APPLICATION OF HOMEOPATHIC MEDICINES IN ADDITION WITH SYNTHETIC CHEMICALS IN THE CONTROL OF ROOT ROT AND ROOT KNOT PATHOGENS AND ON THE GROWTH OF CROP PLANTS

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ABSTRACT

The present study was carried out to control the root rot fungi (*Rhizoctonia solani, Fusarium* spp. and *Macrophomina phaseolina*) and root knot nematode (*Meloidogyne javanica*) by treating leguminous (mung bean and mash bean) and non-leguminous (sunflower and okra) seeds with homeopathic drugs in addition with soil drenching with fungicides and nematicides, respectively. Of the different combined and individual applications of seed treatment and soil drenching, it was found that, combined application of the tested seeds treated with *Arnica montana* and *Thuja occidentalis* at 75% concentration and soil drenching with dithane and mancozeb at 0.1% showed enhancement in growth as well as suppressed the colonization of root rot fungi. In case of the management of root knot nematode, best result was achieved when leguminous and non-leguminous seeds were treated with 75% concentration of *Santonine*-43. Soil drenched with tenekil at 0.1% remarkably reduced the *M. javanica* infection and improved the growth parameters of the tested crops followed by tested seeds treated with *Kent*-20 at 75% concentration and soil drenched with furadan at 0.1%.

Keywords: Homeopathic medicines, fungicides, nematicides, root rot fungi and root-knot nematodes.

INTRODUCTION

Plant Pathogens regarded as infectious agents in plants, creating disturbance during developmental stages reducing the quality of crops (Agrios, 2005). Soil borne pathogens are indirectly responsible for allergic or toxic disorders among consumers due to the production of mycotoxins (Usman *et al*., 2014).

Major pathogenic fungi of roots include; *Fusarium* spp. produces rot and wilt diseases reported on many crop plants regarded as most destructive plant diseases (Ghaffar, 1988; Fouzia *et al*., 2014). *Macrophomina phaseolina* (Tassi) Goid, reported severe losses on more than five hundred plant species (Das *et al*., 2008) initiated from soil, infected seed and plant debris survive as resting sclerotia, during favorable condition produce hyphae causing infection which occurs in all stages of plant growth (Ammon *et al*., 1974; Reuveni *et al*., 1983) leading important diseases which include; charcoal rot, seedling blight, pod, root and stem rot (Ma *et al*., 2010). The appearance of reddish-brown lesions present on the surface of root and stem results in wilting, defoliation and ultimately death of the plant occurs due to xylem tissues blockage (Abawi and Pastor-Corrales, 1990). *R. solani* Kuhn also considered as root rot fungus which causes seed and root rot, wilting and damping off of seedling reported on sixty three host from Pakistan (Mirza and Qureshi, 1978; Mazzola *et al*., 1996). Another major group of parasites causing adverse economic losses in plants, referred as hidden enemies called as plant parasitic nematodes (Wesemael *et al*., 2011). Root-Knot Nematodes (RKNs) especially *Meloidogyne* spp., distributed world-wide (Maqbool and Shahina, 2001) cause heavy destruction in agricultural productivity (Zaki, 2000; Javed *et al*., 2006). Disease incidence in Pakistan recorded between 75-100% (Khan *et al*., 2005) in which losses result from the root-knot nematode which attack every crop (Gheysen and Fenoll, 2002) reducing yields and quality producing morphological and physiological changes within the roots (Sikora and Fernandez, 2005) producing galls commonly known as root knot (Williamson and Kumar, 2006). *Meloidogyne javanica* causes heavy economic damage to both monocotyledons and dicotyledons crops (Perry *et al*., 2009). Infection of nematode includes; disruption of the root xylem, wilting, stunted growth, reduced light interception but also interferes in the nodulation, nitrogen fixation and adversely affects the whole agricultural production (Hillocks, 2002; Williamson and Gleason, 2003; Khan *et al*., 2008).

For that reason, Botanist studied on nematicidal as well as fungicidal efficacy from plant derived compounds (Vulto and Smet, 1988; Mentz and Schenkel, 1989) to obtain friendly methods in controlling plant pathogens (Kumbhar *et al*., 2000). Nowadays, there has been growing interest on the use of natural drugs derived especially from medicinal plants (Ghazalbash and Abdollahi, 2013).From ancient periods, plants have been utilized as a key source of medicines (Samuelsson, 2004), therefore researchers revealed that herbal medicines obtained from medicinal plants reported to be safe and harmless (World Health Organization, 1977; Balunas and Kinghorn, 2005).

Researcher investigated that drugs prepared from medicinal plant showed active constituents exhibiting strong fungicidal and nematicidal activities (Grover, *et al*., 2002; Fowler, 2006). Homeopathic medicines available in prescribing form (highly diluted and potentized) which can be applied to all living beings, including plants (Rossi *et al.,* 2004). The treatment of plants through homeopathy maintains the balance during the development stage of a plant (Bonato, 2007) and inducing resistance and tolerant against harmful pests and have shown positive results in controlling diseases caused by viruses, fungi, nematode and bacteria (Carneiro *et al*., 2010), besides increasing the production of biomass which proves a potential technology for sustainable agriculture (Toledo *et al.,* 2009) are now regarded as the emerging discipline of "agro-homeopathy" - the application of homeopathy to agriculture (Sukul and Sukul, 2004) which do not lead to any accumulation and toxicity in the environment, having no ecological side-effects providing healthy life to plants (Brasilia, 2008) and benefits in farmer economy (Grazia *et al*., 2014). Homeopathic drugs used efficiently in the control of plant pathogens (Kumar, 1980; Khanna and Chandra, 1983) which enhanced the plant growth and improved the productivity of crops (Castro, 2002).

Therefore, main objective of present study was to explore the fungicidal and nematicidal effectiveness of homeopathic medicines along with the addition of synthetic chemicals in the control of root rot and root knot pathogens on okra, sunflower, mung bean and mash bean plants providing safe environment to soil with positive effect on plant growth.

MATERIALS AND METHODS

Homeopathic medicines such as; *Arnica montana*-30C and *Thuja occidentalis* 30C (Dr. Willmar Schwabe), *Santonine*-43 (BM Homeopathy) and *Kent*-20 (Kent Homeopathy) were purchased from medicinal market of Karachi (Pakistan). Soil used for pot experiments was obtained from the Department of Botany (Karachi University) and was sieved through 2mm of mesh sieve to remove stones and transferred in plastic pots @ 300g of soil. Tested seeds used for pot experiments were mung bean (*Vigna radiata* (L.) R. Wilczek. cv. NM-2006), mash bean (*Vigna mungo* (L.) Hepper cv. NM-97), okra (*Abelmoschus esculentus* (L.) Moench cv. Arka anamika) and sunflower (*Helianthus annuus* L. cv. Hysun-38) were treated with *Santonine*-43, *Kent*-20, *Arnica montana*-30C and *Thuja occidentalis*-30C at 75 and 50% concentrations, respectively, whereas seeds treated with sterilized distilled water served as a control were soaked about 10-15 minutes and dried aseptically.

A) ROOT ROT FUNGI

Soil had a natural infestation of 7-8 sclerotia/g of *M. phaseolina* calculated by wet sieving dilution technique (Shiekh and Ghaffar, 1975), 20-21% colonization of *R. solani* estimated on sorghum seeds which used as bait (Wilhelm, 1955) and 3200-3400 CFU/g *Fusarium* spp., determined by soil dilution technique (Nash and Synder, 1962). Two fungicides such as; Mancozeb-750 DF and Dithane M-45 were drenched in the soil at 0.01 and 0.1% containing 20 mL dosage alone and in combination with seeds treatment of homeopathic drugs (*A. montana* and *T. occidentalis*) at 75 and 50% concentrations, respectively. Treatments were replicated thrice and soil without fungicides and non-treated seeds taken as control for the comparison and each treatment replicate thrice. Pots were arranged in Completely Randomized Design (CRD) in a green house bench of Botany Department (KU) under natural sunlight for five weeks and then uproot to assess the growth data and colonization percentage of root rot fungi.

