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Assessment of Seed Dispersal Mechanisms through Vehicular Movement in the District of Charsadda, Pakistan

Wisal[1], J. N. Azorji[2*], M. O. Nwachukwu[3], M. F. Basit[1], M. F. Jaleel[1], C. M. Igbokwe[2] and Iftikhar Ullah[1]

[1]Department of Botany, Bacha Khan University, Charsadda KP, Pakistan.
[2]Department of Biological Sciences, Hezekiah University, Umudi Imo State, Nigeria.
[3]Department of Biology, Federal University of Technology, Owerri, Imo State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author Wisal designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JNA, MON, MFB and MFJ managed the analyses of the study. Authors CMI and IU managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Different seeds are dispersed from infested to uninfested areas possibly due to several biotic and abiotic mechanisms, and this spread of seed aids the invasion process across the landscape. Currently, in District Charsadda KP, Pakistan, there are about thousands of motorized vehicles, each capable of carrying infested seeds and therefore spreading crop seeds and plant seeds. Studies were conducted in 2019 to investigate the role of the utility vehicles in the dispersal of seeds in District Charsadda. A large number of seeds were found on vehicles. In the current study undertaken in KP, the maximum number of species from the family *Apiaceae* (3.00), *Poaceae* (3.00) and *Solanaceae* (3.00) were found dominant on the vehicles. Whereas, the minimum species number from the family *Asteraceae* (1.00), *Fabaceae* (1.00), *Ebenaceae* (1.00), *Umbelliferae* (1.00)

**Corresponding author: E-mail: jnazorji@hezekiah.edu.ng, jnazorji17@gmail.com;*

and *Cucurbitaceae* (1.00) were associated with the vehicle. These seeds were found on several parts of the vehicles and were contained within mud or dust that had presumably transferred to the vehicle as it undertook its routine activities. The early implications from this present study is that utility vehicles are capable of collecting, carrying, and presumably distributing large numbers of seeds that seed is carried on many parts of the vehicle. Thus, any washing or cleaning procedure used to remove seeds from vehicles will need to concentrate on all parts of the vehicle. Cleaning vehicles at appropriate places should be seen as a possible way to reduce seed spread by utility vehicles.

Keywords: Seeds dispersal; vehicles; mechanism.

1. INTRODUCTION

Seed dispersal is a multifarious process that crucially affects species migration rates dynamics of species, metapopulation, plant invasions, and community assembly [1]. Long-distance dispersal takes place through several vectors, including humans, wind, and animals. Long-distance contributes to plant invasions and effects species distributions [2,3]. Currently, the spread of invasive exotic plant species along road verges has attracted considerable interest [4,5]. Only a limited number of studies have focused on the dispersion of native plants, while less research aimed at estimating the contribution of motor vehicles in these dispersion processes [6,7,8].Introductory events and pathways affect plant invasions [9] and the non-native species composition in a region will reflect the dominant introduction pathway [10]. Human-mediated introduction pathways often cause rapid dispersal in the new range than natural channels because they generally initiate multiple introductions to multiple locations across a large area; post introduction anthropogenic activities such as transportation along roads, railways and waterways ensure high spread rates [11,12]. In today‘s world, people are traveling more and more, both locally and internationally. With this increased movement of people, the invasion of unwanted plants is also increasing. Spread of seeds by human-induced mechanisms is now more important than movement by natural mechanisms of spread (e.g., water, wind or animals) and is considered to be the main source of seed spread globally [13]. Among these human-induced mechanisms, and seed spread by vehicles are one of the most important. More recently, has been shown that an average of 16.5 weed species is carried by every tractor, slasher, mower, truck, grader, backhoe, trailer, excavator, and dozer traveling along Australian roads [13]. Seeds of many different species have been found on passenger vehicles in varying quantities [14,15]. Seeds can also accidentally be carried and disperse on clothing, vehicles, domesticated animals, in soil, and animal fodder [16,17,18]. Seed unintentionally transported on/in cars can be dispersed over long distances and in many regions of the world [19,20]. The number of cars on the road and the size and extent of road networks are increasing rapidly in many regions Seed unintentionally transported on/in vehicles can be dispersed over long distances and in many areas in the world [21]. The spread of weed seed by cars is a global-scale problem. Given the increasing numbers of cars globally and in many of these regions, there is an increased risk of seed being dispersed in previously remote areas [22] Many seeds that are dispersed by cars remain viable. The importance of dispersal of viable seeds is well recognized, including the threat they pose to the survival, abundance, and distribution of many native species [23,24,12]

From the foregoing, it is evident that seed dispersal if not checked could lead to introduction of invasive alien species thereby infesting more areas and affecting crop growth and development. It is in light of the above that the present study was conducted to assess seed dispersal mechanisms through vehicular movement in the District of Charsadda, Pakistan.

