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Research Article

ROLE OF ALLELOCHEMICALS FROM AN OBNOXIOUS WEED - *STACHYTARPHETA JAMAICENSIS* (L.) VAHL., ON GROWTH PARAMETERS OF CROP PLANTS- *ELEUSINE CORACANA* GAERTN. (RAGI) AND *TRIGONELLA FOENUM- GRAECUM L.* (FENUGREEK)

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ABSTRACT
The plant *Stachytarpheta jamaicensis (L.)* Vahl., commonly known as blue snakeweed belongs to the family Verbenaceae. It has been considered as an obnoxious weed, distributed throughout the tropics and subtropics and it is naturalized in India (seen in Karnataka and Kerala). It has several medicinal properties and is used in folklore remedies. However, no information is available in literature on the allelopathic activity of this obnoxious weed on the germination of crop plants like *Eleusine coracana* Gaertn. (Ragi) and *Trigonella foenum- graecum L.* (Fenugreek). Hence, the present study was undertaken to analyze the allelopathic effects of the *Stachytarpheta jamaicensis* (L.) leaf leachate allelochemicals at three different of concentrations – 1%, 5% and 10% on the seed germination of test crops - *Eleusine coracana* Gaertn. and *Trigonella foenum- graecum L.*. The linear growth - root and shoot length and the biomass of the seedlings were recorded. The Growth equations- Percent germination of seeds, Percentage seed mortality, Relative elongation of shoot, Relative elongation of root, Relative Biomass Ratio, Seedling Vigour index and Relative growth ratio were calculated for both the test crops. The results showed that the allelochemicals of 10% proved inhibition while, the same of 1% showed promotion in both ragi and fenugreek for all the above mentioned parameters analyzed. Therefore, our study shows that 10% leaf allelochemicals proved inhibitory exhibiting the allelopathic effect on seed germination over the 1% leaf allelochemicals which acted as a liquid fertilizer by promoting the growth in both the test crops studied.

Keywords: *Stachytarpheta Jamaicensis* (L.), *Eleusine Coracana* Gaertn. (Ragi), *Trigonella Foenum-Graecum* L. *(Fenugreek), Leaf Leachate, Allelochemicals and Allelopathy.*

INTRODUCTION
The term allelopathy, originated from the Greek word `allelon' meaning `each other' and `pathos' meaning `suffering' (Gross, 1999). Allelopathy refers to the beneficial or harmful effects of one plant on another plant, both crop and weed species, from the release of biochemicals, known as allelochemicals, from plant parts by leaching, root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems. The different plant parts, including flowers, leaves, leaf litter and leaf mulch, stems, bark, roots, soil, and soil leachates and their derived compounds, can have allelopathic activity that varies over a growing season. Allelochemicals are a subset of secondary metabolites not required for metabolism (growth and development) of the allelopathic organism and some of them have been treated as allelopathic substances because of their potential phytotoxicity (Field *et al.*, 2006; Kato-Noguchi *et al.*, 2014). Allelopathic inhibition is complex and can involve the interaction of different classes of chemicals, such as phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates, and amino acids, with mixtures of different compounds sometimes having a greater allelopathic effect than individual compounds alone. Allelochemicals can also persist in soil, affecting both neighbouring plants as well as those planted in succession Allelochemicals with negative allelopathic effects are an important part of plant defense against herbivore (i.e., animals eating plants as their primary food) (Fraenkel, 1959; Stamp, 2003). Allelopathic effects can be inhibitory or stimulatory (Nasrine, 2011). Use of allelochemicals help in effective economic management of weeds and production of eco-friendly fertilizers.

Stachytarpheta jamaicensis (L.) Vahl is a member of the family of Verbenaceae and is commonly known as Gervao, Brazilian tea, verbena cimarrona, rooter comb, or blue porter weed. This plant mostly grows in the tropical regions of America as well as in the subtropical forests of Africa, Asia and Oceania. It is also widely distributed in acclimatized tropics such as those in Malaysia and Indonesia and found to be naturalized in India (seen in Karnataka and Kerala). It is referred to as "Jolok Cacing" or "Selasih Dandi" in these countries. *S. jamaicensis* is a weedy herbaceous plant that grows 60–120 cm tall. This plant has a smooth, dark green coloured stem, which turns woody towards the base of the stem. It normally reproduces flowers in mix of bluish and pinkish colours or could bear flowers with a purple to deep blue colour. The leaves are opposite, greyish green in colour, have a smooth surface, and have a round apex and distinct petioles. It has been an important medicinal plant with great medicinal properties in traditional and folk medicinal systems. This plant has been used traditionally by the elderly as a cure for allergies and respiratory conditions, cough, cold, fever, constipation, digestive complications and dysentery and promote menstruation among others.

