Original Research Article

In vivo evaluation of botanicals and bio-agents against web blight (*Rhizoctonia solani*) ofMungbean (*Vigna radiata*)

Abstract

Web blight, caused by the fungus Rhizoctonia solani, poses a significant threat to mungbean (*Vigna radiata*) production, leading to yield losses and economic repercussions. This study investigates the antifungal of botanical extracts and bio-agents in managing web blight in mungbean crops. A series of controlled experiments were conducted to assess the antifungal properties of selected botanicals and the biocontrol potential of specific microbial agents.Various extracts, including botanicals and bio-agents have been found effective for management of web blight of mungbean caused by *R. solani*. The present investigation was carried out on disease management through use of botanicals and bio-agents.The minimum disease incidence and maximum disease control was obtained in Garlic followed by Ginger, Neem, Onion, Tulsi,Clerodendron, Sadabahar, at 10% concentrations at 50 days after sowing in pot sown crop, Each treatments differed significantly from each other.

Keywords: Web blight, Antifungal, microbial agents, Botanicals and Bio-agents.

Introduction:

Mungbean(*Vigna radiate* L.) is traditionally cultivated during the rainy season, but the introduction of early maturing varieties has expanded its suitability to spring and summer seasons. Renowned for its rich protein content (24.5%), mungbean stands out due to its high-quality lysine (460 mg/g N) and tryptophan (60 mg/g N). Sprouted mungbean exhibit a notable quantity of ascorbic acid, along with riboflavin (0.21 mg/100 g) and minerals (3.84 g/100g) (Chandra*et al*., 2016). As a short-duration crop, mungbean is well-suited for various multiple and inter-cropping systems. After pod harvesting, mungbean plants can serve as valuable green fodder or green manure. Additionally, the crop contributes to soil enrichment through atmospheric nitrogen fixation. Among pulses, mungbean (*Vigna radiata*L.), commonly known as green gram or golden gram, holds significance as a short-duration pulse crop in India, cultivated during kharif, spring, and summer seasons(Chandra *et al*., 2019). The deep root system of the mungbean plant aids in soil binding, preventing erosion.

Mungbean is utilized in various forms, including dehulled grain, hulled (dal), husked, and dehusked dal. Soaked and sprouted mungbean find application in salads, and the crop is also valued for diverse culinary purposes(Upmanyu*et. al*., 2005)

In India, commonly cultivated pulses include mungbean, urdbean, pigeon pea, lentil, fieldpea, and chickpea. Among these, Mungbean, also known as Green gram and botanically identified as *Vigna radiate* (L.), holds significant importance as one of the country's key pulse crops. It is cultivated during the Kharif, spring, and summer seasons. Mungbean is native to Asia, particularly the North Eastern Indo-Burma region. Its progenitor, *Vigna radiate*can be found growing wild in the wastelands of Central India(Singh*et. al*., 2017).

Mungbean cultivation spans 3.07 million hectares in India, yielding 1.52 million tons of grains. The primary cultivation regions include Rajasthan, Maharashtra, Karnataka, Andhra Pradesh, Orissa, Bihar, Tamil Nadu, Madhya Pradesh, and Uttar Pradesh (Anonymous, 2019). In Uttar Pradesh alone, it occupies 93,000 hectares, producing 94,800 tons. However, the average productivity of mungbean in India and Uttar Pradesh stands at 567 kg/ha and 536 kg/ha, respectively, significantly below its genetic potential of 1500-2000 kg/ha (Anonymous, 2019). This low productivity is attributed to various biotic and abiotic stresses, with diseases caused by fungi, bacteria, and viruses being prominent factors negatively impacting mungbean yields.