B) ROOT KNOT NEMATODE

Two nematicides such as; Furadan and Tenekil were drenched (20 mL) in the soil (300g) at 0.01 and 0.1% as an individually and along in combination with seed treatment with both homeopathic drugs (*Santonine*-43 and *Kent*-20) at 75 and 50% concentrations, respectively. Soil without nematicides and untreated seeds acted as a control for the comparison and treatments were replicated thrice. Pots were kept under natural sunlight in a greenhouse bench and after 7 days emergence of tested seedlings approximately 2000 freshly hatched of *M. javanica* (J_2) were introduced closely to the roots by making holes in the soil (300g). Watered regularly and the plants were uprooted after eight weeks of the nematode inoculation.

C) DATA ASSESSMENT

i. Growth parameters: root length (cm), root weight (g), shoot length (cm), shoot weight (g), and numbers of nodules were recorded for both root rot and root knot experiments.

ii. Isolation of pathogenic fungi from roots: The roots of treated and non-treated plants after washing in running tap water (adhering soil was removed) were surface sterilized with sodium hypochlorite (1.0%) for three minutes, dried on blotter paper and was randomly cut into five small segments. These root fragments from each plant were placed on poured PDA Petri plates having antibiotics (Penicillin and Streptomycin) to inhibit the growth of bacteria. Plates were incubated at room temperature (28-32°C) and after one week of incubation period, emerging fungi from each root segment was identified by using the microscope (40X) and its colonization was determined.

iii. Estimation of number of galls, number of egg masses per root system and eggs/egg mass: The number of galls and number of egg masses developed on the entire root system due to *M. javanica* were counted under a low magnification (4X). Ten egg masses from each treatment of all replicates were selected randomly from the roots. Each egg mass was crushed in a watch glass using one drop of sodium hypochlorite solution (0.1%) due to gelatinous matrix was dissolved and examined under a light microscope according to De Leij, (1992) .

iv. Statistical analysis: Data were analyzed by using one way ANOVA followed by the least significant difference (LSD) test at $p<0.005$ and Duncan's multiple range test was employed to compare treatment means as proposed by Sokal and Rohlf (1995) using "Statistica" software.

RESULTS

A) ROOT ROT FUNGI

In mung bean plants, highest growth parameters were achieved by using *A. montana* at 75% as seed treatment in addition to dithane used at both concentrations (0.01 and 0.1%) as soil drenching as compared to other treatments. Complete suppression of root rot fungi colonization, such as *Fusarium* spp., *R. solani* and *M. phaseolina* had been noticed by seeds treated with *T. occidentalis* at 75% concentration and soil drenched with both fungicides such as mancozeb (0.1% concentration) and dithane (0.01 and 0.1% concentrations). It was recorded that when both homeopathic drugs, *A. montana* at 75% and *T. occidentalis* at 50% concentration along with mancozeb drenched in soil at both concentrations ($p\leq 0.05$) showed complete inhibition of *R. solani* and *M. phaseolina* colonization but complete suppression of *R. solani* colonization followed by *M. phaseolina* and *Fusarium* spp. recorded when seeds treated with *A. montana* at 50% concentration and soil drenched with mancozeb (0.01 and 0.1%) and dithane at 0.01% (Table 1). In mash bean plants, combined effect of seeds treated with *T. occidentalis* at 75% and soil drenched with mancozeb at 0.1% was found to be significantly effective ($P < 0.001$) for the elevation of plant growth followed by treating seeds with *A. montana* used at 75% and soil drenched with mancozeb at 0.1% showed greater growth parameters such as; shoot weight and height, root weight and height as well as number of nodules ($P < 0.001$). Mash bean seeds treated with *A. montana* at 75% and soil drenched with both fungicides at 0.1%, while seeds treated with *T. occidentalis* at 75% and soil drenched with both fungicides containing both concentrations showed complete inhibition of root rot fungi colonization followed by 50% concentration which showed suppression of *R. solani* and *M. phaseolina* colonization completely. Use of mancozeb at 0.01% alone and combined with seeds treated with both homeopathic drugs at 50% concentration inhibited the colonization of *R. solani* completely followed by *M. phaseolina* and *Fusarium* spp. (Table 2). In case of okra plants, highest growth parameters showed by the combined effect of soil drenching with dithane at 0.1% along with treated seeds of *A. montana* at 75% concentration. Greater shoot and root weight were observed by the seeds treated with *A. montana* at 75% and soil drenched with mancozeb at 0.01%, followed by seeds treated with *T. occidentalis* at 75% concentration, while soil drenched with dithane at 0.01%. However, the combined effect of both fungicides (0.01 and 0.1%) and homeopathic drugs (50% concentration) improved the growth of plant weight and height as compared to individual treatments (Table 3). Whereas in sunflower plants, highest length and weight of shoot and root were attained by the combined effect of soil drenching with mancozeb at 0.1% and seeds treated with *T. occidentalis* at 75% concentration followed by dithane at 0.1% along with seed treatment with *A. montana* at 75% concentration (Table 4). Both okra and sunflower showed complete suppression of root decay pathogens ($P < 0.001$) when seeds treated with *A. montana* and *T. occidentalis* at 75% concentration and soil drenched with mancozeb and dithane at both concentrations (0.01 and 0.1%). Colonization of *M. phaseolina* and *R. solani* completely inhibited when seeds treated with both homeopathic drugs at 50% concentration and soil drenched with mancozeb at both concentrations, whereas mancozeb drenched alone in soil at 0.1% showed complete suppression of *M. phaseolina* and *R. solani* colonization followed by 0.01%. It was striking to observe that *R. solani* colonization was inhibited when both fungicides were used while seeds treated with homeopathic drugs at different concentrations showed maximum effect, but combined application gave a profound result in controlling the *R. solani* colonization.

