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Evaluation and validation of IDM module for Phytophthora blight management in sesame

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Abstract
Sesame Phytophthora blight disease is one of the major constraints for successful cultivation and it may reported to cause substantially high yield loss. Integrated Disease Management (IDM) practices, found suitable against Phytophthora blight, developed and evaluated elsewhere, are here by tested and validated as IDM module with slight modifications as per local requirement. This is basically to demonstrate the benefit of good available technology to farmers as on farm trials (OFT). The comparative efficacy of four different modules were incredibly convincing for the farmers. It was realized that all three modules testes were significantly superior over prevailing farmer‘s practice (Module-1). Module-4 having Seed Treatment, Soil treatment with bio-agent and foliar spray of metalaxyl + mancozeb at early onset of disease found most effective in reducing disease incidence (86.21%) which is an average of three crop season. The yield increase (36.05%), net return (Rs. 7439.75) and benefit- cost ratio for the module four were very favorable and encouraging. Module -3 was found to be the next best. The modules were improving production and yield parameters that to without imposing any drastic input burden to farmers, as evidenced by cost and benefit estimates of our study. Hence it can be concluded that Module-4 may be considered for improved sustainable package of practice for Pytophthora blight management of Sesame.

Keywords: IDM, sesame, phytophthora blight and trichoderma viridae

Introduction
Sesame (*Sesamum indicum* L.) is one of the oldest Indian origin, high value oilseed cash crop. India ranks first in world with 19.50 lakh hectare acreage and 8.507 lakh tonnes of production (reference). This is an ancient oilseed crop widely grown in the country. It is rightly quoted as queen of oilseeds since it contains high quality unsaturated fatty acid and natural anti-oxidants i.e Sesamol and Sesamolinol that reduces rate of oxidation. The other major sesame-producing states are West Bengal, Gujarat, Madhya Pradesh, Tamil Nadu, Maharashtra, Karnataka, Rajasthan and Uttar Pradesh.

In Madhya Pradesh the area production and productivity estimates are ……….Lakhha., ………..m tones and ……………kg/ha.

The yield potential of sesame is much higher than the actual yield the farmers are still realizing because much damage occurs by pests and diseases. Among the different diseases, Phytophthora Blight of Sesame caused by *Phytophthora nicotianae* var. *sesame* Butler is a most destructive disease and one of the major constraints for low productivity of this crop. In India this disease was first time reported by Butler. Phytophthora Blight causes 72-80 per cent plant mortality (Singh *et al.*, 1976)). Verma *et al.*, (2005) [15] reported that it may causes up to 79.8 per cent yield loss in central Madhya Pradesh. This disease is often severe in Madhya Pradesh, Chhattisgarh, Rajasthan, Uttar Pradesh, Gujarat, and moderate in Punjab, Haryana, Maharashtra, Andhra Pradesh, Tamil Nadu, West Bengal and Bihar (Verma, 2002) [14].

In standing crop the chemical fungicides are the only option remain left to combat with disease. But some time because of severity disease and other extraneous factors like rain fall, weather condition and stage of the crop, chemicals fail to deliver its expected action. In addition to that indiscriminate use may creates health risk and environmental hazards. Now a days every one’s focus has been shifted towards comparatively safer alternatives of chemical fungicides. In the recent era biological control had got prominence in modern agriculture to minimize the hazards of intensive use of pesticides for disease control. But the limiting factor of bioagents is that its activities and population got declined with time after their application and thus making the beneficial effect short lived. To enhance and extend the desired responses, the environment needs to be altered which selectively favour the activities of the introduced biocontrol agent. This can be overcome by the addition of specific substrates to the soil which can be utilized selectively by the introduced microbe employed as biocontrol agent

(Paulitz, 2000) [10]. Therefore Integrated Disease Management (IDM) that envisages the biocontrol agents, botanicals and judicious use chemicals and other means would reduce the quantum of toxicant used per season in addition to mitigate diseases in an economically viable and sustainable manner.

Therefore, an attempt was made to assess the effect of IDM modules with chemicals, botanicals, and biocontrol agents on disease incidence and yield of sesame in comparison with farmer's practices. In order to assess the efficacy of four different treatments including farmer's practice for management of Phytophthora blight of sesame, a three year on farm trials were conducted by KVK Sidhi in two adopted villages (Chhawari and Mamder) during crop season 2014 to16.

