

EFFECT OF INTEGRATED DISEASE MANAGEMENT PACKAGES ON DISEASES INCIDENCE AND BULB YIELD OF ONION (*Allium cepa* L.)

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ABSTRACT

A field experiment was conducted to find out the effect of different integrated disease management (IDM) packages on severity of basal rot (*Fusarium oxysporum*), white rot (*Sclerotium rolfsii*) and stemphylium blight (*S. vesicarium*) diseases, and bulb yield of onion (*Allium cepa* L.) variety Agrifound Light Red. Nine IDM packages consisting of NPK fertilizers, farm yard manure, biocontrol agents and spray of fungicides starting from 30 days of transplanting at 15 days interval were applied. The incidence of basal rot and white rot of onion bulbs ranged from 0.98-4.31% and 0.00-0.96%, respectively. The highest incidence of basal rot (4.31%) and white rot (0.96) was recorded in bulbs harvested from untreated control. The lowest incidence of basal rot (0.98%) was found in bulbs harvested from the IDM package consisting of NPK @ 100:50:50 kg ha⁻¹ + FYM @ 10 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + copper oxychloride @ 0.3%). White rot did not appear under this package. The lowest Stemphylium blight intensity (3.87%) was achieved with the package having four foliar sprays of propiconazole @ 0.1% followed by mancozeb @ 0.25% and copper oxychloride @ 0.3%. The IDM package increased the bulbs yield over standard check by 25.54% and over untreated control by 109.42%. The average highest bulb diameter (54.15 mm) and bulb size index (23.27 cm²) and lowest incidence (0.98%) of basal rot disease in onion bulbs was also obtained with IDM package consisting of NPK @ 100:50:50 kg ha⁻¹ + FYM @ 10 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + copper oxychloride @ 0.3%.

Key words: *Allium cepa*, integrated disease management.

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INTRODUCTION

Onion (*Allium cepa* L.) is an exportable bulb crop among the cultivated *Allium* species in India. The country is a traditional exporter of fresh onion with 67% share of the total export of fresh vegetables. Onion is exported to the Iran, UAE, Malaysia, Bangladesh, Sri Lanka, Indonesia, Vietnam, Reunion France and Singapore (Anonymous 2008). Onion is cultivated in summer (Rabi), rainy (Kharif) and dry periods (late Kharif) seasons in the country and maximum area under cultivation is being covered in Rabi season. India ranks second in cultivated area as well as onion production in the world. It has been estimated that more than 25% yield losses occur due to foliar diseases, especially Stemphylium blight (*S. vesicarium*) and purple blotch (*Alternaria porri*). Onion crop also suffers from basal rot (*Fusarium oxysporum*) and white rot (*Sclerotium rolfsii*) diseases causing various extents of losses (Entwistle, 1990). About 30-40% storage losses in onion occur due to incidence of *Fusarium* basal rot (Gupta et al., 2008; Barnoczkine, 1986). The diseases are also responsible for deterioration of export quality of onion bulbs (Gupta et al., 2009).

Trichoderma viride and *Pseudomonas fluorescens* have antagonistic capacity against plant pathogens which enhance systemic acquired resistance and plant growth promoting character. *Pseudomonas fluorescens* plays an important role in phosphate solubilization which improves the soil and plant health. Scanty information is available on quality production of onion by approaching integrated crop health and disease management (Gupta et al., 2009).

Gupta et al., (2008) conducted *in-vitro* study for the management of soil borne fungal pathogens like *Fusarium oxysporum* and *Sclerotium cepivorum* using bio agents and oil cakes and findings indicated that *T. viride* inhibited 50.74% mycelia growth as well as 93.59% inhibition in sclerotia production of *S. cepivorum* while 70.40% inhibition in mycelia growth of *F. oxysporum*. Gupta et al. (2011) reported that basal rot and white rot in onion can be managed by the application of *Trichoderma viride*, *T. harzianum* and *Pseudomonas fluorescens*. In view of the above facts, the present study was undertaken to find out the effect of different IDM packages on severity of soil borne and foliar diseases, and yield of onion.

