IEEESEM

The Effects of Different Sunlight Intensities towards the Germination Rate of Corn (*Zea mays*)

Asmairanisah O. Macatanong[1], Muhammad Sodais M. Salic[2], Jannah Azra S. Smith[3], Asnor S. Langlang[4], Yashinie Fatmah P. Pangcoga[5], Jehan A. Macasibar[6], Raniya D. Nasser[7], Nailiyah B. Macapodi[8], Afqar Zainoden M. Abdullah[9], and Abdani D. Bandera[10]

[1-9]Students, Ibn Siena Integrated School Foundation, Biyaba Damag, Marawi City, 9700, Philippines
[10]Faculty, Mindanao State University Main, Marawi City, 9700, Philippines
Email: asmairanisahmacatanong@gmail.com

ABSTRACT

The study, titled "The Effects of Different Sunlight Intensities on the Germination Rate of Corn (*Zea mays*)," was conducted in Saduc Proper, Marawi City. The study used a Randomized Complete Block Design (RCBD). It has five treatments (T1: control, T2: covered with single-layered sunshade net, T3: covered with double-layered sunshade net, T4: covered with triple-layered sunshade net, and T5: covered with four-layered sunshade net). Each treatment is replicated three times and allocated across three blocks. The total area is 16 m2. Results show that the corn covered with a triple-layered net has the highest germination rate of 33.33% after 14 DAE, whereas the corn with no cover shows the lowest germination rate of 11.11%. Based on the findings, T4 has the most significant effect on the germination rate of *Zea mays*.

Keywords : Germination; *Zea mays*; Sunlight Intensities; Corn.

1 Introduction

Different plant species grow through seed germination. Seed germination is a fundamental process by which plants grow from a seed into mature plants. In general, when the soil is moist and the temperature is conducive to growth, seeds "wake up" and begin to germinate (Stivers, 2017). For germination to occur, the environmental conditions must be favorable to support the growing plants (Abayechaw & Wulchafo, 2020). Among the conditions required in seed germination is an adequate supply of water, a suitable temperature range, and, for some seeds, light (Collis George & Williams, 1968). According to Abayechaw and Wulchafo (2020), Most seeds are not affected by light or darkness, but many seeds, including species found in the forests, will not germinate until a canopy opening allows sufficient light for the seedling to grow and thrive.

Sunlight is an important factor in maintaining plants because light energy is used in photosynthesis, the process by which green plants make their food. Sunlight provides the energy plants need to convert carbon dioxide and water into carbohydrates and oxygen. Light intensity influences the production of stem length, leaf color, plant food, and flowering. Generally speaking, plants grown in low light have spindly growth with pale green leaves. While plants grown in very bright light tend to be shorter, have better branches, and have larger, dark green leaves (Light, temperature, And humidity - ornamental production ornamental production, n.d.). In terms of germination, not all seeds have the same light requirements. Most seeds germinate more effectively when left in the dark. The presence of light, which is crucial to seedling development, may stunt the process of germination (Wroblewski, 2021). However, once they have sprouted and turned into a seedling, sunlight becomes essential for them to grow.

Since ancient times, corn (Zea Mays), also known as Maize, has been one of the crops that mankind has been multi-dimensionally using at various stages of growth. According to the DARegional Field Office III. (n.d.), Corn is the second most important crop in the Philippines. It is the main source of income for about 600,000 rural households. For this reason, the researchers preferred to conduct experimental research regarding the seed germination of corn plants due to their prominence. There are many different varieties of corn across the world. The specific type of corn seeds used in this study is Sweetcorn (*Zea mays conva. Saccharata var. rugosa*) in this study. Sweetcorn is a variety of maize with a high sugar content and it is prepared for consumption as a vegetable (Sweet Corn, n.d.). For germination and growth of sweetcorn, the soil temperature must be at least 50°F(10°C), but 60-85°F (15.56-29.44°C) ideal and it should receive full sun for maximum growth and yield (Sideman, 2021).

