

Essential Oils as Natural Sun Protectants for *Vigna radiata*

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Introduction

- Rising ozone, UV, and temperature levels have dramatic impact on plants (Francini et al., 2011)
- Our goal was to find a natural, safe product that can provide UV protection to plants without diminishing growth
 - A product that is already proposed and being developed, PURSHADE (NovaSource, 2012)
- Some natural oils found to have sun protection factor (SPF) when applicable to humans
- Carrot seed oil SPF~30, hazelnut oil SPF~15, castor oil SPF~6 (Floyd, 2013)
- If growth is diminished, how can we counteract those effects?
 - Nitrogen is a major component of plant growth
- Hypotheses:
 - Because the main purpose of a leaf is light collection, a plant's growth will be hindered by limiting the amount of UV light collected
 - A higher SPF should result in less UV light collected
 - A higher SPF oil will cause a decrease in plant growth rate
 - Because higher nitrogen levels have a positive impact on plant growth, a higher soil nitrogen level may be able to counteract oil SPF-related development hindrances
 - A plant treated with an oil and nitrogen-rich fertilizer will have greater growth than a plant treated with the same oil and nitrogen-poor fertilizer

Methodology

- Plant Mung Bean (*Vigna radiata*) seeds (Week 0)
- Cover tops of leaves with oil twice a week (Weeks 1, 2)
 - Avoid applying oil to bottom of leaf so as to avoid interfering with stomata
 - Castor oil (low SPF), carrot seed oil (high SPF), hazelnut oil (medium SPF), and no oil
- Administer 10 mL fertilizer (Weeks 1, 2)
 - Complete fertilizer (N Rich) and nitrogen deficient fertilizer (N Poor)
- Set plants under blacklight bulbs to minimize light wavelength, randomize weekly to vary blacklight exposure and minimize variation between variables (Weeks 1, 2)
 - Blacklight: SYLVANIA brand, 13W, 120V, 60Hz, 0.220A, black
- Record measurements and observations (Weeks 1, 2, 3)
 - Leaflet number, shoot height, shoot diameter, coloration
 - Week 3 specific: shoot biomass, leaf area (FIJI)
- Water with hose four times a week (Weeks 0, 1, 2)

