Karnataka J. Agric. Sci., 13(2):(752-756) 2000

Effect of Organic Amendments and Fungicides on Population of *Fusarium udum* Butler and their interaction with *Trichoderma* spp.*

The production of pigeonpea is greatly hampered due to two major diseases viz., sterility mosaic and fusarium wilt. Fusarium being a soil borne pathogen the yield of pigeonpea are being affected adversely in the traditional pigeonpea growing areas such as northern parts of Karnataka and Maharastra. However, there is no comprehensive method of integrating various control measures to manage this disease. Hence, attempts have been made to manage the disease with fungicide and bio-agent.

Organic amendments viz., oil cakes of mahua *[Madhuca longifolia* (L.) Macb.], niger *(Guizotia abyssinica* Cass.), pongamia *(Pongamia sinensis* L.) or tea *[Camellia sinensis* (L.) O.Kuntzel] waste at the rate of 2 per cent were mixed in unsterilized and sterilized red soil (coarse sand=40%; fine sand=19.5%; silt=4.5%; clay=30%; organic matter=0.61; sandy loam texture; pH=6.5; EC=O. 11 mmhos cm-1). One kg of amended soil was filled in plastic boxes and incubated for one week for decomposition. This experiment was conducted at University of Agricultural Sciences, Bangalore during 1992-93.

Soil inoculation with conidia of *F. udum* was performed according to Sneh *et al.* (1984). Mycelial mat of *F. udum* was grown on potato dextrose broth. After seven days of incubation, the conidial suspension was collected by squeezing the mycelial mat with four layers of cheese cloth and the conidial concentration was adjusted to 10^4 per ml by using a haemocytometer. Hundred ml of this suspension was uniformly mixed to 10 amended unsterilized and sterilized soil and inoculated soil was incubated for three days to allow multiplication. Treatment without organic amendment served as check and each treatment was replicated thrice. Pigeonpea (cv. TTB-7) seeds were sown in all the treatments. The soil samples were collected at weekly intervals and serially diluted. One ml of 10^4 dilution was mixed with 15ml of peptone PCNB (Pentachloronitrobenzene) agar medium (Nash and Snyder, 1962). Colonies of *F. udum* were counted after seven days of incubation and were expressed in terms of colony forming units (cfu) per g of soil. Pigeonpea wilt incidence was recorded on 35th day after sowing.

In another experiment, the conidial suspension (1x106 ml-l) of F *udum* and T *viride* (H, IMI No.317287) were mixed with mahua, niger, pongamia cake or tea waste amended sterilized soil at the rate of 100 ml per 3 kg of soil. T *viride* (H) along with *F. udum* mixed with soil, served as check. Amended soil was filled in plastic tray (30x25x10 cm) and incubated for one week. Pigeonpea seeds were sown in treated soil and each treatment was replicated thrice. The soil samples were collected randomly from Ist to 35th days after sowing. Serial dilutions were made and one ml of 10^4 dilution was plated on peptone PCNB agar medium and another one ml of 10^4 dilution was plated on Trichoderma selective medium (Elad *et al.*, 1981). The counts of *F. udum* and T *viride* were expressed as cfu g^{-1} of soil.

Unsterilized red soil was mixed uniformly with 2 per cent *F. udum* inoculum, which was grown in sand rice bran medium (1:1) and filled in 22 cm earthern pots. Fifteen pigeonpea seeds were sown per pot after 3 days of incubation. Carbendazim (0.1%), blitox (0.2%), captan (0.2%), mancozeb (0.2%), emisan (0.2%) or

*Part of Ph.D. thesis submitted by the senior author to the University of Agricultural Sciences, Bangalore - 560 065

thiram (0.2%) were drenched till saturation, fifteen days after sowing. Four soil samples per replication were collected randomly at an interval of 1, 7, 14, 21 and 35th days after fungicide drenching. One ml of 10^4 dilution was mixed in peptone PCNB agar medium (Nash and Snyder, 1962) and Fusarial colonies were counted and expressed in terms of efu g^{-1} of soil. Pigeonpea wilt incidence was recorded on 35th day of fungicide application.

Since carbendazim and captan were found effective in earlier tests, there were added to potato dextrose agar medium at 20, 40 and 60 ppm concentrations. Agar Mycelial discs of *F. udum or Trichoderma* spp. viz., *T. viride* (Andhra Pradesh), *T. viride* (Hebbal, IMI No.317287), *T. hamatum* (Shimoga, IMI No.317292), *T. koningii* (Shimoga, IMI No.317293) and *T. harzianum* (Mandya) were placed at the centre. Proper checks were maintained. The colony diameter of fungal growth was measured on 7th day of inoculation.

