

EFFECT OF MULCHES ON POTATO TUBER MOTH, *Phthorimaea operculella* (Zeller) (LEPIDOPTERA : YPONOMEUTIDAE) INCIDENCE IN STORAGE

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ABSTRACT: Mulches were evaluated at Agricultural Research Station, Madenur, Hassan, Karnataka in *Kharif* 2005 and 2006 against Potato Tuber Moth (PTM), *Phthorimaea operculella* (Zeller) infestation on potato in storage. Kufri Jyothi potato tubers covered with saw dust mulch treated with fenvalerate @ 1ml/l recorded the least (18.83%) infestation of 11 treatments tried compared to 60 per cent infestation in control. Saw dust mulch provided proper aeration without moisture accumulation and the tubers did not rot.

Keywords: Mulches, *Phthorimaea operculella*, potato, storage

INTRODUCTION

The potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) is the most obnoxious pest both in field and storage (Chandla *et al.*, 2003). Potato tuber moth attacks the potato plant at 65 to 70 days after planting. The PTM serious pest on stored potatoes in Karnataka, India. Palacios and Cisneros (1996) from Peru where potato is a staple food for people found that it is possible to protect effectively potato from PTM by implementation of Integrated Pest Management (IPM) programme. In Peru, the PTM damage to potato was reduced to only 3.4% from 80% in fields due to the combined effect of deep planting, high hilling, frequent irrigation, pheromone traps, control measure at harvest, timely harvesting, storing healthy tubers, covering the tubers and destroying the harvest residues. The present

study was conducted to assess the effect of mulches on PTM.

MATERIALS AND METHODS

Experiments were laid out in godowns at Agricultural Research Station, Madenur, Hassan (12°45' to 13°57' N lat and 76°45' to 78 °24' E long 695 m AMSL) following Completely Randomized Design by heaping two hundred 'Kufri Jyothi' tubers per treatment. Care was taken to select healthy and uninfested tubers for treatments. Each potato heap was mulched and treated with 11 different treatments with a control heap (Table 1). Three replications per treatment were maintained and observations on number of tubers and loss of weight due to rot and PTM were recorded at fortnightly intervals. The per cent

tubers infested and per cent loss by weight were worked out. Field studies were conducted during *Kharif* 2005 and 2006. Data were subjected to ANOVA after square root transformation.

RESULTS AND DISCUSSION

Kufri Jyothi potato tubers did not rot upto 60 days in storage. Also none of the tubers showed rotting symptoms when exposed without mulch. Among the mulches tested, mulching tubers with sawdust and spraying fenvalerate @ 1ml/l recorded the least number of affected tubers and rotting (Tables 1 and 2). Sawdust facilitated proper aeration and prevention of accumulation of moisture. The sawdust mulch afforded good protection to tubers as it did not make the PTM to find suitable ovipositional sites and enter the tubers which is in conformation with the results of Das (1995) and Hussain *et al.* (1994). The potato tubers covered with gunny bag impregnated or sprayed with quinalphos 25 EC @ 2ml/l was the second best treatment in the present study. The good aeration provided by gunny bag and the barrier created by the gunny threads did not allow the PTM to damage the tubers and cause infestation. That is why the tubers loss due to PTM was less (6% to 19%) (Tables 1 and 2).

Mulching potato tubers with *Eupatorium* leaves and a spray with *B. thuringiensis* @ 1ml/l was the third best treatment. Because of the non-preference by adult moths due to odour on tubers, the PTM gravid moths did not accept the tubers for egg laying. So the number of PTM damaged tubers was less. But due to succulent nature, there will be more moisture at early stage and tubers harbored fungal growth resulting in rotting. Even the standard check *i.e.*, mulching the tubers with sand recorded 7.67 per cent rotted tubers. But the number of PTM affected tubers were 17.50 per cent (Das, 1995 and Hussain *et al.*, 1994). Because of the nature of sand, there could be chances of exposing the potato tubers which in turn harbored PTM. Also because of

hygroscopic nature of sand the heap absorbed moisture easily from external environment resulting in tuber rotting due to fungal infection. Kroschel *et al.* (1996) from Germany reported the combined effect of *Bt* and sand against PTM. Sand mulch proved good for maintaining the weight of tubers by lending cooling effect to the tubers. At the same time tubers absorbed moisture from surrounding conditions which led to rotting due to entry of fungal pathogens.

