

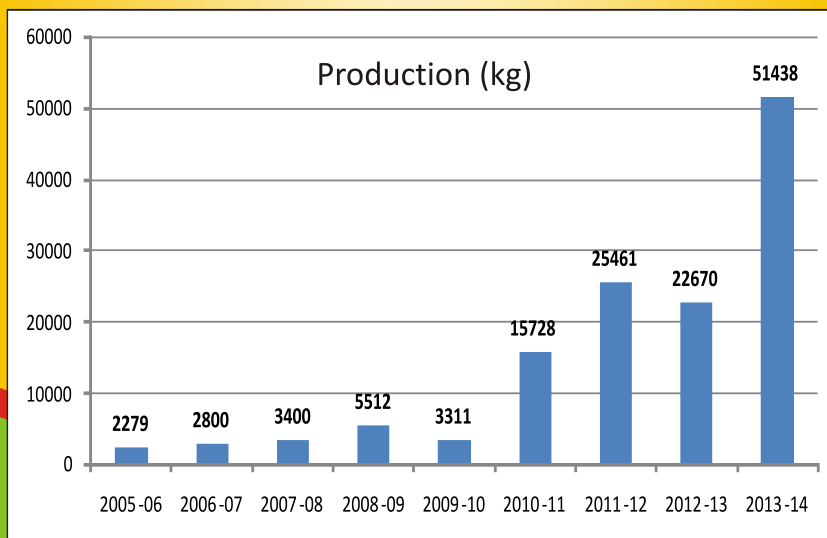
BIOLOGICAL CONTROL OF STEM AND POD ROT DISEASE OF GROUNDNUT

BY "SAWAJ TRICHODERMA"

– A SUCCESS STORY



Hon'ble Chief Minister Shri Narendra Modi interacting with
Hon'ble Vice Chancellor Dr. N. C. Patel about
"SAWAJ TRICHODERMA"



Production of "SAWAJ TRICHODERMA"
at Department of Plant Pathology,
Junagadh Agricultural University, Junagadh



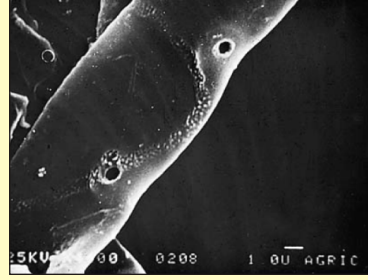
Department of Plant Pathology
College of Agriculture

Junagadh Agricultural University
Junagadh – 362 001



Mycelium of Trichoderma over mycelium of Pathogen

Holes made by Trichoderma on mycelium of pathogen for sucking cell sap



Growth inhibition of pathogen by Trichoderma

Pure culture of Trichoderma in petri dish



Control of pathogenic fungi by Trichoderma



Dean, University of Venda (S.A.)



**Head, Department of Food Sci. & Tech,
University of Venda (S.A.)**



Delegates from Tanzania



Faculty and Students from MIT, USA

Foreign Delegates at Biocontrol Lab

BIOLOGICAL CONTROL OF STEM AND POD ROT

DISEASE OF GROUNDNUT

BY

“SAWAJ TRICHODERMA”

– A SUCCESS STORY

Shri U. M. Vyas

Agricultural Officer &
I/c Bio-Control Lab

Dr. K. B. Jadeja

Professor and Head



Department of Plant Pathology
College of Agriculture

Junagadh Agricultural University

Junagadh – 362 001

SUMMARY

Management of soil borne diseases is not easy as in case of foliar diseases. As a routine practice use of chemical fungicides is harmful for soil health and economically not viable. Stem and pod rot of groundnut is a soil borne disease and for its management non chemical practices are advocated. Biological control of stem and pod rot disease is recommended with the application of *Trichoderma harzianum*, even though its adoption is at low profile. A small scale production of carrier based *Trichoderma* was initiated by Department of Plant Pathology in simple poly pack in the year 2005-06. Later on under the able guidance of hon'ble Vice Chancellor Dr. N. C. Patel production of SAWAJ-Trichoderma in an attractive four colour pack was started under Rashtriya Krishi Vikas Yojana during 2009-10. Onward from 2010-11 the demand of SAWAJ-Trichoderma was increased, specifically for stem and pod rot management in groundnut. A feedback study of SAWAJ-Trichoderma users was conducted during 2010-11, 2011-12, 2012-13 and 2013-14 to know about its actual performance at farmer's fields.

The observations by farmers on application of SAWAJ-Trichoderma for stem and pod rot management are excellent. According to them 72.18 per cent disease reduction with 25.31 per cent increase in pod yield was recorded. We have calculated the economic output to farmers. It is estimated that farmers have received additional income of ₹ 771.60 million during last four years with the use of SAWAJ-Trichoderma for the management of stem and pod rot disease in groundnut. The Junagadh Agricultural University has also generated income of ₹ 8.0 million through selling of SAWAJ-Trichoderma during this period. The market of SAWAJ-Trichoderma is well established among farmers and in coming years the demand will increase by many folds. This successful adoption of biological control agent against a single disease will definitely inspire farmers for the management of other crop diseases.

Groundnut is an important oilseed crop grown globally in 30 million ha, of which India shares 9 million ha. The leading Indian states in groundnut cultivation are Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Odissa. Gujarat is the major groundnut growing state with 20 lakh ha, mainly occupied in Saurashtra and Kutch. Continuous cultivation of groundnut in the same field, lacking deep ploughing and cultivation of high yielding disease prone variety leads to regular occurrence of soil borne diseases, like pre and post immergence rot and stem and pod rot causing economic yield loss.

