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TESTING ALUMINIUM PHOSPHIDE IN INDIAN CRESTED PORCUPINE BURROWS AS A PEST MANAGEMENT TECHNIQUE IN BANNU, PAKISTAN

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ABSTRACT

Indian crested porcupine (*Hystrix indica)* is widely distributed and a serious mammal pest of trees, agricultural crops, orchards and vegetables in different environments of Pakistan. Trials were conducted to evaluate the efficacy of aluminium phosphide (phostoxin; 3 g tablets) against Indian crested porcupine, in the field conditions of Bannu district of Pakistan. Results reflected that in case of cropland fumigation trials, two tablets of phostoxin were not effective in reduction of porcupine burrow activity in small sized burrows, while 66.7% reduction could be achieved by applying four tablets. A 100% reduction in burrow activity was recorded in case of medium and large sized burrows, where 6 – 12 tablets were applied. In the non-cropland area, in case of small sized burrows, two tablets of phostoxin could not be effective in reduction of burrow activity, while in case of four tablets, only, 33.4% reduction could be achieved. Similarly, in case of medium and large sized burrows, 6 – 10 tablets were effective in 100% reduction of porcupine burrow activity. It is suggested that aluminum phosphide fumigation is effective in controlling porcupine population in the cropland and non-cropland areas, if the fumigation dose is optimized.

Keywords: Porcupine control, burrow size, fumigation, cropland, non-cropland.

INTRODUCTION

Porcupines are among the largest rodents of the world and have been considered as pests of forests and agriculture in many regions of the New and Old Worlds (Nowak, 1991). Indian crested porcupine (*Hystrix indica* Kerr) is widely distributed in the Indian subcontinent, exploiting grasslands, temperate scrublands, steppe mountains, forests and sandy desert habitats (Gurung and Singh, 1996; Roberts, 1997; Khan et al., 2000).

This mammal has been reported from throughout Pakistan and in different ecological habitats (Roberts 1997; Khan et al. 2000; Awan et al. 2004; Siddique and Arshad 2004). It is a pest of forests and agricultural crops in Pakistan. Although the Indian crested porcupine is a generalist forager, it prefers to feed on roots and barks of succulent trees and other plants. Through its feeding behavior it girdles trees and uproots nursery seedlings and the planted saplings (Ahmed and Chaudhry, 1977; Greaves and Khan, 1978). Greaves and Khan (1978) reported that porcupine damaged *Melia azedarach*, *Morus alba* and *Dalbergia sissoo* plantations in one forest @ 53%, 24% and 1%, respectively. It has been declared as most dangerous vertebrate pest of fruit trees in the Balochistan (Mian et al., 1988; Pervez, 2006). *Pinus roxburghii*, especially at early age (1-6 years old plantations), are vigorously damaged with reported damage ranging between 38% to 90% (Sheikher, 1998; Khan et al., 2000; Hussain, 2006). In addition, 42% damage to the *Robinia pseudoacacia* (Khan et al. 2000), 30% to the seedlings of *Azadirachta indica*, 12% to *Eucalyptus* spp. (Idris and Rana, 2001) and 5% to the young *Cocos nucifera* plantations (Chakraborthy and Girish, 2002) have been reported in different regions.

Keeping in view the serious losses, caused by the porcupine on forest plantations, all Forest Management Plans of Pakistan have recommended the need for controlling measures for this mammal pest. As regards the management of the pest, physical control strategies (snaring, trapping, dog hunting, fencing and policing, etc.) have proven ineffective for control of this species. The natural predators for this large sized mammal are either not available or have very limited population, which has resulted in their effective control over *H. indica*. Given this scenario, an alternative control technique is to use chemicals for its management.

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From the chemical list, fumigation is a technique that can be considered as important for the control of any burrowing mammal. Greaves and Khan (1978) recommended the use of aluminium phosphide tablets, being safer, convenient, effective and cheaper than cyanide gassing powder. Khan et al. (2006) and Mushtaq et al. (2008) recommended the use of aluminium phosphide tablets for porcupine control under different ecological habitats and suggested the optimization of the dose in the related geographic area. Forest staff use four 3 g tablets of aluminium phosphide per porcupine den, however, foresters hardly achieve 50% porcupine kill with this recommended dose. Therefore, the present study was designed to evaluate different doses of aluminium phosphide in relation to the size of the porcupine burrow in both the cropland and non-cropland area of the Bannu district, Pakistan where Indian crested porcupine is acting as a serious vertebrate pest of different agricultural and forest plantations.

MATERIALS AND METHODS

Study area

Present study was conducted between February to August 2015 in three union councils (Muhammad Khel; 32°58'60N 70°31’60E, Jani Khel; 32°47'55N 70°30'23E and Baka Khel; 32°57'19N 70°30'18E) of district Bannu (Khyber Pakhtunkhwa, Pakistan; KPK). Total area of the district is 1,227 km^2, intersected by hill torrents; the elevation range of the study area is 300 – 400 m above sea level. Climate of the district is warm in summer and cold in winter. There is no regular forested area, and trees have a patchy distribution. The area is rich in agricultural and horticultural activities; major crops of the area being wheat (*Triticum aestivum*), maize (*Zea mays*), rice (*Oryza sativa*), barley (*Hordium vulgare*) and sugarcane (*Saccharum officinarum*). The progressive farmers of the area are seriously affected by the foraging activities of the Indian crested porcupine.