Data on the tuber weight loss under storage during 2005-2006 is presented in Tables 3 & 4, respectively. The weight loss ranged from 15.24 to 35.37 per cent in 11 different treatments compared to weight loss 30.42 per cent of tubers in control during 2005. In 2006, the weight loss of tubers was comparatively less. The loss in 11 different treatments varied from 4.65 to 11.62 per cent with 10.13 per cent under control. Sand mulch appear to have protective tuber from PTM infestation under storage recorded 15.24 per cent in 2005 and 9.73 per cent in 2006 (Tables 3&4). Other treatments varied considerably in effectively protecting the tubers from PTM infestation. For instance, Eucalyptus leaf mulch and neem powder recorded only 4.65 per cent loss in 2006. Whereas in 2005, the tubers with same treatment recorded 27.03 per cent tuber loss. So, Sand mulch and Saw dust mulch with Fenvalrate spray @1 ml/l of water also gave consistent results (Tables 3&4).

Mulching tubers with dry ragi straw was found to be the next best treatment after sand mulch because of good aeration. Hence, number of rotted tubers were low. But the number of PTM infested tubers were high compared to sand mulch, because there could be chance for entry of PTM into lot if the heap is not properly covered (Hussain *et al.*, 1994). Mulching tubers with potato haulms recorded 28.17 per cent tubers infested due to PTM and 3.84 tubers, rotted. With the haulms, there was no proper coverage of potato tubers, formation of gap in the mulch led to the PTM infestation. Mulching the tubers

Table 1. Effect of mulches and biopesticides on PTM under storage, 2005

Treatment	No. of rotted tubers/100 tubers					No. of PTM affected tubers/100 tubers					Loss of tubers (%)
	Days After Storage					Days After Storage					
	15	30	45	60	Total(%)	15	30	45	60	Total(%)	
Neem leaves mulch	3.67 (2.05)	0.67 (1.05)	0.33 (0.88)	0.00 (0.71)	4.67	2.33 (1.64)	10.00 (3.15)	24.33 (4.97)	20.00 (4.52)	56.66	61.33
Eucalyptus leaves mulch + neem powder @ 30 g/100 tubers	2.00 (1.56)	0.33 (0.88)	0.67 (1.00)	0.00 (0.71)	3.00	2.33 (1.57)	6.67 (2.58)	28.67 (5.39)	18.33 (4.32)	56.00	59.00
Potato haulms	2.00 (1.56)	0.67 (1.05)	0.67 (1.05)	0.00 (0.71)	3.34	1.00 (1.17)	8.33 (2.95)	27.33 (5.19)	10.67 (3.31)	47.33	50.67
Gunny bag sprayed with quinalphos @ 2ml / l	3.00 (1.73)	1.67 (1.39)	1.67 (1.39)	0.00 (0.71)	6.34	1.33 (1.27)	4.67 (2.26)	16.00 (3.94)	5.67 (2.45)	27.67	34.01
Eupatorium leaves mulch sprayed with <i>Bacillus thuringiensis</i> @ 1ml	2.00 (1.47)	0.67 (1.05)	1.33 (1.34)	0.00 (0.71)	4.00	1.33 (1.29)	4.33 (2.06)	12.33 (3.57)	9.00 (3.07)	26.99	30.99
Saw dust mulch with fenvalerate spray @ 1ml / l	6.33 (2.33)	1.33 (1.29)	0.00 (0.71)	0.00 (0.71)	7.66	3.33 (1.74)	5.33 (2.38)	10.00 (3.08)	2.00 (1.47)	20.66	28.32
Neem leaves mulch sprayed with nimbecidine @ 3 ml / l	0.33 (0.88)	0.33 (0.88)	0.00 (0.71)	0.00 (0.71)	0.66	3.33 (1.79)	5.33 (2.42)	32.00 (5.65)	13.33 (3.67)	53.99	54.65
Lantana leaves mulch	4.33 (2.10)	0.67 (1.05)	2.00 (1.47)	0.00 (0.71)	7.00	3.33 (1.93)	7.67 (2.84)	24.67 (5.02)	12.67 (3.61)	48.34	55.34
Eucalyptus leaves mulch	1.33 (1.27)	0.00 (0.71)	1.00 (1.10)	0.00 (0.71)	1.33	2.33 (1.65)	5.33 (2.40)	32.67 (5.73)	20.33 (4.56)	60.66	62.99
Ragi straw mulch	3.33 (1.94)	0.67 (1.05)	0.33 (0.88)	0.00 (0.71)	4.33	3.33 (1.79)	9.00 (3.01)	20.67 (4.55)	9.00 (3.07)	42.00	46.33
Sand mulch	2.33 (1.64)	1.00 (1.10)	1.33 (1.27)	0.00 (0.71)	4.66	2.67 (1.74)	3.67 (1.97)	23.33 (4.86)	4.00 (2.08)	33.67	38.33
Potato tubers (exposed)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00	3.00 (1.86)	23.33 (4.78)	57.33 (7.58)	16.33 (4.10)	99.99	99.99
S.Em+	0.38	0.22	0.25	0.00		0.38	0.41	0.47	0.28		
CD ($P=0.05$)	1.11	0.64	0.73	0.00		1.11	1.19	1.37	0.81		