The occurrence of stem and pod rot of groundnut is worldwide. It is incited by a polyphagous fungus *Sclerotium rolfsii* and reduces the pod yield. International Crop Research Institute for Semi-Arid Tropics has reported that this disease causes 10-25% economic yield loss and if whole field is diseased than it results in 80% economic loss. A survey conducted by Department of Plant Pathology during the year 2011-2012 and 2012-2013 revealed 10-32 and 10-65 per cent incidence of stem and pod rot, respectively. The intensity of disease depends upon rainfall, physical condition of soil and the variety of groundnut. In the later crop stage, scattered rain fall and its delay along with excess interculturing favors the disease. Most of the groundnut cultivars are prone to the attack of stem and pod rot fungus and its severity is higher in GG-20, a popular cultivar of Gujarat. In the initial stage white mycelial mat is formed on lower part of stem and on soil surface, which later on give rise to large number of opium seeds like hard structure called sclerotia. The sclerotia remain viable in the soil for 3-4 years and wide host range allows the pathogen to survive. The fungus also attack on underground pods. The affected braches or whole plant may dries.

Major points for the management of stem and pod rot disease of groundnut:

- 1) Crop rotation.
- 2) Deep ploughing during summer season.
- 3) Avoid bunding around crop row and over interculturing.
- 4) Use organic manure.
- 5) Apply Trichoderma as per recommendation.

Trichoderma a versatile bio-control agent:

It is well established that the Trichoderma fungus is a very effective bio control agent against plant diseases, particularly soil borne pathogens. In general its use is at low profile but large numbers of Saurashtra farmers are using the Trichoderma for the management of stem and pod rot disease in groundnut with great success. Trichoderma is a free living, soil inhabitant, dueteromycotinus fungus. It has more than 100 species, out of which *Trichoderma harzianum*, *Trichoderma viride*, *Trichoderma longibrachiatum*, *Trichoderma koningii*, etc. are proved effective against soil borne plant pathogens like *Sclerotium rolfsii*, *Rhizoctonia spp.*, *Fusarium oxysporum*, *Pythium spp.* and *Phytophthora spp.*

Mechanisms of Trichoderma in pathogen control:

- 1) Trichoderma parasitize over mycelium of pathogenic fungi and draw the cell sap.
- 2) Trichoderma releases antibiotics in the surrounding which penetrates the cell wall of pathogenic fungi and kill them.
- 3) Trichoderma deprives the growth of pathogens by competing for nutrients.
- 4) Trichoderma releases different chemicals which increase disease resistance potential of crop.
- 5) Trichoderma increases availability of nutrients to the plants.
- 6) Trichoderma hamper germination of pathogenic spores.

Advantages of Trichoderma:

- 1) Management of soil borne diseases for longer period.
- 2) Improve seed germination.

- 3) Improve crop health and production.
- 4) Eco friendly; do not pollute soil, water and air.
- 5) No any adverse effect on the crop.
- 6) Safer for human health.
- 7) Pathogens do not develop resistance against *Trichoderma*.
- 8) Cheap as compared to chemicals.

Production of SAWAJ Trichoderma at Department of Plant Pathology, JAU, Junagadh:

The production of carrier based *Trichoderma harzianum* for the benefit of farmers was initiated in 2005-06. Later on in 2009-10 a well-equipped laboratory was established for the production of an attractive coloured packing of 'SAWAJ Trichoderma' from the fund received under Rashtriya Krishi Vikas Yojana. The sale detail of 'SAWAJ Trichoderma' is given in Table 1.

Table 1: Sale of SAWAJ Trichoderma by Department of Plant Pathology, College of Agriculture, JAU, Junagadh

Year	Quantity (kg)	Sale price (₹/kg)	Income (₹)
2005 to 2010	17,302	100	17,30,200
2010-11	15,728	70	11,00,960
2011-12	25,461	70	17,82,270
2012-13	22,670	70	15,86,900
2013-14	51,438*	70	36,00,660
Total sale/income	1,32,599	-	98,00,990

* Sale up to 31st October, 2013

Feedback from farmers on field application of 'SAWAJ Trichoderma':

A questionnaire was sent to the farmers (100 each year) who had purchased more than 10 kg 'SAWAJ Trichoderma' from the Department of Plant Pathology during *Kharif* 2010 and 2011. Similarly a questionnaire was also sent to 600 farmers during third year (2012) and 980 farmers during the fourth year (2013). Following simple questions/information was sought from the farmers.

- 1) Which were the sources of information to use 'SAWAJ Trichoderma'?
- 2) Name of the groundnut variety under cultivation in their field.
- 3) Method of *Trichoderma* application.
- 4) Period of *Trichoderma* application.
- 5) Whether stem and pod rot disease was controlled or not? If yes, mention percentage of disease reduction.
- 6) If yield is increased, mention in per cent or in quantity (kg/vigha).

Interpretation of information received from farmers:

Sources of Information:

The information regarding application of *Trichoderma* for controlling white fungus in groundnut was obtained by farmers mainly through neighbours/friends (29.19%), Agricultural University Scientists (22.16%) and personnels from Department of Agriculture and ATMA (11.62%) (Table 2).

