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EVALUATION OF SOME IPM MODULES AGAINST RED ANT *DORYLUS ORIENTALIS* WESTWOOD IN POTATO

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ABSTRACT

Field experiments were conducted at Charaibahi village, Jorhat, Assam during 2015-17 to evaluate six ecofriendly IPM modules against red ants *Dorylus orientalis* Westwood in potato. Among the modules evaluated, Module-II (pre sowing treatment of mustard oil cake @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with neem oil @ 5 ml/ lit after 1st and 2nd earthing up (25 and 60 DAS) recorded the lowest tuber damage both in weight (8.65%) and number (10.70%) basis and found at par with the recommended package of practices (RPP) (application of malathion 5% dust @ 40 kg/ ha+ mustard oil cake @ 150 kg/ ha in the soil after 1st and 2nd earthing up) recording 8.18 and 10.20% tuber damage, respectively. The same module also recorded highest tuber yield (119.37 q/ ha) which was at par with the RPP (120.12 q/ ha). The maximum benefit cost ratio (1.41) was recorded in RPP followed by Module-II (1.33) and Module-VI (1.26). The untreated control plot registered a very high level of tuber damage (25.93 and 28.70 on weight and number basis, respectively) having maximum population of red ants (3.95 numbers/ m^2) with a tuber yield of 89.91 q/ ha.

Key words: *Dorylus orientalis*, IPM modules, incidence, tuber damage, panchagavya, neem oil, mustard oil cake, wood ash, malathion, soil drenching, earthing up, yield, cost benefit

Potato (*Solanum tuberosum* L.) is an important cash crop and a staple food item of Indian diet. India is the second largest producer of potato contributing to approximately12% of global production. As per the third advance estimate for 2018-19 (NHB), India produced 53.02 million tonnes of potatoes (Anon., 2018). Favourable subtropical climatic conditions of Assam also allows extensive potato cultivation both in the plains and hills with a production of 1072780 tonnes (Anon., 2017). Potato crop is attacked by many insect pests right from sowing of tubers to harvesting and storage causing potential yield loss. Among the various insect pests of potato, red ants *Dorylus orientalis* Westwood has long been considered as a major pest both in the plains and hills (Fletcher, 1914) causing extensive damage by making minute holes (2-3 mm diameter) to the underground tubers. Highest infestation is recorded at the time of harvesting which reduces tuber quality as well as market price makes them unfit for human consumption (Bhandari, 2011). In severe cases, the tuber infestation may reach up to 50-90% (Roonwal, 1976 and Chowdhury, 1997). Limited literature available regarding management practices for red ants and available literature is biased toward insecticide based treatments including some of them are banned in our neighbouring country like Sri Lanka (Fernando and Manickavasagar, 1958) and Assam (Anon., 1965; Rahman, 1967). Despite being a pest of potato, concerted efforts for the ecofriendly IPM measures of red ants is still in infancy. Moreover, the North Eastern region is also tagged as "Organic hub of India" and hence the adoption of chemocentric agriculture cannot be overlooked. Considering the above facts, field experiments were carried out to evaluate some IPM management modules against red ants in potato.

MATERIALS AND METHODS

The experiments were conducted in highly red ant endemic areas in the farmer's field of Charaibahi, Jorhat, Assam during 2015-17 to evaluate the effectiveness of six IPM modules in comparison with recommended package of practices and untreated control. The details of different modules are: i) Module-I: Pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%; ii) Module-II: Pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with neem oil @ 5 ml/ l after 1st and 2nd earthing up (25 and 60 DAS); iii) Module-III: Pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with jatropha oil @ 5 ml/