The population of *F. udum* in unsterilized soil decreased significantly with the addition of oil cakes or tea waste. The maximum effect being in soil amended with pongamia cake. The next most effective was niger cake followed by tea waste and mahua cake. However, the minimum population at the end of the experimental period was $5.8x10^4$ cfu g^{-1} in soil amended with pongamia cake, while in rest of the treatments, it ranged between 13.9 to $16.2x10^4$ cfu g^{-1} as against $24.3x10^4$ cfu g^{-1} in unamended soil (Table-1).

The same experiment was repeated in sterilized soil. In pongamia cake amended soil, *F. udum* propagules were reduced from 25.3 to $5.5x10^4$ cfu g^{-1} in 35 days, but there was no effect on *F. udum* propagules in mahua, niger cake and tea waste amended soil (Table-1). Reduction of *F. udum* propagules in oil cake amended unsterilized soil is probably due to increased activity of soil micro-organisms. Singh and Singh (1980) reported lysis of *F. udum* cells in soils amended with carbon materials and found that materials having a low C:N ratio which decomposed and encouraged microbial activity rapidly resulted in greater lysis than with materials having high C:N ratio. Unlike this, the effect of these amendments in sterilized soil was not significantly different from control. The only exception was pongamia cake which suppressed the population of *F. udum* significantly. It is likely that the products of decomposition of pongamia cake are effective in suppressing the population of *F. udum*. The pigeonpea wilt incidence was recorded at the end of 35 days in amended unsterilized and sterilized soil. The per cent wilt incidence was 93.3, where *F. udum* alone was inoculated in both unsterilized and sterilized soil (Table-1). In pongamia amended unsterilized and sterilized soil, the wilt incidence was 6.6 and 20 per cent respectively (Table 1).

The combination effect of oil cakes amendments on *F. udum* and *T. viride* (IMI No.317287) population were investigated in sterilized soil. The population of *F. udum* and pigeonpea wilt incidence (13.3%) were reduced in pongamia cake and *T. viride* (H) amended soil (Table-2). The population of *T. viride* (H) alone in unamended soil was $51.1X10^4$ efu g^{-1} at the end of 35 days of incubation period, while it increased to $252.7x10^4$ cfu g^{-1} in tea waste amended soil and $214.6xl0^4$ cfu g^{-1} in pongamia amended soil (Table 2). In the present studies, conidia of *Trichoderma* added to organic amended soil increased rapidly upto a period and subsequently declined. This trend of Trichoderma population is most probably due to the fact that the conidia germinated in response to some nutrients released from organic matter and subsequently lysed in the absence of food bases adequate enough to sustain further growth and sporulation.

Table 1. Effect of organic amendments on *F. udum* population

Organic amendments	cfu g^{-1} of soil x 10^4						Per cent wilt incidence
	1	7	14	21	28	35	
Unsterilized soil							
Mahua cake	15.0	58.6	29.4	11.6	10.4	16.2	53.3
Niger cake	16.3	14.3	21.5	19.8	19.7	13.9	33.3
Pongamia cake	29.1	32.5	35.0	18.1	6.1	5.8	6.6
Tea waste	18.8	30.2	17.9	15.7	15.9	15.3	13.3
F. udum alone	15.4	24.1	32.2	39.6	22.9	24.3	93.3
CD (P=0.05)	Amendments = 8.9 ; Period = 8.4 ; AxP = 6.3						
Sterilized soil							
Mahua cake	24.2	25.3	16.0	15.0	13.3	20.0	60.0
Niger cake	21.3	19.0	28.3	22.6	18.6	12.3	53.3
Pongamia cake	25.3	17.0	10.6	8.3	6.0	5.5	20.0
Tea waste	30.2	25.3	17.3	22.3	26.2	28.5	53.3
F. udum alone	21.9	29.1	17.6	18.3	21.9	23.6	93.3
CD (P=0.05)	Amendments = 8.1 ; Period = 7.6 ; AxP = 5.7						

Table 2. Effect of organic amendments of *F. udum* and *T. viride* (H) population in sterilized soil

