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Management of late blight of potato by spraying botanical leachates and fungicides in southern dry zone of Karnataka

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Abstract
Late blight of potato caused by an oomycete *Phytophthora infestans* (Mont.) de Bary is the most destructive disease of potato in hills and plain regions of India. It is mainly managed through application of multiple fungicidal sprays which affecting both human health and environment. Hence, economic and environment friendly approach for the management of potato late blight is need to be explored. *Phytophthora infestans* causal organism multiplies very fast and management through botanicals alone may not be that much effective. Therefore, an integration of both chemical and botanical methods is very essential. With the objective of identification of suitable integrated management practices for the management of late blight of potato by spraying different botanical leachates, oils and chemical fungicides in southern dry zone of Karnataka. The following experiment was initiated at HRES, Hassan with fifteen different botanical and chemical treatments during *Kharif* season 2015-17. The pooled data of three years indicated that, out of fifteen different treatments Fenamidone + Mancozeb @ 3 g/l documented highest marketable tuber yield of 16.09 t/ha with lowest late blight disease index of 11.21 per cent followed by Cymoxanil + Mancozeb @ 3 g/l with 14.45 t/ha of marketable tuber yield and 19.01 per cent of light blight disease index. However, treatment with combination of Neem cake leachates @ 20 g/l + Mancozeb @ 2.5 g/l spray was also found effective for the management of late blight of potato with 13.66 t/ha of marketable tuber yield and 21.33 per cent of late blight disease index.

Keywords: Late blight, botanical leachates, fungicide and tuber yield

Introduction
Late blight of potato caused by an oomycete *Phytophthora infestans* (Mont.) de Bary is the most destructive disease of potato in hills and plain regions of India and caused yield losses up to 95 per cent in epidemic conditions (Lal *et al*., 2015) [6]. Late blight of potato is the major biotic constraint responsible for drastic reduction in yield and quality of the potato crop. An increasing severity of late blight in many potato growing areas, a shift in pathogen population towards increased specific virulence and an increasing tolerance to the most effective late blight specific fungicides suggests a need to develop an appropriate disease management strategy (Lal *et al*., 2017) [7]. Conventional control of late blight disease has mostly been tried by using synthetic fungicides, but repeated use of these chemicals has led to ecological hazards in addition to development of fungicide resistance in fungal pathogens. Globally, late blight is managed through application of multiple fungicidal chemical sprays affecting both human health and environment. Hence, economic and environment friendly approach for the effective management of potato late blight is need to be explored (Mirza *et al*., 2000) [8]. An use of different botanicals including neem *(Azadirachta indica* A. Juss) based preparations is innovative approach for the management of potato late blight. Keeping in view of the environment friendly nature, fungicidal properties and cheap availability of neem, its products were evaluated for their effectiveness against different growth stages of potato late blight pathogen *Phytophthora infestans.* Biological activity of the oil against *P. infestans* is probably because of this complex mixture of terpenoids like azadirchtin and its derivatives (Anonymous, 1991) [1]. But, *Phytophthora infestans* multiplies very fast under adverse weather conditions and management through botanicals alone may not be that much effective. Therefore, an integration of both chemical and botanical methods is very essential.

With the objective of identification of suitable integrated management practice for management of late blight of potato by spraying different botanical leachates, oils and

chemicals in southern dry zone of Karnataka. The following experiment was initiated at HRES Hassan using fifteen different botanical and chemical treatments during *Kharif* season of 2015-17.

Materials and Methods

An experiment was conducted under AICRP on potato centre at Horticultural Research and Extension Station, Somanahallikaval, Hassan district, Karnataka state for three consecutive years from 2015 to 2017 to identify suitable integrated management practice for management of late blight of potato by spraying different botanical leachates, oils and chemicals. An experiment was initiated on growing variety Kufri Jyoti which is popular among farmers of Hassan district but susceptible to late blight disease. An experiment was laid out by using RCBD with three replications. The land was well prepared and FYM @ 25 t/ha was incorporated into soil one week before sowing. The tuber sowing was taken up during the first week of in *Kharif* season of all three years by adopting scientific spacing of 60cm x 20cm. The recommended dosage of NPK 75:75:100 kg/ha was incorporated. From the recommended quantity of fertlilizer 50 per cent of nitrogen and full dose of phosphorous and potassium was applied at the time of sowing and remaining 50 per cent of nitrogen was supplemented after 30 days of sowing at earthing-up operation. Treatments containing different botanical formulations and chemicals were imposed as per the schedule and two more sprays were imposed depending upon the disease severity. During the cropping period package of practices of UHS, Bagalkot was followed during different stages of crop growth and harvesting was done at 90 days after sowing.

