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Intraspecific Competition For Beans And Corn In The Green House Of IPB University Bogor Regency, West Java Indonesia

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Abstract. This study aims to analyze the intraspecific competition between peanuts (*Arachis hypogaea)* and corn (*Zea mays*) in a controlled environment in the Green House IPB University, Bogor, West Java. Intraspecific competition occurs when individuals of the same species compete with each other for limited resources, such as light, water, and soil nutrients. This study was conducted using a factorial experimental design, involving various levels of planting density in each species. The observed parameters include plant growth, biomass, competition index, and crop yield. The results showed that the interaction between peanuts and corn under intraspecific conditions affected the efficiency of resource use as well as the yield of each plant. These findings provide important insights for the management of mixed cropping patterns, especially in sustainable agricultural systems that prioritize land and resource use efficiency.

Keywords: Competition, corn, intraspecificgreen house, peanuts

INTRODUCTION

Plants live in an ecosystem where in their habitat there is species interaction in the form of mutually beneficial positive interactions and negative interactions in the form of competition, this interaction is always related to the influence of environmental factors and the availability of resources that can determine the survival of species in their habitat (Stephan et al., 2021; N. Zhang et al., 2021). Competition is an interaction between individuals due to the same need for limited resources in a place and at the same time negatively affecting growth, both between individuals of the same type and between different individuals in a habitat such as: water, nutrients, light, CO_2, and growing space (Nguyen et al., 2021; Postma et al., 2021; Lind et al., 2022).

Interactions between plants can be positive-positive, positive-neutral, positive-negative, neutral-neutral, and negative-negative. Meanwhile, competition is an interaction between two or many individuals that occurs because the source of the needs of the substances needed by the plant is limited and the quality of the source available in a habitat is not in accordance with the source of the needs needed by the plant (Collinge et al., 2022; Gavrilescu, 2021).

Competition is shown in the interaction between two organisms that compete for something in common. This competition can occur between individuals of the same sex or between individuals of different types (Begon & Townsend, 2021). Competition that occurs between individuals of the same type is called intraspecific competition while competition that occurs between individuals of different types is referred to as interspecific competition (Mallard et al., 2020; Ode et al., 2022;

Uchmański et al., 2023). The amount of competition power of competitor plants depends on several factors, including the number of individuals and the weight of competitor plants, the life cycle of competitor plants, the plant period, and the type of plant (van Kleunen et al., 2020; Levine et al., 2022).

Competition between these plants occurs due to limited growth factors. The factors that are competing include nutrients, light, CO_2, light and growing space. In this reseach research, we will find out the determinants of different types of plants and their placement in different habitats, namely habitats exposed to full light, transitional habitats and shaded habitats to the high growth rate and the number of plant leaves in dead corn and mung bean plants and the interactions that occur between the two. The plant response in this research can be in the form of an interplant competition which is a competition between vegetative organs or generative organs in the body of a plant, as a result of which is a difference in stem height, a difference in the number of leaves. Through the above presentation, it is very necessary to compile a research with a report to be able to report the results of this research so that it can be a reference in determining the level of competition between the same and different species in habitats treated with exposure to light, transitional habitats and shaded habitats against high competition for plants and an increase in the number of plant leaves.

The purpose of this research research is to determine the influence of plant height and growth, as well as the increase in the number of leaves in the competition of corn, beans and mixed crops. The treatment is only by placing the research object in a habitat exposed to light, switched, and shaded.

RESEARCH METHOD

Time and Place

This research was carried out on Thursday, April 2017 at the Bio-2 Laboratory of the Department of Biology and Greenhouse, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Dramaga, Bogor Regency, West Java Province, Indonesia.

Tools and Materials

The tools used in this research are polybags, buckets, rulers, and stationery. The ingredients used are good quality corn kernels and beans, soil, and water.

Working Procedure

Intraspecific Competition Test

The test began with the process of selecting long bean seeds using the soaking method, where floating seeds were excluded from planting. The selected seeds were then planted in polybags filled with soil under different habitat conditions. For the long beans, Polybag 1 contained 4 seeds placed in a habitat exposed to light, Polybag 2 contained 4 seeds in a transitional habitat, and Polybag 3 contained 4 seeds in a shaded habitat. Similarly, for the corn kernels, Polybag 1 contained 4 kernels in a habitat exposed to light, Polybag 2 contained 4 kernels in a transitional habitat, and Polybag 3 contained 4 kernels in a shaded habitat.

Interspecific Competition Test

The test began with the process of selecting long beans and corn seeds which was carried out by the soaking method. Floating seeds are not used in planting. The selected seeds are then planted in polybags that have been filled with soil with the condition

1. Polybag 1 filled with 2 long beans and 2 corn seeds in a habitat exposed to light
2. Polybag 2 filled with 2 long beans and 2 corn seeds in a transitional habitat
3. Polybag 3 is filled with 2 long beans and 2 corn seeds in a shaded habitat

Each polybag is made in three replicates and placed in a light-exposed, transitional and shaded habitat. After thinning, watering is carried out daily and height measurements are carried out every week for 4 measurements for 4 weeks of observation. This measurement was carried out to see the height, riap and leaf increase of the plant competition research objects, namely corn, beans and mixtures without fertilization, besides that also looked at the number of leaf increases from each observation object to be carried out statistical analysis tests.