Table 1. Effect of seed treatment with homeopathic drugs along with soil drenching with fungicides on the growth parameters of mung bean plants and control of root rot fungi.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	Number of nodules ± SD	*Fusarium* spp. colonization (%) ± SD	*R. solani* colonization (%) ± SD	*M. phaseolina* colonization (%) ± SD
Control (Sterilized water)	14.06±0.47	0.40±0.066	14.7±1.08	0.16±0.036	13.33±5.03	82.2±10.18	19.44±5.85	30.53±8.24
Seed treatment with *Arnica montana* @ 75%	16.23±0.91	0.57±0.051	18.23±2.22	0.30±0.05	25.0±2.65	26.07±0.92	8.89±3.85	26.07±0.92
Seed treatment with *Arnica montana* @ 50%	16.0±0.78	0.59±0.060	17.43±1.39	0.28±0.066	26.7±4.04	23.3±2.89	6.67±0.0	19.98±6.64
Seed treatment with *Thuja occidentalis* @ 75%	17.10±1.67	0.63±0.025	20.6±1.08	0.33±0.095	25.0±2.65	30.53±3.24	13.33±6.66	24.4±3.81
Seed treatment with *Thuja occidentalis* @ 50%	15.80±0.95	0.74±0.22	20.0±2.55	0.43±0.059	23.0±1.0	32.73±12.04	4.45±3.85	17.75±7.66
Soil drenching with Mancozeb @ 0.01%	15.53±1.27	0.91±0.18	17.80±1.51	0.34±0.10	26.0±2.0	19.98±6.64	15.56±7.69	13.33±6.67
Soil drenching with Mancozeb @ 0.1%	15.37±1.59	0.82±0.27	19.3±5.26	0.39±0.11	24.0±3.0	37.2±11.07	17.37±7.04	13.33±6.67
Soil drenching with Dithane @ 0.01%	15.20±0.88	0.64±0.12	18.0±2.38	0.35±0.087	17.3±1.53	8.89±3.85	17.77±3.87	19.98±6.64
Soil drenching with Dithane @ 0.1%	15.70±0.66	1.23±0.29	18.9±3.32	0.32±0.04	21.3±1.53	24.4±3.81	15.16±9.55	17.78±3.85
S.T with *A. montana* @ 75% + S.D. with Mancozeb @ 0.01%	16.73±0.91	0.60±0.12	20.23±2.99	0.99±0.19	28.3±2.52	2.22±3.85	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Mancozeb @ 0.1%	18.07±0.68	1.04±0.12	24.53±2.31	0.73±0.16	25.7±1.53	2.22±3.825	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.01%	16.90±0.62	0.85±0.14	21.80±2.66	0.43±0.15	24.3±4.16	11.11±3.84	0.0±0.0	6.67±6.66
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.1%	17.40±1.11	0.87±0.10	19.27±3.13	0.32±0.068	24.7±2.52	13.33±6.67	0.0±0.0	2.22±3.85
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.01%	19.00±0.66	0.83±0.09	19.53±1.09	0.39±0.026	25.3±3.51	11.11±10.18	0.0±0.0	8.89±3.85
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.1%	19.03±0.81	0.85±0.14	21.63±2.06	0.34±0.059	27.0±2.65	4.45±3.85	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.01%	16.30±1.95	0.55±0.05	16.53±1.30	0.27±0.045	20.3±1.53	19.98±6.64	0.0±0.0	4.44±7.69
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.1%	17.37±0.25	0.77±0.032	18.93±0.61	0.24±0.025	22.7±3.78	11.11±3.85	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.01%	16.73±0.40	0.69±0.037	19.20±0.46	0.33±0.040	24.0±3.0	0.0±0.0	0.0±0.0	8.89±3.84
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.1%	16.93±0.57	0.88±0.05	19.17±0.55	0.39±0.067	29.3±1.53	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.01%	16.03±0.58	0.69±0.155	18.07±1.70	0.27±0.026	24.3±1.53	17.78±3.85	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.1%	18.73±0.611	0.82±0.13	18.93±0.78	0.38±0.035	27.3±2.08	11.11±3.85	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.01%	17.30±1.42	0.66±0.17	20.3±0.92	0.29±0.042	23.3±1.53	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.1%	18.73±0.15	0.84±0.06	17.87±0.93	0.29±0.026	23.7±2.52	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.01%	13.43±1.19	0.39±0.19	16.13±1.08	0.30±0.056	22.7±3.06	8.89±3.85	4.44±7.69	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.1%	13.90±0.36	0.55±0.24	17.63±0.45	0.29±0.021	25.0±2.65	2.22±3.85	0.0±0.0	0.0±0.0
$LSD_{0.05}$=	1.586	0.238	3.409	0.152	4.469	9.545	6.415	7.198

Where: ± S.D.= Standard deviation. S.D.= Soil drenching. S.T.= Seed treatment

Table 2. Effect of seed treatment with homeopathic drugs along with soil drenching with fungicides on growth parameters of mash bean plants and control of root rot fungi.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	Number of nodules ± SD	*Fusarium* spp. colonization (%) ± SD	*R. solani* colonization (%) ± SD	*M. phaseolina* colonization (%) ± SD
Control (Sterilized water)	13.6+0.8	0.31±0.025	13.63±1.66	0.15±0.03	15.33±4.04	91.07±3.86	23.87±3.44	39.97±13.35
Seed treatment with *Arnica montana* @ 75%	16.2±0.9	0.49+0.08	17.33±0.93	0.22±0.055	22.0±2.0	22.2±3.81	15.56±10.18	19.98±6.64
Seed treatment with *Arnica montana* @ 50%	15.27±0.76	0.58±0.095	17.67±2.17	0.30±0.026	26.7±4.04	19.98±6.64	11.11±3.85	22.18±7.66
Seed treatment with *Thuja occidentalis* @ 75%	14.83±0.40	0.66±0.076	18.43±1.50	0.34±0.081	25.3±3.21	19.98±6.64	15.52±10.15	13.33±6.67
Seed treatment with *Thuja occidentalis* @ 50%	15.1±0.62	0.75±0.066	19.43±0.93	0.25±0.031	21.3±3.06	19.97±6.63	13.33±6.67	13.33±6.67
Soil drenching with Mancozeb @ 0.01%	18.3±1.03	0.80±0.050	20.2±2.38	0.24±0.025	27.0±2.0	11.11±3.85	0.0±0.0	6.67±6.67
Soil drenching with Mancozeb @ 0.1%	18.9±0.50	0.85±0.067	19.63±1.38	0.29±0.031	30.0±2.0	15.55±3.85	2.22±3.85	13.33±6.67
Soil drenching with Dithane @ 0.01%	16.97±0.57	0.64±0.071	13.93±0.25	0.15±0.01	20.3±6.11	13.33±6.67	13.23±6.67	11.11±3.85
Soil drenching with Dithane @ 0.1%	17.03±1.91	0.59±0.097	15.17±2.95	0.17±0.015	16.0±2.0	11.11±3.85	8.89±3.85	4.44±7.69
S.T with *A. montana* @75% + S.D. with Mancozeb @ 0.01%	17.73±1.01	1.093±0.047	19.77±0.47	0.57±0.11	31.0±3.0	8.89±3.85	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Mancozeb @ 0.1%	20.3±1.27	0.91±0.038	20.83±1.99	0.39±0.025	30.3±3.21	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.01%	16.7±0.96	0.71±0.11	18.37±0.67	0.29±0.061	25.3±1.53	17.78±3.85	0.0±0.0	4.45±3.85
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.1%	18.3±0.61	0.69±0.042	18.2±1.67	0.26±0.012	24.7±1.53	11.11±3.84	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.01%	17.7±0.36	0.77±0.076	16.63±1.79	0.27±0.015	25.3±1.53	2.22±3.85	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.1%	16.83±0.40	0.67±0.036	14.57±2.41	0.21±0.015	19.3±2.52	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.01%	15.7±0.85	0.61±0.042	16.37±1.95	0.25±0.032	20.0±1.0	22.17±7.66	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.1%	16.10±2.18	0.68±0.16	17.63±1.70	0.25±0.03	23.7±2.08	15.53±10.14	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.01%	19.47±0.32	0.86±0.035	18.27±0.42	0.29±0.044	26.7±1.53	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.1%	20.70±0.46	0.98±0.051	22.33±0.86	0.37±0.015	31.3±2.52	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.01%	17.17±0.70	0.72±0.035	19.3±0.87	0.24±0.02	24.3±2.08	20.0±6.67	0.0±0.0	4.15±3.85
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.1%	16.80±0.36	0.66±0.049	18.83±1.70	0.26±0.031	22.3±1.53	19.98±6.64	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.01%	16.77±0.15	0.95±0.015	17.6±1.91	0.33±0.065	26.0±2.65	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.1%	17.73±0.57	1.11±0.025	21.63±0.97	0.63±0.20	25.7±1.53	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.01%	16.40±0.26	0.66±0.04	12.97±0.74	0.36±0.097	13.0±2.65	19.98±6.64	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.1%	17.50±0.60	0.69±0.051	14.83±0.40	0.35+0.075	21.7±0.58	15.55±3.85	0.0±0.0	0.0±0.0
$LSD_{0.05}$=	1.441	0.104	2.557	0.102	4.347	8.158	6.152	7.777

