Pak. J. Bot., 48(5): 2131-2138, 2016.

STUDY OF HOMEOPATHIC DRUGS ON SEED GERMINATION AND FUNGAL GROWTH

ASMA HANIF AND SHAHNAZ DAWAR*

Department of Botany, University of Karachi, Karachi-75270, Pakistan
**Corresponding author e-mail: shahnaz_dawar@yahoo.com*

Abstract

In vitro, seeds of mung bean, sunflower, okra and mash bean were treated with homeopathic drugs namely *Arnica montana* and *Thuja occidentalis* (30C) were evaluated against root rot fungi. Different concentrations like 100, 75 and 50% v/v were tested to investigate seeds germination and inhibition of root rot fungi such as *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina*. Results indicated that treated seeds of mung bean, sunflower, okra and mash bean with pure homeopathic drugs (100% v/v) by *A. montana* and *T. occidentalis* (30C) showed complete germination (100%), greater root length and excellent inhibition of root infecting pathogens. However, tested seeds treated with 75 and 50% v/v concentrations (prepared from 30C) by homeopathic drugs, respectively recorded significant increase in germination, root length and maximum zone of inhibition.

Key words: Homeopathic drugs, Seed treatment, Concentrations, Germination, Inhibition of root rot fungi.

Introduction

Plant pathogens particularly fungi poses the most visible threats to crop fields (Fravel, 2005). The losses of world crop production due to fungal diseases estimated as 12% or more in developing countries (Horbach *et al*., 2010). Root rot pathogens like *M. phaseolina*, *R. solani* and *Fusarium* spp. are reported to infect an extensive range of crop plants in Pakistan (Ghaffar, 1988). *F. oxysporum* considered as pathogenic soil inhabitant that has capability to degrade lignin (Sutherland *et al*., 1983) plus complex carbohydrates (Snyder & Hansen, 1940). *F. solani and R. solani* are responsible for causing root rot and damping off diseases on a numerous variety of crop plants (Abu-Taleb *et al*., 2011). *M. phaseolina* found throughout the globe (Hoes, 1985) and considered an essential plant pathogens in the tropical and subtropical regions (Reuveni *et al*., 1983) producing the symptoms mainly damping off, charcoal rot, leaf and stem blight, wilt and dry rot (Cowan, 1999). Association of pathogenic fungi enhances the disease intensity and severity on many crop plants (Piecsarka & Abawi, 1978). The aim of controlling plant disease is to increase the growth quality of crop plants (Stephan *et al*., 1988) by using fungicide application (Perez *et al*., 2004). However, chemical applications produces environmental and human health risks (Mancini *et al*., 2008) and pest resistance also becomes a problem (Bhanti & Taneja, 2007). Therefore, substitute methods of disease control in plants are essential (El-Mougy *et al*., 2004).

Homeopathic drugs used as an alternative control have potential to resist diseases without destruction of an environment (Bonato & Silva, 2003). Application of homeopathic drugs showed positive effect in human beings and animals but in case of using drugs particularly in plants and soil have been developed more recently (Bonato *et al*., 2006). Presently, homeopathic drugs are being used in the control of plant diseases (Kumar, 1980; Hanif & Dawar, 2015a), plant detoxification of metals for example aluminum (AL), (Rocha *et al*., 2002; Moretti *et al*., 2002) and copper (Cu), (Almeida, 2002). Using homeopathic drugs against plant pathogenic fungi has been reported earlier (Khanna & Chandra, 1980, 1981; Goswami & Das, 1980; Khurana & Gupta, 1981). By using the drugs such as *Filixmas* and *Blatta orientalis* showed maximum inhibition of *Fusarium oxysporum* in the seed mycoflora of wheat (Rake *et al*., 1989). Khanna & Chandra (1983) found significant results in the inhibition of root rot fungi on tomato caused by *Fusarium roseum*, by the homeopathic preparation of *Kali iodatum* in 149 CH and *Thuja occidentalis* in 87 CH for both pre and post harvest conditions. Homeopathic drugs minimize plant diseases through the activation of induced resistance (Betti *et al*., 2009). Homeopathic drugs such as, *Thuja occidentalis* (Cupressacae) has been use to treat amenorrhea, enuresis, psoriasis, cystitis, uterine, carcinomas and rheumatism (Chang *et al*., 2000). Plant extracts of *Thuja occidentalis* contain anti-diarrheal and anti-viral activity (Deb *et al*., 2007). *Arnica montana* (Asteraceae) mainly grows on the Central Europe and East, its active constituents identified in its flower, leaves and roots contains chlorogenic acids, lactones, flavonoids, sesquiterpene, carotenoids, tannins, alcohols, essential oil and phenolic acids compounds (Gawlik-Dziki *et al.*, 2011). These compounds are responsible for anti-inflammatory properties (Siedle *et al.*, 2004). *Arnica montana* exhibited anti-bacterial, anti-fungal, anti-septic, anti-oxidant and anti-sclerotic activities (Sugier & Gawlik-Dziki *et al.*, 2009).

Developing countries shows interest in testing seeds for quality and seed research in pathology (Neergaard, 1977). Seeds attack by fungi caused seed shrunken, abortion, reduced size, necrosis, sclerotisation, seed rot and discoloration, reduced or totally germ failure, mechanical and physiological changes (Shetty & Prakash, 1994). Seeds are considered as the carriers of plant pathogens and thus responsible for producing severe diseases leading to huge loss of crop yield (Janardhanan & Husain, 1980). Seeds carrying infection resulting in immense destruction due to seedling blights (Janardhanan, 1994). Pathogenic fungi produce toxic metabolites which kill embryo (Vidyasekaran *et al*., 1970).