Mungbean faces significant challenges globally, as various fungal, bacterial, and viral diseases have been documented, causing substantial yield losses. Notable among these ailments are web blight (Rhizoctonia solani Kühn), cercospora leaf spot (*Cercosporacruenta*), anthracnose (*Colletotrichum capsici*), powdery mildew (*Erysiphe polygoni*), macrophomina blight (*Macrophominaphaseolina*), bacterial leaf blight (*Xanthomonas phaseoli*), leaf crinkle (Urdbean leaf crinkle virus), and yellow mosaic (Mungbean Yellow mosaic virus). Web blight, prevalent in warm and humid tropical zones, poses a significant challenge to mungbean production globally, particularly causing severe losses in Uttar Pradesh and the Tarai region of Uttarakhand (Saksena and Dwivedi, 1973).

The initial report of web blight on mungbean dates back to 1924 in the Philippines by Nacien. In India, Dwivedi and Saksena (1974) were the first to document its presence in Kanpur, Uttar Pradesh. Subsequently, it has been recorded in various regions, including Assam (Saikia, 1976), Punjab (Bains *et al*., 1988), Madhya Pradesh (Tiwari and Khare, 1998), Bihar, Rajasthan, Haryana, Himachal Pradesh, and Jammu & Kashmir (Anonymous,

2004). Rhizoctonia solani (Kuhn) causes significant yield losses in both mungbean and urdbean crops in India (Dubey, 2003).

Web blight, a fungal disease, is a recurring threat with varying intensity each year, leading to substantial reductions in yield. The impact is more severe when plants are infected earlier, specifically after 25 days after sowing (DAS) compared to 35 and 40 DAS (Gupta *et al*., 2003). Gupta *et al*. (2010) reported yield losses ranging from 33.40% to 37.80%, and weight losses ranging from 23.12% to 28.60% in different mungbean varieties, such as K 851, T44, and Pusa Baisakhi.

Materials and Methods:

The current research was conducted within the glass house facilities of the Department of Plant Pathology at Acharya Narendra Deva University of Agriculture & Technology in Kumarganj, Ayodhya, Uttar Pradesh. The specifics of the materials utilized, the experimental procedures employed, and the techniques adopted are provided below.

Geographical distribution:

Web blight, a widespread and common disease in India, significantly impacts the quality and quantity of mungbean production, resulting in substantial losses. The initial report of its occurrence on mungbean in India was made by Dwivedi and Saksena in 1974.

The disease is prevalent in various regions of India, including Uttar Pradesh, Bihar, Rajasthan, Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir (Anonymous, 1999), and Uttaranchal (Anonymous, 2004). Additionally, it affects other leguminous crops such as black gram (Saksena and Dwivedi, 1973; Sharma and Tripathi, 2001), cowpea and soybean (Verma and Thapliyal, 1976). Although the fungus does not seem highly specific to its habitat, it poses a significant threat to mungbean cultivation in Uttar Pradesh, causing substantial losses wherever the crop is grown.

Disease management:

Disease management proves challenging due to the broad host range and soil-borne nature of the pathogen. Efforts have been directed towards controlling this disease through the application of fungicides, bio-agents, and various plant extracts. The use of synthetic fungicides, while one of the control measures, has given rise to environmental pollution, residual effects in grains, and unintended harm to non-target organisms. In contrast, disease

management employing bio-agents and plant extracts is an economical, safe, and environmentally friendly alternative. Bio-agents like *Trichoderma spp*. and plant extracts from diverse species have demonstrated effectiveness against *R. solani*, addressing different diseases in various crops.

Efficacy of plant extracts against *R. solani* in *in vivo*:

The concentration of plant extracts found effective in vivo. Sixty eight pots were filled with sterilized soil @ 4 kg per pots. Fifteen seeds of susceptible mungbean variety (K 851) weresown in each pot and 10 plants were maintained finally. Inoculation of plants with pure culture of R. solani was done uniformly by using mycelial suspension having 15-20 bits per microscopic field (100 x) after 25 days of sowing on the third/fourth leaf and stem from the ground level. After eight hours of inoculation the effective concentration of plant extracts were sprayed to protect the plants. A total of five sprays of plant extracts were done at weekly interval. Check plants were sprayed only with distilled sterilized water alone.

The experiment was conducted in CRD (Completely Randomized Design) with seventeen treatments (plant extracts) including check and four replications kept in glass house.
First appearance of disease was observed. Disease severity was taken in 1- 9 scale given by Stone house, 1994.