MATERIALS AND METHODS

The integrated disease management packages were: T₁=N-P-K (100:50:50) + FYM @ 20t ha⁻¹ + *T. viride* @ 5kg ha⁻¹ + Spray of propiconazole @ 0.1%, T₂= N-P-K (100:50:50) + Vermicompost @ 2 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of propineb @ 0.25%, T₃= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%, T₄= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.25%, T₅= N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Seedling root dip (10g *T.viride*+100g FYM + 1lit.

water) + Spray of propiconazole @ 0.1%, T₆= N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Seedling root dip (10g *Ps. fluorescens* +100g FYM + 1lit. water) + Spray of propineb @ 0.25%, T₇= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%, T₈= N-P=K (100:50:50) + foliar spray of polyfeed and multi-k @ 1.0% with foliar spray of Mancozeb @ 0.25% (standard check) and T₉= Untreated Control

The experiment was conducted during Rabi, 2008-09 and 2009-10 in the experimental farm of Regional Research Station, National Horticultural Research and Development Foundation, Nashik, India. The soil of the experimental field was black soil in texture, having pH-7.2, EC-0.155, organic carbon 0.57%, available phosphorus 47.09 kg ha⁻¹ and potash 414.80 kg ha⁻¹. The field was prepared following standard methods for good tilth (Singh et al., 2001) and divided into 3.0m x 1.5m unit plots maintaining 0.50 m space between plots. Drain was made around the unit plots by digging soil from the space between plots. The soil of the drain was used to raise the unit plot. The experiment was laid out in a randomized complete block design with 3 replications. Eight weeks old onion seedlings of variety Agrifound Light Red were transplanted maintaining 10.0 cm plant to plant and 15.0 cm row to row distances. The dosage of manure, fertilizers, biopesticides and fungicides were the same according to IDM packages selected for the experiment. Manure and fertilizers were applied at the time of final land preparation. *Trichoderma viride* (2x10⁶ cfu g⁻¹) and *Pseudomonas fluorescens* (2x10⁸ cfu g⁻¹) were obtained from M/s. Sun Agro Biosystem Pvt. Ltd., Chennai. The biopesticides were applied to the soil before transplanting or by dipping roots of seedlings in their suspensions before transplanting. Spraying of the fungicides for the management of foliar diseases was started after 30 days of transplanting. A total of 4 sprays were given at 15 days intervals started after 30 days of transplanting. The insecticide deltamethrin @ 0.1% was sprayed uniformly to control insect pest.

All the recommended intercultural practices were followed to grow the crop. Irrigation was applied at regular intervals to maintain the optimum moisture level in the field. The crop was harvested at bulbs maturity. The incidence and intensity of basal rot and white rot of bulbs were recorded after harvesting based on the covering area of infected bulb by the fungal pathogen following 0 to 5 scales. The severity of Stemphylium blight was indexed at 30, 45, 60 and 75 days after transplanting on a 0-5 scale and Percent Disease Index (PDI) was computed (Sharma, 1995). Data on incidence and intensity of basal rot and white rot disease of onion bulbs, exportable bulb yield, gross yield and bulb size were recorded after harvest. The data recorded in two consecutive years were pooled and analyzed statistically by Randomized Block Design. The cost benefit ratio was also computed.