RESULTS AND DISCUSSION

Competition is an interaction between individuals that arises due to the same need for limited resources, thus affecting the survival ability, growth and reproduction of individuals (Gårdmark & Huss, 2020), while Mollen (2002) defines competition as an interaction between individuals that results in a reduction in life ability. Competition can occur between different individuals (intraspecific) and between individuals of the same species (interspecific) (Mallard et al., 2020; Prati et al., 2021). Theoretically, if in a population consisting of two species, there will be an interaction between the two. The form of interaction can vary, one of which is competition between similar plants that can affect growth and development because it is generally detrimental. Competition in a broad sense is aimed at the interaction between two organisms fighting for something in common. Interspecies competition is an interaction between two or more populations of species that adversely affects their growth and life. The forms of competition can be varied and the tendency in competition causes ecological separation. In adjacent or similar species and this is known as *competitive exclusion principles*.

Plant population regulation is essentially a planting distance regulation which will later affect competition in the absorption of nutrients, water, and sunlight (Huber et al., 2021; Pierik & Ballaré, 2021). If this is not regulated properly, crop yields will also be affected. Close planting spacing will result in an interspecies and intraspecies competition. Environmental factors that are contested by plants in competition or competition include light, water, soil, nutrients, and carbon dioxide (Badiani et al., 2023). In addition to the contested factors, there are also external factors that affect the survival of the plant, including the presence of pollinators, seed dispersal agents, soil conditions, soil moisture, air and wind. The disturbance of certain species in a habitat also affects the survival of plants.

Intraspecies Competition

The results of observation of intraspecies and interspecies competition plant growth in corn, beans and corn and peanut mixtures with treatment in light-exposed, transitional and shaded habitats showed that there was a level of competition in the observation of plant height increase and leaf number increase during the observation time period.

Table 1. The height and ripple of corn at various levels of same-sex competition.

No.	Competition	Average increase in height (T) and riap (R) of corn (cm)							
		Week 1		Week 2		Week 3		Week 4	
		T1	R1	T2	R2	T3	R3	T4	R4
1	Light Corn	9	9	30	21	50	20	70	20
2	Corn Transition	16	16	34	18	49	15	67	18
3	Shaded Corn	13	13	12	-1	12	0	14	2

The increase in plant height at each observation has an effect on plant yield, but the calculation of crop yield uses the average value of the crop because there are repeats of corn, beans and mixed crops (corn-beans) (Table 1). From the results of observation of corn height in different habitats, it was found that there was the highest and second growth of corn height in the transitional habitat, but in the shaded habitat the plant yield value became minus because in the 2nd replicate there was dead corn so that the average became minus in the second week (Figure 1).

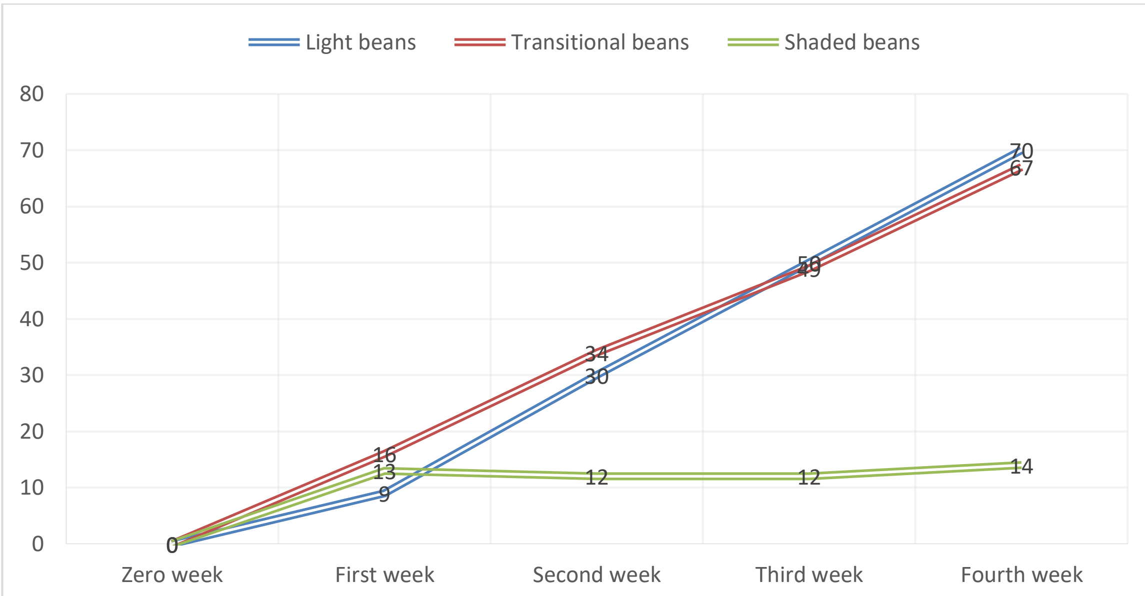

Figure 1. The growth of corn in habitat treatment is different.

