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Evaluation of Aluminium Phosphide Fumigation for the Control of Indian Crested Porcupine (*Hystrix indica)* in Scrublands*

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Abstract.- Indian crested porcupine, *Hystrix indica*, is widely distributed and seriously damages trees, field crops and vegetables in Pakistan. Field trials were conducted to determine the efficacy of aluminium phosphide (3 g tablets) against Indian crested porcupine at two locations in scrub forest of Haripur – Havelian (NWFP). In randomly selected burrows, 100% reduction in burrow activity was recorded, by applying eight tablets of aluminium phosphide/ burrow, 85% with six tablets/ burrow and 75% with four tablets/ burrow. In categorized burrows, 100% reduction in burrow activity was recorded when four tablets of aluminium phosphide per burrow were used 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. Aluminium phosphide fumigation is suggested as cheap and manageable approach for the control of porcupines in man-made forest plantations.

Key words: Porcupine control, burrow size, aluminium phosphide.

INTRODUCTION

Indian crested porcupine, *Hystrix indica*, is a widely distributed mammal of Pakistan inhabiting temperate scrublands, grasslands, coniferous forests (up to 3,200 m above sea level: Awan *et al.*, 2004), steppe mountain regions of the Balochistan (up to 2,750 m above sea level: Roberts, 1997) and irrigated, scrub forest plantations and sandy deserts of the Punjab and Sindh (Nawaz and Ahmad, 1974; Roberts, 1997; Khan *et al.*, 2000; Siddique and Arshad, 2004). It is a pest of forests and agricultural crops in Pakistan and India. It feeds on roots and barks of succulent plants, and in this process girdles trees, and uproots nursery seedlings and planted saplings (Ahmed and Chaudhry, 1977; Greaves and Khan, 1978). Greaves and Khan (1978) estimated incidence of porcupine damage to *Melia azedarach, Morus alba* and *Dalbergia sissoo* in one forest as 52.5%, 24.3% and 1.0%, respectively. It is also a serious pest of fruit trees in Balochistan, Pakistan (Mian *et al.*, 1988; Pervez, 2006). *Pinus roxburghii*, especially at early age (1-6 years), is seriously effected plant with reported damage ranging between 38.1% – 90% (Sheikher, 1998; Khan *et al.*, 2000; Hussain, 2004). Similarly, 42% damage to *Robinia pseudoacacia* (Khan *et al.* 2000), 30% to seedlings of *Azadirachta indica*, 12% to *Eucalyptus* sp. (Idris and Rana, 2001) and 5.39% to young coconut plantations (Chakraborthy and Girish, 2002) have been reported.

In view of the serious impact of porcupine on forest plantations, all forest management plans of Pakistan recommended the adoption of necessary measures for the control of this mammal pest. Physical control measures (trapping, snaring, dog hunting, electric fencing, active policing, etc.) are largely ineffective, while biological controls still not available, which leave the only alternative of using chemical compounds for its management.

Fumigation is a technique that can be considered for the control of any burrowing mammal. Greaves and Khan (1978) recommended that aluminium phosphide tablets, being more convenient, effective, safer and cheaper, should replace cyanide gassing powder for porcupine burrow fumigation. Following their suggestions forest staff uses four tablets of aluminium phosphide (4x3 g) per porcupine den. However, foresters fail to achieve more than 50% kill with this recommended

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dose. Therefore, this study was designed to evaluate different doses of aluminium phosphide in relation to the size of the porcupine den.