Present research has done to explore antifungal activity of homeopathic drugs in the inhibition of root rot fungi namely; *Rhizoctonia solani*, *Fusarium oxysporum* and *Macrophomina phaseolina* by treated crop seeds with homeopathic drugs.

Materials and Methods

Homeopathic drugs like *Arnica montana* and *Thuja occidentalis* (30C) were purchased from the medicinal market of Karachi. Seeds of mung bean (*Vigna radiata* (L.) R. Wilczek. cv. NM-2006), okra (*Abelmoschus esculentus* (L.) Moench cv. Arka anamika), sunflower (*Helianthus annuus* L. cv. Hysun-38) and mash bean (*Vigna mungo* (L.) Hepper cv. NM-97) were treated with Dr. Willmar Schwabe homeopathic drugs like *A. montana* and *T. occidentalis* (30C) with the concentrations of 100, 75 and 50% v/v, respectively whereas, seeds treated with sterilized water and absolute alcohol (MERCK) for about 10-15 mins. served as control and dried aseptically. Four seeds of mung bean, sunflower, okra and mash bean were placed in each Petri plates containing PDA (Potato Dextrose Agar) medium supplemented with antibiotics (penicillin @ 100,000 unit/L and streptomycin @ 200 mg/L) to inhibit the growth of bacteria and in the centre test fungus was inoculated. Root infecting pathogens like *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina* were replicated thrice and plates were incubated for one week at room temperature (26-31°C). Observed the germination percentage (Swati *et al.*, 2013), root length and fungal growth inhibition percentage (Pinto *et al.*, 1998; Lokesha & Benagi, 2007). Data were analyzed by using two way analysis (ANOVA) followed by the least significant difference (LSD) test at P = 0.05 as given by Gomez & Gomez (1984).

Results and Discussion

Mung bean and mash bean seeds when treated with *A. montana* and *T. occidentalis* @ 100, 75 and 50% v/v concentrations showed complete germination ($p<0.05$) but in case of sunflower and okra seeds when treated with both homeopathic drugs @ 100% v/v showed 100% germination followed by 75 and 50% concentrations. Tested seeds when treated with sterilized water and absolute alcohol served as control showed significant reduction ($p<0.05$) in germination and produced severe infection which was visible on seed surface as well as roots easily infected by root rot fungi but also failed to produce zone of inhibition. Highest zone of inhibition and significant root length ($p<0.05$) was observed on mung bean, sunflower, okra and mash bean seeds treated with *A. montana* and *T. occidentalis* @ 100% concentrations (Fig. 1A). Maximum zone of inhibition and root length were recorded when seeds were treated with 75 and 50% v/v concentrations respectively by both homeopathic drugs (Fig. 1B). Highest inhibition was recorded by *A. montana* with different concentrations and was found to be the best drug in controlling the *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina* and also showed highest root length (Table 1). Emphasis on methods has been made which are simple, economic, reproducible and effective but some methods such as blotter and deep freezing suppressed seed germination (Limonard, 1968). Non synthetic media plays an important role in germination of seeds because of the characteristic requirements of moisture and oxygen available for germination (Swati, 2006). Seeds treated with different concentrations of homeopathic drugs plated on PDA medium showed better results in germination, root length and showed maximum zone of inhibition against root rot fungi which was also reported by Farrag & Moharam (2012) when cucumber seeds treated with 1, 2 and 3% peppermint extract exhibited highest seed germination and reduced infection of pathogenic fungi on PDA medium. *T. occidentalis* in 30 M and 200 M showed significant result against *Aspergillus flavus* whereas, by using 50 M against *A. niger* (Gupta & Srivastava, 2002). Singh *et al*. (1980 and 1981) proved antiviral effectiveness of homeopathic drugs against animal and plant viruses. *In vitro*, *T. occidentalis* (30C and 200C) showed maximum inhibition against *Candida albicans* (Gupta *et al*., 2015). Saxena *et al*. (1988) inhibited twenty two genera of fungi on okra seeds when treated with *T. ocidentalis*. Hanif & Dawar (2015b) reported that by using the concentrations of 100, 75 and 50% v/v of *T. occidentalis* and *A. montana* (30C) used as a seed treatment and soil drenching methods inhibit root rot fungi and enhanced the growth of crop plants. *T. occidentalis* and *A. montana* (30C) pellets showed positive results when used *In vitro* and *In vivo* experiments against root rot fungi (Hanif *et al*., 2015). Use of Ceresan for seed treatment avoid the seeds rot in storage and obtain better sprouting of seedlings of *Oroxylum indicum* (Mehrotra, 1990). Seed treatment is an excellent method to protect seed from seed borne and soil borne pathogens which permit the seed to germinate and become established as a healthy seedling (Chang & Kommedahl, 1968). Treatment of crop seeds with fungal and bacterial antagonists showed effectiveness in the inhibition of root rot fungi (Dawar *et al*., 2008, Ikram & Dawar, 2015). *B. thuringiensis* when applied as seed dressing showed significant increase in germination, shoot length, shoot weight, root length and root weight (Sheikh *et al*., 2006). Similarly, seed dressing with *Bacillus subtilis* control variety of crop diseases including *Rhizoctonia solani* (Merriman *et al.*, 1974). Seed dressing increase yield and minimize economic losses by reducing pathogenic fungi (Martha *et al*., 2003). There is a need to enhance the yield and improve seed quality of the crops therefore; treatments of seed should be done as a routine practice due to cheap insurance against possible adversity at a later stage (Bilgrami & Dube, 1976).

