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## Feeding behaviour and perching preferences of black drongo (*Dicrurus macrocercus*) in Ludhiana district (Punjab)

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**Abstract**

Studies on feeding behaviour and perching preferences of Black Drongo were carried out from January 2017 to December 2017 in the campus of Punjab Agricultural University (PAU), Ludhiana considered as location I and village Baranhara (district Ludhiana) as location II. The frequency of insect food foraged upon was 72.5% at location I and 65.4% at location II using both aerial and ground feeding modes. The frequency of insect gleaning from plant species was 14.2% and 13.4% at location I and II respectively. Black Drongo showed feeding/foraging sites with 10 different bird species which was due to fine difference in specie specific food niches. The annual average perching height of Black Drongo on electric power lines ranged between 12.93±0.21 m to 13.28±0.21 m and between 12.19±0.23 m to 12.72±0.19 m at location I and location II respectively. The annual average perching height of Black Drongo on trees ranged between 13.43±0.28 m to 15.93±0.45m and between 11.72±0.55 m to 15.40±0.55 m at location I and location II respectively. The trend of perch site utilisation was trees > ground > crop plants > shrubs > electric power lines was found in similar sequence from May to August at both the locations. Utilization pattern of different types of perching sites showed statistical significance between the locations.

**Keywords:** black drongo, electric power lines, foraging, perching

**1. Introduction**

Insectivorous birds constitute a major component of tropical ecosystem [10]. The Black Drongo *Dicrurus macrocercus* is a small passerine insectivorous bird which belongs to the family Dicruridae. It has an entirely black plumage with a distinctive forked tail [1].

It is common throughout the Indian subcontinent and a resident breeder of South Asia. Mariappan *et al* had stated that majority of the birds hunt their food from the agricultural field areas [17]. Black Drongo being fairly terrestrial perches close to the ground in grasslands and cultivation [21]. It uses different modes of feeding to obtain its food [30]. They are good bio-indicators in the agro-ecosystem and a majority of them check the buildup of insect pest species [22]. Robinson and Holmes reported that vegetation structure, plant species composition, prey abundance and distribution significantly affected the foraging height selection of insectivorous bird species [24]. Insectivorous birds are generally height generalists that forage on various perch sites at different heights. The habitat selection of Black Drongo depends upon the availability of perching sites and their heights [20]. Studies on the foraging ecology of birds have been used to explain community structure and co-existence in a particular habitat. It is useful in knowing the food habits of the species [16]. It constitutes the basic ecology of that species in which it exploits its resources which helps in the identification of the environmental characters that are indispensable for their survival. It helps in the determination of the economic status of the species and its ecological adaptation to the environment [2]. McMaster *et al* mentioned that several aspects of avian biology have been poorly studied for most of the passerine species [18]. The present study was designed to observe feeding behaviour and perching preferences of Black Drongo, *Dicrurus macrocercus*, in agricultural areas of Ludhiana district.

**2. Materials and Methods****2.1 Study area**

The present study was carried out from January 2017 to December 2017 in the campus of Punjab Agricultural University (PAU), Ludhiana i.e location I and village Baranhara (district Ludhiana) i.e location II.

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The PAU campus (N 30° 54' 147, E 075 47' 642) is situated in the Ludhiana city towards west and has a large stretch of agriculture fields. Two transects i.e. transect I and transect II were selected in the areas studied in PAU campus. Transect I started from College of Veterinary Sciences to College of Fisheries including the vegetable farm, PAU petrol pump and Department of Biotechnology having a distance of 0.75 kilometers. Along this road, eight tree species namely Silver Oak (*Grevillea robusta*), Bottlebrush (*Callistemon*), Tun (*Toona ciliata*), Dhek (*Melia azedarach*), Simbal (*Bombax ceiba*), Neem (*Azadirachta indica*), Ficus (*Ficus benjamina*) and Ashoka (*Polyalthia longifolia*) were observed and their number were nine, two, seventeen, three, six, two, one and three respectively. The agricultural area along the transect I consisted of crop plantations of maize (*Zea mays*), sugarcane (*Saccharum officinarum*), sorghum (*Sorghum bicolor*), Berseem (*Trifolium alexandrinum*) and wheat (*Triticum aestivum*). Four shrub species namely Yellow oleander (*Thevetia peruviana*), Bougainvillea (*Bougainvillea glabra*), Crape jasmine (*Tabernaemontana divaricata*) and China rose (*Hibiscus rosa-sinensis*) observed were twenty, four, ten and three in numbers respectively. Transect II consisted of straight road adjacent to the PAU ground near Mohinder Singh Randhawa Library to Thapar Hall having a distance of 0.45 kilometers. Three parallel rows of trees were present on both the sides of the studied transect. On the left side of the transect four tree species namely Indian mahogany (*Chukrasia tabularis*), Ashoka (*Polyalthia longifolia*), Silver Oak (*Grevillea robusta*) and Peepal (*Ficus religiosa*) were found along the road. Shrubs namely Crape jasmine (*Tabernaemontana divaricata*) and China rose (*Hibiscus rosa-sinensis*) were also present.