RESULTS AND DISCUSSION

Incidence of basal rot and white rot diseases

The incidence of basal rot and white rot diseases in onion bulbs ranged from 0.98-4.31% and 0.00-0.96%, respectively. The highest incidence of basal rot as well as white rot was recorded in bulbs harvested from untreated control. The lowest incidence of basal rot (0.98%) was found in bulbs harvested from the treatment T₄ (NPK @ 100:50:50 + FYM @ 10 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + copper oxychloride @ 0.3%). White rot did not appear under this treatment (T₄). However, the lowest incidence of the disease (0.18%) was recorded from T₅ (NPK @ 100:50:50 kg ha⁻¹ + FYM @ 20 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + seedling root dip (10g *T. viride*+100g FYM + 1 liter water + spray of propiconazole at 0.1%). It was found that soil application of *Ps. fluorescens* and *Trichoderma viride* supplemented with root dip method effectively control the soil borne fungal disease of onion. The data presented in figure 4 revealed that 100% control of white rot disease and maximum control of basal rot disease were obtained with the application of *Ps. fluorescens* @ 5 kg ha⁻¹ in the soil in treatment T₄ as compared to the untreated control. The present study revealed that *Ps. fluorescens* was most effective against soil borne disease of onion followed by *T. viride* (Table 1).

Data presented in figure 4 revealed that 100% control of white rot and basal rot of onion bulb was obtained with soil application of *Ps. fluorescens* @ 5kg ha⁻¹ followed by *T. viride* @ 5 kg ha⁻¹ as soil application as well as seedling root dip (10g *T. viride*+100g FYM + 1liter water) compared to the results of the present study reveal that *Ps. fluorescens* and *T. viride* is most effective against soil borne diseases of onion.

Rajendran and Rangnathan (1996) reported that soil application of *T. viride* and other species were effective against basal rot (*Fusarium oxysporum*) pathogen. Other workers also reported that biocontrol agents such as *T. viride*, *Gliocladium zeae* and *Coniothyrium minitans* gave effective control of white rot disease of onion caused by *Sclerotium rolfsii* (Gupta et al., 2011; Ahmad and Tribe, 1977).

Incidence and intensity of Stemphylium blight disease

All the tested fungicides significantly reduced incidence and intensity of Stemphylium blight (*Stemphylium vesicarium*) over control. The lowest Stemphylium blight incidence (25.0%) was recorded before 4th spray of propiconazole @ 0.1% (T₅) and mancozeb @ 0.25% (T₈). However, the lowest Stemphylium blight intensity (3.87%) was achieved with sprays of propiconazole @ 0.1% followed by intensity (4.20 %) in mancozeb @ 0.25%. Significantly the highest Stemphylium blight incidence (43.0%) and intensity (9%) was recorded from untreated control (Table 2).

Propiconazole @ 0.1% was most effective against foliar diseases as well as increasing the onion bulb yield and could be recommended as curative measure against Stemphylium blight as an ad-hoc decision making component of integrated disease management strategy (Table 2).

The data presented in figure 3 revealed that the highest control of *Stemphylium* blight intensity (62.21%) of onion was achieved with foliar sprays of propiconazole @ 0.1% followed by mancozeb @ 0.25% (55.63 and copper oxychloride @ 0.3% (54.78%). The results of the present study reveal that propiconazole was the most effective against *Stemphylium* blight followed by mancozeb and copper oxychloride.

Gupta et al. (1996) reported that spray of contact fungicide mancozeb @ 0.25% reduced the incidence and intensity of *Stemphyllium* blight in onion. Foliar spray of mancozeb @ 0.25 % was also recommended by some other workers for the control of foliar diseases of onion like *Stemphyllium* blight and purple blotch (*Alternaria porri*) of onion (Borkar and Patil, 1995; Srivastava et al., 1999; Mathur and Sharma, 2006; Gupta et al., 2011a & b). Mathur and Sharma (2006) reported that spraying of mancozeb @ 0.2% and copper oxychloride @ 0.3% thrice at 15 days intervals significantly superior in reducing purple blotch and *Stemphylium* blight as well as increasing the yield of onion bulbs. Gupta and Pandey (2011) conducted a field study on management of foliar diseases of onion and reported that propiconazole and mancozeb sprays at 15 days intervals effectively controlled the foliar diseases of onion.

