Southern African Bulb Group

www.sabg.uk

SABG Newsletter no. 50 March 2024

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News

- There are some ***imminent deadlines*** for any interested member not already in touch with Carl Garnham, to contact him regarding joint purchases from South African and other suppliers. See the **Notices and Requests** section below.
- Also in that section there is a request for any interested SABG members to help with testing a new photo gallery.

Dates for your diary

- Saturday 16th March: Lachenalia Day – NAAS Exbury visit: SABG members welcome. If planning to attend please contact Caroline <nerinesociety@gmail.com> to keep track of numbers expected.
- Sunday 24th March: SABG Spring meeting in Winchester, UK – Timothy Walker will give a talk "From Diaz to Diamonds - Plant Hunting in South Africa" (see page 2).
- Sunday 20th October: SABG Autumn meeting in Winchester, UK – Details to follow.

Massonia longipes [Paul Cumbleton]

From the Editor

The main item in this newsletter is an excellent article on artificial lighting written by Carl Garnham, a sequel to his earlier "Thoughts on Heating" in Newsletter 49. It should give you plenty to digest on improving the light levels for our plants and time to plan for next winter.

Carl has distilled decades of study and experience: it's a long article, but well worth reading carefully. It ranges from detailed explanations of the science (or art) of measuring light levels through to many practical tips for improving the light available to our plants, and not just high-tech lamps – a long pole for cleaning the glass can be equally effective!

Notices and Requests

First is a notice from Carl Garnham about joining his list of members interested in participating in joint orders to companies supplying South African bulbs and seeds. Note that details of these companies are listed on our Links page[1], which I try to keep up to date, but Carl will probably have more current information if you contact him. Unfortunately only UK members will be able to participate.

Upcoming joint orders from RSA suppliers

Joint orders are being, or shortly will be, organised with three suppliers as follows -

Lifestyle Seeds – supplier of both seeds and plants/bulbs - use the website[2] to work out what you might want. [*It is too late to join the current order, but Carl might run another joint order in the future.]*

SABC (South African Bulb Co.) – supplier of bulbs only (plus a very few other choice geophytes on occasion) – orders to be with Carl before **11th March**. Please contact Carl for current price/availability list if you are currently not on the circulation. Those on the circulation should already have the list.

Shire Bulbs – supplier of bulbs only. Rob doesn't operate a formal system for his price/availability list (so far as I know anyway), but anticipated deadline for orders is the **3rd or 4th week in March**. Please contact Carl for inclusion on the circulation if you have not already done so.

A reminder of what you might be signing up to: In addition to the cost of the actual seeds/plants, there will be a small charge involved in transferring the cash, plus the cost of a phytosanitary certificate, which is split between those ordering (so just a very few pounds each), the cost of shipping (which obviously depends on weight – this charge is split *pro-rata* based on the weight of anyone's order), plus any charges levied by Customs, should they be applied to the parcel (duty of just a very few %, plus VAT, plus a handling charge). Once the order arrives here, there are UK postal charges to get your order to you.

In the worst case – total cost will be around 50% more than the cost of the order in RSA; best case, around 20% more.

Carl Garnham

SABG online gallery and forum

Improvements are under way in the SABG photo gallery[3]. It is hoped to be able to link it to a forum so that members can submit photos with explanations and make (polite and useful!) comments on them. At the moment we need a few members to help by suggesting ideas and trying out experiments before we open it up to all SABG members. If you are interested in being a guinea pig, please let me know.

Not entirely unconnected with the above, David Lloyd sent me some more of his *Lachenalia* photos, which I have scattered around in this newsletter, which would otherwise have been entirely black and white text!

In the next Newsletter

I plan to produce the next Newsletter (no. 51) for distribution in late spring or early summer 2024. There will be a well illustrated article by Paul Cumbleton on "*Sorting out the Massonias*". A sample photo appears on the previous page. Other contributions short or long will be most welcome, with or without pictures.

SABG meetings

The next SABG meeting

Our next meeting is the Spring 2024 meeting on **Sunday 24th March 2024**. The speaker for this meeting is Timothy Walker. He is a very well known speaker, his lectures renowned for being both informative but also highly entertaining. He was formerly the Director of Oxford Botanic Garden & Harcourt Arboretum, which under his leadership won four gold medals at the Chelsea Flower Show. Currently

1 https://sabg.uk/links:start
2 https://lifestyleseeds.co.za
3 https://sabg.uk/gallery:start

he is a lecturer in Plant Sciences at Oxford University. His website[4] gives a lot more details, including some video if you want to see examples of him speaking.