The village Baranhara (N 30° 50' 06, E 75 46'12.79) is a medium sized village located to the west of Ludhiana city. The village Baranhara lies to the left side of the Hambran road, at a distance of 7.0 kilometers from PAU campus. Two transects were selected in the village Baranhara i.e. transect III and transect IV. Transect III started from the left turn on Hambran road leading to village Baranhara and ends at Primary Government School, Baranhara having a distance of 1.5 kilometers. The end of transect III marked the starting of transect IV which ended at a seasonal water stream (Buddha Nala) that drains into Sutlej river. The distance of transect IV was of one kilometre. The transect III consisted of a total of twenty residential houses, out of which fifteen were having lawns and vegetation (fruit trees such as guava, date palm, banana) and the remaining five houses were without lawns and vegetation. Along the road, the tree species observed were Neem (*Azadirachta indica*), Peepal (*Ficus religiosa*), Ashoka (*Polyalthia longifolia*) and Guava (*Psidium guajava*) and Banana (*Musa acuminata*). It consisted of agricultural area having crops namely Rice (*Oryza sativa*), Sorghum (*Sorghum bicolor*) and Berseem (*Trifolium alexandrinum*). Transect IV was selected in uncultivated area having thirty uncemented houses of labourers and three cattle sheds. Dense growth of wild bushes and shrubs was mainly present. The large part of said transect was utilized for drying cattle dung for fuel purposes. Heaps of domestic waste (kitchen waste) and cattle shed waste were also present. The farmers had constructed huge conical mounds for storing straw and chaff.

## 2.2 Methodology

Observations on the foraging substrate (i.e. air, plants and ground from which Black Drongo took the food), mode of feeding ( i.e. aerial feeding – feeding on the flying prey;

ground feeding – feeding on the prey picked from ground and gleaned- feeding on the prey present on plant species), perch sites ( i.e. electric power lines, trees, shrubs, crop plants and ground) and perching height (height at which Black Drongo perched for feeding purposes) being used were noted at both the studied locations <sup>[5,3,7]</sup>. Data having per observation duration of 20 minutes was taken fifteen times per month per transect at locations I and II on the feeding behaviour of Black Drongo from January 2017 to December 2017. In study area, there were identified two foraging sites per location to study interspecies associations of Black Drongo during feeding activities using point count method <sup>[6]</sup>. Data was noted for 20 minutes at each selected foraging sites, fifteen times in a month for one year. Direct observations were made to identify the insects consumed by Black Drongo without disturbing the bird. Bushnell binocular (magnification 8X and objective lens of 42 mm) was used to identify the insect species which were not visible with naked eye. Line transect was followed to note perching sites utilized by Black Drongo; the pattern of utilization of electric power lines, trees, shrubs, crop plants and ground for foraging purposes were noted fifteen times in a month for already mentioned time duration <sup>[31]</sup>. Height of the perching sites was measured using altimeter. Photography was done with the Nikon coolpix B500 camera (16.0 Mega Pixels and Optical Zoom 40x).

## 2.3 Statistical analysis

One Way Analysis of Variance (ANOVA) was carried out on average perching height of Black Drongo using SPSS software 20. To determine statistical difference Tukey B Test was applied in the mean values of both the locations during each month. Student's t-test was carried out on the average perching sites utilized by Black Drongo at both the studied locations. All the values are presented in Mean ± SE.

## 3. Results

A total of 360 observations (180 per location) on the foraging behaviour of Black Drongo were taken for time duration of 20 minutes each at both the location I and location II. Data on the flock behaviour during foraging attempts of Black Drongo had shown that it perched solitary during the early morning hours and in clusters with other bird species during the evening hours at location I while it was noted to perch in clusters with other bird species during the morning and evening hours at location II. It was very surprising to observe that Black Drongo perched individually as well as in clusters while it fed solitary mainly due to temporarily abundance of insect species at both the studied locations. The frequency of insect food foraged upon was 72.5% at location I and 65.4% at location II, using both aerial and ground feeding modes. It was due to greater area under cultivated land at location I as compared to location II. The frequency of insect gleaned from plant species was 14.2% and 13.4% at location I and II respectively. It might be due to greater tree diversity found at location I. Black Drongo indulged in foraging act during 145 observations and 120 observations out of total 180 observations each taken at location I and location II respectively. So it could be inferred that Black Drongo spend maximum time in foraging activities. In the present study, it was observed that aerial feeding (52%) was the most preferred foraging methods used by Black Drongo at both the locations.