In agriculture and gardening, the germination rate describes how many seeds of a particular plant species, variety, or seed lot are likely

IEEE-SEM, Volume 10, Issue 11, November-2022
ISSN 2320-9151

to germinate over a given period (Jean, 2021). Farmers can adjust their planting patterns to achieve the desired plant population in the field by determining the germination rate. Hence, the study aims to assess how different sunlight intensities, from complete to little or no sunlight exposure, affect corn seeds' germination rate. It aims to determine which sunlight intensity is the best for corn seeds to germinate. Moreover, it also aims to calculate the germination rate of the corn seeds.

2 Related Literature

2.1 Seed Germination and Seedling Growth

A key event in the life cycle of plants is Seed Germination. Several environmental factors such as temperature, light, acidity, and soil moisture have been known to affect the germination of seeds (Chachalis and Reddy; 2000; Koger et al., 2004). Soil moisture is a significant factor that influences seed germination and seedling emergence (Cardwell, 1984).

Successful seed germination following some period of dormancy results from an interaction between physiological and genetic factors (internal) and environmental factors (external), including sediment, light, and temperature (Baskin & Baskin 1998).

The germination process in the seed is characterized by the reactivation of the paralyzed metabolism after physiological maturity and can be affected by internal, external, or environmental factors (Carvalho and Nakagawa, 2000). Among the environmental factors, water, oxygen, and temperature are considered vital components that determine the intensity and germination speed of the species (Marcos Filho, 1986; Bewley & Black, 1994). In addition, luminosity conditions and mechanisms of adaptation to the salinity of the substrate are determining factors for the germination of seeds (Fanti & Perez, 1998).

The germination capacity is one of the most critical points to determine the success in the establishment of an adequate plant stand, so studies on the effect of luminosity, temperature, water, and salinity are essential to understand the ecological and physiological aspects that involve the process (Labouriau, 1983). The ability of the seed to germinate under wide environmental conditions, where it was sown, determines its vigor and consequently its competitive capacity (Perez & Tambelini, 1995).

2.2 Effects of Sunlight Intensity on Plants

Sunlight is the electromagnetic radiation of the sun, particularly infrared, visible light, and ultraviolet light, that reaches the earth. However, not all of them reach the earth. The earth's atmosphere filters the electromagnetic radiation allowing only a margin to enter, especially visible light. The atmosphere emits some of them, while others are scattered and spread to space (Biology Online, 2022).

Sunlight is the primary source of energy for all plants. Through the process called photosynthesis, plants absorb energy from the sun, which fuels the processes necessary for survival. A plant's leaves serve as solar panels, capturing light as efficiently as possible to help the plant grow. This is also the articulated reason for how people will notice something called phototropism or plant leaves changing position depending on their relative orientation to the sun ("The Importance of Sun Exposure," 2021). Along with sunlight, plants also require water, air, space, and nutrients in the mixture of nitrogen (N), phosphorus (P), and potassium (K) for the plants to have sustainability for their continuous growth and development.

A plant that is not receiving the right amount of sunlight it requires to sustain itself, will begin to turn dull green or yellow, drop leaves, and start growing leggy with few if any, new leaves. If the said symptoms occur, it is a sign of the relocation to occur for the plant to regain its correct composition for it to continually grow and exist ("The Importance of Sun Exposure," 2021).

Overexposure can also be harmful to plants. If the plant needs more shade, one will notice signs of burning on the leaves. Oftentimes, this appears as brown patches or singed leaf tips. Again, most plants can recover if moved to a more suitable location where the sunlight intensity is not too much for the plants to handle ("The Importance of Sun Exposure," 2021).

According to Sideman (2021), sweet corn should receive full sun for maximum growth and yield, and soil temperature must be at least 50°F (10°C) for germination and growth. Thus, sunlight has a significant role in the seed germination of corn as the light energy from it is converted to reusable energy that the seed can use to sustain its growth and development.

