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Biological control of horse purslane (*Trianathema portulacastrum* L.) by fungal pathogens*

K. R. ANEJA
Department of Microbiology, Kurukshetra University, Kurukshetra 136119, Haryana India

Trianthema portulacastrum L., commonly called by several names such as horse purslane, blackpig weed, carpet weed and gudbur, enjoys the weed status in different parts of the world. It is a problematic terrestrial weed causing heavy losses in yield of several agricultural crops. It is being controlled mechanically and by the use of chemical herbicides, the latter causing environmental contamination including detrimental effects on nontarget organisms, contamination of soil, groundwater and food, greatly affecting the human and animal health. Exploitations of microorganisms especially plant pathogenic fungi are now emerging as an effective and ecofriendly alternative to toxic chemicals used for weed management. A total of five fungal pathogens (e.g. *Cercospora trianthemae, Colletotrichum gloeosporioides, Drechslera indica, Fusarium oxysporum* and *Gibbago trianthemae*) have been recorded on horse purslane world wide. *Gibbago*, a. phaeodictyoconidial, anamorphic and monotypic fungus, represented solely by *G. trianthemae*, has been isolated from two countries of the world, i.e. the U.S.A. and India. The fungus has been isolated in the pure culture, identified, evaluated for its growth and conidial production on ten agar media, efficacy tests under controlled conditions and the host range studies. Biocontrol studies conducted on the *Trainthema-Gibbago* system at Kurukshetra, India, have revealed the presence of most of the desirable characteristics (i.e. easily culturing on a cheap medium, ability to produce sporulating structures and host specificity) and has the immense potential to be developed as a mycoherbicides against *T. portulacastrum*.

Key words : Weed control, mycoherbicides, horse pursulane, fungal pathogens and terrestrial weed

INTRODUCTION

Weeds continue to cause major problems in agriculture throughout the world, reducing yield and quality of crops by competing for the water, nutrients and sunlight, essential for vigorous crop growth (Aneja, 2009).They cause more economic losses on agriculture lands than all other pests combined (Kremer and Kennedy, 1996). *Trianthema portulacastrum* L. is a much branched, prostrate and annual terrestrial weed of the family Aizoaceae. It is commonly called by several names such as horse purslane, blackpig weed, carpet weed and gudbar. The weed is causing heavy losses in yields of several agricultural crops. It is currently controlled mechanically and treatment with pre- and post-emergent herbicides, the latter causing environmental contamination including detrimental effects on nontarget organisms, contamination of soil, groundwater and food greatly affecting the human and animal health. Exploitation of microorganisms especially plant pathogenic fungi is now emerging as an effective and ecofriendly alternative to conventional methods of weed control (Charudattan, 1991; Mortensen, 1998; Aneja *et al*, 1999, 2009).Excepting the work of Mitchell (1988) and Aneja *et al.* (2000) no work has been done to control this weed by biological agents around the world. The purpose of this paper was to discuss various aspects of the host-pathogen interaction such as losses caused, status of fu[illegible]l pathogens and the study of desirable ch[illegible]teristic of a pathogen that makes it a pote[illegible] biocontrol agent of a weed.

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Losses caused by the weed

Trianthema is an indigenous plant to South Africa. It is represented by 12 species, but *T. portulacastrum* L. (syn *T. monogyna* L.) enjoys the weed status in different parts of the world. It is widely distributed in India, Sri Lanka, West Asia, Africa and Tropical America (Duthie, 1960; Balyan and Bhan, 1986). It is one of the troublesome weeds in Haryana, Punjab, Rajasthan, Uttar Pradesh and Delhi, infesting important agricultural crops such as mustard, maize, sorghum, sugarcane, cotton, mungbean, potato, soybean, black gram, pearl millet, pigeon pea reducing the yield from 50% to 89% when left untreated (Balyan and Malik, 1989; Singh and Prasad, 1994; Aneja *et al*, 2000).