Results

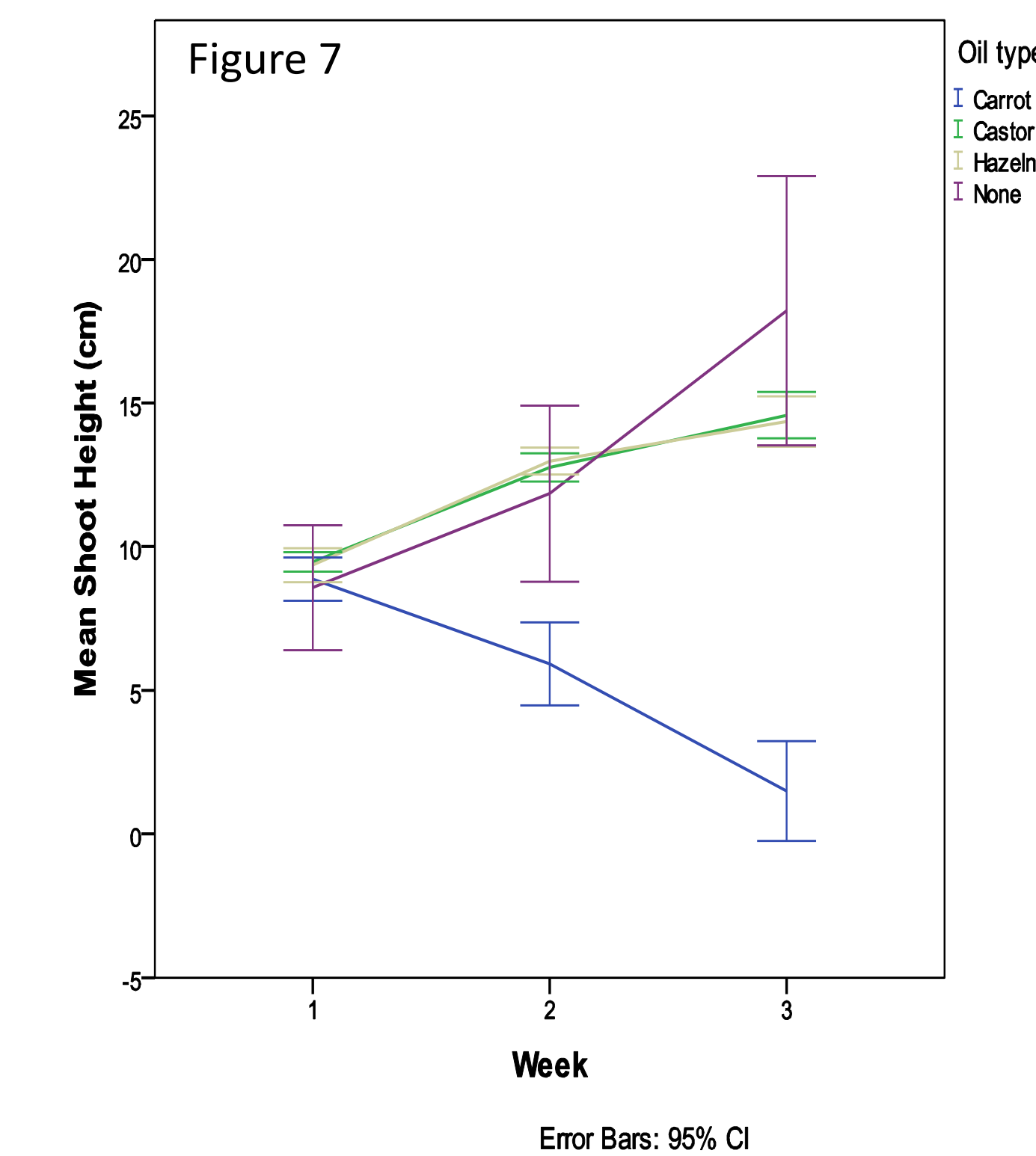