2.3 Effects of Sun Shading on Various Plants

Researchers have categorized plants into sun plants and shade plants. The perception of sun and shade plants has been used for plants that need high irradiance/light and intense shading to grow and complete their life cycle, respectively (Cuzzuol and Milanez, 2012). Light-saturated rates of photosynthesis vary between the sun (high light) and shade (low light) environments (Boardman, 1977, Ojanguren et al., 2013).

Plants modulate themselves according to fluctuating light conditions to attain the utmost robustness (Li et al., 2014, Valladares and Niine-mets, 2008). In low light, plants need to absorb sufficient light for photosynthesis. Under low light conditions, insufficient ATP is produced for carbon fixation and carbohydrate biosynthesis (Shao et al., 2014) leading to a reduction in plant growth. To avoid this, plants growing under low light need to maximize light absorption.

In high light conditions, however, the problem is reversed, as plants need to maximize their Photosystem II capacity for utilizing abundant light energy available while at the same time, dealing with excess sunlight when photosynthetic capacity is exceeded. As a consequence, plants have evolved a variety of features that optimize light interception, absorption, and processing.

In a shade condition, the growth and survival of plants are closely linked to their capacity to intercept light efficiently, and this capacity may be critical to their survival (Kim et al., 2011).

IEEE-SEM, Volume 10, Issue 11, November-2022
ISSN 2320-9151

According to the nature of the light environment to which plants are exposed, either sun or shade leaves are exhibited by the plant. Leaves developed under the sun (high light) are small, thick with well-developed palisade tissue, higher stomatal density, and thin granal stacks as compared to shade leaves (low light) (Jiang et al., 2011, Martins et al., 2014).

Shade leaves, as contrast to sun leaves, are said to enhance light acquisition while lowering the costs of maintaining excess photosynthetic machinery. These leaves are thin and lighter and have a high specific leaf area. Shade leaves also show evidence of high chlorophyll concentrations per unit leaf mass and low ATPase activities and Rubisco contents as compared to sun counterparts (Boardman, 1977, Walters, 2005, Niinemets, 2007, Martins et al., 2013).

A classic shade leaf is at risk of photoinhibition and damage from the high irradiance of sun flecks, while a classic sun leaf is ill-suited to shade conditions (Boardman, 1977, Way and Pearcy, 2012, Martins et al., 2013).

One significant finding in the present study was that shading delayed the initial flowering date and prolonged flowering time, which could impact profitability. A similar flowering date delay has been reported under shading nets in Plukenetia volubilis and Paeonia lactiflora (Zhao et al., 2012, Cai, 2011). Baloch et al. (2009) found that shade could achieve prolonged flowering time in long-day plants while short-day plants could be grown under shade if an early flowering was required.

According to (Zhao et al., 2012), shade not only influences the amount of light received by plants but also changes other small environmental conditions, such as temperature, humidity, carbon dioxide (CO2) concentrations, and so on.

2.4 Shading of Corn Plants

Artificial shade periods accompanied by high rainfall and temperatures, as well as low natural sunlight, tended to limit development the most. Those associated with high levels of natural sunlight had the least impact. When artificial shade was applied to vigorously growing plants, the effects were less pronounced. Because of their maturity, vigor, and growth stage at the time of treatment, inbreds responded differently to periods of limited light (Andrew and Burns, 1978).

While corn leaves that have been artificially shaded help increase grain yield, their effectiveness is greatly diminished (Schmidt el at., 1967). It was discovered that shading corn during anthesis had a greater negative impact on yield than shading during the vegetative and maturation stages (Early et al., 1967). Competition for light has increased as a result of recent trends toward high plant populations. In terms of dry weight accumulation, it's probable that genotypes that can manage high populations can tolerate shade better.

According to Hashemi-Dezfouli and Herbert (1992), a decrease in the number of kernels per ear and complete ear barrenness can occur as a result of competition between corn (*Zea mays L.*) plants for the interception of photosynthetically active radiation (PAR) at high plant densities. The shade level affected the row numbers of the kernels on the corn cob11 (Ephrat et al., 1993).

