J.Mycopathol.Res. 62(2) : 386-391, 2024, ISSN : 0971-3719 (Print), 2583-6315 (Online)
10.57023/JMycR.62.2.2024.386


# Biological Control of Pigeon Pea Wilt

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Received : 08.01.2024 Accepted : 31.03.2024 Published : 24.06.2024

Pigeon pea (*Cajanus cajan*(L.) Millsp.) is one of the major pulse crops of tropics and sub tropics of India. Pigeon pea is known to be affected by more than hundred pathogens but main constraints in boosting the yield of the crop is wilt disease. The wilt pathogen is primarily a soil inhabitant; hence controlling the disease is very difficult as no effective chemicals are available at present. An experiment was conducted during 2012-13 to 2015-16 at NARP, Navsari Agricultural University, Bharuch to find out effective biological control method for management of pigeon pea wilt. *Trichoderma viride* and *T. harzianum* were used for the evaluation. The lowest wilt incidence was recorded in the treatment of seed treated with *Trichoderma viride* @10g/kg seed + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (20.28 %) followed by treatment seed treated with *Trichoderma harzianum*@10g/kg seed + soil application of *T. harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (27.23 %). Amongst the treatments, the highest wilt incidence was recorded in treatment seed treated with *T. viride* @10g/kg seed (36.52%).

**Keywords:** Bioagent, biological control, pigeon pea wilt

## INTRODUCTION

Pigeon pea (*Cajanus cajan* (L.) Millsp.) belongs to family Fabaceae is one of the major pulse crop of tropics and sub tropics. It is popularly known as red gram, tur or arhar which is a key crop of subsistence agriculture and is one of the most extensively grown legume crops in India, accounting for almost 90 per cent of world's area and production (Dhanasekar*et al*. 2010). Pigeon pea is one of the most widely grown food grain legumes in the semi-arid tropics of the world. Pulses are one of the important food crops globally due to higher protein content and are an important group of crops in India. Pulses are the major sources of protein in the diet, 20 to 25 per cent protein by weight which is double the protein content of wheat and three times that of rice (Anonymous, 2023).

India is a principal pigeon pea growing country accounting for approximately 90% of the total world production. India accounts for 72% of area grown to pigeon pea or 3.9 million hectares (FAO, 2018). Among the pulses, pigeon pea is the second most important *kharif* grain legume after chickpea in India and grown predominantly under rainfed conditions. Pigeon pea in India is grown in an area of 47.24 lakh ha. with production of 43.16 lakh tonnes and productivity of 914 kg/ha (Anonymous, 2023). Pigeon pea has been cultivated in Gujarat over 2.50 lakh ha. area with 2.91 lakh tonnes production and 1161 kg/ha productivity. Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, Gujarat, Bihar, Telangana and Andhra Pradesh are the major pigeon pea cultivating states of India (Anonymous, 2022).

Wilt, stem rot, canker and sterility mosaic are the important diseases that threaten pigeonpea production in several pigeonpea growing regions. Among these diseases, *Fusarium* wilt caused by *Fusarium udum* Butler is the most important soil borne disease. The yield loss of pigeon pea by wilt depends on the stage at which the plants wilt and it can approach 100, 67 and 30% when wilt

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occurs at pre-pod, maturity and pre harvest stages, respectively and sometimes it causing up to 100% loss in grain yield (Okiror, 2002). Some chemical fungicides are effectively managing plant disease, but the extreme use of chemicals is harmful and noneconomical. Biocontrol strategies are effective through several antagonistic microorganisms for managing plant disease (Chauhan *et al.* 2021). The development of resistant varieties and combined application of bioagents and fungicides is considered as more practicable for management of pigeon pea wilt (Mahesh *et al.* 2020).

## MATERIALS AND METHODS

The experimented was conducted during 2012-13, 2014-15 and 2015-16 under field condition in Randomized Block Design (RBD) with eight treatments along with control and three replications were maintained during investigation. The experiment was conducted in hot spot of pigeon pea wilt area and national susceptible check (ICP-2376) was sown during investigation. The seeds were sown 90 cm (R) X 20 (P) cm distance with gross plot size of 4.0 m X 5.4 m. The standard agronomical practices were followed during experiment. The seed treatment was given with bioagent/fungicide using slurry and soil application of bioagent as per required in combination with FYM. The wilt incidence was recorded at regular fifteen days interval after initiation of disease. The yield was recorded at harvest.The treatment details are mentioned in Table 1.

## RESULTS AND DISCUSSION

All the treatments were significantly superior over the control during individual years as well as in pooled to manage an incidence of wilt disease of pigeon pea as well as in yield (kg/ha) .

