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3.2.1 Number of research papers per teachers in the Journals notified on UGC website

3.2.1.1 Number of research papers per teachers in the Journals notified on UGC website during the year

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3.2.1. Number of research papers per teachers in the Journals notified on UGC website during the year						
Title of paper	**Name of the author/s**	**Department of the teacher**	**Name of journal**	**Year of publication**	**ISSN number**	**Link to the recognition in UGC enlistment of the Journal**
Wings of Khichan: Unraveling the Ecology, Migration, and Conservation Challenges of Demoiselle Cranes in the Thar Region	Daulal Bohra	Zoology	International Research Journal of Engineering and Technology (IRJET)	2023	2395-0056	https://www.irjet.net/archives/V10/i11/IRJET-V10I1172.pdf
First Report of Breeding Pair of Red-necked Phalarope (*Phalaropus lobatus*) on the Sambhar Ramsar Site, Rajasthan, India	Daulal Bohra	Zoology	International Journal of Zoological Investigations Vol. 9, No. 2, 505-511 (2023)	2023	2454-305	International Journal of Zoological Investigations
Phytoremediation – The Use of Green Plants to Clean Up Polluted Soil Concerning Climate Change and Environmental Effect	Suman Saini and Ankit Kumar Jangid	Botany	International Journal of Pure and Applied Biosciences	2023	2320-7051	http://dx.doi.org/10.187.382/2312-7051.5406
औषधीय पौधों में कायिक प्रवर्धन विकास से औषधीय पादप क्षेत्र में नई पहल	Suman Saini and Ankit Kumar Jangid	Botany	कृषि प्रवाहिका: ई-समाचार पत्रिका	2023	2583-0430	http://krishipravahika.vitalblotech.org/
Mathematical Modelling and Simulation of Fingerprint Analysis Using Graph Isomorphism, Domination and Graph Pebbling	Bhupendra Singh	Mathematics	Advance and Applications in Discrete Mathematics	2023	0974-1658	https://www.pphmj.com/abstract/15044.htm
Electronic Properties of Semiconducting Nanowires: a Comparative Study	Satyendra Singh	Physics	Nepal Journal of Science and Technology	2024	2382-5359	https://doi.org/10.3126/njst.v21i2.67168

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Wings of Khichan: Unraveling the Ecology, Migration, and Conservation Challenges of Demoiselle Cranes in the Thar Region

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Abstract - *The Thar region in Rajasthan provides a habitat for a diverse range of migratory avian species, with the Demoiselle Crane (Anthropoides virgo) being prominent among them. These cranes gather in Khichan village, in search of favorable ecological conditions to sustain, lodge, and nurture their young ones. Anthropoides virgo, the smallest crane, boasts an average adult length of 90cm, featuring streamlined bodies, long rounded grey wings, and short toes and bills. Engaging in a cyclic migration pattern, Demoiselle cranes undertake a demanding journey, covering 5000 kilometers in around two weeks. Originating from Siberia, China, Mongolia, Russia, the Tibetan plateau, they navigate through the Dead Sea, Afghanistan, and Central Asia before settling in their winter habitat in India. Arrival in Khichan typically occurs in late September, and the cranes stay until early March before migrating back to the northern region during spring via the Central Asian Flyway (CAF). The conservation status of Demoiselle cranes, according to the IUCN Red List, is categorized as 'Least Concern.' Research data from 2022-23 indicates a peak winter population of up to 40,000, with estimates in early October ranging between 5000-7000 in Khichan Bird Sanctuary. Key roosting sites include waterbodies such as Vijaysagar Talab, Ratri Nadi, Nibli Nadi, and Teejaniyo Ki Nadi, while the 'Chugga Ghar' serves as a vital feeding ground.*

Despite their resilience, these cranes face threats such as food poisoning, predation by dogs, temperature fluctuations, and electric shocks from power lines. The primary cause of increased mortality is linked to power lines and excessive insecticide use in agricultural areas where the birds roost at night. This study closely examines the Demoiselle crane population, emphasizing habitat utilization, ecological behavior, and the challenges encountered during their winter stay in Khichan village, Rajasthan.

Key Words: Thar region, Migratory avian species, Demoiselle Crane (Anthropoides virgo), Khichan village, Ecological behavior, Threats to Demoiselle Cranes, Population dynamics, Rajasthan.

1.INTRODUCTION

The Central Asia Flyway (CAF), a migratory route guiding Demoiselle cranes to Gujarat and Rajasthan in India, underscores the significance of protected sites such as Important Bird Areas (IBAs), bird sanctuaries, wildlife refuges, and national parks in wetlands. These areas serve as crucial stopovers and wintering grounds for approximately half of India's 243 water bird species and 67 wetland-dependent birds [1] [12].

There are a total of fifteen crane species distributed globally [5]. Among them five crane species found in India, the Demoiselle Crane stands out, embarking on a majestic winter migration journey. Recognized locally as the Kurjan bird, the Demoiselle Crane's distinctive features include long legs, neck, and a compressed bill, with a bluish-grey body adorned by dark and light grey markings. Notably, the Demoiselle Crane holds a conservation status of "Least Concern" according to the IUCN Red List and is listed in Appendix II of CITES (2012). Winter sees thousands of Demoiselle Cranes descending upon Rajasthan's Thar Desert, with Khichan village in Phalodi district standing out as a world-renowned wintering ground, hosting the second-largest population globally (Gehlot et al., 2021). The region's Flyways, often considered as 'routes' for bird migration, play a pivotal role, with India positioned in three key flyway zones: Central Asian Flyway (CAF), East-Asian Australasian Flyway (EAAF), and Asian East African Flyway (AEF). Birds migrating across the Himalayan region confront significant physiological and climatic challenges as they traverse the highest peaks in the world. Ringing programs have contributed valuable data regarding the origins and destinations of these birds [6].

Approximately 370 migratory bird species utilize these flyways, with the Central Asian Flyway alone supporting at least 274 waterbird populations. Demoiselle Cranes, Siberian Cranes, and Hooded Cranes are among the species relying on the Central Asian Flyway [10]. Migratory birds are confronted with perilous threats resulting from huma[illegible]luding the use of

pesticides, deforestation, and industrialization [9]. Conservation hurdles in the area stem from inadequate management practices driven by a lack of understanding of Demoiselle Crane ecology, a shortage of scientific research, unchecked tourism, periodic pond desiccation, the hazard of electric cables leading to crane fatalities, and insufficient medical care for sick or injured birdS [8]. However, this study sets out to uncover the secrets of the Demoiselle Crane: understanding its population dynamics, unraveling migratory mysteries, and confronting the major threats it faces in the enchanting Khichan village in Thar Desert of Rajasthan, India.

1.1 Avian Migration and Its Importance

The ecological significance of migration, as evident in its impact on food production, climate, and conservation, underscores the importance of studying this phenomenon [10]. The Demoiselle Crane's migratory journey, spanning thousands of kilometers, highlights the need for conservation efforts to counter increased anthropogenic threats, habitat destruction, and alteration of resting grounds in their wintering sites [2] [3]. The migratory birds exhibit their highest winter population levels in December, January, and February.

The migration routes spanned between 2170 to 5600 km, while the transit migration covered distances from 1900 to 4600 km, lasting between seven to 13 days. Clearly, the Demoiselle Crane manages this period without the need for immediate energy replenishment, relying on resources accumulated before initiating the transit migration [7].

Every winter, numerous flocks of Demoiselle Cranes make their way to the Thar Desert in Rajasthan. Originating from Siberia, China, Mongolia, Ladakh, and the Tibetan Plateau, their migratory journey extends through Afghanistan and Central Asia before concluding in the north-western part of India, specifically at the Thar Desert. The purpose of this migration is to escape the harsh cold of the Arctic region by seeking warmer climates.

2. Historical perspective; Khichan as Wintering Ground

Khichan, recognized as a crucial wintering site, experiences an annual increase in the Demoiselle Crane population due to distinctive community initiatives [4]. Situated on the outskirts of the Thar Desert, Khichan lies along the migratory route of Demoiselle Cranes as they travel from their breeding grounds in Eurasia to bask in the milder winter climate of India. In late September, the initial flocks embark on their aerial journey from the plateaus, steppes and wetlands of Mongolia and the Caucasus region. Covering approximately 5,000 kilometers in about two weeks, they traverse numerous international borders, soaring over the Himalayas. By November, a multitude of birds descends, and for a duration of five months, Khichan transforms into a 'crane village.'

3. Study Site

The latitude of Khichan village is 27.142930, and the longitude is 72.420227. The population density of this village is 7,025, as per the records collected in 2011. Khichan has been recognized by the Rajasthan Tourism Development Corporation (RTDC) as a tourist hotspot. Thousands of cranes spend the winter in Khichan, and they can be seen right in the middle of the village. Various sites were studied during the survey for data collection, such as agricultural fields, feeding grounds, wetlands, lakes, ponds, etc.

3.1 Feeding Ground (Chugga ghar)

The feeding ground of these cranes is the “chugga ghar,” which is located on the entry pathway of the village and covers an area of 6416 square meters where they feed upon grains. On a daily basis, a total of 2500 kilograms of grains are provided to the birds during the peak winter season. They come to the feeding ground in the early morning, forming a 'V'-flight pattern in the sky.

Fig -1: feeding ground in Khichan

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3.2 Rivers (nadi) and Ponds (talab)

In the northern side of the village, there are two water bodies, “Vijaysagar Talab” (Pond) and “Ratri Nadi” (River). Another water body is situated in the southern region of the feeding ground, and that's “Teerjaniyo ki Nadi” (River). These rivers and ponds are used by the cranes as resting sites in the evening and a source of drinking water.

Fig -3: Roosting site (Vijaysagar talab)

4. Materials and Methods

Selected locations within Khichan's wintering grounds were surveyed for Demoiselle cranes from early September 2022 to late March 2023. Additional information was gathered from secondary sources, including newspapers, magazines, literature, and Mr. Seva Ram Mali, a local shop owner in Khichan. Mr. Mali has been maintaining records of the daily visits to the feeding ground, as well as details about injured, deceased, and rescued birds since October 2010. Surveys encompassed various areas in Khichan village, chosen based on previous data and local knowledge.

4.1 Data Collection

An initial reconnaissance survey was executed in the study area, specifically Khichan village, with the aim of identifying potential habitat locations for Demoiselle cranes. After identifying these sites, additional data collection activities were initiated. Surveys were conducted on foot within the study area, allowing for direct observations during both early morning and daytime hours. Binoculars (8 x 40), iPhone13 and a Canon PowerShot SX40 HS camera, equipped with a 12MP CMOS-based superzoom featuring a 35x zoom and a lens with a 24-840mm equivalent zoom range, were employed for this purpose. The selection of study sites was determined based on the distribution range of the Demoiselle crane.

The "Block Method" was employed to count the number through binoculars, as it proves to be a straightforward and precise technique for estimating the quantities of cranes within sizable and densely populated flocks, whether in flight or on the ground and with the aid of binoculars, tagged birds were also sought to determine their migratory patterns and origin. Comprehensive information regarding the birds' activities and daily routines was gathered through a questionnaire survey conducted among the locals of the village.

5. Findings and Interpretations

The migratory avian species, Demoiselle cranes, are observed in early September during the survey for the research. Our findings indicate that only a few of them migrate towards the Thar region of Rajasthan in the early winter. Their numbers range between 100-200 in the initial winter period, but by late September, it increases significantly to 3000-5000. These cranes cover vast distances, flying thousands of kilometers in search of optimal ecological conditions and habitats for feeding, roosting, breeding, and raising their young.