Where: ± S.D. = Standard deviation. S.D. = Soil drenching. S.T. = Seed treatment

Table 3. Effect of seed treatment with homeopathic drugs along with soil drenching with fungicides on growth parameters of okra plants and control of root rot fungi.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	*Fusarium* spp. colonization (%) ± SD	*R. solani* colonization (%) ± SD	*M. phaseolina* colonization (%) ± SD
Control (Sterilized water)	16.90±3.2	0.64±0.18	8.77±0.84	0.18±0.036	95.53±3.87	26.07±0.92	79.96±11.51
Seed treatment with *Arnica montana* @ 75%	17.10±0.44	0.91±0.06	13.43±4.58	0.24±0.015	24.40±3.81	11.11±3.85	24.40±3.81
Seed treatment with *Arnica montana* @ 50%	16.13±0.57	0.79±0.04	13.20±5.23	0.21±0.015	17.74±7.67	13.33±6.67	28.30±4.40
Seed treatment with *Thuja occidentalis* @ 75%	17.37+0.55	0.99±0.036	16.57±5.52	0.25±0.026	26.07±0.92	15.53+10.15	33.31±17.62
Seed treatment with *Thuja occidentalis* @ 50%	16.93±0.25	0.83±0.026	15.67+5.08	0.19+0.031	19.44±5.85	21.44±13.88	19.98±6.64
Soil drenching with Mancozeb @ 0.01%	15.90±0.26	0.81±0.031	11.07±0.76	0.27±0.01	15.55±3.85	0.0±0.0	13.33±6.67
Soil drenching with Mancozeb @ 0.1%	16.53±0.21	0.84+0.047	10.93±0.25	0.22±0.025	13.30±6.70	0.0±0.0	0.0+0.0
Soil drenching with Dithane @ 0.01%	15.3±0.44	0.77±0.044	8.6±0.80	0.17±0.015	23.87±3.44	0.0+0.0	22.18±7.66
Soil drenching with Dithane @ 0.1%	15.73±0.32	0.85±0.032	9.3±0.26	0.22±0.015	11.09+3.83	0.0+0.0	11.09±3.83
S.T with *A. montana* @ 75% + S.D. with Mancozeb @ 0.01%	18.53±1.36	1.56±0.39	11.93±0.42	0.39±0.12	0.0+0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Mancozeb @ 0.1%	19.53±0.21	1.45±0.12	12.10±0.30	0.57+0.06	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.01%	18.20±0.36	1.13±0.11	10.27±1.17	0.29+0.03	13.33±6.67	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.1%	18.43±1.17	0.99±0.047	9.93±0.85	0.28±0.045	8.89±3.85	0.0+0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.01%	18.87±0.70	1.32+0.079	10.03±0.32	0.48±0.040	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.1%	20.17±0.70	1.8±0.19	16.17±1.00	0.68+0.06	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.01%	17.53+0.81	1.13±0.11	10.27+1.17	0.27±0.02	22.20±3.81	0.0+0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.1%	18.27+1.11	1.18±0.13	11.23±1.82	0.26±0.053	21.64±7.24	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D with Mancozeb @ 0.01%	16.93+0.76	1.10±0.12	10.8±0.87	0.28±0.051	0.0+0.0	0.0+0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.1%	17.70±1.23	1.20±0.13	11.67+1.15	0.29+0.021	0.0±0.0	0.0±0.0	0.0+0.0
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.01%	16.90±0.62	1.09±0.021	11.23±1.31	0.30±0.095	33.31±17.62	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.1%	17.17+0.60	0.97±0.04	11.23±1.79	0.28±0.052	23.87+3.44	0.0+0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D with Dithane @ 0.01%	20.30±2.29	1.19±0.085	13.60±3.79	0.24±0.03	0.0+0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.1%	16.70±0.26	0.98±0.035	13.57±5.31	0.33±0.05	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.01%	16.67±1.01	0.89±0.075	14.80±2.40	0.20±0.032	22.18±7.66	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D with Dithane @ 0.1%	17.3±1.93	0.80±0.067	16.40±4.51	0.19±0.026	21.64±7.24	0.0±0.0	0.0±0.0
$LSD_{0.05}$=	1.816	0.194	4.528	0.075	9.097	6.185	8.287

Where: ±SD. = Standard deviation. S.D. = Soil drenching. S.T. = Seed treatment

Table 4. Effect of seed treatment with homeopathic drugs along with soil drenching with fungicides on growth parameters of sunflower plants and control of root rot fungi.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	*Fusarium* spp. colonization (%) ± SD	*R. solani* colonization (%) ± SD	*M. phaseolina* colonization (%) ± SD
Control (Sterilized water)	14.53±2.41	0.51±0.074	5.13±0.83	0.12±0.025	84.43±7.68	30.53±8.24	86.63±6.65
Seed treatment with *Arnica montana* @ 75%	15.50±0.26	0.75±0.059	7.4±0.44	0.18±0.01	19.98±6.64	13.32±6.67	23.87±3.44
Seed treatment with *Arnica montana* @ 50%	15.13±0.31	0.72±0.055	7.8±0.20	0.17±0.02	31.09±7.72	28.83±3.87	28.30±4.40
Seed treatment with *Thuja occidentalis* @ 75%	15.53±0.31	0.75±0.01	7.53±0.21	0.18±0.01	19.98±6.64	11.10±3.84	37.20±11.06
Seed treatment with *Thuja occidentalis* @ 50%	15.67±0.25	0.78±0.021	8.13±0.21	0.21±0.015	20.0±6.67	19.97±6.65	23.87±3.44
Soil drenching with Mancozeb @ 0.01%	16.17±0.71	0.71±0.067	8.23±1.17	0.18±0.01	30.53±8.24	0.0±0.0	19.98±6.64
Soil drenching with Mancozeb @ 0.1%	15.60±0.62	0.70±0.042	8.7±0.25	0.19±0.021	26.64±6.67	0.0±0.0	19.97±6.63
Soil drenching with Dithane @ 0.01%	15.03±0.74	0.72±0.032	7.4±0.30	0.18±0.01	35.53±7.74	13.33±6.67	22.21±10.17
Soil drenching with Dithane @ 0.1%	16.17±1.00	0.78±0.074	8.2±1.40	0.18±0.015	33.27±11.55	0.0±0.0	15.55±3.85
S.T with *A. montana* @ 75% +S.D. with Mancozeb @ 0.01%	17.73±1.16	1.32±0.41	10.8±0.65	0.27±0.015	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Mancozeb @ 0.1%	18.17±0.45	1.24±0.46	12.13±2.58	0.36±0.059	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.01%	15.37±1.02	0.70±0.067	9.9±0.3	0.23±0.02	15.55±3.85	0.0±0.0	2.22±3.85
S.T with *A. montana* @ 50% + S.D. with Mancozeb @ 0.1%	17.20±0.87	0.81±0.038	10.03±0.99	0.23±0.038	13.33±6.67	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.01%	18.73±0.57	0.89±0.064	10.7±1.97	0.31±0.064	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 75% + S.D. with Dithane @ 0.1%	19.63±0.15	0.33±0.22	14.97±0.83	0.31±0.035	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.01%	16.93±0.45	0.76±0.057	7.77±0.40	0.22±0.042	15.55±3.85	0.0±0.0	0.0±0.0
S.T with *A. montana* @ 50% + S.D. with Dithane @ 0.1%	17.10±0.26	0.80±0.015	8.43±0.25	0.18±0.015	11.11±3.84	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.01%	17.90±0.36	0.83±0.071	11.6±2.31	0.28±0.025	0.0±0.0	0.0±0.0	15.53±10.15
S.T with *T. occidentalis* @ 75% + S.D. with Mancozeb @ 0.1%	22.20±1.44	1.97±0.92	17.2±2.08	0.33±0.055	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.01%	14.27±1.34	0.70±0.078	9.0±0.44	0.23±0.057	26.64±6.67	0.0±0.0	15.53±3.87
S.T with *T. occidentalis* @ 50% + S.D. with Mancozeb @ 0.1%	18.67±0.46	0.97±0.02	11.7±1.55	0.27±0.01	15.55±3.85	0.0±0.0	11.09±3.83
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.01%	18.80±0.41	0.84±0.066	12.43±1.28	0.25±0.031	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 75% + S.D. with Dithane @ 0.1%	18.53±0.32	0.86±0.036	9.93±0.25	0.26±0.021	0.0±0.0	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.01%	12.93±0.15	0.74±0.056	8.1±1.61	0.18±0.025	23.87±3.44	0.0±0.0	0.0±0.0
S.T with *T. occidentalis* @ 50% + S.D. with Dithane @ 0.1%	17.60±1.56	0.79±0.068	13±5.12	0.26±0.036	15.55±3.85	0.0±0.0	0.0±0.0
$LSD_{0.05}$=	1.449	0.379	2.545	0.052	8.869	4.981	7.786