The treatment details were as follows

Treatment details

T1 : Pongamia cake leachates @ 10g/l
T2 : Pongamia cake leachates @ 15g/l
T3 : Pongamia cake leachates @ 20g/l
T4 : Neem cake leachates @ 10g/l
T5 : Neem cake leachates @ 15g/l
T6 : Neem cake leachates @ 20g/l
T7 : Pongamia cake leachates @ 10g/l + Mancozeb @ 2.5g/l
T8 : Neem cake leachates @ 20 g/l + Mancozeb @ 2.5g/l
T9 : Pongamia oil @ 20 ml/l
T10 : Neem oil @ 20 ml/l
T11 : Potassium phosphate @ 4 ml/l
T12 : Mancozeb @ 2.5 g/l
T13 : Mancozeb @ 3 g/l followed by cymoxanil + Mancozeb @ 3g/l and one more spray with Mancozeb @ 3g/l
T14 : Mancozeb @ 3 g/t followed by Fenamidone + Mancozeb @ 3 g/l and one more spray with Mancozeb @ 3g/l
T15 : Control (No fungicidal spray)

Botanical leachates preparation

Neem/pongamia botanical leachates treatments were prepared by soaking cakes of required quanitiy in water for overnight and next day extraction of liquid using funnel and later on make up to the required volume by adding water.

Disease scoring

The per cent late blight disease intensity was recorded at seven days intervals after first notice of disease. The yield of potato tubers of different treatments were documented along with the blighted tubers at harvest (90 days after sowing). The per cent late blight intensity was computed using the following formula and the values were statistically analysed.

$$\text{Late Blight Intensity (\%)} = \frac{\text{Sum of Individual Ratings}}{\text{Total No. of Plants}} \times \frac{100}{\text{Max. Scale}}$$

Malcomson scale

Per cent Area Infected (%)	Score
Trace of infection	9
10	8
11-25	7
26-40	6
41-60	5
61-70	4
71-80	3
81-90	2
Collapsed	1

Results and Discussion

The results of the present study clearly revealed that all the treatments are able to manage late blight disease to some extent as against un-sprayed control treatment in all three years (Table 1, 2 & 3). The pooled data of three years indicated that, out of fifteen different treatments evaluated, Fenamidone+Mancozeb @ 3 g/l documented highest marketable tuber yield of 16.09 t/ha with lowest late blight disease index of 11.21 per cent followed by Cymoxanil + Mancozeb @ 3 g/l with 14.45 t/ha of marketable tuber yield and 19.01 per cent of light blight disease index (Table 4). Similar results were also observed by Chakraborty and Banerjee (2016) [3]; Chakraborty and Mazumdar (2012) [2] who found that Fenamidone + Mancozeb @ 3g/l and Cymoxanil + Mancozeb @ 3g/l are effective chemicals for the management of late blight of potato respectively. Further, the findings found in the present study are in agreement with that of De and Sengupta (1991 and 1988) [5, 4] works, who observed that mancozeb and combined product of systemic and contact fungicide may have synergistic effect against *Phytophthora infestans*. The benefit cost ratio was also computed for all the treatments for three consecutive years, Fenamidone + Mancozeb @ 3 g/l and Cymoxanil + Mancozeb @ 3 g/l both treatments were found cost effective.

