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ARBUSCULAR MYCORRHIZAL FUNGI IMPROVED THE GROWTH AND YIELD PRODUCTIVITY OF *LENS ESCULENTA* UNDER THE INFLUENCE OF POULTRY LITTER

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ABSTRACT

Arbuscular mycorrhizal fungi (AMF) is one of the important micro-bionta, which has a huge influence on plant nutrients. In the past, the application of poultry litter has been well studied in various crops such as wheat, maize and sugarcane. However, the poultry litter under AMF has been poorly studied in some crops including *lens Esculenta*. In order to investigate the effect of AMF with poultry litter on *lens Esculenta*, an experiment was conducted in the year of 2020-2021 in Bacha Khan University, Pakistan. AMF increased plant biomass, as well as biochemical and microbial status, according to the results. The control parameters were compared to the treated plant under all conditions i.e treatment (T1) and treatment (T2), where treated plants, the *Lens esculenta* s show the maximum growth. The plant height in T1 is 16.40% with compared to T2 is 17.40%. 2) No of leaves in T1 is 10.16% with compared to T2 44.8%. The leaf area in T1 is 0.4952% with compared to T2 is 0.6018%. The ratio of chlorophyll a content in T1 is 0.112 with compared to T2 is 0.275, the ratio of chlorophyll b in T1 is 0.341 with compared to T2 0.538. T1 has a fresh shoot weight of 12.35gm compared to T2's 27.79gm, while T1 has a dry shoot weight of 2.99gm compared to T2's 6.3gm. The weight of fresh root in T1 is 0.81gm vs 1.01gm in T2, while the weight of dried root in T1 is 0.28gm vs 0.34gm in T2. These results indicates the response of AMF was high with poultry littler, this indicates the AMF could increase the *Lens esculenta's* growth and productivity under poultry littler.

Keywords: Arbuscular mycorrhizal fungi, Lens esculenta, Growth, yield, Poultry litter

INTRODUCTION

Arbuscular mycorrhizal fungi (AMF) is the soil borne fungi which form a symbiotic relationship with most of the plants, by which both partner share and exchange the foods and shelter (Khan *et al*.., 2020). In the recent reports, AMF has been explored and found to be involved in various processes of plant during plant growth and development (Yaseen *et al*., 2016). AMF helps plants during nutrients uptaking and improve the availability of nutrients in rhizosphere soil. The favourable effects of AMF on plant performance and soil health are vital for the sustainable management of agricultural ecosystems. AMF maintains the balance of micro-ecology in the soil, stabilizes soil aggregates, and prevents plant disease infection (Pawaar *et al.,* 2012). According to several recent research, inoculating AMF at an early stage improves plant development, which is beneficial for establishment. AMF has also been shown in several studies to have an important role in the creation of soil ecosystems and the connection between microorganisms. However, the method by which AMF affects plant development by increasing nutrients and modifying microorganisms is yet unknown.

Since the dawn of civilization, poultry litter has been utilized to improve soil quality; in some cases, these

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fertilizers were the only source of nitrogen for crop development (Samanhudi, 2014. Despite the fact that they contain relatively low concentrations of nutrients and handling them is labour demanding, they are increasingly being used as a nutrition source on many farms in place of inorganic fertilizers (Blum, 1996). They have a considerable advantage over inorganic fertilizers in terms of their good impact on soil physical qualities and the ease with which they dissolve inside soil (Rashid *et al.,* 2007). Because of its high nitrogen concentration, poultry litter is considered one of the most attractive manures (Song *et al.,* 2010). Poultry litter serves as a soil amendment by adding organic matter, which helps enhance the moisture and nutrient retention of the soil (Wilkinson *et al.,* 2011). The usage of poultry litter, particularly poultry litter, aids in agricultural yield and soil fertility enhancement (Moore *et al.,* 1995). Phosphorus, high nitrogen, critical nutrients, and potassium are all found in poultry litter, making it an excellent organic fertilizer (Blum, 1996). Organic matter or manures in the form of organic fertilizer, according to several recent studies, can boost crop yields (Rashid et al., 2007). Organic farming has grown at a rapid rate over the previous decade, with yearly growth exceeding 20%. Poultry litter is a good and inexpensive source of soil fertility, but it includes a lot of human pathogens such *Campylobacter* spp., *Salmonella jejuni*, and *Listeria monocytogenes*, which can pollute the environment and cause foodborne illness outbreaks (Sims *et al.,* 1994; Wilkinson *et al.,* 2011). According to estimates, there will be no soil poultry litter reserves for sustainable agricultural production by the end of 2050, particularly in tropical and subtropical parts of the planet (Singh and Bijayath, 2006; Moore *et al.,* 1995). (Finlay, 2008).

