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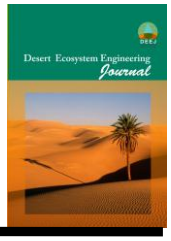

A field study of the variations of wind speed and airflow's turbulence intensity outside and inside a live windbreak

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Extended Abstract

Introduction: Vegetation plays a significant role in reducing wind speed and controlling aeolian erosion. Therefore, understanding the interaction between wind and vegetation is of great importance. Vegetation, which grows typically in crops, wind strips, shelterbelts, and windbreaks, helps shelter the ground surface, reduce wind speed, and trap blown sediment particles. It also alters airflow and affects the properties of the turbulent flow. Thus, analyzing the interaction between wind and vegetation is essential for assessing the wind forces exerted upon plants. Although several studies have examined the effect of vegetation on reducing wind velocity and its interaction with airflow, the relationship between the vegetation effect and wind velocity and airflow needs to be investigated. Moreover, while some studies have evaluated the reductionist effect of windbreaks (artificial or live windbreaks) on wind velocity, the airflow's turbulence intensity in windbreaks has not been well researched. Therefore, this study sought to investigate the variations of wind velocity, turbulence intensity, and standard deviation of wind speed to offer valuable information regarding the effect of vegetation on airflow.

Materials and methods: Located in southeastern Iran, the Sistan region is characterized by an arid and hyper-arid climate, low air humidity, low precipitation, high annual temperature and evaporation, and strong winds and dust storms. The most important meteorological-atmospheric phenomenon in this region is the Levar northerly wind (known as 120-day wind) that blows from the end of June to early September, which is considered the

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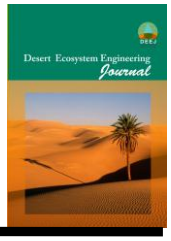

main factor in causing dust storms and controlling dust emission and air quality over the region. Placed in high dusty corridors, the windbreak is located in the Niatak area in the northwestern part of Sistan, which is recognized as a critical wind erosion area. Containing fourteen rows of Tamarix trees planted perpendicular to the prevailing wind direction, the windbreak has a mean height of four meters. The distance between the rows varies from 21 to 32m, and the distance between the trees in each row is about 1.5 m. To assess wind speed variations and turbulence intensity, the wind speed was measured upwind, within, and downwind of the windbreak at the heights of 20, 80, 200, 360, 450, 570, and 700 cm in wind speeds of 10.5 and 19.5 m/s. The mean and standard devastation of each wind speed was calculated. Also, the turbulence intensity was obtained by dividing standard devastations by wind speeds.

Results and Discussion: Wind speeds were found to be normal in the examined wind velocities (10.5 and 19.5 m/s) in all locations. The pattern of wind velocity variations was similar in all heights outside and inside of the windbreak. Moreover, the wind velocity changed simultaneously in all elevations and fluctuated in a smaller range inside the windbreak, implying lower wind velocity within the windbreak than its upwind and downwind. The wind speed downwind of the windbreak was lower than its upwind at a distance of 50 h (h is the height of the windbreak). These observations indicated that wind speed was affected within and downwind (in a long-distance) of the windbreak.

Furthermore, while the wind speed was reduced, the turbulence intensity and standard devastation were increased within the windbreak. The highest turbulence intensity and standard devastation were found at the beginning of the windbreak, where wind velocity was at its lowest rate. A comparison of turbulence intensity in wind speeds of 10.5 and 19.5 m/s in all locations showed that it was similar upwind of the windbreak but different in two wind speeds within the windbreak. However, this different turbulence intensity was reduced at the downwind of the windbreak. It was also found that the turbulence intensity and standard devastation were greater in wind speeds of 10.5 than 19.5 m/s. Moreover, the turbulence intensity in the 19.5m/s wind speed within the windbreak was roughly 20-30% less than what was found in the 10.5 m/s wind speed.

Conclusion: wind speed and turbulence intensity were significantly affected by the windbreak. Investigation of the wind speed, turbulence intensity, and standard devastation upwind, within, and downwind of the windbreak showed low wind velocity. However, turbulence intensity and standard devastation were greater within the windbreak than the upwind and downwind of the windbreak. Furthermore, turbulence intensity was influenced by the windbreak because, in 10.5m/s and 19.5m/s wind speeds, it was similar upwind and outside the windbreak's impacted area but different within the windbreak.

Keywords: Vegetation, Wind erosion, Standard deviation, Niatak, Sistan.