Figures in parentheses are transformed values $\sqrt{X+0.5}$

Table 2. Effect of mulches and biopesticides on PTM under storage, 2006

Treatment	No. of rotted tubers/100 tubers					No. of PTM affected tubers/100 tubers					Loss of tubers (%)
	Days After Storage										
	15	30	45	60	Total(%)	15	30	45	60	Total(%)	
Neem leaves mulch	4.00 (2.10)	1.33 (1.29)	1.68 (1.46)	0.68 (1.00)	7.67	0.00 (0.71)	0.33 (0.88)	1.33 (1.27)	1.68 (1.46)	3.33	11.00
Eucalyptus leaves mulch + neem powder @ 30 g/100 tubers	3.00 (1.68)	1.00 (1.17)	1.33 (1.27)	0.00 (0.71)	5.33	0.33 (0.88)	1.68 (1.46)	0.68 (1.00)	0.67 (1.00)	3.34	8.67
Potato haulms	2.00 (1.43)	0.68 (1.05)	0.68 (1.00)	1.00 (1.10)	4.34	0.33 (0.88)	1.68 (1.35)	1.68 (1.46)	5.33 (2.29)	9.00	13.34
Gunny bag sprayed with quinalphos @ 2ml / l	1.00 (1.17)	0.00 (0.71)	2.00 (1.56)	1.67 (1.35)	4.67	0.00 (0.71)	0.67 (1.00)	0.00 (0.71)	4.00 (2.08)	4.67	9.34
Eupatorium leaves mulch sprayed with <i>Bacillus thuringiensis</i> @ 1ml	1.67 (1.39)	0.68 (1.00)	5.33 (2.33)	2.67 (1.76)	10.34	0.33 (0.88)	1.00 (1.17)	0.00 (0.71)	1.33 (1.34)	2.66	13.00
Potato tubers (exposed)	1.67 (1.39)	2.33 (1.68)	1.00 (1.10)	0.33 (0.88)	5.33	0.00 (0.71)	2.33 (1.64)	5.00 (2.12)	8.00 (2.83)	15.22	20.55
Saw dust mulch with fenvalerate spray @ 1ml / l	3.00 (1.81)	1.33 (1.29)	2.00 (1.43)	0.67 (1.00)	7.00	1.00 (1.17)	1.33 (1.27)	0.00 (0.71)	0.00 (0.71)	2.33	9.33
Neem leaves mulch sprayed with nimbecidine @ 3 ml / l	3.33 (1.94)	1.68 (1.44)	1.33 (1.34)	1.33 (1.29)	7.66	0.00 (0.71)	0.33 (0.88)	0.33 (0.88)	4.33 (2.11)	4.99	12.65
Lantana leaves mulch	1.33 (1.18)	1.33 (1.28)	2.33 (1.68)	2.00 (1.43)	6.89	0.00 (0.71)	1.33 (1.34)	0.33 (0.88)	1.67 (1.46)	3.33	10.22
Eucalyptus leaves mulch	2.33 (1.68)	0.68 (1.05)	3.00 (1.78)	3.67 (1.97)	9.67	0.00 (0.71)	0.33 (0.88)	0.68 (1.00)	1.00 (1.17)	2.00	11.67
Ragi straw mulch	3.33 (1.95)	1.33 (1.29)	1.33 (1.29)	0.67 (1.05)	6.66	0.00 (0.71)	0.00 (0.71)	1.68 (1.35)	0.67 (1.00)	2.34	9.00
Sand mulch	5.00 (2.28)	2.00 (1.43)	3.00 (1.81)	0.67 (1.00)	10.67	0.67 (1.00)	0.33 (0.88)	0.00 (0.71)	0.33 (0.88)	1.33	12.00
SEm±	0.35	0.27	0.32	0.31		0.14	0.23	0.29	0.31		
CD ($P=0.05$)	1.02	0.79	0.93	0.90		0.41	0.67	0.84	0.90		