Table 2: Sources of information for farmers to use *Trichoderma* in crop disease management

Sr. No.	Sources of information	Number of farmers (%)				Combined mean (%)
		2010	2011	2012	2013	
1	Department of Agriculture + ATMA	3.23	2.56	9.29	17.50	11.62
2	Agricultural University Scientists	22.58	23.07	22.86	21.20	22.16
3	Training at Agricultural University	3.23	17.95	2.14	5.00	5.14
4	Village level workers	6.45	5.13	4.29	2.50	3.78
5	Krushi mahotsav	9.68	7.69	4.29	1.90	4.05
6	Agricultural fair	3.23	5.13	5.00	3.70	4.32
7	Agricultural literature	3.23	5.13	2.86	10.60	6.49
8	Akashvani	6.45	0.00	2.86	0.60	1.89
9	Durdarshan and private TV channels	9.68	2.56	2.14	2.50	2.97
10	Agro service centre	6.45	0.00	13.57	3.20	7.03
11	Gujarat State Fertilizer Company depot	3.23	0.00	0.00	2.50	1.35
12	Neighbours/ friends	22.58	30.76	30.71	28.80	29.19
	Total	100	100	100	100	100

Carriers/methods used by farmers for the application of Trichoderma

Out of 370 farmers, 338 used GG-20 variety of groundnut for cultivation. Trichoderma was used mainly in two different ways: 1. Application with carriers. 2. Application by spray pump or irrigation water. Total six carriers were used by farmers (Table.3). The most adopted carriers were FYM/Organic manure (44.00%), sand (27.00%) and cake (18.60%).

Table 3: Application mode of Trichoderma in groundnut (2010, 2011, 2012 and 2013 combined)

Sr. No.	Carrier/method	Number and percentage of farmers	
		Number	Percentage
1	Cake (castor)	69	18.60
2	FYM/ organic manure	163	44.00
3	Sand	100	27.00
4	Soil	14	3.80
5	Moram	1	0.40
6	Dried powder of gobar gas slurry	3	0.80
7	Spray pump	13	3.50
8	Irrigation water	7	1.90
Total		370	100

Application frequency of 'SAWAJ Trichoderma' during season of groundnut

For controlling stem and pod rot, 80.65 % farmers have given single application of 'SAWAJ Trichoderma' in groundnut season during year-2010, which is the highest. While 12.90 % farmers applied twice, 3.23% farmers applied thrice and 3.23% farmers applied 4 times (Table 4(A)). During 2011, 61.54% farmers applied once. 30.77% applied two times, 7.69% applied three times (Table 4(B)). During 2012, 75.71% farmers applied once. 17.86% applied two times, 6.42% applied three times (Table 4(C)). During 2013, 68.10% farmers applied once. 15.00% applied two times, 0.60% applied three times (Table 4(D)). During these four years the overall 71.35% and 12.03% farmers have applied 'SAWAJ Trichoderma' once and twice respectively in a season (Table 4(E)).

Table 4(A): Application frequency of 'SAWAJ Trichoderma'(year 2010).

Sr. No	Number of application in a season	Number and percentage of farmers		Actual area under treatment (%)
		Number	Percentage	
1	One	25	80.65	80.65
2	Two	4	12.90	6.45
3	Three	1	3.23	1.08
4	Four	1	3.23	0.81
Total		31	100	88.99=89

Table 4(B): Application frequency of 'SAWAJ Trichoderma'(year 2011).

Sr. No	Number of application in a season	Number and percentage of farmers		Actual area under treatment (%)
		Number	Percentage	
1	One	24	61.54	61.54
2	Two	12	30.77	15.39
3	Three	3	7.69	2.56
4	Four	0	0.00	0.00
Total		39	100	79.49=80

Table 4(C): Application frequency of 'SAWAJ Trichoderma'(year 2012).

Sr. No	Number of application in a season	Number and percentage of farmers		Actual area under treatment (%)
		Number	Percentage	
1	One	106	75.71	75.71
2	Two	25	17.86	8.93
3	Three	9	6.43	2.14
4	Four	0	0.00	0.00
Total		140	100	86.78=87

Table 4(D): Application frequency of 'SAWAJ Trichoderma'(year 2013).

Sr. No	Number of application in a season	Number and percentage of farmers		Actual area under treatment (%)
		Number	Percentage	
1	One	109	68.10	68.10
2	Two	48	30.00	15.00
3	Three	3	1.90	0.60
4	Four	0	0.00	0.00
Total		160	100	83.78=84

Table 4(E): Application frequency of 'SAWAJ Trichoderma' in a season for the management of stem and pod rot in groundnut (year 2010, 2011, 2012 and 2013 combined)

Sr. No	Number of application in a season	Number and percentage of farmers		Actual area under treatment (%)
		Number	Percentage	
1	One	264	71.35	71.35
2	Two	89	24.05	12.03
3	Three	16	4.32	1.44
4	Four	1	0.28	0.07
Total		370	100	84.89 = 85

Application time of 'SAWAJ Trichoderma' in groundnut

It has been noticed that farmers applied 'SAWAJ Trichoderma' right from sowing time to third month after sowing (Table 5).

Table 5: Application time of 'SAWAJ Trichoderma' in groundnut (2010, 2011, 2012 and 2013 combined)

Sr. No.	Period of application	Farmers	
		Number	Percentage
1	Only at sowing time	14	3.78
2	Only during first month after sowing	89	24.05
3	Only during second month after sowing	114	30.81
4	Only during third month after sowing	46	12.43
5	At sowing time and during first month	17	4.59
6	During first and second month after sowing	24	6.48
7	During second and third month after sowing	47	12.70
8	At sowing time and during first and second month after sowing	1	0.27
9	During first, second and third month after sowing	17	4.59
10	At sowing time and during first, second and third month after sowing	1	0.27
Total		370	100

Single application in a season shared 71.08%, in which 30.81% applied during second month, 24.05% during first month, 12.43% during third month after sowing, and only 3.78% applied at sowing time. 'SAWAJ Trichoderma' was applied during second and third month after sowing by 12.70% farmers, while 4.59% applied three time at an interval of one month after sowing.

