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It's intimidating to choose the best lighting for growing cannabis, especially when there are so many factors to consider, like spectrum, lumens, PPFD, CRI, CCT, and more! Don't know what those terms mean? We've already covered the basics of horticultural lighting, so read that first if you haven't already. We are going to dive deeper into one of those factors – spectrum. Plants use photosynthetically active radiation (PAR; 400 – 700 nm) to drive photosynthesis. But plants use wavelengths outside of the PAR range – mainly UV and far-red light to understand and respond to their environment. This article will explore how far-red light impacts plant growth and development. This article is part of a series covering all the wavelengths of light, including UV, violet, blue, green, yellow, orange, red, and far-red light! Far-red light is radiation with wavelengths between 750 and 850 nm and it falls between the red and infrared regions of the spectrum. Plants sense signals from their environment, such as light, that cause them to change their growth. Light is sensed using photoreceptors, like phytochrome. Phytochrome has an inactive (red light absorbing) and active form (far-red light absorbing), and it switches between the two forms based on the light conditions. The light conditions are often quantified by looking at the ratio of red light to far-red light (usually shortened to "R:FR"). How much red (R) and far-red (FR) light is needed to make phytochrome switch back and forth? Well, it depends on many different factors, such as the species, growing conditions, and light intensity. In one often-used lab species, Arabidopsis, a R:FR of ~2 will switch phytochrome from inactive to active1. A R:FR of ~0.25 will switch it back1. Via phytochrome, far-red light controls seed germination, stem elongation, and flowering time.

Far-Red Light and Seed Germination

Far-red light mediates seed germination in some species. It's important that a seed germinates in a good growing environment – one that has lots of light and isn't too shaded. If a seed germinates in a shady spot, it can be detrimental to the plant because it will not get enough light to grow. Shade environments are enriched in far-red wavelengths compared to other colors of light (Figure 1), so high amounts of far-red radiation can prevent seeds from germinating. Germination rate drops by about 30% when R:FR changes from 1.1 to 0.6[2]. For this reason, seeds should be germinated under bright lights that have high amounts of red light and low amounts of far-red light. Far-red wavelenghts can trick a seed into thinking that it is in a shaded environment, and it is less likely to germinate.

Far-Red Light and Vegetative Growth

The R:FR also impacts vegetative growth in plants. High amounts of far-red light can cause stems to elongate and leaves to get longer and wider[3–5]. This is because the plant is trying to stretch up in hopes of reaching more sunlight. As a result, a plant can look "stretched out" and these long skinny stems are sometimes too weak to hold up heavy cannabis flowers. High amounts of far-red light can also decrease the amount of chlorophyll, anthocyanins, and antioxidants in the plant[6]. Chlorophylls and anthocyanins are

pigments that make a plant colorful, which can factor into the novelty and value of the harvest. Antioxidants protect against harmful free radicals – both for the plant and the humans consuming it! Ideally, a grower wants a plant with vibrant color and high antioxidant levels. To produce plants with strong stems and a vibrant color, they should be given high amounts of red light and low amounts of far-red light. This is especially true if the plants are being grown at high-density.

Far-Red Light and Flowering

By this point, you might be starting to notice a trend: plants associate far-red light with shade. Thus, if you give a plant too much far-red light, they will think they are in a shady environment. Too much shade can be stressful to a plant, so it takes precautionary measures to avoid these conditions. Seeds will avoid germinating and stems will stretch out to reach more light. In response to too much shade, a plant will often start flowering. Flowers are the reproductive tissues of a plant and if a plant thinks there is a risk of death (from too much shade), it begins reproducing ASAP so that it may pass its genetics to the offspring. High amounts of far-red light accelerate flowering in many species – tomato, potato, cucumber, beans, wheat, mustard, and many ornamental flowers[1]. In some species, far-red light also increases the number of flowers produced[7].

As growers, we can use this knowledge to our advantage. If we wish a plant to begin flowering (such as a stubborn cannabis plant that refuses to bud out), we can give it high amounts of far-red light. Far-red light should be applied for a short period to induce flowering, and stopped once buds begin to appear. Small amounts of far-red light applied at nighttime (~2 μmol s^{-1} m^{-2}) is also effective at accelerating flowering and increasing flower number[7].

For most stages of plant growth, a grower should maintain a high R:FR ratio. In other words, plants should be provided with high amounts of red light (and other colors of light, like blue and green light) and low amounts of far-red light. If a grower wishes to induce flowering, they can provide a plant with high amounts of far-red light (either during the day or night) for a short period. Once flowering starts, the plants should be returned to their regular lighting conditions. When choosing a light for growing cannabis, look for a horticultural light that has high amounts of red and blue light, moderate amounts of other colors (green, yellow, and orange), and low amounts of far-red and UV light. When used for an extended period, far-red light can be detrimental to plant growth, so it should be avoided when purchasing a grow light. Far-red light causes plants to stretch out and reduces the amount of chlorophyll (which is essential for plant growth) in leaves. When used for a short period, far-red light can stimulate flowering, which can be advantageous if you have a stubborn plant that refuses to flower.