2. MATERIALS AND METHODS

2.1 The Study Area and Vehicles

The experiment was conducted in the laboratory of Bacha Khan University Charsadda KP Pakistan, located at latitude 34.1509’ N, longitude 71.735’ E, Altitude 908 feet) during winter from April 2019 to February 2020. Twenty different samples from different vehicles from the area of Charsadda were collected. These particular vehicles used in this experiment were first cleaned at the service Station of Charsadda. These vehicles were then used to undertake fifteen (15) days of fieldwork before being

cleaned again and evaluated for their germinable seed load.

2.2 Cleaning Process

Vehicles were parked at a service station on a smooth concrete surface on which a clean black plastic sheet (7 x 5 m) was spread underneath the vehicle once the vehicles had returned from a fifteen day trip. The utility vehicles were cleaned by using the following approaches. Mud and dust were collected from different parts of the vehicles. The mud was first removed by hands using a plastic, spatula, and brush, thereafter the vehicles were vacuum cleaned. The process of cleaning started at the front mudguards and then moved to the back mudguard followed by all four tyres and rims, where after the cleaning process moved to the underside, the engine and radiator, and finally, the cabin. All the materials which were collected on the plastic sheet were transferred to a paper bag. The paper bags were marked and taken to the glasshouse/laboratory at the Bacha Khan University Charsadda, where the contents were set for germination.

2.3 Seed Germination

The paper bags with the particulate matter removed from each part of the vehicle were weighed, their contents were crushed by hand, and spread thinly over a 2 cm layer of compost contained within twenty germination tray (30 x *20 x *5 cm: l/w/h) where after the trays were placed in a glasshouse at the Bacha Khan University (Figs. 1 and 2). The soil and the compost in the trays were moistened to field capacity with tap water, and this watering process was repeated daily, if necessary. The twenty trays were left for five weeks in the glasshouse, during which time emerging seedlings were identified, counted, and removed.

2.4 Classification of Detected Seeds

The characteristics, origin, and history of the species were determined with the help of published literature (http://plannet.rbgsyd.nsw.gov.au/floraonline.htm). From this information, the weed seeds of each species were classified' then the number of seeds of each species found on the vehicle was calculated and statistically analyzed.

2.5 Experimental Design

A randomized complete block design was used in this experiment. The vehicle was considered as the block, the season was regarded as the main plot, while each part of vehicles (front mudguard, back mudguard, rims, tyres, engine, radiator, and cabin) were considered as a subplot. Samples were collected from each vehicle, and germinated were separately in a single tray; every single tray was regarded as a treatment, while the different vehicles were considered to be a replicate. So there were different treatments and different replications in the study.

2.6 Statistical Analysis

Analysis of variance (ANOVA) was conducted using statistic 8.1 computer software using a general linear model. Vehicles were used as block variables, season as treatment variable, and the total number of seeds as dependent variables. The significant means were separated by the least significant difference (LSD) using 95.0% confidence intervals [25].

Figs. 1 &2. Showing germination set up of seeds collected from vehicles

3. RESULTS AND DISCUSSION

3.1 Seeds on Vehicles

A large number of germinable seeds (216), belonging to eight different families on a vehicle that traveled for 15 days in the different areas of District Charsadda KP indicates that vehicles are an important mechanism for wheat seeds spread in this region. Since there are thousand motorized vehicles on the roads in District Charsadda KP, each having the capacities of carrying and spreading, there exists a threat to the agricultural and natural environment. In the present study the number of wheat seeds found on vehicles was similar to that seen in previous studies of [25,26,27,28] but greater than that observed by [21]. Seed spread is one of the fundamental requirements for a successful invasion by species into a new location, from where they can spread further [27]. This study indicated that there was a relationship between the quantity/volume/weight of mud and the number of seeds it contained; the greater the quantity of mud, the larger the number of seeds found in that mud. A similar relationship between mud and the number of seeds was previously reported by [22].

3.2 Species Composition

In general terms, the species composition found on the vehicles was similar to that of the areas where those vehicles have traveled. For example, in the current study undertaken in KP Apiaceae (3.00) and Poaceae (3.00) family were the dominant species found on the vehicles which was similarly to Solanaceae (3.00) while the minimum species number was Asteraceae (1.00) which showed the same result in the family Fabaceae (1.00), Ebenaceae(1.00), Umbelliferae(1.00) and Cucurbitaceae(1.00) (Fig. 3). All of the species either naturalized are or native to district Charsadda KP. These species are dominant and produce seed abundantly. Thus, adding more seed to the seed bank and in a rainy situation, all seed is introduced into the soil. Therefore, when the vehicles go off-road, these seeds are collected in mud and spread further by the vehicles; similarly, the result reported by [28]. In the recent study, the highest number of seeds found on vehicles were those that had seeds that were small in size and often with a simple shape which also indicates that vehicular movement of seeds is likely to be a chief mechanism for seed spread in KP. In the present study, most of the species found on the vehicles were plants introduced to KP.

