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Management of red pumpkin beetle, *Aulacophora foveicollis* (Lucas) with traditional method of dusting with dung ash in cucurbits

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Efficacy of dung ash was evaluated against red pumpkin beetle in cucumber, musk melon and bottle gourd crops during 2018 and 2019 at Entomological Research Farm, Punjab Agricultural University, Ludhiana. After germination, dung ash was dusted on plants 1, 2, 3 and 4 times at weekly interval. Significant decline in adult population in all the treatments was observed as compared to control. Lowest mean adult population was observed in plots which were dusted with ash three to four times at weekly interval and higher percentage reduction compared to control in these treatments was observed. In all the three crops, highest mortality of plants was observed in control during both the years. With three dung ash applications given at weekly interval, an additional yield of 84.33, 98.85 and 254.40 q/ha was obtained in cucumber, musk melon and bottle gourd, respectively. The net return over control with dung ash treatments was also found better in all the three crops. Based on this study, it is concluded that red pumpkin beetle can be managed effectively with dusting of dung ash on the plants 3-4 times at weekly interval. This management technique has the prospective to be utilised as an alternate to harmful chemical insecticides in IPM programmes.

Keywords: Bottle gourd, Cucumber, Dung ash, Musk melon, Red pumpkin beetle

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Cucurbitaceae family comprises a large and diverse group of crops, which constitute a significant part of a diverse and nourishing diet throughout the world. These warm season crops are very good source of fiber along with other nutrients and can be consumed raw, cooked or preserved. These are grown extensively throughout India and are among the most demanded vegetables all over the country. Cucurbit crops grown under Punjab conditions are muskmelon, watermelon, summer squash, pumpkin, bottle gourd, bitter gourd, sponge gourd, ash gourd, cucumber, long melon, round gourd and wanga. In Punjab these are grown throughout the year except during severe winters having 24.15 thousand ha area with annual production of 397.37 thousand tones[1].

Farmers are taking good economic returns through cultivation of cucurbits, but their production is severely affected by a number of insect pests. Among these, red pumpkin beetle, *Aulacophora foveicollis* (Lucas) is the most destructive and major pest of cucurbits. This pest is widely distributed all over the Asia, Australia, Europe and Africa[2]. The adult beetles are red, oblong and approximately 6-8 mm long. Females lay their eggs at the base of the stem and a single female can lay 150 to 300 eggs[3]. Red pumpkin beetle is responsible for varying levels of damage to cucurbits in the world. Damage caused by this beetle range from 35% to 75% damage to all cucurbits except bitter gourd[4]. Both adult and grubs attack the crop and cause serious damage. At the seedling stage damage caused by red pumpkin beetle alone is enormous as it can easily cause mortality of the plants and ultimately complete failure of the crop. The adult beetles occur in large numbers, feed voraciously on young plants and sometimes resowing is required if the attack is severe. They eat out young seedlings, tender leaves and flowers. The grubs are yellowish white in colour and cause injury to the roots[5].

A wide range of insecticides belonging to different groups have been used for the control of red pumpkin beetle from time to time. But indiscriminate and non-judicious use of insecticides has resulted in several problems like development of resistance, pesticide residues, killing of natural enemies, emergence of secondary pests, environmental contamination and health hazards. Also chemicals are costly as compared

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to some cultural control methods and in kitchen garden it is not advisable to go for these sprays. Although many insecticides have been recommended for effective control of red pumpkin beetle, but limited options are available for its management in organic farming and some non-chemical techniques for organic vegetable production should be developed to reduce its pressure and these alternate strategies should be adopted for its management. A variety of non-chemical approaches like early sowing, clean cultivation, crop rotation, killing of beetles manually, dusting of ashes, deep ploughing of fields after harvest, covering plants with net etc. are being tested for managing red pumpkin beetle[6]. But owing to lack of knowledge, these non-chemical management approaches do not find favour with growers.

To reduce reliance on chemicals, some alternate approaches for the management of red pumpkin beetle may be exploited because we neither want to see any insect on our vegetables nor do we want any pesticide residue. So ash can be used as a traditional pest control method to deal with the hazardous and ill effects of chemicals. Some workers have reported management of insect pests with application of ash in different crops and in storage with varied level of success[7-9]. Although, there is no systematic work on the management of red pumpkin beetle with dung ash, some reports indicate the use of dung ash as dusting for the management of various insect pests in tribal areas of India[10,11]. Although management of red pumpkin beetle with ash is an old practice, desired level of success is not achieved because sometimes single application with ash is given or two applications are given at longer intervals. With such an interval or single application, new leaves will emerge on the plant, which are not covered with ash and beetle will attack these untreated leaves. Keeping in mind the above point, this idea was conceived to standardise a method with periodic applications so that new growth is covered at proper time to avoid the attack of this pest. In light of the above stated facts and figures, the present research work was carried out to devise some effective non-chemical method for the management of red pumpkin beetle in cucurbits to cope up with this menace and to keep the economic injury at a manageable level. So, in the present study economical and eco-friendly technology for the management of red pumpkin beetle with dung ash was standardised with periodical applications after different time intervals.