Materials and Methods

Field Survey

Survey and surveillance conducted in twelve villages among three blocks namely Sidhi, Rampur Naikin and Majhauli across Sidhi district of Madhya Pradesh during July-August 2014-15. It was observed during survey that Phytophthora blight disease of Sesame was found to be occur everywhere with varying magnitude (incidence range 18 to 37.5%) in all the 12 villages under survey *viz*., Madawa, Naugawa dheer Singh, Chhavari, Ghordand, Bhaisarha, Jhalwar, Chorgarhi, Katauli, Bhaiswahi, Kamchad, Gotara and Sadala. Geo-coordinates of villages surveyed and corresponding disease incidence range as well as average percent disease occurrence has been mentioned in Table -2.

At every visited field, three locations of size 1x1 meter were selected diagonally to observe overall disease incidence on visual symptoms basis. Data were recorded on disease incidence (%) by counting total number of plant as well as diseased plant. Per cent disease incidence was calculated by following formula.

$$\text{Disease Incidence (\%)} = \frac{\text{(No. of diseased plants / Total no. of assessed plants)}}{\text{(Nene, YL. 1972)}} \times 100$$

Field Experiment

The field experiment were conducted during Kharif season of three consecutive years (2015-16, 2016-17 and 2017-18) at 30 farmer's fields of Chhavari, and Madawa Villages of Sidhi District by Krishi Vigyan Kendra, Sidhi (MP). Here our aim was to found out efficacious integrated disease management modules, against Phytophthora blight of Sesame under the On Farm Trial (OFT) programme of KVK. The trials were laid out in completely randomized block design having four treatments including control (farmers practice) maintaining 5 replications. The experimental field was prepared by ploughing thrice with cultivator followed by planking for fine tilt and smooth surface. Recommended dose of FYM (1 t/ha) was mixed in soil 30 days before sowing and recommended dose of fertilizers (40:30:20 kg NPK/ha) was applied at the time of sowing. To exclude the effect of cultivar variability high yielding area suitable Sesame variety JTS-8 was chosen for this entire trial. Plot size was 25sqm with spacing dimensions 45 X 15 cm and the trial was conducted in second fortnight of July every year. Standard agronomic practices were followed to grow the crop which was validated in Madhya pradsesh by Raikwar and Shrivastava, 2013 [11].

Table 1: Details of different Integrated Disease Management Modules (IDMs) in Sesame

Sl. No.	IDMs	Details
1	IDM-1	Control (Farmer's practice where they supposed to spray in severe cases
2	IDM-2	Seed Treatment with Apron (Metalaxy)-35SD @6 g /Kg seed
3	IDM-3	Seed Treatment with Apron (Metalaxy)-35SD @6 g /Kg seed + Soil treatment with *Trichoderma viride* @ 5 kg $^{-1}$ ha)
4	IDM-4	Seed Treatment with Apron (Metalaxy)-35SD @6 g /Kg seed + Soil treatment with *Trichoderma viride* @ 5 kg $^{-1}$ ha + Foliar Spray of Ridomil Gold_MZ 68 WG @ 0.25% at early onset of disease

Incidence of the disease was recorded by counting total and diseased plants in five middle rows in each plot leaving the borders after 7 days of foliar spray. Percent disease incidence and reduction in disease incidence were calculated by following formulae suggested by Nene (1972) [8].

Estimation of Cost-Benefit Ratio

Grain yield of each plot was taken from whole population separately and yield of each module was calculated by cumulating the successive plucking from respective field and computing to Killogram per hectare. The data were tabulated, pooled and ranked on the basis of their yield performance. The benefit cost ratio (CBR) of different modules was calculated by estimating different cost of cultivation and return from yield after converting them to one hectare land. Average market price of Sesame was assumed at rupees 55.0 per kg during experimental period and cost benefit ratio was calculated.