Table 1. Disease rating scale for Rhizoctonia blight (Stone house, 1994)

Scale	Description	Reaction
1-2	No lesion on leaves	Highly resistant
3-4	1-25% area covered by lesions	Moderately resistant
5-6	25.1-50% area covered by lesions	Moderately resistant
7-8	50.1-75% area covered by lesions, pods also affected.	Susceptible
9	75.1-100% area covered by lesions, pods and stem also highly affected.	Highly Susceptible

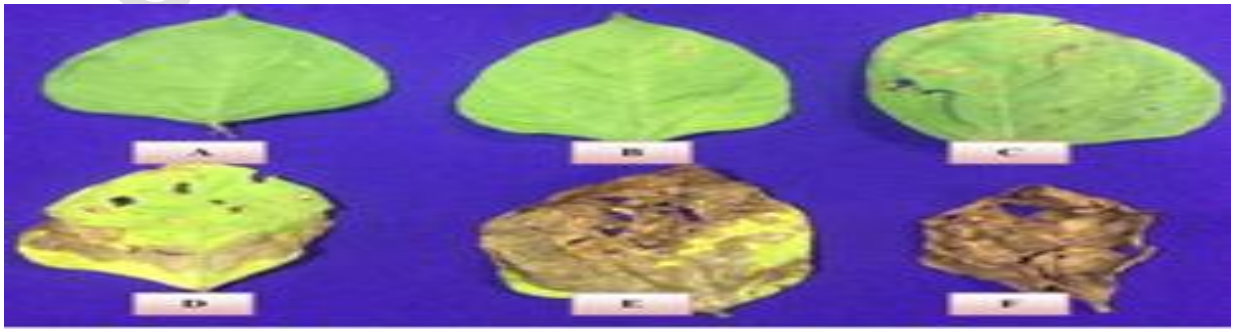

Fig 1. Disease Rating Scale (1-9)

Table 2.Disease rating scale for Rhizoctonia blight

Figure	Scale	Description	Reaction
A	1	No lesion on leaves	HR
B & C	3	1-25% area covered by lesions	MR
D	5	25.1-50% area covered by lesions	MS
E	7	50.1-75% area covered by lesions, pods also affected.	S
F	9	75.1-100% area covered by lesions, pods and stem also affected.	HS

The Per cent Disease Intensity (PDI) was calculated as described below:

Per cent Disease Intensity (PDI)

$$PDI = \frac{\text{Sumofall numerical rating}}{\text{Totalnumberofleavesexaminedx Maximum grade}} \times 100$$

The per cent disease control (PDC) was calculated by using following formula:

$$\text{Percentgrowthinhibition} = \frac{A1 - A2}{A1} \times 100$$

Where as

C= PDI in control

T= PDI in individual treatment.

Efficacy of bio-agents against *R. solani* in vivo:

Trichoderma viride and *T. harzianum* were used to see their effect by spraying on web blight of mungbean caused by *R. solani* in *in vivo.*

Fifteen seed of susceptible variety (K 851) were sown in each pot and finally 10 plants were maintained. The experiment was conducted in CRD with 3 treatments (bio-agents including control) in 4 replication. Pots were kept in glass house. Inoculation of plants by R. solani was done to ensure the disease appearance.

Bio-agents were sprayed @10' cfu (in 10 ml of water) after 8 hours by sterilized atomizer on the plants except check. Five sprays of bio-agents were done at weekly interval.

First appearance of disease was recorded. Per cent Disease Intensity and PDC were calculated as described earlier.

Results

Efficacy of plant extract against R. solani on disease incidence:

Ten per cent concentration of plant extracts was found most effective in vitro and was further tested in vivo to find out the effectiveness of the seven plant extracts at pre-maturity stages of crops i.e. 50 days after sowing.