Materials and Methods

Efficacy of dung ash was evaluated against red pumpkin beetle in cucumber (*Cucumis sativus*), musk melon (*Cucumis melo*) and bottle gourd (*Lagenaria siceraria*) crops at Entomological Research Farm for two years (2018 and 2019). The experiments were laid out in randomized block design with four replications per treatment. The crop was sown following recommended package of practices during both the years[1]. The dried dung cakes were collected from a nearby village and afterwards a heap of 20 dung cakes was made which was burnt for one hour and allowed to cool for another two hours to obtain ash. After germination, dung ash was dusted on plants 1, 2, 3 and 4 times at weekly interval in different treatments with the help of a flour sieve commonly used in our homes. An untreated control with natural infestation was also kept for comparison. The population of red pumpkin beetle adults was recorded from 10 randomly selected plants per plot, before application, 7, 14, 21 and 28 days after initiation of different applications and mean population was worked out. Number of plants which were completely defoliated due to leaf eating of plants by red pumpkin beetle within 30 days after germination of crop were recorded in each treatment and percentage plant mortality was calculated. The yield data were recorded on whole plot basis for each picking and total yield was calculated by adding the yield from all pickings and converted to q/ha. The data were subjected to analysis of variance (ANOVA) after applying appropriate transformations and treatment means were compared[12]. Economics of different treatments was also worked out to account for cost benefit ratio and to check feasibility of management practices.

Results

Effect of dung ash application in cucumber, musk melon and bottle gourd

During the period of investigation, red pumpkin beetle appeared as a damaging pest at seedling stage on cucumber, musk melon and bottle gourd crops. The results on efficacy of dusting with dung ash against this major pest in these crops are given in Table 1, 2 and 3. Red pumpkin beetle population before the treatments was non-significant and per plant it varied from 2.13-3.10 in cucumber, 2.80-4.02 in musk melon and 2.14-2.84 in bottle gourd during both the years. All the tested treatments proved to be

Table 1 — Management of red pumpkin beetle with dung ash in cucumber during 2018 and 2019

Treatment	Dose	Red pumpkin beetle population per plant					*Pooled mean	Percentage decline in beetle population over control	# Per cent plant mortality
		Before treatment	7 DAT	14 DAT	21 DAT	28 DAT			
					2018				
Ash dusting	1 application	2.93	0.30 (1.14)	1.00 (1.41)	2.10 (1.75)	3.80 (2.18)	1.80 (1.67)	55.83	44.05 (41.56)
Ash dusting	2 applications	3.10	0.20 (1.09)	0.60 (1.26)	2.00 (1.73)	3.10 (2.02)	1.47 (1.57)	63.80	31.70 (34.24)
Ash dusting	3 applications	2.85	0.40 (1.18)	0.40 (1.18)	0.80 (1.34)	1.10 (1.45)	0.67 (1.29)	83.44	14.62 (22.47)
Ash dusting	4 applications	2.70	0.30 (1.14)	0.50 (1.22)	0.60 (1.26)	0.80 (1.34)	0.55 (1.24)	86.50	13.87 (21.85)
Control	-	2.85	3.00 (1.99)	3.60 (2.14)	4.50 (2.34)	5.20 (2.49)	4.07 (2.25)	-	61.62 (51.70)
CD (p=0.05)	-	NS	(0.12)	(0.15)	(0.19)	(0.23)	(0.13)	-	(1.51)
					2019				
Ash dusting	1 application	2.25	0.20 (1.09)	0.90 (1.37)	2.00 (1.73)	3.50 (2.11)	1.65 (1.63)	56.00	42.40 (40.61)
Ash dusting	2 applications	2.13	0.40 (1.18)	0.50 (1.22)	1.70 (1.64)	2.70 (1.92)	1.32 (1.52)	64.67	30.17 (33.30)
Ash dusting	3 applications	2.33	0.50 (1.22)	0.30 (1.14)	0.60 (1.26)	1.00 (1.41)	0.60 (1.26)	84.00	13.90 (21.86)
Ash dusting	4 applications	2.50	0.30 (1.14)	0.40 (1.18)	0.50 (1.22)	0.50 (1.22)	0.42 (1.19)	88.67	13.25 (21.33)
Control	-	2.20	2.90 (1.97)	3.10 (2.02)	4.20 (2.27)	4.80 (2.41)	3.75 (2.17)	-	58.75 (50.02)
CD (p=0.05)	-	NS	(0.12)	(0.15)	(0.17)	(0.23)	(0.11)	-	(1.31)