He has a lecture called "From Diaz to Diamonds - Plant Hunting in South Africa". "*The western Cape region of South Africa is one of the most botanically diverse areas of the World. This talk takes a route from the southernmost tip of Africa to the border with Namibia looking at the plants and the ethnobotany of one of the most fascinating countries in the World*." While not specifically about bulbs, it would I'm sure be useful as it could help us see the broader ecological context in which our bulbs grow in the wild. Directions to the meeting hall, the Badger Farm Community Centre near Winchester, are shown on our web-site at https://sabg.tk/meetings:next:start. The doors will open at 10.00, and the meeting will close at about 14.30.

Lachenalia aloides 'Nelsonii' [David Lloyd]

As usual, there will be a display table for any plants that you bring along for others to see. We will have time for some informal short talks and discussion during the afternoon, so that members can point out their plants and answer any questions. If you have any slides or computer images that you would like to show, please bring them along, ideally but not necessarily after emailing a Committee member.

There will also be a sales table where you can offer material for sale on the usual 80:20 basis, i.e. the Group takes a 20% commission to help cover the hall hire costs etc. Please include a second label in each pot, showing the price and your initials, so that we can settle up at the end of the day and return your cash and price labels.

There will be a lunch break from approximately 12.00 until 13.00. For those of you that have not come before, it's worth adding that many Members bring their own food so that they can stay in the hall and have the opportunity to chat to others and pore over the display and sales plants. Alternatively, the Sainsbury's supermarket is based on the same site.

As usual, the charge for the meeting will be £3.00 per person, payable on entry. There is no charge for parking, provided that you remember to add your car registration number to the list, usually in the main entrance hall and on the table just inside the entrance to our meeting room, to avoid any fine for over-staying.

SABG Autumn 2024 meeting

The Spring meeting will be on **Sunday 20th October 2024**. More details of the meeting will follow.

Some thoughts on artificial lighting for plants

Where to start?

Perhaps by stating that there are several useful links at the end of this article which, if you are brave enough and inclined/curious, will help provide even more figures/numbers, detail and understanding, plus other links to, in my opinion, useful equipment etc. (Most products/items linked to are just for illustration, so shop around if inclined to buy anything.) There are also links to websites where you can find data for natural light at least very close to your own location.

I should mention that lamps producing "white light" in particular, are generally quoted to be of a certain colour-correlated temperature (CCT), where a high number, typically around 6000K (K is Kelvin, 6000K is near enough 5730°C), is rich in blue and low in red light, and a low number, typically around 2700K, is relatively rich in red and low in blue. (Conventionally, just to confuse the issue, light of a high CCT is routinely referred to as "cool/cold", and light of a low CCT as "warm".)

Something that frequently gets repeated online, even on what appear to be authoritative websites, is that plants need some white light to grow. This is totally illogical nonsense. There is no such thing as white light. Light that appears white to human eyes is a mixture of colours

4 http://www.timothywalker.org.uk

and the range of different mixtures that appear white, is literally infinite.

My first tinkering with artificial lighting for plant growth

There is a very great deal of online discussion amongst experimenters with clandestine indoor plant cultivation, but over 30 years ago, I was sowing large numbers of cacti and succulent seeds each year and realised that I had to have a propagator to do a “proper job”. I also realised that the only really convenient place for one was at the back of the garage, which had no natural light at all.

Back then commercial greenhouse crops were grown under high pressure sodium lamps – known as HPS/SON/Lucalox, depending on where you come from. This is because SON lamps produce little more than a range of colours in the yellow-orange (see below), although to the human eye they appear silvery gold. *(They were by far the commonest street light across most of the world for many years, until recently. This was also long before Philips introduced SON-T-Agro – a SON lamp with a rather small absolute, but proportionally large, boost in blue output compared to standard SON lamps, which reduces etiolation, but far from eliminates it. Put politely – even 100 times very little is still not very much.)*

(I have no idea where the design for the very old and physically large gro-lamps of 30+ years ago came from – a high pressure mercury discharge capsule (very high blue and not much else), plus a tungsten incandescent filament (which was both ballast for the mercury capsule and provider of lots of red-orange), all in a huge glass outer bulb.)

So, the c. 1m x 0.75m propagator, with an aluminised polyester lid, was fitted with a 70W SON-T (7000 lumens). As a source of blue, I used a 30W 36 inch T8 linear fluorescent lamp as sold for aquarium lighting and high in blue output (something like 2500 lumens). This is something like 12-13000 lux, which produced almost countless cacti and succulent seedlings of perfectly normal growth and colour using the pot-in-bag method. It did get very warm when the lighting was on, but a soil-warming cable in the base, on a thermostat, kept things frost-free when it wasn’t lit.