Table 3. Effect of plant extract on disease incidence against web blight *in vivo* at 50 days

Plant extract	Concentration (%)	Disease incidence
Neem (*Azadirachta indica*)	10	25.40
Garlic (*Allium sativum* L.)	10	20.27
Tulsi(*Ocimumtenuiflorum*)	10	31.30
Onion(*Allium cepa*)	10	28.20
Ginger(*Zingiber officinale*)	10	22.70
Sadabahar(*Catharanthus roseus*)	10	42.60
Clerodendron(*Clerodendrum infortunatum*)	10	37.10
Control	10	82.60
CD at 5%		4.34

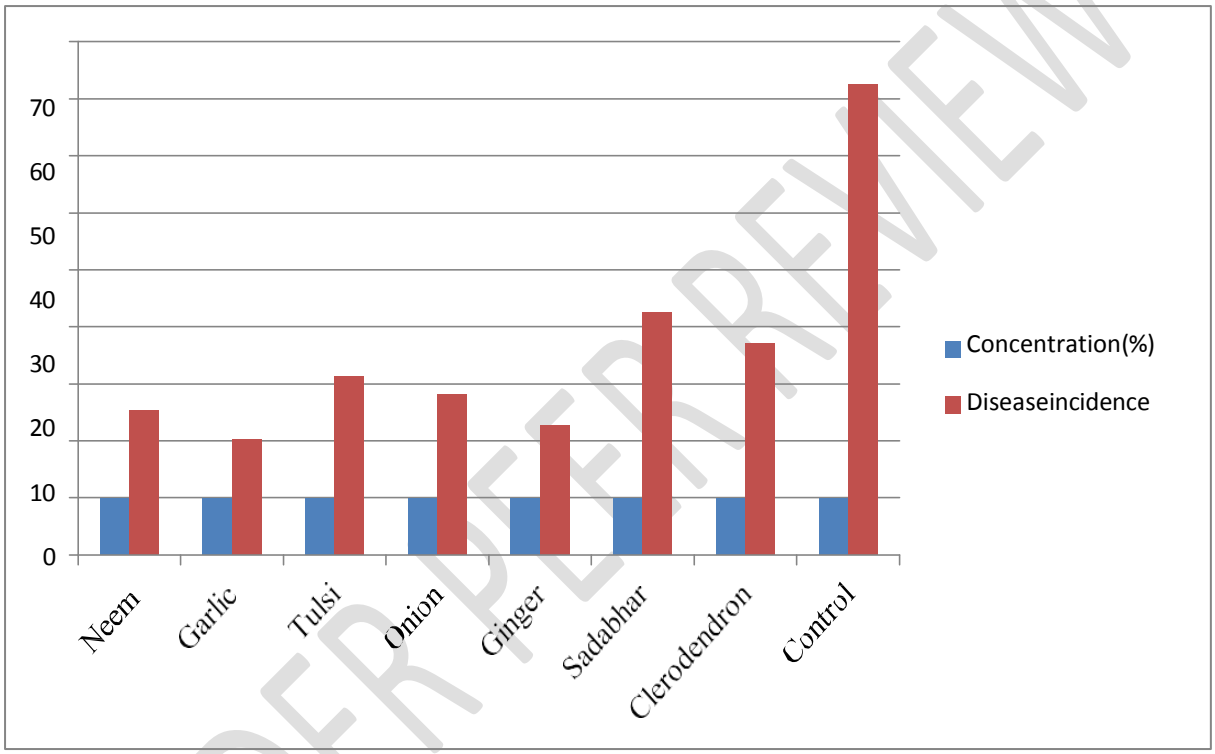

Fig 2. Effect of plant extract on disease incidence against web blight in vivo at 50 days.

The results clearly indicated that the minimum disease incidence was found Garlic (20.27%) followed by Ginger (22.27%), Neem (25.4%), Onion (28.20%), Tulsi(31.3%), Clerodendron (37.10%) and Sadabahar (42.60%), as compared to control (82.6%). Each treatment significantly superior to control where Garlic, Ginger, Neem,Onion and Tulsi were at par to each other. Tulsi, Clerodendron and Sadabahar were statically differed to each other.