This plant has been reported to possess pharmacological effects due to the presence of various bioactive phytochemicals. In herbal medicine, it has been known to demonstrate antacid, analgesic, anti-inflammatory, hypotensive, antihelminthic, diuretic, laxative, lactagogue, purgative, sedative, spasmogenic, vasodilator, vulnerary, and vermifuge properties (Liew and Yong, 2016).

Plate 1: *Stachytarpheta jamaicensis* (L.) Vahl.

Inspite of the above reports on medicinal properties of this plant, very less information is available in the literature on the allelopathic studies of *Stachytarpheta jamaicensis* (L.) Vahl., on crop plants.

The allelopathic effects of aqueous extracts of *Stachytarpheta jamaicensis* (L.) Vahl, was studied against selected fungal pathogen and test plants. Growth response of the test fungi to the extracts include inhibition of spore germination, mycelial growth, reduction in the number and size of lesion (Noriel *et al*., 1994).

The allelopathic extracts caused inhibited germination of seed/tubers and reduction in root and shoot growth of the different test plants. The aqueous leaf extracts of *S. jamaicensis* inhibited seed germination and radicle growth of many local herbaceous plants implying it has allelopathic potential (Kuo, 2001).

The effects of aqueous flower extract of *Stachytarpheta jamaicensis* on seed germination and seedling growth in six economic crops were studied by filter paper method.

The results showed that all the water extracts inhibited the seed germination rate and germination index of the six plant species and this inhibition became strong as the concentration of extractions increased (Guan *et al.*, 2012).

MATERIALS AND METHODS

Materials

The study was conducted in the Laboratory of the Department of Life Sciences, Bangalore University, Bangalore. The leaves of *Stachytarpheta jamaicensis* (L.) Vahl were collected from Maruthi nagar of Bangalore University, Bangalore. The leaves were air dried, packed in paper bags and stored. The leachate was obtained by soaking ten grams of air dried powdered leaves of *Stachytarpheta jamaicensis* (L.) Vahl. (Verbenaceae) in 100ml of glass distilled water for 72hrs at the room temperature. The leachate was then filtered through whatmann No.1 filter paper and stored under refrigeration. From 10% leachate stock, 2 dilutions of 5% and 1% were prepared.

Along with these 2 dilutions, the leachate stock of 10% concentration were tested against control (distilled water) on the growth of the test crops- *Eleusine coracana* (L) Gaertn. (Ragi) and *Trigonella foenum-graecum* L. (fenugreek) obtained from G.K.V.K. farm, Bangalore.

Methods

Bioassay

In the seed germination bioassay, the Ragi and Fenugreek seeds were surface- sterilized in 0.1% Mercuric chloride, washed thoroughly and spread in sets of 7 grains in 9cm diameter petridishes lined with sterilized filter paper moistened with 3ml of DW, 1%, 5% and 10% concentrations respectively. The evaporation loss of the liquid from the medium was made good daily. Each set was replicated 4 times and radical emergence was considered as the criterion of germination. The seedlings were harvested after 10 days. During the experimental period, the mean maximum and mean minimum temperature were 30ºC and 27 ºC respectively. The relative humidity ranged between 53-76%. After 10 days, the morphological parameters viz., the germination of seeds, the linear growth- shoot and root length, dry matter accumulation, germination and growth ratios obtained were recorded (Poornima *et al.,* 2015).

Stastistical Analysis

The values subjected to statistical analysis are expressed as Mean± standard error of Mean (SEM). One way analysis of variance (ANOVA) was employed to elucidate the significance difference at $p<0.05$ between two different groups, following to Duncan's Multiple Range Test (DMRT) post hoc.

RESULTS AND DISCUSSION

Results

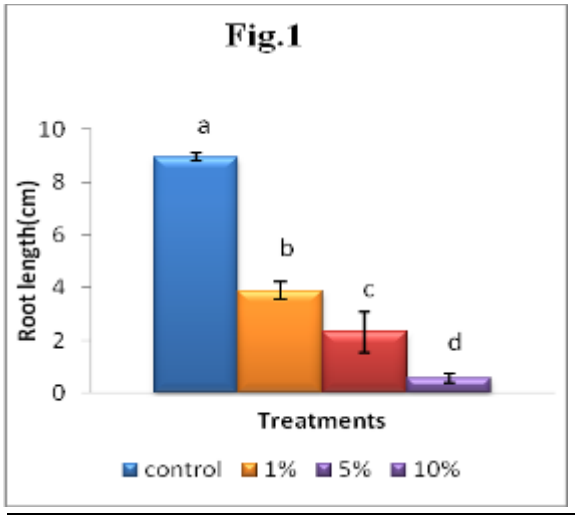
The results of seed bioassay trial with different concentrations of leaf leachate (Control, 1%, 5% and 10%) of *Stachytarpheta jamaicensis* (L.) Vahl on *Eleusine coracana* Gaertn (Plate 2 and Figures 1-11).