The Demoiselle cranes are observed in various regions of the Thar Desert, possibly due to the availability of suitable habitats and protection from the local community in Rajasthan. The ponds situated in Satlana village, Jodhpur district, serve as a secondary habitat for Demoiselle cranes in the Thar Desert. This village, located in Jodhpur district, provides a picturesque setting where Demoiselle cranes coexist with local bird species [11]

Survey Data was recorded from September 2022 to March 2023, representing the annual period of their migration. According to the data, the peak population is observed in January and February, coinciding with the peak of the winter season. During these months, the population status ranged from 35,000 to 40,000, marking the highest count to date. The entire Khichan village was surveyed and recorded an average species count of 35,000-40,000 during the peak winter season.

Table -1: Population status recorded in each month along with time from October 2022 to March 2023

DATE	TIME TO REACH THE FEEDING GROUND	TIME TO LEAVE THE GROUND	POPULATION
06/10/22	07:03 a.m.	10:13 a.m.	5000
06/11/22	07:45 a.m.	09:46 a.m.	9000
06/12/22	07:28 a.m.	09:27 a.m.	18000
06/01/23	07:08 a.m.	09:56 a.m.	32000
06/02/23	07:51 a.m.	11:12 a.m.	40,000
06/03/23	07:54 a.m.	10:43 a.m.	12000

we can conclude that during the early months of winters only few individuals are seen in the khichan village, and the population size increases as the winter increases in the central Asian parts and birds migrate towards the marshy areas of khichan.

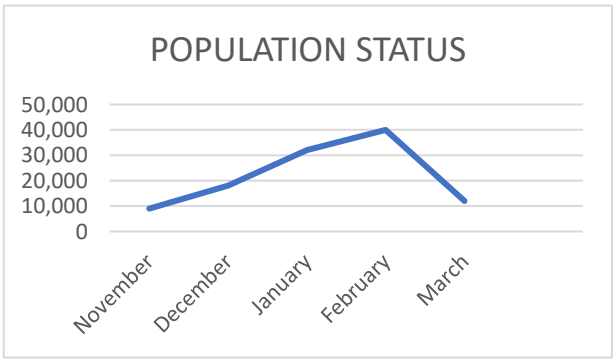

Fig -4: Population status of annual migration.

Mortality Of Demoiselle cranes

A total of 234 deceased individuals were documented between 2010 and 2021 in Khichan and its surrounding areas. The majority of these mortalities were discovered at Vijaysagar Talab and Ratri Nadi, identified as the two primary roosting areas for Demoiselle cranes. Chugga ghar served as their main foraging site. The causes of these mortalities were varied and included food poisoning, collisions with power lines, attacks by feral dogs, temperature increases, and injuries from Chinese manja. In some instances, natural factors were identified as the cause of mortality. They confront numerous other threats, including illegal trades, habitat loss, and hunting or capturing. Given these challenges, the conservation and management of Demoiselle cranes are imperative for the survival of this beautiful species [13]

Vijaysagar, a significant water source for birds to quench their thirst, attracts substantial congregations, consequently drawing predators like stray dogs. The power lines traversing the pond region, a major roosting site, have been accountable for obstructing the flight of birds and contributing to mortality. Figure 5 illustrates recorded reasons such as collisions with power lines, predation by stray dogs, and food poisoning caused by insecticides used in grain agriculture with high phosphorus content.

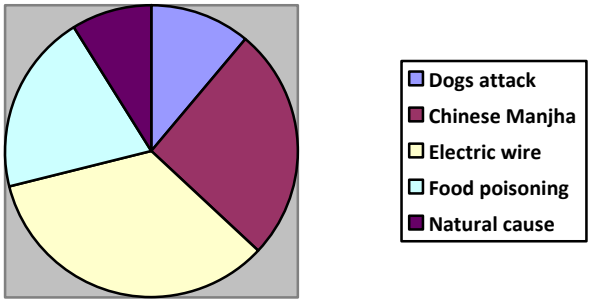

Fig -5: Major threats causing harm to Cranes.

The primary threat to the cranes in Khichan village arises from the presence of electric powerlines within the roosting and feeding grounds of the cranes. Another significant threat contributing to a high mortality rate is food poisoning. This is attributed to the ingestion of fertilizers and insecticides used in agricultural practices, which contain elevated concentrations of phosphorus. The cranes consume these substances through food grains or water in the ponds, which serve as their roosting sites and are contaminated by fertilizers and insecticides.

Fig -6: Demoiselle crane injured by feral dog attack.

Fig -7: Demoiselle crane collapsed with electric wires.

6. Conclusion

The population status is summarized in table 1 and their detail is plotted in the line graph shown in figure 4. We recorded 35,000 – 40,000 individuals in the peak month of winters i.e., January and February. They migrate to the thar region of Rajasthan by the month of September, and they stay there till late march and migrate back to their breeding grounds. The major threats causing the mortality of the cranes are summarized in Figure 5. The incidents and mortality rate of the birds are highest at the roosting site, with the primary causes being electric wires and food poisoning. The overuse of fertilizers and pesticides, particularly those with elevated phosphorus levels, can lead to infections in the gut of cranes, ultimately causing diseases and individual fatalities.

Fig -8: Demoiselle Cranes in Midair.

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I extend my deepest gratitude to Mr. Sevaram Mali, an invaluable collaborator in my research endeavors. His unwavering support in data collection and survey activities in the village has been instrumental in the comprehensive exploration of Demoiselle cranes. His dedicated care for the well-being, sustenance, and living conditions of these cranes since 2010 reflects not only his profound commitment but also his remarkable humility and kindness. His invaluable contributions have significantly enriched the depth and quality of this research, and for that, I am truly indebted.

REFERENCES

[1] Bohra, D. L. (2020). Indicators of changing ecosystems: aquatic bird mass mortality in Sambhar Salt Lake, Rajasthan, India. *CURRENT SCIENCE*, *119*(3), 421-423.

[2] Datta T 2011. Human interference and avifaunal diversity of two wetlands of Jalpaiguri, West Bengal. India Journal of Threatened Taxa 3(12): 2253-2262

[3] Gautam R and Kafle G 2007. A preliminary survey of water birds in Phewa lake, Kaski. (4): 345-356

[4] H S Gehlot, Tapan Adhikari, and Vipul Kachhwaha, "Eternal Attachment of Demoiselle Crane (*Anthropoides virgo*) to the Thar Desert of Rajasthan, India." Applied Ecology and Environmental Sciences, vol. 9, no. 1 (2021): 67-72. doi: 10.12691/aees-9-1-9

[5] HARRIS, J. and MIRANDE, C., 2013. A global overview of cranes: status, threats and conservation priorities. Chinese Birds, vol. 4, no. 3, pp. 189-209. http://dx.doi.org/10.5122/cbirds.2013.0025.

[6] Higuchi, Hiroyoshi & Minton, Jason. (2017). Migratory Routes across the Himalayas Used by Demoiselle Cranes. 10.1017/9781316335420.006.

[7] Ilyashenko, E.I., Mudrik, E.A., Andryushchenko, Y.A. *et al.* Migrations of the Demoiselle Crane (*Anthropoides virgo*, Gruiformes): Remote Tracking along Flyways and at Wintering Grounds. *Biol Bull Russ Acad Sci* **49**, 863–888 (2022).

[8] Jain P, Jeenagar B, Rajpurohit S N. (2013). Conservation and management of Demoiselle crane *Anthropoides virgo* at Kheechan in Rajasthan. Faunal Heritage of Rajashtan, India: Conservation and management of Vertebrates. (Editors B K Sharma et al) Springer's International Publishing, Switzerland 245-259

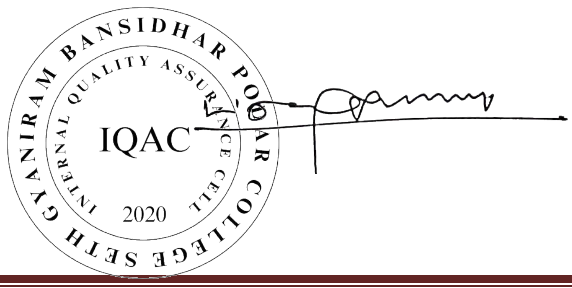
[9] Jayanta Mistry. (2015). Avifaunal diversity in and around Berhampore, Murshidabad district, West Bengal, India, International Journal of Fauna and Biological Studies 2 (4): 06-10.

[10] Kannan, Vaithianathan. (2022). Flyways and Migratory Birds of India. 59. 40-42.

[11] Meenakshi Meena, Kuldeep Garg and Ashok Kumar Jaipal (2021) Population status of demoiselle cranes in Satlana Wetland Jodhpur, Rajasthan, India. J. Exp. Zool. India 24, 000-000. DocID: https://connectjournals.com/ 03895.2021.24.000

[12] Mohan D., and Gaur A., (2008) Avian diversity around Jajiwal pond-A natural wetland, in Proceedings of Taal 2007: The World Lake Conference (Sengupta M. and Dalwani, R., Editors), pp 542-546.

[13] Rehman, J & Alam, Sadia & Khalil, Samina & Hussain, Majid & Iqbal, Manzoor & Khan, Kamal & Sabir, M & Akhtar, Andleeb & Raza, G & Habiba, Ume. (2022). Major threats and habitat use status of Demoiselle crane (Anthropoides virgo), in district Bannu, Pakistan. Brazilian Journal of Biology. 242636. 10.1590/1519-6984.242636.



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First Report of Breeding Pair of Red-necked Phalarope (*Phalaropus lobatus)* on the Sambhar Ramsar Site, Rajasthan, India

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Abstract: The Red-necked Phalarope (*Phalaropus lobatus*) is a vagrant to the Indian Subcontinent with only a little observation. 18 April no any breeding features was show in group, but it's was observed on date 16th May 2020 all 10 pairs have breeding characters show in male and female birds. Sambhar Salt Lake (Ramsar site) where it can be considered a recurring record due to repeated sightings, but the continuation of birds in Sambhar which used to come here during winter is difficult to explain due to climate change.

Keywords: Red-necked phalarope, *Phalaropus lobatus*, Breeding pair, Sambhar salt lake

Citation: Bohra Dau Lal, Dadhich Gouravand Singh Sonalika: First report of breeding pair of Red-necked Phalarope (*Phalaropus lobatus)* on the Sambhar Ramsar Site, Rajasthan, India. Intern. J. Zool. Invest. 9(2): 505-511, 2023.

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Introduction

Red-necked Phalarope (*Phalaropus lobatus*) breed mainly in Arctic regions of North America and Eurasia. It is migratory and unusually winters wader at sea on tropical oceans. The red-necked phalarope is tiny headed, outsized bodied wading bird with a long needle-like bill and lobed toes. In breeding time plumage, adults have white throat patches and a predominantly dark grey head and back. The male has a paler underside than the female, almost entirely white, whereas females have a grey breast. Breeding females have a more brightly colored chestnut red neck than the male. Non-breeding adult birds have pale silvery-grey upperparts, white face and under parts, and a small black patch behind the eye. Juveniles look like non-breeding adults but also have a grey-brown wash on the nape, shoulders and upper wings, and a darker coronet. In the Indian Subcontinent Red-necked Phalarope and Red Phalarope are reported (Khan-Nerezak, 2000; Grimmett *et al*., 20[illegible] and Anderton 2012). Species can [illegible] and therefore

does not meet size limitation criteria (common occurrence < 20,000 km^2, plus reduction or change in size) although population decline is likely, based on population trends (>30% decline in ten years or three generations) the decline is enough to reach the vulnerability point It is not expected to be fast. The population is very large and therefore does not meet the requirements of the large-scale population (adults < 10,000, estimated decline > 10% ten or three generations, or certain population models). These species are rated as Least Concern as per data bases of Birds Life International (2023). Both species winter in the South Pacific, with the Red-necked Phalarope also breeding in the Arabian Sea, and the Red Phalarope in the Atlantic off Africa. Red-necked Phalaropes in Europe and Asia migrate overland, and are sometimes encountered in some numbers on inland wetlands, but Red Phalaropes occur only inland when storm driven (Chandler, 2009).