Light and plant growth, science and measurement

Philips have published almost limitless information about light and plant interactions which can be found online with a little searching. Their data covers not only food crops, but also ornamental/house plants, including cacti.

As a general rule, vegetative growth is stimulated most by yellow - orange -red light, but all visible wavelengths will allow plant growth. Etiolation (extended inter-nodal distance – leggy growth) is controlled by blue light – more blue = more compact growth/less etiolation. Except in northern European winters (and elsewhere at similar latitudes), there is enough natural blue light to produce un-etiolated growth in any plant that relies entirely upon natural light. Flowering is most effectively triggered by red light geared to a particular photo-period, when light intensity is very much a secondary consideration.

Quantities of light emitted are traditionally quoted in absolute terms as energy or power – joules or watts (not to be confused with the power consumed by the actual lamp – VERY different, and far in excess of what energy appears as light, even in LEDs). However, in more recent times, (micro) moles (also shortened to (µ)mols), have become common, especially in horticulture/plant biology. A further complication that arises from trying to compare lumens to mols, is that mols of light are linked to numbers of photons and a photon of blue light carries in the order of double the energy of a red photon.

Empirically, quantities of light are usually given as lumens or lux for lamps used outside of horticulture (one lux is one lumen per square metre). They are empirical units because they are based on actual, averaged, measurements of the effect of the light and although the truly vast majority of lumen figures that are quoted are for human eye photopic (bright light) vision, figures exist for human eye scotopic (dim light) vision (remember rods and cones?), and plant growth. (I worked in light source R&D for some years and we considered any or all as required – beware, there is an awful lot of nonsense published online).

So, lumen measurements allow for the sensitivity of what is being studied – the human eye is most sensitive (photopic vision) in the green-yellow region so one joule or photon of light in this region has a higher lumen equivalent than one joule or photon of blue light – this is part of why, as a general rule, high CCT (high blue content) lamps will be quoted as having a lower lumen output than lamps of the same power (watts) but of a low CCT (low blue content) – at the very simplest level, more blue means that the human eye is less sensitive, so fewer lumens.

So how are joules, mols and lumens related? Unfortunately, this is dependent upon colour (wavelength). However, as a massive over-simplification that gives us growers a ball-park number, for white light only, LED any CCT, 1000 lumens is AROUND 17 μmols of light per second, which is 0.06 mols per hour. (As above, more red means more mols, more blue means less.). For natural daylight, the figure is around 23 μmols. See also link below for a converter for various light sources. Using this crude rule, 10,000 lux (an overcast UK sky, midday), is delivering around 0.6 mols/m²/hour.

Above and opposite: *Lachenalia magentea* [David Lloyd]
(formerly *L. juncifolia* var. *campanulata)*

The fact that lux meters that are commonly available are calibrated in (human photopic) lumens/lux and data for light sources are over-whelming quoted in the same units, means that there is no real choice in what units to use if directly measuring or talking about light in general, outside of the horticultural industry. *(Unless you have an inclination to invest in a HortiPower PG200N. Other meters are available, but be careful, many – all that I can find - are not what they appear to claim. Hint – why would a meter have to be set to any particular light source – HPS, daylight, LED etc. if it was simply measuring light?)*

Checking/calibrating any and all light meters … just another problem

Bright, mid-summer sunlight, from a cloudless sky, even in the UK, can peak somewhat over 100,000 lux. For comparison, most people can read at less than 10 lux even though they would usually, not unreasonably, prefer (quite a lot) more light; general workplace desk illumination is usually around 500 lux for paper-based tasks, less for the use of screens. An overcast UK sky, depending on season as much as anything, will provide 5-10,000 lux around midday. Skylight on dank and dreary UK winter days will drop quite a bit lower than this, often to under 1000 lux, even at midday.

Figures that I have measured have been measured using a Uni-T UT383. This meter uses a silicon photocell, calibrated for light of a CCT of 2856K – which is very low (high in red, low in blue), especially compared to sunlight which has an average CCT of around 5900K (some sources will quote as high as 6500K, but comparatively low in red and high in blue). A further complication is that silicon photocells are several times more sensitive to blue than to red, and are sensitive from the near UV well into the IR. Without complicated test equipment, manufacturer's data, or sight of the software involved, an educated guess would be that the meter produces increasingly exaggerated (high) lux figures when measuring light of increasingly high CCT above 2856K.