Status of fungal pathogens on horse purslane

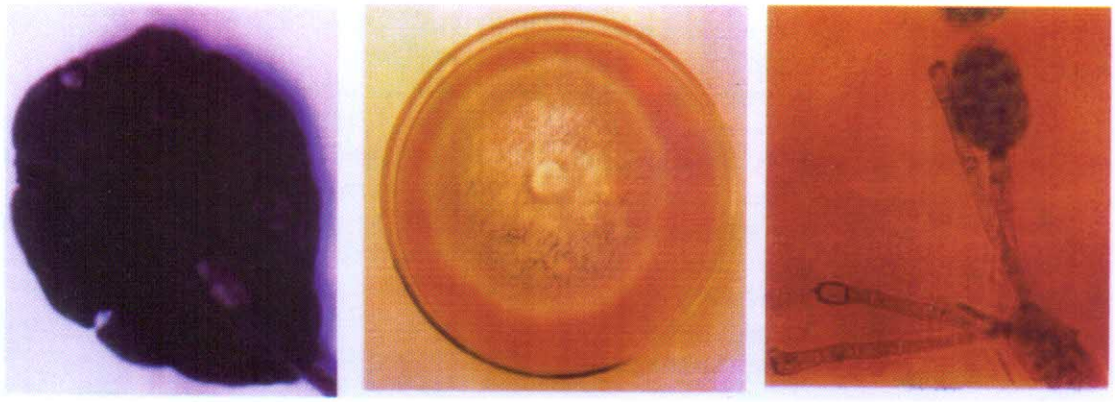
Literature search reveals that not much work has been done on the biocontrol of this weed. A total of five fungal pathogens namely *Cercospora trianthemae* (Chiddarwar, 1962), *Colletotrichum gloeosporioides* (Darshika and Daniel, 1992), *Drechslera indica* (= *Bipolaris indica*) (Rao and Rao, 1987; Taber *et al*, 1988), *Fusarium oxysporum,* (Darshika and Daniel, 1992) and *Gibbago thanthemae* (Simmons, 1986; Aneja and Kaushal, 1998) have been recorded on the weed worldwide (Table I).Of these fungal pathogens, *G. trianthemae* has only been evaluated for its biocontrol potential in green house conditions (Mitchell, 1988; Aneja and Kaushal, 1998).

Symptoms and cultural characteristics of *G. trianthemae*

Gibbago trianthemae Simmons, a phaeodictyoconidial hyphomycetous fungus, the

Table 1 : Isolation of fungal pathogens from *Trianthema portulacastrum*

Fungus	Symptoms	Country	References
Cercospora trianthemae Chiddarwar	Leaf spot	India	Chiddarwar (1962)
Colletotrichum gloeosporioides Penz and Sacc.	Leaf spot	India	Darshika and Daniel (1992)
Drechslera (Exserohilum) indica	Leaf spot	India, Japan	Rao and Rao, (1987) Taber *et al.* (1988)
(Rai, Wadhvvani and Tewari)			Darshika and Daniel (1992)
Mouchacca [= *Bipolaris indica*			
Rai. Wadhwani. and Tewari]			
Fusarium oxysporum Schlecht	Leaf spot	India	Simmons (1986)
Gibbago trianthemae Simmons	Leaf spot	U.S.A., Cuba, Venezuela, India	Aneja and Kaushal (1998)



A B C

Fig 1 : *Gibbago trainthemae.* (A) Leaf spot of horse purslane caused by *G. trainthemae.* (B) Growth on PDA+Y medium. (C) A germinating conidium showing the production of secondary conidium from the germ tube

causal agent of leaf spot on horse purslane (Fig. 1) was first of all isolated in 1986 from the U.S.A followed by its isolation from Kurukshetra, India in 1990 from the diseased plants (Aneja and Kaushal, 1998), thus recorded only from two countries of the world. It caused heavy investation of the weed at Kurukshetra. Leaf spots produced by the pathogen are round to irregular, necrotic, straw coloured with maroon margins, often localized resulting in premature defoliation.