Treatment with combination of Neem cake leachates @ 20 g/l + Mancozeb @ 2.5 g/l spray also found effective for late blight management with 13.66 t/ha of marketable tuber yield and 21.33 per cent of late blight disease index. Neem has the ability to check growth and multiplication of *Phytophthora. infestans*, besides lab works on various products has also shown fungicidal properties against different life cycle stages of *Phytophthora infestans* under in-vitro conditions. (Mirza *et al*., 2000; Rashid *et al*., 2004) [8, 9]. *Pongamia pinnata* extracts also showed inhibitory effect on *Phytophthora infestans* under in-vitro and also shown inhibitory effect against large number of fungal plant pathogens (Rani *et al*., 2006) [10]. However, in the present study the treatments with only botanical leachates and oil used individually could not provide better control as compared to treatments involving leachates with chemical fungicides.

From the current study, it is concluded that Fenamidone + Mancozeb @ 3 g/l and Cymoxanil + Mancozeb @ 3 g/l both are found best fungicides when sprayed as prophylactic as well as curative measures for the management of late blight of potato. However, neem cake leachates @ 20 g/l + Mancozeb @ 2.5 g/l can also be used as alternative management practice

for the management of potato late blight disease during *Kharif* season in southern dry zone of Karnataka for getting higher yields with lower blighted tubers and is best suitable for bio-safety production of potato tubers.

Table 1: Per cent disease intensity (PDI) of late blight, marketable tuber yield and late blight affected tubers in potato as influenced by different botanicals and chemicals during *Kharif*-2015

Treatments	Disease build up at weekly intervals						Marketable tuber yield (t/ha)	Blighted tuber (t/ha)	B:C ratio
	1st week	2nd week	3rd week	4th week	5th week	6th week			
T1-Pongamia cake leachates @ 10g/l	18.52	25.93	29.63	33.33	40.74	41.85	7.56	0.91	-0.99
T2-Pongamia cake leachates @ 15g/l	14.81	18.52	18.52	22.22	38.88	40.15	8.14	0.67	1.06
T3-Pongamia cake leachates @ 20g/l	11.11	14.81	18.52	22.22	29.63	39.04	8.58	0.51	1.11
T4-Neem cake leachates @ 10g/l	18.52	25.93	29.63	29.63	33.33	40.44	9.94	0.67	1.30
T5-Neem cake leachates @ 15g/l	11.11	14.81	18.52	22.22	29.63	38.88	10.16	0.56	1.32
T 6-Neem cake leachates @ 20g/l	11.11	11.11	14.81	18.52	25.93	37.76	10.44	0.59	1.34
T7-Pongamia cake leachates @ 10g/l + Mancozeb @ 2.5g	7.41	11.11	11.11	18.52	22.22	29.63	12.65	0.58	1.46
T8-Neem cake leachates @20 g/l + Mancozeb @ 2.5g/l	7.41	11.11	11.11	14.81	20.22	25.93	13.79	0.41	1.57
T9-Pongamia oil @ 20 ml/lt	22.22	29.63	33.33	33.33	37.04	42.23	8.17	0.64	1.02
T10-Neem oil @ 20 ml/l	22.22	29.63	29.63	33.33	37.04	41.11	8.72	0.54	-0.93
T11- Potassium phosphate @ 4ml/l	7.41	11.11	11.11	14.81	18.52	33.33	11.14	0.49	1.37
T12-Mancozeb @ 2.5 g/l	18.52	22.22	25.93	29.63	37.04	32.23	11.60	0.57	1.39
T13-Cymoxanil + Mancozeb @ 3g/l	7.41	11.11	11.11	14.81	18.52	24.45	14.70	0.38	1.71
T14- Control	29.63	33.33	37.04	40.74	48.15	56.66	6.13	1.14	-0.86
S Em±	2.99	2.62	3.04	2.65	2.56	5.12	1.07	0.14	-
CD(p=0.05)	8.71	7.61	8.85	7.69	7.44	7.89	3.13	0.40	-
CV (%)	19.15	17.78	19.64	18.89	17.12	18.45	11.18	18.26	-

Table 2: Per cent disease intensity (PDI) of late blight, marketable tuber yield and late blight affected tubers in potato as influenced by different botanicals and chemicals during *Kharif*-2016

