OVERT INDENSATION BY PLANTS

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Abstract

Images illustrate the accumulation of water droplets on plant leaves through indensation. Differences in response between plant life forms, and changes to leaf form that alter the response to the perfield are addressed.

Introduction

Situations where plants appeared to obtain more water than available through rainfall (Tunstall 2008) were explained by the occurrence of a mechanism whereby plants obtain water directly from the atmosphere (Tunstall 2009a). The occurrence of this process, termed indensation, was demonstrated by the construction of apparently passive structures devices that can deliver liquid water from the atmosphere under evaporative conditions (Tunstall 2009b).

This paper represents another step in the elucidation of indensation by demonstrating its occurrence with plants.

Methods

Digital images of plant leaves were obtained where droplets of water occurred on leaves under evaporative conditions. Data collection was opportunistic in depending on the occurrence of appropriate conditions, and was made in a household garden.

Results

The first observation of indensation by plants (Fig. 1a) was for clover which had water droplets on leaves late into the morning under conditions of a good breeze, patchy cloud, some sun, and no rain. This plant was vigorous and healthy. Clover mixed with grass located around 1m distant had appreciable indensation, but the surrounding grass only had odd droplets (Fig. 1b). An adjacent patch of grass had limited but obvious indensation (Fig. 1c).

The occurrence of water droplets on the foliage of the clover was monitored at hourly intervals throughout the day until 3pm. A light shower occurred at 3.05pm. The times are given as Eastern Standard Time wherein the sun is highest in the horizon shortly before 12am.

The accumulation of water droplets on the clover leaves is greater at 11am than at 10am. The droplets had declined at 12am to a level similar to 10am, and the decline continued until the final record at 3pm.

The amount of cloud, and hence direct sunlight, changed throughout the day. Direct sunlight was common in the morning with a rating of around 7/10 cloud. Conditions in the afternoon were overcast. A strong breeze continued throughout the day.

The orientation of the clover leaves changed throughout the day. Under sunlit conditions the leaves tend to close through the leaflets becoming vertical, as at 11 and 12am (Figs. 2b,c). Under completely overcast conditions the lamina of the leaflets tends to be horizontal (Figs. 2e,f). This change in leaf orientation occurred despite an overall low level of sunlight and a high level of soil water availability.

Water droplets were observed on plant leaves on hot sunny days with a good breeze at or around noon. However, these were isolated occurrences. The droplets on a clover leaflet in Fig. 3 were the only occurrence of overt indensation observable at that time. The clover leaflets have a pronounced vertical orientation that is commensurate with the high insolation and hot conditions but contrary to the high level of soil water availability.

The images in Fig. 4 illustrate higher accumulation of water droplets on grass than clover. Conditions were close to being condensing but were definitely evaporative. The main difference between environmental conditions for Figs. 1 and 4 relates to the breeze. There was a strong breeze for Fig.1 while for Fig.4 conditions were still.

Fig.5 illustrates the collection of water droplets on leaves on a range of plant species where conditions were evaporative, some highly.

The pattern of collection of water droplets on clover leaflets appears to relate to leaf hairs (Figs. 3, 4). This extends to droplets occurring on the edge of the leaf and not the surface (Fig. 4). While grasses can also exhibit such patterns, as with droplets occurring on leaf tips, the main pattern appears to relate to the arrangement of stomata. With high levels of accumulation the droplets are linearly arranged along the leaf between the veins (Figs. 4, 6), as are the stomata.

Discussion

The accumulation of water droplets on plant leaves under evaporative conditions evidences the occurrence of indensation. However, the absence of such droplets does not identify that indensation is not occurring. The accumulation of droplets appears to arise under strongly indensing conditions when the water accessions by plants exceed their capacity to absorb the water.

Conditions that promote indensation for plants are generally the same as identified for constructed indensers, namely high atmospheric water vapour content and a good breeze. However, indensation was observed for plants when it was not observable with constructed indensers. Moreover, the relative levels of indensation by plants varied depending on conditions. Grasses appear to be more effective than clover under still conditions where this accords with grasslands being prominent on extensive plains and flats. Air movement at nighttime on plains and flats is restricted by the topography.