The Red-necked Phalarope is the smallest of the three Phalarope species, and has the most widespread circum-polar breeding range. A wading bird of the open ocean, it lives virtually as a seabird most of the year, coming on shore to breed. Red-necked Phalarope is not an uncommon wader, during the autumn passage, at suitable locations in Rajasthan. It is regular during autumn passage at Sambhar Lake (Kochiya Ki Dhani and Near Shambhar Railway station), where they were seen during August almost every year since 1990. In disparity, very little is known about the migration of species at sea; the most detailed information about migration comes from a single saline lake in California (Rubega and Inouye, 1994) and the Bay of Fundy (Mercier, 1985; Mercier and Gaskin, 1985; Brown and Gaskin, 1988). Few studies of tracking of birds from breeding locations in Greenland, Iceland and the Shetland islands, Scotland has found that the marked individuals descend the Atlantic coast of North America and then cross the western Caribbean and central America to winter in the Pacific; returning by the similar routes (Smith *et al.*, 2018). It is rarely recorded inland, but on passage is recorded practically throughout Afghanistan, Pakistan, and north-western India; a few records are from west Nepal, Bihar, and inland southern India (Rasmussen and Anderton, 2012). According to Ali and Ripley (1980) it is recorded from a few inland localities on spring and/or autumn passage. On breeding ground and on fresh waters in migration they eat generally insects, including adults and larvae of flies, beetles, caddisflies. During stopovers on alkaline lakes, may eat many brine shrimp. Winter diet on ocean probably includes small crustaceans and mollusks. An predictable 42,000 consideration to breed in Arctic National Wildlife Refuge, Alaska (Brown *et al.*, 2007), although at least local declines have been reported in some areas in recent decades (Bart *et al.*, 2007;bSammler *et al.*, 2008). More than 1,000,000 birds winter in Arabian Sea, with large numbers of these moving through Central Asia, e.g. Kazakhstan, where between c. 590,000 and 650,000 individuals have been estimated to pass through the Tengiz-Korgalzhyn region in spring (< 200,000 in autumn; Schielzeth *et al.*, 2010).

The Red-necked cormorant is a small shorebird that spends most of its time in the open ocean. It has a length of 6-8 inches and a wingspan of 14-15 inches. It has a long, pointed black beak and long black legs with lobed fingers. During the breeding season, the female's breast is gray. The back is dark gray with brown stripes. Its head is dark gray, with a white spot over its eyes, its neck is red, and its chin is white. The color of the males is similar, but slightly darker, with a white line above the eye. During the breeding season, it has a red-necked gray back and a white belly. It has a white head with black patches on his face. More than a few authors identified Red-necked Phalarope (*Phalaropus lobatus*) calls from a flock as well as single one (Andrew Spencer, 2014; Michel Robert, 2022).

Materials and Methods

The red neck phalarope in Sambhar was first seen in summer on 18th April 2020, Jhapok dam, Sambhar Salt Lake, [illegible]N, 75.1284°E) when it was 20 in [illegible]k was reported

(1) **(2)** **(3)**

Fig. 1: Adult female Red-necked Phalarope, breeding plumage during male approaching.
Fig. 2: Adult female Red-necked Phalarope, breeding plumage during grooming.
Fig. 3: Adult female Red-necked Phalarope, breeding plumage.

with Canon 700d with Tamron 150-600 mm G2 lens and recorded. It was the first time that this bird was seen after the end of winter, it was seen in the Sambhar Lake (26.9043^{0}N, 75.1227^{0}E) on 16th May 2020. On date 18 April no any breeding features was show in group, but it was observed on date 16th May 2020 that all 10 pairs have breeding characters shown in male and female birds. The temperature was recorded at a minimum of 29^{0}C and a maximum of 33^{0}C. Sambhar Lake has got 2-3 feet of water after the last 35 years or else the water of Sambhar Lake evaporates in summer. Earlier from here no record of breeding pair with characters of red neck phalarope in spring or summer passage records from Rajasthan. During the breeding season, red-necked woodcocks feed on insects, crustaceans and mollusks. Sand red-necked is not designed for diving, so in the ocean it scrapes zooplankton, small crustaceans and mollusks from the surface. It usually occurs in areas where ocean currents meet and form and rising water levels bring food to the surface.

In female forehead, crown, hindneck, and sides of head blackish neutral gray. Small, brilliant white spots above and below eye, mahogany red bands extend from behind ear coverts down sides of neck, and across front of neck to form horseshoe-shaped collar, variably spotted dark neutral gray on central fore-neck. Upper back and scapulars blackish neutral gray; cinnamon double streak on upperparts formed by edging on outer back- and scapular-feathers. Upper tail-coverts black, fringed cinnamon and tipped white; feathers of sides of rump and upper tail-coverts mostly white. All wing feathers retained from basic plumage (Figs. 1, 2, 3). In males forehead, crown, lores, and cheeks sepia, washed raw umber on cheeks. Blurry mixed white and raw umber super cilium, falls short of bill. White spots above and below eye less bright and less distinct than in female. Lower back, rump, upper tail-coverts, tail, all wing feathers same as in female. Fore neck, chest, sides of breast, and flanks dark neutral gray, broadly fringed white and all other under parts white (Figs. 4 to 9).

Fig. 4: Adult male [illegible] larope, breeding plumage

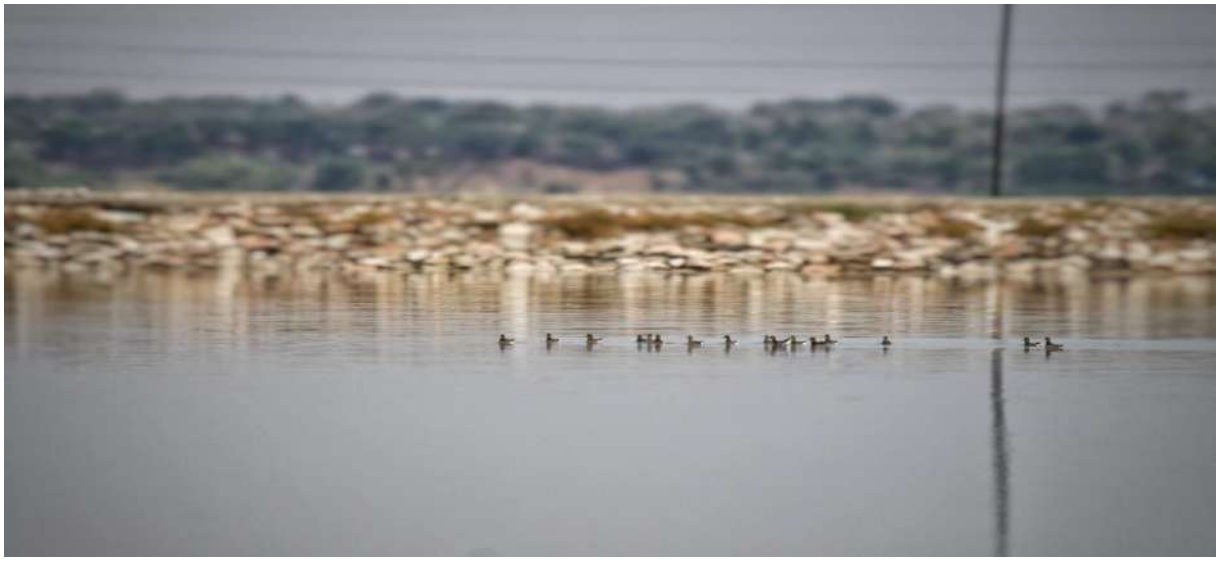

Fig. 5: First arrival of Red-necked Phalarope *Phalaropus lobatus* (18th April 2020, Jhapok dam, Sambhar Salt Lake, Jaipur).

Fig. 6: Females of Red-necked Phalarope *Phalaropus lobatus.*

(A) **(B)**

Fig. 7 (A, B): Adult female Red-necked Phalarope breed

(A) **(B)**

Fig. 8 (A, B): Adult female Red-necked Phalarope, breeding plumage.

Fig. 9: Breeding pair of Red-necked Phalarope *Phalaropus lobatus.*

Results and Discussion

The red neck phalarope is a vagrant to the Indian Subcontinent with only a little observation (Table 1). They have the most marine migration of any species of wader and migrate almost exclusively via sea routes to their main wintering areas. Such strange domestic occurrences, of normally marine or littoral species, are frequently related to unusual weather patterns, and especially to extremely strong aground winds (Ash and Ashford, 1977). Sambhar Salt Lake (Ramsar site) where it can be considered a recurring record due to repeated sightings, but the continuation of birds in Sambhar which used to come here during winter is difficult to explain due to climate change. It is first time recorded breeding pairs in India due to climate change.

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Table 1: Records of Red-necked Phalarope from the Indian Subcontinent (2002-2020)

S. No.	Location	Authors	Numbers of Birds
1	5th February 1999, at Kochia ki Dhani, freshwater pond, Sambhar Lake (26.58ºN, 75.05ºE)	Sangha (2002)	17
2	2nd November 2001, at Kochia ki Dhani, freshwater pond, Sambhar Lake (26.58ºN, 75.05ºE)	Sangha (2009)	5
3	18th December 2007, at Vakeria dhand (23.43°N, 23.60°E), Banni, Great Rann of Kachchh	Jugal Tiwari (2007); Cited in (Sangha, 2017)	1
4	1st December 2009, Sambhar Lake	Divyabhanusinh Chavda & late Shantanu Kumar (2009) Lit.Cited in (Sangha, H. S., 2017)	13
5	West Nepal, Bihar, and inland southern India	Rasmussen & Anderton (2012)	-
6	1st December 2013, at Kochia ki Dhani, freshwater pond, Sambhar Lake (26.58ºN, 75.05ºE)	Abhinav C (2013); Cited in (Sangha, 2017)	14
7	9th September 2013 at Jaisalmer (Rajasthan)	Mishra (2013)	2
8	6th February 2015 at the Najafgarh wetlands (28.60°N, 76.99°E), southwestern Delhi District	Sanjay Sharma (2015) Cited in (Sangha, 2017)	1
9	8th February 2015Soor Sarovar, (27.23°N, 77.85°E), Agra District (Uttar Pradesh)	Jännes (2015)	1
10	16th December 2015, at Badopal (25.15°N, 60.04°E), a saline wetland, in Hanumangarh District, Rajasthan,	Sangha (2015) Cited in (Sangha, 2017)	3
11	6 th May 2018, Malkhed Spillway and Reservoir, Yavatmal District, Maharashtra, India	Praveen Joshi (2021)	1
12	20th September 2018, Nal Sarovar Bird Sanctuary, near Ahmedabad, Gujarat, India	Viral Patel and Pankaj Maheria (2018)	1
13	29th September 2018 Tal Chappar Wildlife Sanctuary, Churu District, Rajasthan, India	Pranjal J Saikia (2018) Cited in (Sangha, 2017)	1
14	12th October 2018 Dhigal, Haryana, India	Nikhil Devasar (2018)	1
15	31st January 2019, Valsura Salt Pans, Jamnagar, Gujarat, India	Patel (2019) Cited in (Sangha, 2017)	1
16	18th April 2020, Jhapok dam, Sambhar salt Lake, Jaipur	Gorav Sharma and Bohra (2020)	20
17	16th May 2020, Dadu Dayal ji ki chatri, Sambhar salt Lake, Jaipur	Gorav Sharma (2020); Bohra (2020)	16

References

Ali S and Ripley SD. (1980) Handbook of the birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan and Sri Lanka. Megapodes to Crab Plovers. Oxford University Press, Delhi, ISBN 13: 9780195612011.