3 METHODOLOGY

3.1 Research Design

The field experiment is conducted at Saduc Proper, Marawi City (8.0033° N, 124.2914° E). The experiment is done using a Randomized Control Block Design (RCBD) with five treatments replicated three times. It is laid in an area approximately 4m x 4m ($16m^2$). Three blocks are made, each representing one replication. Block is distanced 0.75 meter from another block.

3.2 Treatments

Corn (*Zea mays*) seeds are planted and divided into five treatments in each block. There are three replications. one plant per treatment in each replication, hence, fifteen (15) corn plants are utilized in the study. Moreover, the plants are arranged in a randomized order.

The treatments vary according to sunlight intensity. Sunshade nets are used to control the sunlight intensity.

The treatment combinations are the following:

T1	= control
T2	= covered with single-layered sunshade net
T3	= covered with double-layered sunshade net
T4	= covered with triple-layered sunshade net
T5	= covered with four-layered sunshade net

IEEE-SEM, Volume 10, Issue 11, November-2022
ISSN 2320-9151

**Treatments(T)*

3.3 Materials

The following materials are utilized in the study: Garden soil, spade, garden fork, standard ruler, measuring tape, Vermicast fertilizer, sunshade net made of polyethylene fiber, corn seeds (*Zea mays L.var.indentata*).

3.4 Cultural Management

Three (3) blocks, 0.5m in width, 3m in length, and 3 inches deep, are filled with the same type of garden soil. Five (5), two (2) cm deep holes are made in each block with 0.5m distances. Three (3) seeds are then planted in each hole to assure seed germination. In a block, one variation is left to receive natural sunlight. The other four are covered with sunshade nets; mono-layered, double-layered, triple-layered, and quadruple-layered. Thus, this is repeated on the other blocks

Watering is done uniformly and as necessary for all treatments throughout the study period. It is manually examined to make sure that the study is progressing and the seeds are germinating.

3.3 Data Gathering Procedures

3.3.1 Germination Parameters

3.3.1.1 Number of Seeds tested

This was taken by counting the seeds sown in every hole in each block.

3.3.1.2 Number of Seeds germinated

This was taken by counting the seeds that had successfully germinated.

3.3.1.3 Germination Percentage

This was taken by calculating the formula;

$$\text{GP} = \frac{\text{number of seeds germinated}}{\text{number of seeds tested}} x100$$

4 RESULTS AND DISCUSSION

4.1 Germination Percentage

The germination rate of corn 7, 10, and 14 DAE was significantly influenced by different sunlight intensities through the use of shading. As shown in the table, T1 (no cover) has a significantly lower percentage of 11.11% while T4 (triple-layered cover) has a significantly higher percentage of 33.33% among all others.

Table1.

Treatments	Description	replication	7 DAE	10 DAE	14 DAE	Number of seed tested	GP	Total germination percentage
T1	Controlled (No Cover)	Block 1	-	-	-	3	-	11.11%
		Block 2	-	-	-	3	-	
		Block 3	1	1	1	3	33.33	
T2	Covered with mono-layered net	Block 1	2	2	2	3	66.67	22.22%
		Block 2	-	-	-	3	-	
		Block 3	-	-	-	3	-	
T3	Covered with double-layered net	Block 1	-	-	-	3	-	22.22%
		Block 2	-	-	-	3	-	
		Block 3	2	2	2	3	66.67	
T4	Covered with triple-layered net	Block 1	-	-	-	3	-	33.33%
		Block 2	1	1	1	3	33.33	
		Block 3	1	2	2	3	66.67	

IEEE-SEM, Volume 10, Issue 11, November-2022
ISSN 2320-9151

T5	Covered with quadruple-layered net	Block 1	-	-	-	3	-	22.22%
		Block 2	1	1	1	3	33.33	
		Block 3	1	1	1	3	33.33	

The result conforms with the study by Ahmed et al. (2014), which shows that shade had a significant effect on germination and seedling growth variables. Medium shade resulted in a fast rate of germination and high germination percentage. Moreover, to the findings of Semchenko et al. (2011), which state that moderate shade had a strongly facilitative effect on plant growth. However, shading has also negative effects on maize. The results of the study conducted by Yuan et al. (2012) show that maize growth and yield were seriously hindered by long-term shading. Furthermore, the effect differs with different shading periods and intensities (Zhang et al. 2006). In this study, has potential limitations that may have influenced the result of the study. These are; uncontrolled weather disturbances, mainly constant heavy rain; and the lack of pesticides, thus, seeds' vulnerability to pests, insects, and other seed eaters.