Where: ±SD. = Standard deviation. S.D. = Soil drenching. S.T. = Seed treatment

Table 5. Effect of seed treatment with homeopathic drugs along with soil drenching with nematicides on the growth parameters of mung bean plants and control of root knot nematodes.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	Number of nodules ± SD	Number of galls/ root system ± SD	Egg masses/ root system ± SD
Control (Sterilized water)	24.9 ± 2.65	1.03 ± 0.042	15.43 ± 1.17	0.84 ± 0.053	11.00 ± 3.00	58.33 ± 3.21	52.67 ± 3.51
Seed treatment with *Kent*-20 @ 75%	34.23 ± 1.29	1.22 ± 0.04	24.40 ± 2.67	1.01 ± 0.064	23.67 ± 1.53	24.67 ± 2.52	20.33 ± 2.52
Seed treatment with *Kent*-20 @ 50%	32.60 ± 1.91	1.15 ± 0.026	23.60 ± 1.11	0.97 ± 0.050	21.33 ± 1.53	27.00 ± 1.00	22.00 ± 1.00
Seed treatment with *Santonine*-43 @ 75%	36.33 ± 1.56	1.26 ± 0.021	26.47 ± 1.07	0.98 ± 0.010	24.00 ± 3.00	24.33 ± 1.53	19.00 ± 2.65
Seed treatment with *Santonine*-43 @ 50%	33.90 ± 3.24	1.197 ± 0.03	24.67 ± 1.11	0.94 ± 0.010	20.33 ± 1.53	31.00 ± 2.65	26.33 ± 2.082
Soil drenching with Furadan @ 0.01%	33.23 ± 1.99	1.15 ± 0.026	25.77 ± 2.03	0.99 ± 0.064	19.00 ± 2.08	34.67 ± 2.52	28.33 ± 4.51
Soil drenching with Furadan @ 0.1%	36.47 ± 1.07	1.09 ± 0.031	28.50 ± 0.90	1.04 ± 0.020	21.00 ± 3.61	30.00 ± 3.00	24.67 ± 3.79
Soil drenching with Tenekil @ 0.01%	34.73 ± 3.25	1.13 ± 0.042	25.57 ± 2.44	1.05 ± 0.026	19.67 ± 3.79	39.67 ± 3.79	34.33 ± 3.21
Soil drenching with Tenekil @ 0.1%	36.60 ± 0.92	1.16 ± 0.031	26.97 ± 1.43	1.06 ± 0.015	20.00 ± 3.78	35.00 ± 2.00	29.67 ± 1.53
S.T with *Kent*-20 @ 75% +S.D. with Furadan @ 0.01%	37.97 ± 1.49	1.37 ± 0.042	31.83 ± 2.06	1.12 ± 0.020	36.00 ± 4.00	16.33 ± 2.52	10.67 ± 3.79
S.T with *Kent*-20 @ 75% + S.D. with Furadan @ 0.1%	46.80 ± 1.78	1.41 ± 0.031	42.40 ± 3.05	1.16 ± 0.010	41.33 ± 3.06	9.00 ± 2.65	5.00 ± 3.00
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.01%	38.63 ± 3.23	1.32 ± 0.04	32.87 ± 3.89	1.08 ± 0.025	34.00 ± 2.00	17.67 ± 2.52	13.67 ± 2.52
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.1%	37.23 ± 2.87	1.35 ± 0.021	30.97 ± 3.62	1.09 ± 0.026	36.67 ± 1.53	14.67 ± 2.082	11.33 ± 2.082
S.T with *Kent*-20 @ 75% + S.D.. with Tenekil @ 0.01%	38.70 ± 1.25	1.42 ± 0.020	32.57 ± 1.06	1.18 ± 0.040	42.33 ± 1.52	12.33 ± 4.041	7.33 ± 3.51
S.T with *Kent*-20 @ 75% + S.D. with Tenekil @ 0.1%	47.70 ± 1.24	1.45 ± 0.025	35.90 ± 1.38	1.25 ± 0.015	43.67 ± 1.52	7.67 ± 3.06	4.33 ± 3.21
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.01%	38.73 ± 2.60	1.36 ± 0.03	27.43 ± 2.15	1.16 ± 0.021	40.33 ± 1.57	19.33 ± 2.52	14.67 ± 2.08
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.1%	44.77 ± 1.32	1.29 ± 0.031	36.50 ± 1.90	1.19 ± 0.022	39.00 ± 2.65	16.33 ± 1.53	11.67 ± 2.52
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.01%	40.87 ± 2.12	1.49 ± 0.025	38.50 ± 1.10	1.25 ± 0.010	43.33 ± 1.52	25.00 ± 2.00	19.33 ± 2.08
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.1%	47.63 ± 1.07	1.58 ± 0.040	43.13 ± 1.40	1.27 ± 0.026	46.00 ± 1.00	16.67 ± 1.53	13.00 ± 1.00
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.01%	41.43 ± 0.91	1.45 ± 0.031	35.40 ± 2.20	1.22 ± 0.031	36.00 ± 2.00	23.67 ± 2.082	16.33 ± 1.53
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.1%	43.93 ± 3.09	1.40 ±0.038	34.90 ± 2.33	1.24 ± 0.015	41.67 ± 2.52	22.33 ± 1.53	17.00 ± 3.00
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.01%	48.47 ± 0.83	1.35 ± 0.031	36.80 ± 1.42	1.18 ± 0.026	44.33 ± 3.79	15.00 ± 2.65	10.67 ± 3.21
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.1%	49.77 ± 1.27	1.42 ± 0.038	41.63 ± 0.97	1.21 ± 0.031	44.67 ± 2.52	5.67 ± 1.53	3.33 ± 1.53
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.01%	44.70 ± 1.95	1.34 ± 0.015	37.37 ± 1.00	1.14 ± 0.020	42.00 ± 1.00	21.33 ± 3.055	18.67 ± 3.055
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.1%	45.77 ± 1.76	1.26 ± 0.016	39.50 ± 0.80	1.17 ± 0.015	43.00 ± 2.65	13.67 ± 1.53	11.67 ± 2.52
$LSD_{0.05}$=	3.325	0.0512	3.214	0.0507	4.136	4.057	4.529

