International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 2748-2751

Received: 28-07-2018
Accepted: 30-08-2018

RL Sharma
Krishi Vigyan Kendra, Gariaband, Chhattisgarh, India

Tushar Mishra
Krishi Vigyan Kendra, Gariaband, Chhattisgarh, India

Rakesh Bhagat
Krishi Vigyan Kendra, Gariaband, Chhattisgarh, India

Vivek Swarnkar
Krishi Vigyan Kendra, Gariaband, Chhattisgarh, India

Khirod Kumar
Krishi Vigyan Kendra, Gariaband, Chhattisgarh, India

Correspondence
RL Sharma
Krishi Vigyan Kendra, Gariaband, Chhattisgarh, India

Integrated Disease Management for Pigeon pea wilt caused by *Fusarium udum*

RL Sharma, Tushar Mishra, Rakesh Bhagat, Vivek Swarnkar and Khirod Kumar

Abstract
Field experiments were conducted during *Kharif* seasons of 2013 and 2014 in the farmer's field of Gariaband district, Chhattisgarh to find out different integrated management levels of control schedule for pigeonpea wilt disease. All treatments had significant effect on germination per cent, disease incidence, seed yield and disease index in both the consecutive years of experimentation. T_4 –Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* + Soil application of *Trichoderma Viride*, resulted in higher germination percentage (96.8 and 97.2), wilt incidence per cent at 60 DAS (2.97 and 3.15), wilt incidence per cent at 150 DAS (9.68 and 7.65) and seed yield (15.10 and 16.28 q ha^{-1}) during 2013 and 2014, respectively and was found superior over rest of the treatments. The loss in pigeonpea yield was up to the tune of 18.86 to 54.24 per cent due to the incidence of wilt disease.

Keywords: Disease, *Fusarium*, Integrated, Pigeonpea, Wilt, *Trichoderma*

Introduction
Pigeon pea, commonly known as red gram and tur or arhar [*Cajanus cajan* (L.) Millsp.], is the second most important pulse crop after chickpea in India. It is one of the important legume crops of tropics and subtropics and cultivated since prehistoric times. Among the pulses, it is extensively used as an important source of protein in human diet. Generally, Pigeonpea is grown in almost all states of India, but it is cultivated extensively in Bihar, Uttar Pradesh, Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka, West Bengal, Gujarat and Chhattisgarh. It finds an important place in the farming systems adopted by small and marginal farmers in a large number of developing countries as it restores the soil fertility by fixing atmospheric nitrogen. The heavy shedding of leaves adds considerable organic matter to the soil. Pigeon pea has multiple uses, besides its consumption in the form of dry split dhal the tender green seeds are used as vegetables and the stem and roots as fuel wood. In addition, it is also used for forage purpose and improves soil health through its deep strong rooting system, leaf drop at maturity and addition of nitrogen by symbiotic activities during the crop growth. The main constraints in boosting the yield of the crop are its susceptibility to diseases, insects and other physiological stresses. Pigeon pea is affected by more than hundred pathogens (Nene *et al.*, 1981) [5]. Incidentally, only a few of them cause economic losses (Kannaiyan *et al.*, 1984) [6] and the distribution of the most important diseases is geographically restricted, among which wilt caused by *Fusarium udum* is a serious problem in the production of pigeon pea. The incidence of infection ranges from 3-94% in the field. The disease can attack at any stage of the plant but highest mortality occurs at flowering and podding stage.

The total geographical area of Chhattisgarh is 13.8 m ha of which 5.9 m ha area is under gross cultivation. Pigeon pea occupies 52.82 thousand ha with production of 29.48 000MT and average productivity of 558 kg ha^{-1} (Agriculture Statistics, Govt. of Chhattisgarh 2013). In the year 2015-16 pigeon pea was cultivated in 5000 ha area in Gariaband district of Chhattisgarh state with a production of 3.990 '000 MT. The average productivity of pigeon pea in district is 798 kg ha^{-1}. There are several constraints affecting the productivity of pigeon pea, most important of them is diseases, which often pose a serious problem. The diseases of economic importance at present are *viz*., *Fusarium* wilt, Sterility Mosaic Disease (SMD), *Phytophthora* Blight (PB), Macrophomina root rot, Stem canker, Alternaria blight and pearly cyst nematode. Among these diseases, the wilt is one of the major constraints, followed by Phytophthora

blight and Sterility mosaic in the district, which is affecting the productivity of this crop per unit area.