*Figures in the parentheses are square root transformed values
#Figures in parentheses are arc sine transformation
DAT- Days after treatment

Table 2 — Management of red pumpkin beetle with dung ash in musk melon during 2018 and 2019

Treatment	Dose	Red pumpkin beetle population per plant					*Pooled mean	Percentage decline in beetle population over control	# Per cent plant mortality
		Before treatment	7 DAT	14 DAT	21 DAT	28 DAT			
					2018				
Ash dusting	1 application	3.55	0.70 (1.29)	1.30 (1.51)	3.50 (2.12)	4.30 (2.29)	2.45 (1.85)	48.69	52.05 (46.16)
Ash dusting	2 applications	4.02	0.50 (1.22)	0.90 (1.37)	2.90 (1.97)	3.90 (2.21)	2.05 (1.74)	57.07	42.37 (40.59)
Ash dusting	3 applications	3.67	0.60 (1.26)	0.90 (1.37)	1.20 (1.48)	1.60 (1.61)	1.07 (1.44)	77.49	16.05 (23.59)
Ash dusting	4 applications	3.47	0.60 (1.26)	1.00 (1.41)	1.10 (1.44)	1.20 (1.48)	0.97 (1.40)	79.58	15.07 (22.83)
Control	-	3.90	4.20 (2.28)	4.40 (2.32)	4.70 (2.38)	5.80 (2.61)	4.77 (2.39)	-	71.07 (57.47)
CD (p=0.05)	-	NS	(0.13)	(0.13)	(0.16)	(0.17)	(0.10)	-	(1.68)
					2019				
Ash dusting	1 application	3.10	0.40 (1.18)	1.20 (1.48)	2.90 (1.97)	3.70 (2.17)	2.05 (1.74)	51.76	53.95 (47.25)
Ash dusting	2 applications	3.43	0.50 (1.22)	0.80 (1.34)	2.20 (1.78)	3.50 (2.12)	1.75 (1.65)	58.82	43.20 (41.07)

(*Contd*.)

Table 2 — Management of red pumpkin beetle with dung ash in musk melon during 2018 and 2019 (*Contd*.)

Treatment	Dose	Red pumpkin beetle population per plant					*Pooled mean	Percentage decline in beetle population over control	# Per cent plant mortality
		Before treatment	7 DAT	14 DAT	21 DAT	28 DAT			
Ash dusting	3 applications	3.24	0.30 (1.14)	0.89 (1.37)	1.00 (1.41)	1.70 (1.63)	0.97 (1.40)	77.06	15.07 (22.83)
Ash dusting	4 applications	2.80	0.60 (1.26)	0.80 (1.34)	0.90 (1.37)	1.10 (1.44)	0.85 (1.36)	80.00	14.55 (22.40)
Control	-	3.30	2.90 (1.97)	4.10 (2.25)	4.30 (2.29)	4.70 (2.38)	4.25 (2.29)	-	69.87 (56.69)
CD (p=0.05)	-	NS	(0.09)	(0.08)	(0.23)	(0.16)	(0.09)	-	(1.23)

*Figures in the parentheses are square root transformed values
#Figures in parentheses are arc sine transformation
DAT- Days after treatment

Table 3 — Management of red pumpkin beetle with dung ash in bottle gourd during 2018 and 2019