Differences in indensation between plant life forms were reflected in the responses of different forms of indenser. While the pipe indenser (Tunstall 2009b) was consistently the best other forms could exhibit indensation depending on the specific conditions[1].

[1] The air well indenser that was previously the best had been degraded through developments. Progress has been constrained by the work load and the limited occurrence of environmental conditions that are highly conducive to indensation.

The ‘closure’ of clover leaves by way of the leaflets becoming erect has generally been considered to be a response to water stress. However, while conditions were sometimes strongly evaporative the plants exhibiting this response would not have been particularly stressed due to the ready availability of soil water. A more logical explanation is that the vertical orientation increases the indensing capacity relative to the horizontal, which it does. As light is most limiting under conditions of low light the foliage is held horizontally. Photosynthesis saturates with strong light hence the vertical arrangement of leaves can increase the capacity to obtain water without appreciably reducing photosynthesis.

The images illustrate the occurrence of indensation under ideal conditions. Under most conditions indensation would serve only to reduce the water loss. The images do not quantify the level of indensation, nor do they rigorously examine effects of environmental conditions or the differences in response between different plant species and life forms. There is currently no information that allows reliable estimation of the magnitude of indensation relative to rainfall that is significant for landscape hydration and global warming.

References

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Fig. 1 Overt indensation

Subterranean clover
(*Trifolium repans*)
13-10-09, 10am

Good breeze, patchy cloud, some sun, no rain

Only the ball indenser was obviously indensing

A Clover (sunlit)

B Clover overtly indensing, surrounding Fescue grass generally not.

C Limited overt indensation by Fescue grass (shaded).

Fig. 2 Clover overtly indensing during the day. 13/10/09 Rain at 3.05.

