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An Approach to Integrated Management of Sunflower Wilt through Bio-Inoculants

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Abstract

Sunflower is a new emerging oilseed crop which can grown through-out the year. In West Bengal this crop mainly grow in rabi season which suffers many biotic stresses, out of which soil borne diseases are of great economic importance. A field study was conducted by AICRP on Sunflower, Nimpith Centre to identify the best management approaches to overcome the yield loss due to wilt of sunflower. It was observed that most of the fungal and bacterial antagonists tested were found effective against soil borne diseases *in-vivo* conditions. The isolates of fungal antagonists *Trichoderma viride* (Tv), and *Trichoderma harzianum* (Th) and one isolate of bacterial antagonist *Pseudomonas fluorescens* (Pf) were found very effective to control this seed borne disease when used as bio-agents. The above antagonists (bio-agents) with their combinations found highly effective against all the soil borne pathogens causing the sunflower wilt under in vivo conditions were used for seed, soil and seed+soil treatments to observe their effectiveness on seed germination, seedling emergence, early seedling growth and resistance of wilt incidence in sunflower cv. DRSH-1. Post studies further revealed that seed+seedling+soil application of the antagonists resulted in lesser wilt incidence compared to only seed or soil application of these antagonists resulting higher seed yield in farmer's field. The lowest mortality of sunflower plants either in seedling stage or in mature stage also observed when the bio-inoculants were used in combination (*T. harzianum+P. fluorescens* (5.0g/lit 5.0g +5.0g/ kg of seed) and when the combination was used as seed inoculants and also used for spraying at the crown region before first and second irrigation. The data across of the years of study on demonstration fields, indicated that economic advantage in terms of the Benefit: Cost (B:C) ratio of the farmers under improved method of sunflower cultivation with seed treatments and application of bio-inoculants results higher Benefit: Cost (B:C) ratio higher was recorded 1.41 (2014-15) and 1.45 (2015-16) which were much higher compared to conventional cultivation systems/ Farmer's Practice, 1.06 (2014-15)-1.18 (2015-16). The conclusion of the present study is that *T. viride*, *P. fluorescens* and *T. harzianum* and their combinations have significant role on to effective management of sunflower wilt in West Bengal.

Keywords: Sunflower; *Sclerotium* wilt; Bio-inoculants; Seed yield

Introduction

In India, the sunflower is grown on about 7.0 million ha (2013-14) (Anonymous, 2016) and mostly grown in the states of Karnataka, Maharastra, Andhra Pradesh and Tamil Nadu with potential scope of growing in the non-traditional areas like West Bengal [1]. In West Bengal, Sunflower is one of the important oilseed crops after rapeseed-mustard during rabi season and it was grown on about 12,500 ha in last rabi season 2016-17. Due to delay and short winter spell and late release of land, the sowing of mustard was delayed which ultimate reduced the production of rapeseed-mustard [2]. The delayed sowing also invites the insect pests in most of the years. Sunflower is being a photoperiod natural crop has wide scope to replace the rapeseed-mustard cultivation with high yield potentiality [3,4]. The present acreage under sunflower cultivation in India is about 6.91lakh ha area with a production and productivity of 5.47 lakh and 791 kg/ha respectively during 2013-14 [5].

The crop was infected by a number of fungal and viral disease viz. sunflower wilt (*Sclerotium sclerotiorum* (*S. rolfsii*) pv. *helienthii*, powdery mildew, SND and downy mildew are the most important diseases [6]. Sunflower wilt is one of the major disease in Eastern parts of our country which impose a great limitation in realizing the potential productivity. Management of stem rot of sunflower is a problem, since in the commercial hybrids and varieties resistance to this disease is not still available. Sunflower wilt is the most important diseases of sunflower and in West Bengal next to Sunflower Necrosis Disease (SND). It can be a devastating disease and in sunflower it is highly dependent on weather conditions. Sunflower can be affected in three ways: 1. Root infection which results in wilt or

stalk rot; 2. Midstalk infection; and 3. Head infection or head rot.

