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Investigating Wind Speed Reduction Rate and Aeolian Erosion via Multi-Row Windbreak in Three Dust Storm Events

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Extended Abstract

Introduction: Wind erosion results from desertification in arid and semi-arid regions and is intensified by any decrease in rainfall and vegetation. Sistan region, located in southeastern Iran, has been exposed to severe wind erosion and dust storms for about 23 years as a result of frequent and prolonged drought in the region and desiccation of Hamoun lakes. Therefore, finding appropriate methods for reducing wind erosion and controlling dust storms is essential. Using local vegetation is the most efficient method in this regard. This study investigated the reduction rate of wind speed and aeolian sediments within a fourteen-row windbreak in Niatak.

Material and Methods: The study windbreak is located in Niatak area in eastern Sistan region. Being located in a dusty corridor, the region is always exposed to severe dust storms. Therefore, to reduce wind erosion and control sediment movement, the area has been re-vegetated. The windbreak is actually

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one of those revegetated areas. Having been located perpendicular to the prevailing wind direction, it consists of 14 rows of *Tamarix* tress with a distance of 21-32 m between the row and 1.5 m between each tree on the row. The windbreak's mean height and porosity were obtained as 4 m and 39% respectively. Moreover, wind speed and aeolian sediments were measured at seven heights and three points, namely upwind (x = -100), within (x = 256), and downwind (x = 448) of the windbreak. Wind speed was monitored during three wind speeds of 14, 16 and 19 m/s and aeolian sediments was assessed throughout three dust storms. Seven anemometers were mounted at the heights of 20, 35, 80, 200, 360, 450, 570, and 700 cm, and seven sediment samples were installed at the heights of 20, 35, 80, 140, 300, 550, 570, and 700 cm. The sand samplers were installed before each event and were collected after the event. They were, then, emptied into labelled plastic bags, taken to the laboratory, and weighed with an electronic balance with a precision of 0.001 g. Standard deviations were measured for aeolian sediments at each point and height.

Results: The study's findings indicated that wind speed and aeolian sediment were decreased within the windbreak, and that the reduction rates were the same in all wind speeds and dust storm events. This reduction was roughly 30% for wind speed and more than 50% for aeolian sediment at all heights from the ground surface (0.2 m) to about two times the windbreak' height (7 m). Moreover, the rate of aeolian sediment was higher at downwind (x = 448) than within (x = 256) the windbreak, but less than the rate for the upwind of the windbreak (x = -100). It was also found that the horizontal pattern of aeolian sediment changed from upwind to within and downwind of the windbreak in according to the wind speed variations in all events. Similar to wind speed, a significant breaking was observed in the aeolian sediment patterns, indicating that the windbreak considerably affected wind speed and aeolian sediment in all heights, even in heights higher than its own one. The aeolian sediment' standard deviation within the windbreak was reported as being less than its value downwind and upwind of the windbreak. Moreover, the standard deviation values at different heights close within the windbreak were found to be close to each other and far from each one upwind of the windbreak. These findings suggested that the deviations of the aeolian sediment values were less within the windbreak than its upwind.

Discussion and Conclusions: This study investigated the effect of a multi-row windbreak on wind speed and aeolian sediment in three dust storm events and three wind speeds. The study's findings could be used for designing windbreaks. Moreover, the results of wind speed and aeolian sediment distribution at different heights are applicable to validating wind erosion models, assessing wind erosion and its control. The study's findings indicated the critical role of vegetation in reducing wind speed, aeolian sediment, and aeolian erosion. It was also found that windbreak reduced wind speed and aeolian sediment in all dust storms and wind speeds, suggesting effectiveness of the windbreak which results from its multi-row structure. Generally, the study's findings showed that windbreak was able to reduce wind speed and aeolian erosion in various dust storms and different wind speeds. Therefore, it could be argued that multi-row windbreaks are applicable for other regions of Iran that are engaged with severe wind erosion and dust storms.

Keywords: Windbreak, Wind Erosion, Sediment Flux, Wind Speed, Niatak Sistan.