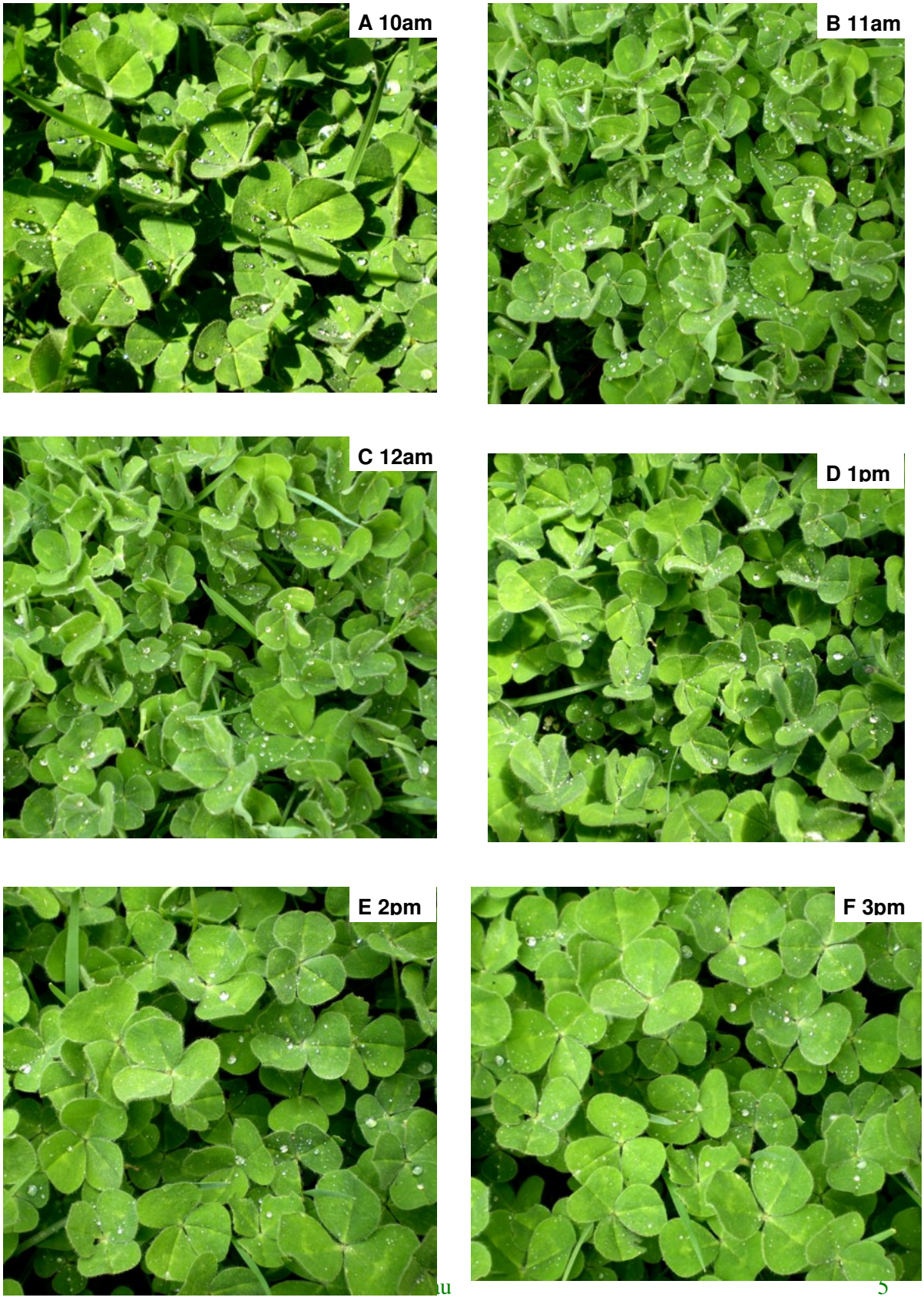

Fig. 3 Clover overtly indensing at 11am on a hot sunny day. 19/10/09
A General plant **B** Sole patch of water droplets

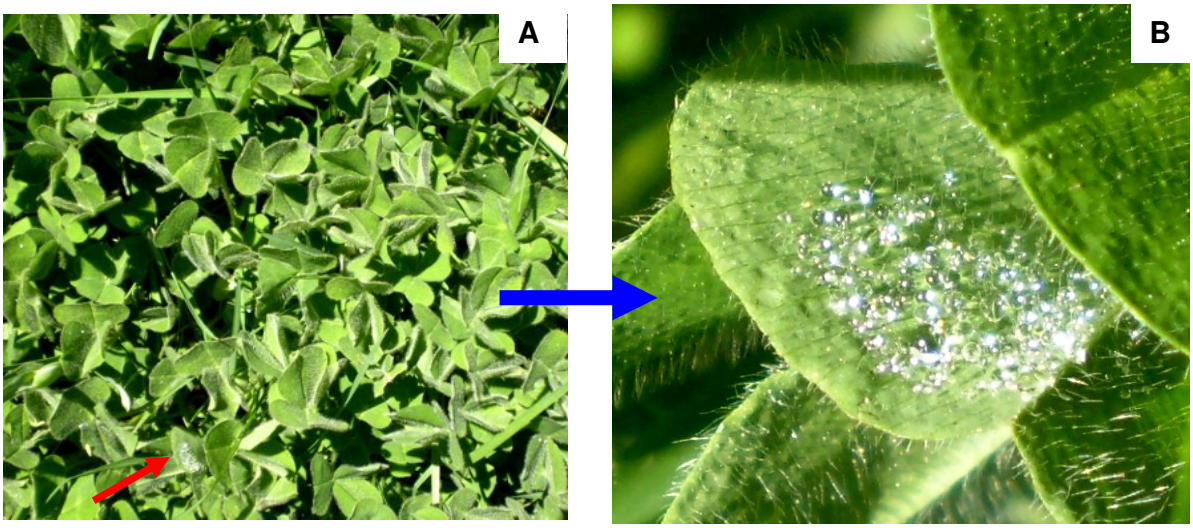

Fig. 2 Overt indensation by clover and oats at 6am. 21/10/09 **A** Clover **B** Oat