Porcupine burrow density

Two types of habitats, i.e., cropland and non-cropland areas were selected for estimation of porcupine burrow density and fumigation trials. In each habitat, four quadrats of one Km^2 each were extensively surveyed for location of the porcupine burrows with the help of local farmers and / or shepherds. All the burrows were marked, assigned a number and were examined, carefully, for signs of porcupine activity, like, presence of the fresh quills, foot prints on loose soil, fresh signs of excavation and fecal pellets, near the openings of the burrows. The active status of the each burrow was, further, confirmed by setting the tracking patches of fine powdery soil ($1m^2$), established in front of the opening of the burrow for three consecutive nights, following Dolbeer et al. (1991). The burrow was considered active only when porcupine foot prints were found on the tracking patches.

Fumigation trials

Porcupine burrows were treated with aluminium phosphide (a grayish green solid), which upon exposure to moist air reacts to produce phosphine; a colorless, toxic gas widely used for controlling burrowing rodents (Carl, 1983). Aluminium phosphide (available in Pakistan as phostoxin 56% active ingredient) tablets (3 g each) were placed deep inside the porcupine burrows with the help of a long stick (2 m long), following Mushtaq et al. (2008). Treated burrows were plugged with brushwood and loose soil. Two field experiments were conducted to test the efficacy of the aluminium phosphide as follows:-

For fumigation trials, a total of 18 active burrows were selected from each type of habitat, i.e., cropland and non-cropland.The selected burrows were categorized into three groups of 6 burrows, each, on the basis of their size i.e., small (cropland; top to bottom = 32.33 (mean) ± 3.26 (SEM) cm, left to right = 33.66 ± 4.22 cm, circumference = 117.5 ± 9.85 cm: non-cropland; 29.5 ± 5.22 cm, 30.44 ± 6.33 cm, 112.5 ± 10.5 cm), medium (cropland = 34.5 ± 5.40 cm, 46.30 ± 2.50 cm, 150.83 ± 9.51 cm; non-cropland: 33.23 ± 5.50 cm, 45.55 ± 3.40 cm, 145.55 ± 12.40 cm) and large (cropland: 37.83 ± 3.86 cm, 56.5 ± 3.27 cm, 174.60 ± 5.64 cm; non-cropland: 38.34 ± 4.44 cm, 58.66 ± 4.32 cm, 187.50, ± 9.66 cm). Each group of 6 burrows was, again, divided into two groups of 3 burrows, each. In each group (of 3 burrows), phostoxin tablets were applied @ 2 and 4 tablet for small size burrows, 6 and 8 for medium and 10 and 12 for large sized burrows.

Reduction in burrow activity

Phostoxin tablets were delivered in the evening (6 – 8 pm) and the treated burrows were plugged with brushwood and soil dirt. In case of multiple openings, all the openings were closed, while the phostoxin tablets were applied in the main opening of the burrow system. Before starting the fumigation trial, active status of the each burrow was confirmed by setting tracking patches of fine powdery soil ($1m^2$), established in front of the opening of the burrow for three consecutive nights, following Dolbeer et al. (1991). The burrow was considered active only when porcupine foot prints were found on the tracking patches in the morning, especially on the last night, when fumigation was done. Post-treatment observations were noted, on daily basis, and each burrow was recorded as closed or reopened as an indicator of burrow activity after 24 hours of treatment, for five days. The animal (s) in the completely closed burrows were considered as dead, because they have neither escaped from any hole / opening nor the burrow was completely empty. The burrows could not be excavated to search the dead animals, inside, because the porcupine burrows are quite extensive and may reach up to 18 meters in length (Michael et al., 2003) and the local farmers were reluctant to allow the disturbance to their lands.

RESULTS

Burrow density

A total of 44 porcupine burrows were recorded in four quadrats sampled, from the cropland area, which is equal to 11 porcupine burrows per km^2. In regards to the proportion, of these 32 (72.7%) were active burrows. In the non-cropland area, 28 porcupine burrows were recorded from four quadrats samples, which is 7 burrows per km^2; 4 (37.5%) of which were active burrows.

Fumigation

Results on the effectiveness of aluminium phosphide fumigation trials in the cropland area reflected that in small sized burrows (Table 1), two tablets of phostoxin were not effective in reduction of burrow activity (0% reduction), while four tablets resulted in 66.7% reduction in burrow activity. A 100% reduction in porcupine burrow activity was recorded in medium sized burrows, where 6 and 8 aluminium phosphide tablets were applied. Similarly none of the large sized porcupine burrow was re-opened (100% reduction), where 10 and 12 aluminium phosphide tablets were applied.