The root length showed significant decrease in treatments 1%, 5% and 10% when compared to control. Whereas treatment 1% showed promotion and the 10% showed much lesser significant value than all other treatments (Figure 1). For shoot length there was significant decrease in treatments 1%, 5%, 10% when compared to control. However, 1% showed promotion and the 10% showed significantly lesser value than all other treatments (Figure 2). There was insignificant decrease in fresh weight of treatments 1%, 5%, 10% when compared to control. Whereas, treatment 10% was found to be insignificantly less than all other treatments (Figure 3). In case of dry weight, there was significant decrease in treatments 5% and 10% when compared to control. However, treatment 1% is moderately significant than control and 5% (Figure 4). With respect to Percent germination, there was insignificant decrease in the treatment 5% when compared to control. Whereas, 10% showed significant decrease to control. However, 1% treatment showed comparable insignificant as compared to control (Figure 5).

In case of Percent mortality rate, the treatment 10**%** showed significant increase when compared to control and 5%. Whereas, treatment 5% and control are insignificant compared to each other. Percent mortality rate is 0 in 1% (Figure 6). There was significant decrease in Relative elongation of shoot in treatments 1%, 5%, 10% when compared to control. Whereas, treatment 1% showed significant increase on Relative elongation of shoot than treatment 5%. However, treatment 10% showed least significant decrease than all other treatments (Figure 7). In case of Relative elongation of root, there was significant decrease in treatments 1%, 5%, 10% when compared to control. Whereas, treatment 5% showed

significant decrease than treatment 1%. However, treatment 10% showed least significant decrease than all other treatments (Figure 8).

Plate 2: Seed Bioassay Trails of *Eleusine coracana* (L.) Gaertn (Ragi) with Leaf Leachate of *Stachytarpheta jamaicensis* (L.) Vahl. (Control (DW), 1%, 5% and 10% Leachate)