The *Lens esculenta* is the world's fourth most significant pulse crop. India, Pakistan, China, Iran, and Bangladesh are the major *Lens esculenta* producing countries in Asia. *Lens esculenta* , after beans and chickpea, ranks third among grain legumes in terms of sowing area and output in Iran, with 189.7 thousand ha and 839.9 thousand tons, respectively (Ngodigha *et al.,* 2009). *Lens esculenta* is a legume that grows in the savannah region, the tropics, and the subtropics. It's also cultivated extensively throughout West and Central Africa. Its usefulness stems from its high protein content, capacity to withstand drought, and capacity to fix atmospheric nitrogen when grown in poor soil (Bolan *et al.,* 2010). *Lens esculenta* seeds are mostly used as a pulse, providing up to 30% protein (similar to those of peas and beans). This crop's output potential must be increased by a successful plant breeding program. The effectiveness of breeding programs is determined not only by genetic variety, but also by the amount of accessible nourishment in the soil (Chinivasagam *et al.,* 2010). The aim of this study was to see how poultry litter affected the growth and yield of *Lens esculenta* under arbuscular mycorrhizal fungi, and how these two applications affected the biomass and yield production of lens Esculenta.

MATERIALS AND METHODS

Experimental design: An experiment was conducted in experiment net house of Department of Botany Bacha Khan University Charsadda, Pakistan, during the winter season (2020-2021) in order to investigate the effect of poultry litter on the growth of lintel. Seeds of *Lens esculenta* s were supplied by National Agricultural Research Centre (NARC) Islamabad. Seeds for sowing were selected which were equal in size and healthy. The experiment was conducted to study the effect of poultry litter on the yield components of lintel at Department of Botany, Bacha Khan University Charsadda, Pakistan, during winter 2020. Seeds of *Lens esculenta* were sown in the plots selected in the Botanical Garden of Bacha Khan University Charsadda. The study is aimed at investigating the effect of poultry litter on the growth of lintel Therefore, poultry manure was obtained from local poultry farm at Nahaqi Daudzai Village Peshawar in the same local government where the poultry were under 5 weeks old. The manures were weighed 1kg. The applied manure was allowed to mix well for the T1. Seeds sown in 5cm deep in field.

Soil analysis: The soil of the experimental site was sandy loam and low in organic matte content, Nitrogen (0.05), Phosphorus (0.06), pH (6.8) and EC (0.15). The organic matter content of the soil is less than 1%. (RCBD) design was applied consisting of two fields. One was kept as control and other one were treated as experimental. Control was denoted by TO, while the remaining one labelled as T1 (Table.1). The seed of *Lens esculenta* variety (2009 was sown on 07 March, 2019 in a plot size of 6 x 4 having 2 rows 6-meter-long and 30 cm apart.

Table.1 Treatments

S/No	Treatments	
1)	T0	Control
2)	T1	AMF Soil+ Poultry Litter

Morphological traits: The following different parameters of *Lens esculenta* s were recorded in different treatments. I.e. plant height, number of leaves, plant fresh weight, plants dry weight, and the fresh weight of rhizomes. First irrigation was applied soon after emergence. Data were recorded on various growth and yield parameter.

Fresh and dry weight: The fresh weight of root and shoot was determined directly after harvesting by using electronic balance. For dry weight, shoots and roots were first dried in an open air oven at 72 ^{0}C for three days and their weight was determined.

Leaf area: Leaf width and leaf length of plants in all treatment were measured in (Cm) from each by using measuring tape. Leaf area was calculated as following (Shortall *et al.,* 1975).

$$\text{Leaf area (CM2)} = \frac{\text{Leaf length}}{\text{Leaf width}} \times 0.71$$

Soil Sampling and Root Extraction: In our field from the University Botany Lawn, root and soil samples of *Lens esculenta* plants were collected from our field randomly. 4-5 healthy *Lens esculenta* plants were collected at each pots along with rhizosphere soil and roots at vegetative stages. Roots and rhizosphere soil was dug out with a trowel at a depth of 0-15 cm after scrapping away the top 1 cm layer of soil. Samples were collected randomly from our field in each pots, pooled and homogenized. Soil samples along with secondary and tertiary roots of our field for 5 *Lens esculenta* plants were collected during course of investigation from 2019. Rhizosphere soil (about 200 gm) were air dried for 2 weeks, and then stored in sealed plastic bags at room temperature for further processes.

Assessment of roots colonization: The procedure of root colonization (Giovannatti and Mosse, 1980) was followed. It is + slides method. Three segments of roots of individual plant each proximately 1cm long were randomly selected for microscopic study.

$$\text{Percent colonization} = \frac{\text{Total number of colonized root segment}}{\text{Total number of root segment examined}} \times 100$$

Determination of chlorophyll contents: For the chlorophyll determination the following equipment's or materials were used.