Doing some simple measurements to get a feel for how the meter performs, repeatability seems very good. Covering the sensor with a new, very clean piece of standard greenhouse glass reduces light intensity by something like 10%, possibly because soda-lime glass is an excellent absorber of UV. Covering the sensor with some very clean 3mm thick polycarbonate reduces light intensity by around 5%. Greenhouse glass with a slight algal film – not immediately obvious until you inspect the glass closely (or, as I had to recently, replace a cracked pane with new glass – I was truly amazed to see the difference …) – reduces light intensity by around 50%. The latter change in intensity is not at all obvious to the naked eye, amazingly enough. A single thickness of small bubble bubble-wrap reduces light intensity by around 15% (this may or may not be real – misleadingly high – as the structure of the bubble-wrap will produce quite a bit of scatter as well as absorbing some of the light, but see below).

I cleaned the greenhouse glass and the reduction in sunlight is now around 30% – the amount of light reaching the plants has increased by about 40% (from 50% to 70% of sunlight).

Glass with a film of water, either from rain, or condensation on the inside of the glass, may also reduce lux levels by 50% or more.

Philips suggest 30-50% reduction in natural light within a commercial greenhouse as typical. This is down to framework and fittings obscuring natural light, as well as “dirty” glass. Maybe this figure should be no surprise – how many times have I taken a plant from a very sunny windowsill, indoors, placed it outdoors, even out of direct sun, and found it scorched half way to death 3 days later?

On an overcast autumn day, early afternoon, ambient light measured c. 2800 lux, on the greenhouse bench it was c. 1900 lux, and with one layer of small bubble bubble-wrap installed c. 70cm above the bench, light intensity on the bench was c. 1600 lux. A surprisingly (to me at least), close approximation to 30% reduction in light intensity due to the greenhouse structure and 15% reduction due to the bubble-wrap.

There are also smart-phone apps to measure (presumably human eye photopic) lux, including data logging versions, but I have no idea how accurate/repeatable/expensive they are. (Being of a scientific bent, downloadable data logging would be interesting, but only at a low, for the sake of curiosity, price, as it would enable insolation figures to be calculated. Hand-held data-logging meters are also available, but the same provisos apply, although prices start very low at around £35.)

Natural lighting and SA bulbs

Maybe a comparison, so far as data that I can find allows, between an arbitrary point in the UK, and another in the west of RSA?

The upper levels of the atmosphere above the UK receive around 80% of the total solar radiation that RSA does during summer, but only around 30% in winter, albeit the cycle is shifted by six months. In terms of the total solar radiation that actually reaches the earth’s surface (“insolation”, although the term is widely misused online), RSA as a whole, annually receives 2-4 times what the UK does.

Some of the differences in insolation are down to day length (latitude) – shortest to longest day in Cape Town is only a 4.5 hour difference (minimum around 10 hours), in London (UK) it is around 8 hours (minimum is around 8 hours, 20% less than in Cape Town, the longest over 16, almost 30% longer than in Cape Town). As you travel north of Cape Town, day-length tends towards year-round equinox/equilux.

Going no further than this, if plants were to be lit in a UK greenhouse during winter, to a level similar to in habitat within RSA, the amount of light arriving at the plant would, on average, have to be (far) more than doubled compared to ambient light, outdoors.

Unfortunately, how different species/varieties of plant react to light varies considerably both in rate of photosynthesis (a reasonable indicator of growth rate) at any particular light intensity, and also in the light level beyond which photosynthesis ceases to increase, and ultimately may decrease. This being so, we cannot know, or even discover online, what light intensity to aim for, for optimum growing conditions in cultivation to produce habitat-like growth, flowering etc., in any but very few plants. This is most especially so within our hobby, for winter-growers.

That said, around 40-45% of the sun’s radiation (which includes radiation other than light, not least heat), that reaches the earth’s surface could be used for photosynthesis – photosynthetically active radiation (PAR). Not that anything but a small proportion of that is used by plants – a figure of 2-3% of PAR is often used – if nothing else, plants would be black if they absorbed it all.

Across the world, sunlight provides 5-60 mols of PAR /m^2/day at the earth’s surface. The western half of RSA, and further north on that side of southern Africa, is at the top of that range in summer, and around half that in winter. Commercially, for actively growing plants, 10-12 mols/m²/day is generally regarded as optimum (balance of cost and effect).

Artificial plant lighting

What is the target? Growth? Flowering? Growth character control? Propagation?