Where: ±S.D. = Standard deviation, S.D. = Soil drenching, S.T. = Seed treatment

Table 6. Effect of seed treatment with homeopathic drugs along with soil drenching with nematicides on the growth parameters of mash bean plants and control of root knot nematodes.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	Number of nodules ± SD	Number of galls/ root system ± SD	Egg masses/ root system ± SD
Control (Sterilized water)	24.20 ± 1.28	0.99 ± 0.095	17.5 ± 1.05	1.01 ± 0.031	17.33 ± 3.06	67.00 ± 5.57	63.33 ± 5.51
Seed treatment with *Kent*-20 @ 75%	34.67 ± 0.50	1.06 ± 0.021	25.10 ± 2.41	1.11 ± 0.030	26.67 ± 1.53	22.33 ± 3.79	18.00 ± 4.00
Seed treatment with *Kent*-20 @ 50%	28.73 ± 1.60	1.04 ± 0.020	23.23 ± 1.46	1.09 ± 0.03	24.33 ± 1.52	29.00 ± 6.25	26.67 ± 5.69
Seed treatment with *Santonine*-43 @ 75%	35.23 ± 1.45	1.11 ± 0.031	26.80 ± 1.73	1.16 ± 0.01	28.33 ± 4.04	25.33 ± 2.52	21.67 ± 3.51
Seed treatment with *Santonine*-43 @ 50%	30.30 ± 3.05	1.06 ± 0.01	27.90 ± 1.14	1.08 ± 0.032	26.67 ± 1.53	31.67 ± 4.51	28.00 ± 4.00
Soil drenching with Furadan @ 0.01%	30.07 ± 1.60	1.03 ± 0.042	23.50 ± 2.54	1.04 ± 0.049	20.33 ± 2.08	36.33 ± 1.53	32.67 ± 2.52
Soil drenching with Furadan @ 0.1%	34.13 ± 1.53	1.06 ± 0.022	26.43 ± 0.91	1.07 ± 0.031	24.33 ± 1.53	33.00 ± 1.00	30.33 ± 2.08
Soil drenching with Tenekil @ 0.01%	30.80 ± 2.12	0.95 ± 0.083	23.13 ± 2.03	1.09 ± 0.021	19.00 ± 2.65	33.67 ± 3.21	29.00 ± 2.65
Soil drenching with Tenekil @ 0.1%	32.63 ± 2.48	1.02 ± 0.049	26.47 ± 1.07	1.11 ± 0.030	24.00 ± 1.00	26.33 ± 1.53	21.33 ± 3.06
S.T with *Kent*-20 @ 75% +S.D. with Furadan @ 0.01%	36.37 ± 1.85	1.23 ± 0.050	35.83 ± 1.31	1.37 ± 0.050	36.33 ± 2.08	15.67 ± 1.55	12.00 ± 2.65
S.T with *Kent*-20 @ 75% + S.D. with Furadan @ 0.1%	45.90 ± 1.68	1.34 ± 0.015	39.77 ± 1.44	1.44 ± 0.015	42.33 ± 2.52	9.67 ± 2.08	7.33 ± 2.52
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.01%	36.13 ± 1.26	1.21 ± 0.031	32.07 ± 3.25	1.34 ± 0.010	38.00 ± 2.00	25.00 ± 2.00	20.33 ± 2.51
S.T with *Kent*-20 @ 50% + S.D with Furadan @ 0.1%	38.50 ± 0.96	1.29 ± 0.026	36.63 ± 2.00	1.37 ± 0.036	37.67 ± 3.06	19.67 ± 1.57	16.33 ± 2.56
S.T with *Kent*-20 @ 75% + S.D. with Tenekil @ 0.01%	46.10 ± 1.13	1.42 ± 0.035	37.40 ± 2.20	1.29 ± 0.031	42.00 ± 2.00	10.67 ± 2.08	5.67 ± 1.57
S.T with *Kent*-20 @ 75% + S.D. with Tenekil @ 0.1%	49.37 ± 0.96	1.49 ± 0.031	40.13 ± 1.62	1.32 ± 0.032	46.00 ± 2.65	7.00 ± 1.00	4.67 ± 2.08
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.01%	46.30 ± 1.05	1.35 ± 0.030	33.83 ± 1.59	1.28 ± 0.040	36.67 ± 1.53	15.00 ± 1.00	10.67 ± 3.51
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.1%	42.20 ± 1.40	1.40 ± 0.026	35.13 ± 3.01	1.32 ± 0.021	37.66 ± 2.52	9.33 ± 2.52	5.67 ± 2.08
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.01%	47.40 ± 1.20	1.46 ± 0.020	37.30 ± 1.05	1.35 ± 0.010	40.00 ± 2.65	15.67 ± 2.08	12.00 ± 1.00
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.1%	52.27 ± 1.41	1.55 ± 0.031	43.10 ± 1.42	1.38 ± 0.015	43.67 ± 1.53	7.67 ± 3.77	5.00 ± 2.65
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.01%	43.63 ± 0.85	1.41 ± 0.030	32.60 ± 1.05	1.24 ± 0.012	35.00 ± 2.00	25.00 ± 2.00	21.67 ± 3.51
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.1%	45.77 ± 0.96	1.45 ± 0.020	37.17 ± 1.20	1.28 ± 0.015	38.33 ± 1.53	20.67 ± 1.54	15.67 ± 2.08
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.01%	47.13 ± 1.50	1.44 ± 0.020	37.80 ± 2.12	1.30 ± 0.026	43.33 ± 1.52	13.00 ± 1.00	9.33 ± 2.52
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.1%	52.73 ± 2.14	1.55 ± 0.025	44.83 ± 2.89	1.32 ± 0.020	45.00 ± 2.65	7.33 ± 2.52	4.67 ± 3.06
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.01%	43.63 ± 0.96	1.36 ± 0.026	36.17 ± 3.40	1.26 ± 0.021	41.67 ± 1.57	21.00 ± 2.65	16.33 ± 2.08
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.1%	46.70 ± 1.71	1.38 ± 0.032	40.80 ± 1.35	1.29 ± 0.026	40.33 ± 2.08	16.00 ± 1.00	13.00 ± 1.00
$LSD_{0.05}$=	2.565	0.0623	3.772	0.046	3.633	4.557	4.963

Where: ± S.D. =Standard deviation, S.D. = Soil drenching, S.T. = Seed treatment

Table 7. Effect of seed treatment with homeopathic drugs along with soil drenching with nematicides on the growth parameters of sunflower plants and control of root knot nematodes.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	Number of galls/ root system ± SD	Egg masses/ root system ± SD
Control (Sterilized water)	19.60 ± 0.92	0.89 + 0.042	9.67 ± 0.81	0.96 ± 0.015	52.00 ± 4.00	48.33 ± 3.51
Seed treatment with *Kent*-20 @ 75%	25.80 ± 1.25	1.05 ± 0.010	16.47 ± 0.70	1.12 ± 0.025	14.67 ± 1.53	12.67 ± 1.53
Seed treatment with *Kent*-20 @ 50%	24.60 + 0.89	0.97 ± 0.010	14.50 ± 0.82	1.06 ± 0.015	18.33 + 2.52	15.00 ± 3.00
Seed treatment with *Santonine*-43 @ 75%	30.40 ± 2.20	1.04 ± 0.020	17.40 + 0.95	1.07 ± 0.016	19.67 ± 2.56	14.67 ± 2.08
Seed treatment with *Santonine*-43 @ 50%	27.20 ± 1.75	1.00 + 0.020	15.70 ± 0.99	1.06 ± 0.015	26.00 ± 2.65	21.33 + 2.06
Soil drenching with Furadan @ 0.01%	22.60 = 1.11	0.95 = 0.025	12.63 ± 1.07	1.04 + 0.015	26.67 + 1.53	23.00 ± 2.00
Soil drenching with Furadan @ 0.1%	24.30 ± 1.35	0.98 ± 0.015	13.63 ± 0.95	1.05 ± 0.030	16.33 ± 2.08	13.67 ± 1.53
Soil drenching with Tenekil @ 0.01%	24.10 ± 0.78	1.04 ± 0.025	12.43 ± 0.87	1.07 ± 0.010	26.67 ± 1.53	23.00 + 2.00
Soil drenching with Tenekil @ 0.1%	25.77 + 1.56	1.04 ± 0.026	13.43 ± 1.15	1.04 ± 0.020	21.00 + 2.65	16.33 ± 2.08
S.T with *Kent*-20 @ 75% +S.D. with Furadan @ 0.01%	28.40 ± 0.92	1.07 ± 0.015	15.50 + 0.95	1.09 ± 0.012	3.00 ± 1.00	2.00 ± 1.00
S.T with *Kent*-20 @ 75% − S.D. with Furadan @ 0.1%	31.33 ± 1.86	1.15 ± 0.021	18.30 ± 0.93	1.27 ± 0.015	0.00 ± 0.00	0.00 ± 0.00
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.01%	27.70 ± 1.37	1.20 ± 0.020	14.33 ± 0.47	1.30 ± 0.021	8.00 ± 2.00	5.33 ± 2.09
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.1%	28.53 ± 1.21	1.14 + 0.021	13.80 ± 1.31	1.24 ± 0.025	6.67 ± 2.08	4.33 ± 2.52
S.T with *Kent*-20 @ 75% + S.D. with Tenekil @ 0.01%	33.27 ± 2.14	1.15 ± 0.031	15.47 ± 1.07	1.28 ± 0.015	5.67 ± 1.53	3.33 ± 1.53
S.T with *Kent*-20 @ 75% + S.D. with Tenekil @ 0.1%	36.93 ± 1.41	1.23 ± 0.015	18.47 + 0.83	1.30 ± 0.038	7.33 ± 4.16	5.00 + 3.61
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.01%	27.13 = 1.51	1.28 ± 0.017	14.37 ± 1.06	1.34 ± 0.020	22.00 + 4.00	18.33 ± 5.51
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.1%	30.80 ± 1.64	1.18 ÷ 0.021	14.80 ± 1.42	1.25 ± 0.031	15.00 ± 2.00	12.33 ± 1.52
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.01%	36.73 ± 1.67	1.24 ± 0.015	16.53 ± 1.03	1.28 ± 0.036	11.33 ± 3.06	9.00 + 3.00
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.1%	37.00 + 2.21	1.36 ± 0.020	14.50 ± 0.82	1.35 + 0.020	4.33 + 1.53	3.33 ± 1.57
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.01%	32.27 ± 1.67	1.37 ± 0.021	12.63 + 0.75	1.38 ± 0.015	22.33 ± 3.79	19.33 ± 4.73
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.1%	35.70 ± 0.95	1.31 ÷ 0.026	13.60 ± 0.90	1.30 ± 0.021	14.67 ± 1.53	10.33 ± 3.06
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.01%	34.53 + 2.50	1.32 ± 0.028	15.60 ± 0.98	1.34 ± 0.028	9.00 + 3.61	6.67 + 3.79
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.1%	37.80 ± 1.40	1.35 ± 0.049	16.37 ± 1.11	1.38 + 0.038	4.67 = 2.08	2.00 ± 1.00
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.01%	30.17 ÷ 1.79	1.25 ± 0.031	14.50 + 0.82	1.42 ± 0.020	17.33 ± 3.06	13.00 ± 1.00
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.1%	34.83 ± 2.24	1.31 + 0.025	13.47 ± 1.22	1.35 ± 0.012	12.67 ± 3.51	7.67 ± 3.06
$LSD_{0.05}$=	2.626	0.0389	1.606	0.0371	4.281	4.343