In the non-cropland area, in small sized burrows (Table 1), again, two tablets of phostoxin were not effective in reducing burrow activity (0% reduction), while four tablets caused 33.4% reduction in burrow activity. In case of medium sized burrows, 66.7% reduction in porcupine burrow activity was recorded, where 6 tablets were used, while 100% reduction was achieved where 8 aluminium phosphide tablets were tested. Similarly none of the large sized porcupine burrow was re-opened (100% reduction), where 10 and 12 aluminium phosphide tablets were applied.

Table – 1: Efficacy of aluminium phosphide fumigation for reduction in activity of Indian crested porcupine burrows in Bannu district, Pakistan.

Area type	Burrow category	Fumigation tablets applied (#)	Burrows fumigated (#)	Burrows not reopened (#)	Reduction in burrow activity (%)
Cropped	Small	2	3	3	Nil
		4	3	2	66.7
	Medium	6	3	0	100
		8	3	0	100
	Large	10	3	0	100
		12	3	0	100
Non-cropped	Small	2	3	3	Nil
		4	3	1	33.4
	Medium	6	3	2	66.7
		8	3	0	100
	Large	10	3	0	100
		12	3	0	100

DISCUSSION

Due to limited success of trapping and other alternative control methods against Indian crested porcupine, use of chemicals is the only effective strategy for controlling porcupine population and minimizing the economic losses caused by this pest species (Hadler and Buckle, 1992). Yet application of these poisons could lead to the possible development of rodenticidal bait resistance and / or limited uptake of the bait materials, which is common in many areas of the world (Singleton et al., 2004). Aluminium phosphide fumigation is probably the most widely used fumigant, worldwide. Aluminium phosphide tablets produce highly toxic phosphine gas on contact with water vapours in the air. A 3 g tablet of aluminium phosphide produce 1 g of phosphine gas. The complete release of phosphine may take 48-72 hours; although 40% release may be competed in first 12 hours (Carl, 1983).

Fumigation of porcupine burrows with different methods has been recommended for the control of porcupine populations in different ecological zones of Pakistan with varying degree of success. Nawaz and Ahmad (1974) achieved 83% porcupine control with aluminium phosphide atblets but did not mentioned the dose applied. Chaudhry and Ahmad (1975) tested aluminium phoshpide tablets @ 2-15 / burrow and achieved 100% porcupine kill by using 5, 10 and 15 tablets / den, but did not described the experimental procedure. Khan *et al*. (1992) tested aluminium phosphide tablets in arid lands and recorded varying degree of success by using 2-6 tablets / burrow..Mushtaq et al. (2008) used aluminium phosphide tablets in relation to porcupine den size (small, medium and large) in scrubland area (soil of the area is silty loam and silty clay loam) of Haripur, Pakistan and recorded 100% reduction in burrow activity by applying four tablets of aluminium phosphide per burrow in small (circumference 100.2 ± 2.93 cm), six tablets in medium (127.7 ± 0.93) and eight tablets in large (157.4 ± 2.44) sized burrows. In the present study area, the porcupine burrows are relatively larger in size (described in methodology section). The soil type of the area is clay to sandy loam (Wasiullah and Bhatti 2006).

No study is available on using aluminium phosphide tablets in cropland and non-cropland areas for controlling porcupine population. Present results indicate that two and four tablets are not sufficient for small sized burrows in both types of habitats and six tablets are not sufficient in the medium sized burrows of the non-cropland area. Present results may be exploited to achieve maximum porcupine kill by optimizing the aluminium phosphide fumigation dose in the cropland and non-cropland area by categorizing the burrows (small, medium and large). The maximum porcupine control can be achieved by using eight tablets of aluminium phosphide in all kinds of burrows and in both types of habitats. Six tablets are sufficient for maximum reduction in porcupine burrow activity in the cropland area for small and medium sized burrows and eight tablets for large sized burrows. In case of non-cropland area, six tablets are suggested for small burrows, eight for medium sized and ten aluminium phosphide tablets for large burrows. Current results advocate that the population of Indian crested porcupine can be effectively controlled by using phostoxin tablets in the current area. This method is more economical as compared to other control methods (Mushtaq et al., 2008), although, anticoagulant baiting may be highly effective against Indian porcupine; yet has certain limitations. The most important one is that the total release of phosphine gas within the shortest period of time is required so that sufficient fumigant is available to kill porcupines in their burrow system. The total phosphine gas is released in 72 hours and 40% within the first day of its application. Under practical situation, the porcupines are exposed to the fumigation for almost 10-12 hours before the animals come out of their dens in the early hours of the night (being nocturnal). So the animals are exposed to 20% or less of the total gas produced. In such cases majority of the animals re-open the dirt plug of the burrow openings. Secondly, crevices and tunnels created by other rodents or lizzards linked internally with the porcupine burrow system, results in the leakage of phoshpine gas (Khan et al., 2011), so number of phostoxin tablets, should be adjusted, keeping in view the porcupine burrow size and the soil type. Further studies are required to find out the minimum dose of aluminium phosphide in relation to different soil types.

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