In terms of lumens, designs for commercial horticulture use come in two broad types – high lumen density units being designed primarily for promoting growth, lower lumen density for affecting growth form and stage changes, such as flowering or "compactness". In addition, photoperiod, light intensity and also spectrum are manipulated commercially; again, Philips have made available lots of information online, so much, that finding what you are specifically interested in can be quite a challenge.

Light levels in both nature and commercial greenhouses have been covered above, however, optimum photoperiods for vegetative growth of between 14 and 20 hours have been determined in different commercial greenhouse crops, dependent upon the species – lettuce, basil, tomatoes, sweet peppers, cucumbers, bedding plants, various cut flower species, etc. etc. For our plants, the logical approach would appear to be to provide at least the same photo-period as in habitat.

However, purpose-made/designed LED arrays for commercial plant production (plant growth) are very far from cheap to buy and set-up for the amateur (unless growing those clandestine crops). While total lighting systems, for °vertical farming° and growing rooms, are increasingly common, units for providing additional lighting in conventional greenhouses are installed and in the UK will produce broadly in the order of 0.8 mols PAR/hr/m² in winter.

Even LED "grow lamps", compatible with domestic lamp-holders and intended for use with houseplants and vivaria etc., are very expensive compared to lamps aimed at general household use but most have the advantage that they do not require reflectors.

The major advantage of many purpose-designed commercial plant growth LED installations for supplying supplemental light is that they produce very little shadow or wasted light – they are small (little shadow) and highly directional (most of the light should hit the crop if used/installed correctly), generally being a narrow strip of light-emitting elements with beam angles in the order of 120°. Conversely, most non-horticultural lamps require relatively large reflectors to throw the light where it is wanted and those reflectors produce a shadow from natural light (also true of many LED arrays designed for horticulture, or at least plant growth, where there is little or no natural light so that shadow from reflectors is not important).

No matter the format, one major advantage of LEDs is that they run cool (but not cold), so can be positioned very close to plants.

A further word of caution – when using anything except incandescent lamps, there will need to be running gear somewhere as nothing except incandescent lamps can run at mains voltage. In many lamps aimed for domestic use, and lots of others, the running gear is inside the cap. Traditional industrial lamps and all linear fluorescent lamps have external running gear (ballasts). The running gear consumes energy and in low power lamps (say, sub 20W), the gear can consume a significant amount of power compared to the actual lamp. The power and light output quoted on the box in which a lamp is delivered to you are for what is inside the box, be that with or without running gear. This is yet another complication.

Lachenalia orthopetala [David Lloyd]

Artificial lighting – the choices

If the bench/plants in a greenhouse is/are to be illuminated by 10,000 lux from LEDs (doubling the light intensity from an overcast day in the UK), using LED lamps designed for domestic use of around 100 lumens per watt, would require **all** of the light from crazy numbers of domestic-type lamps in reflectors. To provide significant levels of PAR, while casting minimal shadow, commercial horticultural lighting is unavoidable, whether LED or any other type of source (eg. SON).

By way of illustration, Philips manufacture one product that will provide all the light for plant growth in a four foot cube, white-painted, growing room (link at the end– lined with aluminium foil or aluminised film would be far better). The lighting unit produces 1700 µmol/s of PAR, and runs at 640W. Illumination level depends on vertical distance from the LED array (dimmable versions are available), but illumination level plots are given for distances between 6 and 48 inches, which vary approx. 1400-400 µmols/s/m² (4.7-1.4 mols/hr/m²) – link at the end.

Broadly similar designs for commercial horticulture exist in smaller and larger packages but are generally banks of multiples of the same LED bar/strip lighting unit, a common power being around 100W per strip, each strip in the order of 1m long.

LED flexible strip lighting of similar design, intended for domestic use, is available reasonably cheaply, but is only around 6W(100 lumens) per metre.

Lumatek, link below, provide a very simple online calculator to suggest lighting configurations suitable for vegetative growth, albeit as the sole source of light.

When to provide extra light, for what? Brighten the daytime, or extend the photoperiod? Increased growth, differences in appearance, or flowering?

In the absence of any hard and fast data, I would suggest that habitat must be the starting point for experimentation. So far as vegetative growth goes, I hope that that has been covered above.

Photoperiod dictates seasonal events in very many plants, assuming other growing conditions are suitable, not least flowering – bear in mind, summer days are longer in the UK than in SA, and vice versa for winter. Despite a great deal of searching, I can find no minimum lux level for producing photoperiodic effects in any plants, but over the years, through to today, pictures of greenhouses lit to produce such effects, commonly out-of-season flowering in houseplants, show them to be dimly lit. Back before LEDs, standard GLS lamps were used at very low densities commercially, as they produced the dim light required at minimal cost, now, similarly low level lighting from LED lamps with tailored spectra are used commercially (link below).