MATERIALS AND METHODS

Study area

The study was conducted during September to December 2006 at different locations of Haripur (34° 08' N, 73° 12' E) and Havelian (34° 33' N, 73° 19' E), in the North Western Frontier Province, Pakistan. The study area falls in the western reaches of the summer monsoon, originating from the Indian Ocean. The composition of the vegetation varies in different parts of the study area, depending upon the altitudes, precipitation and soil type. *Quercus dilata*, *Q. incana*, *Acer caesium*, *Populus ciliate*, *Taxus baccata*, *Pinus roxburghii*, *P. wallichiana*, *Berberis ceratophyla*, *B. lyceum*, *B. heteropoda*, *Viburnum nervosum*, *Skimmia laureola*, *Fragaria* sp., *Viola* sp., *Impatiens* sp., *Clematis gouriana*, *Cassia* sp., *Apluda aristata*, *Themeda anathera*, *Aristida cyanantha*, *Picea smithiana*, *Cedrus deodara*, *Indigofera gerardiana*, *Sambucus ebulus*, *Sorbaia tementosa* and *Plactranthus rugosus* are some of the dominant angiospermic plant species, which appear in different admixtures in different parts of the study area (Champion *et al*., 1966; Beg, 1975; Sheikh, 1993). The dominant field crop during the study period was maize. The soil is silt loam.

Selection of active burrows and fumigation

Active porcupine burrows were located, through physical survey of the denning habitat with the help of local farmers and staff of the Forest Department, and confirmed by observing the footprints, quills and fresh faecal pellets near the opening of the burrow. To ensure that the burrow was being used by porcupine only, foot prints of porcupine were tracked on powdery soil dirt patches ($1m^2$) created in front of the main active opening of the den for three consecutive nights, following Dolbeer *et al*. (1991).

Aluminium phosphide (available in Pakistan as phostoxin) tablets (3 g each) were placed deep inside different burrows with the help of a shovel (2 m long). The treated burrows were then plugged with brushwood and soil dirt. Two field experiments were conducted to test the efficacy of the aluminium phosphide as follows.

A total of 60 active burrows were selected, the circumference and diameters (top-bottom and left-right) of the openings of each den was measured (cm), marked and randomly divided into three sets (of 20 burrows each). Each burrow was treated with four tablets of phostoxin in set-I, six tablets in set-II, and eight tablets in set-III.

As four and six tablets per burrow did not give the desired results, therefore, in the second experimental set, 20 burrows each of small (range 82 – 110 cm, mean circumference 100.23±2.93 Cm), medium (111–140 cm, 127.65±0.93 cm) and large burrows (141–172 cm, 157.38±2.44 cm) were identified and suitably marked. Small burrows were treated with four tablets, medium with six and the large with eight tablets of phostoxin.

Post-treatment observations were recorded, daily for five days and each burrow was recorded as closed or reopened as an indicator of burrow activity after 24 hours of treatment.

RESULTS

Random burrow treatments

The highest reduction in burrow activity (100%) was recorded in set III, *i.e.*, by applying eight tablets of phostoxin per burrow, followed by set II (85% reduction in burrow activity) by using six tablets per burrow and 75% reduction in burrow activity was recorded in set III, by applying four tablets per burrow (Table I)..

Burrow size related treatments

A 100% reduction in burrow activity was recorded in all size groups of burrows, i.e., small, medium and large burrow systems, by applying, four, six and eight tables of phostoxin per burrow, respectively (Table I).

Economics of porcupine control

Table II represents the economics of porcupine control as per market rates in Pakistan. Total cost of fumigant for one burrow system was Rs. 6.00 for small burrows, Rs. 9.00 for medium burrows and Rs. 12.00 for large burrows. A field worker can locate, mark and fumigate 10 burrows daily claiming Rs. 300. The average labour cost for location, marking and fumigation comes to Rs. 30 / burrow. Thus the total cost to fumigate one burrow system is estimated at Rs. 36 (US $ 0.60) for a small burrow, Rs. 39 for a medium burrow and Rs. 42 for a large burrow.