Total chlorophyll was determined for the equation given by (Sim and Wu, 2010).

Total chlorophyll (mg/l) = (12.21 x A645) + (2.81 x B663)

Physiochemical Analysis of soil

A. Determination of soil PH: The PH value indicates the acidity and alkalinity of the soil and is a measure of the hydrogen ion activity of the soil water system. It is a critical soil attribute because it impacts the availability of nutrients, microbial activity, and soil physical state. The pH of soil water suspension was determined using Equiptronics PH meter as described by (Richardson *et al.,* 2002).

b. Determination of electrical conductivity (EC) of soil: An EC meter was used to test the electrical conductivity (EC) of soil samples (Richardson *et al.,* 2002).

c. Soil texture: The hydrometer technique was used to determine the texture of the soil, as reported by (Richardson *et al.,* 2002). Textural triangles were used to assess the amount of silt and clay in the soil, as well as the texture class (Hussain, 1989).

F. Chlorophyll content: The Chlorophyll content was calculated according to the method of (Holm, 1954).

RESULTS AND DISCUSSION

In the present studies influence of Poultry litter was studied on *Lens esculenta* plants treated with various level of poultry litter. The poultry litter were applied to the field before sowing in a field experiment. The common parameters which were studied for plant in different treatment are present below.

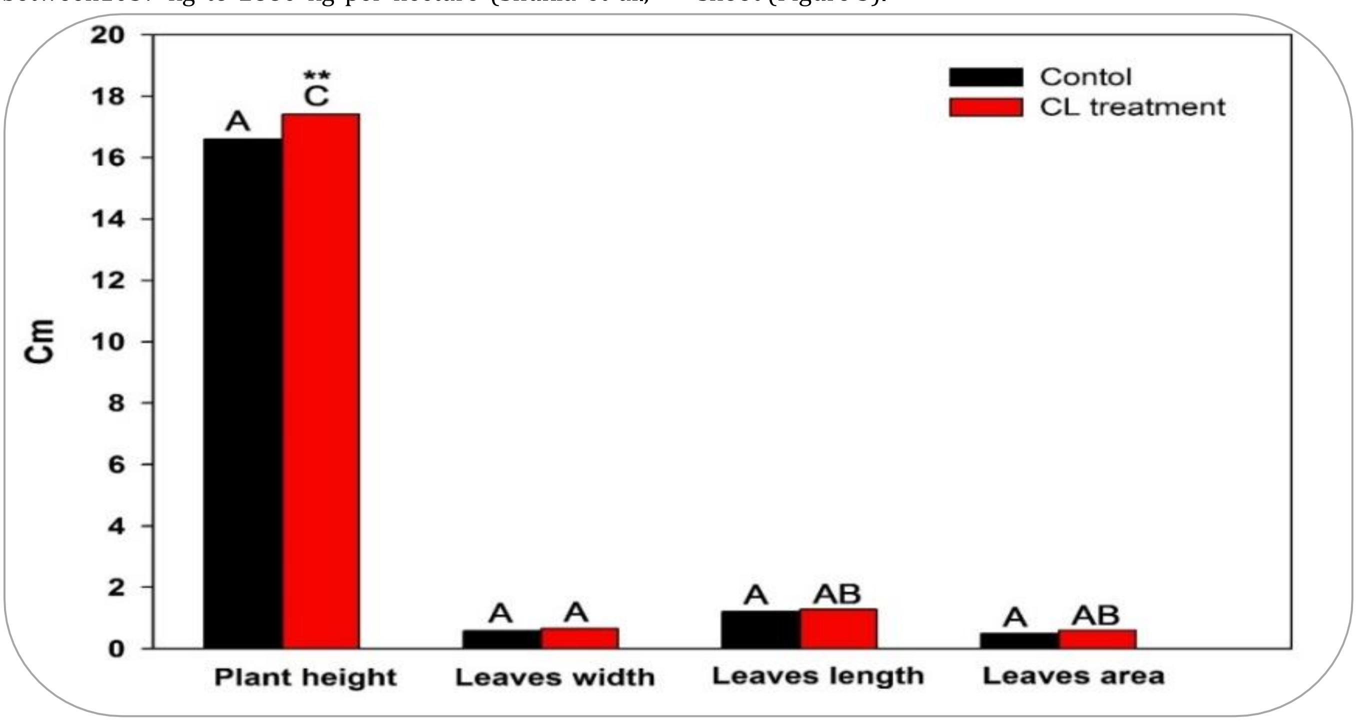
Agronomic parameter

Plant height: The results revealed that poultry litter had a greater impact on *Lens esculenta* plant height than the control group. Elongation of the shoot is aided by the application of 1 kg of poultry litter. On shoot length, the encouraging impact of poultry litter was more substantial. The condition of the poultry litter had a positive influence on the length of the shoots (Figure 3). The use of organic manure might result in the *Lens esculenta* plants growing taller (Figure 1). In general, organic manure application can help *Lens esculenta* development and productivity. On the basis of plant height, leaf number, and fresh weight, organic manure can boost *Lens esculenta* development and productivity. Experiments with tomato plants indicated that poultry dung is superior to the other manures, with 15 tons/ha organic manure producing the maximum plant fresh weight, followed by