Based on the data in the graph, there is an acceleration of growth in transitional corn because all corn seeds grow, while in corn exposed to light in the first week there are corn seeds that have not yet grown so that the average height of corn in the first week is relatively low when compared to the height of corn in transitional and shaded habitats. In corn, the shaded habitat decreased in the 3rd and 4th weeks due to the presence of corn that died, so that the average of the height increase decreased and the graph gradient decreased. In the results of the observation of peanuts for 4 observations (Table 2).

Table 2. Bean height and riap at various levels of same-sex competition.

No	Competition	Average increase in height (T) and riap (R) beans (cm)							
		Week 1		Week 2		Week 3		Week 4	
		T1	R1	T2	R2	T3	R3	T4	R4
1	Light Beans	17	17	33	15	40	7	44	4
2	Transition Beans	20	20	33	13	39	6	42	3
3	Shade Beans	19	19	26	7	30	4	34	4

For more details, the gradient of elevation and bean riaps in 3 (three) habitats can be seen in Graph 2. In this research, beans are used to determine the effect of light intensity on bean growth. In the growth of bean plants after germination, the conditions that allow normal growth are in plants that are treated without shade or full lighting. The high level of competition between habitats differed in these three treatments because all seeds in all replicates grew (Pik et al., 2020; Rehling et al., 2021; Vukeya et al., 2021). Beans are comparatively easier to grow than fast-growing corn. In general, peanut plants placed in a bright place grow shorter because light can decompose auxins (growth hormone) (Huong et al., 2022; Mascarenhas et al., 2023). This event occurs due to the influence of phytohormones, especially the hormone auxin (Mazzoni-Putman et al., 2021; Zhao et al., 2021). This auxin hormone will decompose and be damaged so that the rate of increase in plant height is not too fast (Leopold, 2022; Sheldrake, 2021). Plants placed in a bright place grow in the direction of the sun (perpendicular) while plants placed in a dark place have their stems bent because they are towards the sun (Li et al., 2020).

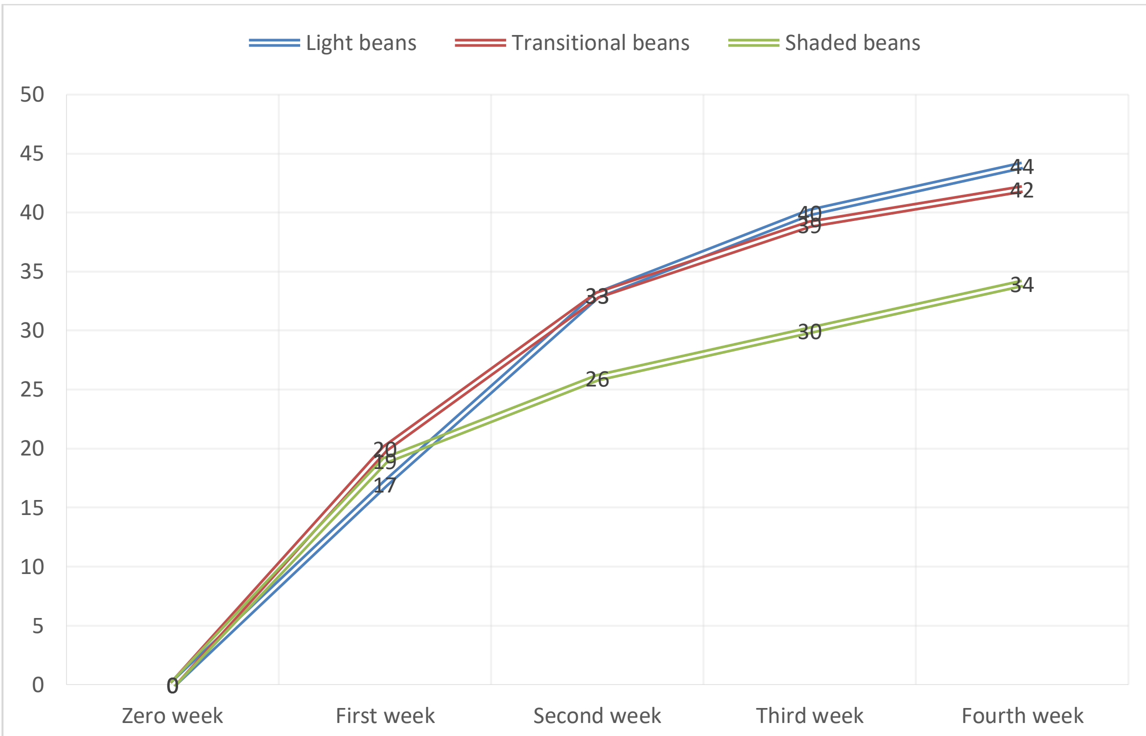

Figure 2. The growth of beans in habitat treatment is different.