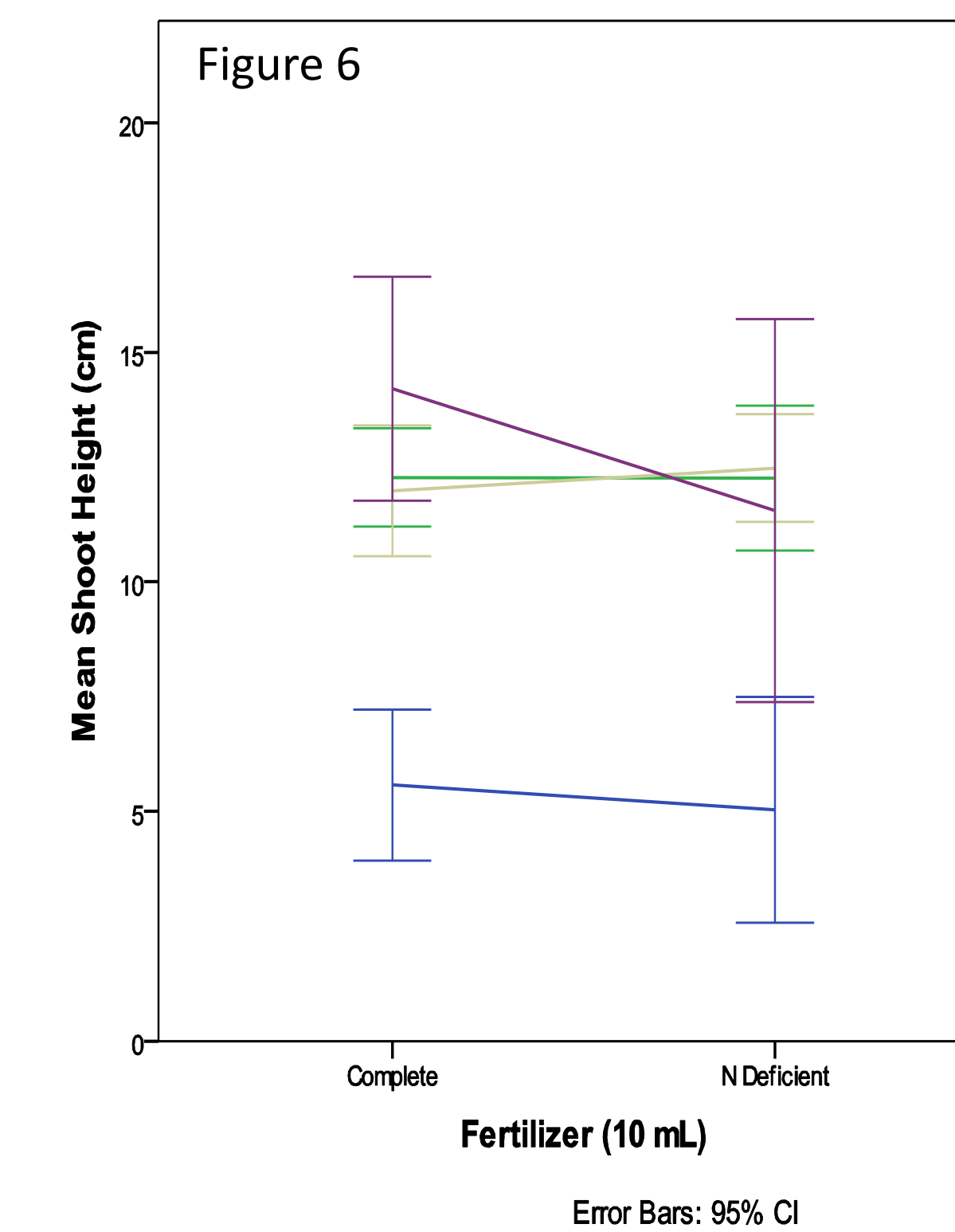
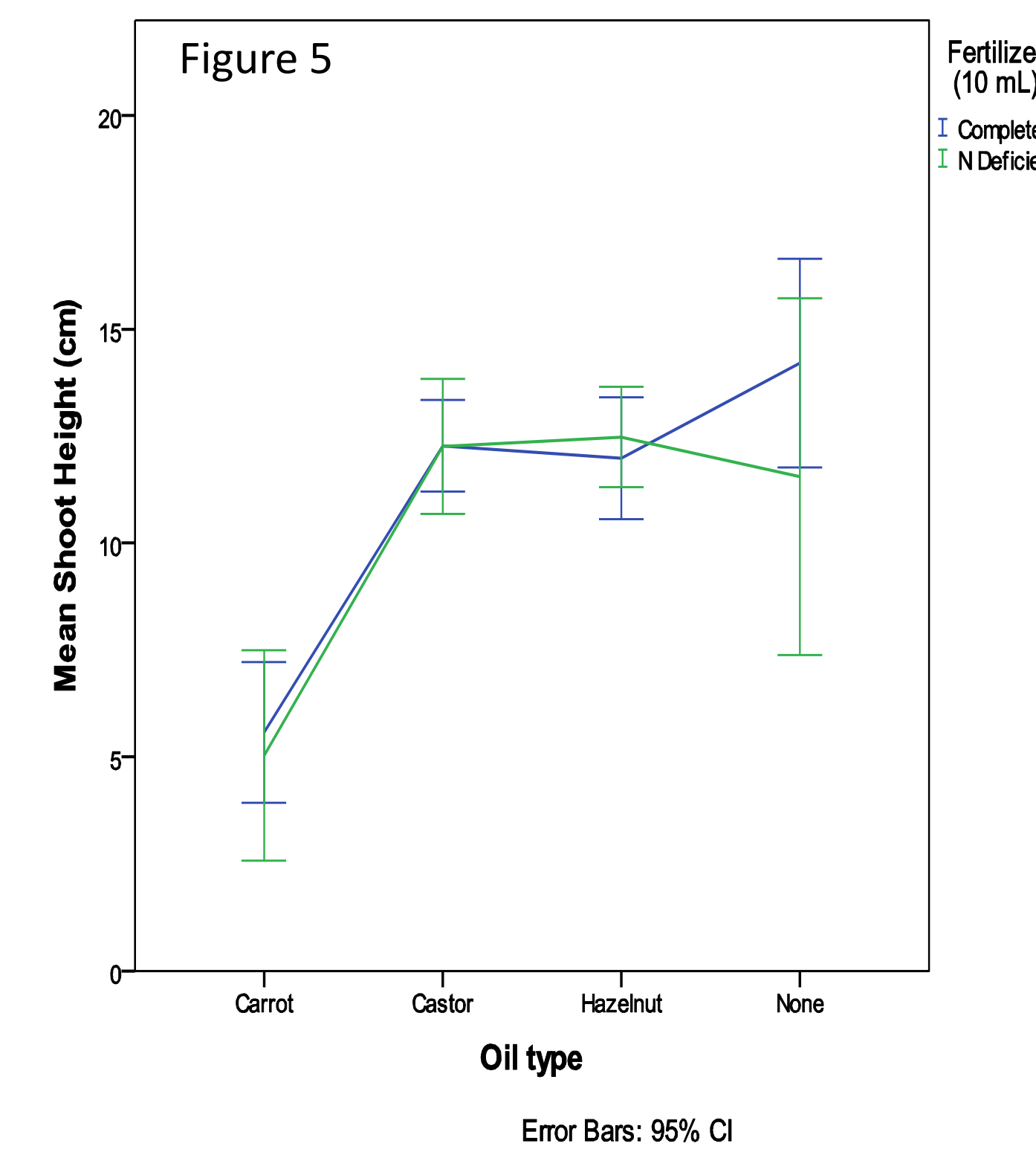