Present studies showed that seed treatment with homeopathic dugs *In vitro* was found to be better and cheap method for the inhibition of root rot fungi which protect seeds and roots. For that reason, experiment would be carried out in the field to improve the yield and increase the productivity of crop plants.

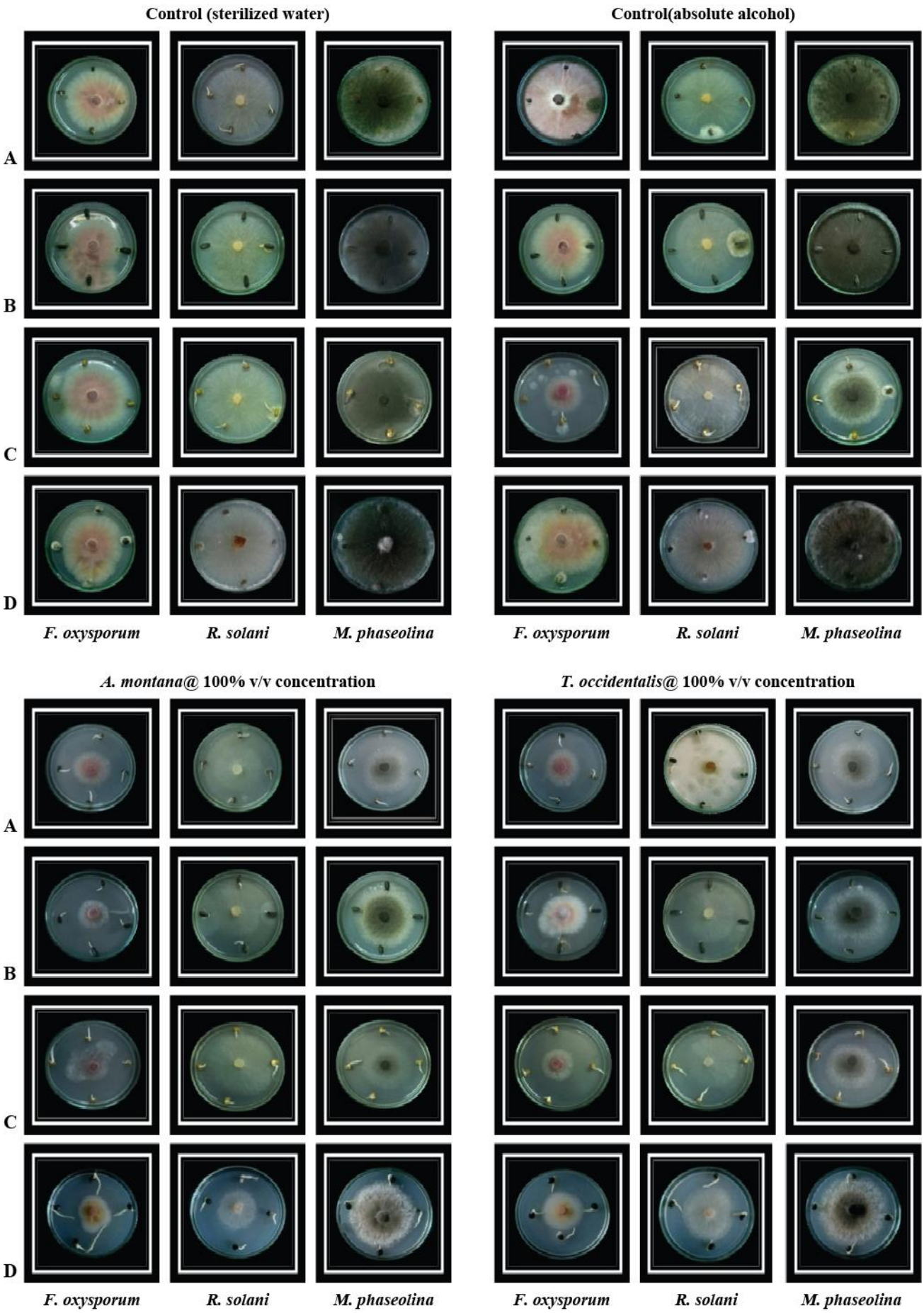
Control (sterilized water)
Control(absolute alcohol)
A
B
C
D
F. oxysporum
R. solani
M. phaseolina
F. oxysporum
R. solani
M. phaseolina
A. montana@ 100% v/v concentration
T. occidentalis@ 100% v/v concentration
A
B
C
D
F. oxysporum
R. solani
M. phaseolina
F. oxysporum
R. solani
M. phaseolina

Fig. 1A.(Cont'd.).