'SAWAJ Trichoderma' usage per unit area in groundnut:

According to recommendations of agricultural university (2.5 kg/ha) the per unit area usage is:

Year 2010:

$$\frac{15728 \times 89}{2.5 \times 100} = 5600 \text{ ha under 'SAWAJ Trichoderma' treatment}$$

Which is 0.31% of the total area of 17, 83,400 ha of groundnut in Saurashtra region.

Year 2011:

$$\frac{25461 \times 80}{2.5 \times 100} = 8148 \text{ ha under 'SAWAJ Trichoderma' treatment}$$

Which is 0.49% of the total area of 16, 63,500 ha of groundnut in Saurashtra region.

Year 2012:

$$\frac{22670 \times 87}{2.5 \times 100} = 7889 \text{ ha under 'SAWAJ Trichoderma' treatment}$$

Which is 0.86% of the total area of 9,16,000 ha of groundnut in Saurashtra region.

Year 2013:

$$\frac{51438 \times 84}{2.5 \times 100} = 17283 \text{ ha under 'SAWAJ Trichoderma' treatment}$$

Which is 1.93% of the total area of 9,16,000 ha of groundnut in Saurashtra region.

Disease control and increase in yield with the use of 'SAWAJ Trichoderma'

During the year 2010, 2011, 2012 and 2013 the mean stem rot reduction under SAWAJ Trichoderma treated fields was 69.84%, 73.67%, 60.63% and 84.57% respectively. The mean disease reduction for these four years is 72.18%. In response to disease reduction, the increase in pod yield during these years was 25.48%, 28.92%, 12.37% and 34.48% respectively. The overall increase in pod yield was 25.31% (Table 6).



Sclerotia and white mycelium of *Sclerotium rolfsii* Diseased plants at maturity

Table 6: Reduction in stem and pod rot disease and increase in pod yield of groundnut with application of 'SAWAJ Trichoderma' (2010, 2011, 2012 and 2013).

Year	Disease Reduction		Increase in pod yield and additional income				
	Range	Mean (%)	Range	Mean (%)	Yield Increase (kg/ha)**	Additional income incurred (₹/ha)***	Total additional income (₹)
2010	0 to 100	69.84	0 to 65	25.48	499	13,645	7,64,00,647
2011	5 to 100	73.67	10 to 60	28.92	567	21,305	17,35,82,914
2012*	8 to 100	60.63	0 to 30	12.37	243	10,725	8,46,11,241
2013	0 to 100	84.57	0 to 70	33.11	649	24,485	42,31,78,368
Combined mean		72.18		25.31		-	
Total							75,77,73,170

Calculation of economic returns:

* Poor rainfall

**The average yield of groundnut cv. GG-20 is 1960 kg/ha for Saurashtra region

***Additional income (₹/ha) = yield increase (kg/ha) × price in respective year (₹) – input expenses (₹/ha)

(Price: year 2010 = ₹ 30/kg, year 2011 = ₹ 40/kg, year 2012 = ₹ 50/kg, year 2013 = ₹ 40/kg)

Spent: 'SAWAJ Trichoderma' price/ha + rate of caster cake + labour cost
(₹ 175/ha = 70 x 2.5 kg) + (₹ 1000/ha) + (₹ 150/ha) = ₹ 1325

Additional income (Rs/ha):

- (1) Year 2010 : (499 x 30) = 14970 – 1325 = ₹ 13,645
- (2) Year 2011 : (567 x 40) = 22,680 – 1375 = ₹ 21,305
- (3) Year 2012: (243 x 50) = 12,150 – 1425 = ₹ 10,725
- (4) Year 2013: (649 x 40) = 25,960 – 1475 = ₹ 24,485

(A) Financial benefit incurred to farmers in purchase price:

'SAWAJ Trichoderma' is sold to farmers @ ₹ 70/kg by the university. The private company Trichoderma products available in the market at the cost of ₹ 120 to 260 /kg which makes an average price of ₹ 190/kg.

Financial benefit in purchasing = Average of company rate – rate of 'SAWAJ Trichoderma'

$$= (120 \text{ to } 260)/2 = 190 - 70 = ₹ 120/\text{kg}$$

- (1) Year 2010: Total sale x financial benefit in price
 $15,728 \times 120 = ₹ 18,87,360$
- (2) Year 2011: Total sale x financial benefit in price
 $25,461 \times 120 = ₹ 30,55,320$
- (3) Year 2012: Total sale x financial benefit in price
 $22,670 \times 120 = ₹ 27,20,400$
- (4) Year 2013: Total sale x financial benefit in price
 $51,438 \times 120 = ₹ 61,72,560$

Combined benefit (2010, 2011, 2012 and 2013) in purchase price
 $= 18,87,360 + 30,55,320 + 27,20,400 + 61,72,560 = ₹ 1,38,35,640$

(B) Financial benefit incurred to farmers with additional production=

Financial benefit incurred with Additional Production = $\frac{\text{Sawaj Trichoderma sale (kg)} \times \text{Av. Unit area} \times \text{Additional income (₹/ha)}}{\text{Application rate of Trichoderma (kg/ha)} \times 100}$