Andrew Spencer (2014) Red-necked Phalarope (*Phalaropus lobatus*) calls from a flock of 150 or so birds foraging. https://ebird.org/species/renpha.

Ash JS and Ashford OM. (1977) Great Black-headed Gull *Larus ichthyaetus* Red Phalaropes *Phalaropus lobatus* Hist Soc Nat Mus

Bart J, Brown S, Harrington B and Morrison RIG. (2007) Survey trends of North American shorebirds: population declines or shifting distributions? J Avian Biol. 38(1): 73-82.

Birds life International (2023) http://datazone.birdlife.org/species/factsheet/22693490.

Brown RGB and Gaskin DE. (1988) The pelagic ecology of the Grey and Red-necked Phalaropes *Phalaropus fulicarius* and *P. lobatus* in the Bay of Fundy, eastern Canada. Ibis. 130(2): 234-250.

Chandler R. (2009) Shorebirds of the northern hemisphere. Christopher Helm, London.

Dhadwal DS and Kanwar B. (2018) Birds of Himachal Pradesh. Non-Passerine. Vol 1, pp. 1-301.

Grimmett R, Inskipp C and Inskipp T. (2011) Birds of the Indian Subcontinent. Helm Field Guides, ISBN 9781472972507.

Jännes H. (2015) Tigers and birds of Bandhavgarh. http://www.birdquest-tours.com/pdfs/report/INDIA%20-BANDHAVGARH-%20REP%2015-ebook.pdf.

Joshi Praveen (2021) Records of migratory water birds on the reservoirs of Yavatmal District, Maharashtra, Central India. Int J Recent Sci Res. 12(2): 40925-40928.

Kazmierczak K. (2000) A field guide to the birds of India, Sri Lanka, Pakistan, Nepal, Bhutan, Bangladesh and the Maldives. 1st ed., Om Book Service, New Delhi, pp. 352.

Mercier F and Gaskin DE. (1985) Feeding ecology of migrating Red-necked Phalaropes (*Phalaropus lobatus*) in the Quoddy region, New Brunswick, Canada. Canadian J Zool. 63: 1062-1067.

Mercier FM. (1985) Fat reserves and migration of Red-necked Phalaropes (*Phalaropus lobatus*) in the Quoddy region, New Brunswick, Canada. Canadian J Zool. 63: 2810–2816.

Michel Robert (2022) Red-necked Phalarope (*Phalaropus lobatus*) Baffin Region, 17UNV60: 53.29822, -80.00036, Baffin, Nunavut, Canada. https://cdn.download.ams.birds.cornell.edu/api/v1/asset/467277161/spectrogram_small.

Rasmussen PC and Anderton JC. (2012) Birds of South Asia: the Ripley guide. 2nd ed. Washington, D.C. and Barcelona: Smithsonian Institution and Lynx Edicions. 2 vols., pp. 1–378; 1–683.

Rubega MA and Inouye C. (1994) Switching in phalaropes: feeding limitations, the functional response and water policy at Mono Lake, CA. Biol Conserv. 70: 205-210.

Sammler JE, Andersen DE and Skagen SK. (2008) Population trends of tundra-nesting birds at Cape Churchill, Manitoba, in relation to increasing goose populations. Condor 110(2): 325-334.

Sangha HS. (2002) Occurrence and association of red-necked phalarope *Phalaropus lobatus* with other species at Sambhar, Rajasthan. J Bombay Natural History Soc. 99(2): 301.

Sangha HS. (2009) The birds of Sambhar Lake and its environs. Indian Birds 4(3): 82-97.

Sangha HS. (2017) Winter records of Red-necked Phalarope *Phalaropus lobatus* from Sambhar Lake environs, Rajasthan. Indian Birds 13(1): 22-23.

Schielzeth H, Kamp J, Eichhorn G, Heinicke T, Koshkin MA, Lachmann L, Sheldon RD and Koshin AV. (2010) Wader, gull and tern population estimates for a key breeding and stopover site in Central Kazakhstan. Bird Conserv Int. 20(2): 186-199.

Smith M, Bolton M, Okill JD, Harris P, Petrie G, Riddington R and Wilson JD. (2018) Further evidence of transatlantic migration routes and Pacific wintering grounds of Red-necked Phalaropes breeding in Shetland. British Birds 111(8): 428-437.

Mishra VV. (2013) Red-necked Phalarope (*Phalaropus lobatus*), Sept 9th, 2013 at Jaisalmer (Rajasthan). http://indianbirdsphotography.blogspot.com/2013/11/delhibirdpix-red-necked-phalarope.html.

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OPEN ACCESS

PHYTOREMEDIATION – THE USE OF GREEN PLANTS TO CLEAN UP POLLUTED SOIL CONCERNING CLIMATE CHANGE AND ENVIRONMENTAL EFFECT

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ABSTRACT

Phytoremediation, an environmental technology that is a new discipline which integrates living materials, mainly plants, and very small micro-organisms like algae to address the problems of environmental management and sustainable development. Phytoremediation is a word formed from the Greek prefix "Phyto" means plant and suffix "remedium" meaning to clean (or) restore (Cunningham et.al.,1996) The term actually refers to advise collection of plant based technologies that use either naturally occurring (or) genetically engineered plants for cleaning contaminated environments (Flathman and lanza, 1998), Phytoremediation consists of four different plant based technologies, each having a different mechanism of action for the remediation of metal polluted soil, sediment or water. This review article provides a critical review of the recent progress towards the development of transgenic plants with improved phytoremediation capabilities and their potential use in environmental clean-up.

Keywords: *Phytoremediation, Environment, Micro-organism.*

INTRODUCTION

Environmental bio-technology is a new discipline which integrates living materials, mainly plants, and very small animals like earth worms, micro-organisms to address the problems of nvironmental management and sustainable development Phytoremediation is a word formed from the Greek prefix "Phyto" means plant and suffix "remedium" meaning to clean (or) restore (Cunningham et.al.,1996) The term actually refers to advise collection of plant based technologies that use either naturally occurring (or) genetically ngineered plants for cleaning contaminated environments (Flathman and lanza, 1998), Phytoremediation consists of four different plant based technologies, each having a different mechanism of action for the remediation of metal polluted soil, sediment or water. These include phytoextraction,n where plants absorb metals from soil and ranslocate them to harvestable shoots where they accumulate. Rhizofiltration involves the use of plant to clean various aquatic environments. hytostabilization, where plants are used to stabilize rather than clean contaminated soil. Some plants tolerate and accumulate high concentrations of metal in their tissues but not at the level required to be called as hyper accumulators. Researches in environmental biotechnology promise to enhance the phytoremediation efficiency by a known phytoremediator plant.

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MATERIAL AND METHODS

Phytoremediation is a method which green plants use for cleaning up contaminated hazardous wastes sites. Phytoremediation has applied Ex-situ and In-Situ, continually and induces to clean up contaminated terrain of toxic metals. The following are the steps involved in the hytoremediation process

1. Identification of area.
2. Chemical analysis of the soil before application of the phytoremediation.
3. Sowing the plant phytoaccumulators.
4. Usage of agricultural and technical measures and Inspection of vegetative development.
5. Picking and drying the plants.
6. Chemical analysis of the soil near the root after finished phytoremediation.
7. Chemical analysis of green leaves of plants.
8. Determination of co-efficient (Concentration factors) of plants.

The material is dried in shadow and draft without genus including 7 pollution indicators genus. After sample preparation content mof heavy metal is determined by Atomic Absorption Spectroscopy. For enhancing the phytoremediation process the following steps are considered.

- To enhance the speed and quantity of metal uptakes by plants, some researchers are advocating the use of various chemicals like acidifying agents (Blaylocke and Huang, 2000), fertilizer salts (Lasat *et al*. 1997, 1998) and chelating materials (Blay lock *et al*. 1997).
- Soil pH is a major factor influencing the vailability of elements in the soil for plant uptake

(Marschenev, 1995).

- Acidifying agents are also used to increase the availability of radio active elements in the soil for plant uptake.

Working process of phytoremediation

Plant roots take contaminants from the ground into the plant body. The plant root zone is referred to as the rhizosphere; this is where the action occurs. This soil supports large populations of diverse micro organisms. This is due to chemicals exuded by plants roots which provide carbon and energy for microbial growth. This combination of plants and micro organisms used to increase the biodegradation by compounds.

Plants have the ability to absorb heavy metals and some other minerals which are essential for their growth and development however they accumulate some heavy metals which are not involved in the biological functions such as lead cadmium Cobalt chromium Mercury nickel silver zinc etc.

Plants take heavy metals and degrade them from toxic to non toxic or useful form and can directly accumulate toxic heavy metals in plant part like vacuel and tonoplast.

Proper plant selection

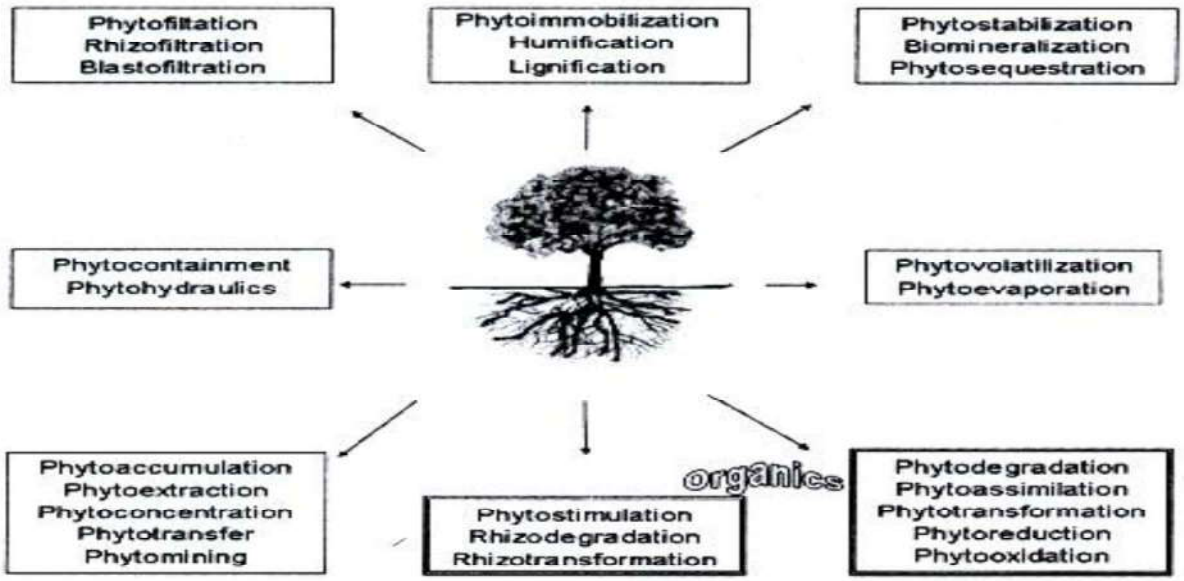
As a plant based technology, the success of phytoextraction is inherently dependent upon proper

plant selection. Plants used for the phytoextraction must be fast growing and have the ability to accumulate large quantities of environmentally important metal contaminants in their shoot tissue (Blay lock *et al.* 1994) Researches initially envisioned using hyper accumulators (Salt and Kramer, 2000) to clean metal polluted sites. At present, there are nearly 400 knownm hyper accumulators but majority are not appropriate for phytoextraction, because of their slow growth and small size. Several researches are screened fast-growing, high-biomass-accumulating plants, including agronomic crops, for their ability to tolerate and accumulate metals in their shoots (Banuelus *et al*. 1997).