Colonies (Fig. 1) on PDA+Y medium at 25± 1°C are grey coloured, surface spreading. Conidiophores are macronematous, slightly swollen at the apex, proliferating sympodially. Conidia (poroconidia) are yellow-brown, beakless, muriform, ellipsoid, smooth walled having 3-6 complete or partial transverse septa with constrictions and 1-6 complete or partial longitudinal septa, 30-68 × 19-38 µm. Each conidium germinates by 1 -7 germ tubes produced from apical, lateral and basal cells, apical germ tubes giving rise directly to secondary conidiophores bearing secondary conidia (Fig. 1) identical with the primary conidia (Fig. 1). The fungus shows holoblastic conidiogenesis (Aneja and Kaushal, 1998).

Growth and sporulation on different culture media

Growth and sporulation studies conducted on ten agar media at 25°C revealed the best growth of *G. trianthemae* on Trianthema extract dextrose agar (TeDA), followed by PDAY > PDA media (Fig.2).Growth was good on PCA> V-6 juice agar >NA >ME and very poor growth was observed on CDAY> CDA and MA media. Best sporulation was found on TeDA followed by PDA and PDA+Y (8.6×10^5 > 8.0 > < 10^5 > 7.35×10^5 conidia/ml, respectively).Interestingly *G. trianthemae* showed growth but failed to sporulate in all the three broths where oxygen might be a limiting factor. Thus, TeDA is a suitable culture medium for preparation of inoculum for field studies.

Effect of temperature and R.H. on conidial germination

Studies conducted on the conidial germination of *G. trianthemae* revealed the best conidial production at 25°C and was much lower at 15 and 35°C while no germination occurred at 5°, 45° and 55°C.The effect

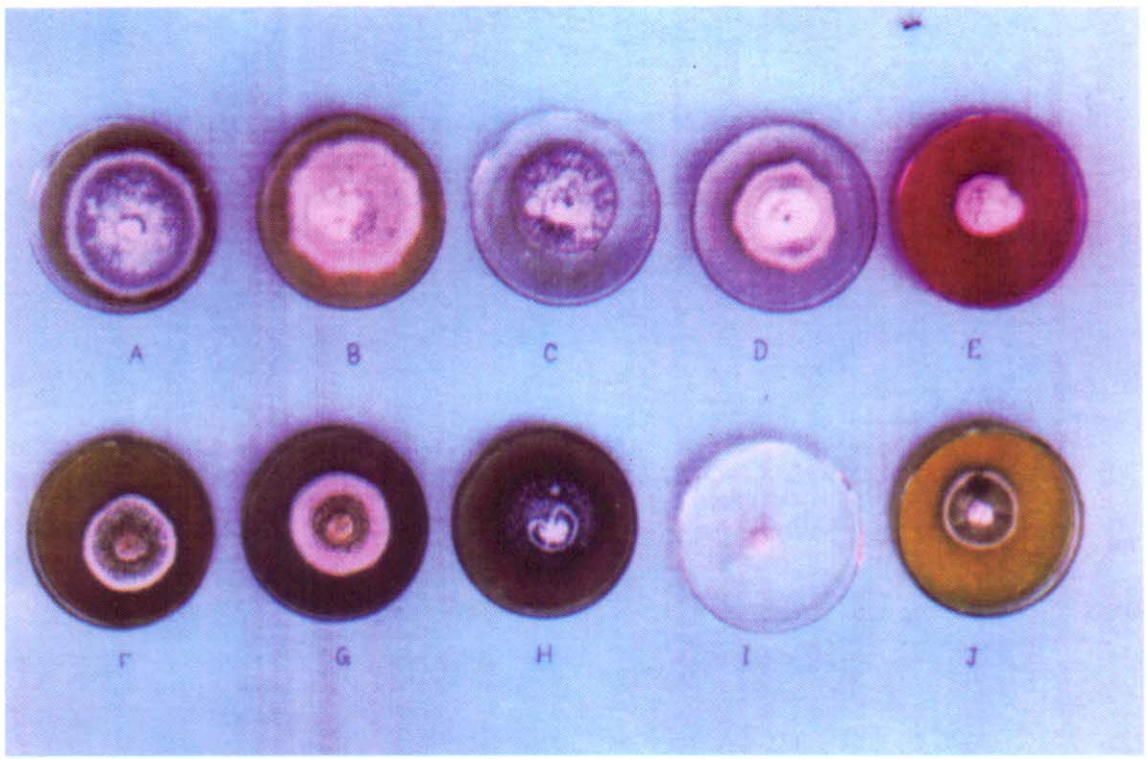


Fig 2 : Comparative growth rate of *Gibbago trianthemae* incubated at 25±2° C on 10 different media

of R.H. on conidial germination was quite high. Hundred per cent germination was recorded at 100% R.H. that reduced to 14% (i.e. 7 times) at 50 % R.H.