In the present study, it was found that a number of insect species (i.e. aphids, dusky bug, dragonfly, moths, honey bee, beetles, black ants, armyworms, green lace wing, termites,

spider, grasshopper, pink stalk borer and cut worms) were present at both the studied locations but it was not found to feed on all of them which might be due to its high selectivity in insect food consumption (Table 1). During aerial feeding, Black Drongo was noticed to feed on insect species like dragonfly and moths at both locations I and II while it also fed on honey bee at location I. During ground feeding, Black Drongo was observed to feed on harmful insect species like beetles (*Orcytes boas*), termites (*Macrotermes bellicosus*) and grasshopper (*Hieroglyphus daganensis*) which cause damage to roots and shoots of the crop plants (i.e. maize, sugarcane

and berseem) and also on other insect species like spiders (*Steatoda triangulosa*) and black ants (*Camponotus pennsylvanicus*) at both the locations I and II. At location I, Black Drongo was observed to glean tree trunks of Neem (*Azadirachta indica*), Ficus (*Ficus polita*) and Simbal (*Bombax ceiba*) while at location II, it was found to glean tree trunks of Neem (*Azadirachta indica*) and Guava (*Psidium guajava*). At both the studied locations Black Drongo foraged on insect found on fodder crop Berseem (*Trifolium alexandrinum*) (Table 2).

**Table 1:** Animal species consumed by Black Drongo

Name of the animal species	Scientific Name	Family	Mode of Feeding	Location I	Location II
Dragonfly	<i>Libellula saturate</i>	Petaluridae	Aerial Feeding	+	+
Moths	<i>Platysphinx Phyllis</i>	Sphingidae		+	+
Honey Bee	<i>Apis spp</i>	Apidae		+	-
Beetles	<i>Orcytes boas</i>	Scarabaeid	Ground Feeding	+	+
Black ants	<i>Camponotus pennsylvanicus</i>	Formicidae		+	+
Termite	<i>Macrotermes bellicosus</i>	Termitidae		+	+
Spider	<i>Steatoda triangulosa</i>	Theridiidae		+	+
Grasshopper	<i>Hieroglyphus daganensis</i>	Acrididae		+	+

**Table 2:** Tree species/Fodder Crop gleaned by Black Drongo for insect food

TREE SPECIES	Tree species/Fodder Crop gleaned on	Scientific Name	Family	Mode of feeding	Location I	Location II
TREE SPECIES	Neem	<i>Azadirachta indica</i>	Meliaceae	Gleaning	+	+
	Ficus	<i>Ficus polita</i>	Euphorbiaceae		+	-
	Drumstick Tree	<i>Moringa oleifera</i>	Moringaceae		+	-
	Plum Fruit	<i>Prunus bokharensis</i>	Rosaceae		+	-
FODDER CROP	Berseem	<i>Trifolium alexandrinum</i>	Leguminosae		+	+

During the present study, Black Drongo was found to share feeding/foraging sites with 10 different bird species (Table 3). Cattle Egret (*Bubulcus ibis*), Red-wattled Lapwing (*Vanellus indicus*), Eurasian Collared-Dove (*Streptopelia decaocto*) and Asian Pied Starling (*Sturnus contra*) were observed sharing feeding site with Black Drongo at transect I and III due to the presence of agricultural area. Bird species namely Common Myna (*Acridotheres tristis*), House Crow (*Corvus splendens*), Common Babbler (*Turdoides caudate*) and Blue Rock Pigeon (*Columba livia*) were observed sharing the feeding site with

Black Drongo at all the studied transects. Bank Myna (*Acridotheres ginginianus*) and Greater Coucal (*Centropus sinensis*) were observed in feeding association with Black Drongo at transect I, III and IV. Bank Myna (*Acridotheres ginginianus*) and Greater Coucal (*Centropus sinensis*) were not observed in feeding association with Black Drongo at transect II. No competition for food was observed between Black Drongo and other bird species at the observed feeding sites which might be due to niche specialization.