goat manure, buffalo dung, and cow dung. The use of poultry litter boosted soil fertility in this study, and the effect of poultry litter derived from birds provided probiotic-supplemented feed vs poultry litter acquired from birds administered antibiotic-supplemented feed on *Lens esculenta* growth and production was investigated. Poultry litter is reportedly being utilized to boost the production of numerous vegetables, legumes, and other crops. Many studies have showed that putting poultry manure to the fields increased the yield of lady finger (*Abelmoschus esculentus*), cucumber (*Cucumis sativus*), maize (*Zea mays*), and *Lens esculenta* (Moore *et al.,* 1995; Shortall and Liebhardt, 1975). The results of this study clearly showed the efficacy of poultry litter on soil fertility, plant growth and yield per hector as compared to negative control. In this study, maximum crop yield obtained was1243.93 kg per hector of (P) plot. The results are similar to the work that was reported earlier which showed the increase in yield of *Lens esculenta* crop after addition of poultry manure to soil and the increase of *Lens esculenta* ranged between1057 kg to 2880 kg per hectare (Shukla et al., 2011).

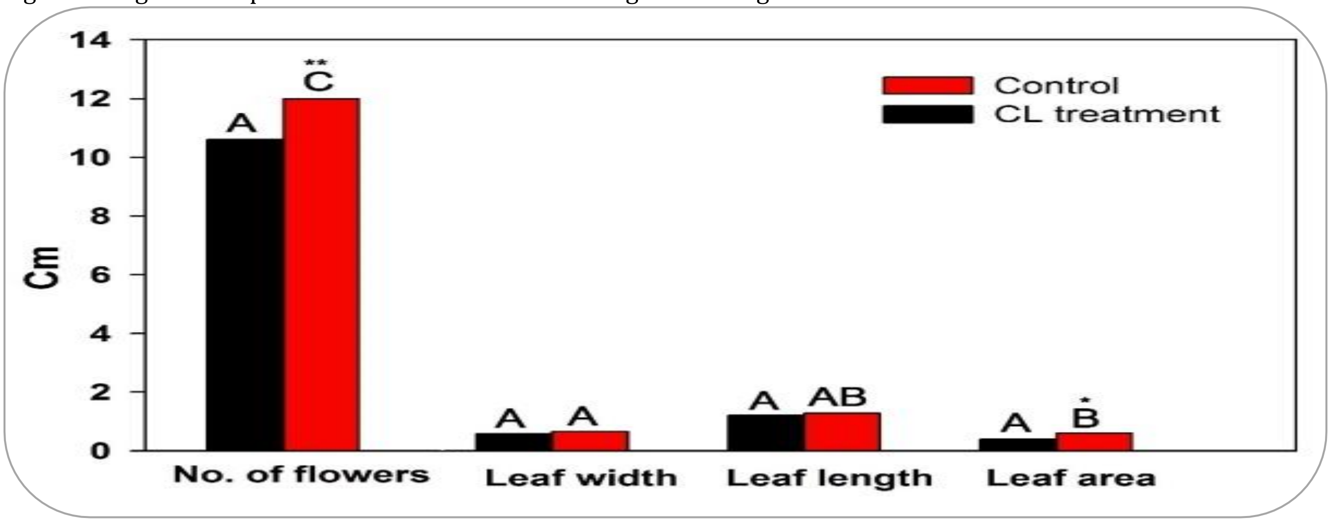
Number of leaves and leaf area: Leaf counts were taken in both the treatment and control groups. The reported number of leaves per plant impacts the capability for photosynthetic radiation interception per unit leaf area (Figure 1, 2). The production of new leaves depends on the availability of fertilizer, when comparing the effect of poultry litter on the leaf numbers, the highest leaf number was found in treated plant. The leaves width in treated plant is increased as compared to the control plant. The length of leaf in increased in treated plant as compared to control in (Figure 1, 2).

Flowering stage: The Result showed the flowers of *Lens esculenta* plant were increased under the condition of poultry litter. A clear difference in flowering stage was also observed between the treated and control. Application of the organic manure can give effect to the increasing the number of flowers of the *Lens esculenta* (Figure 2A). They indicate that as compared to no manure treatment, organic manure can enhance the quantity of *Lens esculenta* blooms. In general, organic manure treatment can help *Lens esculenta* development and productivity.