Day-length varies north to south but 10 hour or longer days (the minimum day length in Cape Town) occur from sometime in February to sometime in October in the UK, the 10 hour days being approximately 0700 to 1700. By choice, I would use a plug-in timer, feeding an adjustable photocell switch, feeding some 2700K 7W golfball LED lamps (lower power lamps would suit, but I have 7W…..), no shades (almost no shadow). With the timer set to be on 0630 to 1730, the photocell would switch the lamps on any time between these times that light was very dim. However, all of the cheap adjustable photocell switches get lots of dreadful reviews online and the one that I tried was sent back within 3 hours of receiving it.

I have experimented over the 2023-24 winter, and provided 10-11 hour minimum photoperiod, the 3 lamps producing 150-700 lux across the 12 x 3 foot greenhouse bench. The lamps were switched on from 1530 to 1830 (GMT), on a timer, from early October to late February. A VERY long way from anything like a controlled experiment, but growth seems far more compact than previously. I would recommend it as an experiment if nothing else, one which will cost you around 3kWhr of electricity – around 90p, here in the UK Midlands, however, this winter the glass is reasonably clean, and bubble-wrap is only in place when temperatures are headed below 5C.

(Lots of these simple controllers (not clock-type timers) are exceedingly simple to build and will be far more robust than many/most commercially-available units, but hand-built electronics are actually very expensive today, compared to what is available from China, ready-built. If anyone wants circuit diagrams for electronic thermostats and/or light-sensitive switches and/or dimmers get in contact – I built them all, long ago, when they were a fraction the cost to make as to buy.)

Measurements using low watt golfball LED lamps

Reflectors are horrendously expensive and the great majority are shaped to suit fashion rather than function. Yet again, there is a complication, especially with cheap versions – LED lamps are very largely provided with frosted/pearl bulbs, and the light-emitting elements are frequently small panels set inside the cap; both of these make design of a reflector that is very strongly directional (able to focus the light), essentially impossible – that would ideally require a point source.

I actually use stainless steel bowls (rather than basins) and punch 29mm holes in the middle of the bases. Entirely adequate, very light gauge ones can be had for around £1 each if you hunt around.

Data for 7.5W, 2700K CCT, 806 lumens (13.6 μmol/s) and 7.5w 6000k, 600 lumens (10.2 μmol/s) lamps, same manufacturer (note lower lumens spec' for bluer lamp). I have two sizes of reflector (thinking about shadows again …), one a 22cm diameter bowl and the other a 12cm bowl, each mounted to the pendant fitting so that the whole of the lamp bulb is within the up-turned bowl. One-off measurements were taken in a horizontal plane 30cm below the crown of the lamp. Lux figures are measured with the meter as above, mol/hr/m² figures are calculated from lux, for white light, as above. (Measured after dark to make life simple!)

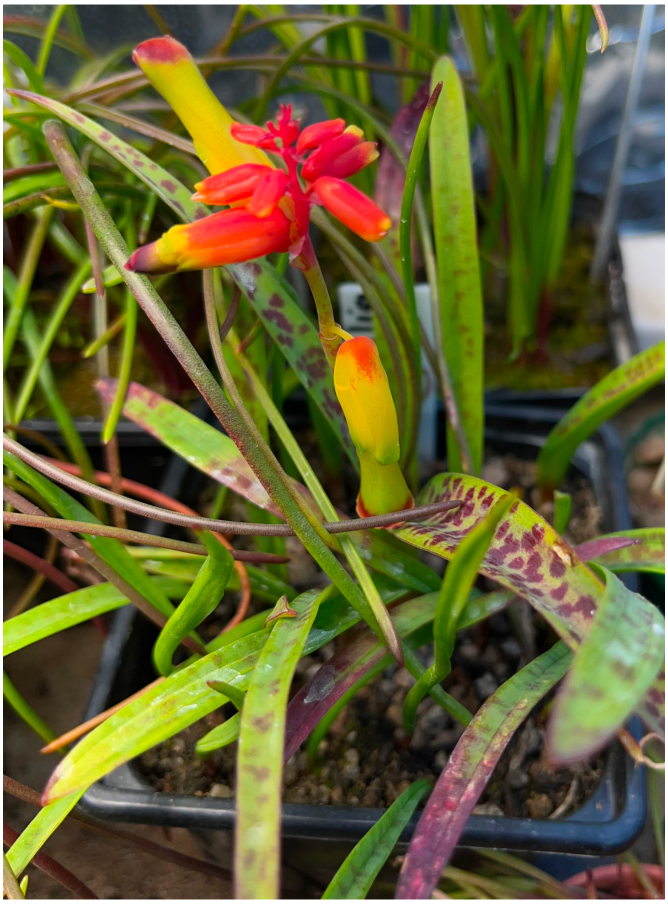
lux	max.	20cm from max.	40cm from max.
no reflector 2700k	1320	900	450
12cm reflector 2700k	1400	1000	500
22cm reflector 2700k	1900	1100	800
22cm reflector 6000k	1740	1000	730

