Pak. J. Weed Sci. Res., 18: 281-288, Special Issue, October, 2012

WEED SEED SPREAD BY VEHICLES: A CASE STUDY FROM SOUTHEAST QUEENSLAND, AUSTRALIA

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ABSTRACT

Weed seed spread, from infested to uninfested areas, is by a number of biotic and abiotic mechanisms, and this spread of seed aids the invasion process across the landscape. Currently in Queensland there are approximately 3.2 million motorized vehicles, each capable of carrying, and therefore spreading, weed seeds. Studies were conducted in 2009/10 to investigate the role of the utility vehicle in the spread of weed seeds in south east Queensland. A large number (209) of viable seed were found on vehicles and in each of the four seasons of the year. The largest number seeds per vehicle were collected in the autumn (48%) and the lowest number in the winter (14%). These viable seeds were found on a number of parts of the vehicles and were contained within mud or dust that had presumable transferred on to the vehicle as it undertook its routine activities. The highest percentages of seed were collected from the underside of the vehicle (36%), followed by back mudguards (24%), front mudguard (16%) and cabin (12%). Lower percentages were found on engine, radiator (3%) and tyres and rims(9%). The seeds found on the vehicles belonged to 90 species, coming from 26 families. The majority of these species were alien to Australia (66%) and Queensland (73%).The early implications from this present study are that utility vehicles are capable of collecting, carrying and presumably distributing large numbers of viable weed seeds, that seed is carried on many parts of the vehicle and that this occurs in all seasons of the year. Thus, any washing or cleaning procedure used to remove weed seeds from vehicles will need to concentrate on all parts of the vehicle and that this should be done in all seasons. Cleaning vehicles at appropriate places should be seen as a possible way to reduce weed seed spread by utility vehicles.

Key words: Weed seeds, vehicle, southeast Queensland

INTRODUCTION

The majority of plants considered to be weeds in Australia have come from many regions of the world. So far a total of 429 weeds have been declared to be noxious or are under some form of legal control within Australia (AWS 2006). In today's world people are

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Note: This study is a part of PhD Dissertation

travelling more and more, both locally and internationally. With this increased movement, the invasion of weeds is also increasing. Spread of weed seeds by human-induced mechanisms is now more important than movement by natural mechanisms of spread (e.g. by water, wind or animals) and is now considered to be the main source of weed seed spread globally (Mack and Lonsdale 2001). Among these human-induced mechanisms, weed seed spread by vehicles is one of the most important. As far back as 1930 Ridley (1930) has suggested that weed seed spread along roadsides was mainly by weed seed attached to vehicles in mud. This conclusion was based on the observations only that many weeds first appear along roadsides before anywhere else in the landscape. A later study by Clifford (1955) also indicated the importance of vehicle transfer of weed seed, who estimated that every kg of mud attached to vehicles contained 100 to 180 weed seeds. More recently Wace (1977) has also confirmed that the motor vehicle is a very important vector for weed seed spread in the modern landscape.

Due to the increasing number of vehicles on Australian roads, the opportunities for weed seed spread is increasing. More recently Moerkerk (2006) has shown that an average of 16.5 weed species is carried by every tractor, slasher, mower, truck, grader, backhoe, trailer, excavator and dozer travelling along Australian roads. Another study has shown that many viable weed seeds (18,566 from 259 species) were to be found at the bottom of an automatic carwash (Wace, 1977) indicating that motor vehicles do indeed carry great numbers of viable weed seed. In another study, Lonsdale and Lane (1994) assessed tourist vehicles that entered Kakadu National Park (Australia) and found 1,960 viable weed seeds (from 88 species) on 304 tourist's vehicles (Lonsdale and Lane, 1994). In this study they found a significant variation in number of seed per vehicle and majority of the vehicle carried one or no seeds. However some carried very high number of seed (789). Moreover, season did not show any significant effect on the number of seed per vehicle. Thus, the objectives of the present study were: (1) to determine how many weed seeds are to be found on utility vehicles that have undertaken field work close to an urban centre, Brisbane, and in different seasons of the year and (2) to determine which parts of the vehicle these weed seeds collected on.