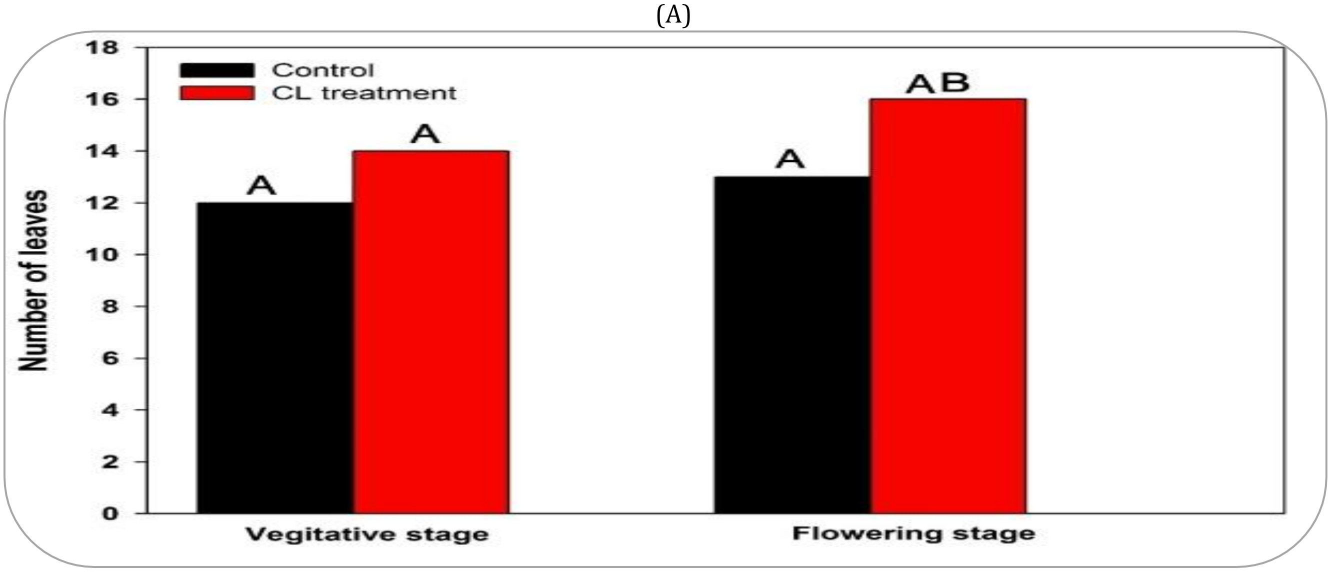
Weight of *Lens esculenta* dry shoot: Poultry litter greatly boosted the weight of dry shoots, according to the results. Under normal conditions, the treatment of seeds with poultry litter had no effect on the dry weight of the shoot (Figure 3).



Figures 1. Agronomic parameter of *Lens esculenta* at vegetative stage



(A)



(B)