mol/hr/m²	max.	20cm from max.	40cm from max.
no reflector 2700k	0.081	0.055	0.028
12cm reflector 2700k	0.086	0.061	0.031
22cm reflector 2700k	0.116	0.067	0.049
22cm reflector 6000k	0.106	0.061	0.045

These are obviously way below natural sunlight levels during a good deal of even an overcast day in the UK. Consequently, on a bright day, around midday, plants immediately under a lamp in a 22cm reflector were very obviously in shade simply because the lamp produced less light than was lost due to shading from sunlight by the reflector.

The inverse square law being applicable, if the distance from a plant was halved, to 15cm, at least the maximum lux reading would be expected to quadruple, taking maximum figures to similar levels to a very overcast day around midday (the law only applies within the beam angle achieved by any reflector). At that distance there would be very noticeable warmth reaching the plant, even from an LED lamp.

On the other hand, an overcast day has diffuse light and that produces minimal shadows. Taking some measurements provided some evidence of an interesting optical illusion, possibly – around 5000 lux at pot level in the greenhouse but under the 22cm reflector things looked very much "sunnier" to the naked eye, but 3500 lux maximum. I have no explanation! (Unless it is linked to the red/blue sensitivity of the sensor in the meter (see above) – lamp CCT 2700K, sunlight CCT 5900K. Oh that life was simple …)



Lachenalia quadricolor [David Lloyd]
(formerly *L. aloides* var. *quadricolor)*

A parting thought – something that has been mentioned almost time beyond number over the years – moving plants to a high shelf for maximum light. Unless a greenhouse is a jungle, how does moving a plant 50-100cm nearer the sun provide it with more light?

Conclusions

1. Always keep greenhouse glass, inside and out, as scrupulously clean as is possible.

2. If any particular plant/species is associated with shade in habitat, think carefully about possible lighting levels habitat v. inside a UK greenhouse.

3. Within a UK greenhouse, in winter, with clean glass and bubble insulation in place, light levels and insolation will be a small fraction (10-20%?) of the level in winter, in habitat, in RSA.

4. Remove bubble-wrap insulation when not required, although it may be needed during the winter, the time of least natural daylight (insolation) in the UK.

5. Providing truly significant supplementary levels of growth-promoting lighting (PAR) beyond sunlight in a UK greenhouse is neither simple, nor cheap, more so if using anything but commercial horticultural designs and very much so in winter.

6. Stimulation of flowering/extending photoperiod does not require major levels of lighting.

7. Experiment, with winter photoperiod, lamps, reflectors and positioning of lamps, and perhaps colour of lighting – there is no data out there for any plant that we choose to grow, so far as I have been able to find. (Just a prompt – is the glaucous colour of some plants seen in nature, which is seldom seen in many plants in European cultivation, triggered by total insolation, or by high levels of just one colour? It would be comparatively easy to massively boost a narrow band of colour if that was all that the LED produced (assuming that LEDs are available that produce that colour), which is what commercial horticultural lighting does.)

8. If anyone experiments, to come closest to understanding what is going on, a measurement device is needed; you cannot trust your eyes (a consequence of the amazing biological engineering that eyes represent).

Links and references

[If you are not in the UK you might need to change some UK-specific links, e.g. change "amazon.co.uk" to "amazon.de" or "amazon.com", etc.]

