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ASSESSING THE EFFICIENCY OF ALUMINIUM PHOSPHIDE AND ARSENIC TRIOXIDE IN CONTROLLING THE INDIAN CRESTED PORCUPINE (*HYSTRIX INDICA*) IN AN IRRIGATED FOREST PLANTATION OR PUNJAB, PAKISTAN

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The Indian crested porcupine, *Hystrix indica,* is widely distributed in the irrigated forests of Punjab, Pakistan and causes serious damage to trees, nursery stocking, field crops and vegetables. Field trials were conducted to determine the efficacy of aluminium phosphide (Phostoxin, 3g tablets) and arsenic trioxide bait (at 2.5g per apple) against the porcupine in a forest plantation. For fumigation with phostoxin, tablets were used at the rate of four, five, six and seven tablets per den. Observations showed that four tablets were ineffective, five and six tablets provided partial control, while seven tablets provided complete control of porcupines. Baiting with arsenic trioxide also resulted in 89 % reduction of the porcupine population occupying the treated dens.
Key words: aluminium phosphide, arsenic trioxide, control, forest plantation, *Hystrix indica*.

INTRODUCTION

The Indian crested porcupine, *Hystrix indica*, is a widely distributed mammal in Pakistan inhibiting temperate scrublands, grasslands, moist temperate coniferous forests up to 3,200 m above sea level (Awan *et al*., 2004), steppe mountain regions of the Balochistan to 2,750 m above sea level (Roberts, 1997), irrigated, scrub forest plantations and sandy deserts of the Punjab and Sindh (Nawaz and Ahmad, 1974; Roberts, 1997; Khan *et al*., 2000). It is a pest of forests and agricultural crops in Pakistan and India, feeding on roots and bark of succulent plants, resulting in girdles in trees, uprooting of nursery seedlings and planted saplings (Ahmed and Chaudhry, 1977; Greaves and Khan, 1978; Taber *et al.,* 1967). The incidence of porcupine damage to *Melia azedarach, Morus alba* and *Dalbergia sissoo* in Changa Manga forest was estimated at 52.5, 24.3 and 1.0 %, respectively (Nawaz and Ahmad, 1974; Greaves and Khan, 1978). The porcupine is also a serious pest of fruit trees in Kallat, Balochistan, Pakistan (Mian *et al*., 1988; Pervez, 2006). *Pinus roxburghii*, especially at an early growth stage is seriously affected with damage reported to range between 38 - 90 % (Sheikher, 1998; Khan *et al*., 2000). 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% to young coconut plantations (Chakraborthy and Girish, 2002) have been reported. The Indian crested porcupine is a generalist forager, exploiting a wide variety of cultivated and wild plants and consuming both hypogeal and epigeal plant tissues (Gutterman, 1982; Alkon and Salt, 1985; Brooks *et al*; 1988; Khan *et al.*, 2000).

In view of the serious deterioration impact of porcupines on forest plantations, Punjab forest management plans recommended the adoption of necessary measures for the control of this mammalian pest. Physical control measures such as trapping, netting, snaring, dog hunting, electric fencing, active policing, etc. have proved to be ineffective. Hence the use of chemical compounds at present is the only available option and need to be evaluated in respect of their efficacy against Indian crested porcupine.

Fumigation is a technique that has been employed for the control of burrowing mammals. Greaves and Khan (1978) recommended that aluminium phosphide tablets, since it is more convenient to use, effective, safer and cheaper, should replace cyanide gassing powder for the fumigation of porcupine burrows. In irrigated forest plantations of the Punjab, forest officers generally use four tablets of aluminium phosphide per den. However, foresters are of the view that achieving 50 % control with this recommended dose, is difficult. The objective of this study was thus to assess the efficacy of two chemicals, aluminium phosphide and arsenic trioxide, in controlling the Indian crested porcupine (*Hystrix indica*) in an irrigated forest plantation of Punjab.

