g), mimosa (1.20 g) and control (0.98 g).

The 50% concentrations also showed a significant effect on the shoot dry weight of cucumber, pumpkin and bottle gourd seedlings ($p<0.001$) (Table 5). In cucumber, the top successor is ivy gourd (0.88 g), followed by royal poinciana (0.72 g), sisso (0.51 g), mint (0.42 g), asthma plant (0.42 g), false daisy (0.38 g), devil's cotton (0.31 g), bougainvillea (0.31 g), drumstick (0.29 g), mimosa (0.27 g) and control (0.23 g). For pumpkin, royal poinciana (1.33 g) performed best followed by sisso (1.03 g), false daisy (0.99 g), mint (0.99 g), bougainvillea (0.98 g), ivy gourd (0.91 g), drumstick (0.90 g), devil's cotton (0.84 g), mimosa (0.83 g), asthma plant (0.83 g) and control

(0.73 g). Finally, the bottle gourd seedling found royal poinciana (2.07 g) best followed by false daisy (1.42 g), ivy gourd (1.39 g), sisso (1.27 g), bougainvillea (1.25 g), mimosa (1.20 g), devil's cotton (1.16 g), mint (1.12 g), asthma plant (1.06 g), drumstick (1.05 g) and control (0.98 g).

Root dry weight: All medicinal plant extracts of 25% concentrations significantly affected the root dry weight of cucumber, pumpkin and bottle gourd seedlings ($p<0.001$) in Table 6. In cucumber, highest dry weight was resulted from royal poinciana (0.05 g) followed by drumstick (0.04 g), sisso (0.04 g), mimosa (0.04 g), mint (0.04 g), devil's cotton (0.04 g), ivy gourd (0.04 g), asthma plant (0.03 g), bougainvillea (0.02 g), false daisy (0.02 g) and control (0.01g). In pumpkin, royal poinciana (0.19 g) secured top position followed by asthma plant (0.13 g), sisso (0.13 g), ivy gourd (0.11 g), bougainvillea (0.10 g), false daisy (0.10 g), mimosa (0.10 g), mint (0.10 g), drumstick (0.08 g), devil's cotton (0.07 g) and control (0.03 g). For bottle gourd, royal poinciana (0.14 g) also resulted maximum dry weight followed by bougainvillea (0.14 g), asthma plant (0.13 g), ivy gourd (0.11 g), sisso (0.11 g), mimosa (0.10 g), mint (0.10 g), devil's cotton (0.10 g), false daisy (0.09 g), drumstick (0.08 g) and control (0.04 g).

All medicinal plant extracts of 50% concentrations significantly affected the root dry weight of cucumber, pumpkin and bottle gourd seedlings ($p<0.001$) (Table 6). In cucumber, the best recorded dry weight was found for royal poinciana (0.05 g) followed by ivy gourd (0.04 g), sisso (0.04 g), mint (0.03 g), asthma plant (0.03 g), bougainvillea (0.02 g), false daisy (0.02 g), drumstick (0.02 g), mimosa (0.02 g), devil's cotton (0.02 g) and control (0.01 g). For pumpkin, royal poinciana (0.16 g) listed top followed by sisso (0.11g), asthma plant (0.10 g), drumstick (0.09 g), bougainvillea (0.08 g), false daisy (0.08 g), ivy gourd (0.08 g), mint (0.08 g), devil's cotton (0.07 g), mimosa (0.04 g) and control (0.03 g). For bottle gourd, royal poinciana (0.11 g) also resulted best followed by false daisy (0.10 g), sisso (0.10 g), bougainvillea (0.09 g), drumstick (0.09 g), asthma plant (0.09 g), ivy gourd (0.08 g), mint (0.08 g), mimosa (0.06 g), devil's cotton (0.06 g) and control (0.04 g).