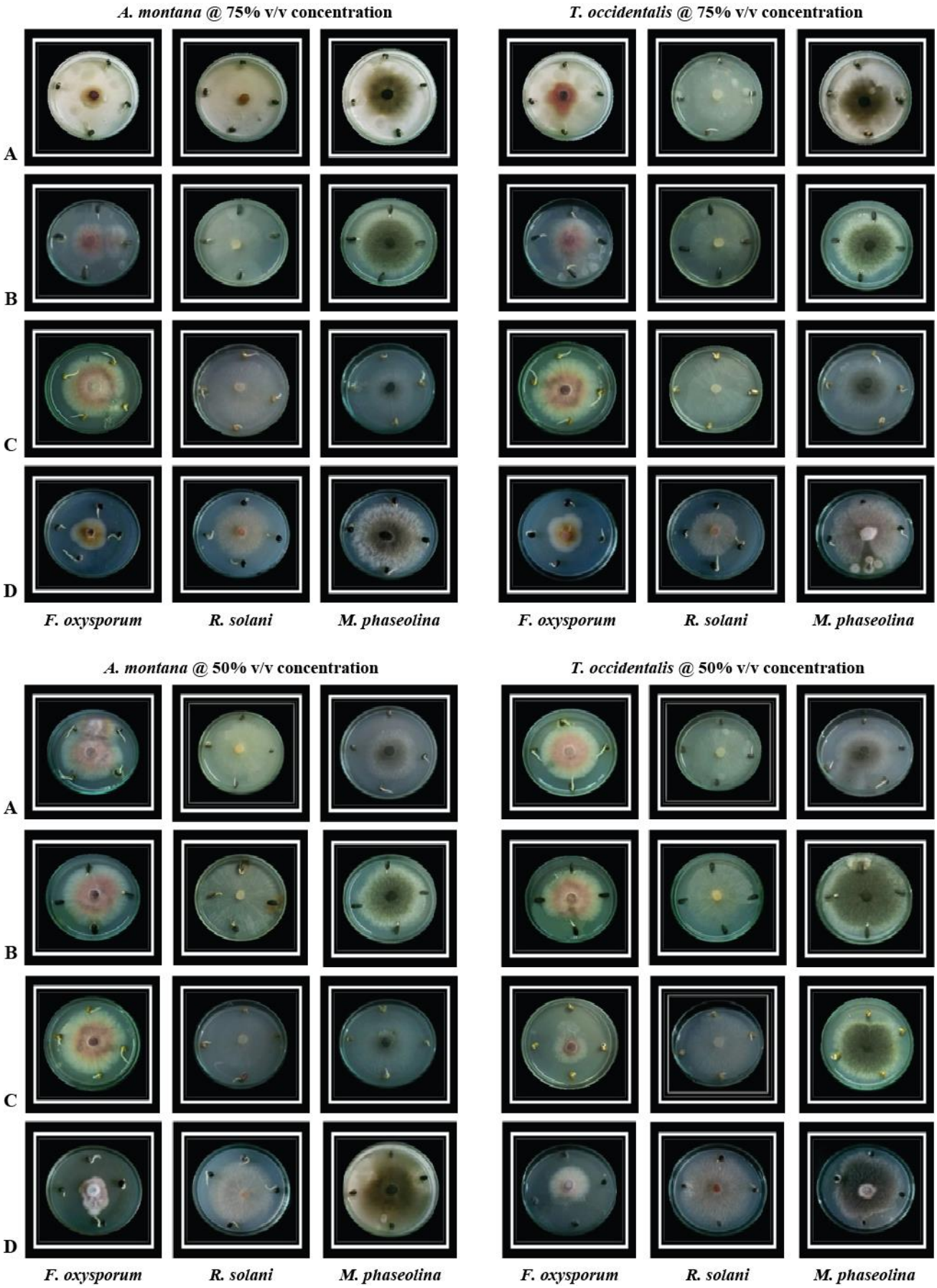

Fig. 1A. = *In vitro*, inhibition of root rot fungi by homeopathic drugs treated crops seeds on PDA (Potato Dextrose Agar) medium

Where; **A**= Mash bean (*Vigna mungo* (L.) Hepper), **B**= Sunflower (*Helianthus annuus* L.), **C**= Mung bean (*Vigna radiata* (L.) R. Wilczek.), **D**= Okra (*Abelmoschus esculentus* (L.) Moench) seeds.