### *Per cent Disease Incidence*

**2012-13:** The lowest disease incidence was recorded in seed treatment with *Trichoderma viride* @10g/kg + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at the time of sowing (7.22%) followed byseed treatment with *Trichoderma harzianum*@10g/kg +soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at the time of sowing(14.80%) as per (Table2). The next best treatment in order of lower wilt incidence was seed treatment with carboxin + thiram @ 3g/kg + *T. viride* @ 10g/kg (22.93%) which was statistically at par with seed treatment with *T.harzianum*@10g/kg (25.11%). The highest disease incidence was recorded in control (50.35%) mentioned in Table 2.

**2014-15:**The lowest disease incidence was recorded in seed treatment with *T.viride* @10g/kg + soil application of*T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (15.40%) in (Table2).The next best treatment was seed treatment with *T.harzianum*@10g/kg + soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (22.42%) which was statistically at par with seed treatment with carboxin + thiram @ 3g/kg + *T. viride* @ 10g/kg (26.23%). The highest disease incidence was recorded in control (50.52%) as per Table2.

**2015-16:**As per previous year the same trend has been observed,**t**he minimum wilt incidence was recorded in seed treatment with *T. viride* @10g/kg + soil application of *T. viride*@ 2.5kg in 500kg FYM/ha in furrow at time of sowing (14.52%)(Table2).The next best treatment was seed treatment with *T. harzianum* @10g/kg + soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (26.43%) which was statistically at par with seed treatment with *T. harzianum* @10g/kg (27.87%),seed treatment with carbendazim + mancozeb@2.5g/kg +soil application of *T. viride* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (35.04%) and seed treatment with *Pseudomonas fluorescens*@10g/kg (32.59%) as per Table 2.

### *Pooled*

Pooled data of wilt incidence at harvest showed that, the lowest incidence of wilt per cent was recorded in seed treated with *T.viride* @10g/kg seed + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (20.28 %) followed by treatment seed treated with *T. harzianum*@10g/kg seed + soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (27.23 %). Seed treated with

**Table 1:** List of various treatments used during investigation

| Treatment no. | Treatment details |
|---|---|
| $T_1$ | Seed treatment with *Trichoderma viride* @10g/kg |
| $T_2$ | Seed treatment with *Trichoderma harzianum* @10g/kg |
| $T_3$ | Seed treatment with *Pseudomonas fluorescens*@10g/kg |
| $T_4$ | Seed treatment with *T. viride* @10g/kg + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing |
| $T_5$ | Seed treatment with *Trichoderma harzianum*@10g/kg + soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing |
| $T_6$ | Seed treatment with carbendazim + mancozeb @2.5g/kg +soil application of *T. viride* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing |
| $T_7$ | Seed treatment with carboxin + thiram @ 3g/kg + *T. viride* @ 10g/kg |
| $T_8$ | Control |

**Table 2:** Effect of various treatments on pigeon pea wilt incidence

| Treatment | Treatment | Average wilt incidence (%) Years | | | |
|---|---|---|---|---|---|
| | | 20012-13 | 2014-15 | 2015-16 | Pooled |
| $T_1$ | Seed treat with *Trichoderma viride* @10g/kg | 36.10 (34.77) | 37.65 (37.34) | 35.82 (34.27) | 36.52 |
| $T_2$ | Seed treat with *Trichoderma harzianum*@10g/kg | 29.93 (25.11) | 36.41 (35.29) | 31.76 (27.87) | 32.70 |
| $T_3$ | Seed treat with *Pseudomonas fluorescens*@10g/kg | 36.41 (35.25) | 35.99 (34.58) | 34.81 (32.59) | 35.73 |
| $T_4$ | Seed treat with *T.viride* @10g/kg + Soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing | 15.58 (7.22) | 23.05 (15.40) | 22.20 (14.52) | 20.28 |
| $T_5$ | Seed treat with *T.harzianum*@10g/kg +Soil application of *T. harzianam* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing | 22.61 (14.80) | 28.23 (22.42) | 30.85 (26.43) | 27.23 |
| $T_6$ | Seed treatment with carbendazim + mancozeb @2.5g/kg +Soil application of *T. viride* @ 2.5 kg in 500 kg FYM/ha in furrow at time of sowing | 34.84 (32.64) | 35.18 (33.23) | 36.24 (35.04) | 35.42 |
| $T_7$ | Seed treatment with Carboxin+Thiram @ 3g/kg + *T. viride* @ 10g/kg seed | 28.57 (22.93) | 30.78 (26.23) | 32.65 (29.19) | 30.66 |
| $T_8$ | Control | 45.20 (50.35) | 45.47 (50.52) | 46.07 (51.85) | 45.58 |
| | S.Em. ± (T) | 1.40 | 1.74 | 2.32 | 1.11 |
| | C.D. at 5%(T) | 4.26 | 5.28 | 7.06 | 3.16 |
| | S.Em. ± (Y x T) | - | - | - | 1.86 |
| | C.D. at 5%(Y x T) | - | - | - | NS |
| | C.V. % | 7.81 | 8.85 | 11.94 | 9.79 |