Treatments	Disease build up at weekly intervals (days)						Marketable tuber Yield (t/ha)	Late blight affected tubers (t/ha)	B:C ratio
	7 days	14 days	21 days	28 days	35 days	42 days			
T1-Pongamia cake leachates @10g/l	12.92	21.83	25.83	29.19	26.86	22.81	10.09	0.71	1.32
T2-Pongamia cake leachates @15g/l	10.56	19.17	24.99	28.89	24.64	21.94	10.25	0.56	1.34
T3-Pongamia cake leachates @20g/l	10.83	18.22	23.87	27.78	22.94	20.89	10.65	0.53	1.38
T4-Neem cake leachates @ 10g/l	11.11	20.55	22.21	26.66	21.39	18.11	10.71	0.39	1.40
T5-Neem cake leachates @ 15g/l	11.94	19.16	21.00	24.44	20.99	17.22	10.93	0.42	1.42
T 6-Neem cake leachates @ 20g/l	14.47	18.91	20.11	23.35	19.83	17.08	11.02	0.27	1.42
T7-Pongamia cake leachates @ 10g/l+ Mancozeb @ 2.5g	11.50	17.11	19.94	21.00	17.22	15.19	12.23	0.29	1.41
T8-Neem cake leachates @ 20 g/l+ Mancozeb @ 2.5g	12.77	16.67	18.80	19.19	16.88	14.36	13.22	0.26	1.50
T9-Pongamia oil @ 20 ml/l	13.33	23.05	24.44	28.89	24.58	21.28	10.45	0.88	1.30
T10-Neem oil @ 20 ml/l	13.88	21.55	23.60	27.76	23.50	20.72	10.81	0.62	1.16
T11- Potassium phosphate @ 4 ml/l	12.78	17.39	20.12	20.27	20.53	16.16	11.69	0.36	1.44
T12-Mancozeb @ 2.5 g/l	12.81	17.22	20.00	19.98	19.58	15.83	11.83	0.63	1.42
T13-Cymoxanil + Mancozeb @ 3 g/l	10.94	16.94	18.16	17.41	16.41	13.69	14.33	0.32	1.66
T14-Fenamidone + Mancozeb @ 3 g/l	11.94	14.44	16.67	14.75	12.86	9.83	15.56	0.24	1.63
T15-Control	13.22	31.94	40.97	43.36	46.75	49.19	6.67	1.05	-0.93
S Em±		1.02	3.31	1.00	0.97	0.98	0.79	0.08	-
CD(p=0.05)	NS	2.90	9.44	2.86	2.78	2.79	2.26	0.25	-
CV %		13.84	19.54	12.80	12.75	12.75	9.65	17.58	-

Table 3: Per cent disease intensity (PDI) of late blight, marketable tuber yield and late blight affected tubers in potato as influenced by different botanicals and chemicals during *Kharif*-2017

Treatments	Disease build up at weekly intervals						Marketable tuber yield (t/ha)	Blighted tubers (t/ha)	B:C ratio
	7 days	14 days	21 days	28 days	35 days	42 days			
T1 : Pongamia cake leachates @ 10g/l	15.55	36.66	42.96	54.44	48.88	42.22	8.50	1.68	1.11
T2 : Pongamia cake leachates @ 15g/l	13.70	31.10	39.99	54.44	46.66	39.99	10.13	1.62	1.32
T3 : Pongamia cake leachates @ 20g/l	17.77	29.62	38.88	53.33	45.55	38.88	10.75	1.57	1.39
T4 : Neem cake leachates @ 10g/l	16.66	31.10	39.99	52.22	47.81	40.36	9.80	1.68	1.28
T5 : Neem cake leachates @ 15g/l	12.59	28.14	39.62	52.22	45.55	37.77	10.06	1.64	1.30
T6 : Neem cake leachates @ 20g/l	15.55	28.14	38.88	51.11	45.18	37.77	10.28	1.58	1.32
T7-Pongamia cake leachates @ 10g/l + Mancozeb @ 2.5g	17.03	21.47	33.33	38.88	31.11	26.66	13.57	1.06	1.57
T8-Neem cake leachates @20 g/l +	13.70	20.36	31.11	37.03	29.25	23.70	14.59	1.05	1.66