Result and Discussion

Results presented in Table -2 clearly indicated that occurrence of Phytophthora blight of sesame was observed in each surveyed fields of Sidhi District of Madhya Pradesh. Maximum Phytophthora blight (37.5%) incidence was recorded in Ghordand village of Sidhi developmental block and Gotara village of Kushmi developmental block followed by Bhaiswahi (36.0%) village of Majhauli developmental block and Shadla (31.7%) village of Sihawal developmental block. Although variation in Phytophthora blight incidence was observed to be there from place to place but non of them was disease free. The minimum disease incidence (18%) was recorded in Jhalwar village of Rampur Naikin developmental block. The variable disease occurance may be attributable to many factors *viz*., crop variety rainfall climatic condition and farmers allrtness. For instance disease incidence up to 91.7 (45.0 to 91.7) was reported by Kapadiya *et al.*, 2015. Singh *et al.*, 1976 recorded that the mortality of the plants due to the disease may be as high as 72 to 79%. Therefore to exclude genotypic differences same variety was selected for trial at both the location Chhavari, and Madawa Villages of Sidhi District. Our experimental Results data compilled in Table -3 revealed that the Phytophthora blight incidence was significantly reduced in all Integrated Disease Managements modules (IDMs). The minimum incidence (3.44 to 5.4%) that to consistently in all three years off trials was recorded in IDM-4. If we compare the disease reduction potential of different modules tested, this can be stated that this treatment combination-4 is capable to reduce disease incidence to the tune of av. 86.21% out of three consecutive years (Table-3). As mentioned in module details in the materials and method, this IDM-4 had have seed treatment with Apron (Metalaxy)-35SD @6 g /Kg seed + Soil treatment with *Trichoderma viride* @ 5 kg $^{-1}$ ha + Foliar Spray of Ridomil gold_MZ 68 WG @ 0.25% at early onset of disease. The next best package of treatments was module -3 where seed treatment with Apron (Metalaxy)-35SD @6 g/Kg seed + Soil treatment with *Trichoderma viride* @ 5 kg $^{-1}$ ha, having disease incidence barely 11.14 to 13.48%. The last treatment i.e. IDM-2 was having only seed treatment with Apron (Metalaxy)-35SD @6 g /Kg seed) observed to have disease incidence 24.06 to 27 per cent. The maximum Phytophthora blight incidence (30-33.86 per cent) was recorded in control that is farmer's practice. Our finding clearly indicating that the individual protection measures tested were performing up to some extent but when they were integrated in a suitable manner and spray schedule followed at an early stage of disease occurrence. Then it turn out to be incredible. The performance of bio agents had been studied by earlier workers *viz*. Harman *et al.* (2004) [4] and Haikal (2008) [3] who also observed similar effects of *T. viride* in different crops. Papavizas and Lumsden (1980) [9] opined that changes in soil reaction due to increased activity of introduced Trichoderma species might be one among the reasons for the increased seedling growth beside production of growth regulating substances by the antagonists. But the limiting factor of bioagents is that its activities and population got declined with time after their application and thus making the beneficial effect short lived. Minuto *et al.* (2000) [7] reported that among tested fungicides against *Phytophthora nicotianae* var *parasitica* caused root rot of lavender, metalaxyl showed the best efficacy for control of Phytophthora root rot. Farih and Jrifi (1998) [2] reported that metalaxyl and fosetyl-Al were effectively control *Phytophthora citrophthora* caused brown rot in citrus.

Singh and Dubey in 2010 [13] concluded that the integration of P. fluorescence with Apron or Riomil MZ as seed treatment significantly reduced the Phytophthora blight incidence and enhanced seed germination and grain yield of pigeon pea. Taking in to account the above findings of earlier workers, Jayalaxami *et al.*, 2013 [5] integrated the use full and beter performing measures in a rational manner. They found the performance of integration control measures was even better than their individual once. Similar modules with slight modification we have followed here. The results shown in Table 4 also reveling that the grain yield was significantly increased in all IDMs during individual years. Highest average grain yield consistently in three successive years was obtained in module-4 (……………..) followed module-3 (……….). Rakholiya and Jadeja, 2016 [12] reported that minimum severity of Phytophthora blight (19.47 per cent) and maximum grain yield (800 kg/ ha) of sesame were recorded in three foliar spray of Ridomil MZ-72 @ 0.2 per cent however, may not advisable because of economic and environmental concerns. The findings of Jayalaxami *et al.*, 2013 [5] corroborated our recent observations where they stated that integrated use of *T. viride* as seed and soil treatment with soil application of neem cake and two foliar application of Azadiractin reducing maximum disease incidence coupled with maximum seed yield with higher cost benefit ration in sesame. The maximum loss deduction due to diseases was also attained through module-4 (Av. of three years 26.39%)

Yield attributes like number of capsules/plant, were also highest i.e. 100.4; 100 and 101.2 capsules/plant in the year 2015-16; 2016-17 and 2017-18, respectively) in treatment IDM-4 followed by IDM-3 (89.2; 87.4 and 89.4 capsules / plant in aforesaid corresponding years, respectively). The least number of capsules /plant in three successive years were recorded in control plot (IDM-1).