Figures in parentheses are transformed values $\sqrt{X+0.5}$

Table 3. Effect of mulches and biopesticides on tuber weight loss under storage, 2005

Treatments	Loss of weight													Initial wt. of 100 tubers (Kg)	Total wt. loss (Kg)	Weight loss (%)
	Wt. of rotted tubers/100 tubers (g)		Wt. of PTM affected tubers/100 tubers (g)										Total wt. loss (Kg)			
	Days After Storage										Wt.(Kg)					
	15	30	45	60	Wt.(Kg)	15	30	45	60	Wt.(Kg)						
Green Neem leaves mulch	286.67 (14.76)	23.33 (4.20)	83.33 (8.92)	513.30 (21.79)	0.91	360.00 (17.33)	396.67 (19.55)	13.33 (2.59)	0.00 (0.71)	0.77	4.75 (2.29)	1.68	35.37			
Eucalyptus leaves mulch + neem powder @ 30 g/100 tubers	260.00 (13.03)	6.67 (1.98)	73.33 (6.15)	316.67 (17.47)	0.66	186.67 (13.64)	456.67 (21.31)	26.67 (3.46)	0.00 (0.71)	0.67	4.92 (2.32)	1.33	27.03			
Potato haulms	283.33 (15.26)	20.00 (3.91)	30.00 (4.67)	450.00 (21.14)	0.78	190.00 (13.62)	236.67 (15.20)	30.00 (4.73)	0.00 (0.71)	0.46	4.71 (2.28)	1.24	26.33			
Gunny bag sprayed with quinalphos @ 2ml / l	70.00 (7.07)	56.67 (6.38)	30.00 (4.67)	280.00 (16.37)	0.44	150.00 (10.74)	120.00 (10.89)	86.67 (7.85)	0.00 (0.71)	0.36	4.17 (2.16)	0.80	19.18			
Eupatorium leaves mulch sprayed L with <i>Bacillus thuringiensis</i> @ 1ml	283.33 (12.04)	20.00 (3.87)	46.67 (5.78)	236.67 (12.88)	0.59	88.33 (8.62)	183.33 (13.43)	93.33 (9.49)	0.00 (0.71)	0.37	5.17 (2.38)	0.96	18.57			
Saw dust mulch with fenvalerate spray @ 1ml / l	176.67 (12.93)	50.00 (6.03)	166.67 (12.19)	190.00 (13.17)	0.58	206.67 (13.21)	26.67 (4.45)	0.00 (0.71)	0.23	4.80 (2.30)	0.81	16.88				
Neem leaves mulch sprayed with nimbecidine @ 3 ml / l	6.67 (1.96)	16.67 (2.84)	163.33 (12.67)	190.00 (13.48)	0.38	176.67 (12.15)	330.00 (17.66)	0.00 (0.71)	0.51	5.06 (2.36)	0.89	17.59				
Lantana leaves mulch	113.33 (10.13)	30.00 (4.73)	160.00 (12.32)	290.00 (16.84)	0.59	196.67 (14.01)	416.67 (20.33)	86.6 7(7.71)	0.00 (0.71)	0.70	4.86 (2.32)	1.29	26.54			
Eucalyptus leaves mulch	93.33 (7.95)	0.00 (0.71)	43.33 (6.27)	276.67 (16.57)	0.41	153.33 (12.38)	550.00 (23.32)	40.00 (4.13)	0.00 (0.71)	0.74	4.42 (2.22)	1.15	26.02			
Ragi straw mulch	176.67 (12.81)	33.33 (5.72)	143.30 (11.84)	326.67 (17.67)	0.68	170.00 (12.02)	280.00 (16.66)	10.00 (2.31)	0.00 (0.71)	0.46	4.78 (2.30)	1.14	23.85			
Sand mulch	103.33 (9.48)	40.00 (4.13)	80.00 (8.20)	143.33 (11.26)	0.37	120.67 (11.27)	273.33 (14.77)	60.00 (6.41)	0.00 (0.71)	0.45	5.38 (2.43)	0.82	15.24			
Potato tubers (exposed)	66.67 (5.19)	10.00 (2.31)	76.67 (8.75)	716.67 (26.42)	0.87	313.33 (17.69)	343.33 (18.37)	0.00 (0.71)	0.66	5.03 (2.35)	1.53	30.42				
Sem±	4.53	2.02	2.27	3.06		2.93	2.34	2.38	0.00		0.05					
CD (<i>P</i> =0.05)	13.18	5.88	6.61	8.91		8.53	6.81	6.93	0.00		0.15					