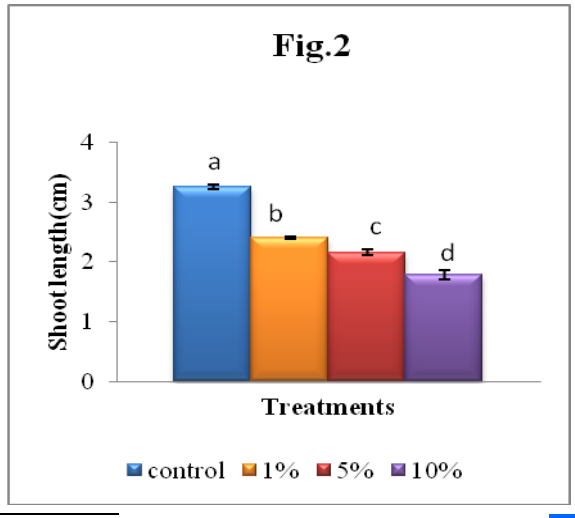


Fig.3

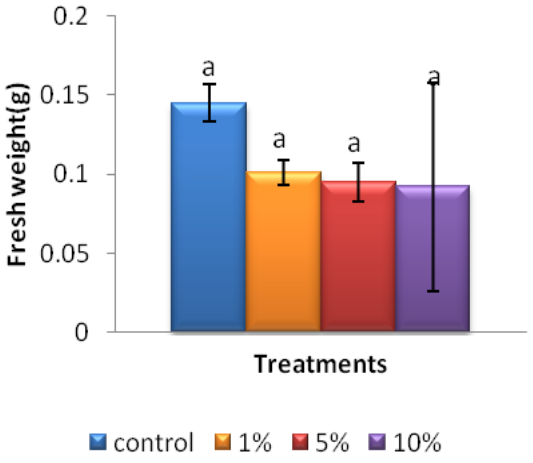


Fig.4

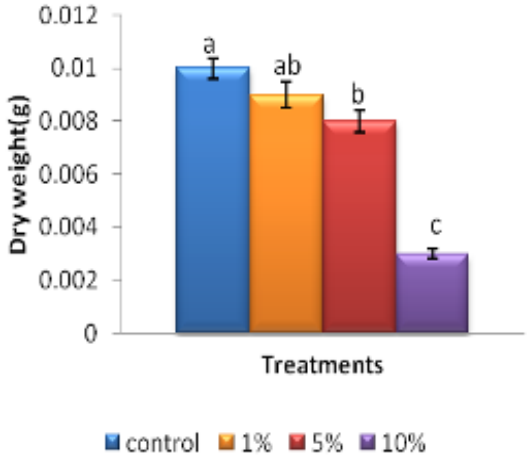


Fig.5

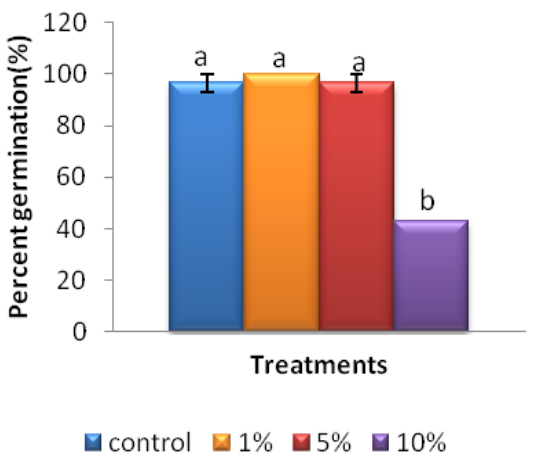


Fig.6