- (1) Year 2010 = $\frac{15728 \times 89 \times 13645}{2.5 \times 100} = ₹ 7,64,00,647$
- (2) Year 2011 = $\frac{25461 \times 80 \times 21305}{2.5 \times 100} = ₹ 17,35,82,914$
- (3) Year 2012 = $\frac{22670 \times 87 \times 10725}{2.5 \times 100} = ₹ 8,46,11,241$
- (4) Year 2013 = $\frac{51438 \times 84 \times 24485}{2.5 \times 100} = ₹ 42,31,78,368$
- (5) Combined benefit(2010, 2011,2012 and 2013) by additional production
 $= 7,64,00,647 + 17,35,82,914 + 8,46,11,241 + 42,31,78,368$
 $= ₹ 75,77,73,170$

(C) Total benefit incurred to farmers by application of 'Sawaj Trichoderma' (2010, 2011, 2012 and 2013)=

Financial benefit in purchase price + Economical benefit by additional production

$$= 1,38,35,640 + 75,77,73,170$$

$$= ₹ 77,16,08,810$$

Economical interpretation on sale and use of 'SAWAJ Trichoderma':

Sustainability of any biotechnology depends on its economic output as well as eco-friendly in nature. 'SAWAJ Trichoderma' has benefited its users and producers. Primarily farmers paid lesser price as compared to other company products in the market and get huge economic benefit by better yield due to the disease control. Agricultural university also generated fund by selling of 'SAWAJ Trichoderma'.

During the year 2010, 2011, 2012 and 2013 farmers have gained a price difference benefit of ₹ 18,87,360/-, ₹ 30,55,320/-, ₹ 27,20,400/- and ₹ 61,72,560 respectively which in together makes ₹ 1,38,35,640/-.

Similarly financial gains received by increase in yield is estimated ₹ 7,64,00,647/-, ₹ 17,35,82,914/-, ₹ 8,46,11,241/- and ₹ 42,31,78,368/- during the year 2010, 2011, 2012 and 2013 respectively. So, during these four years the combined benefit to the farmers with increase in yield is estimated ₹ 75,77,73,170/-.

The overall benefit to the farmers using 'SAWAJ Trichoderma' for stem and pod rot management in groundnut during four years (2010, 2011, 2012 and 2013) is estimated ₹ 77,16,08,810/- and adding sale amount of four years received by Junagadh Agricultural University (₹ 80,70,790) the combine economic gain is established ₹ 77,96,79,600/- (Table 7). This may be a small amount in the agricultural growth of the state but noteworthy.

Table 7: Economic benefit to the farmers by the application of 'SAWAJ Trichoderma' and income generated to the Junagadh Agricultural University during last four years (2010, 2011, 2012 and 2013)

Year	Price difference benefit (₹)	Additional income due to increase in yield (₹)	Actual economic gain to farmers (₹) (2+3)	Income to JAU, Junagadh (₹)	Combined economic gain (₹) (4+5)
1	2	3	4	5	6
2010	18,87,360	7,64,00,647	7,82,88,007	11,00,960	7,93,88,967
2011	30,55,320	17,35,82,914	17,66,38,234	17,82,270	17,84,20,504
2012	27,20,400	8,46,11,241	8,73,31,641	15,86,900	8,89,18,541
2013	61,72,560	42,31,78,368	42,93,50,928	36,00,660	43,29,51,588
Combined gain in four years	1,38,35,640	75,77,73,170	77,16,08,810	80,70,790	77,96,79,600



Growth of fungus on Groundnut pod



Discolouration of Groundnut kernels

Table 8: Feedback of farmers using 'SAWAJ-Trichoderma' for stem and pod rot management in groundnut(Kharif– 2010)







Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Kantibhai Premjibhai Goriya To, Mesvan Ta.: Keshod Dist. : Junagadh Mo.No.: 94287 75953	With castor cake, at 30 DAS	70	20
	Kanubhai Dayabhai Dudhatra To, Shergadh Ta.: Keshod Dist : Junagadh Mo.No.: 98249 89449	With FYM, sand and moram, at 40 DAS	40	21
Photo not available	Natha Lakshmanbhai Umretia To, Chhodavadi Ta. : Bhesan Dist : Junagadh Mo.No.: 94287 04424	With FYM and sand, at 45 DAS	90	12
	Dineshbhai Rambhai Bharai Po.: Ganod Ta. : Upleta Dist : Rajkot Mo. No. : 99792 91645	Mixed with sand, applied at 35 DAS	80	35
	Hiteshbhai M. Nariya Po. :Upleta Dist : Rajkot Mo. No. : 94269 96380	With sand, sprinkled with jaggary at 30-40 DAS	100	50
	Menshibhai R. Ram Po. : Pipali Ta. : Keshod Dist : Junagadh Mo.No.: 97127 26987	With FYM, applied at 32 DAS	100	22
	Girishbhai P. Bhesaniya Po. : Shobhavadala (Lashkar) Ta. : Visvadar Dist : Junagadh Mo.No.: 94269 86481	With castor cake at 45&60 DAS	80	15






Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Bhikhubhai K. Parmar Po. : Satapar Ta. : Jamjodhpur Dist : Jamnagar Mo.No.: 99092 97200	With castor cake, by automatic seed drill at 20 DAS	20	65
Photo not available	Jayantilal Hansrajbhai Sadariya Po. : Juthal Ta. : Mangrol Dist : Junagadh Mo.No.: 94277 35405	With moist soil, broadcast at 30 DAS	209	
	Bachubhai Valajibhai Patoliya Po. : Datrana Ta. : Mendarada Dist : Junagadh Mo.No.: 99741 64831	With FYM, applied at 60 DAS	10	4
	Balubhai Trikambhai Trada Po. : Mithapur Ta. : Mendarada Dist : Junagadh Mo.No.: 99094 62778	With FYM and sand, at 30 & 80 DAS	80	20
	Mayurkumar M. Dalsania Po. : Sajadiyali Ta. : Upleta Dist : Rajkot Mo.No.: 99243 21116	With sand, at 25 to 30 DAS	90	22
Photo not available	LalitbhaiPunjabhaiPatat Po. : Bhanduri Ta. : Maliya (Hatina) Dist : Junagadh Mo.No.: 94293 63646	With FYM, at later crop stage	80	35
	Niteshbhai B. Baldha To. : Chanaka Ta. : Bhesan Dist : Junagadh Mo.No.: 96624 32302	With moram, broadcasted at 45 DAS	70	8








Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Hareshbhai B. Kathiriya To. : Chuda Ta. : Bhesan Dist : Junagadh Mo.No.: 99251 70894	With sand, broadcasted at 40 DAS	60	20
	Bhanubhai B. Savaliya Po. : Ambala Ta. : Visavadar Dist : Junagadh Mo.No.: 99095 79196	With FYM and wheat flour, at 40 DAS	70	22
	Ramnikbhai M. Faldu Po. : Shapur Ta. : Vanthali Dist : Junagadh Mo.No.: 94264 42834	With FYM, at 90 DAS	90	35
	Vallabhai M. Moliya To. : Beraja (Pasaya) Ta.,Dist.: Jamnagar	With FYM, at sowing time	80	18
	Devashibhai G. Patat Po. : Bhanduri Ta. : Maliya(Hatina) Dist : Junagadh Mo.No.: 99257 39548	With FYM and sand, during rainy days	90	16
	Atulbhai M. Chaniyara Po. : Motimarad Ta. : Dhoraji Dist : Rajkot Mo.No.: 94286 99109	With FYM, at 42 and 70 DAS	90	35
	Bhikhubhai M. Hirpara Po. : Motakotada Ta. : Visavadar Dist : Junagadh Mo.No.: 99139 23099	With FYM, at 30 and 70 DAS	100	60

Table 9: Feedback of farmers using SAWAJ-Trichoderma for stem rot management in groundnut(Kharif-2011)








Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Bhimabhai Vikrambhai Vala To, Lodhva Ta.: Sutrapada Dist. : Junagadh Mo.No.: 9277351365	With compost during sowing	68	28
	Ramnikbhai Rajabhai Kathrotia To, Vadli Ta.: Una Dist : Junagadh Mo.No.: 9904943329	With sand, furrow application during sowing	70	31
	Vijaybhai Karshanbhai Godhaniya To, Khambhodar Ta.,Dist : Porbandar Mo.No.: 94287 04424	Through spray pump, at 20 DAS	70	37
	Arjanbhai Mahidasbhai Ladani Po. Kevadra Ta. : Keshod Dist. : Junagadh Mo. No. : 9909059850	With castor cake, at 25 DAS	90	22
	Balubhai Meghjibhai Ghori Po. : Bhandariya Ta.,Dist : Bhavnagar Mo.No.: 9426550698	With castor cake, before sowing	75	32
	Rajendrabhai Jentibhai Godhani Po. : Kolki Ta. : Upleta Dist : Rajkot Mo.No.: 94272 23251	With castor cake, at one month of emergence	85	40
	Meragbhai Govindbhai Dodiya Po. : Patra Ta. : Maliya (Hatina) Dist : Junagadh Mo.No.: 97127 20036	Through spray pump, at 15 DAS	90	38











Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Nathabhai Goganbhai Bariya Po. : Sevatra Ta. : Upleta Dist : Rajkot Mo.No.: 9898780621	With sand, at one month of emergence	75	24
	Jayeshbhai Gandubhai Bhesaniya Po. : Vandarvad Ta. : Bhesan Dist : Junagadh Mo.No.: 9428623436	With FYM, at 35 DAS	75	20
	Bipinchandra Kalabhai Raviya Po. : Matarvaniya Ta. : Maliya (Hatina) Dist : Junagadh Mo.No.: 9904390980	With sand, at 30 DAS	75	33
	Chandubhai Dudabhai Kagathara To. : Khorasa (Gir) Ta. : Maliya (Hatina) Dist : Junagadh Mo.No.: 9687707978	With castor cake, at 35 DAS	70	12
	Gopalbhai Ukabhai Dobariya To. : Aniyala Ta. : Mendarda Dist : Junagadh Mo.No.: 9725794877	With gobar gas slurry, at 30 DAS	100	50
	Dhirajlal Karshanbhai Patel Po. : Baheripur Kampa (Dahegam) Ta.,Dist : Gandhinagar Mo.No.: 9427320230	With compost, at sowing and 40 DAS	60	29
	Parsottambhai Naranbhai Kalariya Po. : Bavaniptli Ta. : Keshod Dist : Junagadh Mo.No.: 9824277373	With castor cake, at 70, 85 and 100 DAS	100	14

Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Shri Madhubhai Jadavbhai Buha To. : Baradiya Ta. : Visavadar Dist.: Junagadh Mo.No.: 8140226886	With FYM, at 45 and 80 DAS	70	12
	Vrajlal Gokallal Kardani Po. : Dhanfuliya Ta. : Vanthli Dist : Junagadh Mo.No.: 9925434412	With sand, at 30 and 65 DAS	80	35
	Hasmukh Dharamshibhai Dhudiya Po. : Toraniya Ta. : Dhoraji Dist : Rajkot Mo.No.: 9429185603	With FYM, at 60 and 100 DAS	80	24