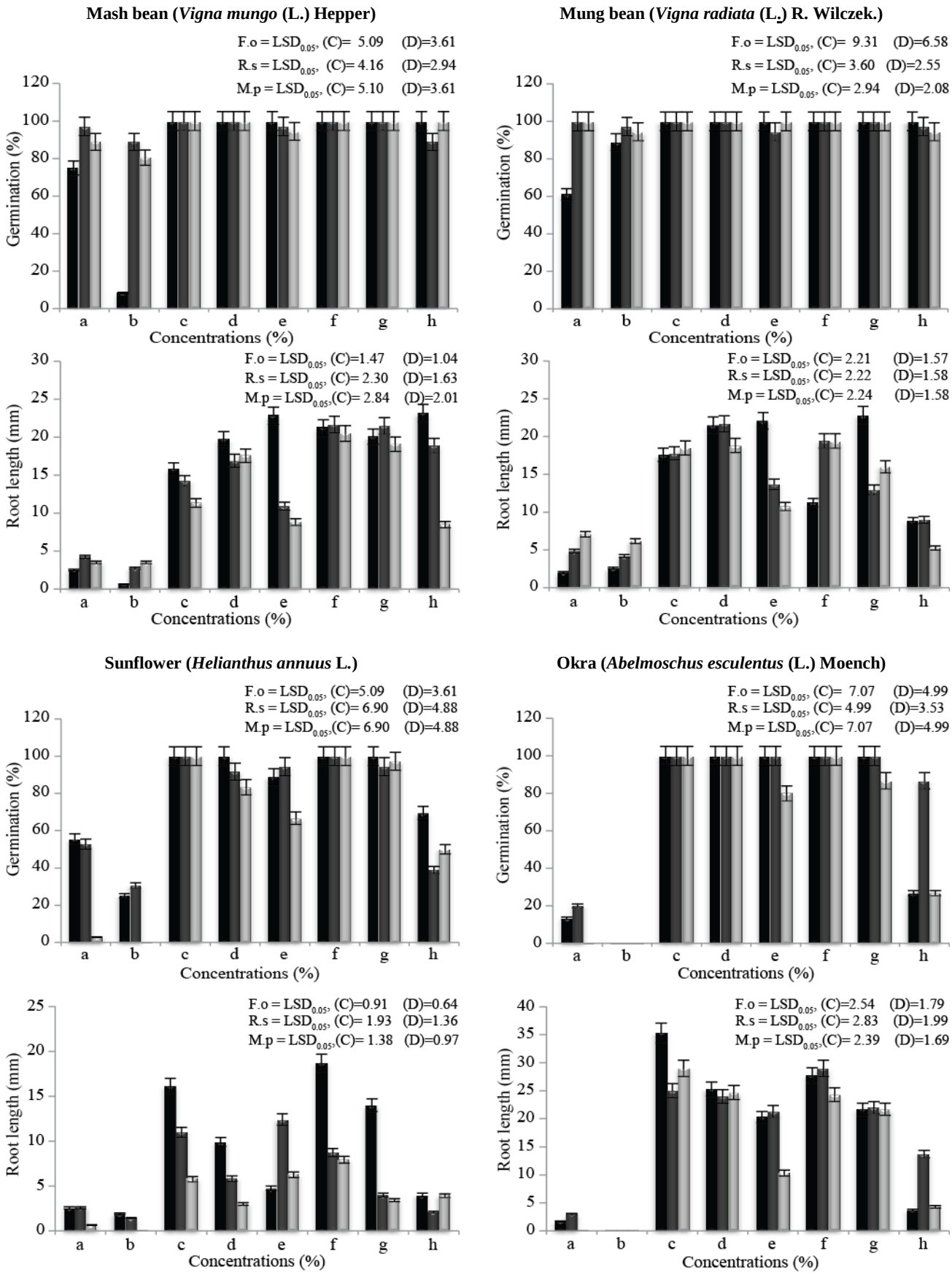

Fig. 1B. Effect of seed treatment with *Arnica montana* and *Thuja occidentalis* (30C) in the control of root rot fungi on crop seeds.

KEY: ***F.o****= Fusarium oxysporum* ***R.s****= Rhizoctonia solani* ***M.p****= Macrophomina phaseolina* **a**= Where; **a**=Control (Sterilized water), **b**= Control (Absolute alcohol) **c**= A@100%, **d**= A@75%, e= A@50%, f= T@100%, **g**= T@75%, **h**= T@50% v/v concentrations, **(C)** =Concentrations, **(D)** =Drugs

Table 1. *In vitro*, inhibition of root rot fungi by *A. montana* and *T. occidentalis* (30C) on treated crop seeds.

Homeopathic drugs	Concentrations/ Growth inhibition (MIC)											
	Fusarium oxysporum (%)				*Rhizoctonia solani* (%)				*Macrophomina phaseolina* (%)			
	C±SD	100±SD	75±SD	50±SD	C±SD	100±SD	75±SD	50±SD	C±SD	100±SD	75±SD	50±SD
Mash bean (*Vigna mungo* (L.) Hepper)												
A. monatana	0.0 ± 0.0	74.82 ± 2.08	72.60 ± 6.03	40.73 ± 1.53	0.0 ± 0.0	65.18 ± 1.53	65.18 ± 3.05	38.51 ± 2.08	0.0 ± 0.0	75.56 ± 2.00	63.71 ± 1.53	48.16 ± 1.53
T. occidentalis	0.0 ± 0.0	82.20 ± 4.58	68.20 ± 1.53	38.4 ± 4.51	0.0 ± 0.0	87.30 ± 2.52	55.60 ± 3.61	32.70 ± 5.86	0.0 ± 0.0	72.70 ± 1.53	46.70 ± 3.00	42.20 ± 2.65
$LSD_{0.05}$ (Conc.) =			4.04				3.61				2.25	
(Drugs) =			2.85				2.55				1.59	
Sunflower (*Helianthus annuus* L.)												
A. monatana	0.0 ± 0.0	89.62 ± 2.52	61.50 ± 4.16	17.10 ± 2.08	0.0 ± 0.0	68.16 ± 2.08	64.40 ± 2.65	11.80 ± 1.53	0.0 ± 0.0	56.2 ± 3.79	57.80 ± 4.00	10.40 ± 1.53
T. occidentalis	0.0 ± 0.0	65.20 ± 2.08	46.70 ± 1.00	27.60 ± 5.03	0.0 ± 0.0	73.30 ± 1.00	43.80 ± 3.06	17.80 ± 2.00	0.0 ± 0.0	68.20 ± 3.06	41.60 ± 1.53	18.50 ± 3.21
$LSD_{0.05}$ (Conc.) =			3.31				2.38				3.19	
(Drugs) =			2.34				1.68				2.26	
Mung bean (*Vigna radiata* (L.) R. Wilczek.)												
A. monatana	0.0± 0.0	73.30 ± 8.72	48.89 ± 1.00	40.00 ± 2.00	0.0 ± 0.0	65.18 ± 9.29	52.60 ± 1.53	37.10 ± 1.53	0.0 ± 0.0	71.10 ± 6.24	60.73± 3.51	33.30 ± 3.61
T. occidentalis	0.0± 0.0	88.20 ± 1.53	60.00 ± 5.57	64.40 ± 2.65	0.0 ± 0.0	61.50 ± 6.03	42.96 ± 1.53	43.78 ± 1.53	0.0 ± 0.0	59.30 ± 4.16	65.18 ± 1.53	35.56 ± 3.61
$LSD_{0.05}$ (Conc.) =			4.93				4.97				4.35	
(Drugs) =			3.48				3.52				3.08	
Okra (*Abelmoschus esculentus* (L.) Moench)												
A. monatana	0.0 ± 0.0	65.11 ± 2.08	54.00 ± 1.53	46.60 ± 1.53	0.0 ± 0.0	55.60 ± 1.00	44.44 ± 1.00	36.20 ± 3.06	0.0 ± 0.0	42.90 ± 2.08	31.80 ± 1.53	18.44 ± 1.53
T. occidentalis	0.0 ± 0.0	57.80 ± 2.00	51.11 ± 1.00	42.20 ± 1.00	0.0 ± 0.0	48.90 ± 1.00	42.90 ± 1.53	28.90 ± 2.00	0.0 ± 0.0	44.44 ± 2.00	31.70 ± 3.78	28.90 ± 3.00
$LSD_{0.05}$ (Conc.) =			1.68				1.87				2.61	
(Drugs) =			1.18				1.32				1.84	