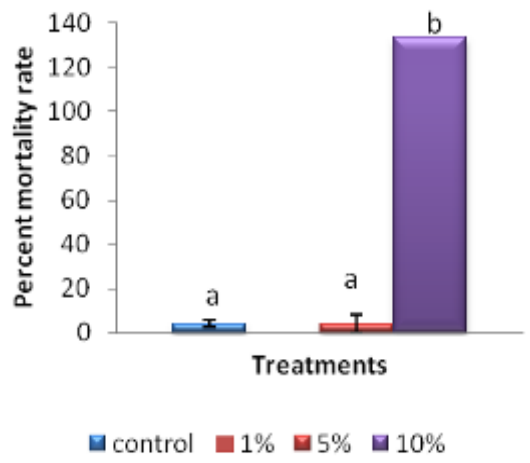


Fig.7

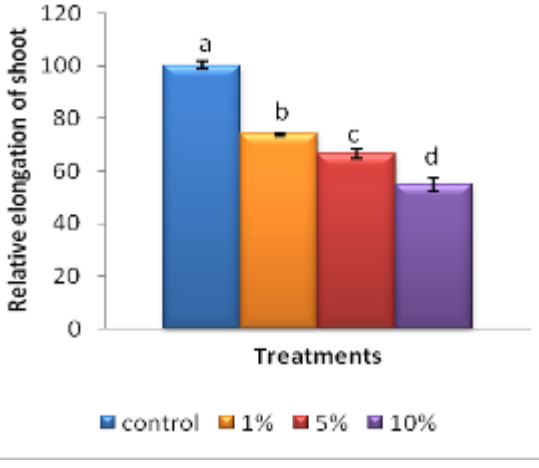
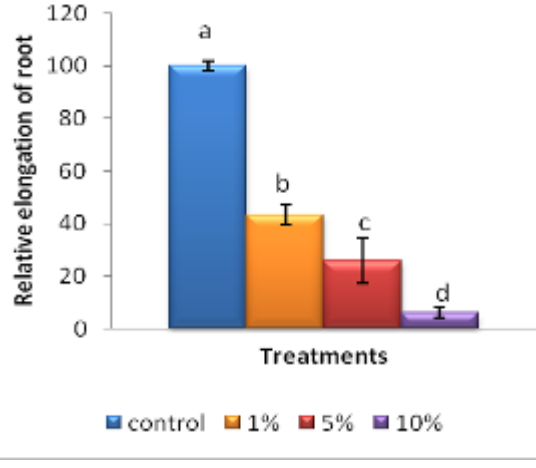
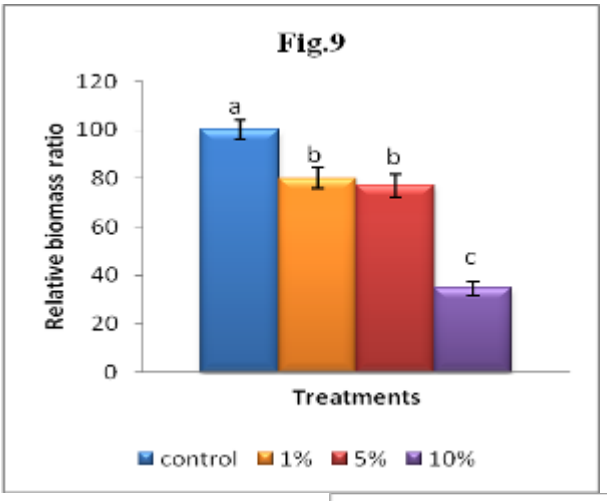
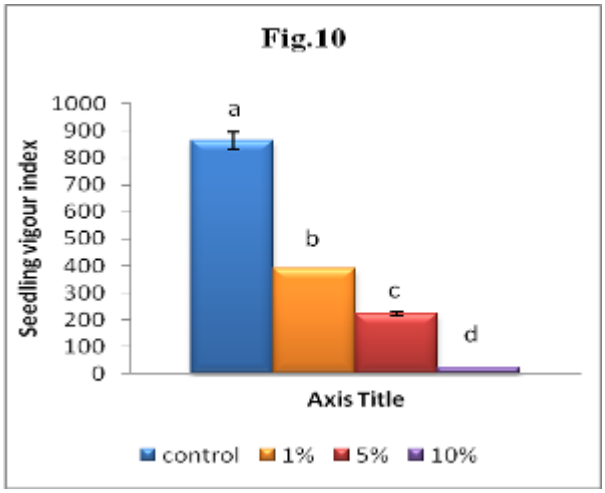


