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Record of flower visitors and the pasturage for pollinators of Cashew

Introduction:

Pollination plays an important role in the reproduction and fruit set of flowering plant communities. In nature, only five per cent of the crops are self-pollinated and remaining 95 per cent are cross-pollinated and insects play a key role in pollination of several flowering plants. Cashew is an important tree nut crop. It is andromonaecious and the pollen grains are sticky in nature. Even the longer stamen of the hermaphrodite flower is shorter than style, thus making self pollination difficult. The flowers require external agents for pollen transmission and insects play a key role in pollination. In general, anthesis of cashew flowers occurs between 9.00 am and 2.00 pm, and the peak period of anther dehiscence is from 9.30 am to 11.30 am.

Several studies showed that fruit set in cashew is mainly influenced by activity of pollinators. Flies (Roubik 1995), moths (Kevan, 1975) and bees (Heard et al., 1990; Freitas and Paxton 1998) have been viewed as the major cashew pollinators world-wide. But very little information is available about the effective pollinators of cashew. It is important to document the diverse pollinators in a locality to understand and address pollination issue.

Flower visitors of cashew at Puttur

Cashew flowers are visited by diverse group of insects. However, some species visit cashew flowers with less frequency and are not good pollinators. The flower visitors of cashew recorded at Puttur region of Karnataka include 40 insect species belonging to 13 families of three insect orders. The hymenopterans were the major floral visitors comprising of bees (belonging to Apidae and Halictidae), ants and wasps followed by Dipterans (Table 1). The list excluds pests of cashew flowers (several lepidopterans, hemipterans and coleopterans damage cashew flowers), predators (except ants and wasps that visit cashew flowers for nectar from extra floral nectarines (EFN) and floral

Table 1. Flower visitors of cashew at Puttur, Karnataka

Common name		Scientific name	Common name		Scientific name
Bees	Reed bees	*Braunsapis picitarsus* (Cameron) *	Butterflies	-	Undetermined sp.
	Small carpenter bee	*Ceratina hieroglyphica Smith* *	Flies	Blow fly	*Stomorhina sp.*
	Small carpenter bee	*Ceratina binghami* *		-	Undetermined sp.
	Small carpenter bee	*Ceratina sp.*		-	Undetermined sp.
		Braunsapis sp. *		-	Undetermined sp.
	Sweat bee	*Pseudapis oxybeloides Smith**		Hover fly	*Paragus sp.*
	Sweat bee	*Pseudapis sp.*		Hover fly	*Ischiodon scutellatis*
	Sweat bee	*Lasioglossum sp. 1**		Hover fly	Undetermined sp.
	Sweat bee	*Lasioglossum sp. 2*		-	Undetermined sp.
	Sweat bee	*Seledonia sp.**		-	Undetermined sp. 1.
	Asian hive bee	*Apis cerana indica F.**		-	Undetermined sp. 2.
	Indian little bee	*Apis florea L.* *		-	Undetermined sp.
	Stingless bee	*Tetragonula sp.**	Wasps	-	*Chalybion bengalense*
	Carpenter bee	*Xylocopa sp.*		Potter wasp	*Eumenes sp.*
Ants	Carpenter ant Black golden ant	*Camponotus compressus F.* *Camponotus sericius F.*		-	*Antepipona sp.*
	-	*Prenolepis naoroji Forel*			
	Yellow Crazy ant	*Anaplolepis gracillipes* Smith			
	Weaver ant	*Oecophylla smaragdina* (F.)			
	Cocktail ant	*Crematogaster sp.*			
	-	*Monomorium sp.*			
	Short legged hunchback ant	*Myrmecaria brunnea* Saunders			
	White footed ghost ant	*Technomyrmex albipes Smith*			
	Odour ant	*Tapinoma melanocephalum F.*			
	Arboreal bicoloured ant	*Tetreponera rufonigra* Jerdon			

Table 2. Foraging reward of cashew pollinators

Bee species	Foraging reward	Preferred flower	
		Male/female	Fresh or old
Apis cerana indica F.	Nectar > pollen	♂&♀	Fresh > a day old
Apis florea L.	Nectar> pollen	♂&♀	Fresh > a day old
Braunsapis picitarsus	Pollen>nectar	♂ > ♀	Fresh
Ceratina hieroglyphica	Pollen>nectar	♂	Fresh > a day old
Tetragonula sp.	Pollen>nectar from Extra floral nectarines> nectar	♂ > ♀	Fresh
Lasioglossum sp. 1	Pollen>Nectar> nectar from Extra floral nectarines	♂ > ♀	Fresh
Pseudapis oxybeloides	Pollen>Nectar	♂ > ♀	Fresh
Seledonia sp.	Pollen>Nectar	♂ > ♀	Fresh > a day old

Apis cerana indica

Braunsapis picitarsus

Pseudapis oxybeloides

nectar, respectively) and parasitoids of cashew pests which are not pollinators.

Important pollinators of cashew

Among the 40 species recorded as flower visitors of cashew, eight species are considered as important pollinators of cashew belonging to Apidae and Halictidae family (Table 2). Depending on the sunshine, initiations of activities of bee species on cashew flowers were noticed in the morning and the peak activity was between 11.00 and 1.00 pm. Peak foraging period of pollinators coincides with peak anther dehiscence in cashew, which is very

much advantageous for effective pollination in cashew. Certain bees visited mainly for pollen, while, few bees mainly for nectar and extra floral nectarines. For A. c. indica and A. florea, nectar was the major foraging reward. For Tetragonula sp., foraging reward was nectar from extra floral nectarines followed by pollen and nectar. Whereas, pollen was the major foraging reward for B. picitarsus, C. hieroglyphica, P. oxybeloides, Lasioglossum sp. and Seledonia sp. followed by nectar. Since pollen was the foraging reward for most of the bee species, fresh male flowers were most preferred.