In a bright place, the beans get more intense light, as a result of which the growth of the beans will be slow, because most of the auxin hormone is broken down by sunlight (Mackenzie et al., 2024). As a result, the growth of beans in dark places tends to be bent, the stems of the plant will be shorter, but with the physical condition of the plant is healthy, fertile, the stems look fat and strong, the leaves look fresh and green because they get enough light for photosynthesis and have enough chlorophyll (Chamovitz, 2020). In a half-lit place, the growth of beans looks optimal, because beans placed in a dark place will grow longer or taller than bean plants placed in a bright place, but plant conditions will appear healthy on plants that get full sunlight or with half shade or no shade.

In dark places, peanuts do not get enough sunlight which causes the auxin hormone contained in peanut seeds to become very active and work optimally. This causes the growth of beans to be very fast but uneven. So that the stem is weak and the color is yellowish (Vidak et al., 2022; Yulianah et al., 2020). As a result, the stem of the plant will be longer if it is planted in a dark place, but with the physical condition of the plant is not healthy, the roots are many and dense, the stem looks thin and unhealthy (weak), the color of the stem and leaves is pale and there is a lack of chlorophyll so that the leaves are yellowish called etiolasis.

Interspecies Competition

In the corn and soybean competition is called an interspecific competition with a composition of 2 corn and 2 beans in each polybag with 3 repetitions in each habitat exposed to light, the habitat of the corn and the shaded habitat can be seen in Figure 3 and Figure 4.