The wilt caused by *Fusarium udum* is one of most serious and oldest known disease (Butler, 1906) and is known to cause heavy losses every year in India (Kannaiyan *et al.,* 1981) [5]. *Fusarium* wilt (*Fusarium udum*) is a soil borne disease. The genus *Fusarium* has wide host range and survives for long time in the field in the absence of host plant. Therefore, chemical control is not satisfactory, adequate and economical as a long-term solution. Frequent application of fungicides to the soil has caused environmental hazards causing water and soil pollution in addition to killing the non-target beneficial microorganisms in soil. Recently, the bio control approaches have been initiated by using antagonistic microorganisms to combat the wilt disease in pigeon pea. Considering, the crop health and economic losses, the alternative to this is to explore integration of chemical and biological control, which can be successfully adopted in modern agriculture. Keeping this in view, present investigation was envisaged with an objective to develop integrated management schedule for pigeon pea wilt disease.

Materials and Methods

The present study was conducted during consecutive *Kharif* season of year 2013 and 2014 at farmers field of Mahulkot village of Gariaband district. This experiment was laid out in Randomized Block Design with six number of replications. The soil of the farmers field was sandy loam in texture, neutral in reaction and had low nitrogen and medium phosphorus and potassium contents. Treatment combinations of chemical fungicide, bio agents and culture both as seed and soil treatment were tested during experimentation. The treatment combinations consisted of two chemical fungicide *i.e.* Thiram and Carbendazim, one biological agent *i.e Trichoderma Viride* of which both seed treatment and soil application was done and one nitrogen fixing culture *Rhizobium*. The combinations were framed out as T_1 – Control, T_2 – *Trichoderma Viride* (Seed treatment), T_3 – Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* and T_4 - *Thiram* + *Carbendazim* + *Trichoderma Viride*+ *Rhizobium* + Soil application of *Trichoderma Viride*. Pigeonpea variety "Rajivlochan" was grown as a test crop. The duration of variety Rajivlochan is 180-190 days with production potential of 18-20 q ha^{-1} and is a wilt resistant variety. The crop was sown manually after onset of monsoon with spacing of 60 cm x 15 cm using a certified seed with seed rate of 20 kg ha^{-1}. To prevent the crop from soil and seed borne diseases, the seeds were treated with combination of different fungicide, bioagents and culture as per the treatments. The crop was fertilized with 20, 60 and 30 kg N, P_2O_5 and K_2O ha^{-1}, respectively. The harvesting was done manually with the help of sickle, when the crop attained full maturity. The produce of a square meter from four randomly selected of each plot was tied into bundle and allowed to sun drying in respective plots. The harvested bundles were weighed with the help of balance and transported to threshing floor. Threshing of produce of each plot was done separately by beating with wooden sticks; the seeds were then cleaned manually and weighed.

Germination per cent of each treatment was calculated at 15 DAS from four randomly selected area of each plot with the help of 1 m^2 quadrate.

Wilt incidence per cent (WI %) is calculated at 60 DAS and 150 DAS, with the help of following formulae :

$$\text{Wilt incidence (WI) \%} = \frac{\text{Number of Plants infected by wilt disease}}{\text{Total Number of plants observed}} \text{ X } 100$$

Seed yield of the net plot was noted down, after threshing, winnowing and drying and calculated in q ha^{-1}.

Disease index indicate the reduction in yield of crop due to disease attack and is expressed in per cent by using formulae:

$$\text{Disease index (\%)} = \frac{\text{Yield from best treated plot-Yield from untreated plot}}{\text{Yield from best treated plot}} \text{X} 100$$

Results and Discussion

Different integrated management levels of control schedule for pigeonpea wilt disease had significant effect on germination per cent, disease incidence per cent, seed yield and disease index in both the consecutive year of experimentation.

Effect on germination per cent

Among different integrated management levels of control schedule for pigeonpea wilt disease, combination of fungicides with bioagents and culture, as seed and soil treatment have significantly improved germination (%) over control. Treatment T_4 – Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* + Soil application of *Trichoderma Viride*, resulted in higher germination percentage of 96.8 and 97.2 during 2013 and 2014, respectively with mean of 97.0 per cent and was found significantly superior to other treatments, followed by T_3 – Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* (91.26 and 93.45), and T_2 – Seed Treatment with *Trichoderma Viride* alone (84.62 and 86.25) during 2013 and 2014 with mean per cent of 92.36 and 85.44, respectively. Pawar *et al.* (2013) [11] also reported almost same results, indicating that all the fungicides as well as bi control agents have significantly improved germination (%) over untreated control. The results fall in line with the findings of Gholve and Kurundkar (2002) [4]. The lowest germination per cent was observed in control plot (80.35 and 81.17) during 2013 and 2014 with mean of 80.76.