Exportable and gross yield of onion

Significantly highest exportable onion bulb yield (289.63 t ha⁻¹) as well as gross yield (311.81 t ha⁻¹) was recorded from the IDM package T₄ (NPK @ 150:50:50 + FYM @ 10 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + copper oxychloride @ 0.3%) which was followed by yield the treatment T₆ (N.P.K. @100:50:50 + FYM @ 20 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + seedling root dip (10g *Ps. fluorescens* +100g FYM + 1 lit. water) + Spray of propineb @ 0.25% and treatment T₅ (Table 1). Significantly the highest bulb diameter (54.15 mm) and bulb size index (23.27 cm²) was recorded in the package T₄. The highest cost benefit ratio (1: 4.24) was also recorded in this package (T₄). However, the lowest exportable yield of onion bulbs (230.89 t ha⁻¹) was recorded in standard check T₈ (NPK (100:50:50) + foliar spray of polyfeed and multi-k @ 1.0% with foliar spray of Mancozeb @ 0.25%) and the lowest exportable yield (13.830 t ha⁻¹) was observed under control. The highest gross yield (31.181t ha⁻¹) of onion bulbs was also recorded from treatment T₄ which was at par with other treatments except gross yield noticed in treatment T₃ (N.P.K. (100:50:50) + FYM @ 10 t ha⁻¹ + vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%) and untreated check (Table 1).

Figures 1 and 2 show that, remarkably higher exportable yield of onion bulbs was observed in integrated nutrient applying chemical fertilizers along with organic manures (T₄) which caused an increase of 25.44% over recommended doses of NPK fertilizers (standard check) and 109.42% over untreated control.

The findings of the present study revealed that judicious use of fertilizers, organic manures, and chemical pesticides supplemented with biopesticide are effective to

increase yield as well as quality of the onion bulb. The improvement in bulb diameter, size index and yield attributes due to phosphate solubilizers may be due to the ability of *Ps. fluorescens* to solubilize and increase availability from insoluble or fixed phosphorus to soluble or readily available phosphorus (P). Similar findings have been reported by other workers (Gupta, 2009; Verma and Mathur, 1989).

The favorable nutritional environment in the root zone created by the addition of organic manures and biofertilizers resulted in increased absorption of the nutrients from soil which was responsible for increasing the yield of onion bulbs (Gupta et al., 2009). Similar findings have been reported in carrot (Luzzati et al., 1980) and in potato (Mandal and Roy, 2001). The higher yield was obtained in potato based cropping systems by the use of fertilizers in combination with organic manures than the use of inorganic fertilizers alone (Sharma and Dua, 1995). Studies conducted on integrated nutrient management (INM) in onion bulb crop improved the quality and yield of onion bulbs through integration of chemical fertilizers along with organic manures (Singh et al., 2001).

CONCLUSION

The findings of the present study revealed that application of NPK @ 100:50:50 + FYM @ 10 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ with foliar spray of copper oxychloride @ 0.3% was adjudged better in increasing the yield of export quality onion bulbs. Four sprays of mancozeb @ 0.25% and propiconazole @ 0.1% starting from 30 days after transplanting with an interval of 15 days are effective to reduce foliar diseases of onion.

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Table 1: Yield of onion bulbs, yield attributing characters, soil borne diseases and cost benefit ratio (pooled data of Rabi, 2008-09 and 2009-10)

Treatments	Exportable yield (t/ha)	Gross yield (t/ha)	Bulb diameter (mm)	Bulb size index (cm ²)	Basal rot (Inc. %)	White rot (Inc. %)	C:B ratio
T ₁	23.874	26.496	49.0	19.49	1.95	0.45	1:2.09
T ₂	23.463	27.315	48.5	18.67	2.04	0.26	1:2.60
T ₃	21.566	25.378	49.5	18.89	1.95	0.41	1:2.19
T ₄	28.963	31.181	54.2	23.27	0.98	0.00	1:4.24
T ₅	24.785	28.015	48.9	19.08	1.12	0.18	1:2.27
T ₆	25.074	28.109	51.0	20.56	1.55	0.51	1:2.19
T ₇	22.257	26.785	48.5	18.79	2.76	0.46	1:2.32
T ₈	23.089	27.837	49.1	19.30	2.95	0.56	1:1.69
T ₉	13.830	18.500	48.2	18.48	4.31	0.96	
S. Em	20.47	21.81	-	-	0.73	0.42	-
CV %	8.90	8.19			33.78	10.55	
C.D. at 5%	46.30	49.33	-	-	1.65	2.32	-