Treatment	Dose	Red pumpkin beetle population per plant					*Pooled mean	Percentage decline in beetle population over control	# Per cent plant mortality
		Before treatment	7 DAT	14 DAT	21 DAT	28 DAT			
					2018				
Ash dusting	1 application	2.82	1.74 (1.65)	2.00 (1.73)	2.63 (1.90)	4.20 (2.28)	2.69 (1.90)	35.49	45.72 (43.50)
Ash dusting	2 applications	2.74	1.60 (1.61)	1.40 (1.54)	2.10 (1.75)	2.80 (1.94)	1.97 (1.71)	52.76	32.12 (34.50)
Ash dusting	3 applications	2.84	1.60 (1.61)	0.70 (1.30)	0.60 (1.26)	1.30 (1.51)	1.05 (1.42)	74.82	21.25 (27.43)
Ash dusting	4 applications	2.66	1.40 (1.54)	0.60 (1.26)	0.30 (1.13)	0.50 (1.22)	0.70 (1.29)	83.21	19.10 (25.89)
Control	-	2.9	3.20 (2.04)	3.60 (2.14)	4.70 (2.38)	5.20 (2.48)	4.17 (2.26)	-	70.12 (56.84)
CD (p=0.05)	-	NS	(0.08)	(0.10)	(0.09)	(0.07)	(0.26)	-	(1.64)
					2019				
Ash dusting	1 application	2.14	0.50 (1.22)	2.10 (1.76)	3.20 (2.04)	3.70 (2.16)	2.37 (1.82)	26.40	40.57 (39.54)
Ash dusting	2 applications	2.25	0.60 (1.26)	0.90 (1.37)	2.80 (1.94)	3.90 (2.21)	2.05 (1.73)	36.34	31.55 (34.13)
Ash dusting	3 applications	2.32	0.40 (1.17)	0.50 (1.22)	0.90 (1.37)	1.30 (1.51)	0.77 (1.33)	76.09	18.30 (25.31)
Ash dusting	4 applications	2.35	0.50 (1.22)	0.40 (1.18)	0.60 (1.26)	0.50 (1.22)	0.50 (1.22)	84.47	15.35 (23.05)
Control	-	-	2.70 (1.92)	3.00 (1.99)	3.40 (2.09)	3.80 (2.19)	3.22 (2.04)	-	68.00 (55.56)
CD (p=0.05)	-	NS	(0.11)	(0.10)	(0.14)	(0.12)	(0.16)	-	(2.07)

*Figures in the parentheses are square root transformed values
#Figures in parentheses are arc sine transformation
DAT- Days after treatment

significantly better in controlling red pumpkin beetle as compared to control during both the years. The application of dung ash proved effective in decreasing the red pumpkin beetle population as post application data showed significant decline in adult population in all the treatments except control.

After seven days, all the treatments were found effective, being at par with each other and significantly better than control as at this point of

time, treatments were at same, i.e., at weekly, interval. However, after 14 days of application of dung ash, first treatment i.e., where single application was proved inferior in reducing beetle population due to the fact that new growth of the plant was not covered with ash. Similarly, 21 and 28 days after treatment, plots with one or two applications witnessed significantly higher number of beetles than other treatments. Analysis of pooled data revealed that lowest mean adult population per plant was observed in the plots which were dusted with ash four times at weekly interval and was at par with the treatment where ash was dusted three times during both the years in all the three crops.

During 2018, percentage reduction in beetle population over control in cucumber was 86.50 and 83.44, in musk melon 79.58% and 77.49% and in bottle gourd was 83.21% and 74.82% in the plots which were dusted with ash four and three times, respectively. Whereas, during 2019 with four and three applications reduction was 88.67% and 84.00% in cucumber, 80.00% and 77.06% in musk melon and 84.47% and 76.09% in bottle gourd. Among the ash treatments, lowest plant mortality was observed in the plots which were dusted with ash four times at weekly interval and was at par with the treatment where ash was dusted three times during both the years. Highest mortality of cucumber plants (61.62% and 58.75%) due to foliage feeding by red pumpkin was observed in control during 2018 and 2019, respectively (Table 1). In musk melon crop, plant mortality was 71.07% and 69.87% in control plots during 2018 and 2019, respectively (Table 2) and in bottle gourd crop quite high mortality (70.12% and 68.00% in 2018 and 2019) in control plots was observed (Table 3).

Yield

Fruit yield was significantly higher in all the treatments as compared to the control (Table 4). Among the ash treatments, higher fruit yield was observed in the plots which were dusted with ash four times at weekly interval and was at par with the treatment where ash was dusted three times in all the three crops during both the years. In cucumber, during 2018 yield was 146.00 and 144.93 q/ha with four and three applications of dung ash being at par with each other and during 2019 respective yield of 148.00 and 146.80 q/ha was obtained. In musk melon, yield obtained with four and three times dusting of dung ash was 138.00 and 137.43 q/ha during 2018 and 139.75 and 138.55 q/ha during 2019, respectively. Whereas in bottle gourd a yield of 430.30 and 426.68 q/ha during 2018 and 442.00 and 439.88 q/ha during 2019 was obtained with four and three applications of dung ash, respectively. Yield was significantly lower in control during both the years due to higher mortality of plants by red pumpkin beetle and it was 60.50 and 62.63 q/ha in cucumber, 38.00 and 40.30 q/ha in musk melon and 171.693 and 185.80 q/ha in bottle gourd during 2018 and 2019, respectively.