Effect on wilt incidence (%)

The data on wilt disease incidence per cent under various treatments have been presented in Table. Results reveal that all the treatments significantly differ from each other. However, the lowest disease incidence per cent (2.97 and 3.15) at 60 DAS in both the years 2013 and 2014, respectively was found with treatment T_4 –Seed treatment with *Thiram* + *Carbendazim* + *Trichoderma Viride* + *Rhizobium* + Soil application of *Trichoderma Viride*, and was found significantly superior over rest of the treatments with mean per cent of 3.06 followed by T_3 –Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* (3.46 and 3.48) and T_2 – Seed Treatment with *Trichoderma Viride* alone (4.45 and 5.28) during 2013 and 2014 with mean disease incidence per cent of 3.65 and 4.87, respectively. The highest wilt incidence was obtained with control plot *i.e.* 7.89 and 8.54 with mean per cent of 8.22.

As far as wilt incidence per cent at 150 DAS is concerned, similar results were obtained. Treatment T_4 –Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* +

Rhizobium + Soil application of *Trichoderma Viride* recorded lowest wilt incidence per cent during both the years (9.68 and 7.65), followed by T_3 –Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* (14.90 and 12.33) and T_2 – Seed Treatment with *Trichoderma Viride* alone (18.01 and 15.58). The highest wilt incidence was obtained with control plot (28.64 and 31.04). All the treatments were found statistically significant from each other.

These results confirm the findings of Verma and Rai (2008) [17] in which he reported that seed treatment with 4g *Trichoderma viride* formulation + 3 g thiram kg^{-1} seed and application of 2 kg *T. viride* formulation with 125 kg farm yard manure ha^{-1} has also been reported to control the disease. This report was supported by Mandhare and Suryawanshi (2005) [9] who recommended the application of *Trichoderma* as a seed treatment and soil application for managing *Fusarium* wilt of pigeonpea. Various reports have shown that supplementing the soils with fungal or bacterial antagonists reduces incidences of *Fusarium* wilt (Bapat and Shar, 2000; Singh *et al*., 2002; Anjaiah *et al*., 2003; Maisuria *et al*., 2008) [1, 3, 8, 16]. This also confirms the findings of Bapat and Shar (2000) [3], Siddiqui *et al*. (2005) [13], Siddiqui (2006) [14] and Siddiqui and Shakeel (2007) [15] in which they revealed that numerous rhizobacteria have been used as bio control agents. Soil amendment with *Trichoderma harzianum* at all pathogen levels has also been reported to give a disease control of 22% -61.5% (Prasad *et al*. 2002) [12].

Effect on Seed yield

Under different integrated management levels of control schedule for pigeonpea wilt, treatment T_4 – Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* + Soil application of *Trichoderma Viride* recorded statistically significant highest seed yield (15.10 and 16.28 q ha^{-1}) in both years with mean yield of 15.69 q ha^{-1}, and was found superior over the rest of the treatment combination. On the other hand, the minimum seed yield was recorded under control plot.

Mahesh *et al*. (2010) [7] also reported the similar findings in which they stated that combination of carbendazim seed treatment @ 2g kg^{-1} of seeds + soil application of *T. viride, B. subtilis* + *P. fluorescens* each @ 2.5 kg ha^{-1} in FYM @ 50 kg ha^{-1} recorded significantly lowest wilt incidence of 5.32 per cent with highest yield of 1437 kg ha^{-1}, followed by combination of carbendazim seed treatment @ 2g kg^{-1} of seeds + *T. viride* soil application @ 2.5 kg ha^{-1} in FYM @ 50 kg ha^{-1} recorded wilt incidence of 9.30 per cent and yield of 1398 kg ha^{-1}.

Effect on Seed yield

Under different integrated management levels of control schedule for pigeonpea wilt, treatment T_4 – Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* + Soil application of *Trichoderma Viride* recorded statistically significant highest seed yield (15.10 and 16.28 q ha^{-1}) in both year with mean yield of 15.69 q ha^{-1}, and was found superior over rest other combination of treatments. On the other hand, the minimum seed yield was recorded under control plot.

Mahesh *et al*. (2010) [7] also reported the similar findings in which they stated that combination of carbendazim seed treatment @ 2g kg^{-1} of seeds + soil application of *T. viride, B. subtilis* + *P. fluorescens* each @ 2.5 kg ha^{-1} in FYM @ 50 kg ha^{-1} recorded significantly lowest wilt incidence of 5.32 per cent with highest yield of 1437 kg ha^{-1}, followed by combination of carbendazim seed treatment @ 2g kg^{-1} of seeds + *T. viride* soil application @ 2.5 kg ha^{-1} in FYM @ 50 kg ha^{-1} recorded wilt incidence of 9.30 per cent and yield of 1398 kg ha^{-1}.

The capacity of plants to produce seed yield depends not only on the size of photosynthetic systems, it's efficiently and length of time for which it is active but also on translocation of dry matter into economic sink. The final buildup of yield is cumulative function of yield components.