The latter two infections are dependent on ascospore infection.

Sclerotia of the causal organism are hard, small black bodies produced by the disease in a host of broad leaf crops. The spores need dew or rain and dead or senescing plant tissues such as dead florets to germinate and infect. The infection occurs via the sunflower roots which stimulate the nearby sclerotia to germinate. The infection moves into the plant via the roots and the plant dies suddenly or literally wilts. Sclerotia develop at the base of the diseased plant and return to the soil.

Conventional method of disease control included extensive use of broad spectrum fungicides. There are very limited report regarding developing resistance source for effective management of the disease, [7]. In an effort to develop eco-friendly measures for the management of this disease, bio-inoculants, such as different *Trichoderma* and *Pseudomonas fluorescens* species isolates were screened. Variability in all the different treatments of *T. viride* and *P. fluorescens* singly or in combination were tested against *Sclerocium sclerotiorum* (*S. rolfsii*) pv. *helienthii* the causal agent of stem rot/wilt of sunflower. *Trichoderma viride*, *Pseudomonas fluorescens* and *Trichoderma harzianum* were used as bio-agents which is an eco-friendly and cost effective management of sunflower wilt.

There are very few effective chemicals are available but their use also limited. There are few reports indicating the efficacy of bio agents against stem rot of sunflower. However, no systemic studies have so far been made to explore the possibility of developing biological management of stem rot. *Trichoderma viride*, *Pseudomonas fluorescens* and *Trichoderma harzianum* has been effectively used for preventing damping off disease of peanut caused by *S. rolfsii* and *Rhizoctonia solani*. The antagonism of *Trichoderma spp.* Against *Sclerocium scleroceorum* (*S. rolfsii*) and other phytopathogenic fungi has been well documented by the earlier workers like [8-10]. The similar findings also reported by [11] against chickpea in management of Sclerotium rot. The present investigation was carried out on aimed to (i) evaluate the performance of isolates of *Tricoderma* species and *Pseudomonus fluorescens* against *S. Rolfsii*; pv. *helienthii* to find out the most effective treatment(s) or bio-inoculant(s) (in single or in combination) for the management of sunflower wilt and improvement in respect to yield and yield component and economics in sunflower and for their further evaluation to management of Sunflower wilt. (ii) To identify the superior treatment combination suitable for rabi season for minimizing the yield loss and to increasing in benefits to the sunflower growers in West Bengal.

Materials and Methods

The experiment was carried out during December 2013-14 to 2015-16 under AICRP Sunflower, Nimpith Centre of RAKVK Research Farm, South 24 Parganas, West Bengal. At first in 2013-14, the experiment was carried out in Nimpith AICRP-Sunflower farm for study the efficacy of some treatments or superiority of some bio-inoculants and after observed the superiority of some bio-inoculants for effective management of sunflower wilt, in next two years (2014-15, 2015-16) the experiments were repeated in farmers field also for study the efficacy of bio-inoculants. The experiment was carried out in farmers field with three replications in Randomized complete block design. The plot size was 4.5m x 3.0 m. In the 1st year (2014-15), sunflower hybrid DRSH-1 were tested in RAKVK-AICRP (Sunflower) research farm, Nimpith Centre, South 24 Parganas, West Bengal. The soil texture was clay loam in “On station” and “FLD” plots. Three irrigations were provided during the cropping period. One foliar spray was given with Boron @ 2g/lit. of water in ray floret opening stage. The row per plot were five in number with a row spacing of 60 cm and plant to plant spacing was 30 cm. Uniform dose of fertilizer @80 kg N, 40 Kg P_2O_5 and 40 kg K_2O per ha was applied. The germinated seed of sunflower used as the planting materials and one per hill were maintained throughout the cropping period. The data was recorded from each plot of all replications on i) Disease Mortality % at 21DAS, ii) Mortality % at 45DAS ,iii) Mortality % at the time of harvest. The data was recorded in ten randomly selected plants from each plot of all replications on the following characters viz., days to 50% flowering, days to maturity, plant height at harvest (cm), head diameter per plant (cm), seed weight per head (g), 100-seed weight (g), husk content (%), volume weight (g/cc) and percentage of infected plants by sunflower wilt (on plot basis). The seed yield (kg/ha), oil percentage and oil yield (kg/ha) were estimated on plot basis. The mean values were subjected to statistical analysis.