Table I.- **Results of the efficacy of aluminium phosphide (phostoxin) tablets against porcupine, *Hystrix indica*.**

Category of Burrow system	Size of burrow openings (Mean±SE, cm)			No. of burrows treated	Phostoxin tablets (#)	Reduction in burrow activity (%)
	Circumference	Diameter				
		Top-Bottom	Left-Right			
	126.37 ± 4.31	38.83 ± 1.41	39.14 ± 1.99	20	4	75
Random	118.11 ± 6.86	38.08 ± 2.11	37.94 ± 2.06	20	6	85
	131.64 ± 4.54	37.86 ± 1.34	39.13 ± 1.86	20	8	100
Small	100.23 ± 2.93	29.75 ± 1.79	32.09 ± 1.58	20	4	100
Medium	127.65 ± 0.93	35.71 ± 1.38	44.66 ± 1.87	20	6	100
Large	157.38 ± 2.44	40.24 ± 1.75	48.50 ± 3.00	20	8	100

Table II.- **Economics of aluminum phosphide fumigation for controlling porcupine, *Hystrix indica.***

Category of burrow system	Circumference (Mean ± SE, cm)	Phostoxin tablets used per burrow system (#)	Cost per burrow system (Pak Rs.)		Total cost (Rs.) per burrow system
			Fumigant	Labour cost	
Small	100.23 ± 2.93	4	6.00	30.00	36.00
Medium	127.65 ± 0.93	6	9.00	30.00	39.00
Large	157.38 ± 2.44	8	12.00	30.00	42.00

DISCUSSION

In Pakistan, different studies have been conducted on the use of fumigants for controlling porcupines in irrigated forests. Nawaz and Ahmad (1974) reported 83% kill with aluminium phosphide in Changa Manga plantations, but did not indicate the dose applied. Chaudhry and Ahmad (1975) used aluminium phoshpide tablets at the rate of 2-15 per burrow and obtained 100% mortality with 5, 10 and 15 tablets per burrow. They found that aluminium phoshpide was more effective in loamy than in stony and sandy soils. Khan *et al*. (1992) tested the efficacy of aluminium phosphide in arid lands. They used 2-6 tablets of aluminium phosphide per burrow and obtained 50% reduction in burrow activity by using two tablets, 66.66% by using four tablets and 83% by using six tablets. None of the above mentioned studies used the number of aluminium phosphide tablets in relation to the size of porcupine den. Therefore, degree of success varied between the workers and dens. In addition, there are some technical problems with the use of phosphine gas against Indian porcupine. 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. Total phosphine is released in 72 hours, 40% within the first day of its application. However, under practical situation, the porcupines are exposed to phosphine fumigation for 10-12 hours before the animals come out of their dens in the early hours of the night. Thus the animals are exposed to 20% or less of the gas produced. In such cases majority of the animals re-open the dirt plug of the den openings. This situation exists when four tablets per den are used. Secondly, crevices and tunnels created by other rodents or lizzards linked internally with the porcupine burrow system, results in the leakage of phoshpine gas. This leakage is difficult to detect at the time of treatment or even few hours after its application. To find solution to these problems and to achieve higher porcupine mortality, Khan *et al*. (2006) tested the efficacy of two fumigants (carbon monoxide and calcium cyanide powder) against the Indian crested porcupine, in forest plantations and drylands of Pakistan. Carbon monoxide was generated from a two-ingredient cartridge (250 g: 65% from sodium nitrate and 35% charcoal w/w). The two-ingredient gas cartridge gave 95.84% reduction in burrow activity, while, calcium cyanide (42%) showed 96.52% reduction in burrow activity.

The results of the present study may be exploited to get maximum porcupine control by optimising the aluminium phosphide concentration through categorising the burrows according to their circumference. A higher percent kill of porcupine can be achieved by applying eight tablets of aluminium phosphide in all kinds of burrows, but six and four tablets can be used in medium (circumference, 127.65±0.93 cm) and small (circumference, 100.23±2.93 cm) burrows. The present calculation on economics of porcupine control, suggests that aluminium phosphide fumigation can be a cheap and easily manageable approach for control of porcupine in man-made forest plantations. However, anticoagulant baiting (Khan and Mian, 2008), although highly effective against Indian porcupine but it is expensive, labour intensive and is not environment friendly. Further studies are suggested to test the efficacy of aluminium phosphide at the operational level in different soil types.

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