Higher seed yield under these treatments was due to high germination, lower wilt incidence, causing a higher dry matter production resulting in superiority of yield attributing characters and ultimately high yield.

Effect on Disease index

Disease index indicates the reduction in yield of crop due to disease attack. The data presented in Table reveals that the yield loss in pigeon pea crop ranged from 18.86-54.24 per cent. Maximum loss or disease index was noticed under control plot (43.71 and 54.24 per cent), whereas minimum disease index was registered under T_3 –Seed treatment with Thiram + Carbendazim + *Trichoderma Viride* + *Rhizobium* (24.90 and 18.16 per cent) closely followed by T_2 – Seed Treatment with *Trichoderma Viride* alone (32.38 and 30.47 per cent) in both the years, respectively.

Conclusion

Present investigation suggests that seed treatment with *Thiram + Carbendazim + Trichoderma Viride + Rhizobium* and soil application of *Trichoderma Viride* was found to be effective in controlling wilt in pigeonpea and reducing the yield loss.

References

1. Anjaiah V, Cornelis P, Koedam N. Effect of genotype and root colonization in biological control of *Fusarium* wilts in pigeonpea and chickpea by *Pseudomonas aeruginosa* PNA1. Canandian. Journal of Microbiology. 2003; 49:85-91.
2. Anonymous. Agriculture Statistics. Government of Chhattisgarh, 2013. http://cgagridept.nic.in/
3. Bapat S, Shar AK. Biological control of *Fusariam* wilt of pigeon pea by *Bacillus brevis.* Canadian Journal of Microbiology. 2000; 46(2):125-132.
4. Gholve VM, Kurundkar BP. Biological control of Pigeonpea wilt by *Pseudomonas fluorescens* and Trichoderma viride. Indian J Pulses Res. 2002; 15(2):174-176.
5. Kannaiyan J, Nene YL, Reddy MV. Influence of wilt at different growth stages on yield loss in Pigeonpea. Tropical Pest Management. 1981; 27:141.
6. Kannaiyan J, Nene YL, Reddy MV, Ryan JG, Raju TN. Prevalence of pigeon pea diseases and associated crop losses in Asia, Africa and the Americas. Tropical Pest Management. 1984; 30:62-71.
7. Mahesh M, Saifulla M, Sreenivasa S, Shashidhar RK. Integrated management of pigeon pea wilt caused by *Fusarium udum* Butler. EJBS. 2010; (2):1.
8. Maisuria VB, Gohel V, Mehta AN, Patel RR, Chhatpar HS. Biological control of *Fusarium* wilt of pigeonpea by *Pantoea diepersa*, a field assessment. Annals of Microbiology. 2008; 58(3):411-419.

9. Mandhare VK, Suryawanshi AV. Application of *Trichoderma* species against pigeonpea wilt. JNKVV Research Journal. 2005; 32(2):99-100.
10. Nene YL, Kannaiyan J, Reddy MV. Pigeon pea diseases: resistance screening techniques. Information Bulletin No.9. ICRISAT, India, 1981.
11. Pawar SV, Deshpande GD, Dhutraj DN, Dey Utpal. Integrated management of pigeonpea wilt disease incited by *Fusarium udum* var. Cajani. Internat. J Plant Sci. 2013; 8(1):42 44.
12. Prasad RD, Rangeshwaran R, Hegde SV, Anuroop CP. Effect of soil and seed application of Trichoderma haezianum on pigeonpea wilt caused by *Fusarium udum* under field conditions. Crop Protection. 2002; 21:293-297.
13. Siddiqui S, Siddiqui ZA, Iqbal A. Evaluation of fluorescent pseudomonads and *Bacillus* isolates for the biocontrol of wilt disease complex of pigeon pea. World Journal of Microbiology and Biotechnology. 2005; 21:729-732.
14. Siddiqui ZA. PGPR: Prospective biocontrol agents of plant pathogens. *In:* Siddiqui Z.A (ed.). *Biocontrol and biofertilization*. Springer, Amsterdam, the Netherlands, 2006, 111-142.
15. Siddiqui ZA, Shakeel U. Screening of *Bacillus* isolates for potential biocontrol of the wilt disease complex of pigeon pea (*Cajanus Cajan*) under greenhouse and small-scale field conditions. Journal of Plant Pathology. 2007; 89(2):179-183.
16. Singh R, Singh BK, Upadhyaya SK, Rai B, Youn Su Lee. Biological Control of *Fusarium* Wilt Disease of Pigeonpea. Journal of Plant Pathology. 2002; 18(5):279-283.
17. Verma AK, Rai R, 2008. http://vasat.org/learning resources/pigeonpea/disease/Disease/*Fusariumwilt*.html.