Isolates of *T. viride*, *T. hazianum* and *P. fluorescens* used in present investigation were obtained from Rice pathological and Bio control Laboratory, Pantnagar. Few isolates of *Trichoderma spp.* also collected from different location of the district South 24Pgs and North 24Pgs.

For Front Line Demonstrations (FLD) on sunflower were conducted at farmer’s fields in different villages of Bankura districts of West Bengal to assess the performance of the different treatments during rabi season of the 2015-16 and 2016-17 under irrigated condition. In farmer’s demonstration field, each farmers have 1.0 acre of land, out of which 66% (2/3rd of land) each they followed Improved Technologies (2) and rest 33% (1/3rd) of the land under conventional practices.

Results and Discussion

The farmer’s field data are only presented here for the year, 2014-15 and 2015-16. The results indicated that the growth of *Trichoderma viride*, *Trichoderma harzianum*, *Pseudomonas fluorescens* or their combination treated seedlings exhibited better result over the untreated ones for management of Sunflower wilt. The result of the three consecutive years of experiment i.e. in 2013-14, 2014-15 and 2015-16 it was revealed that all the bio-inoculants, either in single or in combination have significant contribution to reduction of sunflower wilt. In 2013-14, it was recorded that the seed treatment and spraying of T.H and P.F and T.H and P.F in combination were recorded lower mortality % due to sunflower wilt (13.5% and 11%) respectively.

The highest seed yield also recorded from the treatment T4 (*T. viride+P. fluorescens* (5.0g+5.0g /kg of seed) and T5 (*T. harzianum+P. fluorescens* (5.0g/lit5.0g+5.0g/ kg of seed) the treatments, 1902 kg/ha and 1914 kg/ha respectively **(Table 1)**. The maximum gross return also recoded when P.F. was applied in combination with TH or TV (seed treatment and spraying in crown region before 1st and 2nd irrigation). The gross return were recorded in both treatments, Rs. 56,486 and Rs. 56,155 respectively. The highest yield improvement over untreated control also recorded in these two treatment, 30.2%, 29.7 % respectively followed by *Pseudomonas fluorescens* (in single when applied with seed treatment+application in crown region) **(Table 1)**.

Table 1: Efficacy of the Bio-inoculants to Management of Sunflower Wilt (disease mortality, Seed Yield and economics) in Sunflower (2013-14) at AICRP-SUF, Nimpith.

Treatments (Seed treatments +Spray 2 times before 1st and 2nd irrigatio)	% of Mortality at 21DAS	% of Mortality at 45DAS	% of Mortality at Harvest	Seed yield	CC	GR	NR	%YI	B:C
T1: *Trichoderma viride* (@10.0g kg of seed)	5.9	13.5	29.5	1620	42138	47973	5835	17.5	1.1
T2: *Trichoderma harzianum* (10.0g kg of seed)	6.2	12.7	28.3	1667	42138	49350	7212	19.8	1.2
T3: *Pseudomonas fluorescens* (@10.0g /kg of seed)	6.7	9.5	25.5	1772	42138	52381	10243	24.6	1.2
T4: *T. viride+P. fluorescens* (5.0g+5.0g /kg of seed)	3.3	7.5	13.5	1902	44065	56155	12090	29.7	1.3
T5: *T. harzianum+P. fluorescens* (5.0g/ lit5.0g+ 5.0g/ kg of seed)	3	6	11	1914	44065	56486	12421	30.2	1.3
T6: Control (No seed treat and No foliar application)	21.5	32.3	40.5	1336	36882	39876	2994	0	1.1
SEm(±)	0.6	1.8	2.3	27.5					
CD (P=0.05)	1.9	5.5	6.8	8.6.5					
CV(%)	7.8	8.5	8.9	9.4					

