Crimson Publishers
Wings to the Research

Mini Review

Benefits of Intercropping Legumes with Cereals

Tamer Ibrahim Abdel-Wahab[1]*, Sherif Ibrahim Abdel-Wahab[1] and Eman Ibrahim Abdel-Wahab[2]

[1]Crop Intensification Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt

[2]Research Institute, Agricultural Research Center, Giza, Egypt

ISSN: 2694-4391

***Corresponding author:** Tamer Ibrahim Abdel-Wahab, Crop Intensification Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt

Submission: March 01, 2019

Published: April 16, 2019

Volume 1 - Issue 2

How to cite this article: Tamer I Abdel-Wahab, Sherif I Abdel-Wahab, Eman I Abdel-Wahab.. Benefits of Intercropping Legumes with Cereals. Int J Conf Proc.1(2). ICP.000510.2019.
DOI: 10.31031/ICP.2019.01.000510

Abstract

Reducing use of mineral nitrogen (N) fertilizer is one of the potential ways to reverse land degradation and ultimately increase the productivity of degrading soils of Egypt. We found that intercropping legume with cereal species in the same row can increase efficiency of photosynthetic process in legumes and reduce mineral N fertilizer inputs in cereals. Hence, intercropping culture can maintain agro-ecosystem without air, soil and water pollution.

Keywords: Intercropping; Ecosystem; Legumes; Cereals; Mineral N fertilization

Introduction

Special attention has been directed towards increasing crop productivity per unit area in Egypt. There is some legumes such as peanut (*Arachis hypogaea* L), soybean (*Glycine max* L) and cowpea (*Vigna unguiculata* L) are grown in the summer. These legumes lack chlorophylls in vascular bundle sheath cells, while cereals such as maize (Zea mays L), sorghum (*Sorghum bicolor* L) or sugar cane (*Saccharum officinarum* L) does. These cereals have a higher photosynthetic rate than legumes, especially under high temperature and light intensity during summer season. Several studies reported that C_4 crops have higher competitive ability over plants possessing the common C_3 carbon fixation pathway under intercropping conditions (Sayed Galal et al., 1984; El-Habbak, 1985; Sayed Galal and Metwally, 1986; Zohry, 1994; El-Gergawy et al., 1995; El-Douby et al., 1996; Abou-Kresha et al. 1997; Hussein et al., 2000; Metwally et al., 2003 and 2009; Abdel-Galil et al., 2014; Abdel-Wahab and Abdel-Rahman, 2016; Hefny et al., 2017; Morsy et al., 2017 and Metwally et al., 2018). [1-19].

This is because these cereals lack photo-respiratory carbon dioxide (CO_2) loss. CO_2 is the gas that plants need for photosynthesis where photosynthesis of these legumes is limited by CO_2. Certainly, adenosine tri phosphate (ATP) and nicotinamide adenine dinucleotide phosphate (NADPH) formed in the light reactions of photosynthesis are used to convert CO_2 into hexoses and another organic compound. The cereals use a biochemical pump to concentrate CO_2 at the locations within the leaf where the ribulose 1.5-bisphosphate carboxylase/oxygenase (RUBISCO) enzyme mediates incorporation of CO_2 by the Calvin-Benson photosynthetic cycle. Since CO_2 concentrations are already high within the bundle sheath cells, increasing atmospheric CO_2 concentrations above current levels has little direct effect on photosynthetic rates for these cereals. Accordingly, shading of the cereals can contribute largely in increase the capacity of the Calvin cycle and the thylakoid reactions to regenerate ribulose bisphosphate (RuBP) that consumed by RUBISCO in leaves of intercropped legumes under hot summer season where temperature reaches 40-45 °C. Naturally, legumes have the unique reaction sequences for CO_2 reduction to triose phosphates and the associated reductive pentose phosphate pathway-all of which must be coordinately regulated to avoid wasteful futile cycling and to ensure proper allocation of carbon to energy production and synthesis of starch and sucrose (Figure 1). Consequently, it is possible to say that intercropping legumes with cereals in the same row could increase the capacity of starch and sucrose synthesis to consume triose phosphates and regenerate inorganic phosphate for photo-phosphorylation.