Fig.8







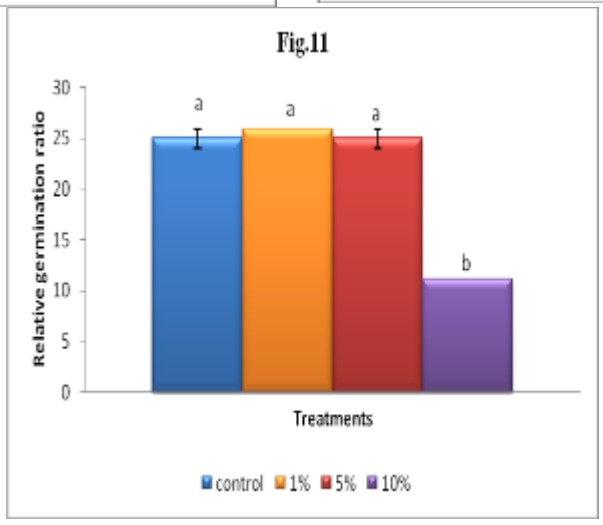


Figure 1-11: Effect of *Stachytarpheta jamaicensis* (L.) Vahl Leaf Leachate Treatments (1%, 5% & 10% & Control (DW)) on various Growth Parameters of *Eleusine coracana* (L.) Gaertn (Ragi)

There was significant decrease on relative biomass ratio in treatments 1%, 5% and 10% when compared to control. Whereas, treatment 5% showed insignificant decrease on Percent mortality rate than treatment 1%. While 10% showed total inhibition (Figure 9). With respect to seedling vigour index, there was significant decrease in treatments 1%, 5% and 10% when compared to control. The 10% showed least significant decrease on seedling vigour index compared to all (Figure 10).

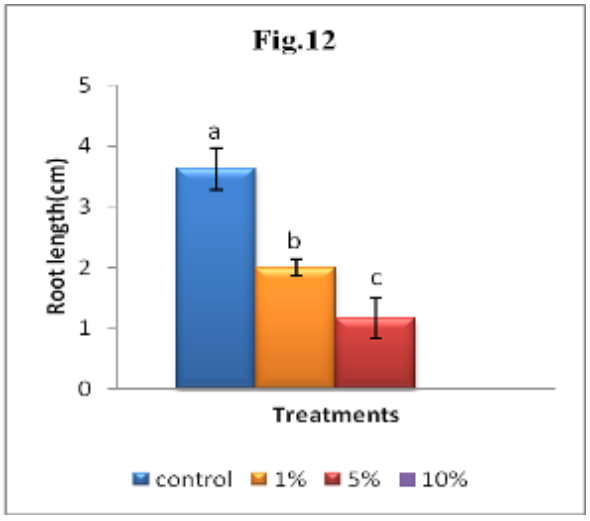
There was significant decrease in Relative germination ratio in treatment 10% when compared to control. Whereas treatments1% and 5% showed insignificant value as compared to each other. However, 1% treatment is nearer to control (Figure 11).

The results of seed bioassay trial with different concentrations of leaf leachate (Control, 1%, 5% and 10%) of *Stachytarpheta jamaicensis* (L.) Vahl on *Trigonella foenum- graecum L.* (Plate 3 and Figures 12-22).