The economics was also calculated after the experimentation based on the expenditure incurred for different IDM modules under trial. The income data from the yield of Sesame are presented in Table 5. While comparing the economics all IDMs, maximum net returns of Rs.20527.2 to 21672.25/ ha were obtained from IDMs-4 followed by IDMs-3 (Rs. 18007.2 to 9364.219742 / ha) which is significantly higher than the usual practice done by the farmers of the area. Highest benefit–cost ratio that was 2.7:1; 2.7:1 and to 2.74:1 in the year 2015-16; 2016-17 and 2017-18, respectively in the IDM-4, followed by followed by IDM-3 (2.56:1; 2.59:1 and 2.62:1 in 2015-16; 2016-17 and 2017-18) respectively. Whereas the lowest number of benefit – cost ratio 2.22:1; 2.20:1 and 2.29 in above mentioned cropping season were recorded in control plot (IDM-1). Hence, looking to the disease control potential, grain yield gain, and maximum protection due to disease losses and net return and favorable benefit cost ratio as well as sustainability, the module- 4, would be recommended for the management of Phytophthora blight of Sesame.

Table 2: Incidence of Phytophthora blight of Sesame in Different Blocks of District Sidhi, Madhya Pradesh

Locations	Block	Variety	GPS Location		Blight Incidence (%)	
			Latitude	Longitude	Range	Average
Madawa	Sidhi	JT-55	24^{0}22' 56.1"	81^{0}56'20.9"	21-42	31.5
Naugawa dheer Singh	Sidhi	TKG-21	24^{0}23' 53.2"	81^{0}47'39.0"	06-52	22.6
Chhavari	Sidhi	JT-11	24^{0}12' 46.0"	81^{0}45'48.10"	05-38	29.0
Ghordand	Sidhi	Unknown	24^0 15' 03.0''	81^0 41' 9.9''	9-46	37.5
Bhaisharha	Rampur Naikin	TKG-21	24^{0}17' 22.0"	81^{0}21'47.2"	11-43	29.4
Jhalwar	Rampur Naikin	Unknown	24^{0}23' 36.9"	81^{0}34'16.6"	8-29	18.0
Chorgahi	Rampur Naikin	JT-11	24^{0}18' 53.0"	81^{0}24'41.0"	18-34	24.5
Katauli	Rampur Naikin	Unknown	24^0 17'11.0''	81^0 20' 51.9''	7-42	31.25
Bhaiswahi	Majhauli	JT-12	24^{0}08' 29.0"	81^{0}36'6.18''	12-46	36.0
Kamchad	Majhauli	JTS-8	24^{0}10' 6.3"	81^{0}51'35.8"	0-49	35.0
Gotara	Kushmi	Unknown	24^{0}12' 1.5"	81^{0}50'48.5"	13-42	37.5
Shadala	Sihawal	JTS-8	24^{0}24' 50.0"	81^{0}01'44.3"	11-55	31.7

Table 3: Effect of IDM modules on Phytophthora blight disease incidence of Sesame

Treatments	Blight Incidence (%)			% Reduction in Disease Incidence		
	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
T1	30	31.1	33.86	-	-	-
T2	24.06	26.84	27	19.8	13.69	20.25
T3	11.14	13.48	11.8	52.86	56.65	65.03
T4	3.44	4.34	5.4	88.53	86.04	84.05
CD at 5%	3.44	2.18	3.56	-	-	-

Table 4: Effect of Integrated Phytophthora Blight Management Modules on Yield and Yield attributes of Sesme

Treatments	Yield (qt./ ha)			% Avoidable Yield Loss			No. of Capsule/ plant			% Increase in No. of Capsule/ plant		
	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
T1	5.152	5.132	5.052	-	-	-	69.0	69.6	70.0	-	-	-
T2	5.63	5.572	5.68	8.49	7.89	11.05	79.2	80.4	80.2	14.78	15.51	14.57
T3	6.422	6.482	6.374	19.77	20.82	20.74	89.2	87.4	89.4	29.27	25.57	27.71
T4	7.08	6.942	6.844	27.23	25.78	26.18	100.4	100	101.2	45.50	45.11	44.45
CD at 5%	0.194	0.188	0.354	-	-	-	5.479	6.82	6.71	-	-	-

Table 5: Economic of different IDM modules of Phytophthora blight management practices in Sesame

Treatments	Cost of Cultivation (Rs./ha)			Grass return (Rs./ ha)			Net return (Rs./ ha)			B:C Ratio		
	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
T1	10874.8	10952.6	11027.5	24150	24120.4	25260	13275.2	13167.8	14232.5	2.22	2.2	2.29
T2	11102.8	11359.5	11557.3	25898	26188.4	28400	14795.2	14828.9	16842.7	2.33	2.3	2.45
T3	11524.8	11747.75	12128	29532	30465.4	31870	18007.2	18717.65	19742	2.56	2.59	2.62
T4	12040.8	12057.5	12547.75	32568	32627.4	34220	20527.2	20569.9	21672.25	2.7	2.7	2.74

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