MATERIALS AND METHODS

The present study was carried out in a forest plantation (186.1 ha) at Chak No.155/R.B Faisalabad, Punjab. The study was emphasized on controlling porcupines in order to reduce prevent damage and losses to crops and forest plantations. The forest plantation was divided into 17 compartments (Table 1). The *D. sisso* and *Eucalyptus* spp. were the trees commonly damaged by porcupines in the plantation. The undergrowth vegetation comprised of *Saccharum munja* and *Prosopis juliflora.* The nurseries of the forest plantation in all the compartments were visited for sampling of porcupine burrows. Additional information was also collected from the local forest staff.

Each compartment was divided into 10 m wide sampling strips. Active porcupine burrows were identified by a physical survey of the habitat along the strips with the aid of local farmers and staff of the forest department. To ensure that the porcupines were using the selected burrows, footprints of porcupines 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).

Porcupine occupied burrows were selected for treatment by considering the specific characteristics of their entrances; presence of foot prints, quills and droppings near the dens. A total of 95 burrows were recorded from the irrigated plantation. Compartments having majority of active burrows were selected for treatment purposes. Burrows were selected in the 1^{st} and 2^{nd} compartment for baiting trials. Poison baiting with arsenic trioxide was used at the rate 2.5 g per apple by boring the apple with a cork borer. One poisoned apple per animal was placed near each burrow opening on the basis of estimated animals through pre-baiting trials. Twenty active burrows were selected for fumigation and different doses of the phostoxin tablets were placed deep inside the burrow with a long stick fitted with a spoon and the burrows thereafter were closed. Similarly, twenty burrows were treated with apple bait of arsenic trioxide. Post-treatment observations were recorded for five days and the status of each burrow as 'closed' or 'reopened' was considered an indicator of burrow activity.

ESULTS AND DISCUSSION

Due to poor maintenance of the forest plantations it was not possible to conduct a thorough census of burrows and take measurements of burrow openings. The maximum numbers of burrows (12) were recoded from compartment No.1, while the minimum numbers of burrows (four) were located in compartment No 2. While not a single active burrow was found from six compartments.

Table 1. Estimated porcupine (*Hystrix indica* L.) burrows in forest plantation, Chak No. 155/R.B, Punjab, Pakistan.

Compartment No.	Area sampled (ha.)	No. of active burrows	Burrows per 100 ha.
1.	16.19	12	74
2.	8.9	8	89
3.	15.3	13	84
4.	12.95	10	77
5.	10.12	-	-
6.	8.88	-	-
7.	12.95	-	-
8.	12.14	5	41
9.	10.12	7	69
10.	4.00	-	-
11.	12.14	8	65
12.	16.19	11	67
13.	19.19	10	61
14.	2.0	-	-
15.	8.09	4	49
16.	10.12	7	69
17.	10.12	-	-

Although the porcupine inhibits forest plantations, they do not have as high densities as they do in some non-crop areas in central Punjab. The diameter of the burrow openings ranged from 36.58 to 85.34 cm. The number of burrow openings ranged from 2 to 3 per burrowing system. The population estimates in various burrows ranged between 2 to 3 animals per den. It was evident that there was a positive association between the diameter of burrows and the number of porcupines inhabiting burrows. In burrows with a diameter of between 37 to 64 cm the number of porcupines was between one and two whereas in burrows with diameter between 67 to 85 cm the number of animals increased to three. Nawaz and Ahmad (1974) has reported that burrow openings ranged from 25 to 60 cm and that an average of 2.88 animals were found in burrows system. During the present study, 1.73 and 1.95 porcupines per burrow system were estimated in plots treated with arsenic bait and phostoxin, respectively

The consumption of arsenic poisoned apple bait ranged from 130.5 to 324.5 g. The observations revealed that bait consumption gradually increased during the first five days and decreased, thereafter. The average population of porcupines before baiting was 34.60 in twenty burrows and after baiting the population decreased to 3.60 individuals resulting into 89.58% control of porcupines (Fig.1). The pair wise t-test of these burrows show t =12.27** and df =19, (P<0.01) highly significant.The dead animals were retrieved from the fields with the help of local farmers and hunting dogs.

Several studies that have been conducted on the use of acute poison baits against *H. indica* have recorded varying levels of success (Arshad *et al.*, 1988; Khan *et al*., 1992, 2007a). These compounds (1080, temik, endrin, zinc phosphide, strychnine etc.) were used in fresh bait types such as chopped mango stones. These chemicals are highly toxic to non-target animals and cannot be therefore recommended for the management of porcupines. However, the use of anticoagulants needs to be investigated in detail (Khan and Mian, 2008) because these are safe and environmentally friendly with the animals displaying no apparent bait shyness.