Mancozeb @ 2.5g									
T9-Pongamia oil @ 20 ml/l	16.66	27.40	38.88	51.11	44.44	38.88	9.87	1.60	1.23
T10-Neem oil @ 20 ml/l	12.22	25.17	36.66	48.51	42.22	36.66	9.55	1.59	1.02
T11- Potassium phosphate @ 4 ml/l	15.55	22.27	32.22	46.66	39.99	32.96	11.76	1.58	1.44
T12-Mancozeb @ 2.5 g/l	15.55	21.47	29.99	42.22	32.22	27.77	13.62	1.50	1.63
T13-Cymoxanil + Mancozeb @ 3 g/l	11.11	18.51	27.77	32.59	29.99	18.88	14.84	1.02	1.72
T14- Fenamidone + Mancozeb @ 3 g/l	13.70	17.77	24.44	31.11	24.07	12.59	16.62	0.75	1.74
T15- Control	14.81	40.37	57.40	67.40	75.18	83.70	5.92	2.67	-0.83
S Em±	0.76	2.07	0.71	0.77	0.61	0.76	0.61	0.18	-
CD(p=0.05)	2.20	5.99	2.06	2.24	1.78	2.19	1.76	0.54	-
CV (%)	8.90	13.44	13.34	12.81	12.54	13.65	9.29	21.22	-

Table 4: Pooled data of management of late blight of potato using botanicals during 2015-2017

Treatments	Late Blight Disease Index (%)			Pooled	Marketable tuber yield (t/ha)			Pooled	Late blight affected tubers (t/ha)			Pooled
	2015	2016	2017		2015	2016	2017		2015	2016	2017	
T1 : Pongamiacake leachates @ 10g/l	41.85	22.81	42.22	35.63	7.56	10.09	8.50	8.72	0.91	0.71	1.68	1.10
T2 : Pongamia cake leachates @ 15g/l	40.15	21.94	39.99	34.03	8.14	10.25	10.13	9.51	0.67	0.56	1.62	0.95
T3 : Pongamiacake leachates @ 20g/l	39.04	20.89	38.88	32.94	8.58	10.65	10.75	9.99	0.51	0.53	1.57	0.87
T4 : Neem cake leachates @ 10g/l	40.44	18.11	40.36	32.97	9.94	10.71	9.80	10.15	0.67	0.39	1.68	0.91
T5 : Neem cake leachates @ 15g/l	38.88	17.22	37.77	31.29	10.16	10.93	10.06	10.38	0.56	0.42	1.64	0.87
T6 : Neem cake leachates @ 20g/l	37.76	17.08	37.77	30.87	10.44	11.02	10.28	10.58	0.59	0.27	1.58	0.81
T7-Pongamia cake leachates @ 10g/l +Mancozeb @ 2.5g	29.63	15.19	26.66	23.83	12.00	12.23	13.57	12.60	0.58	0.26	1.06	0.63
T8-Neem cake leachates @20 g/l + Mancozeb@ 2.5g	25.93	14.36	23.70	21.33	13.17	13.22	14.59	13.66	0.41	0.26	1.05	0.57
T9-Pongamia oil @ 20 ml/l	42.23	21.28	38.88	34.13	8.17	10.45	9.87	9.50	0.64	0.88	1.60	1.04
T10-Neem oil @ 20 ml/l	41.11	20.72	36.66	32.83	8.72	10.81	9.55	9.69	0.54	0.62	1.59	0.92
T11- Potassium phosphate @ 4ml/l	33.33	16.16	32.96	27.48	11.14	11.69	11.76	11.53	0.49	0.36	1.58	0.81
T12-Mancozeb @ 2.5 g/l	32.23	15.83	27.77	25.28	11.60	11.83	13.62	12.35	0.57	0.63	1.50	0.90
T13-Cymoxanil + Mancozeb @ 3 g/l	24.45	13.69	18.88	19.01	14.17	14.33	14.84	14.45	0.38	0.32	1.02	0.57
T14- Fenamidone + Mancozeb @ 3g/l	-	9.83	12.59	11.21	-	15.56	16.62	16.09	-	0.24	0.75	0.50
T15- Control	56.66	49.19	83.70	63.18	6.13	6.67	5.92	6.24	1.14	1.05	2.67	1.62
S Em±	5.12	0.98	0.76	2.92	1.07	0.79	0.61	0.39	0.14	0.08	0.18	0.11
CD (p=0.05)	14.89	2.79	2.19	8.45	3.13	2.26	1.76	1.14	0.40	0.25	0.54	0.31
CV (%)	23.85	12.75	13.65	16.62	11.18	9.65	9.29	6.17	18.26	17.58	21.22	19.03