In 2014-15 and 2015-16, the study reveals that the seed treatment and spraying of T.H with P.F and T.V with P.F were the best treatments against all other treatments and lowest mortality % due to sunflower wilt were recorded in these two treatments (12% and 12.5%, and 12% and 13.3%) respectively **(Table 2)**. In both the year, the highest seed yield also recoded in both these treatments, 2014 k/ha and 2002 kg/ha (2014-15) and 2042 kg/ha, and 2016 kg/ha (2015-16) respectively **(Table 2)**. The highest yield improvement over untreated control also recorded in these two treatment, 50.4% and 49.6% (2014-15) and 43%, and 41.2% (2015-16) respectively followed by *Pseudomonas fluorescens* 18.5% and 20.5% respectively (when applied in single as seed treatment+twice application in crown region as spray @10glit. of water).

Table 2: Efficacy of the Bio-inoculants to Management of Sunflower Wilt (disease mortality, Seed Yield and economics) in Sunflower (2014-15 and 2015-16) at Farmer's field at Nimpith.

Treatments	Mortality% at (1)45DAS (2) at Harvest				Seed yield(kg/ha)		2015-16		2014-15		B:C ratio		Yield Improvement(%)	
	2014-15		2015-16		2014-15	2015-16	GR	NR	GR	NR	2014-15	2015-16	2014-15	2015-16
Pesticides	45 DAS	Harvest	45DAS	Harvest										
T1: *Trichoderma viride* (@10.0g kg of seed)	12.5	25.5	13.5	27.5	1705	1721	56806	9123	54567	10211	1.23	1.28	27.4	20.5
T2: *Trichoderma harzianum* (@10.0g kg of seed)	11.7	23.3	12.3	25.7	1755	1764	58211	10528	56178	11822	1.26	1.31	31.1	23.5
T3: *Pseudomonas fluorescens* (@10.0g /kg of seed)	8.7	18.5	7.5	20.5	1865	1855	57908	10225	59694	15338	1.33	1.31	39.3	22.9

T4: *T. viride+P. fluorescens* (5.0g+ 5.0g /kg of seed)	6.5	12.5	6.5	13.3	2002	2016	66415	1655 2	64089	17705	1.4	1.43	49.6	41.2
T5: *T. harzianum+P. fluorescens* (5.0g/lit5.0g+ 5.0g/ kg of seed)	6	12	6	12	2014	2042	67398	1753 5	64455	18071	1.41	1.45	50.4	43
T6: Untreated Control	32.3	45.5	32.3	40.5	1338	1428	47114	4247	42427	2551	1.06	1.18	-	-
SEm(±)	0.6	1.4	0.7	2.2	35.8	52.2	-		-		-	-	-	-
CD (P=0.05)	1.9	4.2	2.2	6.5	106.5	156.8	-		-		-	-	-	-
CV(%)	8.2	8.8	9.2	9.5	8.9	9.6	-		-		-	-	-	-

The yield advantage or yield improvement of both the treatments were highly significant and recorded in farmer's demonstration field also. The highest percentage of reduction due to disease mortality were recorded in these two treatments 33% in 2014-15 and 28 % in 2015-16 respectively. The maximum gross return also recoded when *Pseudomonas fluorescens* was applied in combination with *Trichoderma harzianum* or *T. viride* (seed treatment and spraying in crown region before 1st and 2nd irrigation). The gross return were recorded in both treatments, Rs.64,455 and Rs.64,089 in 2014-15, Rs.67,398 and Rs.66,415 in 2015-16 respectively. The highest Benefit: cost return were observed in these two treatments (1.41 and 1.40 in 2014-15), 1.45 and 1.43 in 2015-16 respectively. The research observation have close proximity with the findings of Sharma et al. [10], where he were reported the severity and yield loss due to Sclerotiorum wilt and critical stages for effective management of the same disease for reducing the yield loss **(Table 3)**.