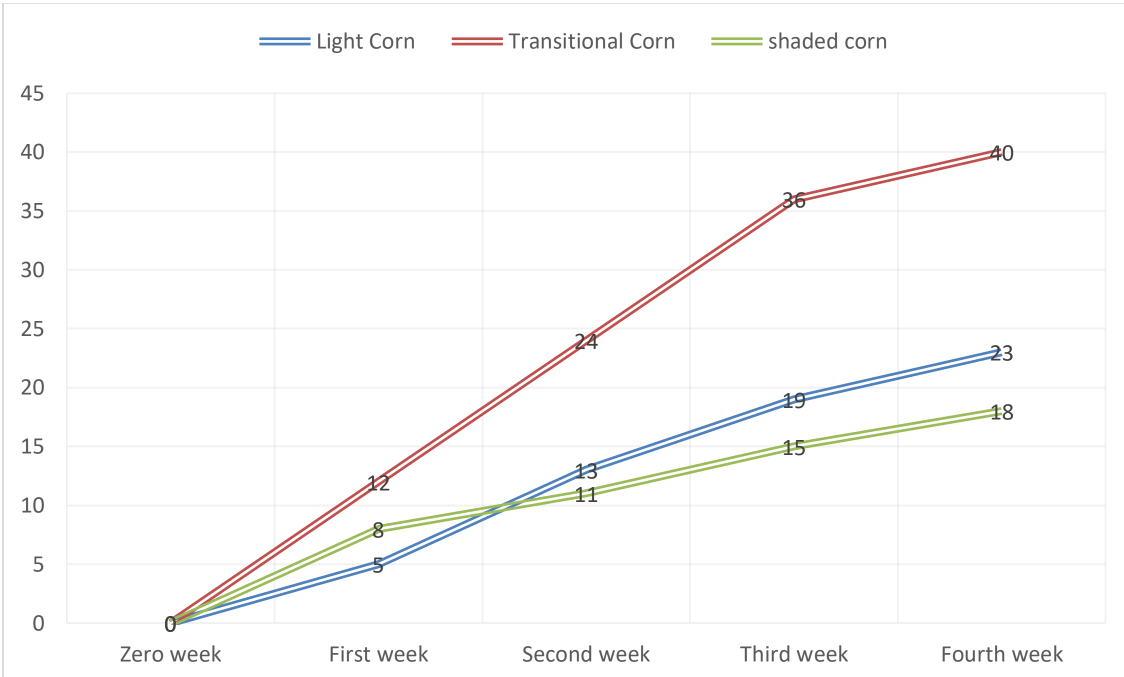

Figure 3. Height Increase in Mixed Corn in mixed habitats

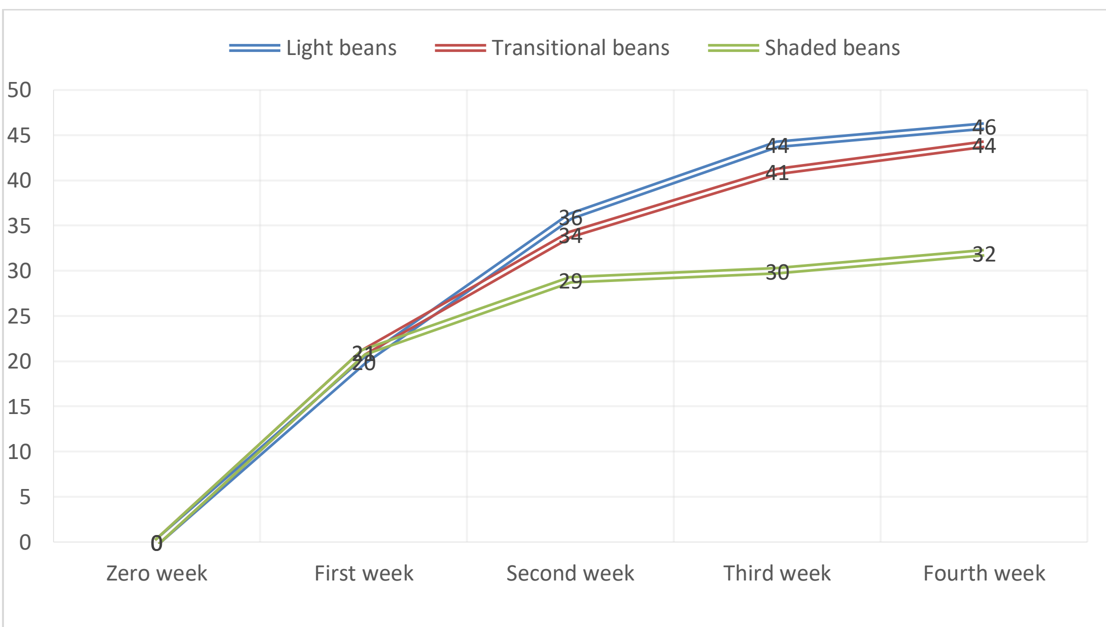

Figure 4. Height Increase in Mixed Beans in mixed habitats

Based on the results of the observation of the weekly calculation of this interspecies competition, it can be seen that in corn the habitat exposed to light is lower than in the transitional habitat because the number of corn seeds growing in polybags is only found in the 1st replicate, while the 2nd and 3rd replicates do not grow so that the average high growth is relatively lower. In the seeds, bean plants have a relatively fast growth ability in light-exposed and transitional habitats compared to the habitat of the treatment habitat (Janeeshma et al., 2022; Asaeda et al., 2023). Based on the observation results, beans have a larger average growth height. Meanwhile, in corn plants, the average growth height is smaller. According to Setiadi (1989) reported that the growth of plants planted in homospecies is slower than the growth of plants planted in heterospecies. This is because the competition to obtain nutrients and other substances needed is stronger.

Corn plants are plants that actively take nitrogen in the soil. In addition, corn plants are also plants that are greedy for nutrients. Usually in agriculture, to cultivate corn plants fertilely, palawija is planted which can produce more nitrogen, so that it can supply for corn growth. The growth of peanuts that are superimposed with corn plants will indeed decrease drastically, due to the shade of corn plants so that (Zhang et al., 2020; Bi & Zhou, 2021). But in this research, observation was only carried out for 4 weeks so that the growth and development of the beans were not disturbed. Competition for CO_2 in this interspecies competition between corn and beans can occur although in general in nature this competition is rare. CO_2 fixation in C3 plants will quickly become saturated at a relatively lower light intensity compared to the C4 type. C4 plants will use water more efficiently than C3 plants and this makes them more competitive than C3 plants (Kukal & Irmak, 2020; Sibret et al., 2021).

Corn Leaf Increase

The increase in corn leaves in different habitats was found to have additional leaves in habitats exposed to light and peraparia every week with an average increase of 1-2 leaves (Figure 5 and Figure 6), while in corn in shaded habitats there was a decrease in the number of leaves because there were corn leaves that were eaten by grasshopper pests, besides that there were also leaves that shrunk, withered and blackened followed by stems that slowly blackened and died so that the leaf gradient in the shaded habitat decreased.