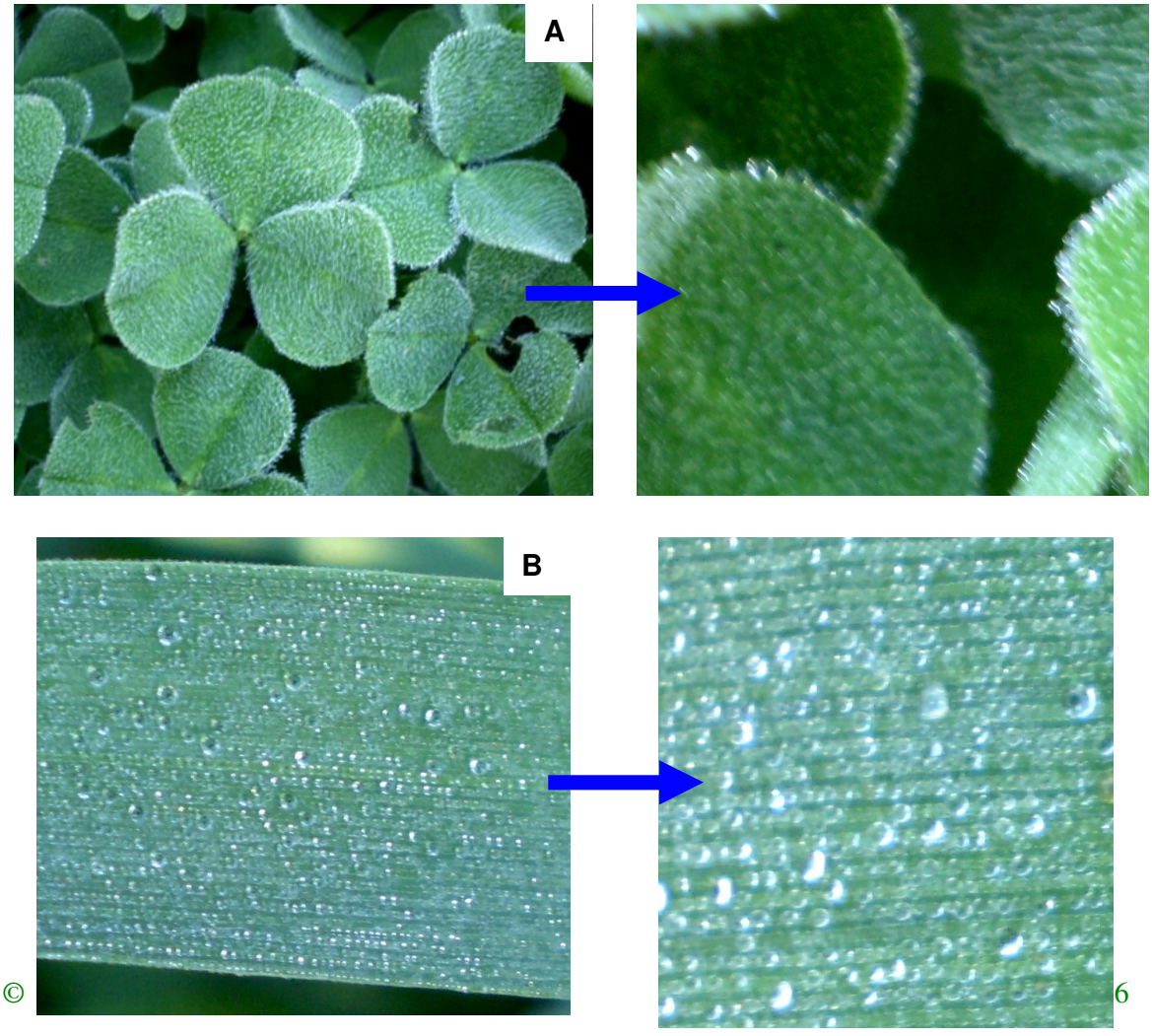

Fig. 4 Plant species overtly indensing. **A** Clover **B** Thistle **C** Celery **D** Hardenbergia **E** Paspalum **F** Paromychia **G** Galium