Where; C= Control, Conc. = Concentrations and SD = ± Standard deviation, MIC = Minimum inhibitory concentration

References

Abu-Taleb, M. Amira, K. El-Deeb Fatimah and O. Al-Otibi. 2011. Assessment of antifungal activity of *Rumex vesicarius* (L.) and *Ziziphus spina-christi* (L.) wild extracts against two phytopathogenic fungi. *Afri. J. Micr. Res*., 5(9): 1001-1011.

Almeida, M.A.Z. 2002. Resposta do manjericão (*Ocimum basilicum* L.) à aplicação de preparações homeopáticas. Tese (Mestrado em Fitotecnia) - Universidade Federal de Viçosa, *Viçosa – MG*, pp. 68.

Betti, C., D. Scherr, G. Shah-Rossi, T. Trebbi, S. Jager, Baumgartner and V. Majewsky.2009. Use of homeopathic preparations in phytopathological models and in field trial: a critical review. *Homeopathy*, 98: 244-266.

Bhanti, M. and A. Taneja.2007. Contamination of vegetables of different seasons with organo-phosphorous pesticides and related health risk assessment in northern India. *Chemosphere*, 69: 63-68.

Bilgrami, K.S. and H.C. Dube. 1976. *A Text Book of Modern Plant Pathology*. Vikas Publishing House PVT, Ltd. New Delhi. pp. 164.

Bonato, C.M. and E.P. Silva.2003. Effect of the homeopathic solution *Sulphur* on the growth and productivity of radish. *Acta Scientiarum. Agronomy*, 25: 259-263.

Bonato, C.M., E.G. Viotto, J.H.R. Hara, A.T. Mizote and J.A.O. Cisneros. 2006. The application of the homeopathic drugs *Lachesis* and Isotherapic Virus in the growth and infection control for SCMV in Sorghum (*Sorghum* (L.) Moench). *Cultura Homeopática Arquivos da Escola de Homeopatia*, 16:51.

Chang, I. and T. Kommedahl. 1968. Biological control of seedling blight of corn by coating kernels with antagonistic micro-organisms. *Phytopathology*, 58: 1395-1401.

Chang, L.C., L.L Song and E.J. Park. 2000.Bioactive Constituents of *Thuja occidentalis*. *Journal of Natural Product*, 63: 12-35.

Cowan, M. 1999. Plant products as anti-microbial agents. *Clinical Microbiology Review*, 12: 564-582.

Dawar, S,. H. Sadia, M. Anis and M.J. Zaki. 2008. Effect of seed coating material in the efficacy of microbial antagonists for the control of root rot fungi on okra and sunflower. *Pak. J. Bot.*, 40(3):1269-1278.

Deb, L., S.K. Dubey, A.K. Jain, A. Jain, G.S. Pandian and S.P. Rout.2007.Anti diarrhoeal activity of *Thuja occidentalis* Linn. ethanol extract on experimental animal. *Indian Drugs*, 44: 319.

El-Mougy, N.S., F. Abd-El-Karem, G.E. Nadia and Y.O. Fotouh.2004. Application of fungicides alternatives for controlling cowpea root rot diseases under greenhouse and field conditions. *Egypt. J. Phytopathol.*, 32: 23-35.

Farrag, E.S.H. and M.H.A. Moharam.2012. Pathogenic fungi transmitted through cucumber seeds and safely elimination by application of peppermint extract and oil. *Notulae Scientia Biologicae*, 4(3):83-91.

Fravel, D. 2005. Commercialization and implementation of bio-control. *Annu. Rev. Phytopathol.*, 43: 337-359.