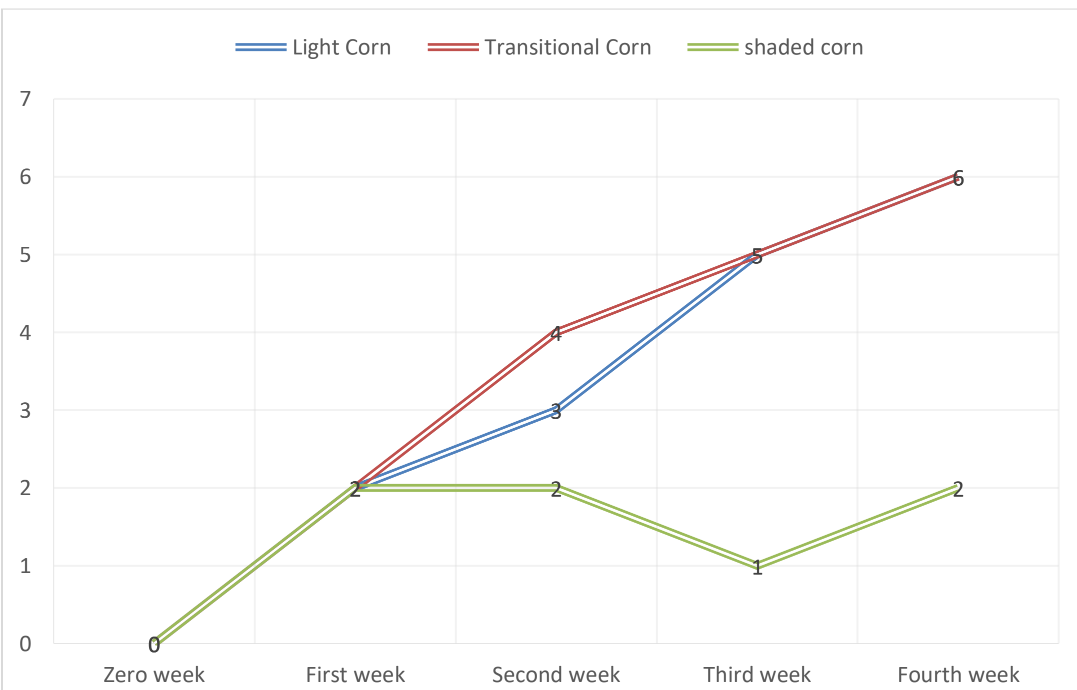

Figure 5. The number of corn leaf additions

Leaf growth in beans is greatly influenced by light factors as seen in the graph that leaf growth in the treatment of habitats exposed to the highest light when compared to leaf growth in transitional habitats and shaded habitats is thought to be related to the ability to maximize metabolism in light-exposed habitats that utilize sunlight in the process of photosynthesis (Janeeshma et al., 2022; Viji, 2020).

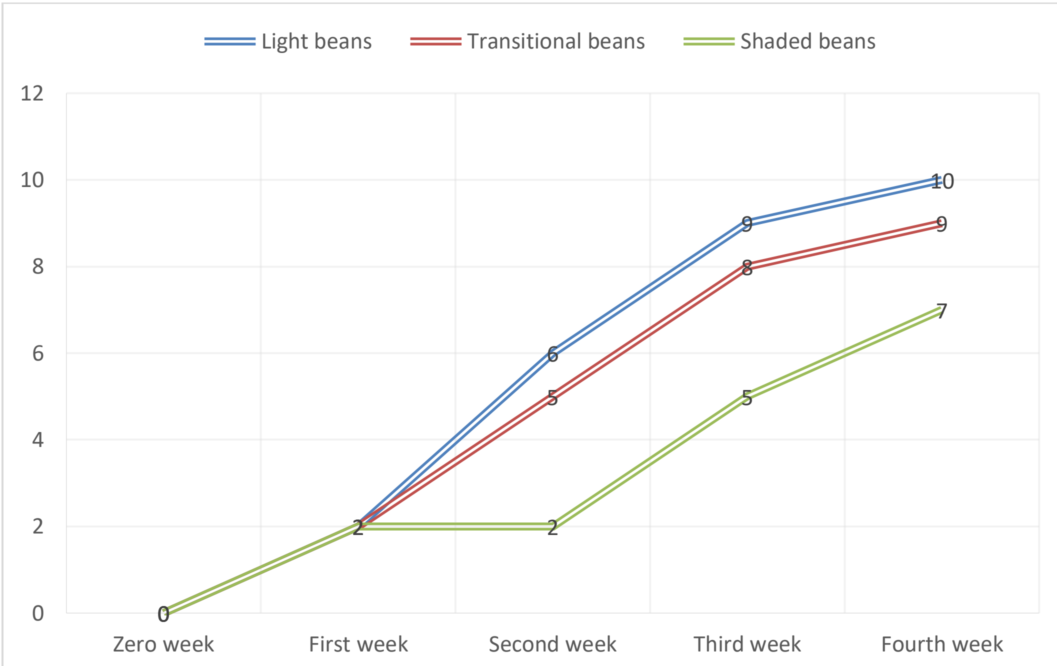

Figure 6. The number of peanut leaf additions

Statistical Analysis

Data analysis of various fingerprint results of the influence of plant composition in polybags and light in the face of plant growth.

Tests of Between-Subjects Effects

Dependent Variable: Growth Power

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1135.000A	13	87.308	3.604	0.004
Intercept	2150.074	1	2150.074	88.765	0.000
Plant Composition	297.736	3	99.245	4.097	0.019
Light Factor	409.843	2	204.921	8.460	0.002
Plant Composition*Light Factor	391.967	6	65.328	2.697	0.041
Deuteronomy	35.453	2	17.727	0.732	0.492
Error	532.884	22	24.222		
Total	3817.958	36			
Corrected Total	1667.884	35			

The results of the ANOVA test on the growth data of peanut and corn plants at various levels of competition showed that the influence of light on the growth of each plant was affected by the cahay in all treatments, namely in the location exposed to light, switching and in the shade, this can also be seen from the height growth of plants every week. Meanwhile, in the increase in plant leaves in different habitats, the treatment of exposure to light, switching and shade did not have a significant effect.