DISCUSSION

In this experiment, we found that bougainvillea increased the seed germination, growth and vigour of some of the cucurbit seeds compare to control (Fig. 1-8, Table 3-6). Phytochemical screening of flower extracts of bougainvillea revealed the presence of alkaloids, flavonoids, phlobatannins and terpenoids and these bioactive natural products in flower extracts showed effective anti-pathogenic activities[29]. And along with anti-pathogenic activities, the leaf extracts enhanced seed germination and growth of bell pepper and tomato[10]. With false daisy, the germination and growth of cucurbits were not affected that much compare to control (Fig. 1-8, Table 3-6) and somewhere it was the same as control. A study showed that false daisy leaf extract inhibited the seed germination and seedling growth of crops and weeds[11]. In the current study, no allelopathic effect has been observed but neither it was a growth enhancer. The drumstick extract was tested in various ways previously. In this study, the germination percentage of cucumber and bottle gourd increased for 25 and 50% concentration, respectively which is consistent with the previous study[30]. The same trend was observed for other parameters like length, weight and vigour index (Fig. 1-8, Table 3-6). As some previous studies also found that the drumstick leaf extract contains an effective plant growth hormone zeatin that can increase the yield of crops by 25-30%[31]. Since the application of fresh drumstick leaf extract increased the growth and yield of wheat, maize, tomato and pepper[12,32-35]. But for pumpkin, it did not show any significant effect in all parameters. This study found the sisso leaf extracts as a growth enhancer (Fig. 1-8, Table 3-6) for cucumber crops rather a previous study found its suppressor for some cereal crops[14]. In contrast, the leaf extracts of mimosa inhibited the seed germination of three cucurbit species (Fig. 1-8, Table 3-6). The same result was also observed with brinjal, tomato and chili[15]. In an experiment, it was shown that mint-derived essential oil killed the mosquito larvae[36]. But here, when mint leave extracts were applied on seeds, it showed enhancing effect on seed germination and development (Fig. 1-8, Table 3-6). Devil's cotton, asthma plant and ivy gourd increases the germination and growth of all three tested cucurbits seeds. Though they did not perform the same for the same concentration always it can be seen that they increased germination and growth compared to control (Fig. 1-8, Table 3-6). The interesting thing is that all medicinal plant extracts showed an effect on germination and growth for 25 and/or 50% concentrations but the royal poinciana, maintained its consistency of increasing seed germination percentage, root length, shoot length, vigour index, fresh and dry weight of at those three cucurbits (Fig. 1-8, Table 3-6). Among all ten extracts, royal poinciana performed better. As we know, plant extracts and crop residues have been reported to influence seedling growth and yield of crops[37-41]. Plant extracts influence dry matter weight, root length and shoots length of crop plants. The influence of plant extracts on seed and seedling vigour due to the presence of phytochemicals

has been reported earlier[42,43]. Allicin in garlic juice corrected the poor germination of wheat seeds and showed the growth-promoting activities of garlic juice on wheat seedling vigor[44]. Seed treatment with an aqueous extract of sisal agave (*Agave sisalana*) improves seed health and seedling growth of sorghum[45]. So, the different phytochemicals present in extracts could trigger the seed germination of the three tested crops in our experiment. Though there is information available regarding phytochemicals for the tested medicinal plants but in a phytochemical screening, it was found that alkaloids, terpenoids, steroids, saponins, phenol and flavonoid were found to be present in leaves, root and stem extract of royal poinciana[46,47]. And those could affect the germination and growth of cucurbits seeds.

CONCLUSION

All medicinal plants proved them as growth stimulators while applied as 25% concentration or 50% concentration or both. However, this is the first experiment where royal poinciana, mint, devil's cotton, asthma plant and ivy gourd were tested on seed and a promising result has been found for royal poinciana especially. A further detailed experiment is required to find out the actual chemical component with appropriate concentration.

SIGNIFICANCE STATEMENT

This study discovered the ability of royal poinciana along with four newly tested medicinal plants to enhance germination and early seedling growth of cucurbits crops. The consistent results observed for royal poinciana indicate a good prospect to be used as a germination and growth regulator that can be beneficial for organic and eco-friendly farming.

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