Solar (Sun) Intensity By Location and Time [https://engaging-data.com/solar-intensity]

Worldwide Solar Maps – Solar Insolation & PV Potential [https://www.altestore.com/diy-solar-resources/solar-insolation-map-world]

Convert Lumens to PPF – Online Calculator [https://www.waveformlighting.com/horticulture/convert-lumens-to-ppf-online-calculator]

What is the difference between PPFD and PPF? [https://www.waveformlighting.com/horticulture/what-is-the-difference-between-ppfd-and-ppf]

Are CRI and luminous efficacy influencing the Photon Efficacy? [www.yujiintl.com/are-cri-and-luminous-efficacy-influencing-the-photon-efficacy/]

Daily light integral [wikipedia.org/wiki/Daily_light_integral]

PI curve [wikipedia.org/wiki/PI_curve]

Sunrise and sunset times in London (other cities/towns available) [www.timeanddate.com/sun/uk/london]

UT383 Mini Light Meter Uni-T (this is the one that I use) [amazon.co.uk/dp/B07QFXSDKL]

Digital Auto Ranging Data Logging Light Meter 200,000 Lux 20,000 FC [amazon.co.uk/DIGITAL-RANGING-LOGGING-INTERNAL-SOFTWARE/dp/B00V3ZXCII]

How Horticulture Lighting Works [www.shine.lighting/threads/how-horticulture-lighting-works.25/]

Photosynthetically active radiation [wikipedia.org/wiki/Photosynthetically_active_radiation]

Professional LED grow lights [www.lighting.philips.com/application-areas/specialist-applications/horticulture]

Horticulture LED Light Recipes [www.lighting.philips.co.uk/content/B2B_LI/en_GB/products/horticulture/light-recipe.html]

VBR-100 PAR Meter Up to 6000 µmol/m²/s and 400,000 lux PPFD [amazon.co.uk/Meter-Light-6000umol-tester-Illuminance/dp/B0B11H31DH]

LED B22 Bayonet Light Bulbs 100W Equivalent, 2700K Warm White, 11W 1200LM, 6-Pack [amazon.co.uk/Bayonet-Equivalent-1200LM-Frosted-Non-Dimmable/dp/B0C22X1Y9B]

Linkind 6 Pack Bayonet Cap B22 LED Golf Ball Light Bulbs, 7.5W, 60W Equivalent, 806 Lumen 2700K [amazon.co.uk/gp/product/B08Q44X4YM]

Telescopic extending window cleaner 3.5m/11 feet (This type of tool is very highly recommended, although mine is not this particular model, it is near identical. I use warm Flash solution.) [amazon.co.uk/TELESCOPIC-EXTENDING-CLEANER-SQUEEGEE-EQUIPMENT/dp/B0BW133XF6 – unavailable on 6/3/2024, but this one looks the same: amazon.co.uk/dp/B0BLPBK57X]

Offay Stainless Steel Dipping Bowls [amazon.co.uk/Dipping-Stainless-Seasoning-Appetizer-Restaurant/dp/B09T9G7SWC]

Electralite 30W LED Strip Light, 5m 2700K [ledhut.co.uk/products/electralite-6w-led-strip-light-non-waterproof-ip20-5m-2700k]

Philips GreenPower LED Gridlighting Technical Specifications [assets.signify.com/is/content/Signify/Assets/philips-lighting/global/20230124-philips-gridlighting-technical-specification-sheet.pdf]

Philips GreenPower LED Gridlighting Photosynthetic Flux Density [assets.signify.com/is/content/Signify/Assets/philips-lighting/global/20230124-gridlighting-photosynthetic-flux-density.pdf]

LUMATEK Professional Grow Lighting | Ballasts | Lamps | Reflectors [lumatek-lighting.com/}

GreenPower LED flowering lamp [lighting.philips.co.uk/application-areas/specialist-applications/horticulture/greenpower-specialist-applications/led-flowering-lamp]

Sensky Automatic Photocell Sensor Switch Dusk to Dawn, Waterproof Timer Sensor Switch, LUX and Time Adjustable (This was returned as non-functioning but the design principles are perfect for producing "minimum day length" lighting. Building one would not be difficult – the circuitry would be simple enough, but it would not be cheap, and I could not be bothered.) [amazon.co.uk/dp/B011UJ5TSC]

Carl Garnham

Bulbils

Lachenalia and Ledebouria

PostScript Books[5] still have "*The Genus Lachenalia*" by Graham Duncan on sale for £50 (RRP £130).

My attention was recently drawn to this botanical monograph, which I have added to the SABG Digital Library[6]. It seems that the genus *Ledebouria* is larger and much more diverse and interesting than I had realised, having grown only *L. socialis* (formerly known as *Scilla violacea* etc.) S. Venter (2008) Synopsis of the Genus *Ledebouria* Roth (Hyacinthaceae) in South Africa, Hibbertia, **62**, 85-155. [7]

5 https://www.psbooks.co.uk/genus-lachenalia
6 https://sabg.uk/library:start
7 https://sabg.uk/_media/library:synopsis_of_the_genus_ledebouria_roth_hy.pdf

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Ixia gloriosa [David Lloyd]