6 Conclusion

First, the use of different layers of the net as shading to cover all the treatments and control sunlight intensities plays a major role in determining the germination rate of the corn seeds. In addition, T4 (triple-layer net shading) is the most effective while T1 (no shade) is the least effective. Second, as far as the germination rate, T2 (mono-layer net shading), T3 (double-layer net shading), and T5 (quadruple-layer net shading) lie between T4 and T1, with a percentage of 22.22%.

7 Recommendation

Based on the results of the experiment, the method of covering sown areas with a triple-layer net after seed sowing is therefore recommended for farmers who are planning to plant corn (*Zea mays*). This will increase the germination rate of the sown corn seeds which means that those corn seeds will have a higher chance of thriving; and consequently, boost the total yield of farmers. Additionally, further study in the use of net shading in corn is recommended, especially on replicating the experiment in a controlled environment; and the use of the such method in other varieties of corn; and other types of crops such as rice.

References

[1] Abayechaw, D., & Wulchafo, K. (2020, May 20). The concept and process of seed germination - A Review. International Journal of Current Research and Academic Review. Retrieved from http://www.ijcrar.com/8-5-2020/Desta%20Abayechaw%20and%20Kedir%20Wulchafo2.pdf

[2] Ahmed, L. T., Warrag, E. I., & Abdelgadir, A. Y. (2014, June 2). Effect of shade on seed germination and early seedling growth of moringa Oleifera Lam. Academia.edu. Retrieved October 28, 2022, from https://www.academia.edu/7223695/Effect_of_Shade_on_Seed_Germination_and_Early_Seedling_Growth_of_Moringa_Oleifera_Lam#:~:text=The%20results%20showed%20that%20shade,light%20and%20high%20germination%20percentageW.-K. Chen, *Linear Networks and Systems.* Belmont, Calif.: Wadsworth, pp. 123-135, 1993. (Book style)

[3] Andrew, R. H. and Burns, M.C.: Effect of Shade Applied at Consecutive Periods on Sweet Corn Development - Soc. Hort. Sci. 103(5): 658-661. 1978.

[4] Baloch J.U.D., Khan M.Q., Zubair M., Munir M.: Effects of Different Photoperiods on Flowering Time of Facultative Long Day Ornamental Annuals - International Journal of Agriculture & Biology 11: 138-144, 2009.

[5] Baskin CC and Baskin JM (1998) Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, New York.

[6] Bewley, J.D.; Black, M. Seeds: physiology of development and germination. 2.ed. New York: Plenum,1994. 445p.

[7] Biology Online (2022, July 24). Sunlight Definition and Examples - Biology Online Dictionary. Biology Articles, Tutorials & Dictionary Online. Retrieved from https://www.biologyonline.com/dictionary/sunlight

[8] Boardman N.K.: Comparative photosynthesis of sun and shade plants. – Annu. Rev. Plant Physio. 28: 355-377, 1977.

[9] Cai Z.: Shade delayed flowering and decreased photosynthesis, growth and yield of Sacha Inchi (Plukenetia volubilis) plants – Industrial Crops and Products 34: 1235-1237, 2011.

[10] Cardwell, V.B., 1984. Seed germination and crop production. pp. 53-92. In: M. B. Teaser, ed. Physiological Basis of Crop Growth and Development. Madison, WI: American Society of Agronomy.

[11] Carvalho, N.M.; Nakagawa, J. Sementes: ciência, tecnologia e produção. 4.ed. Jaboticabal: Funep, 2000.588p.