Plant Composition Against Dayat Grow

Duncana,b

Plant Composition	N	Subset	
		1	2
KC	9	5.268	
JC	9	6.037	
KG	9	7.014	
JA	9		12.592
Sig.		0.485	1.000

Light factor on growth power

Duncana,b

Plant Composition	N	Subset	
		1	2
KC	9	5.268	
JC	9	6.037	
KG	9	7.014	
JA	9		12.592
Sig.		0.485	1.000

CONCLUSION

Plants respond differently at different levels of competition. Descriptively, the response given by corn plants to competition is relatively faster compared to peanut plants. The higher the level of competition for corn plants, the lower the growth rate. The closer the planting distance, the faster the growth will be because the competition will be greater and the lower part is shaded by the upper leaves, causing the plant to have to look for more light sources in the upper way. Meanwhile, based on the results of statistical tests, there is a real influence on the difference in habitat exposure to light, switching and shade on the increase in plant yield in all treatments, so it can be concluded that intraspecies and interspecies corn and beans are very determined by sunlight because it is an essential factor in the photosynthesis process to produce energy.

REFERENCES

Asaeda, T., Rashid, M. H., Liping, X., Vamsi-Krishna, L., Barnuevo, A., Takeuchi, C., & Rahman, M. (2023). The distribution of submerged macrophytes in response to intense solar radiation and salinity reveals hydrogen peroxide as an abiotic stress indicator. *Scientific Reports*, *13*(1), 4548.

Badiani, M., Raschi, A., Paolacci, A. R., & Miglietta, F. (2023). Plants responses to elevated CO2; a perspective from natural CO2 springs. In *Environmental pollution and plant responses* (pp. 45–81). Routledge.

Begon, M., & Townsend, C. R. (2021). *Ecology: From individuals to ecosystems*. John Wiley & Sons.

Bi, Y., & Zhou, H. (2021). Changes in peanut canopy structure and photosynthetic characteristics induced by an arbuscular mycorrhizal fungus in a nutrient-poor environment. *Scientific Reports*, *11*(1), 14832.

Chamovitz, D. (2020). *What a plant knows: A field guide to the senses: Updated and expanded edition*. Scientific American/Farrar, Straus and Giroux.

Collinge, D. B., Jensen, D. F., Rabiey, M., Sarrocco, S., Shaw, M. W., & Shaw, R. H. (2022). Biological control of plant diseases–What has been achieved and what is the direction? *Plant Pathology*, *71*(5), 1024–1047.

Gårdmark, A., & Huss, M. (2020). Individual variation and interactions explain food web responses to global warming. *Philosophical Transactions of the Royal Society B*, *375*(1814), 20190449.

Gavrilescu, M. (2021). Water, soil, and plants interactions in a threatened environment. *Water*, *13*(19), 2746.

Huber, M., Nieuwendijk, N. M., Pantazopoulou, C. K., & Pierik, R. (2021). Light signalling shapes plant–plant interactions in dense canopies. *Plant, Cell & Environment*, *44*(4), 1014–1029.

Huong, N. T. M., Hoai, P. T. T., Thao, P. T. H., Huong, T. T., & Chinh, V. D. (2022). Growth stimulation, phosphate resolution, and resistance to fungal pathogens of some endogenous fungal strains in the rhizospheres of medicinal plants in Vietnam. *Molecules*, *27*(16), 5051.

Janeeshma, E., Johnson, R., Amritha, M. S., Noble, L., Aswathi, K. R., Telesiński, A., Kalaji, H. M., Auriga, A., & Puthur, J. T. (2022). Modulations in chlorophyll a fluorescence based on intensity and spectral variations of light. *International Journal of Molecular Sciences*, *23*(10), 5599.

Kukal, M. S., & Irmak, S. (2020). Characterization of water use and productivity dynamics across four C3 and C4 row crops under optimal growth conditions. *Agricultural Water Management*, *227*, 105840.

Leopold, A. C. (2022). *Auxins and plant growth*. Univ of California Press.

Levine, J. I., Levine, J. M., Gibbs, T., & Pacala, S. W. (2022). Competition for water and species coexistence in phenologically structured annual plant communities. *Ecology Letters*, *25*(5), 1110–1125.

Li, D., Shi, G., Kong, W., Wang, S., & Chen, Y. (2020). A leaf segmentation and phenotypic feature extraction framework for multiview stereo plant point clouds. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *13*, 2321–2336.

Lind, L., Eckstein, R. L., & Relyea, R. A. (2022). Direct and indirect effects of climate change on distribution and community composition of macrophytes in lentic systems. *Biological Reviews*, *97*(4), 1677–1690.

Mackenzie, A. M., Smith, H. E., Mould, R. R., Bell, J. D., Nunn, A. V., & Botchway, S. W. (2024). Rooting out ultraweak photon emission a-mung bean sprouts. *Journal of Photochemistry and Photobiology*, *19*, 100224.

Mallard, F., Le Bourlot, V., Le Coeur, C., Avnaim, M., Péronnet, R., Claessen, D., & Tully, T. (2020). From individuals to populations: How intraspecific competition shapes thermal reaction norms. *Functional Ecology*, *34*(3), 669–683.

Mascarenhas, R., Mathur, T., Maheshwari, J., & Nagella, P. (2023). Interaction of Nanomaterials with Plant Macromolecules: Nucleic Acid, Proteins and Hormones. In *Nanomaterial Interactions with Plant Cellular Mechanisms and Macromolecules and Agricultural Implications* (pp. 231–271). Springer.