In case of root length, there was significant decrease in treatments 1%, 5% when compared to control. The treatment 5% showed lesser significant value when compared to 1%. The seedlings did not germinate in 10% (Figure 12). With respect to shoot length, the 1% showed insignificant decrease than control. While there was significant decrease in treatment 5% when compared to control. The seedlings did not germinate in 10% (Figure 13). For fresh weight, there was significant decrease in treatment 5% when compared to control. Whereas, treatment 1% showed insignificant value as compared to control. The

seedlings did not germinate in 10% (Figure 14). With respect to dry weight, the value was moderately significant in treatment 1% when compared to control. Whereas 5% was found to be less significant as compared to 1%. The seedlings did not germinate in 10% ((Figure 15). In case of Percent germination of seeds, there was significant decrease in the treatment 5% when compared to control. However, treatment 1% showed insignificant increase than control. The seedlings did not germinate in 10% (Figure 16).

Plate 3: Seed Bioassay Trails of *Trigonella Foenum- Graecum L. (*Fenugreek) with Leaf Leachate of *Stachytarpheta Jamaicensis* (L.) Vahl (Control (DW), 1%, 5% and 10% Leachate)



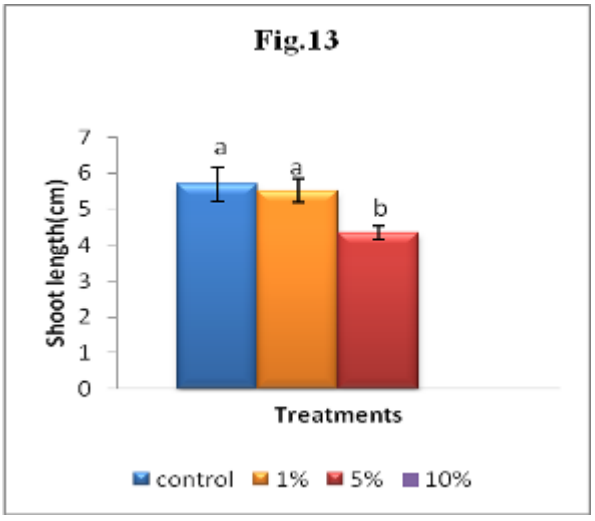


Fig.14

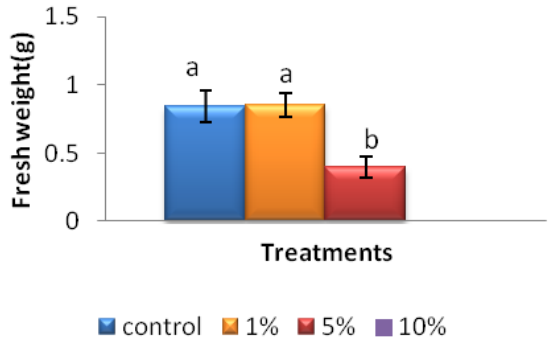


Fig.15

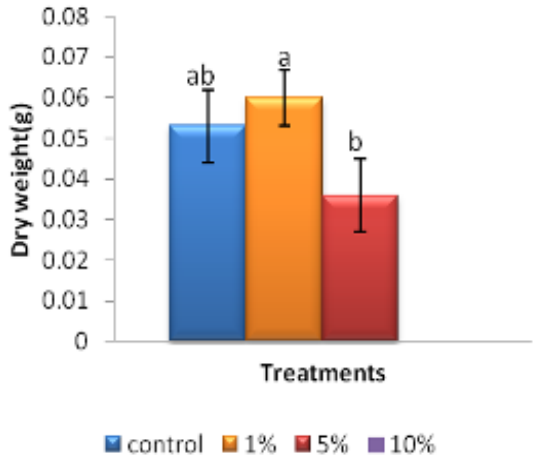


Fig.16

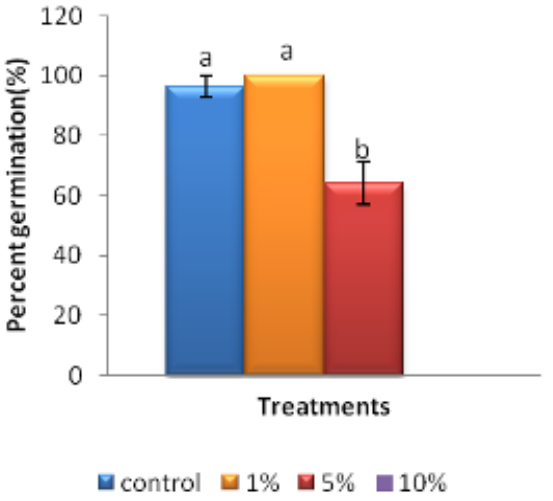


Fig.17

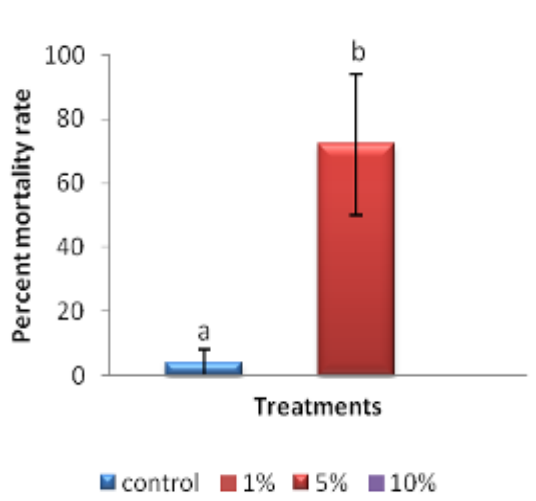


Fig.18

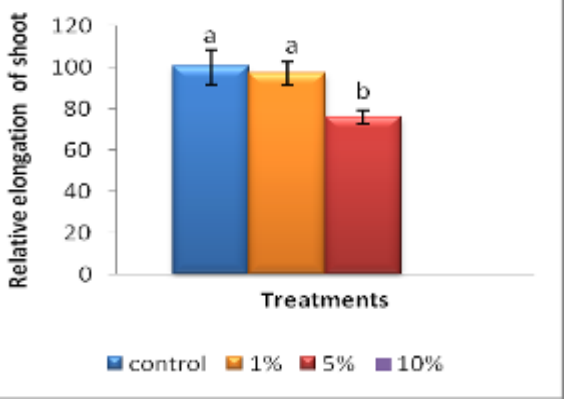
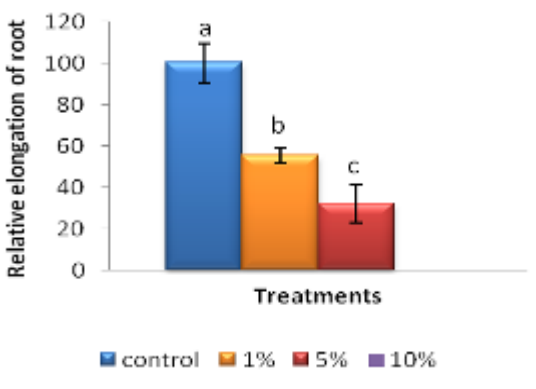