carboxin + thiram @3g/kg + *T. viride* @ 10g/kg (30.66 %) and seed treated with *T. harzianum* @10g/kg (32.70 %) were statistically at par with each other in wilt per cent incidence. Amongst the treatments, the highest wilt incidence was recorded in seed treated with *T.viride* @10g/kg seed (36.52%) as per Table2. Interaction (Y x T) were non-significant indicating the consistent performance of treatments over the years.

***Yield***

**2012-13:** The highest grain yield was recorded in seed treatment with *T.viride* @10g/kg + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (1273kg/ha) as per Table 3. The next best treatment in order of higher return was seed treatment with *T. harzianum* @10g/kg + soil application of *T.harzianum* @

**Table.3:** Grain yield (kg/ha) in different treatments during experiment

| Treatment | Treatment | Grain yield (kg/ha) Years | | | |
|---|---|---|---|---|---|
| | | 20012-13 | 2014-15 | 2015-16 | Pooled |
| $T_1$ | Seed treat with *Trichoderma viride* @10g/kg seed | 686 | 881 | 684 | 750 |
| $T_2$ | Seed treat with *Trichoderma harzianum*@10g/kg seed | 777 | 901 | 844 | 841 |
| $T_3$ | Seed treat with *Pseudomonas fluorescens*@10g/kg seed | 887 | 991 | 839 | 906 |
| $T_4$ | Seed treat with *T.viride* @10g/kg seed + Soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing | 1273 | 1169 | 1235 | 1226 |
| $T_5$ | Seed treat with *T.harzianum*@10g/kg seed +Soil application of *T. harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing | 936 | 1091 | 862 | 963 |
| $T_6$ | Seed treatment with carbendazim + mancozeb @2.5g/kg seed +Soil application of *T. viride* @ 2.5 kg in 500 kg FYM/ha in furrow at time of sowing | 836 | 984 | 734 | 851 |
| $T_7$ | Seed treatment with carboxin+thiram @ 3g/kg seed + *T. viride* @ 10g/kg seed | 810 | 912 | 759 | 827 |
| $T_8$ | Control | 598 | 577 | 579 | 585 |
| | S.Em. ± (T) | 82.80 | 90.94 | 47.13 | 42.43 |
| | C.D. at 5%(T) | 251.19 | 275.85 | 142.96 | 120.21 |
| | S.Em. ± (Y x T) | - | - | - | 76.04 |
| | C.D. at 5%(Y x T) | - | - | - | NS |
| | C.V. % | 16.87 | 16.79 | 10.00 | 15.17 |

2.5kg in 500 kg FYM/ha in furrow at time of sowing (936 kg/ha) which was statistically at par with T3 (887kg/ha), T6 (836kg/ha), T7 (810kg/ha) and T2 (777kg/ha). The lowest yield was observed in the control i.e, 598kg/ha (Table 3).

**2014-15:**The maximum grain yield was recorded in seed treatment with *T. viride* @ 10g/kg + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (1169 kg/ha) as given in Table3. The next best treatment in order of higher return was seed treat with *T. harzianum*@10g/kg + soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (984 kg/ha) which was statistically at par with T3 (991 kg/ha), T6 (984 kg/ha), T7 (912 kg/ha) and T2 (901 kg/ha) mentioned in Table3. The minimum yield was observed in control i.e, 577 kg/ha.

**2015-16:**The highest grain yield was recorded in seed treatment with *T.viride* @10g/kg + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (1235 kg/ha)(Table3).The next best treatment in order of higher return was seed treat with *T. harzianum*@10g/kg + soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (862 kg/ha)which was statistically at par with T2 (844 kg/ha), T3 (839 kg/ha), T6 (734 kg/ha), T7 (759kg/ha) and T6 (734kg/ha). The lowest yield was observed in the control i.e.579 kg/ha as per Table 3.