Figures in parentheses are transformed values $\sqrt{X+0.5}$

Table 4. Effect of mulches and biopesticides on tuber weight loss under storage, 2006

Treatments	Loss of weight															Initial wt. of 100 tubers (Kg)	Total wt. loss of tubers (Kg)	Weight loss (%)	
	Wt. of rotted tubers/100 tubers (g)			Wt. of PTM affected tubers/100 tubers (g)			Days After Storage					Wt.(Kg)							
	Days After Storage																		
	15	30	45	60	Wt.(Kg)	15	30	45	60	Wt.(Kg)									
Green Neem leaves mulch	166.6 (12.47)	0.00 (0.71)	41.67 (6.42)	16.67 (2.44)	0.23	0.00 (0.71)	8.33 (2.16)	33.33 (4.88)	43.33 (6.58)	0.09	3.77 (1.98)	0.31	8.22						
Eucalyptus leaves mulch+ Neem powder @ 30 g/100 tubers	116.67 (8.38)	33.33 (4.98)	41.67 (6.42)	0.00 (0.71)	0.19	8.33 (2.16)	41.67 (6.42)	13.33 (2.59)	16.67 (2.84)	0.08	3.68 (1.91)	0.17	4.65						
Potato haulms mulch	8.33 (2.16)	8.33 (2.16)	16.67 (2.84)	8.33 (2.16)	0.04	8.33 (2.16)	45.00 (5.42)	38.33 (6.17)	131.60 (10.76)	0.22	3.63 (1.90)	0.26	7.16						
Gunny bag sprayed with quinalphos @ 2ml / l	8.33 (2.16)	41.67 (5.50)	25.00 (4.29)	41.67 (5.26)	0.12	0.00 (0.71)	23.33 (3.27)	0.00 (0.71)	101.67 (9.57)	0.13	3.55 (1.88)	0.24	6.76						
Eupatorium leaves mulch sprayed with <i>Bacillus thuringiensis</i> @ 1ml	36.67 (5.20)	25.00 (4.29)	233.30 (14.14)	66.67 (8.08)	0.36	8.33 (2.16)	18.33 (3.76)	0.00 (0.71)	38.33 (6.12)	0.07	3.70 (1.92)	0.43	11.62						
Saw dust mulch with fenvalerate spray @ 1ml / l	108.33 (9.80)	50.00 (7.11)	75.00 (6.64)	16.67 (2.84)	0.25	25.00 (4.29)	16.67 (3.60)	0.00 (0.71)	0.00 (0.71)	0.04	3.38 (1.83)	0.29	8.56						
Neem leaves mulch sprayed with nimbecidine @ 3 ml / l	100.0 (10.02)	33.33 (3.81)	33.33 (5.74)	33.33 (4.98)	0.20	0.00 (0.71)	8.33 (2.16)	10.00 (2.31)	158.33 (11.68)	0.18	3.55 (1.88)	0.38	10.70						
Lantana leaves mulch	50.00 (4.56)	8.33 (2.16)	66.67 (8.08)	75.00 (6.64)	0.00	0.20 (0.71)	33.33 (5.74)	10.00 (2.31)	50.00 (7.03)	0.09	3.44 (1.86)	0.29	8.43						
Eucalyptus leaves mulch	70.00 (8.30)	16.67 (3.60)	75.00 (8.14)	101.67 (9.58)	0.26	0.00 (0.71)	8.33 (2.16)	16.67 (2.84)	30.00 (4.67)	0.06	3.60 (1.90)	0.32	8.89						