T₁=N-P-K (100:50:50) + FYM @ 20t ha⁻¹ + *T. viride* @ 5kg ha⁻¹ + Spray of propiconazole @ 0.1%, T₂= N-P-K (100:50:50) + Vermicompost @ 2 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of propineb @ 0.25%, T₃= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%, T₄= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.25%, T₅= N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Seedling root dip (10g *T.viride*+100g FYM + 1lit. water) +Spray of propiconazole @ 0.1%, T₆= N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Seedling root dip (10g *Ps. fluorescens* +100g FYM + 1lit. water) +Spray of propineb @ 0.25%, T₇= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%, T₈= N-P-K (100:50:50) + foliar spray of polyfeed and multi-k @ 1.0% with foliar spray of Mancozeb @ 0.25% (standard check) and T₉= Untreated Control.

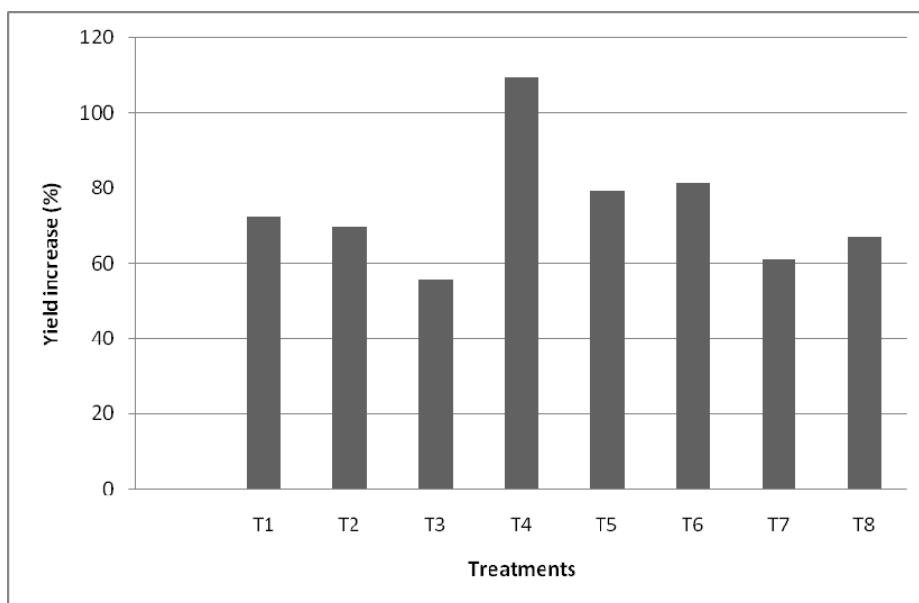


Figure 1: Exportable yield of onion bulbs increased (%) in different treatments over Control CD (P=0.05) 21.32 under field condition