Efficacy of plant extracts against *R. solani* on per cent disease control.

The maximum disease control was found in Garlic (75.34%) followed by Ginger (72.52%), Neem (69.25%), Onion (65.86%), Tulsi (62.11%), Clerodendron (55.05%) and Sadabahar (48.43%). Each treatment were significantly superior to control, Sadabahar and Clerodendron were statistically differed to each other. Tulsi and Onion, Onion and Neem, Neem and Ginger, Ginger and Garlic were at par to each other.

Table 3. Effect of plant extract on per cent disease control against web blight in vivo at 50 days

Plant extract	Concentration (%)	Disease incidence
Neem (*Azadirachta indica*)	10	69.25
Garlic (*Allium sativum* L.)	10	75.34
Tulsi(*Ocimumtenuiflorum*)	10	62.11
Onion(*Allium cepa*)	10	65.86
Ginger(*Zingiber officinale*)	10	72.52
Sadabahar(*Catharanthus roseus*)	10	48.43
Clerodendron(*Clerodendrum infortunatum*)	10	55.08
Control	10	0.00
CD at 5%		3.87

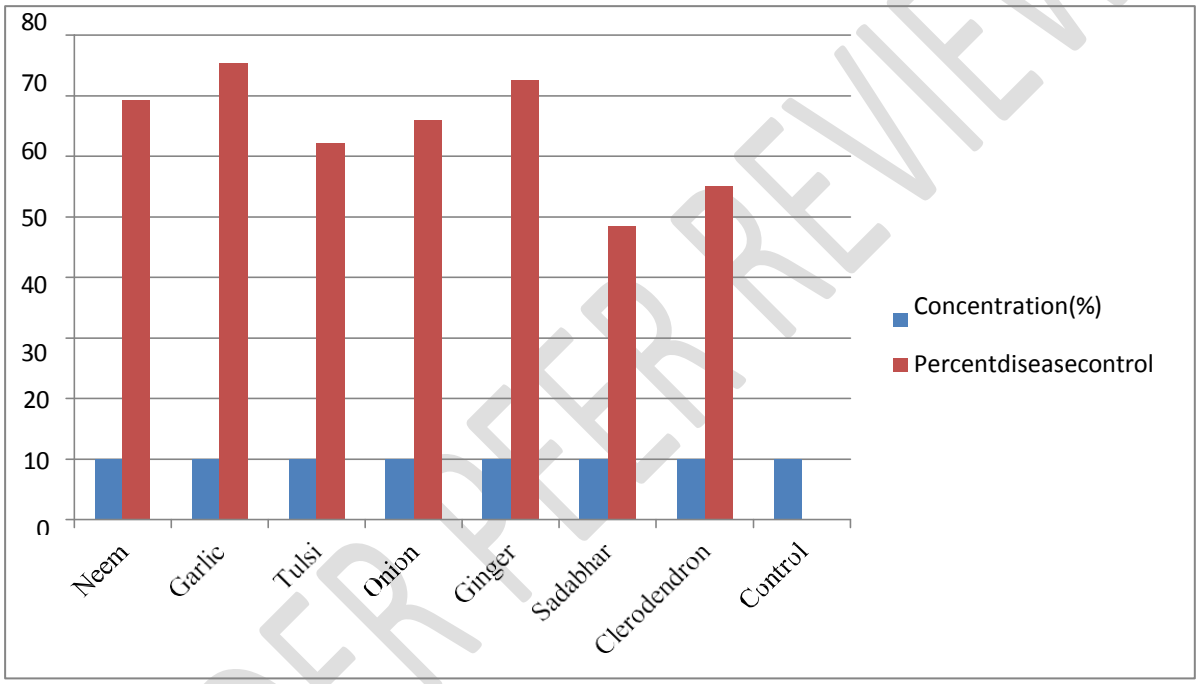

Fig 3. Effect of plant extract on per cent disease control against web blight in vivo at 50 days.

Thus, Garlic was most effective and Sadabahar was least effective reducing disease incidence.