Where: ± S.D. =Standard deviation. S.D. = Soil drenching. S.T. = Seed treatment

Table 8. Effect of seed treatment with homeopathic drugs along with soil drenching with nematicides on the growth parameters of okra plants and control of root knot nematodes.

TREATMENTS	Shoot Length (cm) ± SD	Shoot Weight (g) ± SD	Root Length (cm) ± SD	Root Weight (g) ± SD	Number of galls/ root system ± SD	Egg masses/ root system ± SD
Control (Sterilized water)	20.70 ± 2.10	1.01 ± 0.12	12.07 ± 1.47	0.96 ± 0.020	66.67 ± 5.03	62.33 ± 5.51
Seed treatment with *Kent*-20 @ 75%	30.07 ± 2.27	1.14 ± 0.015	18.97 ± 1.40	1.06 ± 0.015	25.00 ± 3.00	21.00 ± 2.65
Seed treatment with *Kent*-20 @ 50%	26.83 ± 1.89	1.06 ± 0.032	17.60 ± 0.80	1.04 ± 0.017	33.67 ± 2.08	28.33 ± 3.51
Seed treatment with *Santonine*-43 @ 75%	30.83 ± 3.28	1.14 ± 0.020	18.53 ± 1.16	1.05 ± 0.030	24.33 ± 1.53	20.67 ± 3.06
Seed treatment with *Santonine*-43 @ 50%	26.07 ± 1.40	1.04 ± 0.015	15.37 ± 0.85	1.00 ± 0.049	31.33 ± 3.06	27.33 ± 3.51
Soil drenching with Furadan @ 0.01%	27.07 ± 1.49	1.03 ± 0.021	15.60 ± 1.11	1.037 ± 0.015	39.00 ± 2.65	35.67 ± 2.08
Soil drenching with Furadan @ 0.1%	28.60 ± 0.80	1.07 ± 0.015	17.53 ± 1.11	1.053 ± 0.021	33.33 ± 1.53	29.67 ± 2.52
Soil drenching with Tenekil @ 0.01%	25.30 ± 1.90	1.07 ± 0.026	16.53 ± 1.90	1.057 ± 0.032	38.33 ± 1.52	35.00 ± 3.00
Soil drenching with Tenekil @ 0.1%	27.27 ± 1.67	1.09 ± 0.024	16.60 ± 1.31	1.05 ± 0.010	34.33 ± 3.06	29.00 ± 2.65
S.T with *Kent*-20 @ 75% + S.D. with Furadan @ 0.01%	29.40 ± 0.92	1.37 ± 0.042	22.27 ± 1.67	1.37 ± 0.050	9.00 ± 2.00	5.67 ± 2.08
S.T with *Kent*-20 @ 75% + S.D. with Furadan @ 0.1%	32.63 ± 0.85	1.42 ± 0.021	25.80 ± 1.44	1.42 ± 0.042	4.00 ± 2.00	2.00 ± 1.00
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.01%	30.10 ± 1.49	1.29 ± 0.057	22.57 ± 1.11	1.27 ± 0.015	14.67 ± 2.08	11.00 ± 3.00
S.T with *Kent*-20 @ 50% + S.D. with Furadan @ 0.1%	28.43 ± 0.91	1.36 ± 0.021	23.17 ± 2.18	1.34 ± 0.026	11.67 ± 1.57	9.33 ± 2.52
S.T with *Kent*-20 @ 75% + S.D with Tenekil @ 0.01%	33.90 ± 1.61	1.27 ± 0.030	22.37 ± 1.56	1.42 ± 0.013	16.33 ± 2.09	13.00 ± 1.00
S.T with *Kent*-20 @ 75% + S.D. with Tenekil @ 0.1%	31.13 ± 3.79	1.38 ± 0.032	25.57 ± 1.12	1.47 ± 0.010	8.33 ± 1.55	4.67 ± 2.08
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.01%	26.87 ± 1.81	1.25 ± 0.025	24.70 ± 1.95	1.38 ± 0.032	25.67 ± 2.08	21.67 ± 2.52
S.T with *Kent*-20 @ 50% + S.D. with Tenekil @ 0.1%	29.50 ± 1.05	1.31 ± 0.026	26.50 ± 0.82	1.41 ± 0.030	20.00 ± 2.00	15.33 ± 1.57
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.01%	33.97 ± 1.32	1.39 ± 0.036	22.53 ± 0.90	1.36 ± 0.021	11.00 ± 2.00	7.00 ± 3.00
S.T with *Santonine*-43 @ 75% + S.D. with Furadan @ 0.1%	37.00 ± 1.44	1.42 ± 0.015	20.27 ± 0.61	1.39 ± 0.015	6.33 ± 2.08	4.33 ± 2.52
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.01%	30.53 ± 0.70	1.26 ± 0.021	18.53 ± 1.21	1.31 ± 0.015	16.67 ± 2.52	13.67 ± 1.52
S.T with *Santonine*-43 @ 50% + S.D. with Furadan @ 0.1%	33.83 ± 1.40	1.29 ± 0.047	19.27 ± 1.17	1.37 ± 0.017	13.33 ± 1.52	9.33 ± 2.52
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.01%	34.37 ± 2.65	1.35 ± 0.031	22.27 ± 1.40	1.36 ± 0.020	8.33 ± 1.57	5.00 ± 2.00
S.T with *Santonine*-43 @ 75% + S.D. with Tenekil @ 0.1%	36.10 ± 2.02	1.36 ± 0.030	24.93 ± 1.44	1.37 ± 0.021	5.00 ± 1.00	3.33 ± 1.57
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.01%	30.37 ± 2.35	1.31 ± 0.025	19.10 ± 2.09	1.26 ± 0.020	14.00 ± 2.00	10.33 ± 3.21
S.T with *Santonine*-43 @ 50% + S.D. with Tenekil @ 0.1%	33.10 ± 1.73	1.35 ± 0.015	19.30 ± 2.15	1.32 ± 0.020	10.00 ± 2.65	6.33 ± 4.16
$LSD_{0.05}$=	3.061	0.0602	2.384	0.0418	3.773	4.529