Types of Vegetation Used

Some of the plants used in phytoremediation are:

-
- Hybrid Trees
- Blue-green Algae
- Arrowroot
- Grasses
- Sunflower



Rajasthan is the largest state in India located in the North Western region of country. it has large variation in climatic conditions soil and vegetation. The most geological feature is present so Aravali range which is one of the most oldest mountain range in the world.

The Western edit and semi arid zone of Rajasthan represents the Savanna vegetation mixer of four distinct phyto geographical elements is represented in the vegitation of Rajasthan it total of about 12.48% angiospermic plants of entire country are found in Rajasthan among them one percent are ending to state it gives the figure of 234 in just for mix species among which one one four are while species and agro horticulture species.

Contamination of Pb, Zn, Cd, cu, Zn, could be removed by plant plants such as acalyphs indica, Cicer arientinum , Eichhornia crassipes, Lantana camara, physalis angulaata, zea maize etc.

DISCUSSION

Soil & water contaminated with toxic metals pose major environmental and human health problems. According to EEA (European Environment Agency) estimation 1.4 million areas are contaminated (Puschenreither and Wenzel, 2003). Environmental biotechnology has given rise to an allied discipline called "bio-engineering". It is a 'Green' (or) 'Soft" and alternative to the "hard" and costly Civil Engineering works for the environmental restoration and reconstruction. In modern times, not only the biological organisms are used but their genetic materials (DNA) too. Modern biotechnology has made wonders and has revolutionized and heralded a new era in the field of environmental management. With the new biotechnological tools (recombinant DNA technology, genetic engineering) working at genetic or molecular level scientists can change the genetic make up of organisms in which characteristics are not found naturally. Plant Enzymes implicated in Phytodegradation and phytotransformation of organic compounds

In the last few years, several commercial companies practicing phytoremediation for environmental clean up in USA and Europe. Important among them are phytotech (USA), phyto works (USA), earth care (USA), bioplanta (Germany), picco plant (Germany), plant techno (Italy,), Slater (UK), aquaphyte remediation (Canada).

Role of Environmental biotechnology and genetic-

Engineering in improving efficiency of Phytoremediation. [illegible] involved in the translocation, sequestration and [illegible] has now been identified. [illegible] genes into

candidate plant will result in developing "Transgenic plants" with enhanced ability for metal uptake and accumulation for the removal from environment.

Environmental biotechnology is a tool to accumulate the phytoremediation process through over expression of those genes responsible for the sequestration of heavy metals and radio nuclide in plants or through "genetransfer". Any appropriate genes of foreign origin been transferred in plants like Arabidopsis thaliana, Nicotiana tobaccum, Brassica junceae, Brassica olevaceae, Varbotrytis, Lycopersicon Esculentum etc., to enhance the phytoremediation efficiency of these plants.

Many hyper accumulator plants are rare, with small population occurring in remote places (or) have restricted distribution. They often have slow growth rate and produce small biomass. Such hyper accumulator species may provide suitable genes involved in metal uptake, translocation, and sequestration for enhancing the phytoremediation. If genes from highly metal tolerant and hyper accumulator plants are transferred to high biomass yielding and growing cultivars, this can do miracle.

Important Achievements

- Transfer of human MT-2 gene to tobacco (*Nicotiana tobaccum*) resulted in transgenic plant with enhanced cadmium (cd) tolerance and accumulation.
- Transfer of Pea MT gene in Arabidopsis thaliana resulted in enhanced copper (Cu) accumulation in the transgenic Arabidopsis Thaliana.
- Transfer of Yeast CUP 1 gene in Cauliflower (*Brassica capitata*) resulted in 16-fold higher accumulation of cd in transgenic Cauliflower (Eaper *et al*. 2006).
- Transfer MT gene in *Nicotiana* spp., *Brassica* Spp., *Arabidopsis thaliana* resulted in highly tolerant to Cd and other metals.
- Somatic cell hybrid produced between *Brassica junceae* (a high biomass yielding plant) and Thalaspi caeruiescens (a known Zn and Ni hyper accumulator) showed increased tolerance to Pb and Ni, Zn and the total amount of lead phytoextracted was much greater because of high biomass produced (Dushenkov *et al*. 200).

Advantages

i) The cost of the phytoremediation is lower than that of traditional process both in-situ and ex-situ

ii) The plants can be easily monitored.

iii) The possibility of the recovery and re-use of valuable metals.

iv) It is the least harmful method because it uses naturally occurring organisms and preserves the natural state of the environment.

Limitations

i) With plant based systems of remediation, it is not possible to completely prevent the leaching of contaminants into the ground water.

ii) The survival of the plant is affected by the toxicity of the contaminated land and general conditions of the soil.

iii) Possible bio accumulations of contaminants which then passed into the food-chain from primary level consumers up wards.

S. No.	Plant Name	Family	References
1.	Abutilon indicum	Malvaceae	Subhashini et al (2017)
2.	Acacia senegal	Fabaceae	Baunthiyal and Sharma (2012)
3.	Acalypha indica L.	Euphorbiaceae	Subhashini et al (2017)
3.	Albizia lebbeck	Fabaceae	Baunthiyal and Sharma (2012)
4.	Ailanthus excelsa	Simaroubaceae	Raju et al. (2013)
5.	Cassia fistula L.	Fabaceae	Chauhan et
6.	Eucalyptus spp.	Myrtaceae	Lakshmi et

Future research direction

Further use of molecular biology expertise to greater understanding of phytoremediation at the genetic and molecular level research objectives in these areas.

i) Probing of the Bio-path ways involved in contaminant degradation and sequestration.
ii) Identifying the specific genes involved in phytoremediation process.
iii) Investigating cell signaling path ways that affect the genetic expression plant and microbial enzymes.
iv) Studying the molecular ecology of root-microbial interactions.
v) Analyzing and identifying root exudates.

Now it has become possible to:

- Create economically valuable and ecologically adapted crops called transgenic crops with desired characters.
- Create hyper-accumulator plants which can tolerate and bio accumulate high levels of toxic metals.
- Grow thousands of replicas of economically important plants in shorter time by tissue culture.

CONCLUSION

A phytoremediation is amenable to a variety of organic and in organic compounds may be applied either in-situ or ex-situ. Phytoremediation is considered to be an innovative technology and hope fully by increasing our knowledge and understanding of this intricate clean up method, it will provide a cost effective, environment friendly alternative to conventional cleanup methods.

REFERENCES

1. Cunningham, S.D. and Ow, D.W. 1996. Promises and prospects of phytoremediation. *Plant physiology.* 110 :715 - 719.
2. Dushenkov, S. Skarzhinskayam, Glimeliusic, Glebad and Ruskin, I. 2002. Bioengineering of a P.R Plant by means of somatic hybridization. *International Journal of Phytereomedation*. 4 :117-126.
3. Jogdanand, S.N. 1995. *Environmental Bio Technology.* Himalaya Publishing House, Mumbai, India.
4. Kumar, P.B.A.N., Dushenkor, V., Ensley, V.D., Chet, I. and Raskin, I 1995. Phytoremediation: a novel strategy
5. for the removal of toxic metals from Environment using plants. *J. of Bio Tech*. 13 :1232-1238.
6. Macek, T., Mackova, M. and Kas, J. 2000. Exploitation of plants for the several of organics in Environmental
7. remediation. *Biotechnological Advances*. 18 : 23-34.
8. Prasad, M.N.V. and Freitas, H.M.D. 2003. metal hyper accumulation in Plants: Biodiversity prospecting for
9. phytoremediation Technology. *Electronic Journal of Biotechnology.* 6 : 285-321.
10. Prasad, M.N.V., *et al*., 2009. Knowledge explosion in phyotechnologies for environmental solutions. *Environ. Pollut*. doi:10.1016/J.envpol. 2009. 07. 038.
11. D.E., Blaylock, M., Kumar, P.B.A.N., Dushenkov, Ensley, B.D., Chet, I. and Ruskin, I 1995. Phytoremediation: A novel strategy for the removal of toxic metals from the Environmental using plant. *Bio Tech*. 13 : 468-474
12. Sinha, Rajivk, Sunil Heart and Tandon, P.K. 2003. Review of Phytoremediation as a cost effective, Ecologically sustainable and socially acceptable Bio Engineering Technology, *Proceedings of the National Environment*
13. *conference*; June 18-20, 2003; Brisbane, Australia.
14. website: www.mobot.org/jwcross/phytoremediation.

http://krishipravahika.vitalbiotech.org/

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औषधीय पौधों में कायिक प्रवर्धन विकास से औषधीय पादप क्षेत्र में नई पहल

सुमन सैनी[1], अंकित कुमार जांगिड़[2]

[1]सहायक प्रोफ़ेसर व विभागाध्यक्ष
[2]सहायक प्रोफ़ेसर, वनस्पति विज्ञान विभाग,
सेठ ज्ञानीराम बंसीधर पोदार कॉलेज, नवलगढ़

औषधीय पौधे या उनके उत्तक से पौधे का उत्पादन करने की प्रक्रिया को औषधीय कायिक प्रवर्धन विकास कहा जाता है।

WHO के अनुसार औषधीय पौधे के उत्पादन उद्योग का वैश्विक बाजार मूल्य 2050 में 5 ट्रिलियन अमेरिकी डॉलर तक बढ़ है। वर्ष 2000 से 2050 तक उद्योग के लिए वैश्विक बाजार की वृद्धि 7% प्रति वर्ष होने की उम्मीद है।

भारत में औषधीय पौधों की स्थिति-

- 20 कृषि-पारिस्थितिक क्षेत्र।
- 17 मेगा जैव विविधता वाले देशों में से एक।
- विश्व जैव विविधता का 7%।
- 17000 पुष्पिये पौधों की प्रजातियाँ।
- लोक औषधियों में लगभग 9000 औषधीय पौधों की प्रजातियों का उपयोग किया जाता है।
- 1172 प्रजातियाँ व्यापार में हैं जिनमें से 242 प्रजातियाँ ऐसी है जिनकी खपत 100 मीट्रिक टन से अधिक है।
- उच्च मांग वाली 40% प्रजातियाँ खेती से प्राप्त होती हैं (कवरेज 0.3 मिलियन हेक्टेयर)

स्वास्थ्य क्षेत्र से औषधीय पौधों की मांग-

- आयुर्वेद - 1587 प्रजातियाँ
- सिद्ध - 1128 प्रजातियाँ
- यूनानी - 503 प्रजातियाँ
- सोवा-रिग्पा - 253 प्रजातियाँ
- होम्योपैथिक - 468 प्रजातियाँ
- पश्चिमी - 192 प्रजातियाँ