**Table 3:** Bird species sharing same feeding site with Black Drongo

Common Name	Scientific Name	Order	Location I		Location II	
			Transect I	Transect II	Transect III	Transect IV
Cattle Egret	<i>Bubulcus ibis</i>	Ciconiformes	+	-	+	-
Common Myna	<i>Acridotheres tristis</i>	Passeriformes	+	+	+	+
House Crow	<i>Corvus splendens</i>	Passeriformes	+	+	+	+
Red-wattled Lapwing	<i>Vanellus indicus</i>	Charadriiformes	+	-	+	-
Common Babbler	<i>Turdoides caudate</i>	Passeriformes	+	+	+	+
Eurasian Collared-Dove	<i>Streptopelia decaocto</i>	Columbiformes	+	-	+	-
Asian Pied Starling	<i>Sturnus contra</i>	Passeriformes	+	-	+	-
Bank Myna	<i>Acridotheres ginginianus</i>	Passeriformes	+	-	+	+
Greater Coucal	<i>Centropus sinensis</i>	Cuculiformes	+	-	+	+
Blue Rock Pigeon	<i>Columba livia</i>	Columbiformes	+	+	+	+

Five indigenous tree species namely Tun (*Toona ciliata*), Dhek (*Melia azedarach*), Neem (*Azadirachta indica*), Ficus (*Ficus benjamina*) and Ashoka (*Polyalthia longifolia*) and three exotic tree species namely Silver Oak (*Grevillea robusta*), Bottle Brush (*Callistemon*) and Simbal (*Bombax ceiba*) were present at transect I of location I. Black Drongo was observed to utilize all the four indigenous tree species and no exotic tree species was utilized for perching purposes at the studied transect. At transect II, eight indigenous tree

species namely Tun (*Toona ciliata*), Ashoka (*Polyalthia longifolia*), Kusum (*Schleichera oleosa*), Indian mahogany (*Chukrasia tabularis*), Blue jacaranda (*Jacaranda mimosifolia*), Kachnar (*Bauhinia variegata*), Gulmohar (*Delonix regia*) and Peepal (*Ficus religiosa*) were present, out of which only five indigenous tree species namely Tun (*Toona ciliata*), Ashoka (*Polyalthia longifolia*), Indian mahogany (*Chukrasia tabularis*), Kachnar (*Bauhinia variegata*) and Gulmohar (*Delonix regia*) were utilized for

perching by Black Drongo. At transect II, two exotic tree species namely Silver Oak (*Grevillea robusta*) and White Frangipani (*Plumeria obtusa*) were present out of which Black Drongo was observed to utilize only one exotic tree species namely White Frangipani (*Plumeria obtusa*) for perching at the studied transect. Six indigenous trees namely Neem (*Azadirachta indica*), Ashoka (*Polyalthia longifolia*), Peepal (*Ficus religiosa*), Curry tree (*Murraya koenigii*), Guava (*Psidium guajava*), Banana (*Musa acuminata*) were present at transect III. Black Drongo was found to utilize four indigenous tree species namely Neem (*Azadirachta indica*), Ashoka (*Polyalthia longifolia*), Curry tree (*Murraya koenigii*) and Guava (*Psidium guajava*) for perching at the studied transect. Black Drongo did not utilize exotic tree species namely Date Palm (*Phoenix dactylifera*) for perching purposes at transect III. At transect IV, three indigenous tree species namely Dhek (*Melia azedarach*), Neem (*Azadirachta indica*) and Peepal (*Ficus religiosa*) were present out of which, Dhek (*Melia azedarach*) and Neem (*Azadirachta indica*) were utilized for perching by Black Drongo. Exotic tree species were not present at transect IV (Table 4). In transect I, four shrub species namely Yellow Oleander (*Thevetia peruviana*), Bougainvillea (*Bougainvillea glabra*), Crape Jasmine (*Tabernaemontana divaricata*) and China rose (*Hibiscus rosa-sinensis*) were present out of which

Bougainvillea (*Bougainvillea glabra*) and China rose (*Hibiscus rosa-sinensis*) were utilized for perching by Black Drongo. Black Drongo utilized only one shrub species namely China rose (*Hibiscus rosa-sinensis*) out of two shrub species namely Crape jasmine (*Tabernaemontana divaricata*) and China rose (*Hibiscus rosa-sinensis*) present at transect II. At transect III, three shrub species namely Bougainvillea (*Bougainvillea glabra*), Crape jasmine (*Tabernaemontana divaricata*) and China rose (*Hibiscus rosa-sinensis*) were present out of which Bougainvillea (*Bougainvillea glabra*) and China rose (*Hibiscus rosa-sinensis*) were utilized for perching by Black Drongo. Shrub species were not present in transect IV (Table 5).

At transect I four crop plants were present out of which only Maize (*Zea mays*), Sugarcane (*Saccharum officinarum*) and Sorghum (*Sorghum bicolor*) were utilized for perching by Black Drongo. At transect III, four crop plants were present namely Sorghum (*Sorghum bicolor*), Rice (*Oryza sativa*), Bathua (*Chenopodium album*) and Berseem (*Trifolium alexandrinum*) out of which Black Drongo utilized Sorghum (*Sorghum bicolor*), Bathua (*Chenopodium album*) and Berseem (*Trifolium alexandrinum*) crop plants for perching. Crop plants were not present in transect II and transect III (Table 6).