MATERIALS AND METHODS

In each of the four season of the year (2009/10), six utility vehicles were identified and cleaned, and the samples collected assessed for their viable weed seed content. These vehicles had been cleaned then exposed to a week of routine business for Powerlink Ltd.

This business included visits to field sites for power cable repair and maintenance in southeast Queensland. Prior to vehicle cleaning, each vehicle was driven over a large black plastic sheet. In the cleaning process, mud was scraped off the exposed surfaces of the vehicle by hand using a plastic spatula, and a brush and then recleaned using the house-hold vacuum cleaner. For collecting samples, the following order of cleaning of vehicle was followed and number of small components were considered as one part in the following order: (1) Mud-guards, wheel arches, flaps (front) and around the break lines, (2) Mud-guards, wheel arches, rims and flaps (back) and around the break lines, (3) Tyres and rim (front and back added together) (4) Underside including the chassis rail, recess and holes, around struts and stabilizers, steering components, the axel, the spare tyres, fuel tank and silencer), (5) Engine including front grill, radiator and other cooling cores, the grill and recess under the wiper, blades, the engine mounts, top of the gearbox and battery recess/tray and (6) The cabin including foot well, the carpets and mats, the seats and toolbox. If mud fell off the vehicle it was swept from the plastic sheet and added to the sample, so all final samples contained the dry mud scrapings the vacuum samples and the plastic sheet sweepings.

Air-dried samples were then weighed and the contents broken up and spread thinly over a 2 cm layer of potting compost contained within a germination tray (30 x 20 cm). Thirty six trays (one per vehicle part for six vehicles) were placed in a glasshouse for 16 weeks and watered daily to field capacity level. An additional tray was placed in the glasshouse with potting compost alone to act as a control to detect any weed seeds that may be in the compost or in the glasshouse atmosphere. Upon emergence all seedlings were counted and identified and then removed from the germination trays. Weed seed germination was recorded weekly and all data sets for six vehicles in all four seasons of the year were analysed and compared. After germinations, number of seeds germinated data per each part of the vehicle was transformed into percentage of the total number of seeds per vehicle. Then percent data was analysed through analysis of variance (ANOVA) and general linear model (GLM) techniques, using the Minitab computer software 15 (Minitab Inc., 2007). Means were separated through Tukey's simultaneous test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Season

An average of 209 viable seeds was found on each vehicle and in each season. These seed represented 90 species, coming from 26 families (Table-1) of which 66 % were alien to Australia and 80 % were alien to Queensland. An analysis of variance revealed that the

total number of viable weed seeds found each season were significantly different (at P ≤ 0.05p-value = 0.000) with the greatest number of seeds to be found in the autumn (47%) and followed by summer (23%), and lowest number of seeds were found in winter (14%); (Figure 1). Number of seeds associated with the amount of mud was different in different season of the year. For example, in autumn these seeds were collected in a total of 5.1 kg of dry mud, with an average of 0.85 kg of mud per vehicle. However, in summer these seeds were collected in a total of 5.6 kg of dry mud, with an average of 0.93 kg of mud per vehicle. These results for number of seeds per kg of mud in different season of the year are comparable to those of Clifford (1959), who found 100 seed per kg dry mud in one season and 180 weed seeds per kg of dry mud in other season. There was variation among the species found and their attachment position on the vehicle. Among these seeds found on vehicles in all seasons, the maximum number of species came from the Asteraceae or Poaceae (Table 1). This could be due to the nature of the dispersal unit of these families which are either small in size or have appendages that enable them to stick into mud. Our results are similar to those Moerkerk (2005), who also showed that the most common species found on vehicles were from the Poaceae, asteraceae and fabaceae.