At saturating light intensity, moderate temperature (25-30 °C) and elevated CO_2, the capacity of RuBP regeneration or the photophosphorylation regeneration capacity limits the rate of net CO_2 assimilation in C_3 plants [18].

On the other hand, the legumes participate with bacteria that live in their nodules by fixing atmospheric N, chemically reducing it to a form that can be taken up and used by plants. Under elevated CO_2 conditions, legumes may be able to shunt excess carbon to root nodules where it can serve as a carbon and energy source for the bacterial symbionts. Therefore, legumes could be able to exchange the excess carbon for N and thereby maximizing the benefits of elevated atmospheric CO_2. Hence, intercropping such legumes with cereals is the commonest type of intercropping that the presence of legumes must provide a net N benefit to agro-ecosystem. It is important to mention that there is two points should be considered when growing legumes with cereals in the same row to obligate cereals to take advantage of fixed N by the legumes. The first point is planting date of the intercrops where the legumes should be grown three weeks earlier before the cereals that using fixed N in their metabolic process later. The second point is mineral N fertilizer rate of cereals through adding two-thirds of recommended mineral N fertilizer to the cereals for encouraging cereal roots to more penetrate into soil layers and absorbing more N from the rhizosphere of intercrops. Particularly, low mineral N fertilizer of cereals is enhancing nodulation of adjacent legume roots and leading to promotion of N-fixing bacteria growth nearer to rhizosphere of cereal roots. Plant growth promoting bacteria especially rhizobia can play an important role in growth promotion of cereals [3,8]. Accordingly, it is expected that intercropping legumes with cereals in the same row will minimize mineral N fertilizer rates and in turn small losses of reactive N to the environment will move nitrate to ground water or surface waters and emissions of nitrous gases to the atmosphere.

Conclusion

Intercropping N-fixing crops with cereals in the same row increased the capacity of starch and sucrose synthesis in cereals with reducing N leaching and gas emissions.

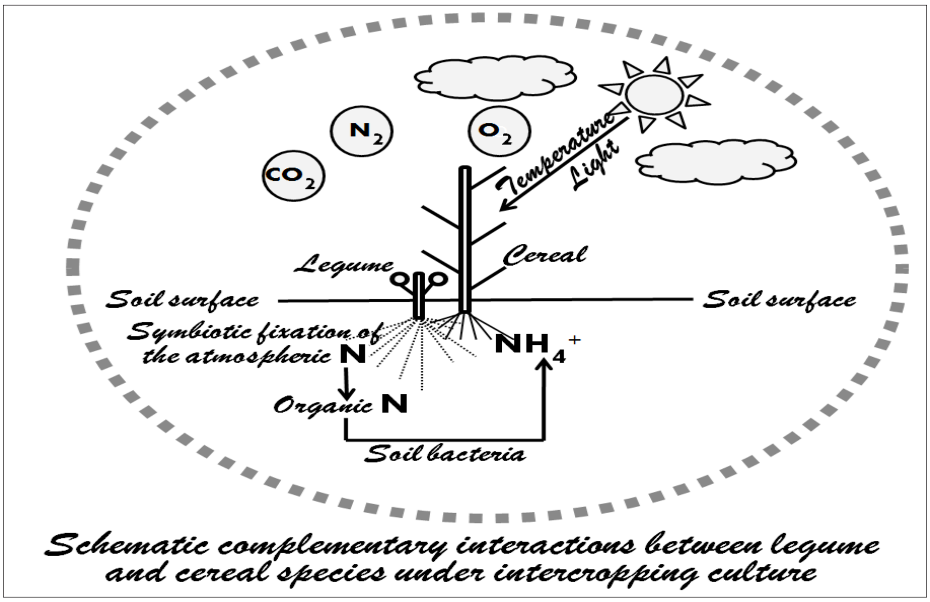

Figure 1: Schematic complementary interactions between legume and cereal species under intercropping culture.