Organic amendments	cfu g^{-1} of soil x 10^4 (days)						Per cent wilt incidence
	1	7	14	21	28	35	
***F. udum* population**							
Mahua cake	40.5	26.7	17.3	12.8	11.8	21.1	60.0
Niger cake	17.7	21.3	30.1	21.3	16.9	17.3	66.6
Pongamia cake	16.5	7.9	11.0	7.8	5.5	3.5	13.3
Tea waste	38.5	28.4	18.2	34.3	30.9	41.0	13.3
F. udum alone	21.9	29.1	17.6	18,3	21.9	23.6	93.3
LSD (P=0.05)	Amendments = 8.08 ; Period = 7.60 ; AxP = 5.68						
***T. viride* (H) population**							
Mahua cake	49.3	219.9	425.9	392.2	147.3	151.9	--
Niger cake	59.0	254.1	265.3	183.3	60.2	98.7	--
Pongamia cake	44.0	105.9	156.3	142.9	203.8	214.6	--
Tea waste	118.3	239.7	292.5	196.3	235.5	252.7	--
F. udum alone	14.3	67.3	91.3	26.0	28.7	51.1	53.3
LSD (P=0.05)	Amendments = 64.2 ; Period = 60.1 ; AxP = 44.9						

Papavizas (1985) observed such a trend in Trichoderma population in soils amended with organic matter. *T. viride* population was enhanced in soil amended with pongamia cake. Based on these results, it appears that the application of *T. viride* with pongamia cake would be helpful in reducing pigeonpea wilt. *T. viride* (H) had no adverse effect on seed germination and plant growth as tested in a separate experiment (Somasekhara, 1992).

The efficacy of various fungicides were tested in the greenhouse on pigeonpea wilt disease.The fungicides were applied to the soil and at intervals the extent of *F. udum* propagules (cfu g^{-1}) was recorded. There was a significant decline in population of *F. udum* from 7th day onwards in most of the treatments. At the end of 35th day, least propagules of *F. udum* were observed in captan ($4.16xl0^3$ cfu g^{-1}), carbendazim ($5.7x10^3$ cfu g^{-1}) and emisan ($4.73xl0^3$ cfu g^{-1}) drenched soils, whereas mancozeb, thiram and blitox were ineffective against *F. udum* (Table 3). The trend was similar with regard to wilt incidence also. At the end of 35th day, least wilt incidence (9.7%) was in case of carbendazim, followed by captan (12.6%), emisan (18.9%), blitox (38.3%), thiram (41.1%), mancozeb (57.6%) as against 70.5 per cent in untreated soil (Table 3). Similar results were also obtained in case of Fusarium root rot of betelvine, wherein carbendazim, emisan and captan were effective in controlling the disease (Siddappa and AnilKumar, 1985).

Table 3. Effect of fungicides on *F. udum* population and pigeonpea wilt incidence

Fungicides	cfu g^{-1} of soil x 10^4 (DAT) *					Per cent wilt incidence
	1	7	14	21	35	
Carbendaziin (O.1%)	23.33	11.33	4.33	3.80	5.70	9.70
Blitox(0.2%)	19.67	14.37	18.70	17.00	17.40	38.33
Captan(O.2%)	22.00	4.76	3.20	3.13	4.16	12.63
Mancozeb(O.2%)	24.33	13.33	10.86	13.90	14.60	57.62
Emisan(O.2%)	21.33	17.70	4.96	3.53	4.73	18.98
Thiram(0.2%)	21.33	18.66	19.67	17.60	15.80	41.11
F. udum alone	20.33	21.67	18.67	18.30	17.20	70.55
LSD (P=0.05)	Fungicide = 3.17 ; Period = 3.56 ; FxP = 2.39 15.59					

*DAT=Days after treatment.

The two most effective fungicides (captan and carbendazim) were tested against *Trichoderma spp.* Captan was not inhibitory to any species of the *Trichoderma tested* except *T. viride* (A.P) isolate, which showed 40.4, 42.8 and 66.6 per cent inhibition over control at 20, 40 and 60 ppm respectively. The extent of inhibition of *F udum* was 25.3, 47.3 and 75.3 per cent at 20; 40 and 60 ppm respectively in captan amended medium. The complete inhibition of *F. udum and Trichoderma* spp. was observed at all the concentrations of carbendazim amended soil. Abdl Ei-Moity *et al.* (1982) found strong inhibition of *T. harzianum* even at as low concentration of benomyl as 0.5 mg per litre. They also found captan to have no inhibitory effect against *T. harzianum.* In the present studies, captan was completely safe

even at 60 ppm against all *Trichoderma* spp. tested except one isolate of *T. viride* (A.P). It can be seen from the above experiments that pongamia cake and soil inoculation with *T. viride* would result in an effective suppression of wilt even in wilt sick soils.

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(Received : April, 1999)

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