Figure 2. A, B. Agronomic parameter of *Lens esculenta* at vegetative stage

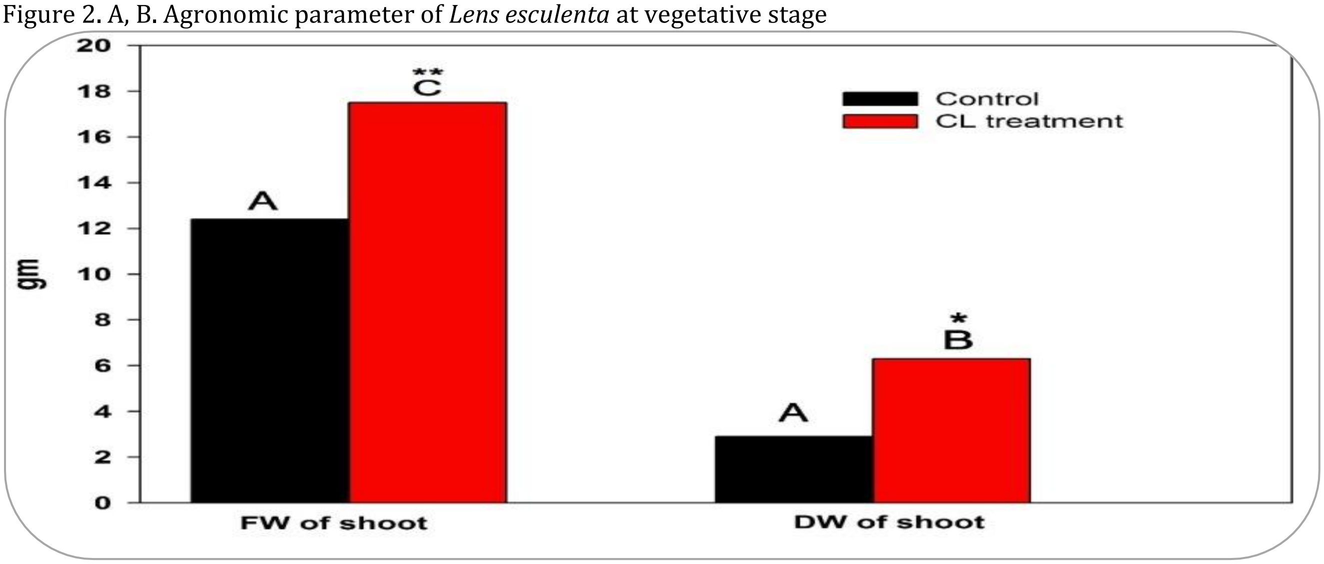


Figure 3. Fresh and dry weight of shoot *Lens esculenta* with and without AMF

Weight of fresh shoot and roots: Poultry litter significantly increased the weight of young shoots as compared to the control. (Figure 3). The weight of fresh roots of *Lens esculenta* was positively impacted by poultry litter, according to the ANOVA. Similarly, root fresh weight was maintained under poultry litter (Figure 4).

Weight of dry roots: In comparison to the control, poultry litter had a greater influence on the weight of dried roots. However, with poultry litter, the weight of dried roots was greatly increased (Figure 4).

Chlorophyll content: The ANOVA two-way analysis revealed that drought treatment resulted in a significant increase in leaf chlorophyll *a* content compared to control groups of plants. Seeds treated with poultry litter induced the formation of leaf chlorophyll 'a' in both normal and poultry litter conditions (Figure 5). Similarly after comparing the chlorophyll 'b' content of *Lens esculenta* plants grown in poultry litter to control plants, it was discovered that the plants grown in poultry litter had a higher chlorophyll 'b' content (Figure 5). Under all soil conditions, seeds treated with poultry litter enhanced the chlorophyll 'b' level in the leaf compared to controls.