***Pooled***

The pooled data were found significantly superior in all the treatments over untreated control. Amongst all treatments, significantly the highest

**Table 4 :** Economics of different treatments for management of pigeon pea wilt

| Treat ment | Treatments | Qty required/ ha | Cost of materials (Rs./ha) | Labour charges (Rs. /ha) | Total cost of treatment (Rs/ha) | Grain yield (kg/ha) | Gross return (Rs/ha) | Net return (Rs/ha) | Additional benefit over control (Rs.) | CBR |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Seed treat with *Trichodermaviride* @10g/kg seed | 120 g | 30 | 150 | 180 | 750 | 56250 | 56070 | 10440 | 58.0 |
| $T_2$ | Seed treat with *Trichoderma harzianum*@10g/kg seed | 120 g | 30 | 150 | 180 | 841 | 63075 | 62895 | 17265 | 95.91 |
| $T_3$ | Seed treat with *Pseudomonas fluorescens*@10g/kg seed | 120 g | 30 | 150 | 180 | 906 | 67950 | 67770 | 22140 | 123.0 |
| $T_4$ | Seed treat with *T.viride* @10g/kg seed + Soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing | 2.620 g + 500kg FYM | 1155 | 450 | 1605 | 1226 | 91950 | 90045 | 44415 | 27.67 |
| $T_5$ | Seed treat with *T.harzianum*@10g/k g seed +Soil application of *T. harzianam* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing | 2.620 g + 500kg FYM | 1155 | 450 | 1605 | 963 | 72225 | 70620 | 24990 | 15.57 |
| $T_6$ | Seed treatment with carbendazim + mancozeb **@**2.5g/kg seed +Soil application of *T. viride* @ 2.5 kg in 500 kg FYM/ha in furrow at time of sowing | 30 g + 2.5kg +500kg FYM | 1145 | 450 | 1595 | 851 | 63825 | 62230 | 16600 | 10.40 |
| $T_7$ | Seed treatment with Carboxin+Thiram @ 3g/kg seed + *T. viride* @ 10g/kg seed | 36g +120g | 55 | 150 | 205 | 827 | 62025 | 61820 | 16190 | 78.97 |
| $T_8$ | Control | - | - | - | - | 585 | 43875 | 45630 | - | - |

grain yield was recorded in the treatment of seed treated with *T.viride* @10g/kg seed + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing (1226 kg/ha) followed by treatment seed treated with *T.harzia-[\num*@10g/kg seed +soil application of *T.harzianam* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing (963 kg/ha) as revealed in Table 3,while the lowest yield was found in untreated control (585 kg/ha).

Chaudhary *et al.* (2017) studied bio-efficacy of *Trichoderma* species against pigeonpea wilt and *T. viride* was found most effective to reduce pigeon pea wilt. Mahanthi *et al.* (2019) screened oils and bioagents against pigeon pea wilt under field condition and recorded that the least incidence (22%) of disease was observed in plants treated with Castor oil (5%) +*Trichoderma viride* (5%).Pushpa *et al*. (2020) studied biological control of pigeon pea wilt with the help of various bioagent under *in vitro* and green house condition. *Trichoderma* isolates were found effective in inhibiting pigeon pea wilt under pot condition along with plant growth promotion. Mishra *et al*. (2023) evaluated 17 *Trichoderma* isolate against *Fusarium udum*under laboratory and field condition and *T. asperellum*recorded higher inhibition under *in vitro* condition and reduced wilt disease incidence by 78–85%.

The *T. viride* found the most effective for the management of pigeon pea wilt than *T.harzianum*and other bioagent it may be because

of higher production of pathogenesis related proteins i.e. glucanase proteases, and chitinase by *T. viride* as compared to*T. harzianum.* The secondary metabolites and lytic enzymes production potentiality of *T. viride*will be maximum under field condition as compared to *T. harzianum*. The root colonization and fast growth is main characteristics of effective bioagent (Waghunde *et al*. 2016), the *T. viride* root colonization rate and siderophore production efficiency may be comparatively maximum than *T. harzianum* under field conditionhence *T. viride* found the most effective than *T. harzianum.*

## CONCLUSION

Seed treatment with *Trichoderma viride* @10g/ kg seed + soil application of *T. viride* @ 2.5kg in 500kg FYM/ha in furrow at time of sowing was foundthe most effective management of wilt to get the higher grain yield and better net profit and thereby higher grain yield of pigeon pea followed by treatment seed treated with *Trichoderma harzianum*@10g/kg seed +soil application of *T.harzianum* @ 2.5kg in 500 kg FYM/ha in furrow at time of sowing. The seed treatment with *Pseudomonas fluorescens* found ineffective as compared to seed treatment of *Trichoderma.* It recorded comparatively higher wilt incidence and lower yield than *T. viride* and *T. harzianum.* All the treatments were recorded significantly lower wilt incidence and higher grain yield against untreated control and better returns.

## ACKNOWLEDGEMENT

The authors are highly grateful to Principal, College of Agriculture, Bharuch, all staff of the NARP, Bharuchand Director of Research, NAU, Navsari for providing necessary facilitiesduring the present investigation.

## DECLARATIONS

Conflict of Interest: Authors declare no conflict of interest.

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