Bee flora

Abundance and occurrence of pollen and nectar sources are important factors for bees survival. During non-flowering period of cashew bees especially, Apis cerana indica, *Apis dorsata, A. florea, Xylocopa spp., Ceratina sp, Braunsapis sp., Lasioglossum sp., Tetragonula* sp. foraged on surrounding trees like arecanut, coconut, neem, May flower, acacia, golden showers etc. Weed species visited by bees include *Leucas aspera, Vedalia sp., Tridox procumbens, Mimosa pudica, Melastoma malabathricum, Lantana camara, Spermacoce hispida, Blumea sp., Antigonon leptopus, Caesalpinia spp., Passiflora foetida, Alternanthera* sp., *Gompherena sp., Ixora sp., Terminalia* sp., etc. Among the flora, A. leptopus was found to be preferable for Braunsapis sp., Certaina spp., *A. florea* and few other wild bees. It was also reported by Sundararaju et al., (2011) that during lean period of cashew, halictid bees sustained on *Spermacoce ocymoides B., S. stricta, M. pudica, Caesalpinia mimosoides Lindernia antipoda, Acacia pennata, Rungia repens, L. aspera, Muntingia calabura and Blumea* sp. in cashew plantations of coastal Karnataka.

Conclusion

Pollination of cashew is resulted by many native bee species and the important pollinators include *B. picitarsus, P. oxybeloides, A. cerana and C. hieroglyphica* etc. Peak foraging activity of all the recorded bee species coincides with the peak anthesis and anther dehiscence period of cashew flowers thus ensuring more pollination. Enhancing bee flora in and around the cashew plantations especially during non-flowering period of cashew will ensure bee survival and conservation.

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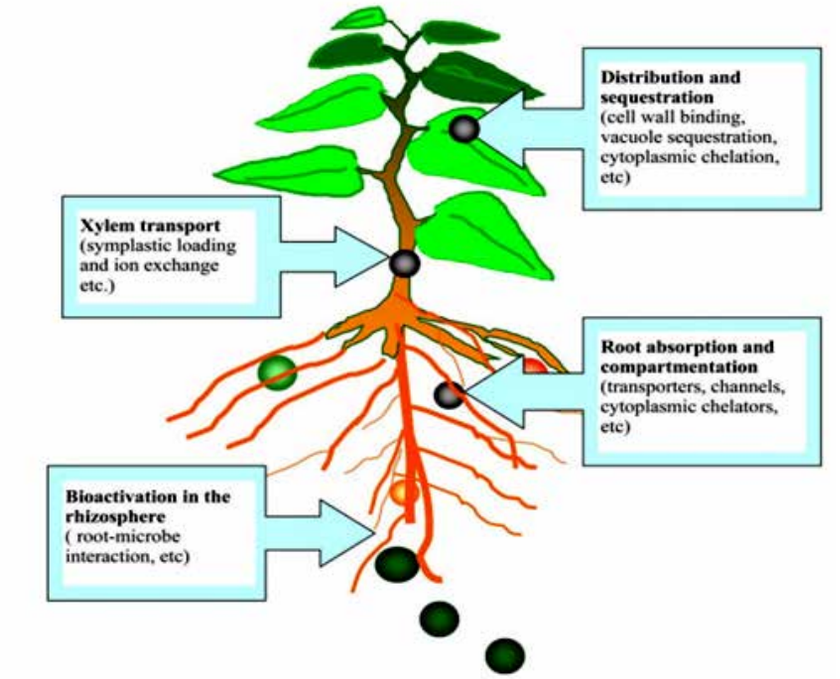
PHYTOREMEDIATION

A potential remediation technology for heavy metal contaminated sites

Introduction

The contamination of environment with heavy metals started parallel to the dawn of industrialization not only in India but worldwide. These are important environmental pollutants as many of them are toxic even when present in traces. The accumulation of heavy metals in living biota may cause various diseases and disorders due to their toxic nature. Heavy metal accumulation in soil and plants due to anthropogenic activity has been reported from different parts of India (Sachan et al., 2007; Shanker et al., 2005; Deka and Bhattacharyya, 2009; Rajindiran et al., 2015). Excess heavy metals in the soil originate from many sources, which include atmospheric deposition, untreated wastewater discharge on land, sewage irrigation, application of industrial sludge as manure, mining activities and the use of pesticides and fertilizers (Zhang, 2011). Irrespective of their sources in the soil, accumulation of heavy metals can degrade soil physico-chemical and biological properties, and hence reduce crop yield and the quality of agricultural products which negatively impact the health of human, animals, and the ecosystem (Nagajyoti et al., 2010). The existing heavy metal pollution of soil and water in India requires a special attention for remediation through eco-friendly and cost-effective approach by using plants called phytoremediation.



Phytoremediation

Phytoremediation is defined as the use of green plants to remove pollutants from the environment or to render them harmless/ immobile/bio-unavailable (Raskin et al., 1994, Sumiahadi and Acar, 2018). It is being considered as a new highly promising and potential technology for the efficient remediation of sites polluted with both organic and inorganic pollutants. Phytoremediation is often also referred as botanical bioremediation or green remediation (Chaney et al.,