Burrow fumigation is one of the most economically viable techniques that may be employed for the control of burrowing mammals. Fumigants such as aluminium phosphide and carbon monoxide have been investigated in different eco-zones of Pakistan (Khan *et al*., 2007b; Mustaq *et al.*, 2008). However, investigations on the use of aluminium phosphide in irrigated or man made forests of Punjab is still lacking. Currently forest officers of Punjab recommend the use of four tablets of Phostoxin per burrow with which even 10% control is not possible.

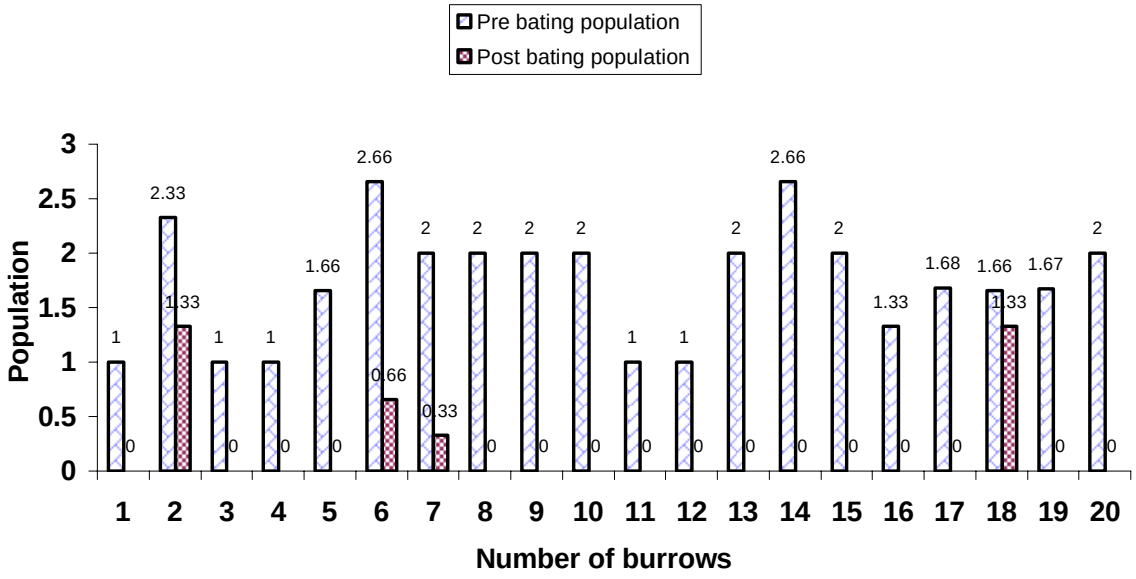

Figure 1: Comparison of pre and post-baiting porcupine populations with arsenic trioxide in forest plantation of Chak No. 155/R.B, Punjab, Pakistan.

Table 2: Estimated population of porcupines before and after fumigation of burrows using phostoxin tablets in forest plantation of Chak No. 155/R.B, Punjab, Pakistan.

Sr. No.	Diameter of Burrow opening (cm)	Estimated porcupines per burrow	Dose (tablets/burrow)	Activity after treatment	No. of animals killed
1	65.0	3	4	reopened	-
2	60.0	2	4	reopened	-
3	42.5	1	4	reopened	-
4	42.5	1	4	reopened	-
5	60.0	2	4	reopened	-
6	42.5	1	5	reopened	-
7	60.0	2	5	closed	2
8	72.5	3	5	reopened	Nil
9	52.5	2	5	reopened	"
10	60.0	2	5	reopened	"
11	35.0	1	6	closed	1
12	65.0	2	6	closed	2
13	60.0	2	6	closed	2
14	72.5	3	6	closed	3
15	37.5	1	6	closed	1
16	75.0	3	7	closed	3
17	60.0	2	7	closed	2
18	60.0	2	7	closed	2
19	75.0	3	7	closed	3
20	42.5	1	7	closed	1

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