Where: ± S.D. = Standard deviation. S.D. = Soil drenching. S.T. = Seed treatment

B) ROOT KNOT NEMATODE

When mung bean and mash bean seeds treated with *Santonine*-43 at 75% concentration and soil drenched with tenekil at 0.1% were found to be best in the plant weight and height as well as reduced the galls and egg masses numbers of the leguminous roots. Seeds of mung bean and mash bean when treated with *Kent*-20 at 75% concentration with furadan as well as with tenekil at 0.1% were found increased growth parameters in terms of root weight, shoot weight, number of nodules along with greater suppression of galls and egg masses per root system. Both homeopathic drugs at 50% concentration showed significant ($p < 0.001$) effect on growth when applied alone, but in combination with both nematicides drenched at 0.1% in soil, reduced the root knot infection followed by 0.01% as compared to the control (Tables 5-6). In case of sunflower plant, seeds treated with *Santonine*-43 and *Kent*-20 at 75% concentration and soil drenched with tenekil at 0.1% showed excellent shoot weight, shoot length, root length and root weight but also reduced the galls and egg masses formation produced by *M. javanica*. It was interesting to note that seeds treated with *Kent*-20 and soil drenched with furadan at 0.1% not only improved the growth parameters but no galls formation and egg masses were recorded on sunflower roots followed by 0.01%. Both concentrations (75 and 50%) of *Santonine*-43 and *Kent*-20 and soil drenching (0.1 and 0.01%) with furadan and tenekil showed significant ($p < 0.001$) results in growth promotion and reduced the root knot infection as compared to control (Table 7). Okra seeds when treated with *Kent*-20 at 75% and soil drenched with furadan at 0.1% showed greater shoot and root weight whereas highest shoot and root length observed when seeds were treated with *Santonine*-43 in addition with tenekil at 0.1% drenched in soil. 75% concentration of *Kent*-20 and *Santonine*-43 along with both nematicides (furadan and tenekil) at 0.1% reduced the galls and egg masses followed by 0.01% concentration. However, 50% concentration ($p < 0.001$) showed maximum control of forming galls and egg masses on okra roots as compared to control (Table 8).

Overall results of root rot fungi and root knot nematode showed that all treatments improved the growth parameters either used alone or in combination with fungicides and nematicides, respectively as compared to control. Compared with 0.01% concentration of fungicides and nematicides, 0.1% gave more pronounced results. However, promising results of controlling plant pathogens as well as remarkable effect on the growth promotion attained by the combined application of homeopathic drugs in addition with synthetic chemicals as compared to individual treatments.

DISCUSSION

Modern approaches of rapid successful management of suppressing root rot fungi colonization were generally achieved by using the fungicides (Stranger and Scott, 2005) and decreasing root knot nematodes populations was generally controlled by nematicides (Hallmann *et al*., 2009) showed remarkable control of pathogenic infection. Combined application of fungicides (mancozeb and dithane) drenched (20 mL) in 300g of soil at 0.1% on leguminous (mung bean and mash bean) and non-leguminous (okra and sunflower) seeds treated with *A. montana* – 30C and *T. occidentalis* – 30C at 75% showed complete inhibition of root rot fungi colonization. Similarly, when nematicides (furadan and tenekil) drenched (20 mL) in 300g of soil at 0.1% along with tested seeds treated with *Kent*-20 and *Santonine*-43 at 75% concentration showed complete suppression of the nematode population as well as no gall formation produced by *M. javanica* was observed. Application of synthetic chemicals as soil treatment, though increases the crop production by suppressing plant pathogens (Arcury and Quandt, 2003; Jahanshir and Dzhalilov, 2010) but causes undesirable changes if used improperly (Pérez *et al*., 2004) producing human health risks (Mancini *et al*., 2008), high toxicity (Nascimento *et al*., 2000), elongated degradation period (Zhonghua and Michailides, 2005) and killed beneficial organisms (Serfoji *et al*., 2010). Therefore, before the application of using fungicides and/or nematicides, farmer must have the knowledge of using appropriate amount of agro-chemicals (Choi *et al*., 2007; Kaþkavalci *et al.,* 2009). Seed treatment regarded as best method which permits the seed to emerge into healthy seedling (Chang and Kommedahl, 1968) enhances the crop yield and minimizes economic losses by reducing the plant pathogens (Martha *et al.,* 2003). Leguminous and non-leguminous seeds treated with homeopathic medicines (*A. montana* – 30C, *T. occidentalis* – 30C, *Kent*-20 and *Santonine*-43) improved the plant weight and length at 75% followed by 50% concentration. Use of homeopathic medicines efficiently improved the agricultural productivity and plants considered as distinctive model for research of studying ultra dilutions of homeopathic medicines (Novasadyuk, 2011). Experimental research on homeopathic drugs against plant pathogens has been performed mostly in Europe, Mexico, India and Brazil (Marques *et al.,* 2011). Use of *A. montana* with 3, 6 and 12 CH potencies improved growth of the tested crops (Bonfim *et al*., 2008). Most of the studies using homeopathic drugs against plant pathogenic fungi and nematodes were conducted by Indian researchers. Chaube *et al*., (1978) reported that *Apis, Kali, Thuja, Sulphur* (30 and 200C potencies) showed strong toxicity against spore germination of *Cochliobolus miyabeanus, Haematonectria haematococca* and *Penicillium decumbens.* Mishra

(1983) treated *Arsenicum album, Calcarea carbonica, Graphites* and *Phosphorus* with 200C potency showed inhibition of *Aspergillus niger* (90%) during coriander and cumin seeds storage. *Thuja, Sulphur* and *Nitric acid* (200C) completely suppressed the growth almost of all the tested fungal species, while *Teuricum* (Mother tincture) and *Nitric acid* (30C) failed to inhibit *Aspergillus flavus, A. fumigatus, A. niger, Alternaria alternata, Penicillium oxalicum, P. granulaum, Rhizopus stolonifer, R. nigricans* and *Mortierella subtilissima.* Rolim *et al.,* (2001) investigated that by using homeopathic treatments such as *Kali iodatum, Lachesis trigonocephalus, Staphysagria* (30 and 100C), *Sulphur* (30C) and *Oidium lycopersici* (100C) against powdery mildew caused by *Podosphaera leucotricha* on apple trees were sprayed twice at 12 day intervals and best result attained by *Staphysagria* (100C) showing significant reduction in the disease incidence. For nematode control, especially *Meloidogyne* spp., Sukul and Sukul (1999) tested *Cina* (1000C) on cow pea plants inoculated with second stage juveniles and reported significant results in treated plants which showed greater shoot/root length and weight as well as reduced the galls and nematode population as compared to control (untreated). Sukul *et al*. (2001) studied the effects of *Cina* (200 and 1000C) on tomato plants inoculated with *M. incognita* larvae which showed more pronounced results in 200C rather than 1000C. Sukul *et al*., (2006) inoculated *M. incognita* on okra plants which was treated with *Cina, Santonine* (30C) and 90% ethanol, respectively. They found impressive reduction of galls, nematode population and protein content at using *Cina* and *Santonine* (30C) as compared to 90% ethanol on okra roots. Using *Cina* (Mother tincture at 200C) controlled *M. incognita* infection in mulberry have been investigated by Datta (2006).

Homeopathic medicines found to be eco-friendly, inexpensive and used in small doses (Toledo *et al.,* 2011) providing potential technology for agriculture which increases the resistance against plant pathogens by improving yield productivity (Rossi *et al*., 2004) due to this reason homeopathic drugs used intensely in Pakistan (Alam, 2009) as they improved metabolic process in plants and disease management (Espinoza, 2001) without any adverse side effects in an environment (Shukla *et al*., 2011). Hence, studies on the effectiveness of homeopathic medicines need to be increased (Benzie and Wachtel – Galor, 2011). In the present study, seed treatment with homeopathic drugs considered as new method for the protection of seeds against plant diseases and improves germination and promotes healthy plant growth along with the soil drenching with fungicides and nematicides, respectively in minute amount showed complete control of plant pathogens within a short period of time which can be used as a fastest and quick way against root rot fungi and root knot nematodes.

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