**Table 4:** Tree species utilized by Black Drongo for perching

Tree Species	Scientific Name	Location I				Location II			
		Transect I		Transect II		Transect III		Transect IV	
		Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)
<b>Indigenous Tree Species</b>									
Tun	<i>Toona ciliata</i>	+	√	+	√	-	X	-	X
Dhek	<i>Melia azedarach</i>	+	√	-	X	-	X	+	√
Neem	<i>Azadirachta indica</i>	+	√	-	X	+	√	+	√
Ashoka	<i>Polyalthia longifolia</i>	+	√	+	√	+	√	-	X
Kusum	<i>Schleichera oleosa</i>	-	X	+	X	-	X	-	X
Indian mahogany	<i>Chukrasia tabularis</i>	-	X	+	√	-	X	-	X
Blue Jacaranda	<i>Jacaranda mimosifolia</i>	-	X	+	X	-	X	-	X
Kachnar	<i>Bauhinia variegata</i>	-	X	+	√	-	X	-	X
Gulmohar	<i>Delonix regia</i>	-	X	+	√	-	X	-	X
Peepal	<i>Ficus religiosa</i>	-	X	+	X	+	X	+	X
Curry tree	<i>Murraya koenigii</i>	-	X	-	X	+	√	-	X
Ficus	<i>Ficus benjamina</i>	+	X	-	X	-	X	-	X
Guava	<i>Psidium guajava</i>	-	X	-	X	+	√	-	X
Banana	<i>Musa acuminata</i>	-	X	-	X	+	X	-	X
<b>Exotic Tree Species</b>									
Silver Oak	<i>Grevillea robusta</i>	+	X	+	X	-	X	-	X
Date Palm	<i>Phoenix dactylifera</i>	-	X	-	X	+	X	-	X
Bottle Brush	<i>Callistemon</i>	+	X	-	X	-	X	-	X
Simbal	<i>Bombax ceiba</i>	+	X	-	X	-	X	-	X
White Frangipani	<i>Plumeria obtusa</i>	-	X	+	√	-	X	-	X

**Table 5:** Shrub species utilized by Black Drongo for perching

Shrub Species	Scientific Name	Location I				Location II			
		Transect I		Transect II		Transect III		Transect IV	
		Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)
Yellow oleander	<i>Thevetia peruviana</i>	+	X	-	X	-	X	-	X
Bougainvillea	<i>Bougainvillea glabra</i>	+	√	-	X	+	√	-	X
Crape jasmine	<i>Tabernaemontana divaricata</i>	+	X	+	X	+	X	-	X
China rose	<i>Hibiscus rosa-sinensis</i>	+	√	+	√	+	√	-	X

**Table 6:** Crop plants utilized by Black Drongo for perching

Crop Plants	Scientific Name	Location I				Location II			
		Transect I		Transect II		Transect III		Transect IV	
		Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)	Present/Not Present(+/-)	Utilized for perching/Not utilized (√/X)
Maize	<i>Zea mays</i>	+	√	-	X	-	X	-	X
Sugarcane	<i>Saccharum officinarum</i>	+	√	-	X	-	X	-	X
Sorghum	<i>Sorghum bicolor</i>	+	√	-	X	+	√	-	X
Wheat	<i>Triticum aestivum</i>	+	X	-	X	-	X	-	X
Rice	<i>Oryza sativa</i>	-	X	-	X	+	X	-	X
Bathua	<i>Chenopodium album</i>	-	X	-	X	+	√	-	X
Berseem	<i>Trifolium alexandrinum</i>	-	X	-	X	+	√	-	X

A total of 360 observations (180 per location) were taken on the perching height of Black Drongo on the electric power lines and trees. All the values of data are presented in Mean±S.E (Table 7). The annual average perching height of Black Drongo on electric power lines ranged between 12.93±0.21 m to 13.28±0.21 m and between 12.19±0.23 m to 12.72±0.19 m at location I and location II respectively. The annual average perching height of Black Drongo on trees ranged between 13.43±0.28 m to 15.93±0.45 m and between 11.72±0.55 m to 15.40±0.55 m at location I and location II respectively. It was noted that the Black Drongo preferred low

tree height for perching sites during the breeding season from May to August at both the locations. It was found to perch on the same branch of the tree in close proximity to the nest to protect it from the invading predators. Black Drongo preferred comparatively higher perch sites during the non-breeding season from September to April at both the studied locations. No such height preference for electric power lines was noted during breeding and non-breeding season at both the locations. Significant relationship was found between mean values of both the locations during each month (ANOVA at 5% level of significance).