[12] Chachalis, D., Reddy, K.N., 2000. Factors affecting Campsis radicans seed germination and seedling emergence. Weed Science, 48: 212-216.

[13] Collis-George, N. and Williams, J., 1968. Comparison of the effects of soil matric potential and isotropic effective stress on the germination of Latuca sativa. Australian Journal of Soil Research, 6, 179–192.

[14] Cuzzuol G.R.F., Milanez C.R.D.: Morphological and physio-logical adjustments in juvenile tropical trees under contrasting sunlight irradiance. – In: Najafpour M.M. (ed.): Advances in Photosynthesis. Fundamental Aspects. Pp. 501-518. In Tech Croatia, Rijeka 2012.

IEEE-SEM, Volume 10, Issue 11, November-2022
ISSN 2320-9151

[15] Early E. B., Mcilrath W.O., Seif R. D., and Hageman R. H.: Effects of shade applied at different stages of plant development on corn (*Zea mays L.*) production - Crop Science 7: 151-156. 1967.

[16] Ephrat J., Wang R. F., Terashima K., Hesketh J.D., Huck M.G., Hummel J., W. Shading effects on corn. BIOTRONICS 22, 15-24,1993.

[17] Fanti, S.C.; Perez, S.C.J.G.A. Efeito do estresse hídrico, salino e térmico no processo germinativo de sementes de Andenanthera pavonina. Revista Brasileira de Sementes, v.20, n.1, p.167-77, 1998.

[18] Fenghui Y., De-xin G., Anzhi W., Jiabing W., Changjie J., (2012). Effects of long-term shade on maize (*Zea mays L.*) growth and yield in west of Liaoning province, Northeastern China. Journal of Food Agriculture and Environment 10(3):357-361.

[19] Hashemi-Dezfouli, A., Herbert, S.J.: Intensifying Plant Density Response of Corn with Artificial Shade - Agronomy Journal 84 (4): 547-551, 1992.

[20] Jean, M. (2021, December 9). Seed Germination Biochemical Mechanism in Plants. Journal of Plant Biochemistry & Physiology. Retrieved November 18, 2022, from https://www.longdom.org/open-access/seed-germination-biochemical-mechanism-in-plants-88416.html

[21] Jiang C.D., Wang X., Gao H.Y. et al.: Systemic regulation of leaf anatomical structure, photosynthetic performance, and high-light tolerance in sorghum. – Plant Physiol. 155: 1416-1424, 2011.

[22] Jiwang Z., Kongjun W., Shuting D., Changhao H., P. Liu, (2006). Effects of shading on the growth, development and grain yield of summer maize. The journal of applied ecology 17(4):657-62.

[23] Kim S. J., Yu D. J., Kim T. C., Lee H. J.: Growth and photosynthetic characteristics of blueberry (Vaccinium corymbosum cv. Bluecrop) under various shade levels. - Scientia Horticulturae 129: 486-492, 2011.

[24] Koger, C.H., Reddy, K.N., Poston, D.H., 2004. Factors affecting seed germination, seedling emergence, and survival of Texas weed (Caperonia palustris). Weed Science, 52: 989-995.

[25] Labouriau, L.G. A germinação das sementes. Washington: Secretaria da O.E.A., 1983. 173p.

[26] Li T., Liu L.N., Jiang C.D. et al.: Effects of mutual shading on the regulation of photosynthesis in field grown sorghum. – J. Photoch. Photobio. B 137: 31-38, 2014.

[27] Light, temperature and humidity - ornamental production ornamental production. Aggie Horticulture®. (n.d.). Retrieved from https://aggie-horticulture.tamu.edu/ornamental/a-reference-guide-to-plant-care-handling-and-merchandising/light-temperature-and-humidity/

[28] Marcos Filho, J. Germinação de sementes. In: Cicero, S.M.; Marcos Filho, J.; Silva, W.R. (Eds.). Atualização em produção de sementes. Campinas: Fundação Cargill, 1986. p.11-39.