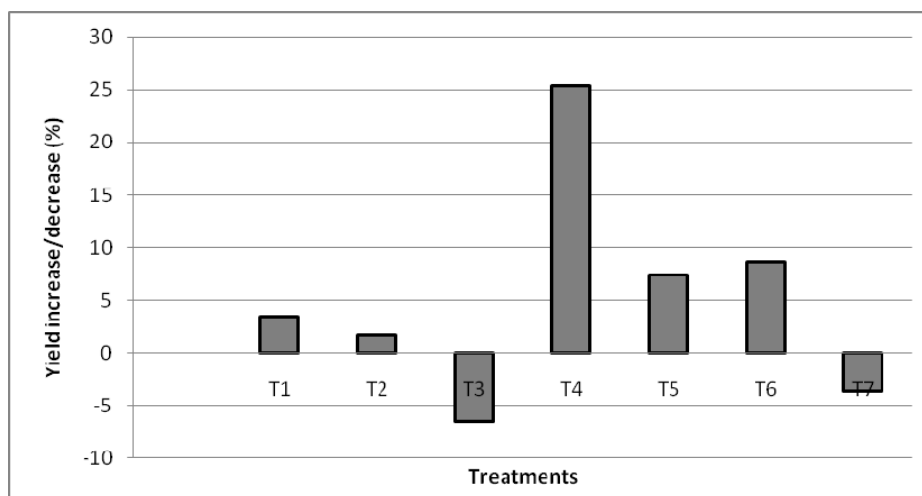


Figure 2: Exportable yield of onion bulbs increased or decreased (%) in different treatments over standard check CD (P=0.05) 23.30 under field condition

Table 2: Incidence and intensity of Stemphylium blight disease (*Stemphylium vesicarium*) of onion (pooled data of Rabi, 2008-09 and 2009-10)

Treatments	Percent incidence and intensity of <i>Stemphylium</i> blight disease							
	Before 1 st spray		Before 2 nd spray		Before 3 rd spray		Before 4 th spray	
	Inc.	Int.	Inc.	Int.	Inc.	Int.	Inc.	Int.
T ₁	11.67	0.60	20.00	1.33	28.34	3.74	30.00	5.07
T ₂	15.00	0.94	20.00	1.54	28.34	4.42	31.67	5.60
T ₃	15.00	0.87	21.67	1.74	30.00	4.87	30.00	6.07
T ₄	15.00	0.93	20.00	1.54	26.67	3.60	30.00	5.40
T ₅	11.67	0.74	18.33	1.27	25.00	3.00	25.00	3.87
T ₆	18.34	0.94	20	1.54	30.00	4.14	30.00	5.34
T ₇	16.67	1.20	23.34	2.20	30.00	4.80	35.00	6.47
T ₈	13.34	0.67	18.34	1.53	21.67	2.94	25.00	4.20
T ₉	28.33	2.00	33.33	3.13	36.67	6.14	43.34	9.27
S.E.	3.91	0.35	3.57	0.42	2.93	0.35	2.55	0.55
CV %	24.26	35.13	16.47	24.17	10.26	8.33	8.18	9.61
C.D. at 5%	8.84	NS	8.08	0.95	6.63	0.79	5.77	1.24

Inc. : Incidence, **Int.**: Intensity

T₁=N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *T. viride* @ 5kg ha⁻¹ + Spray of propiconazole @ 0.1%, T₂= N-P-K (100:50:50) + Vermicompost @ 2 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of propineb @ 0.25%, T₃= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%, T₄= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *Ps. fluorescens* @ 5kg ha⁻¹ + Spray of copper oxychloride @ 0.25%, T₅= N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + Seedling root dip (10g *T.viride*+100g FYM + 1lit. water) +Spray of propiconazole @ 0.1%, T₆= N-P-K (100:50:50) + FYM @ 20 t ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Seedling root dip (10g *Ps. fluorescens* +100g FYM + 1 lit. water) +Spray of propineb @ 0.25%, T₇= N-P-K (100:50:50) + FYM @ 10 t ha⁻¹ + Vermicompost @ 1t ha⁻¹ + *T. viride* @ 5 kg ha⁻¹ + *Ps. fluorescens* @ 5 kg ha⁻¹ + Spray of copper oxychloride @ 0.3%, T₈= N-P-K (100:50:50) + foliar spray of polyfeed and multi-k @ 1.0% with foliar spray of Mancozeb @ 0.25% (standard check) and T₉= Untreated Control.