**Table 7:** Average perching height of Black Drongo

Perch Sites ↓ Months	Electric Power Line (m) (N= 15)		Trees (m) (N= 15)	
	Location I Mean± SE (m)	Location II Mean ± SE (m)	Location I Mean ± SE (m)	Location II Mean ± SE (m)
January	13.16±0.22 <sup>b</sup>	12.45 ± 0.21 <sup>b</sup>	15.27±0.45 <sup>a</sup>	13.02±0.60 <sup>a</sup>
February	13.13±0.24 <sup>bc</sup>	12.30 ± 0.20 <sup>c</sup>	15.13±0.39 <sup>a</sup>	14.00±0.36 <sup>ab</sup>
March	13.11±0.22 <sup>b</sup>	12.33±0.21 <sup>b</sup>	15.38±0.43 <sup>a</sup>	13.94±0.46 <sup>ab</sup>
April	13.28±0.21 <sup>ab</sup>	12.51±0.20 <sup>ab</sup>	14.45±0.49 <sup>a</sup>	12.10±0.44 <sup>b</sup>
May	13.08±0.22 <sup>a</sup>	12.40±0.21 <sup>a</sup>	13.43±0.28 <sup>a</sup>	11.88±0.51 <sup>a</sup>
June	12.98±0.23 <sup>ab</sup>	12.65±0.19 <sup>ab</sup>	13.97±0.32 <sup>a</sup>	11.72±0.55 <sup>b</sup>
July	13.25±0.24 <sup>ab</sup>	12.36±0.22 <sup>bc</sup>	13.79±0.26 <sup>a</sup>	11.83±0.36 <sup>c</sup>
August	13.00±0.20 <sup>ab</sup>	12.38±0.22 <sup>ab</sup>	13.67±0.34 <sup>a</sup>	12.07±0.41 <sup>b</sup>
September	12.93±0.24 <sup>bc</sup>	12.19±0.23 <sup>c</sup>	15.33±0.39 <sup>a</sup>	13.56±0.58 <sup>ab</sup>
October	13.03±0.23 <sup>b</sup>	12.41±0.21 <sup>b</sup>	15.25±0.45 <sup>a</sup>	15.40±0.55 <sup>a</sup>
November	13.17±0.24 <sup>b</sup>	12.31±0.21 <sup>b</sup>	15.11±0.37 <sup>a</sup>	12.81±0.51 <sup>b</sup>
December	12.93±0.21 <sup>b</sup>	12.72±0.19 <sup>b</sup>	15.93±0.45 <sup>a</sup>	13.97±0.55 <sup>ab</sup>

Mean values with the same letter are not significantly different (ANOVA at 5% level of significance)

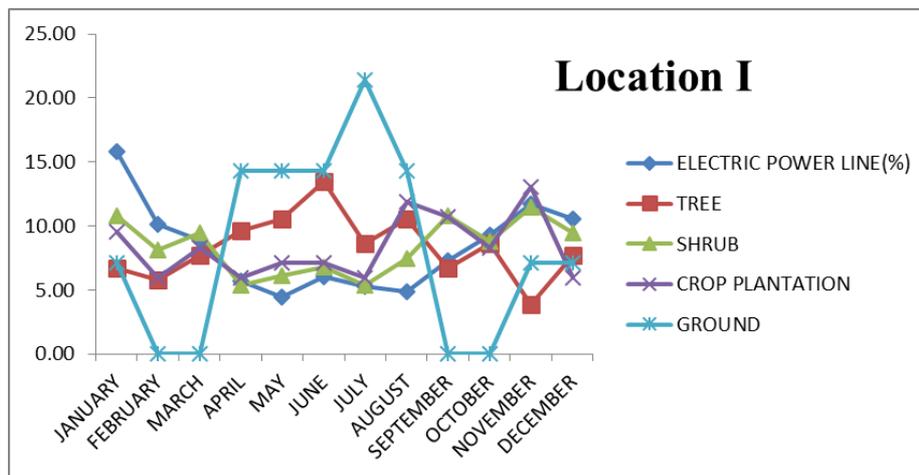
The trend of perch site utilisation trees > ground > crop plants > shrubs > electric power lines was found in similar sequence from May to August at both the locations (Table 8). It was observed that Black Drongo foraged perching on trees as compared to other perching sites maximum times during the breeding season (May to August) (Fig. I). This behaviour might have helped it in keeping its nest, eggs and chicks safe from predators. Electric power lines were the most preferred perching sites during the non-breeding season (September to April) as compared to trees, shrubs, crop plants and ground (Fig. II). Electric power lines seemed to provide better view for easy prey detection and hunting. It was observed that Black Drongo predominantly gleaned ground for food hunting

near their nesting sites during the breeding season from May to August. Both parents were not observed on ground together during the breeding season as they took turns to look for food while one of them was always near the nesting site. House crows were noticed attacking Black Drongo nests during the incubation period.