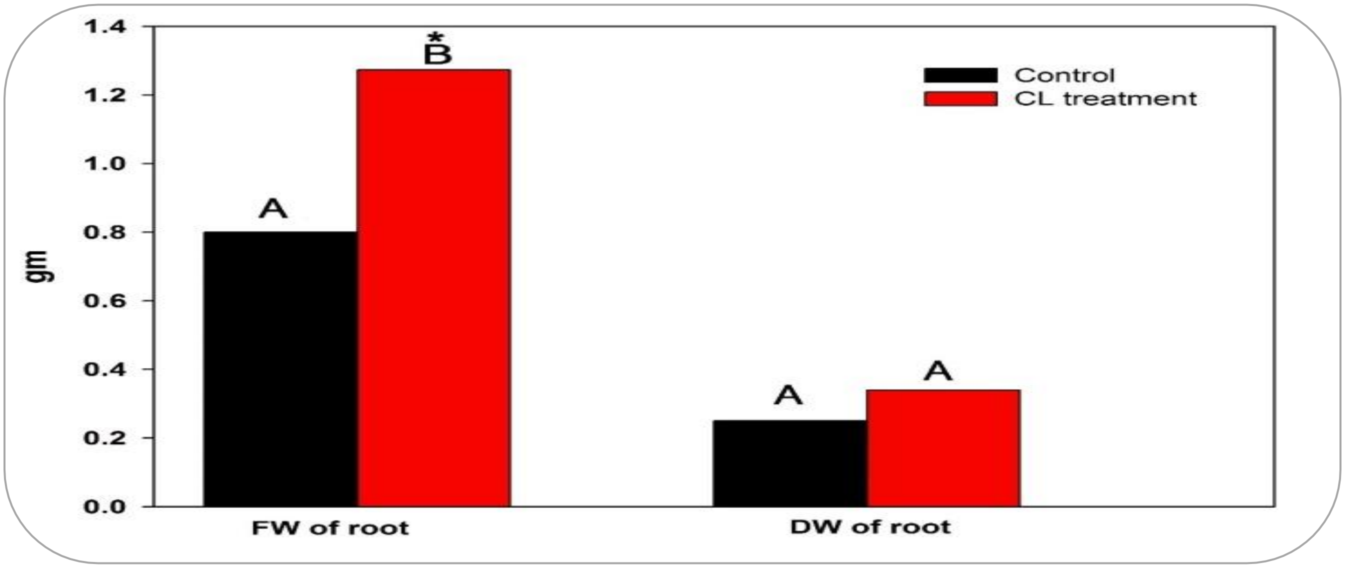


Figure 4. Comparison of control with treatment in fresh and dry weight of root

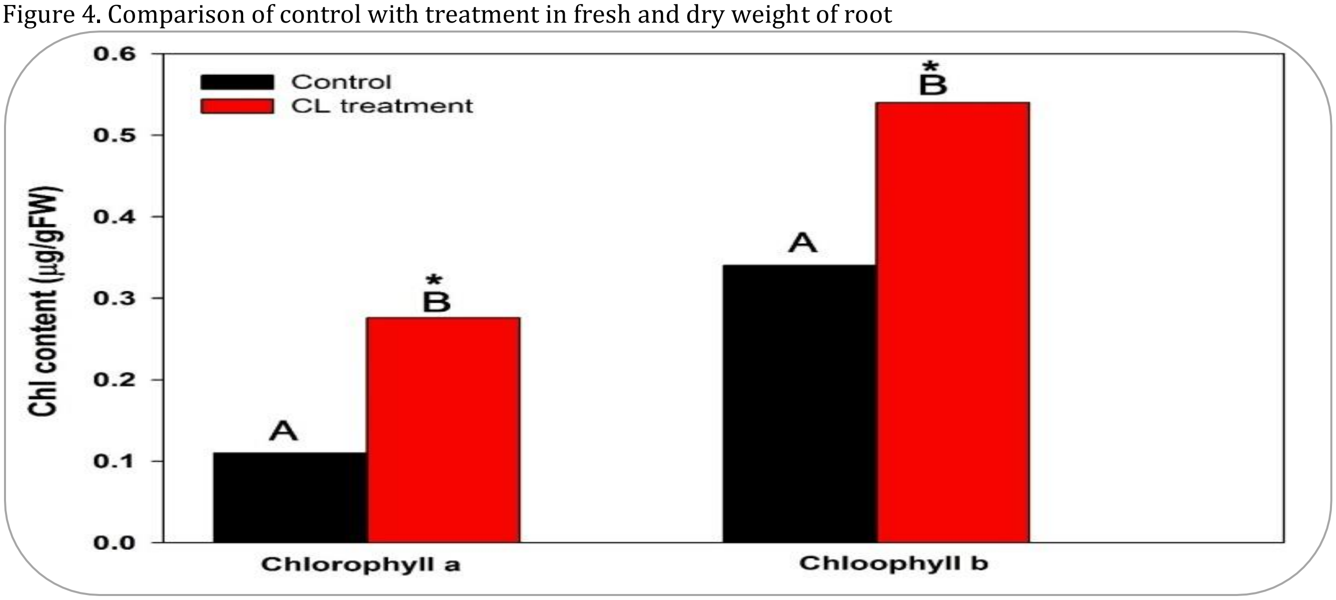


Figure 5. Comparison of control with treatment in chlorophyll content

Poultry litter and root colonization in *Lens esculenta:* In our study, we observed three type of root infection are recorded in *Lens esculenta's* root colonization i.e Arbuscular, Vesicles, Internal and External hyphae as shown in (Figure 6, 7). It has been noticed that with poultry littler the AMF colonization is healthier than control as shown in (Figure 7 A, B, C). Our result is similar with (Khan *et al.,* 2012), who reported the same AMF colonization for different plants under phosphorus and nitrogen addition. Similarly, Khan et al., 2020 has been reported that AMF spore increased the growth and root colonization in *leymus chinensis* under nitrogen addition, which is suggested that AMF could improve the growth a various plants under various condition. Some similar studies also investigated the effects of organic matter and existence of arbuscular mycorrhizal fungi characteristics. The root colonization of arbuscular mycorrhizal is given in the (Figure 6 A, B, C; 7 A, B, C).