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Satyendra Singh

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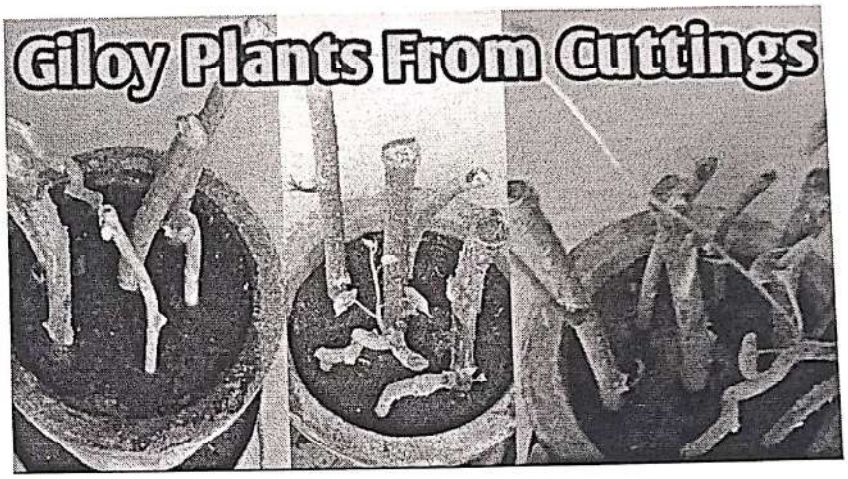
औषधीय पौधों में कायिक प्रवर्धन :-

1. गिलोय के बेल में कायिक प्रवर्धन



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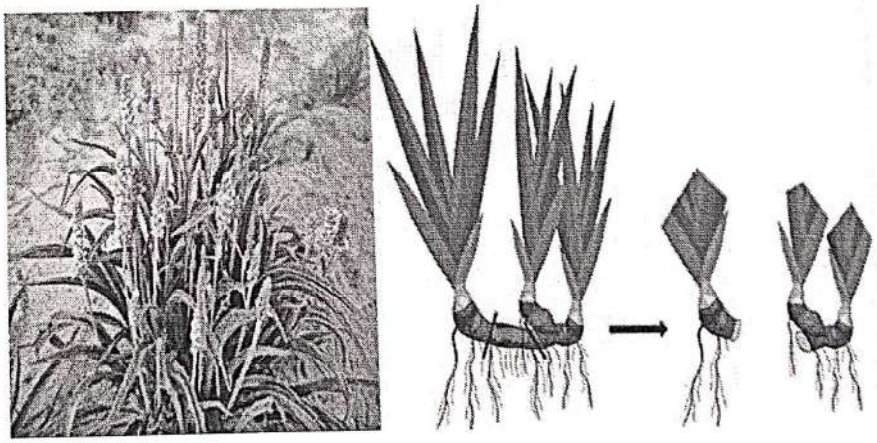
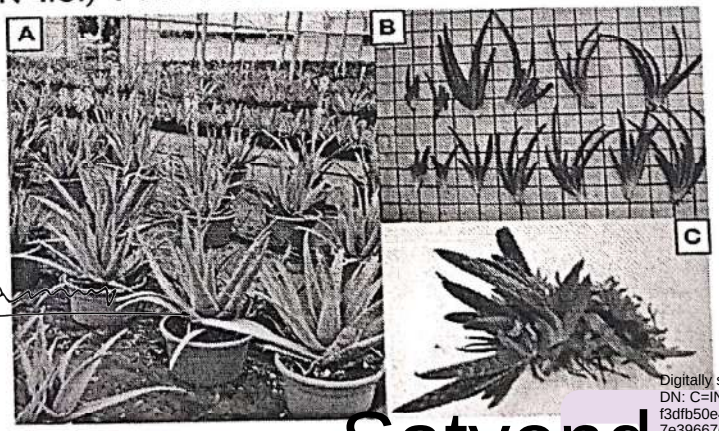
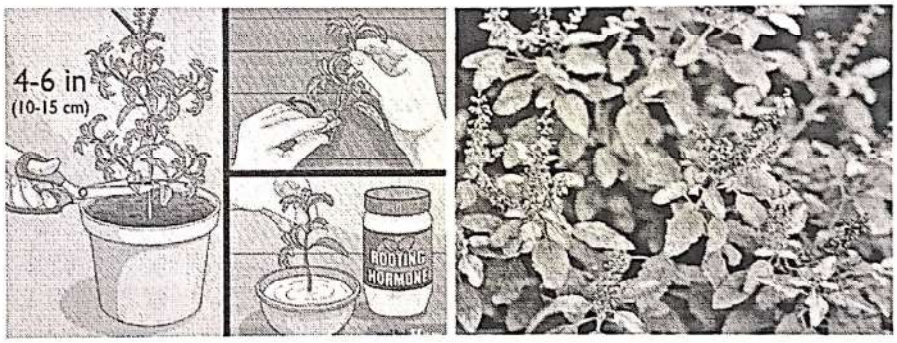


3. एलोवेरा (ग्वार पाठा) में कायिक प्रवर्धन:



4. नीम के पौधे में कायिक प्रवर्धन:

5. तुलसी के पौधे में कायिक प्रवर्धन:



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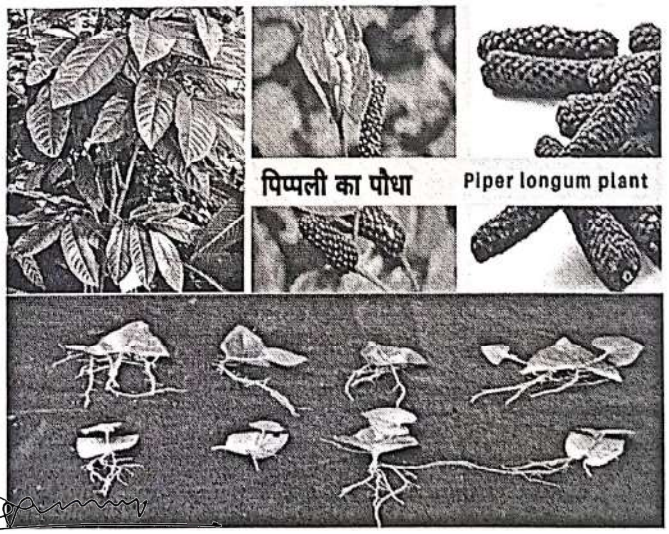
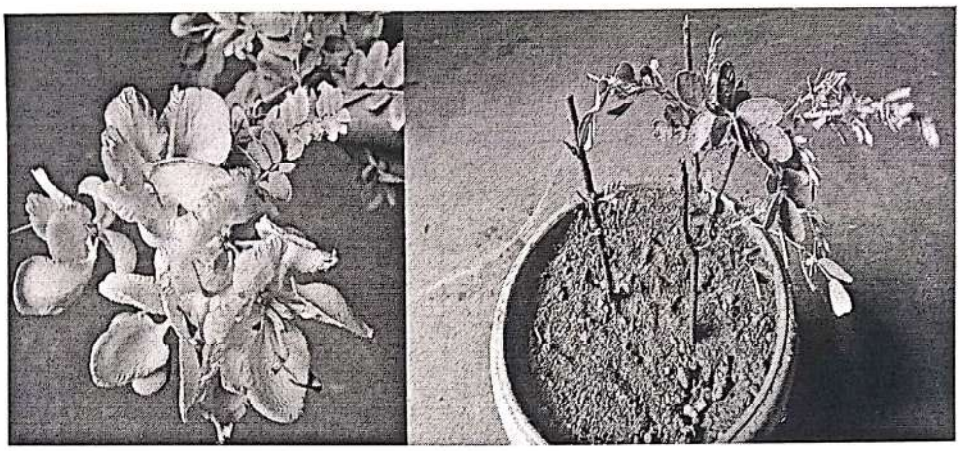


7. सोना पत्ता पौधे में कायिक प्रवर्धन



प्राकृतिक उपचार:

1. मधुमेह:

मधुमेह सबसे गंभीर, दीर्घकालिक चयापचय संबंधी विकार है और इसकी विशेषता उच्च रक्त शर्करा स्तर है। यह अब एक सामान्य चयापचय रोग है जो असामान्य रूप से उच्च प्लाज्मा ग्लूकोज स्तर की विशेषता है, जो मधुमेह न्यूरोपैथी, रेटिनोपैथी और हृदय रोगों जैसी बड़ी जटिलताओं का कारण बनता है।

प्रयुक्त पौधे – मोमोर्डिका चारेंटिया, सिज़िगियम क्यूमिनी, जिम्नेमा सिल्वेस्ट्रे, ट्राइगोनेला फोनमग्रेकम, टिनोस्पोरा कॉर्डिफोलिया और ओसीमम टेनुइफ़्लोरम

2. उच्च रक्तचाप (उच्च रक्तचाप):

एलियम सैटिवम (सामान्य नाम: लहसुन) लहसुन का उपयोग लंबे समय से विभिन्न प्रकार की हृदय संबंधी स्थितियों, विशेषकर हाइपरलिपिडिमिया के लिए किया जाता रहा है। इसमें हाइपोटेंसिव एक्शन होने की भी जानकारी दी गई है। ऐसा माना जाता है कि यह नाइट्रिक ऑक्साइड उत्पादन को बढ़ाता है, जिसके परिणामस्वरूप चिकनी मांसपेशियों को आराम मिलता है और वासोडिलेशन होता है।

एपियम ग्रेवोलेंस (परिवार: अपियासी; सामान्य नाम: सेलेरी अजमोडा)।

कैसिया एब्सस (परिवार: कैसलपिनियासी; सामान्य नाम: चाकसू)

त्वचा संबंधी विकार

3. मानव त्वचा:

शरीर का बाहरी आवरण, शरीर का सबसे बड़ा अंग है। यह रक्षा की पहली पंक्ति भी है। त्वचा में कई विशिष्ट कोशिकाएँ और संरचनाएँ होती हैं। इसे तीन मुख्य परतों में विभाजित किया गया है। एपिडर्मिस, डर्मिस और हाइपोडर्मिस। प्रत्येक परत त्वचा के समग्र कार्य में एक विशिष्ट भूमिका प्रदान करती है।

अचिरांथेस एस्पेरा- (सामान्य नाम: कांटेदार फूल, डेविल्स हॉर्सव्हिप अपामार्गा) परंपरागत रूप से, पौधे का उपयोग फोड़े, खुजली और अन्य त्वचा रोगों में किया जाता है।

एलोवेरा - एलोवेरा ने त्वचा रोगों में बहुत अच्छे परिणाम दिखाए हैं और इसे अक्सर स्वास्थ्य पेय के रूप में लिया जाता है। यह झुर्रियों, स्ट्रेच मार्क्स और पिग्मेंटेशन के इलाज में भी प्रभावी पाया गया है। ऐसा लगता है कि यह क्षेत्र के माध्यम से रक्त परिसंचरण में सुधार करके और घाव के आसपास कोशिका मृत्यु को रोककर घाव भरने में तेजी लाने में सक्षम है। जेल में ऐसे गुण होते हैं जो कुछ प्रकार के बैक्टीरिया और कवक के लिए हानिकारक होते हैं

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MATHEMATICAL MODELLING AND SIMULATION OF FINGERPRINT ANALYSIS USING GRAPH ISOMORPHISM, DOMINATION, AND GRAPH PEBBLING

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Electronic Properties of Semiconducting Nanowires: a Comparative Study

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ABSTRACT

The presented work has explored the comparative study of electronic properties of semi conducting nanowires of different materials. These nanowires have critical role in photovoltaic and it shapes the future of new and renewable energy. The study has been performed for different shapes of nanowires. The various shapes under consideration are 2-atom Linear Nanowire, 2-atom Zigzag Nanowire, 4-atom Square Nanowire and 6-atom Hexagonal Nanowire. The findings for electronic properties reveal that 2-atom linear wire can be conducting as well semi conducting, 2-atom zigzag wire is conducting for almost all materials, 4-atom square wire is insulating for most of the materials while 6-atom hexagonal wire has come out to be insulating for all materials. Hence a semiconducting material shows conducting, semiconducting and insulating behavior depending on the proposed shape for various materials.