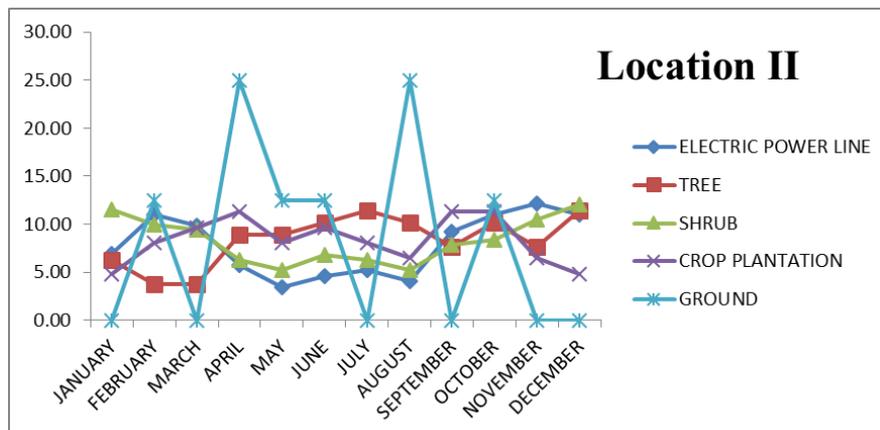
Student's t-test has been carried out on the average perching sites utilized by Black Drongo at both the locations. The statistical comparison showed the significant difference at 5% level of significance ( $p < 0.05$ ) on electric power lines, trees, shrubs and crop plants between both the locations. Non significant difference was found at 5 % level of significance ( $p > 0.05$ ) on the ground between both locations.

**Table 8:** Average perching sites utilized by Black Drongo

Perching sites →	Electric power lines		Trees		Shrubs		Crop Plants		Ground	
	Location I Mean±SE(m)	Location II Mean±SE(m)								
MONTHS ↓										
January	3.25±0.39	1.83±0.34	0.58±0.26	0.42±0.24	1.33±0.25	1.83±0.28	0.67±0.23	0.25±0.19	0.08±0.16	0
February	2.08±0.32	1.58±0.26	0.50±0.26	0.25±0.19	1.00±0.27	1.58±0.30	0.42±0.21	0.42±0.21	0	0.08±0.15
March	1.83±0.22	1.42±0.24	0.67±0.23	0.25±0.19	1.17±0.28	1.50±0.24	0.58±0.24	0.50±0.24	0	0
April	1.17±0.22	0.83±0.22	0.83±0.22	0.58±0.21	0.67±0.25	1.00±0.25	0.42±0.21	0.58±0.24	0.17±0.18	0.17±0.18
May	0.17±0.18	0.08±0.15	0.92±0.24	0.83±0.24	0.42±0.24	0.25±0.19	0.50±0.24	0.42±0.21	0.75±0.23	0.58±0.26
June	0.17±0.18	0.08±0.15	1.25±0.25	1.08±0.27	0.42±0.24	0.25±0.19	0.50±0.21	0.50±0.24	1.17±0.24	0.67±0.20
July	0.25±0.23	0.25±0.19	1.00±0.25	0.83±0.22	0.42±0.24	0.42±0.24	0.67±0.20	0.58±0.24	0.75±0.23	0.75±0.23
August	0.50±0.26	0.17±0.18	1.00±0.25	0.83±0.28	0.58±0.24	0.33±0.20	0.67±0.25	0.50±0.26	0.92±0.26	0.67±0.25
September	1.50±0.24	1.33±0.23	0.58±0.24	0.50±0.24	1.33±0.20	1.25±0.27	0.75±0.23	0.58±0.26	0	0
October	1.92±0.29	1.58±0.26	0.75±0.19	0.67±0.23	1.08±0.24	1.33±0.25	0.58±0.24	0.58±0.24	0	0.08±0.15
November	2.42±0.32	1.75±0.28	0.33±0.20	0.50±0.21	1.42±0.27	1.67±0.29	0.92±0.26	0.33±0.20	0.08±0.15	0
December	2.17±0.28	1.58±0.26	0.67±0.23	0.75±0.25	1.17±0.29	1.92±0.24	0.42±0.21	0.25±0.19	0.08±0.15	0



**Fig 1:** Percent utilization of perching sites by Black Drongo at location I



**Fig 2:** Percent utilization of perching sites by Black Drongo at location II

**4. Discussion**

Observations had showed that the percent of insect food fed upon was higher than that of plant species gleaned upon by Black Drongo. The results correlated with Okosodo *et al* that reported the higher consumption of insect species (86.6%) by Black Drongo as compared to the plant species (14.4%) [21]. The results correlated with Kaur *et al* that Black Drongo belonging to P/I trophic level, fed on both insect and plant matter during the study conducted on bird assemblages at village ponds in Punjab [11]. In our study, aerial feeding was the most preferred foraging method used by Black Drongo.