Efficacy of bio-agents against R. solani on disease incidence

Disease incidences were found 62.90 per cent and 63.18 per cent in *T. viride* and *T. harzianum*, respectively as compared to control 82.56 per cent. The disease incidence in *T. viride*and *T. harzianum*were at par but differed with control.

Table 4. Effect of bio-agents on disease incidence against web blight in vivo at 50 days.

Treatment	Disease incidence %
Trichodermaviride	62.90

Trichodermaharzianum	63.18
Control	82.50
CD at 5%	15.29

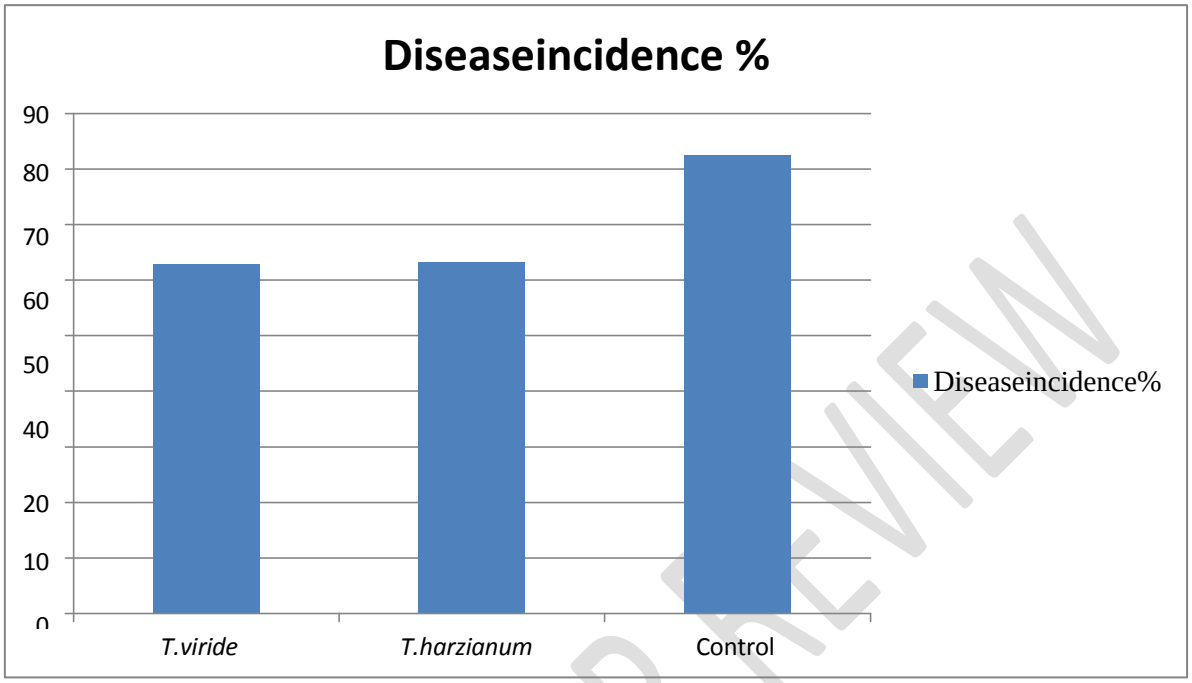

Fig 4. Effect of bio-agents on disease incidence against web blight in vivo at 50 days.

Efficacy of bio-agents against R. solani on per cent disease control.

Per cent disease control was found 24.40 per cent and 23.56 per cent in *T. viride* and *T. harzianum* respectively. *Trichoderma viride* and *T. harzianum* were at par with each other.

Thus, results clearly indicated that *T. viride* and *T. harzianum* suppressed the growth of *R. solani* in vitro but did not show any effect in vivo.

Table 5. Effect of bio-agents on percent disease control against web blight in vivo at 50 days

Treatment	Percent disease control
Trichodermaviride	24.40(29.03)
Trichodermaharzianum	23.56(29.03)
Control	0.00 (0.00)
CD at 5%	3.67

Figure given in parenthesis are transformed value.