Gawlik-Dziki, U., M. Swieca, D. Sugier and J. Cichocka. 2011. Comparison of *In vitro* lipoxygenase, xanthine oxidase inhibitory and antioxidant activity of *Arnica montana* and *Arnica chamissonis* tinctures. Acta Scientiarum Polonorum. *Hortorum Cultus*., 10(3): 15-27.

Ghaffar, A. 1988. Soil borne diseases research centre. Final research report. Department of Botany, University of Karachi, Karachi-75270, Pakistan. pp.111.

Gomez, K.A. and A.A. Gomez. 1984. *Statistical procedure for Agricultural Research* 2nd ed. Willey, New York, pp. 680.

Goswami, N. and D. Das.1980. Possibilities of homoepathic treatment in plants and animal diseases. *Hahnemannian Gleaning XL*, 8: 332-341.

Gupta, G. and A.K. Srivastava. 2002. *In vitro* activity of *Thuja occidentalis* Linn. against human pathogenic *Aspergilla. The Homeopathic Heritage*, 27(1): 5-12.

Gupta, G., A.K. Srivastava, N. Gupta, G. Gupta and S. Mishra. 2015. Anti-candidal activity of homoeopathic drugs: An *In-vitro evaluation. Ind. J. Res. in Homoeopathy*, 9(2): 79-85.

Hanif, A. and S. Dawar. 2015a. Use of homeopathic drugs in combination with fertilizers for the control of root rot fungi. *Pak. J. Bot.*, 47(6): 2455-2462.

Hanif, A. and S. Dawar. 2015b. Fungicidal effects of homeopathic drugs in the control of root rot fungi and growth of leguminous and non leguminous crops. *Int. J. Biol. Biotech*., 12(1): 97-105.

Hanif, A., Dawar, S., Tariq, M. and Imtiaz, F. 2015. Fungicidal potential of homeopathic pellets in the inhibition of root rot fungi and for promotion of crop plants productivity. *Euro. J. Biol. and Med. Sci. Res*., 3(6): 26-39.

Hoes, J.A .1985. *Macrophomina phaseolina*: causal agent of charcoal rot of sunflower and other crops. Agric. *Canada Research station, Modern Manitoba*, pp.9.

Horbach, R., Q.A.R. Navarro, W. Knogge and H.B. Deising. 2010. When and how to kill a plant cell: Infection strategies of plant pathogenic fungi. *Journal of Plant Physiology*, 168: 51-62.

Ikhram, N. and S. Dawar. 2015. Efficicay of wild plant in combination with microbial antagonist for the control of root rot fungi on mung bean and cowpea. *Pak. J. Bot*., 47(4): 1547-1551.

Janardhanan, K.K. 1994. Phytotoxins produced by some seed-borne fungi. In: *Vistas in Seed Biology*. (Eds.): Tribhuwan Singh and Pravin Chandra Trivedi). *Rupa Offset Printers*, Jaipur. 1: 45-56.

Janardhanan, K.K. and A. Husain.1980. Phytotoxins in plant diseases. In: *Recent Advances in Plant Pathology*. (Eds.): Husain, A., K. Singh, B.P. Singh and V.P. Agnihotri. *Lucknow Print House*, Lucknow (India). pp. 136- 158.

Khanna, K.K. and S. Chandra. 1981. Homoeopathic drug induced abnormalities in the germ tubes of *Pestalotia mangiferae* and *Gloeosporium psidii*. *Advancing Homoeopathy*, 1: 35-36.

Khanna, K.K. and S. Chandra. 1983. Control of fruit rot caused by *Fusarium roseum* with homeopathic solutions. *Indian Phytopathol*, 36:356-357.

Khanna, K.K. and S.Chandra. 1980. A homoeopathic drug (*Lycopodium*) controls mango fruit rot caused by Pestalotia mangiferae Henn. *Hahnemannian Gleanings XL*, 8: 441-448.

Khurana, K.K. and G. Gupta. 1981. Homoeopathy: promise and prospects for plant protection. *Advancing Homoeopathy*, 1: 107: 116.

Kumar, R.S. 1980. Effect for certain homeopathic medicines on fungal growth and conidial germination. *Indian Phytopathol*, 33: 620-622.

Limonard, T. 1968. Ecological aspects of seed health testing. *Proc. Int. Seed Test. Assoc*., 33: 343-513.

Lokesha, N.M. and V.I. Benagi. 2007. Biological management of pigeon pea dry root rot caused by *Macrophomina phaseolina*. *Karnataka. J. Agric. Sci.*, 20:54-56.

Mancini, F., A.J. Termorshuizen, J.L.S. Jiggins and A.H.C. Bruggen. 2008. Increasing the environmental and social sustainability of cotton farming through farmer education in and Hra Pradesh, India. *India Agric. Syst.*, 96: 16-25.

Martha, M., J. Riesselman, D. Mathre, B. Jhonston and S. Blodgett. 2003. *Manual of small seed grain treatment guide*. pp: 55.

Mehrotra, M.D. 1990. A study on fungal deterioration of seed and damping off in *Oroxylum indicum* and their control. *Indian Forester*, 116(12): 977-979.

Merriman, P.R., R.D. Price and K.F. Baker. 1974. The effect of inoculation of seed with antagonists of *Rhizoctonia solani* on the growth of wheat. *Aust. J. Agric. Res.*, 25: 213-218.