Ragi straw mulch	100.00 (10.02)	8.33 (2.16)	33.33 (4.98)	16.67 (3.60)	0.16	0.00 (0.71)	0.00 (0.71)	50.00 (5.95)	20.00 (3.07)	0.07	3.85 (1.95)	0.19	4.94						
Sand mulch	150.00 (11.81)	133.33 (10.99)	91.67 (9.11)	16.67 (3.60)	0.39	10.00 (2.31)	8.33 (2.16)	0.00 (0.71)	8.33 (2.16)	0.027	3.39 (1.84)	0.33	9.73						
Potato tubers (exposed)	36.67 (9.74)	33.33 (5.74)	33.33 (3.81)	8.33 (2.16)	0.11	0.00 (0.71)	75.00 (8.14)	110.00 (8.81)	96.67 (9.28)	0.28	3.85 (1.96)	0.39	10.13						
Sem±	2.48	1.81	2.47	2.11		1.02	1.66	1.89	2.01		0.08								
CD ($P=0.05$)	7.22	5.27	7.19	6.14		2.97	4.83	5.50	5.85		0.23								

Figures in parentheses are transformed values $\sqrt{X+0.5}$

with Lantana leaves gave satisfactory control and was almost on par with the Eucalyptus and neem leaves mulch that was sprayed with nimbecidine @ 3 ml/ liter of water. Among the three mulches, mulching with Lantana leaves was encouraging, as the leaf texture did not permit the PTM moths to settle on the leaves. Reports of Islam *et al.* (1991), Kashyap *et al.* (1992) Das (1992), Pradhan (1987) and Anonymous (2001) recommended lantana mulching of potato tubers to protect tubers against PTM in warehouses or stores. Even the pungent odour might repel the adult PTM moths. However, with increase in time, the leaves became crinkled, brittle, fragile and powdered. Because of loss of moisture from leaves, the leaves dry and move down from the mulch and make tubers accessible to PTM for egg laying.

Many workers have recommended leaf mulching of tubers to get protection from PTM, because these leaves are locally and easily available and are eco-friendly (Wahundeniya, 1990, Kashyap *et al.*, 1992, and Kroschel and Koch 1996). However, use of neem and eucalyptus leaves have not been recommended as these impart odor to the stored tubers. All workers have recommended immense utility of leaf mulching to stored tubers as even in the present study exposed tubers recorded infestation up to 57.61 per cent due to PTM alone. In addition, some per cent tubers are loss due to rotting. Therefore, mulching of tubers with any sort of locally available plant leaves would be worthwhile.

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