Keywords: Nanowire, Electronic properties, Density functional Theory, Pseudopotential, Band structure.

1. Introduction

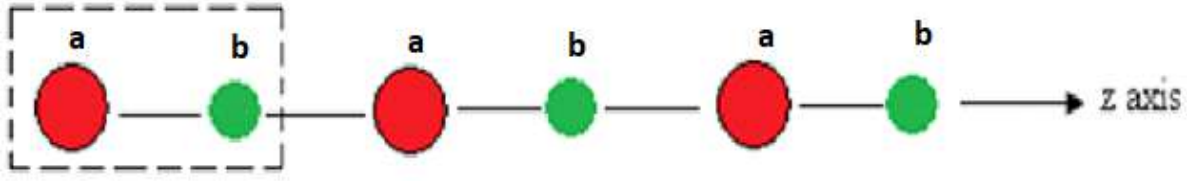
The present era is era of Science and Technology. In this technological era the behavior of electronic devices matters a lot. The photovoltaic has played its critical role in the present industrialization by bridging the gap between the demand and supply of ever-increasing demand of electricity. The efficiency of the photovoltaic cell is dependent on the semiconducting wire used for its manufacturing. The presented work revolves around this central idea of efficacy of photovoltaic cell and has explored the electrical behavior of semiconducting nanowire which are used in solar cells and has also explored other potential material for the same purpose. The electrical behavior of semiconducting nanowires plays a very critical role for the desired output efficiency of such electronic devices. The material like cadmium sulphide, zinc selenide and cadmium telluride in particular play a critical role in efficiency of solar cell.

Many researchers have shown their keen [illegible] properties of the nanowires since around 198[illegible] with significant conclusions. If we compare th[illegible]

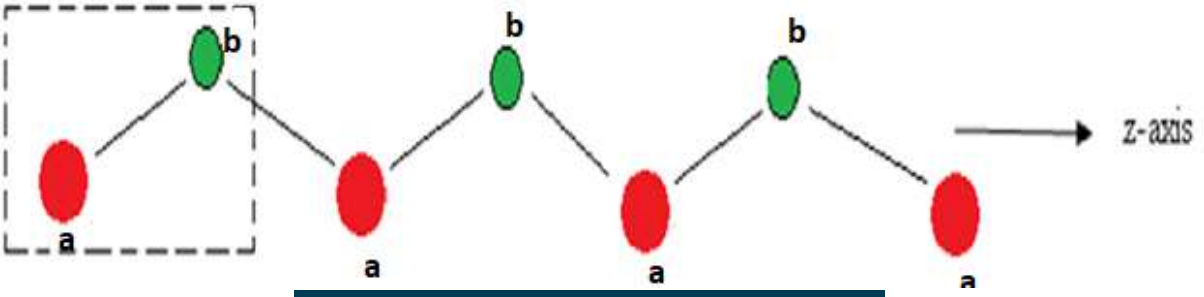
nano dimension of these materials then a variation in electrical as well as other properties is noticed. Exotic properties were reflected by these miniature structures at nano-scale and because of this there has been an urgent need for exploration and investigation of such structures. The devices made on this technique are seen to have technical advantages over other devices based on photolithography. The Review on structural dependence of electronic behavior of various nanowires as reported by the researchers in past around thirty years is the outcome of this proposed work.

From the early eighties of 20th Century, the germanium and silicon nanowires have been the central spot for the researchers and thus sufficient experimental work on these nanowires have already been performed by various researchers (Li *et al.* 2003; Tian 2007; Greytak 2004). The work has explored review of electronic properties of various semiconducting materials as proposed by many researchers and it also includes our work in which we have performed the study for cadmium sulphide, zinc selenide and cadmium telluride. Cadmium Sulphide is used as buffer layer in the cell (Kapadnis *et al.* 2020) and is also used in designing the photovoltaic cell, Zinc Selenide, which may be used to improve the absorption coefficient which affects solar cell (Nisreen *et al.* 2020) and Cadmium Telluride which can be used for increasing the efficiency of Solar Cell (Fardi *et al*. 2013). The semiconducting nanowires play a significant role in efficiency of present-day devices and hence are the material under much explored study. This has attracted us to explore these materials in terms of electronic properties and hence we have performed the review which shall be very critical for future researchers.

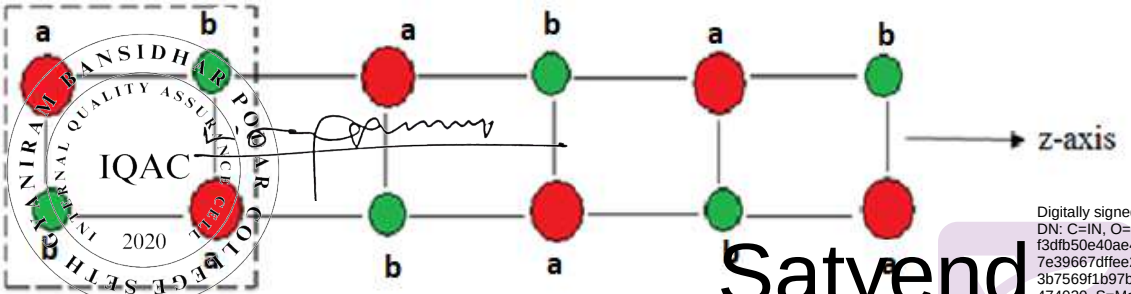
The different atomic arrangements are discussed in the performed study. The various shapes explored by the different researchers in this review are: 2-atom linear, 2-atom zigzag, 4-atom square and 6-atom hexagonal shapes as shown below in Fig. 1.



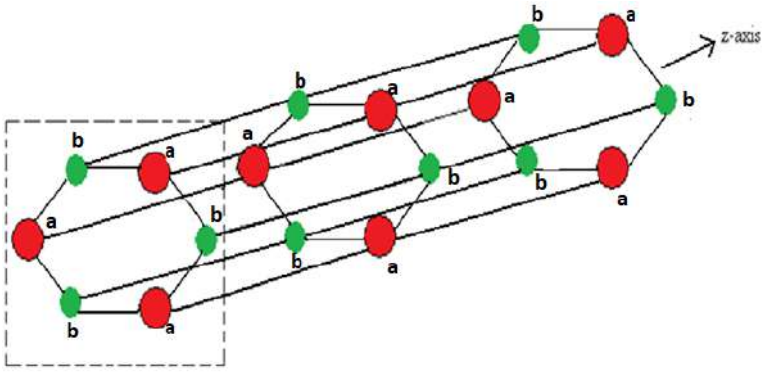
(a) 2-atom Linear Nanowire



(b) 2-atom Zigzag Nanowire



(c) 4-atom Square Nanowire



(d) 6-atom Hexagonal Nanowire

Fig.1. Structures of Nanowires (a) 2-atom Linear Nanowire (b) 2-atom Zigzag Nanowire (c) 4-atom Square Nanowire (d) 6-atom Hexagonal Nanowire.

Srivastava (Srivastava *et al.* 2008) studied Gallium Nitride by pseudopotential density functional by using generalized gradient approximation (Perdew *et al.* 1996) and proposed that the 2-atom linear wire reflected semi conducting nature, 2-atom zigzag & 4-atom square wires reflected metallic nature and 6-atom hexagonal wire showed insulating nature. Materials at lower dimension show different behavior for Gallium Arsenide was established by a group of researchers and it was also proposed in their findings that for 2-atom linear and 2-atom zigzag shapes are conducting for GaAs whereas 4-atom square and 6-atom hexagonal shapes are insulating (Singh *et al.* 2009). The same group of researchers employed ab-initio DFT calculations (Hohonberg *et al.* 1964; Kohn *et al.* 1965) on Gallium Antimonide and proposed that the 2-atom linear and 2-atom zigzag shapes are conducting here also whereas 4-atom square and 6-atom hexagonal shapes are insulating in nature for GaSb. In 2011, Srivastva (Srivastva *et al.* 2011) used exchange correlation potential of Trouiller– Martin (Troullier et al. 1991) and performed the study on Gallium Phosphide and proposed that the 2-atom linear & 2-atom zigzag wires are reflecting metallic nature whereas 4-atom square and 6-atom hexagonal wires are insulating in nature. Srivastva (Srivastva *et al.* 2011) performed the structural dependence of aluminum nitride and predicted the electronic behaviour of the material by stating that 2-atom linear,2-atom zigzag & 4-atom square shape is conducting in nature whereas 6-atom hexagonal wire have shown insulating character. Singh (Singh *et al.* 2015) by employing 15-k point sampling for integration of Brillouin Zone by Monkhorst-pack method (Monkhorst *et al.* 1976) on Zinc Oxide (ZnO) performed the ab-initio study for electronic behavior, his study for band structure indicated that 2-atom linear shape is semiconducting, 2-atom zigzag shape is semiconducting while 4-atom square and 6-atom hexagonal shapes are insulating in nature.

We have also performed the ab-initio DFT calculations and decided to extend the work for II-VI semiconducting nanowires and choose Cadmium Sulphide (CdS), Zinc Selenide (ZnSe) and Cadmium Telluride (CdTe). The selected wires have their unique applications like ZnSe semiconductor has its unique application as light emitting diodes (Chen *et al.* 2005), photo detector (Vigue *et al.* 200) & scintillator (Nasieka *et al.* 2014) while CdS semiconductor has its unique application as field emitter (Yi *et al.* 2007), logic gate (Ma *et al.* 2007) and CdTe has its application of being used in solar cells (Amin *et al.* 2007).

Our findings for cadmium telluride (CdTe) revealed that for various shapes the electronic behavior is also different. The electronic behavior reflected that for cadmium telluride the 2-atom linear and 2-atom zigzag wires are semi-conducting in nature while 4-atom square & 6-atom hexagonal shapes are insulating in nature (Kaushik *et al.* 2020). The study for cadmium Sulphide (CdS) nanowires by us established that 2-atom linear shape is conducting, 2-atom zigzag shape is semiconducting and 4-atom square shape & 6-atom hexagonal shapes are reflecting insulating characters (Singh et al. 2020). The ab-initio study for Zinc Selenide by us (Kaushik *et al.* 2020) for electronic properties reflected that the 2-atom zigzag wire is conducting, 2-atom linear wire is semiconducting whereas 4-atom square & 6-atom hexagonal shape [illegible] insulating here also [illegible] reviewed structural dependence material and the stability has also

varying atomic arrangement. The electronic properties of Organic-Inorganic mixed halides-based perovskites have been analyzed by density functional theory is also being performed by us (Sharma *et al.* 2023) and found that addition of halogen shifts the energy bands in band structure which results in change of bandgap for of Solar Energy Material $CH_3NH_3PbX_3$ (X= I, Br and Cl) Perovskites. A model developed to study the effect of size and shape on the bandgap of semiconductor nanomaterials has found that bandgap increases by decreasing the size and depends on the shape considered (Paneru *et al*. 2023). The bandgap variation are reported (Singh *et al.* 2023) for spherical, thin film, nanowire, regular tetrahedral and regular octahedral shapes of semiconductor nanosolids. According to the study shape effect becomes prominent as the form changes from spherical to regular tetrahedral shape up to the size limit of 20 nm and concluded that the bandgap increases on decreasing size to the nanoscale.