Fig.19



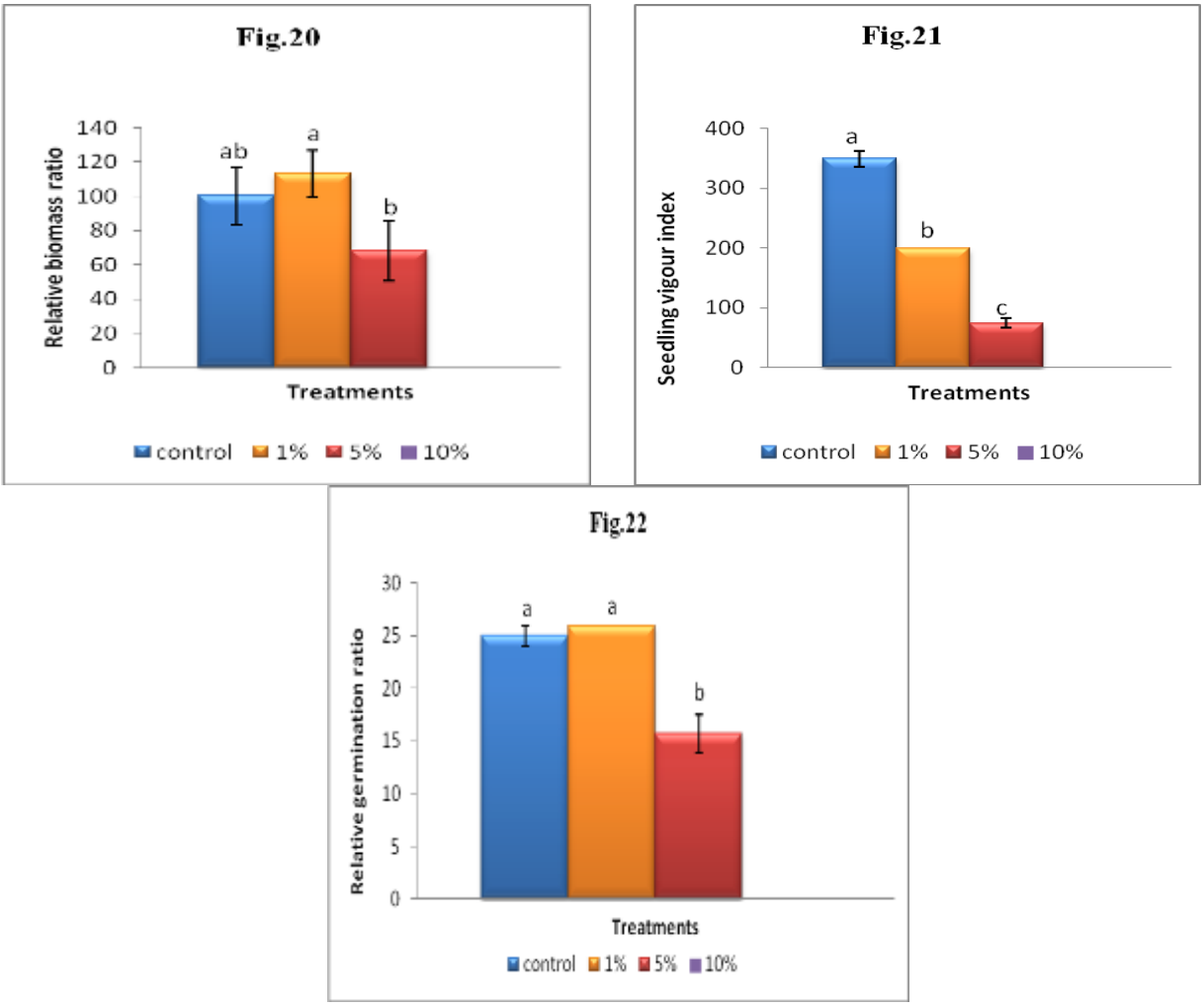


Figure 12-22: Effect of *Stachytarpheta jamaicensis* (L.) Vahl Leaf Leachate Treatments (1%, 5%, 10% & Control (DW)) on various Growth Parameters of *Trigonella Foenum- Graecum L* (Methi)

In case of Percent mortality rate, there was significant increase on in treatment 5% when compared to control. While none of the seeds died in 1% and none of the seeds germinated in 10%. The seedlings did not germinate in 10% (Figure 17). For Relative elongation of the shoot, there was significant decrease in treatment 5% when compared to control. However, treatment 1% showed insignificant decrease than control. The seedlings did not germinate in 10% (Figure 18). For Relative elongation of root, there was significant decrease on in treatment 1% and 5% when compared to control. Whereas, treatment 5% showed least significant decrease when compared to all. The seedlings did not germinate in 10% (Figure 19).

For Relative Biomass Ratio, the value was moderately significant in treatment 1% when compared to control. Whereas, treatment 5% showed moderately significant decrease on relative biomass ratio as compared to 1%. The seedlings did not germinate in 10% (Figure 20). In case of seedling vigour index, there was significant decrease in treatment 5% and 1% when compared to control. However, treatment 5% showed least significant decrease on seedling vigour index level than all. The seedlings did not germinate in 10% (Figure 21).

In case of Relative germination ratio, there was significant decrease in treatment 5% when compared to control and 1%. However, treatment 1% showed insignificant value as compared to control. The seedlings did not germinate in 10% (Figure 22).

Discussion

The aqueous crude leaf leachate of 1%, 5% and 10% concentration of *Stachytarpheta jamaicensis* (L.) rich in allelochemicals were tested on seed germination of the test crops – *Eleusine coracana* Gaertn. and *Trigonella foenum- graecum L.*

In case of ragi, the 1% leachate concentration promoted Root length, Shoot length, Fresh and dry weight of seedlings, Percentage germination of seeds, Relative elongation of shoot and root, Relative biomass ratio, Seedling vigour index, relative germination ratio and showed zero percent mortality rate compared to 5% and 10% leachate concentrations while the 10% leachate proved inhibitory on all the above mentioned parameters and showed maximum percent mortality rate. Markedly the percentage germination of seeds and relative germination ratio was significantly high in 1 % compared to control.

In case of Fenugreek, the 1% leachate concentration promoted all the above mentioned parameters compared to 5 and 10% leachates. Markedly the percentage germination of seeds, relative biomass ratio and relative germination ratio was significantly high in 1 % compared to control. The 10 % leachate showed complete inhibition as none of the seeds germinated in the same. Therefore, our study proves that 10% inhibits the growth and 1% promotes the growth in both the test crops studied.

Allelochemicals of *Stachytarpheta jamaicensis* (L.) Vahl containing liquid fertilizers enhanced the growth in the treated plants over control plants. These allelochemicals at lower concentration -1% act as eco-friendly fertilizers which also confers disease resistance in crop plants. Hence, we authors opine to create awareness among the scientific community, farmers and public to encourage the utilization of weed derived allelochemicals as liquid fertilizers for enhancing crop productivity which also marks an efficient weed management strategy in the future days to come.

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