Parts of vehicle

All vehicle parts analysed carried weed seed but the proportion on each part differed possibly due to their ability to have mud and dust stick to them and also due to the amount of air movement each part is exposed to. The association of mud and number of seeds is different in different season of the year. For example in autumn, the maximum amounts of mud were collected from the underside (0.32 kg)of the vehicle and the back (0.20 kg) and front mud guards (0.15 kg) of the vehicle and these parts carried the highest number of weed seeds (Figure 2). However, other parts of the vehicles such as the cabin (18.3%), the engine (0.4%) and the tyres (3.2%) also carried weed seeds, where less amounts of mud were collected. However, front mudguard carried the less number of seeds as compared to the back mudguard. As front tyres disturbed the soil and subsequently soil and seeds were taken by either back mud guard or underside of the utility vehicle (Fig. 2).

Species

There was an association between parts of the vehicle seed stuck to and the plant species. Even though there was less mud in cabin, a large number of weed seeds were found within fruits with spines or hooks. Examples of such species include Khaki Weed (*Alternanthera repens* L.) or Cobbler's pegs (*Bidens pilosa* L.) and were found only in the cabin and nowhere else on the vehicles. The

study also showed that the engine (including front grill, radiator and other cooling cores etc.), although trapping and carrying many seeds, only had a few viable seeds per vehicle. Presumably the heat and desiccation received by the seeds in these areas of the vehicle were enough to kill them.

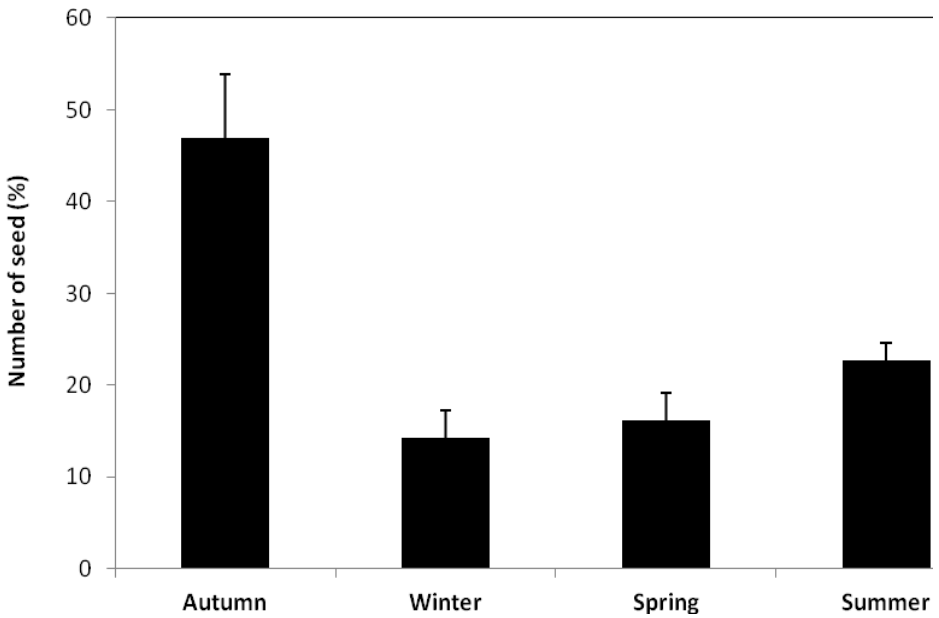

Figure 1. Number of viable weed seed (%) attached to six different parts of the utility vehicles in different season of the years. In each season, the amount of mud was collected by a single utility vehicle was different, such as in autumn (0.85 kg), in winter (0.70 kg), spring (0.63 kg) and Summer (0.93 kg), where number of seed and association mud is different in different seasons.

The conclusions are that utility vehicles can pick up and carry a large number of weed seeds. These weed seeds can attach to almost all parts of the vehicle, often 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 smaller and important collection were made from the cabin and the radiator, the engine, and the tyres. To prevent weed seed spread by vehicles, cleaning procedures, including washing and vacuuming, can be used to remove weed seeds. This will need to be applied to all parts of the vehicle and in all four seasons of the year.

Table-1. The families and number of species from those families that were found on utility vehicles used for routine field work for 1 week around southeast Queensland.