If we talk about economics of control measures with traditional method i.e., dung ash, it is observed that ash is available in abundance, can be obtained with ease and used in the fields without any constraint. In cucumber, musk melon and bottle gourd an additional yield of 84.33, 98.85 and 254.40 q/ha, respectively, was obtained with three dung ash applications given at weekly intervals (Table 5). The net return over control in ash treatment was found better in all the three crops. Net returns of Rs. 83205.00, 97725.00 and 185350.20 were obtained in cucumber, musk melon and bottle gourd, respectively, with dusting of ash three times at weekly intervals**.**

Discussion

Red pumpkin beetle is a foliage feeder, so it can be easily controlled by just dusting dung ash on the leaves. Results of our study are in conformity with

Table 4 — Effect of application of dung ash on yield of cucumber, musk melon and bottle gour

Treatments	Dose	Yield (q/ha)*					
		Cucumber		Musk melon		Bottle gourd	
		2018	2019	2018	2019	2018	2019
Ash dusting	1 application	80.93	82.93	58.25	60.43	252.05	260.13
Ash dusting	2 applications	97.75	101.18	67.93	70.63	279.38	283.88
Ash dusting	3 applications	144.93	146.80	137.43	138.55	426.68	439.88
Ash dusting	4 applications	146.00	148.00	138.00	139.75	430.30	442.00
Control	-	60.50	62.63	38.00	40.30	171.93	185.80
CD (p=0.05)		1.80	1.76	2.88	1.95	3.18	4.53

*Mean of four replications

Table 5 — Economics of application of dung ash against red pumpkin beetle in cucurbits

Treatments	Dose	*Pooled yield (q/ha)	Cost of application (Rs/ha)	Additional yield over control (q/ha)	Income from additional yield (Rs/ha)	Net returns over control (Rs/ha)
			Cucumber			
Ash dusting	3 applications	145.88	1125	84.33	84330.00	83205.00
			Musk melon			
Ash dusting	3 applications	138.00	1125	98.85	98850.00	97725.00
			Bottle gourd			
Ash dusting	3 applications	433.28	1125	254.40	186475.20	185350.20

* Mean of two years
Cost of ash dusting single time: Rs. 375/ha

findings of some earlier studies in which successful control of red pumpkin beetle (98-100%) was achieved by dusting wood ash on cucurbits in the morning[13]. In another study synthetic insecticide Lufron and ash were found to be most effective in reducing beetle population in snake cucumber[14]. A survey of four villages of Kachar district in Assam revealed that farmers are using fly ash for the successful management of red pumpkin beetle in cucurbits[15]. Dusting the cucurbit plants with ash repels the beetles and is advocated as a component of integrated pest management strategy by[16].

Our findings are in partial agreement with results of a study that dung ash at 2-3 g/plant was effective in avoiding complete plant mortality by red pumpkin beetle but less effective than chemical control in cucumber[17]. Variation in results might be due to longer interval of 10 days between the applications. A study revealed that minimum number of red pumpkin beetles and maximum fruits yield in cucumber were recorded with soil application of carbofuran followed by seed treated with thiamethoxam and dusting with rice husk ash[18]. However, our results are not in line with that of Mahmood *et al*.[19], who stated that use of dung ash alone in cucumber was not effective against red pumpkin beetle but a mixture of permethrin and ash gave very good control. Also dung ash gave short-term repellency to the adults and proved effective only upto 3 days in musk melon[20].

Conclusion

Red pumpkin beetle can be managed effectively in cucurbits during initial crop stage which is most susceptible as far as economic damage by this pest is concerned with dusting of dung ash on the plants 3-4 times at weekly intervals starting from seedling stage. This non-chemical method of management of red pumpkin beetle will not only help the vegetable growers to manage this serious pest but also help in reducing pesticide load in cucurbits. This ecologically sound low-cost technology has the potential to be used as alternate to synthetic insecticides and can fit well in IPM programmes. So, it is advocated to go for 3-4 applications of dung ash, that too at weekly interval to save the crop from the attack of this notorious pest.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

Conceptualization and designing of the research work (RSC); Execution of field experiments and data collection (RSC, AK, NA): Analysis of data and interpretation (RSC, AK, NA); Preparation of original draft manuscript (RSC); Review & editing of manuscript (RSC, AK, NA).

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