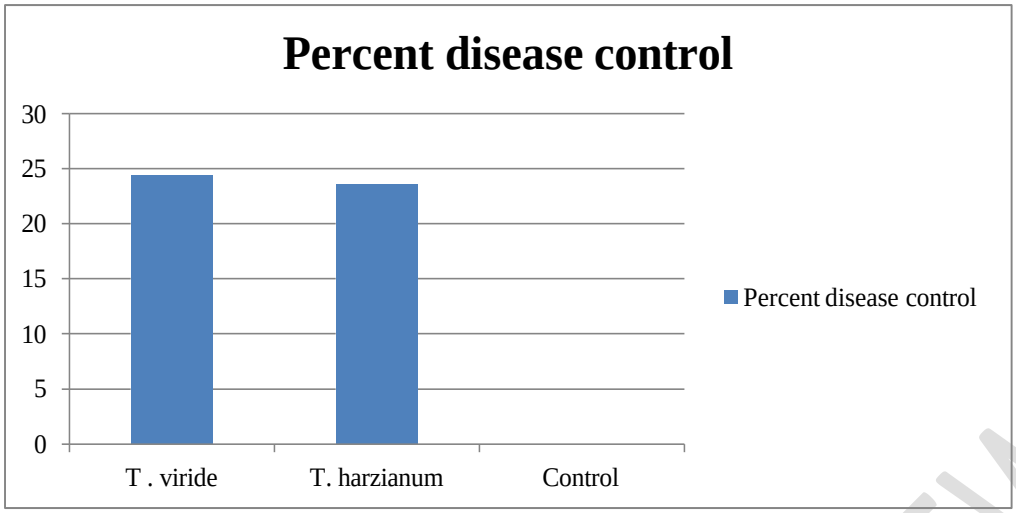

Fig 5. Effect of bio-agents on percent disease control against web blight in vivo at 50 days.

Conclusion:

1. The disease control was 24.40 and 23.56 per cent in *T. viride* and *T. harziamum*, respectively, which were at par to each other. Thus, the effect of bio-agents were very less when applied as foliar spray. This might be due to that the conditions were not favorable for increasing the population of bio-agents on the plants. As the bio-agents is mostly soil inhabitant and grow saprophytically in presence of high organic matter in soil and increase their population very fast.
2. In most of the cases bio-agents have been used either as seed treatments or in soil for suppressing the soil borne pathogen and reducing the disease incidence, through hyper parasitism, antibiosis and competition.
3. Effect of plant extract on disease incidence against web blight in vivo at 50 days: The results clearly indicated that the minimum disease incidence was found Garlic (20.27%) followed by Ginger (22.27%), Neem (25.4%), Onion (28.20%), Tulsi(31.3%), Clerodendron (37.10%) and Sadabahar (42.60%), as compared to control (82.6%) where Garlic and Ginger , Ginger and Neem , Neem and Onion, Onion and Tulsi were at par to each other.
4. Efficacy of plant extracts against R. solani on per cent disease control. The maximum disease control was found in Garlic (75.34%) followed by Ginger (72.52%), Neem (69.25%), Onion (65.86%), Tulsi (62.11%), Clerodendron (55.05%) and Sadabahar (48.43%). Each treatment were significantly superior to control, Sadabahar and Clerodendron were statistically differed to each other. Tulsi and Onion, Onion and Neem, Neem and Ginger, Ginger and Garlic were at par to each other.

Thus, Garlic was most effective and Sadabahar was least effective reducing disease incidence.

6. Efficacy of bio-agents against *R. solani* on disease incidence. Disease incidences were found 62.90 per cent and 63.18 per cent in *T. viride* and *T. harzianum*, respectively as compared to control 82.56 per cent. The disease incidence in *T. viride* and *T. harzianum*were at par to each other.
7. Efficacy of bio-agents against *R. solani* on per cent disease control. Per cent disease controls were found 24.40 per cent and 23.56 per cent in *T. viride* and *T. harzianum*, respectively. *Trichoderma viride* and *T. harzianum* were at par with each other.

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