Mazzoni-Putman, S. M., Brumos, J., Zhao, C., Alonso, J. M., & Stepanova, A. N. (2021). Auxin interactions with other hormones in plant development. *Cold Spring Harbor Perspectives in Biology*, *13*(10), a039990.

Nguyen, J., Lara-Gutiérrez, J., & Stocker, R. (2021). Environmental fluctuations and their effects on microbial communities, populations and individuals. *FEMS Microbiology Reviews*, *45*(4), fuaa068. https://doi.org/10.1093/femsre/fuaa068

Ode, P. J., Vyas, D. K., & Harvey, J. A. (2022). Extrinsic inter-and intraspecific competition in parasitoid wasps. *Annual Review of Entomology*, *67*(1), 305–328.

Pierik, R., & Ballaré, C. L. (2021). Control of plant growth and defense by photoreceptors: From mechanisms to opportunities in agriculture. *Molecular Plant*, *14*(1), 61–76.

Pik, D., Lucero, J. E., Lortie, C. J., & Braun, J. (2020). Light intensity and seed density differentially affect the establishment, survival, and biomass of an exotic invader and three species of native competitors. *Community Ecology*, *21*(3), 259–272.

Postma, J. A., Hecht, V. L., Hikosaka, K., Nord, E. A., Pons, T. L., & Poorter, H. (2021). Dividing the pie: A quantitative review on plant density responses. *Plant, Cell & Environment*, *44*(4), 1072–1094.

Prati, S., Henriksen, E. H., Smalås, A., Knudsen, R., Klemetsen, A., Sánchez-Hernández, J., & Amundsen, P.-A. (2021). The effect of inter-and intraspecific competition on individual and population niche widths: A four-decade study on two interacting salmonids. *Oikos*, *130*(10), 1679–1691.

Rehling, F., Sandner, T. M., & Matthies, D. (2021). Biomass partitioning in response to intraspecific competition depends on nutrients and species characteristics: A study of 43 plant species. *Journal of Ecology*, *109*(5), 2219–2233.

Sheldrake, A. R. (2021). The production of auxin by dying cells. *Journal of Experimental Botany*, *72*(7), 2288–2300.

Sibret, T., Verbruggen, W., Peaucelle, M., Verryckt, L. T., Bauters, M., Combe, M., Boeckx, P., & Verbeeck, H. (2021). High photosynthetic capacity of Sahelian C3 and C4 plants. *Photosynthesis Research*, *147*(2), 161–175.

Stephan, P., Bramon Mora, B., & Alexander, J. M. (2021). Positive species interactions shape species' range limits. *Oikos*, *130*(10), 1611–1625.

Uchmański, J., Niewolski, M., & Janiszewski, J. (2023). Interspecific competition in perennial sedentary organisms: An individual-based model. *Population Ecology*, *65*(1), 38–53.

van Kleunen, M., Brumer, A., Gutbrod, L., & Zhang, Z. (2020). A microplastic used as infill material in artificial sport turfs reduces plant growth. *Plants, People, Planet*, *2*(2), 157–166.

Vidak, M., Lazarević, B., Javornik, T., Šatović, Z., & Carović-Stanko, K. (2022). Seed water absorption, germination, emergence and seedling phenotypic characterization of the common bean landraces differing in seed size and color. *Seeds*, *1*(4), 324–339.

Viji, M. M. (2020). *Physiological and biochemical studies in cluster bean (Cyamopsis tetragonoloba (L.) Taub) as influenced by light and moisture stress*. Department Of Plant physiology, College Of Agriculture, Vellayani.

Vukeya, L. R., Mokotjomela, T. M., Malebo, N. J., & Oke, S. (2021). Interspecific competition in germination of bird-dispersed seeds in a habitat with sparse tree vegetation in South Africa. *Botanical Studies*, *62*(1), 10.

Yulianah, I., Waluyo, B., & Ashari, S. (2020). Variation in morphological traits of a selection of Indonesian winged bean accessions (Psophocarpus tetragonolobus) and its analysis to assess genetic diversity among accessions. *Biodiversitas Journal of Biological Diversity*, *21*(7).

Zhang, G.-C., Dai, L.-X., Hong, D., Ci, D.-W., Ning, T.-Y., Yang, J.-S., Zhao, X.-H., Yu, H.-Q., & Zhang, Z.-M. (2020). Response and adaptation to the accumulation and distribution of photosynthetic product in peanut under salt stress. *Journal of Integrative Agriculture*, *19*(3), 690–699.

Zhang, N., Nunan, N., Hirsch, P. R., Sun, B., Zhou, J., & Liang, Y. (2021). Theory of microbial coexistence in promoting soil–plant ecosystem health. *Biology and Fertility of Soils*, *57*, 897–911.

Zhao, B., Liu, Q., Wang, B., & Yuan, F. (2021). Roles of phytohormones and their signaling pathways in leaf development and stress responses. *Journal of Agricultural and Food Chemistry*, *69*(12), 3566–3584.