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Research Article

BIORATIONAL MANAGEMENT OF RED ANT *(DORYLUS ORIENTALIS* WESTWOOD) OF POTATO IN TAPLEJUNG, NEPAL

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ABSTRACT

Red ant (*Dorylus orientalis* Westwood) has long been known as an important pest of potato in middle hills of Nepal. Several management approaches against this pest were studied in Fungling VDC-4 of Taplejung district in 2012. Field efficacy of botanicals (*Artemisa, Eupatorium, Agave, Justicia,* and *Azadirachta*) @ 1.44 kg/plot and chemical chlorpyrifos (pyrifos 20 EC @ 2 ml/litre of water) as treatments with four replications were tested using the susceptible variety, Kufri Jyoti. The application of agave was effective to reduce the damage by 42.93 ± 1.20% as compared to control i.e. 68.39±0.62%. Among all the treatments, the application of chemical insecticide, chlorpyrifos gave lower mean yield damage than the control plot. These findings can be verified and applied for the management of red ant of potato under farmers' field condition.

Key words: *Dorylus orientalis,* Biorational management, Chloropyrifos, RCBD

INTRODUCTION

Potato is grown in more than 125 countries of the world. The survival of hundreds of millions of people in the developing countries depends on the potato today. China with its 70 million tons per year is the biggest potato producer worldwide (IYP, 2008). Potatoes are well known for being nutritious. They are rich in carbohydrates, protein and vitamin C, making them a good source of energy. Therefore, potatoes can be an important factor in improving the health of rural populations in developing countries (IYP, 2008). The year 2008 was declared the International Year of the Potato by the United Nations, noting that the potato is a staple food in the diet of the world's population, and affirming the need to focus world attention on the role that the potato can play in providing food security and eradicating poverty.

Productivity of potato in Nepal is low (13.12 mt/ha) as compared to other producing countries, such as, New Zealand (50.2 mt/ha) (IYP, 2008). Damage due to insect pest is the

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major constraints of low productivity. More than 40 insect species have been found to be associated with potato crops in Nepal (NPRP, 2008). Of them, the red ant (*Dorylus orientalis* Westwood) is major pest of potato in the mid hills of Nepal (GC *et al.*, 1997). It is estimated that pests cause a loss of 15-20% in food production (Baker and Gyawali, 1994; Neupane, 2000). As the damage of *D. orientalis* is emerging as a threat for the success of potato crop, effective management strategy of this pest is essential.

In Nepal, as in other developing countries, the use of pesticides has increased during the last decades to a worrying level leading yield reduction due to resistance, resurgence and secondary pest outbreaks (Baker and Gyawali, 1994). Farmers depend on heavy use and misuse of chemical pesticides to control pests of the major crops (Thapa, 2003), which creates many problems, such as soil degradation, water pollution and human health hazards. Majority of the farmers use highly toxic chemical pesticides on vegetable crops. However in Nepal, the use of active ingredients (a.i.) as compared to other Asian countries on the per hectare basis is quite low (396 g/ha) (PPD, 2015). But lately, overuse and misuse of pesticides is observed in some of commercial crops. The consumption of pesticides in commercial farming of vegetables in Nepal is 1400 g/ha. (Sharma, 1994; Thapa, 1994; Thapa, 1999).

IPM in Nepal has been official policy of crop protection to achieve sustainable agricultural development, which has been reflected in FAO manual (FAO, 2008). The agriculture perspective plan (APP, 1995) has also highlighted on the need of IPM and has emphasized in the rapid dissemination of its techniques among the farmers as a primary plant protection measure. In such condition, biorational measures of pest management are very useful to suppress pests and reduce waiting period to harvest and market fresh vegetables. Such eco-friendly measures rather are safe to non-target organisms, such as biological control agents, human health and the environment as a whole.

Hence, this is an attempt to use bio-pesticides and compatible insecticides to control red ant. Because of its biodegradable nature after application, capacity to alter the behavior of target pests and favourable safety profile, it is hoped that plant-based pesticides play a significant role in achieving evergreen revolution. At the same time, the technology contributes increased crop production and productivity by reducing the insect pest damages. So this study considers biorational management of red ant under farmer's field condition. This paper presents the information on efficacy of local materials for integrated management of red ant evaluated during 2012 in Taplejung. Such result will be helpful for development of eco-friendly management option of red ant of potato.