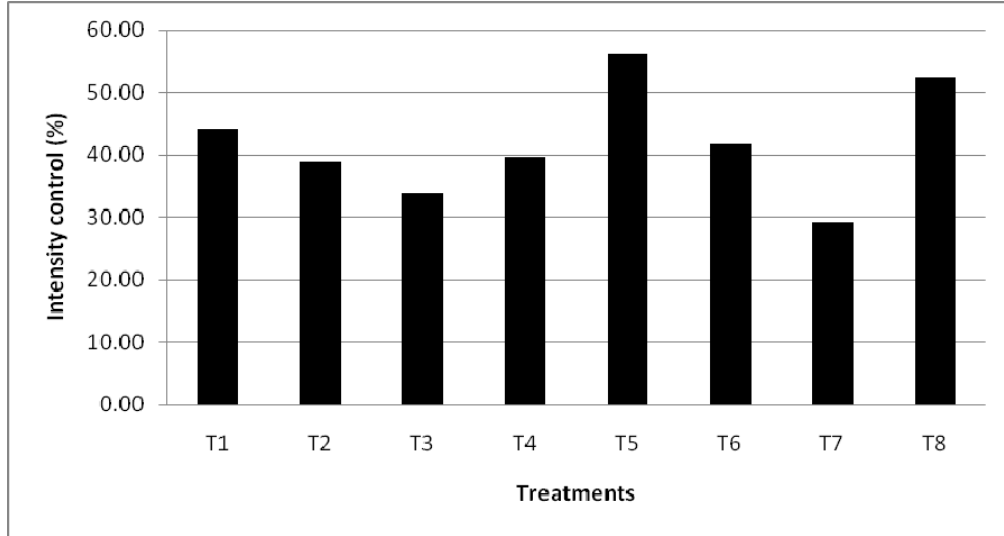


Figure 3: Percent disease control (PDC) of stemphylium blight in different treatments over control CD (P=0.05) 13.82 under field condition

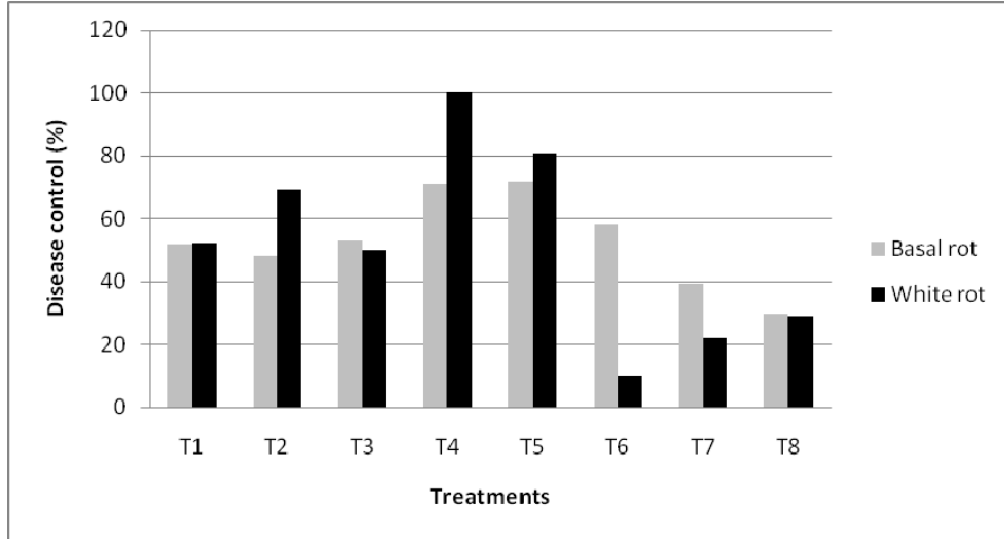


Figure 4: Percent disease control (PDC) of basal rot and white rot in different treatments over control CD (P=0.05) 33.95 under field condition