Murakami had stated that Black Drongo and Small Bee-eater foraged mostly by aerial feeding whereas Common Myna used ground feeding as a common foraging technique [19]. Narayana *et al* reported that foraging behaviour of Black Drongo is interlinked with habitat and accessibility of food resources [20]. Bell and Ford had stated that foraging substrates play an important role in prey selection in insectivorous birds [5]. During the present study, it was noted that Black Drongo fed on harmful insect species mainly beetles, termites and grasshopper which harm the crop plantations, therefore acted as useful species for farmers. Similar observations were given

by Okosodo *et al* [21].

Black Drongo was recorded to feed selectively on the insect species found at the studied locations. Recher and Davis found that mode of feeding in insectivorous birds changed according to habitats and prey availability [23]. In our study, Black Drongo was observed to share same feeding site with other bird species without any competition for food resources at both the studied locations. The results correlated with Royama that many insectivorous bird species feed selectively and utilize factors such as prey abundance and size for its food consumption [25]. Gokula and Vijayan had stated that habitat structure and food availability are responsible for the variations in the foraging behaviour of insectivorous bird [9]. Workers had mentioned that insectivorous birds preferred agricultural lands due to relatively rich supply of insects for food consumption [28]. Authors had mentioned that Black Drongo occupied food guild of insectivorous nature and had explored aerial and perch-to-site foraging guild in wheat and rice agroecosystem [13]. Black Drongo showed gleaning behaviour while hunting for insects on trunks of Neem, Ficus, Drumstick tree and Berseem crop. Studies on the avian foraging ecology in wheat agroecosystem had utilized insectivorous food guild and both aerial and perch-to-site foraging guild in mustard agroecosystem which showed its biocontrol potential against agricultural pests [14].

It could be inferred from the present study that Black Drongo preferred crop fields over other habitat types like orchards. The present observations are in consonance with that reported by Sidhu and Kler that Black Drongo was found lesser observed bird species at the orchards and was found mainly near the crop fields [26]. Similar findings were noted by Kler and Kumar that Black Drongo was found most abundant in the agricultural habitats [12]. In present study, Black Drongo utilized indigenous and exotic tree species, shrub species and crop plants for perching purposes and had also showed different tree height preferences during the breeding and non-breeding season. Sohi and Kler had studied nest site preferences of fifteen different bird species in relation to indigenous trees and exotic trees in Punjab [29]. Sidhu and Kler had reported that the insectivorous species (namely Small Bee-eater, Wire-tailed Swallow, Indian Chat, Plain Prinia and Black Drongo) had utilized different perching heights for food hunting and had higher relative abundance at Guava flowering stage as compared to its fruit set stage and fruit ripening stage due to easy availability of insect diversity [27]. Authors had mentioned that insectivorous bird species searched for food at different heights with selection of various perch sites and applied different foraging methods to obtain their food [30].

In present study, Black Drongo used a variety of perch sites namely electric power lines, trees, shrubs, crop plants and ground. It was noted that Black Drongo preferred foraging on trees and electric power lines during breeding and non-breeding season respectively. Workers had mentioned that Black Drongo preferred to use electric power lines more often as compared to other perch sites as it provided suitable perches to bird for prey detection and hunting [32, 20, 4]. Lammers and Collopy stated that the avian predators are attracted to electric power lines as they provide better perches for prey hunting [15]. Gokula and Vijayan found that perch sites and characteristics play an important role in prey hunting in insectivorous birds [9]. Authors stated that utilization of perch sites and its height might play a significant role in prey selection and hunting in case of insectivorous birds [3,8]. Insectivorous birds are height generalists which depend on vegetation structure, prey abundance and distribution and it

affected their perch height selection. The results correlated with Narayana *et al* that perch types, height and foraging height is interlinked with the habitat and availability of food resources. During present observations, Black Drongo perched frequently at same place for hunting of prey insects. Similar observations were noted by Narayana *et al* [20]. Ali *et al* 2010 stated that several factors mainly species abundance, availability and type of prey in a particular habitat influenced the perch type preference in insectivorous birds [1].

## 5. Conclusion

Foraging behaviour of Black Drongo had showed insect food as predominant diet component captured by both aerial and ground foraging activities. Feeding association of Black Drongo with 10 different bird species belonging to different food guilds had been observed. Nine indigenous tree species, one exotic tree species, two shrubs and five crop species had been utilized by Black Drongo for perching purposes. It showed preference for low tree height during breeding season and high tree height during non-breeding season respectively. Statistical significance was found on perch site utilization behaviour of Black Drongo in relation to electric power lines, trees, shrubs, crop plants and ground between both the locations. It may be inferred that location specific habitat features may determine the perching and foraging behaviour of Black Drongo.

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