Table 3: Effect of foliar spray of (*T. harzianum+P. fluorescens*) on seed yield and economics of sunflower under irrigated field situations (No. of Demonstration: 10).

Year	Mean seed yield (Kg/ha)		Yield gap (kg/ha)	Cost of cultivation (Rs./ha)		Gross Return (Rs./ha)		Net return (Rs./ha)		Additional Net return (Rs/ha)	Increase in yield %	Benefit: Cost ratio	
	IP	FP		IP	FP	IP	FP	IP	FP			IP	FP
2014-15	1988	1721	267	51167	49292	81938	74304	30770	25012	5758	15.5	1.6	1.5
2015-16	2450	2060	390	58,400	55530	101840	88900	47690	33370	14320	18.9	1.82	1.63
Avg.	2219		329	54784		91889	81602	39230	29191	10039	17.4	1.71	1.56

The conclusion of the present study is that *T. viride*, *P. fluorescens* and *T. harzianum* and their combinations have significant role on management of sunflower wilt if the bio-inoculants were used for seed treatment and when they are used for application in crown region before 1st and 2nd irrigation and all the bio-agents either in combination or individually proved to be a boon for management of Sunflower wilt and thereby a potent source for increasing sunflower seed yield.

The yield advantage also associated with the seed treatments with bio-inoculants like and Bio-fungicides (*T. viride+P. fluorescens*) each @ 10g /kg of seed) as well as application of the same (*T. viride/T harzianum+P. fluorescens*) @10g+10g /lit. of water) before 1st and 2nd irrigation for reducing the need of the Plant protection chemical (20% to 25%)and for effectively management of the Sunflower wilt which is main disease of that region.

The study in depicted that seed treatment and necessary plant protection techniques are very much essential for higher seed yield of sunflower in farmer's field. Through regular field level training and monitoring before sowing and during crop growth stage, the awareness was developed among the farmers regarding the seed Treatment, proper spacing, thinning and weeding and earthing up and implementation of proper and cost effective Plant protection techniques at proper crop growth stage. Over and under population was observed in farmer's sunflower and often resulted in poor seed yield. Hence, optimum plant population should be mentained by proper inter row and intra row spacing and adoption of proper and cost effective Plant protection techniques at proper crop growth stage. The yield advantage in demonstration plot also associated with the adoption of these practices in farmer's level. The data across of the years of demonstration indicated that the economic advantage in terms of the Benefit: Cost (B:C) ratio of the farmers under improved method of sunflower cultivation with seed treatments and application of bio-inoculants results higher Benefit: Cost (B:C) ratio higher was recorded 1.60 (2014-15) and 1.82 (2015-16) which were much higher

compared to conventional cultivation systems /Farmer's Practice, 1.50 (2014-15) and 1.63 (2015-16) **(Table 3)**. The research observation have close proximity with the findings of Pandey et al. where he pointed out the role of *Trichoderma spp*. in integrated management of *S. sclerotiorum* in Indian Mustard [11].

The lowest mortality of sunflower plants either in seedling stage or in mature stage also observed when the bio-inoculants were used in combination (*T. virade* and *P. fluorescens*) and when the combination were used as seed inoculants and also used for spraying at the crown region before first and second irrigation [12-14].

Conclusion

The conclusion of the present study is that *T. viride*, *P. fluorescens* and *T. harzianum* and their combinations have significant role on to effective management of sunflower wilt in West Bengal and the best result may be obtained when the bio-inoculants were used in combination (*T. harzianum* and *P. fluorescens*) and when the combination were used as seed inoculants and also used for spraying at the crown region before first and second irrigation.

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