Farmers queue at selling point of Bio agents

Table 10: Feedback of farmers using SAWAJ-*Trichoderma* for stem rot management in groundnut (*Kharif*–2012)




Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Sureshbhai Jerambhai Vachhani Po. :Juthad Ta.: Mangrol Dist. : Junagadh Mo.No.: 99255 43109	With FYM, at 20-30 DAS	70-80	45
Photo not available	Vallabhbhai Narshibhai Dobariya Po. :Shergadh Ta.: Keshod Dist. : Junagadh Mo.No.:97247 45213	With FYM, at 20-30 DAS	50	35
	Hareshbhai Gobarbhay Patoliya Po. :MotiKhodiyar Ta.: Mendarada Dist. : Junagadh Mo.No.:94287 06832	With FYM, at 20&40 DAS	50	40
	Lakshaman Vasharambhai Patel Po. :Jiyapar farm Ta.: Gandhinagar Dist. : Gandhinagar Mo.No.:94270 48733	With compost, at time of sowing	50-60	40
Photo not available	Jitendrabhai Premajibhai Shekhat Po. :Ajab Ta.: Keshod Dist. : Junagadh Mo.No.:94274 47596	With FYM & sand, at 30-35 & 60-65 DAS	80	35
Photo not available	Vajubhai Mohanbhai Giniya Po. :Prabhatpur Ta.: Junagadh Dist. : Junagadh Mo.No.:97141029549	With castor cake, at 60 DAS	10-15	8
Photo not available	Piyush Parshotambhai Radadiya Po. :Itali Ta.: Mendarada Dist. : Junagadh Mo.No.: 99791 52712	With FYM, at 90 DAS	25	20



Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
Photo not available	Bhavinbhai Merambhai Babariya Po. :Varjangjaliya Ta.: Upleta Dist. : Rajkot Mo.No.:94275 65808	With sand, at 25 DAS	60	30
Photo not available	Fulabhai Kanabhai Kumbhani Po. :Itali Ta.: Mendarada Dist. : Junagadh Mo.No.:90166 46075	With FYM, at 75 DAS	40	35
Photo not available	Rakeshbhai Arvindbhai Kalariya Po. :Pipali Ta.: Keshod Dist. : Junagadh Mo.No.:98378 56556	With FYM, At 60 DAS	50	40
Photo not available	Ramanikbhai Dudabhai Javiya Po. :Nandarakhi Ta.: Vanthali Dist. : Junagadh Mo.No.:98790 68217	With sand, at 30-50 DAS	50-60	45
Photo not available	Jaysukhbhai Kalabhai Dobariya Po. :Amargadh Ta.: Mendarada Dist. : Junagadh Mo.No.:99139 02572	With FYM, at 75 DAS	90	50
	Dinesh Parsotambhai Savasani Po. :Alidhra Ta.: Mendarada Dist. : Junagadh Mo.No.:99249 68552	With FYM, at 40 DAS	80	70
	Chandulal Bachubhai Bera Po. :Bhukhi Ta.: Dhoraji Dist. : Rajkot Mo.No.:94272 39086	With castor cake, at sowing & 40 DAS	100	70






Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Nathabhai Rajabhai Dodiya Po. :Vadodara Ta.: Veraval Dist. : Junagadh Mo.No.:94295 14210	Mixed with FYM & sand, applied 60-65 DAS	40	20
	Jayanti Dhanjibhai Bhensdadiya Po. :Kolaki Ta.: Upleta Dist. : Rajkot Mo.No.:94081 86447	With castor cake, at 90 DAS	95	70
	Dalsukhbhai Kanjibhai Rupapara Po. :Akala Ta.: Jetpur Dist. : Rajkot Mo.No.: 98796 32662	With sand, at 60 DAS	90	70
Photo not available	Rameshbhai Govindbhai Patoliya Po. :Simasi Ta.: Mendarada Dist. : Junagadh Mo.No.: 81402 41468	With FYM & sand, at 25 & 75 DAS	80-90	65
Photo not available	Nagabhai Rajsibhai Mandera Po. :logad Ta.: Mangarol Dist. : Junagadh Mo.No.:97124 78983	With FYM, at 60 DAS	100	75
	Hansraj Nathabhai Aghera Po. : MotiVavadi Ta.: Dhoraji Dist. :Rajkot	Mixed with send, applied 60 DAS	80	70
	Virjibhai Nanjibhai Koradiya Po. : Avaniya Ta.: Maliya Hatina Dist. :Junagadh	Mixed with send, applied 55 DAS	50	22

Table 11: Feedback of farmers using SAWAJ-Trichoderma for stem rot management in groundnut (Kharif-2013)






Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Thakarashi Punjabhai Patoliya Po. :Char Ta.: Keshod Dist. : Junagadh Mo.No.:76002 80399	With FYM & sand, at 45 DAS	90-95	60
Photo not available	Kishor Khimanandbhai Solanki Po.Ta.: Mendarada Dist. : Junagadh Mo.No.:94279 75405	With FYM & sand, at 45-65 DAS	90	65
	Jaysukhbhai Balabhai Khetani Po. :MotaMunjiyasar Ta.: Bagasara Dist. : Amareli Mo.No.:99094 45965	With sand, at sowing & 50 DAS	80	60
Photo not available	Nileshbhai Dhanabhai Dodiya Po. :Vadodara Ta.: Veraval Dist. : Somnath Mo.No.:99797 91951	With FYM, at 80 DAS	80	70
	Mathurbhai Lakshmidas Vachhani Po. :Mervadar Ta.: Upleta Dist. : Rajkot Mo.No.:94277 21225	With FYM & sand, at 30-60-80 DAS	100	70
	Dhavalbhai Jaysukhbhai Bhadani Po. :Bandhiya Ta.: Gondal Dist. : Rajkot Mo.No.:81412 39020	With FYM, at 30 DAS	50	40
	Karshanbhai Ramabhai Karena Po. :Aaditpara Ta.: Ranavav Dist. : Porbandar Mo.No.: 94277 34572	Through pump, at 15 DAS	100	75











Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
Photo not available	Ravibhai Lakshmanbhai Pampaniya Po. :Umbari Ta.: Sutrapada Dist. : Junagadh Mo.No.:94279 75741	With sand, at 20 DAS	100	70
Photo not available	Nathubhai Lakshmanbhai Ram Po. :Ishra Ta.: Keshod Dist. : Junagadh Mo.No.:95378 19568	With sand, at 75-80 DAS	20	30
Photo not available	Batukbhai Nathubhai Pipalava Po. : Kanavadala Ta.: Jamkandorana Dist. : Rajkot Mo.No.: 99131 82983	With sand, at 45 & 70 DAS	90	60
Photo not available	Dalsukhbhai Kanjibhai Rupapara Po. :Akala Ta.: Jetpur Dist. : Rajkot Mo.No.:98796 32662	With castor cake, at 25 &70 DAS	90	70
	Ukabhai Hamirbhai Vadher Po. :Chitravad Ta.: Talala Dist. : Gir Somnath Mo.No.:99984 38523	With castor cake,at 45 DAS	100	80
	Navinbhai Manilal Makadiya Po. :Sidsar Ta.: Jamjodhpur Dist. : Jamnagar Mo.No.: 99134 49618	With castor cake,at 30 DAS	30	40
	Dhirajbhai Bachubhai Sojitra Po. :Upleta Ta.: Upleta Dist. :Rajkot Mo.No.: 99740 47689	With castor cake, at sowing and 30 DAS	75	55

Photo	Name, Address and Contact No.	Mode of Application	Opinion	
			DR (%)	YI (%)
1	2	3	4	5
	Shamjibhai Mandanbhai Monia Po. : Beraja Ta.: Aliyapada Dist. :Jamnagar Mo.No.:94281 27161	With FYM, at 60 DAS	80	70
	Ramnikbhai V. Kalariya Po. : Jamjodhpur Ta.: Jamjodhpuar Dist. :Jamnagar Mo.No.: 94269 94583	With compost, at 20 DAS	95	-
	Ranchodbhai Jethabhai Ramoliya Po. : Jamjodhpur Ta.: Jamjodhpur Dist. :Jamnagar Mo.No.:94265 71202	With compost at 15 DAS	60	-
	Vallabhbai Lakhmanbhai Po. : Sarangpipali Ta.: Manavadar Dist. :Junagadh Mo.No.:95866 17209	With castor cake,at 15 DAS	-	-
	Dipakbhai Kantibhai Tanna Po. : Hadamatiya Ta.: Kodinar Dist. :Gir Somnath Mo.No.:99988 86945	Through pump, at 20 DAS	100	-
	Jayantibhai Bhailalbhai Patel Po. : Vadodara(Jalaram Farm) Ta.: Gandhinagar Dist. :Gandhinagar Mo.No.:94290 24070	With sand, at 40 DAS	100	-
	Haribhai G. Sakariya Po. : Khajuri(Gundala) Ta.: Jetpur Dist. :Rajkot Mo.No.:94273 73230	With sand, at 35 DAS	5	25

DR = Disease Reduction YI = Yield Increased

Significant conclusive points:

- ❖ Successful use of bio control agent for crop disease management.
- ❖ Different methods of biocontrol application used by farmers based on their own wisdom worked satisfactorily.
- ❖ Higher economic gain to the farmers.
- ❖ A good amount of fund generated by Junagadh Agricultural University through sale of bio agent.

Future thrust:

- ❖ Experiments are under progress on application of bioagents for the management of other important soil borne diseases of Saurashtra region like wilt of cumin and capsicum.
- ❖ Field evaluation on compatibility of different agro chemicals with SAWAJ Trichoderma.
- ❖ Field evaluation of bioagent consortium for crop disease management.
- ❖ Evaluation of growth promoting efficiency of SAWAJ Trichoderma on important regional crops.
- ❖ Increase the awareness among farmers to incorporate biological control practices in crop diseases management.

MESSAGE

Agriculture and allied industries provides lion share in the development and prosperity of Gujarat. In advance farming biological control is an important component of integrated crop diseases management. The biological agent – Trichoderma is known for plant disease management. It is a low cost and environment friendly input. The “SAWAJ Trichoderma” produced by Junagadh Agricultural University has been successfully used for the management of stem and pod rot of groundnut with economic gain in production. This has been reflected in the feedback received from farmers and well compiled in a booklet entitled “BIOLOGICAL CONTROL OF STEM AND POD ROT DISEASE OF GROUNDNUT BY “SAWAJ TRICHODERMA” – A SUCCESS STORY”. I congratulate the scientists of Department of Plant Pathology to develop and deliver 'SAWAJ Trichoderma' to the groundnut growers for the remedy of a noxious problem and hope for such success in other crop diseases also.