lit after 1st and 2nd earthing up (25 and 60 DAS); iv) Module-IV: Pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with pongamia oil @ 5 ml/ lit after 1st and 2nd earthing up (25 and 60 DAS); v) Module-V: Pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with castor oil @ 5 ml/ lit after 1st and 2nd earthing up (25 and 60 DAS); vi) Module-VI: Pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with sesamum oil @ 5 ml/ lit after 1st and 2nd earthing up (25 and 60 DAS); vii) RPP: Application of malathion 5% dust @ 40 kg/ ha+ mustard oil cake @ 150 kg/ ha in the soil after 1st and 2nd earthing up (25 and 60 DAS); and viii) Untreated control. The potato crop (variety: Kufri Jyoti) was grown by following all the recommended package and practices of Assam. The experiment was conducted in randomized block design with 3 replications with plot size of 4x 3 m^2. The efficacy of each module was assessed on the basis of tuber damage (weight and number basis), number of red ants/ m^2 at the time of harvest (30 cm depth of soil) and tuber yield (q/ ha). The cost benefit ratio was also computed from the total expenditure and net return. The data on tuber damage (weight and number basis) were subjected to angular transformation and data on number of red ants/ m^2 and tuber yield were analysed by ANOVA (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The effect of IPM modules evaluated against *D. orientalis* based on tuber damage (weight and number basis), red ant incidence, tuber yield and benefit cost ratio are presented in Table 1. Experimental results revealed that all the evaluated modules were statistically superior over untreated control. Among the IPM modules, Module-II (pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with neem oil @ 5 ml/ l after 1st and 2nd earthing up (25 and 60 DAS) led to the least tuber damage on weight basis (8.65%) and this treatment was at par with RPP (8.18%). The next best treatment was Module-VI (pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with sesamum oil @ 5 ml/ l after 1st and 2nd earthing up (25 and 60 DAS) recording 12.38% on weight basis followed by Module-III (pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with jatropha oil @ 5 ml/ l after 1st and 2nd earthing up (25 and 60 DAS) (14.79%) and Module-IV (pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with pongamia oil @ 5 ml/ l after 1st and 2nd earthing up (25 and 60 DAS) (16.92%). Module-V (pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with castor oil @ 5 ml/ l after 1st and 2nd earthing up (25 & 60 DAS) recorded 18.43% and Module-I (pre sowing treatment of MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%) registered 20.65% tuber damage on weight basis, respectively. The maximum tuber damage on weight basis was observed in untreated control (25.93%).

When tuber damage was assessed on number basis, the % infestation followed the same trend as observed in weight basis. Module-II led to the least values (10.70%) which was found to be at par with RPP (10.20%). The plot treated with Module-VI recorded 14.60% tuber damage followed by Module-III (16.89%). Module-IV (18.63%), Module-V (21.16%) and Module-I (23.57%) registered tuber damage. The untreated control plots recorded 28.70% tuber damage. As regards to tuber yield, maximum yield was obtained from Module-II (119.37 q/ ha) and was found to be at par with RPP (120.12 q/ ha). This treatment was followed by Module-VI (114.67 q/ ha), Module-III (111.41 q/ ha) and Module-IV (108.24 q/ ha). Module-V registered tuber yield of 105.83 q/ ha and Module-I (94.91 q/ ha), respectively. The tuber yield recorded in untreated control plots was 89.91 q/ ha. While considering the red ant incidence in different treatments, it was found to range from 2.37 to 3.95 at the time of harvesting. However, among all the six IPM modules evaluated, least number of ants/ m^2 was with Module-II (2.47). The highest B: C ratio (1.41) was recorded in RPP followed by Module-II (1.33) and Module-VI (1.26), respectively.

The present findings are in agreement with Borah (1994) who in potato fields at Diphu, Assam during 1992-94 found that soil drenching with malathion 50EC @ 0.1% was very effective in reducing infestation caused by *D. orientalis*. Application of chlorpyriphos 20EC @ 5ml/ l of water thrice around the root zone starting from 45 days after sowing at 10 days interval registered the least tuber infestation (17.28 and 10.68% reduction) with (62.77 and 56.60% reduction) closely followed by 3 times application of carbaryl 85 WP @ 3 gm/ l of water (20.14 and 13.73% reduction) with (85.77 and 81.71% reduction) (Dash et al., 2013). Bhattacharyya et al. (2014) also observed that soil drenching with chlorpyriphos 20EC @ 0.06% was

Table 1. Efficacy of ecofriendly IPM modules against red ant *D. orientalis* in potato (2015-17)

Modules	Pre-sowing treatment	Soil drenching	Tuber damage (%) on weight basis	Tuber damage (%) on number basis	Tuber yield (q/ ha)	Ant counts No./ m^2	BCR
Module-I	MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%	-	20.65 (27.02)	23.57 (29.04)	94.91	3.36	1.04
Module-II	MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%	Soil drenching with neem oil @ 5 ml/ lit after 1st & 2nd earthing up (25 & 60 DAS)	8.65 (17.05)	10.70 (19.06)	119.37	2.47	1.33
Module-III	MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%	Soil drenching with jatropha oil @ 5 ml/ lit after 1st & 2nd earthing up (25 & 60 DAS)	14.79 (22.59)	16.89 (24.24)	111.41	2.70	1.22
Module-IV	MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%	Soil drenching with pongamia oil @ 5 ml/ lit after 1st & 2nd earthing up (25 & 60 DAS)	16.92 (24.27)	18.63 (25.54)	108.24	2.82	1.18
Module-V	MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%	Soil drenching with castor oil @ 5 ml/ lit after 1st & 2nd earthing up (25 & 60 DAS)	18.43 (25.41)	21.16 (27.36)	105.83	3.07	1.16
Module-VI	MOC @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3%	Soil drenching with sesamum oil @ 5 ml/ lit after 1st & 2nd earthing up (25 & 60 DAS)	12.38 (20.56)	14.60 (22.44)	114.67	2.60	1.26
RPP	Malathion 5% dust @ 40 kg/ ha+ mustard oil cake @ 150 kg/ ha in the soil after 1st & 2nd earthing up (25 & 60 DAS)		8.18 (16.55)	10.20 (18.58)	120.12	2.37	1.41
Control	-		25.93 (30.60)	28.70 (32.39)	89.91	3.95	-
S.Ed (±)			0.24	0.30	0.43	-	-
CD (p=0.05)			0.52	0.66	0.93	-	-