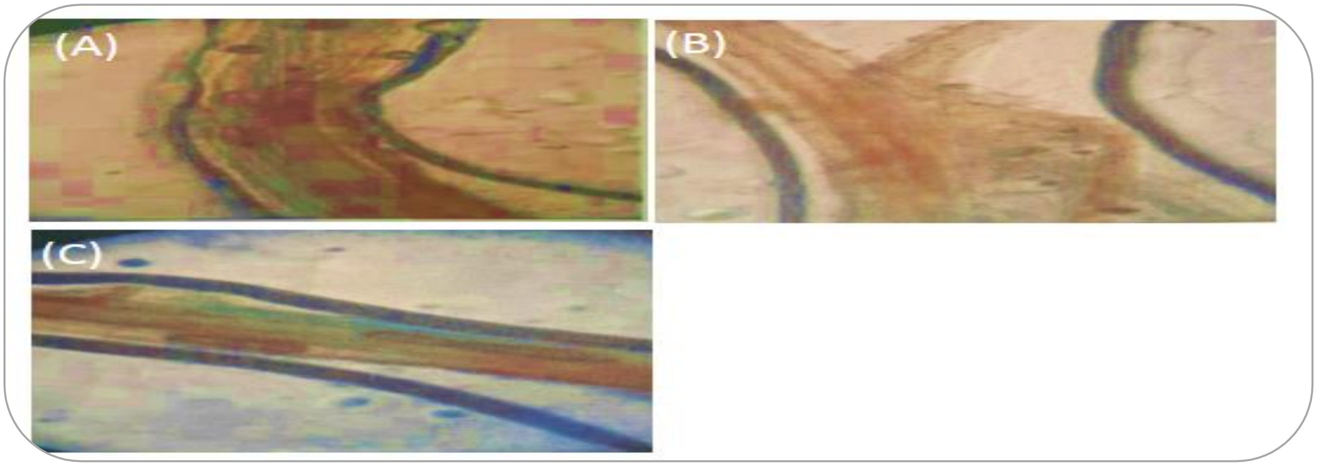


Figure 6. AMF colonization in *Lens esculenta* without poultry litter i.e. (A) Vesicales + Internal Hypha (B) Arbuscules + Vesicales (C) Oval Shaped Vesicales

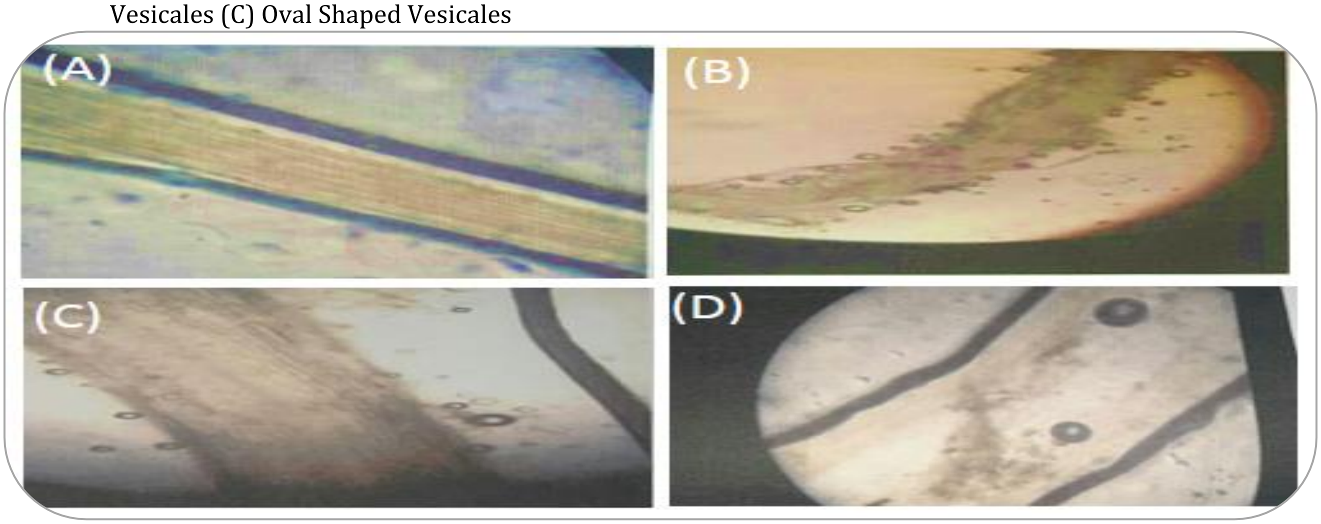


Figure 7. Root Colonization in treated plants. (A) Internal Hypha, (B) Vesicales, (C) Vesicales+Internal+External Hypha, (D) Vesicales + Arbuscules

CONCLUSION

The study concludes that the growth and production rates and productivity of AMF are increasing with and without poultry litters. AMF has a substantial impact on agricultural *Lens esculenta*'s characteristics with poultry litter. Furthermore, with poultry litter AMF increased the chlorophyll content and enhanced the nutrients. Although the poultry littler also have positive effect on the *Lens esculenta's* growth. Based on it, it is suggested that AMF with poultry litter could increase the agronomic parameters of *Lens esculenta* and its leads to have high yield and productivity. So, for the *Lens esculent's* crop, we recommended AMF with poultry littler, and it is expected to improve the crop and productivity in the future.

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Contribution of Authors:

Yaseen Khan	:	Generated the idea of research
Amir Sohail	:	Conducted research trails
Tabassum Yaseen	:	Helped in research
Khushnood U. Rehman	:	Wrote manuscript
Muhammad Noor	:	Reviewed manuscript
Kamran Akbar	:	Analyzed data