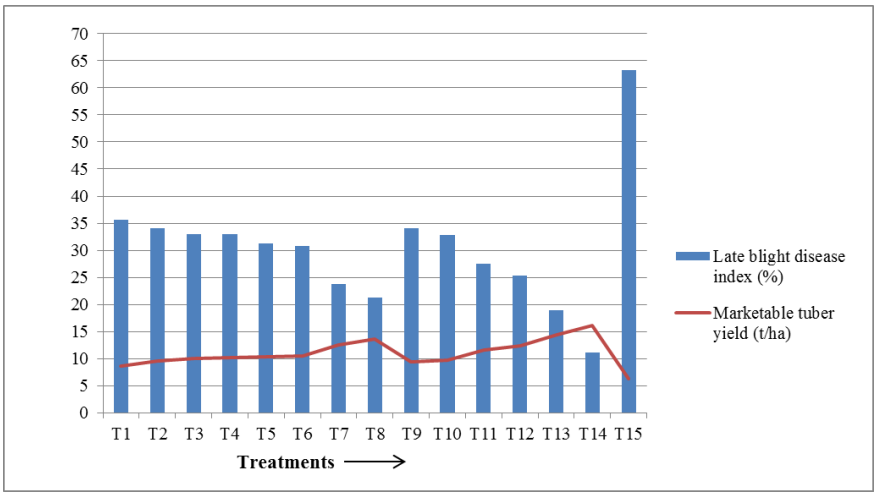

Fig 1: Per cent disease intensity (PDI) of late blight, marketable tuber yield of potato as influenced by different treatments

Plate 1: Crop view of experimental plots

Plate 2: Crop view and harvested tubers of best treatment with Fenamidone + Mancozeb @ 3 g/l

Plate 3: Crop view and harvested tubers of best treatment with Neem cake leachates @ 20 g/l + Mancozeb@ 2.5g/l

References

1. Anonymous. Chemical constitution of *Azadirchta indica* A. Juss (Neem) with particular reference to their therapeutic potential and pesticidal activity. Final Technical report (July 1989 to June, 1990). H. E. J. Research Institure of Chemistry, University of Karachi, 1991, 90.
2. Chakraborty A, Mazumdar D. Development of effective spray schedule for the management of late blight of potato in plains of West Bengal. Potato J. 2012; 39(1):92-94.
3. Chakraborty A, Banerjee H. Effective management strategies against late blight of potato. SAARC J Agri., 2016; 14(1):111-117.
4. De BK, Sengupta PC. Studies on spray schedule of fungicide against late blight disease of potato caused by Phytophthora infestans. Indian Agriculturist. 1988; 32:1-17.
5. De BK, Sengupta PC. Evaluation of fungicide against late blight disease of potato in plains of West Bengal. J Indian Potato Assoc. 1991; 18:176-177.
6. Lal M, Yadav S, Chand S, Kaushik SK, Singh BP, Sharma S. Evaluation of fungicides against late blight (*Phytophthora infestans*) on susceptible and moderately resistant potato cultivars. Indian Phytopathol. 2015; 68:345-347.
7. Lal M, Yadav S, Sharma S, Singh BP, Kaushik SK. Integrated management of late blight of potato. J App. Natural Sci. 2017; 9(3):1821 -1824.

8. Mirza JI, Hameed S, Ahmed I, Ayub N, Strang RHC. *In vitro* antifungal activity of neem products against *Phytophthora infestans*, Pakistan J Biol. Sci. 2000; 3(5):824-828.
9. Rashid A, Ahmad S, Iram J, Mirza JI, Rauf CA. Efficiency of different neem (*Azadirachta indica* A. Juss) product against various life stages of *Phytophthora infestans* (Mont.) de Bary, Pak. J Bot. 2004; 36(4):881-886.
10. Rani A, Bhat MN, Singh BP. Efficacy of neem formulations against late blight of potato in sub-tropical plains. Crop Res. 2006; 31:179-180.