Assessing changes in plant functional diversity within grassland ecosystems under agrivoltaic systems

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Résumé

Agrivoltaic systems, which integrate agricultural production with solar energy generation, are gaining prominence. The installation of photovoltaic (PV) panels into grasslands directly affects this ecosystem, notably by altering microclimatic conditions and potentially affecting the functional diversity of plants. This study aims to characterize the plant functional diversity of grasslands beneath PV. During two years, we focused on three agrivoltaic sites grazed by sheep in different areas of France: Braize (B, Allier), Marmanhac (M, Cantal) and Eglisottes (E, Gironde). All sites varied in infrastructure size and type, pedo-climatic conditions, and botanical composition due to historical factors. To evaluate the effects of PV panels on grasslands, three modalities were examined: beneath solar panels (P), in inter-rows (I), and control (C) areas exposed to full sunlight. Microclimate alterations induced by PV panels were measured using sensors placed above and below-ground across the three modalities. Botanical surveys and leaf traits measurements were conducted to evaluate grassland responses.

Results revealed significant alteration in vegetation microclimate due to solar panels, particularly in terms of radiation and precipitation, which decreased by an average of 83% and 88%, respectively, across sites. Although air temperature remained relatively stable between modalities, soil temperature decreased by about 1.6 to 2.5∘C and soil humidity either increased (M, E) or decreased (B), beneath the panels compared to full sunlight conditions. Moreover, there was a reduction in grassland vegetation density beneath both panels and inter-rows across at all sites, partly due an increase in bare soil percentage and moss abundance (especially evident at B and M sites). Botanical composition varied among treatments, primarily driven by changes in species composition rather than species number on all sites, although a decreasing trend was observed beneath solar panels. Grasses dominated beneath the panels, with a decline in legumes observed at two sites (B, M); however, in the third site (E), legumes remained present in similar abundance to dicots. Furthermore, some species exhibited leaf phenotypic plasticity across modalities, leading to higher community weighed specific leaf area observed beneath PV panels across all sites, potentially conferring higher light use efficiency.

In conclusion, the installation of PV panels has significantly influenced plant species functional diversity in the three sites. These findings underscore the importance of carefully managing the integration of solar energy infrastructure into grassland environments to ensure the preservation and sustainability of ecosystem functions in the long term.

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Mots-Clés: microclimate, SLA, botanical composition