MATERIALS AND METHODS

The research attempts to use bio-pesticides and compatible insecticides to control red ant. The botanical materials obtained in the farming communities, like Indian wormwood (*Artemisia indica* Willd*)*, Agave (*Agave americana* L.), Malabar nut tree (*Justicia adhatoda* L.), Neem (*Azadirachta indica* A. Juss*)* and Crofton weed (*Eupatorium adenophorum* Spreng*)* are used against red ants. Botanical pesticides are simple to use, cheap and more readily available.

Study site

The research was also conducted at farmer's field of Fungling VDC of Taplejung district. It was one of the highest production sites of potato in Taplejung district. DADO Taplejung in 2011 reported that the area was being infested by noxious soil inhabiting insect pest and farmers regarded that red ant was number one pest. The climatic and edaphic factors were quite congenial for potato cultivation. The altitude, longitude and latitude of research site are; 1725 m, 27^{o} 21'26" N and 87^{o} 39' 94" E, respectively.

Experimental design

The experiment was laid out in Randomized Complete Block Design (RCBD) with seven treatments and four replications. The total experimental area was 192.7 m^2 (21.3 X 9 m) with spacing between replications and plots 1 m and 0.5 m, respectively. There were 28 experimental plots having geometry of 2.4 m X 1m.

Selection of treatments

Four locally available botanicals (*Artemisia indica* Willd; *Eupatorium adenophorum* Spreng; *Agave americana* L. and *Justicia adhatoda* L.) as treatments were collected from nearyby jungle, while *Azadirachta indica* A. Juss was collected from Chitwan district. They were placed in furrow 5 days before planting at the time of land preparation. Chemical treatment chlorpyrifos (Pyrifos 20 % EC @ 0.04%) was drenched in the soil near plant @ 100 ml per plant. The first spray was done when crop was 30 days old and subsequent sprays at 15 days interval for 4 times.

Planting

Kufri Jyoti was the most susceptible to ant, which was selected as a test crop brought from Temperate Horticulture Nursery Centre, Daman, Makawanpur. The tuber was planted in the furrow ridge up at the distance of 60 cm row to row and 20 cm plant to plant. Uniform size of tubers weighing 30-50 g was planted in February 2, 2012.

Table 1. Treatment details for biorational management of red ant in Taplejung, 2012

S.N.	Treatment	Application rate
1.	T1: *Ar. indica*	1.44 kg/plot (2.4m^2)
2.	T2: *E.adenophorum*	1.44 kg/plot (2.4 m^2)
3.	T3: *A. americana*	1.44 kg/plot (2.4 m^2)
4.	T4: *J. adhatoda*	1.44 kg/plot (2.4 m^2)
5.	T5: *A. indica*	1.44 kg/plot (2.4 m^2)
6.	T6: Chlorpyrifos, (Pyrifos 20 % EC)	2 ml/l water (0.4%)
7.	Control	-

Data collection and analysis

Vegetative and yield parameters were measured during the experimental period. Plant height, leaf numbers were taken as vegetative parameters. The observations were taken at 15 days interval, i.e. at 45, 60, 75 and 90 days after planting. Whereas total yield/plot, tuber number/plot, marketable and non-marketable yield/plot, skin tuber preference to red ant, intact, slight damage and spoiled yield of tuber were taken as yield attributing parameters at harvest. Tubers were categorized as mentioned in Table 2.

Table 2. Tuber categorization criteria of Potato

Type	Tuber category	Definition
Tuber Damage	Intact (a)	Clear tuber without any damage by ant
	Slight damage (b)	Tubers having one or two shallow holes
	Spoiled (c)	Tubers having more than two deep holes
TuberYield	Marketable yield (a+b)	Intact yield + Slight damage yield
	Non-marketable yield (c)	Spoiled yield
Tuber Size	Small tubers	< 10 mm diameter
	Medium tubers	10-20 mm diameter
	Large tubers	>20 mm diameter

Source: Joshi (1998)

Six randomly selected plants were taken from each experimental plot for recording of vegetative and yield attributing parameters. Statistical computer software namely Microsoft Excel and MSTAT-C were used for the analysis of different parameters collected during the experiment. Means were compared using Duncan's multiple range test (DMRT) at 5% level of significance. The graphs were prepared using Microsoft Excel.