Figure 5: Mean shoot height for each oil type, separated by fertilizer type
 Fertilizer *p* value: 0.1949
 Oil Type *p* value: 4.906E-11
 Interactive *p* value: 0.6684

Figure 6: Mean shoot height for each fertilizer type, separated by oil type
 Fertilizer *p* value: 0.1949
 Oil Type *p* value: 4.906E-11
 Interactive *p* value: 0.6684

Figure 7: Mean shoot height for each oil type throughout the experiment
 Week *p* value: 6.099E-06
 Oil Type *p* value: 7.405E-21
 Interactive *p* value: 3.339E-15

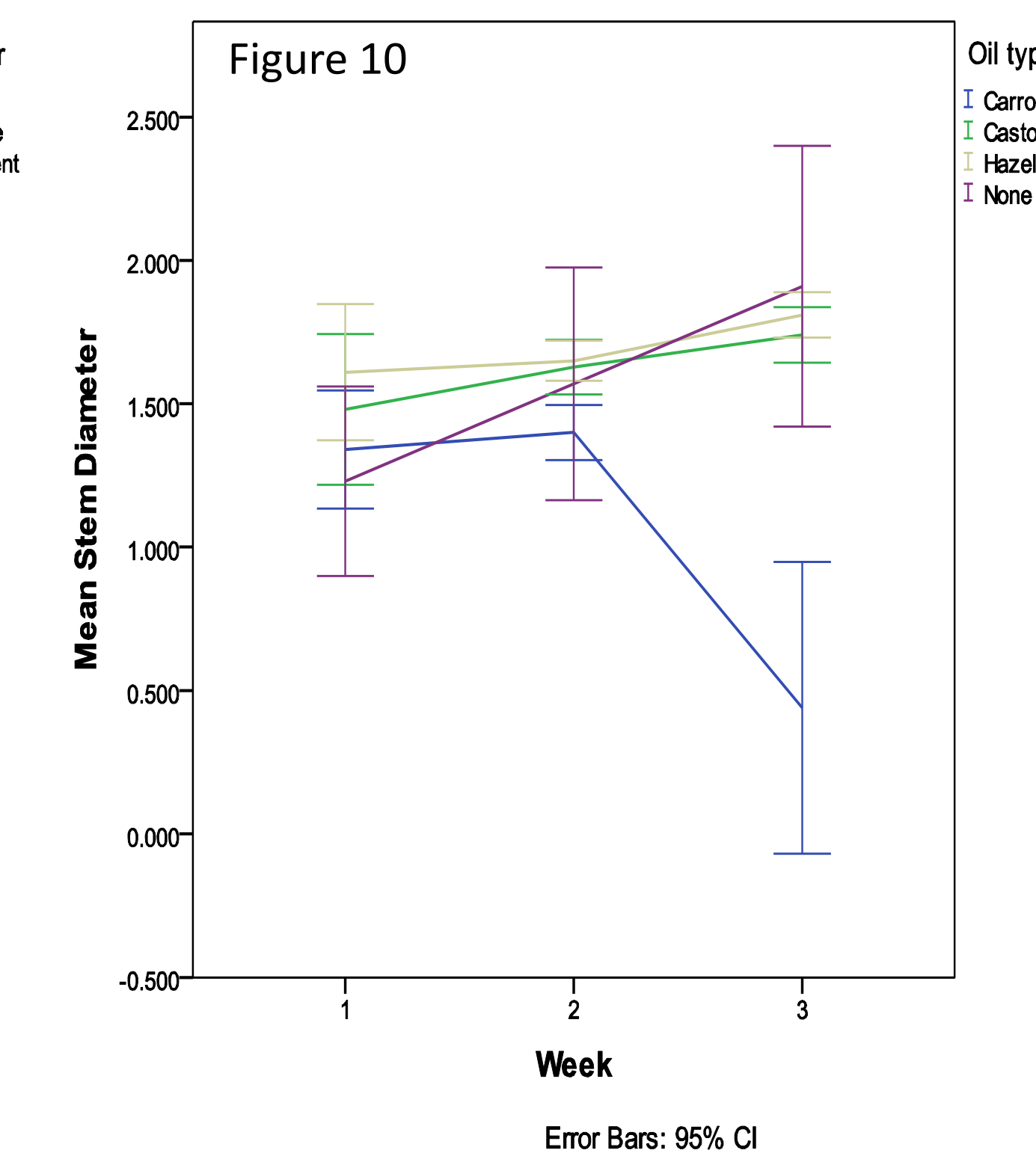
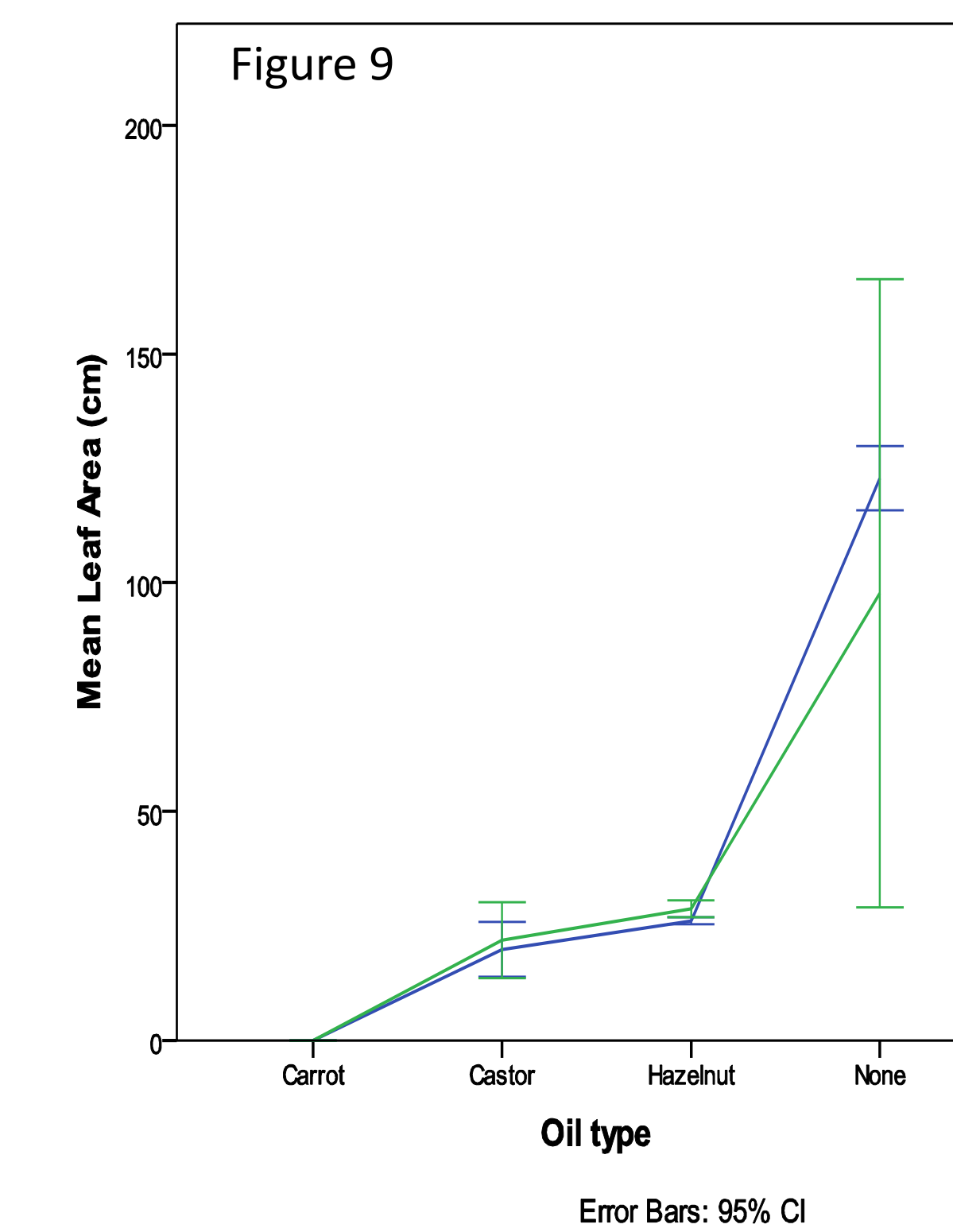
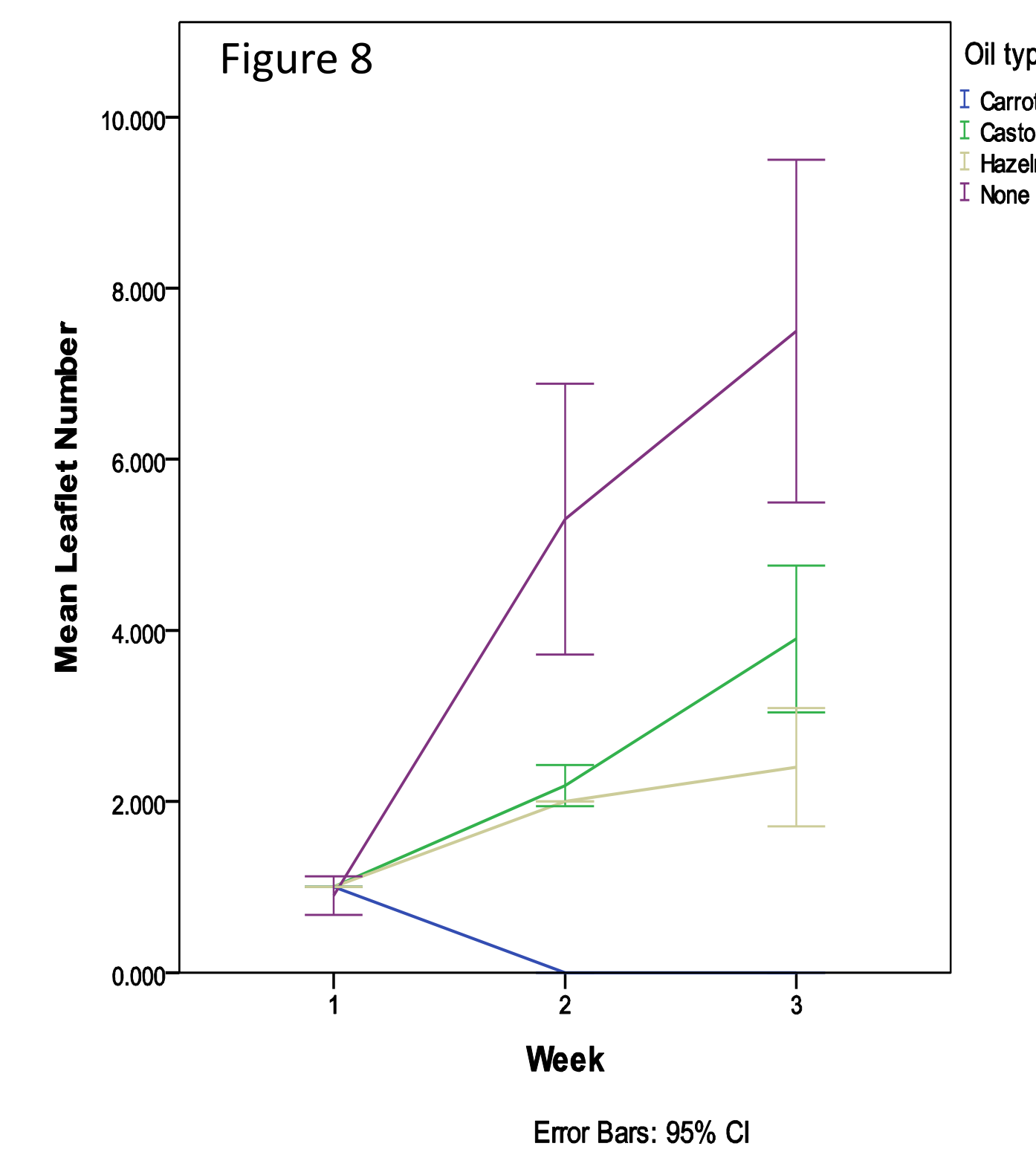