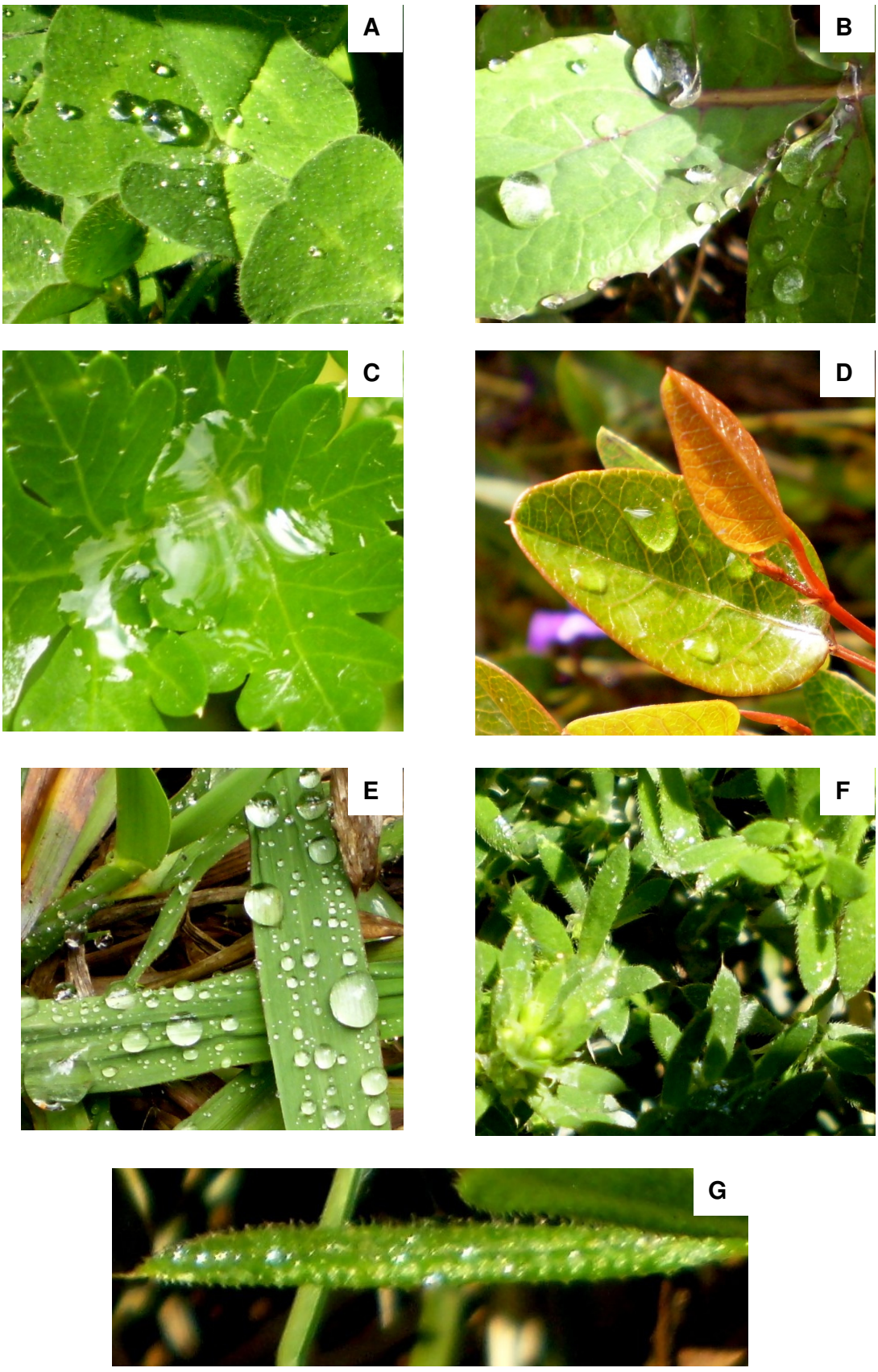

Fig. 5 Overt indensation, oat leaf segment.