*RPP- Recommended package of practices.\; Figures in parentheses angular transformed values

found to be the best with least tuber damage (6.81 and 7.28% on weight and number basis) and maximum tuber yield (123.38 q/ ha) followed by the application of banana trap @ 350-400 numbers/ ha mixed with malathion 5% dust recording 8.68 and 8.94% tuber damage on weight and number basis, respectively; this gave a tuber yield of 119.33 q/ ha. Saikia and Debnath (2017) reported that combined application of malathion 5% dust @ 40 kg/ ha and MOC @ 150 kg/ ha followed by chlorpyriphos 20 EC @ 5 ml/ l and carbofuran 3 G @ 25 kg/ ha were the best in Cachar district, Assam.

The present study brings out the very good efficacy of panchagavya, for the organic cultivation, as it has been invariably included in all the modules evaluated herein. The efficacy might be due to the fact that it acts as potential biopesticide and bioenhancer as reported earlier (Pathak and Ram, 2013; Golakiya et al., 2019). Panchagavya being a mixed culture of naturally occurring, beneficial microbes mostly lactic acid bacteria (*Lactobacillus*), yeast (*Saccharomyces*), actinomyces (*Streptomyces*), photosynthetic bacteria (*Rhodopseudomonas*) and certain fungi (*Aspergillus*) promoted the growth and yield of different crops and registered higher B:C ratio (Shailaja et al., 2014). Boomiraj et al. (2004) reported that panchagavya was effective against leafhopper (*Amrasca biguttula biguttula*) and whitefly (*Bemisia tabaci*) in okra. Panchagavya+ Neem Seed Kernel Extract (NSKE) proved as best in managing *Spodoptera litura* larvae followed by panchagavya+ *Vitex nigundo* and calotropis in groundnut and soybean (Bharathi, 2005). Neelakanth (2006) noted that panchagavya+ cow urine in combination with NSKE proved next best over spinosad in controlling *Plutella xylostella* in cabbage. While studying the effect of panchagavya against 9 insect pests in teak, Kumar et al. (2015) recorded that 7 and 5% diluted panchagavya application was found to be more effective.

The superiority of neem oil in reducing various soil insect pests is known- Nwilene et al. (2008) observed that neem seed oil can be effective control against termites on rice fields and can also be used as alternatives to persistent pesticides. Similarly, Devi and Mohandas (1982) and Pereira and Wohlgemuth (1983) reported that neem oil at 1% and 0.8% applied on red gram and cowpea respectively, acted as a good protectant against *Callosobruchus chinensis*. Ali et al. (1983) observed that neem oil @ 0.5% on gram seed as most effective against *C. chinensis*. Verma et al. (1983) found oil and cakes of neem, castor and mustard to be effective in reducing the fecundity, egg hatching and adult emergence in *Sitotroga cerealella*. Kumari et al. (1990) reported that neem oil at 1% as the highly effective against *C. chinensis*. In all the tested management modules against *D. orientalis*, two important components *viz*., mustard oil cake and wood ash were also included which might have contributed in reducing the infestation. The efficacy of the mustard oil cake may be attributed to essential oils that acts as repellent against *Agrotis ipsilon* (Isman et al., 2000). The results clearly indicate that among the modules evaluated, Module-II (pre sowing treatment of mustard oil cake @ 150 kg/ ha+ wood ash 150 kg/ ha+ panchagavya @ 3% and soil drenching with neem oil @ 5 ml/ lit after 1st and 2nd earthing up (25 and 60 DAS) led to the least tuber damage both in weight and number basis. The tuber yield and benefit cost ratio were also more. Therefore, Module-II may be recommended for application against the *D. orientalis* infestation in potato.

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