RESULT AND DISCUSSION

Effects of different treatments on the tuber yield and quality damaged by *D. orientalis*

The response of treatments in the mean tuber yield and tuber damage by the pest is presented in Table 3. There was highly significant variation in total mean tuber yield per plot among the treatments. The maximum mean tuber yield (11.85 ± 0.27 kg/plot) and the minimum mean tuber yield (6.87 ± 0.26 kg/plot) was obtained from Chlorpyrifos treated plot and from the control plot, respectively. The tuber damages per plot the lowest (25.95 ± 1.12%) in Chlorpyriphos treated plot, which significantly differed from control (68.39 ± 0.6%). Among botanicals, application of *Agave* leaves showed good response against red ant and the rest other botanicals did not show encouraging results in terms of damage reduction.

Table 3. Mean (mean ± SE) tuber yield and tuber damage caused by *D. orientalis* in Fungling VDC of Taplejung, 2012

Treatment	Tuber yield (kg/plot)	Tuber damage (kg/plot)	Damage (%)
Ar. indica	8.37 ± 0.34^{c} (2.89)	5.26 ± 0.25^{a} (2.29)	62.76 ± 0.95^{b} (0.67)
E. adenophorum	8.45 ± 0.15^{c} (2.90)	5.34 ± 0.19^{a} (2.30)	63.22 ± 1.94^{b} (0.68)
A. americana	9.63 ± 0.12^{b} (3.10)	4.13 ± 0.13^{b} (2.03)	42.93 ± 1.20^{c} (0.44)
J. adhatoda	7.95 ± 0.38^{c} (2.81)	5.12 ± 0.28^{a} (2.25)	64.39 ± 1.56^{b} (0.70)
Az. indica	8.07 ± 0.39^{c} (2.83)	5.09 ± 0.27^{a} (2.25)	63.11 ± 1.92^{b} (0.68)
Chlorpyrifos	11.85 ± 0.27^{a} (3.44)	3.07 ± 0.11^{c} (1.75)	25.95 ± 1.12^{d} (0.26)
Control	6.87 ± 0.26^{d} (2.62)	4.69 ± .142^{ab} (2.165)	68.39 ± 0.62^{a} (0.75)
LSD	0.7413 (0.1329)	3.822	0.5942
CV	5.71% (2.99%)	8.56%	4.61 % (5.16%)
P-value	**	**	**

CV= Coefficient of variation, LSD =Least Significant Difference, NS =Non-Significant, Value with same letters in a column are not significantly different at ά = 5% by DMRT, figures before ± indicate treatment means and figures after ± indicate standard error

The figures in parentheses are square root transformations.

The figures in parentheses of damage percent column are arc data transformed values

The response of treatments on marketable yield of potato

The research revealed that there was highly significant variation among treatments (Table 4). Though all botanical treatments distinctly differed from the control, *Agave* @ 1.44 kg/plot) was the best among botanicals, which resulted higher marketable tubers after chlorpyrifos application @ 0.04 %. The highest mean marketable yield (10.36 ± 0.17 kg/plot) was harvested from chlorpyrifos treated plots and the lowest mean yield (5.37 ± 0.21 kg/plot) from control plots. Mean marketable tuber yield (8 ± 0.11 kg/plot) from *Agave* treated plot was significantly higher than that of control. The mean yield obtained from

Artemisia, Eupatorium, Justicia and *Azadirachta* treated plots were also statistically significant from the control. Similarly, non-marketable tuber yield was also significantly different from the control.

Table 4. Marketable and non-markatable tuber yield (mean ± SE) of potato in Fungling VDC of Taplejung, 2012

Treatment	Marketable (kg/plot)	Non- marketable (kg/plot)
Ar. indica	6.63 ± 0.25[c] (2.57)	1.73 ± 0.10[bc] (1.32)
E. adenophorum	6.64 ± 0.11[c] (2.58)	1.80 ± 0.03[b] (1.34)
A. americana	8.00 ± 0. 11[b] (2.83)	1.63 ± 0.04[bc] (1.27)
J. adhatoda	6.41 ± 0.30[c] (2.53)	1.53 ± 0.08[bc] (1.23)
Az. indica	6.49 ± 0.33[c] (2.55)	1.58 ± 0. 06[bc] (1.25)
Chlorpyrifos @0.04 % EC	10.36 ± 0.17[a] (2.33)	1.48 ± 0.11[c] (1.29)
Control	5.37 ± 0.21[d] (3.22)	3.44 ± 0.18[a] (1.82)
LSD	0.1151	0.2699
CV	5.52% (2.92) %	9.63% (4.43) %
P-value	**	**

CV= Coefficient of variation, LSD =Least Significant Difference, NS =Non-Significant, Value with same letters in a column are not significantly different at ά = 5% by DMRT, figures before ± indicate treatment means and figures after ± indicate standard error