Efficacy of *G. trianthemae*

Under green house conditions, when the plants were sprayed with conidial suspension of the pathogen (2 xio^5 conidia/ml) grown in earthen pots under covered and uncovered conditions, revealed the increase in disease severity (72-' 83% infection) (Fig. 3), reduction in the number of leaves (36-37%), height (53-60%) and biomass (65-85%), showing its potential to suppress the weed.

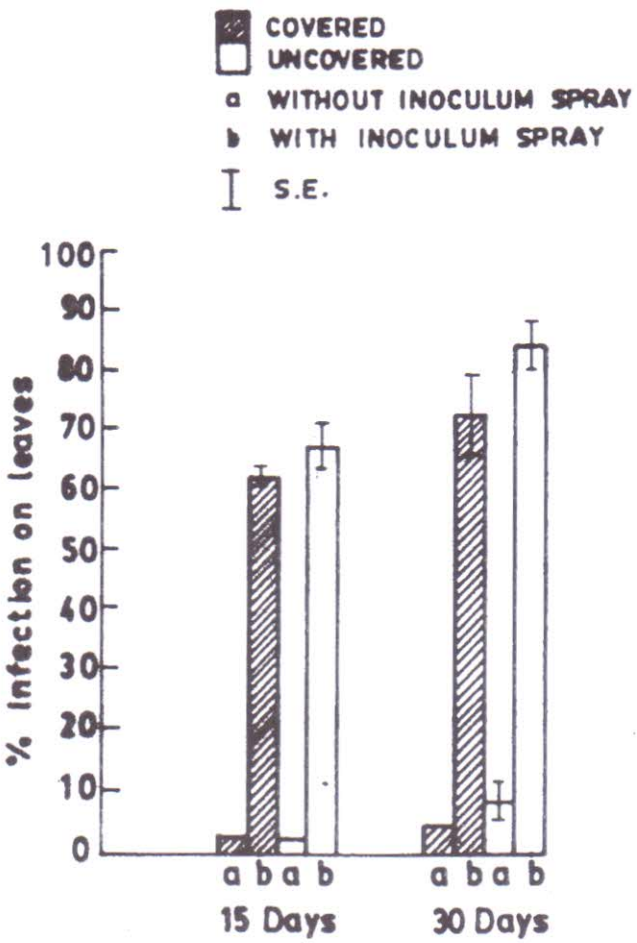


Fig. 3 : Diseases severity on horse purslane shown by *Gibbago trianthemae* when sprayed with inoculum (2 x 10^3 conidia/ml) in the experimental pots after 15 and 30 days, under covered and uncovered conditions.

Host responses

Host range studies conducted on 12 plants species, selection of plants based on the centrifugal phylogenetic relationship with the target weed (Wapshere, 1974) as well as on the basis of their economic importance, revealed that the diseases occurred only on horse purslane and none of the other tested plant (e.g. pig weed, bathua, wheat, maize, jowar, rice, oat, barley, mustard, arhar or soybean) showed the leaf spot symptoms thus proving the host-specificity of the test pathogen.

CONCLUSIONS

The present study leads to the interference that *Gibbago trianthemae* (isolate A/1) has the potential to control horse purslane when applied as foliar spray in field controlled conditions, moreover, the pathogen has all the desirable characteristics suggested by various weed scientists and environmentalist (Aneja, 1999) such as its high level of efficacy, narrow host range, easy culturing on natural host, good sporulation capacity and fast growth rate, thus has immense potential to be developed as a mycoherbicide against *Trianthema portulacastrum*. According to the R.C. McFadyen, of the Queensland Department of Natural Resources, Australia, "biological control is the only safe, cost-effective, truly successful and environmentally sustainable method of weed control". For making it more fruitful, the biocontrol scientists needs to publicize their success.

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