Moretti, M.R., M. Rocha and C.M. Bonato. 2002. Efeito de diferentes dinamizações homeopáticas de $AlCl_3$ no comprimento da raiz principal de plântulas de milho. Proceedings of the XI Encontro Anual de Iniciação Científica; Maringá, Brazil.Maringá: *Universidade Estadual de Maringá*. pp. 75.

Neergaard, P. 1977. Seed Pathology, Vol I and II, *MacMillan Press*, London, U.K, p. 1187 .

Pérez, M.L., O.L.J. Durán, M.R. Ramírez, P.J.R. Sánchez and P.V. Olalde. 2004. Sensibilidad *In vitro* de aislados del hongo Phytophthora capsici a funguicidas. Memorias Primera Convención Mundial del Chile. León, Guanajuato, México. *Resumen*, pp. 144-150.

Piecsarka, D.J. and G.G. Abawi. 1978. Effect of interaction between *Fusarium*, *Pythium*, *Rhizoctonia* on severity of bean root rot. *Phytopathology*, 68: 403-408.

Pinto, C.M.F., L.A. Maffia, V.W.D. Casali and A.A. Cardoso. 1998. *In vitro* effect of plant leaf extracts on mycelial growth and sclerotial germination of *Sclerotium cepivorum*. *Journal of Phytopathology*, 146: 421-425.

Rake, K., K.K. Khanna, C. Sudhir, R. Khanna and S. Chandra.1989. Effect of homeopathic drugs on seed mycoflora of wheat. *Natl. Acad. Sci. Lett*, 12: 39-41.

Reuveni, R., A. Nachmias and J. Krikun.1983.The role of seed borne inoculum on the development of *Macrophomina phaseolina* on melon. *Plant Diseases*, 67: 280-281.

Rocha, M., M.R. Moretti and C.M. Bonato. 2002. *Efeito de Sulphur Ultradiluído sobre a respiração de Ápices Destacados de Zea mays (Milho). In*: *Mostra academica de trabalhos de agronomia*, Londrina. *Anais.* Londrina, UEL. pp. 98.

Saxena, A., M.I. Pandey and R.C. Gupta. 1988. Effects of certain homoeopathic drugs on incidence of seed borne fungi and seed germination of *Abelmoschus esculentus*. *Indian Journal of Mycology and Plant Pathology*, 17(2): 191-192.

Sheikh, L.I., S. Dawar, M.J. Zaki and A. Ghaffar. 2006. Efficacy of *Bacillus thuringiensis* and *Rhizobium meliloti* with nursery fertilizers in the control of root infecting fungi on mung bea and okra plants. *Pak. J. Bot*., 38(2): 465-473.

Shetty, H.S. and H.S. Prakash.1994. Pathological effects of seed-borne inoculums of fungal pathogens. In*: Vistas in Seed Biology*. (Eds.): Tribhuvan Singh and Pravin Chandra Trivedi. *Printwell, Jaipur*. 1: 9- 23.

Siedle, B., A.J. Garcia-Pineres, R. Murillo, J. Schulte-Monting, V. Castro, P. Rungeler, C.A. Klaas, F.B Da Costa, W. Kisiel and I. Merfort. 2004. Quantitative structure activity relationship of sesquiterpene lactones as inhibitors of the transcription factor NF-kappa B. *J. Med. Chem*., 47: 6042-6054.

Singh, B.P., G. Gupta and K.M. Srivastava. 1980. Homeopathic drugs as inhibitor of tobacco mosaic virus. *Indian Journal of Homeopathy*, 4(7): 301-303.

Singh, L.M., G. Gupta and P. Khurana. 1981. Homeopathy: Promises and prospects for plant protection. *Advancing Homeopathy*, 1: 107-116.

Snyder, W.C. and H.N. Hansen.1940. The species concept in *Fusarium*. *Amer. J. Bot*., 27: 64-67.

Stephan, Z.A., I.K. Al-Mamoury and B.G. Antoon. 1988. The efficiency of nematode, solar heating and the fungus *Paecilomyces lilacinus* in controlling root knot nematode *M. javanica* in Iraq. *Zanco*, 6: 69-76.

Sugier, D. and U. Gawlik-Dziki. 2009. The influence of foliar fertilization on yielding and quality of mountain arnica (*Arnica montana* L.) and chamisso arnica (*Arnica chamissonis* var. *foliosa*), Annales UMCS, *Agricultura*, 64(3): 129-139.

Sutherland, J.B., A.L. Pometto and D.L. Crawford. 1983. Lignocellulose degradation by *Fusarium* species. *Can. J. Bot.*, 61: 1194-1198.

Swati, S. 2006. *Physiological analysis, seed viability and seedling growth of two multipurpose tree species Diploknema butyracea and Bauhinia variegate in Kumaun.* Ph.D. Thesis. Kumaun University, Nainital.

Swati, S.P., S. Mohanty and K.D. Nabin. 2013. Effects of potentised homeopathic medicines on the germination, growth and photosynthetic activity of *Pisum sativum* L. *Recent research in Science and Technology*, 5(4): 11-14.

Vidyasekaran, P., C.L. Subramanian and C.V.G. Swamy. 1970. Production of toxins by seed-borne fungi and its role in paddy seed spoilage. *Ind. Phytopath*., 23: 518-525.

(Received for publication 26 June 2015)