2. Computational Details

The structures of the mentioned nanowires have been explored through Density Functional Theory calculations (Hohonberg *et al.* 1964; Kohn *et al.*1965). The pseudopotential technique has proven to be a very dynamic tool for studying electronic properties for different materials (Martin *et al.* 2009). Most of the above studies are performed by using ABINIT Code (Gonze *et al.* 2002).

3. Results

We have performed the extensive review with the available existing studies for electronic behavior for various semiconducting materials. The electronic properties show a drastic variation when the atomic arrangement is varied. The behavior of the semi conducting material under observation has shown all possible behavior. The detailed findings of the reviewed literature for electronic behavior are of critical importance.

The findings for electronic behavior for various materials as shown below in Table I reflect that 2-atom linear wire has come out to be conducting as well semiconducting for various materials depending on the nature of material, 2 atom zigzag wire has come out to be conducting for almost all materials other than cadmium sulphide and cadmium sulphide where it has shown semiconducting nature, 4-atom square shape has come out to be insulating for all materials other than gallium nitride and aluminum nitride where it has shown conducting nature but 6-atom hexagonal wire has come out to be insulating in all cases.

Table 1: Electronic Behavior Table for various Materials.

Material	Electronic Behavior of Material for Different Shapes			
	2-atom linear	2-atom zigzag	4-atom square	6-atom hexagonal
Gallium Nitride (GaN)	Semi-conducting	Conducting	Conducting	Insulating
Gallium Arsenide (GaAs)	Conducting	Conducting	Insulating	Insulating
Gallium Antimonide (GaSb)	Conducting	Conducting	Insulating	Insulating
Gallium Phosphide (GaP)	Conducting	Conducting	Insulating	Insulating
Aluminum Nitride (AlN)	Conducting	Conducting	Conducting	Insulating
Zinc Oxide (ZnO)	Semi-conducting	Conducting	Insulating	Insulating
Cadmium Sulphide (CdS)	Conducting	Semi-conducting	Insulating	Insulating
Zinc Selenide (ZnSe)	Semi-conducting	Conducting	Insulating	Insulating
Cadmium Telluride (CdTe)	Semi-conducting	Semi-conducting	Insulating	Insulating

4. Conclusion

The review on electronic properties of semiconducting nanowires has been performed. The structural dependence of electronic properties for different material by using ab initio DFT calculations have been analyzed. It is concluded that the electrical behavior of the nanowire is critically dependent on shape. A semiconducting nanowire may possess the conducting, semi conducting and insulating nature by varying the atomic arrangement i.e., the electronic behavior can be changed by changing the atomic arrangement for the materials under study. The pr[illegible] very carefully utilized while [illegible] designing various scientific de[illegible]

Acknowledgements

We are also thankful to all researchers cited in the review. It is because of their reported work because of which we could perform the study and reach to such an important conclusion. We also express our gratitude for SCERT Gurugram, for providing infrastructural facilities because of which we could carry out our experimental work.

References

Abdalameer, N. K., S. N. Mazhir, and K. A. Aadim, 2020. The effect of ZnSe Core/shell on the properties of the window layer of the solar cell and its applications in solar energy. *Energy Reports*, *6*, 447-458.
DOI: 10.1016/j.egyr.2020.09.023

Amin, N., K. Sopian, and M. Konagai, 2007. Numerical modeling of CdS/CdTe and CdS/CdTe/ZnTe solar cells as a function of CdTe thickness. *Solar energy materials and solar cells*, *91*(13), 1202-1208.
DOI: 10.1016/j.solmat.2007.04.006

Chen, H. S., S. J. J. Wang, C. J. Lo, and J. Y. Chi, 2005. White-light emission from organics-capped ZnSe quantum dots and application in white-light-emitting diodes. *Applied Physics Letters*, *86*(13), 131905.
DOI: 10.1063/1.1886894

Fardi, H., and F. Buny, 2013. Characterization and modeling of CdS/CdTe heterojunction thin-film solar cell for high efficiency performance. *International Journal of Photoenergy*, *2013*.
DOI: 10.1155/2013/576952

Gonze, X., J. M. Beuken, R. Caracas, F. Detraux, M. Fuchs, G. M. Rignanese, and D. C. Allan, 2002. First-principles computation of material properties: the ABINIT software project. *Computational Materials Science*, *25*(3), 478-492.
DOI: 10.1016/s0927-0256(02)00325-7

Greytak, A. B., L. J. Lauhon, M. S. Gudiksen, and C. M. Lieber, 2004. Growth and transport properties of complementary germanium nanowire field-effect transistors. *Applied Physics Letters*, *84*(21), 4176-4178.2020
DOI: 10.1063/1.1755846

Hohenberg, P., and W. Kohn, 1964. Inhomogeneous electron gas. *Physical review*, *136*(3B), B864.
DOI: 10.1103/PhysRev.136.B864

Kapadnis, R. S., S. B. Bansode, A. T. Supekar, P. K. Bhujbal, S. S. Kale, S. R. Jadkar, and H. M. Pathan, 2020. Cadmium telluride/cadmium sulfide thin films solar cells: a review. *ES Energy & Environment*, *10*(2), 3-12.

Kaushik, S. P., S. Singh, and R. K. Thakur, 2020. First Principles Study of Structural Stability and Electronic Properties of CdTe Nanowires. *Journal of Computational and Theoretical Nanoscience*, *17*(12), 5210-5214
DOI: 10.1166/jctn.2020.9631

Kaushik, S. P., R. K. Thakur, and S. Singh, 2022. Structural Dependence of Stability of Semiconducting Nanowires, *Shodhsankalp Journal*, 2(2), 25-31.

Kohn, W., and L. J. Sham, 1965. Self-consistent equations including exchange and correlation effects. *Physical review*, *140*(4A), A1133.
DOI: 10.1103/PhysRev.140.A1133

Li, D., Y. Wu, P. Kim, L. Shi, P. Yang, and A. Majumdar, 2003. Thermal conductivity of individual silicon nanowires. *Applied Physics Letters*, *83*(14), 2934-2936.
DOI: 10.1063/1.1616981

Lin, Y. F., Y. J. Hsu, S. Y. Lu, K. T. Chen, and T. Y. Tseng, 2007. Well-aligned ternary Cd1-x Zn x S nanowire arrays and their composition-dependent field emission properties. *The Journal of Physical Chemistry C*, *111*(36), 13418-13426.
DOI: 10.1021/jp074094b

Ma, R. M., L. Dai, H. B. Huo, W. J. Xu, and G. G. Qin, 2007. High-performance logic circuits constructed on single CdS nanowires. *Nano letters*, *7*(11), 3300-3304.
DOI: 10.1021/nl0715286
PMID:17935372

Martin, R. M., 2009. Electronic structure. *Physik Journal*, *8*(4), 54.

Monkhorst, H. J., and J. D. Pack, 1976. S[illegible] for Brillouin-zone integrati[illegible]

B, *13*(12), 5188.
DOI: 10.1103/PhysRevB.13.5188

Nasieka, I., M. Boyko, V. Strelchuk, N. Kovalenko, A. Gerasimenko, N. Starzhinskiy, and D. Sofronov, 2014. Optical characterization of Er-doped ZnSe for scintillation applications. *Optical Materials*, *38*, 272-277.
DOI: 10.1016/j.optmat.2014.10.052

Paneru, P., and M. Kumar, 2023. Development of size and shape dependent model for bandgap of semiconductor nanomaterials. *Modern Physics Letters B*, 2350111.
DOI: 10.1142/S0217984923501117

Perdew, J. P., K. Burke, and M. Ernzerhof, 1996. Generalized gradient approximation made simple. *Physical review letters*, *77*(18), 3865.
DOI: 10.1103/PhysRevLett.77.3865
PMID:10062328

Prakash, K. S., S. Satyendra, and K. R. Krishna, 2020. Stability and electronic properties of ZnSe nanowires: An ab initio approach. Наносистемы: физика, химия, математика, *11*(5), 546-552.
DOI: 10.17586/2220-8054-2020-11-5-546-552

Sharma S., S. P. Kaushik, R. K. Thakur, and V. K. Shukla, 2023. Study of Structural Properties of Solar Energy Material $CH_3NH_3PbX_3$ (X= I, Br and Cl) Perovskites and its Mixed Halides Using Density Functional Theory, *Nepal Journal of Science and Technology*, 21(2).
DOI: 10.3126/njst.v21i2.62360

Singh, M., S. Lara, N. J. Matjelo, L. Lepekola, M. Kao, and M. T. Matobako, 2023. Modeling Size and Shape Dependence of Electro-Optical Properties of Semiconductor Nanosolids. *International Journal of Nanoscience*, 2350052.
DOI: 10.1142/S0219581X23500527

Singh, S., S. P. Kaushik, and Supreet, 2020. Ab Initio Study of Electronic Properties of Cadmium Sulphide Nanowires. *Journal of Computational and Theoretical Nanoscience*, *17*(2-3), 546-551.
DOI: 10.1166/jctn.2020.8907

Singh, S., P. Srivastava, and A. Mishra, 2009. Ab-initio study of gallium arsenide nanowires. *Journal of Computational and Theoretical Nanoscience*, *6*(7), 1556-1560.
DOI: 10.1166/jctn.2009.1211

Singh, S., P. Srivastava, and A. Mishra, 2009. Structural stability and electronic properties of GaSb nanowires. *Physica E: Low-dimensional Systems and Nanostructures*, *42*(1), 46-50.
DOI: 10.1016/j.physe.2009.08.017

Singh, S., and P. Srivastava, 2015. Ab-initio Study of the Structural Stability and Electronic Properties of ZnO Nanowires. In *2015 Fifth International Conference on Communication Systems and Network Technologies* (pp. 1279-1283), IEEE.
DOI: 10.1109/CSNT.2015.226
PMID:25711148

Srivastava, P., and S. Singh, 2011. Shape Dependent Electronic Properties of Aluminium Nitride Nanowires. *Journal of Computational and Theoretical Nanoscience*, *8*(9), 1764-1768.
DOI:10.1166/jctn.2011.1880

Srivastava, P., S. Singh, and A. Mishra, 2011. Electronic properties of GaP nanowires of different shapes. *Journal of Nanoscience and Nanotechnology*, *11*(12), 10464-10469
DOI: 10.1166/jnn.2011.3960
PMID:22408927

Srivastava, P., S. Singh, and A. Mishra, 2008. Stability and Electronic Properties of GaN Nanowires-An Ab-Initio Approach. *Journal of Computational and Theoretical Nanoscience*, *5*(4), 635-638.
DOI: 10.1166/jctn.2008.029

Tian, B., X. Zheng, T. J. Kempa, Y. Fang, N. Yu, G. Yu, and C. M. Lieber, 2007. Coaxial silicon nanowires as solar cells and nanoelectronics power sources. *Nature*, *449*(7164), 885-889.
DOI: 10.1038/nature06181
PMID:17943126

Troullier, N., and J. L. Martins, 1991. Efficient pseudopotentials for plane-wave calculations. *Physical review B*, *43*(3), 1993.
DOI: 10.1103/PhysRevB.43.1993
PMID:9997467

Vigue, F., E. Tournie, and J. P. Faurie, 2000. ZnSe-based Schottky barrier photodetectors. *Electronics Letters*, *36*(4), 352-354.
DOI: 10.1049/el:20000282