3.3 Seed Location on the Vehicle

It has been stated that small seeds, like those from grass, generally attach to the undersides of a vehicle in mud or dust [14]. In the present study, the grass species were found mostly in mud on the underside of the vehicle. The Asteraceae seeds were predominantly found on all parts of the vehicle. Another important location for seeds to collect is within the cabin as such seeds can easily attach to socks and clothes and then fall off in the cabin [28].

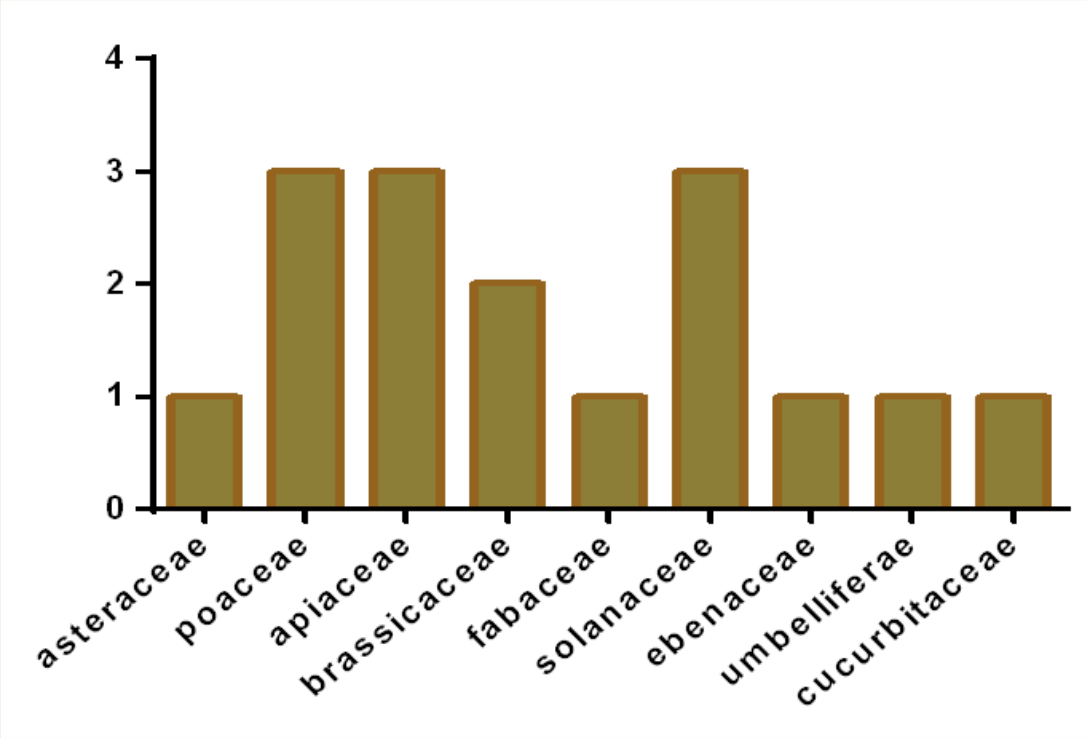

Fig. 3. Number of species

Table 1. Species of determined plants and families to which they belong

S. No	Common Name	Scientific Name	Family
1	Wheat	*Triticum aestivum*	Poacea
2	Manilla Grass	*Zoysia matrella*	Poaceae
3	Bermuda Grass	*Cynodon dactylon*	Poaceae
4	Coriander	*Coriandrum sativum*	Apiaceae
5	Dill	*Anethum graveolens*	Apiaceae
6	Cumin	*Cuminum cyminum*	Apiaceae
7	Field mustard	*Brassica rapa*	Brassicaceae
8	Field pea	*Pisum sativum*	Fabaceae
9	Devil's trumpet	*Datura metel*	Solanaceae
10	Chilly	*Capsicum frutescens*	Solanaceae
11	Tomato	*Solanum lycopersicum*	Solanaceae
12	Bitter melon	*Momordica charanita*	Cucurbitaceae
13	Date plum	*Diospyros lotus*	Ebenaceae
14	Sunflower	*Helianthus annus*	Asteraceae

4. CONCLUSIONS

From the present study, it is concluded that a large number of weed seeds are attached to almost all parts of the utility vehicles during a field trip and often associated in mud from the ground. Therefore, much of this seed load is to be found on the underside, on the back, and front mudguards while the smaller collection was from the cabin and the radiator, the engine, and the tyres. To prevent weed seed spread by vehicles, cleaning procedures, including washing and vacuuming, should be done to remove seeds. This will need to be applied to all parts of the vehicle to prevent further spread of invasive alien species.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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