The figures in parentheses are square root transformations

The effects of treatments on quality yield of tuber

The effects of treatments were significantly different from control in terms of intact, slight damage and spoiled yield of potato (Table 5). The plot treated with chlorpyrifos gave the highest mean intact yield (8.78 ±0.28 kg/plot) followed by *Agave* (5.50 ± 0.129 kg/plot), which was also significantly higher than the control plot (2.18±0.128 kg/plot). On the other hand, the control plot gave minimum slight damage (1.25 ± 0.286 kg/plot) but maximum spoiled (3.45 ±0.186 kg/plot) tuber yield as compared to other tested varieties, which were significantly different among them.

Table 5. Tuber damage catagory wise tuber yield (mean ± SE) of potato in Fungling VDC of Taplejung, 2012

Treatment	Tuber yield kg/plot (2.4 m^2)		
	Intact (kg/plot)	Slight damage (kg/plot)	Spoiled (kg/plot)
Ar. indica	3.11 ± 0.125[c] (1.77)	3.52 ± 0.193[a] (1.87)	1.74 ± 0.104[bc] (1.31)
E. adenophorum	3.10 ± 0.175[c] (1.76)	3.54 ± 0.163[a] (1.88)	1.80 ± 0.039[b] (1.34)
A. americana	5.50 ± 0.129[b] (2.34)	2.50 ± 0.161[b] (1.58)	1.63 ± 0.043[bc] (1.27)
J. adhatoda	2.83 ± 0.188[c] (1.68)	3.58 ± 0.210[a] (1.89)	1.54 ± 0.084[bc] (1.23)

Treatment	Tuber yield kg/plot (2.4 m^2)		
	Intact (kg/plot)	**Slight damage (kg/plot)**	**Spoiled (kg/plot)**
Az. indica	2.98 ± 0.239^c (1.72)	3.51 ± 0.243^a (1.86)	1.58 ± 0.059 ^{bc} (1.25)
Chlorpyrifos	8.78 ± 0.288^a (2.96)	1.59 ± 0.171^c (1.25)	1.49 ± 0.111^c (1.22)
Control	2.18 ± 0.128^d (1.47)	1.25 ± 0.286^c (1.08)	3.45 ± 0.186^a (1.85)
LSD	0.1151	0.6509	0.2699
CV	8.19%	15.75%	9.63%
P-Value	**	**	**

CV= Coefficient of variation, LSD =Least Significant Difference, NS =Non-Significant, Value with same letters in a column are not significantly different at ά = 5% by DMRT, figures before ± indicate treatment means and figures after ± indicate standard error

The figures in parentheses are square root transformations

Among all botanical treatments, *Agave* was found superior in terms of marketable yield (8.00 ± 0.11 kg/plot).which is equivalent to 32.79 mt/ha and extent of damage (42.93 ± 1.20%) which is least in comparison to other treatment. Similar result was observed by Bandari (2010) and he reported that more than nine times tuber yield damage (3.13 mt/ha) was in control field as compared to *Agave* treated field (0.31 mt/ha) in Dhading. He reported maximum marketable tuber yield from field treated with *Agave* and the lowest from control field. Similarly, Duwadi *et al.* (1993) reported soil treatment with 1 kg of boketimur (*Zanthazylum alatum* Roxb.) powder and 0.5 kg of siltimur (*Lindera neesiana* Benth.) powder in 6 m^2 plots and soil covered by polythene sheet for 4 days prior to cauliflower planting checked red ant population effectively.

Red ant damaged large numbers of tubers having large size (>20 mm) than medium (10-20 mm) and small size (<10 mm) tubers. This is because of more surface area occupied by the larger size tubers that may provide a good micro habitat for resting red ant. In addition to this, there was great extent of tubers damage was found in botanicals treated plot and in control plot as compared to chlorpyrifos treated plot, which is due to high toxicity and long persistency nature of insecticide.

CONCLUSION

The pest under study was found in all potato growing areas of Fungling VDC. It can reach the new potato pockets since the farmers are not familiar with this insect and the insect itself is migratory in nature. Some botanical pesticides (*Artemisia indica* Willd; *Eupatorium adenophorum* Spreng; *Agave americana* L. and *Justicia adhatoda* L.) which are effective in managing this pest, can be suggested as eco-friendly management technique in integrated management of the pest. The result of investigation may not be representative of the whole nation, so intensive work in this line is essential and at most to check this devastating pest to migrate to the virgin areas.

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