No	Family	No. of species in each season in of the year			
		Autumn	Winter	Spring	Summer
1	Asteraceae	14	7	3	8
2	Poaceae	14	11	7	8
3	Cyperaceae	3	2	1	1
4	Apiaceae	2			
5	Brassicaceae	2	1		2
6	Caryophyllaceae	2			
7	Chenopodiaceae	2	2		
8	Fabaceae	2	2	2	1
9	Polygonaceae	2	1		
10	Portulacaceae	2	2	2	1
11	Verbenaceae	3			
12	Amaranthaceae	1	1	1	3
13	Campanulaceae	1			
14	Clusiaceae	1			
15	Crassulaceae	1			
16	Euphorbiaceae	1	2	5	2
17	Gentianaceae	1			
18	Lamiaceae	1			
19	Onagraceae	1			
20	Oxalidaceae	1	1	1	1
21	Plantaginaceae	1			1
22	Solanaceae	1	1		
23	Aizoaceae				1
24	Moraceae				1
25	Rubiaceae				1
26	Verbenaceae		1	1	2
	Total	**59**	**34**	**23**	**33**

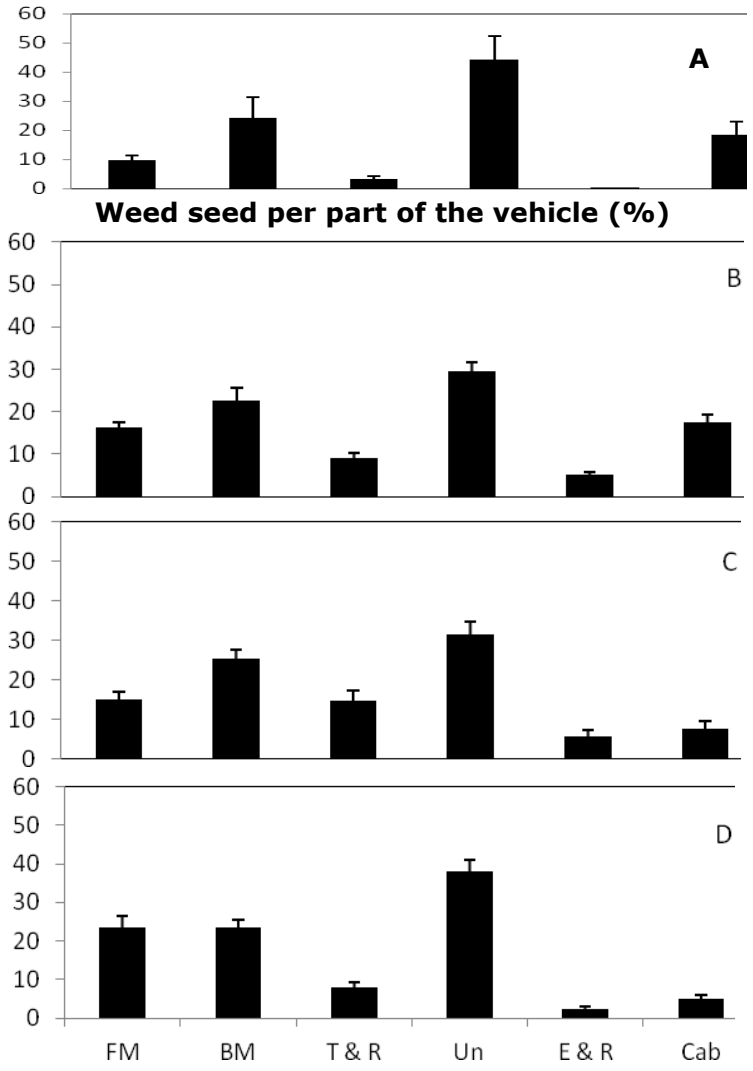

Figure 2. Number of viable weed seed (percent of the total viable seed on a single vehicle) attached to six different parts of the utility vehicles in the four seasons of the year (A) autumn (B) winter, (C) spring (D) summer (2009/10). The part of the vehicle cleaned was BM = Back mudguard, Ca = Cabin, E & R = Engine and Radiator, FM = Front Mudguard, T & R = Four Tyres and Rims and Un = Underside.

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