References

1. Abdel-Galil AM, Abdel-Wahab ShI and Abdel-Wahab TI. 2014. Compatibility of some maize and soybean varieties for intercropping under sandy soil conditions. Proceeding of International Soybean Research Conference, 22 – 24 February 2014, India.
2. Abdel-Wahab TI and Abdel-Rahman Rehab A (2016) Response of some soybean cultivars to low light intensity under different intercropping patterns with maize. International Journal of Applied Agricultural Sciences 2(2): 21-31.
3. Abdel-Wahab ShI, El Sayed WM and El Manzlawy Amal (2016) Influences of some preceding winter crops and nitrogen fertilizer rates on yield and quality of intercropped maize with cowpea. American Journal of Experimental Agriculture 11(6): 1-19.
4. Abou-Kresha MA, Zohry AA, Farghly BS (1997) Effect of intercropping some field crops with sugar cane on yield and its components of plant cane and third ratton. Mansoura Journal of Agricultural Sciences 22(12): 41-63.
5. El-Gergawy ASS, Saif M, El-Amari TS, Geddawy IH (1995) Intercropping soil oil crops with spring planted sugar cane in middle Egypt. Egyptian Journal of Applied Sciences 10(5): 225-234.
6. El-Douby KA, El-Habbak KD, Khalil HE, Attia Zahira M (1996) Effect of some intercropping patterns on growth and yield of maize and soybean. Annals of Agricultural Sciences, Moshtohor 34(3): 919-933.
7. El-Habbak KD (1985) Studies on competition and intercropping in maize and soybean. Ph D Thesis, Faculty of Agriculture, Moshtohor, Zagazig University, Egypt.
8. El-Shamy Moshira A, Abdel-Wahab TI, Abdel-Wahab ShI, Ragheb SB (2015) Advantages of intercropping soybean with maize under two maize plant distributions and three mineral nitrogen fertilizer rates. Advances in Bio Science and Bio Engineering 3(4): 30-48.
9. Hefny YA, Safina SA, Sheha AM (2017) Evaluation of intercropping groundnut (Arachis hypogaea L) with maize under different plant densities in sandy soils. Egyptian Journal of Agronomy 39(1): 9-18.

10. Hussein Samira MA, Shams SA, El Melegy MA (2002) Effect of some intercropping patterns and foliar application with nutrients mixture on yield of maize and peanut. Annals of Agricultural Sciences 40(3): 1427-1447.
11. Lamlom MM, Abdel-Wahab ShI, Abdel-Wahab TI and Ibrahim MAA (2018) Crop interference effects of some winter and summer field crops on Egyptian cotton characters. Advances in Crop Science and Technology 6(5): 394.
12. Metwally AA, Shafik MM, El-Metwally El-MA, Safina SA (2003) Tolerance of some soybean varieties to intercropping. Proceedings of 10th Conference of Agronomy, Suez Canal University, Faculty of Environmental Sciences, EL Arish, Egypt.
13. Metwally AA, Shafik MM, El-Habbak KE, Abdel-Wahab ShI (2009) Yield and land equivalent ratio of intercropped soybean with maize under different intercropping patterns and high population densities. Egyptian Journal of Agronomy 31(2): 199-222.
14. Metwally AA, Safina SA, Abdel-Wahab TI, Abdel-Wahab ShI, Hefny YA (2018) Productivity of soybean varieties under intercropping culture with corn in Egypt. Soybean Research 16(1&2): 63-77.
15. Morsy AM, Elwan AM, Eissa Nadia MA (2017) Studies on intercropping soybean with sugar cane under different nitrogen levels. Egyptian Journal of Agronomy 39(2): 221-237.
16. Sayed Galal Jr, Abdalla MMF, Metwally AA (1984) A step forward identifying other soybean cultivars suitable for intercropping with corn. World soybean Res Con, Ames, Iowa, US.
17. Sayed Galal Jr, Metwally AA (1986) Science in practice. In: Proceedings of the Second Conference in Agronomy, Alexandria University, Egypt 1: 489-503.
18. Sharkey TD (1985) O_2-insensitive photosynthesis in C_3 plants its occurrence and a possible explanation. Plant Physiology 78: 71-75.
19. Zohry AA (1994) Effect of intercropping soybean with sugar cane. Ph D Thesis, Faculty of Agriculture, Al Azhar University, Egypt.