Figure 8: Mean leaflet number for each oil type throughout the experiment
 Week *p* value: 1.054E-15
 Oil Type *p* value: 9.043E-26
 Interactive *p* value: 2.59E-16

Figure 9: Mean leaf area for each oil type, separated by fertilizer
 Fertilizer *p* value: 0.4207
 Oil Type *p* value: 3.3633E-13
 Interactive *p* value: 0.3513

Figure 10: Mean stem diameter for each oil type throughout the experiment
 Week *p* value: 0.2584
 Oil Type *p* value: 1.887E-08
 Interactive *p* value: 1.215E-07



Figure 1: Measurement sites
 A: shoot height
 B: a single leaflet
 C: location of shoot diameter measurement

Figure 2: Non-randomized plants after first oil and fertilizer treatment (Week 1). Effects seen in plants treated with carrot seed oil within one hour.

Figure 3: Randomized plants after third oil and second fertilizer treatments (Week 2).

Figure 4: Randomized plants after fourth oil treatment (Week 3).

Discussion

- Carrot seed oil was found to contain flavonoid particles, which we attribute to the devastating effect the oil had on the plants (Mierziak et al., 2014)
- The effects of hazelnut and castor oil on plant development were fairly similar, except for leaflet number, as shown in Figure 8
- Plants with nitrogen poor fertilizer experienced yellowing
- Conclusion:
 - The application of natural oils had a negative effect on plant development, although it is not likely that these effects are SPF dependent
 - Increased nitrogen levels did not seem to counteract the effects of the oils
- Future research:
 - Try other oils such as Wheat Germ oil
 - Look into carrot seed oil as natural herbicide

Acknowledgements

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Literature Referenced

Mishra, A.K., Mishra, A., Chattopadhyay, P. "Assessment of In Vitro Sun Protection Factor of Calendula Officinalis L. (Asteraceae) Essential Oil Formulation", 4(1), 2013. pp.17-21.

Hupel M., Poupart N., Ar Gall E. "Development of a new in vitro method to evaluate the photoprotective sunscreen activity of plant extracts against high UV-B radiation". (2011) *Talanta*, 86(1). pp. 362-371.

Floyd, T. "Using Natural Oils with SPF as Sunscreen." *Babble.com*. Disney, 2013. Web.

Francini, A., Lorenzini, G., & Nali, C. "The Antitranspirant Di-1-p-menthene, a Potential Chemical Protectant of Ozone Damage to Plants". *Water, Air, & Soil Pollution*, 219(1-4), 2011. pp. 459-472.

Mierziak, J., Kostyn, K., Kulma, A. "Flavonoids as Important Molecules of Plant Interactions with the Environment" Faculty of Biotechnology, Wroclaw University, 2014, pp. 16240-16265

Kapoor, S., Saraf, S. "Efficacy Study of Sunscreens Containing Various Herbs for Protecting Skin from UVA and UVB Sunrays". *Phcog Mag* 2009, pp.238-48

NovaSource. *Purshade*. Phoenix: NovaSource, 2012. *NovaSource.com*. Tessengerlo Kerly, Inc. Web.

Sharma, K. D., et al. "Chemical Composition, Functional Properties and Processing of Carrot—a Review." *Journal of food science and technology* 49.1 (2012): 22–32. *PMC*. Web. 21 Nov. 2016.

Tevini, M. "Ozone Holes and UV-Radiation: Ecological Consequences for Plants". *Skin Cancer and UV Radiation*, 2011. pp. 50-58.