[29] Martins S.C.V., Detmann K.C., Reis J.V.D. et al.: Photosynthetic induction and activity of enzymes related to carbon metabolism: insights into the varying net photosynthesis rates of coffee sun and shade leaves. – Theor. Exp. Plant Physiol. 25: 62-69, 2013.

[30] Martins S.C.V., Galmés J., Cavatte P.C. et al.: Understanding the low photosynthetic rates of sun and shade coffee leaves: bridging the gap on the relative roles of hydraulic, diffusive and biochemical constraints to photosynthesis. – PLoS ONE 9: e95571, 2014.

[31] Niinemets U.: Photosynthesis and resource distribution through plant canopies. – Plant Cell Environ. 30: 1052-1071, 2007.

[32] Ojanguren C.T., Goulden M.L.: Photosynthetic acclimation within individual Typha latifolia leaf segments. – Aquat. Bot. 111: 54-61, 2013.

[33] Perez, S.C.J.G.A.; Tambelini, M. Efeitos dos estresses salino e hídrico e do envelhecimento precoce na germinação de algarobeira. Pesquisa Agropecuária Brasileira, v.30, n.11, p.1289-95, 1995.

[34] Republic of the Philippines Department of Agriculture Regional Field Office III City of San Fernando, Pampanga. DARegional Field Office III. (n.d.). Retrieved from https://rfo3.da.gov.ph/corn-program/

[35] Shao Q., Wang H., Guo H. et al.: Effects of shade treatments on photosynthetic characteristics, chloroplast ultrastructure, and physiology of Anoectochilus roxburghii. – PLoS ONE 9: e85996, 2014.

[36] Schmidt, W. H., and W. L. Colville. 1967. Yield and yield components of *Zea mays L.* as influenced by artificially induced shades. Crop Sci. 7:137-139.

[37] Semchenko, M., Lepik, M., Götzenberger, L., & Zobel, K. (2011). Positive effect of shade on plant growth: Amelioration of stress or active regulation of growth rate? Journal of Ecology, 100(2). https://doi.org/10.1111/j.1365-2745.2011.01936.x

[38] Sideman, R. (2021). Growing Sweet Corn – University of New Hampshire. Retrieved from https://extension.unh.edu/resource/growing-sweet-corn-fact-sheet.

[39] Stivers, L. (2017, March 9). Understanding seeds and seedling biology. Penn State Extension. Retrieved from https://extension.psu.edu/understanding-seeds-and-seedling-biology

[40] Sweet Corn. Home. (n.d.). Retrieved from https://www.plantgrower.org/sweet-corn.html

[41] The Importance of Sun Exposure (2021, May 3) – Royal City Nursery. Retrieved from https://royalcitynursery.com/the-importance-of-sun-exposure/#:~:text=Why%20Do%20Plants%20Need%20Sunlight,the%20processes%20necessary%20for%20survival.

[42] Valladares F., Niinemets U.: Shade tolerance, a key plant feature of complex nature and consequence. – Ann. Rev. Ecol. Evol. Syst. 39: 237-257, 2008.

[43] Walters R.G.: Towards an understanding of photosynthesis acclimation. – J. Exp. Bot. 56: 435-447, 2005.

[44] Way D.A., Pearcy R.W.: Sunflecks in trees and forests: from photosynthetic physiology to global change biology. – Tree Physiol. 32: 1066-1081, 2012.

[45] Wroblewski, M. T. (2021, February 2). Do seedlings need light before they sprout? Home Guides | SF Gate. Retrieved November 18, 2022, from https://homeguides.sfgate.com/seedlings-need-light-before-sprout-77157.html

[46] Zhao D., Hao Z., Tao J.: Effects of shade on plant growth and flower quality in the herbaceous peony (Paeonia lactiflora Pall.) – Plant Physiology and Biochemistry 61: 187-196, 2012.

IEEE-SEM, Volume 10, Issue 11, November-2022
ISSN 2320-9151

APPENDIX


Picture 1.


Picture 2.


Picture 3.


Picture 4


Picture 5


Picture 6


Picture 7.


Picture 8.