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Effects of Arbuscular Mycorrhizal Fungi (AMF) Inoculation on Proximate Analysis of Chickpea Varieties

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Abstract: A pot experiment was conducted to evaluate the effect of arbuscular mycorrhizal fungi (AMF) inoculation on different varieties of *Cicer arietinum* L. (Chana Punjab 2008, Chana Dasht and Chana bakar 2011). The experiment was carried out in completely randomized block design (RCBD) with AMF treatments and replications three times repeated under natural condition during Rabi season 2014-2015 at Department of Botany Bacha Khan University Charsadda, Khyber Pakhtunkhwa-Pakistan. The pots were filled with processed soil and each pot having 4Kg of phosphorus deficient soil (1.43 mg kg^{-1}). Size of each pot (23cm x 19.5cm). Some pots were inoculated with arbuscular mycorrhizal fungi and twenty seeds of chickpea were sown in each pot. The results show that arbuscular mycorrhizal fungi inoculation significantly increased proximate composition in Chickpea verities as compared to non-inoculated plants. Inoculated plants performed better when compared with control plants. Similarly it is also proved that Chickpea verities are more dependent on mycorrhizal inoculation under P-deficient condition for better survival.

Keywords: AMF Inoculation, Glomus Aggergatum, Glomus Fasciculatum, Glomus Mosseae and Sclerocystis Niger, Cicer Arietinum, Proximate Analysis

1. Introduction

Mycorrhiza is described as a mutual sharing of life, whereby the fungal is the major partner of the plant has the duty to supply food, growth hormones and protection of plants' root from pathogens and a fine plant will offer high energetic material to the fungus [1]. Arbuscular Mycorrhizal (AMF) symbiosis is formed by approximately 80% of the vascular plant species in all terrestrial biomes [2]. AMF establish a symbiotic relationship with plant roots and influence the host's metabolic processes. Numerous studies have noted that AMF can directly or indirectly influence the secondary metabolism of plants, causing changes in secondary metabolite levels [3, 5]. Legumes are helpful in enhancing the protein content. Accumulation of chemical matters of varieties in seeds has not been investigated [6]. Especially accumulation of moisture, ash, total nitrogen, total protein, water soluble protein, oil and fiber varied speedy with time [6]. Proximate and nutrient analysis of edible fruit and vegetables plays a crucial role in assessing their nutritional significance [7]. Chickpea is a good source of energy, protein, minerals, vitamins, fiber, and also contains potentially health-beneficial minerals and vitamins. The nutritional value of chickpea has been documented in numerous publications [8]. The proximate composition of cowpea seeds affected by AMF inoculation, Inoculation significantly improved the ash contents, crude protein and the crude fat contents of cowpea seeds [9]. AMF fungi i.e. *Glomus mosseae* and *Acaulospora laevis* either alone and/or in combination with *Trichoderma viride* and *Pseudomonas fluorescens* on growth enhancement of groundnut by using dual inoculation significantly increases nutritional value such as protein percent and oil content were found to be in

Glomus. mosseae + *A. laevis* + *T. viride* + *P. fluorescens* treatment [10]. The interaction between inoculation of *gloms mossea Trichoderma harzianum* and soil treatment showed significantly higher value of protein, carbohydrates fats, crud fibers, and dry matter of soya bean then control plant [11]. Arbuscular mycorrhizal fungi showed a significant effects on proximate analysis in crude protein, fat, moisture and ash content in mycorrhizal plants except carbohydrate and crude [12].

Little work has been done on yield, proximate and elemental analysis of food pulses. But in Pakistan some authors studied that arbuscular mycorrhizal fungi (AMF) inoculation significantly affect food pulses in terms of growth, yield and nutrient uptake [13, 15-17]. Therefore the present study was an attempt to investigate the effect of AMF inoculation and their relation to enhance proximate composition of chickpea varieties.

2. Materials and Methods

The present experiment was carried out at Botany department Bacha Khan University, Charsadda during Rabi season 2014-2015. The experiment was comprises of two factors (inoculated and control), control treatment was taken for comparison with tested plants. The experiment was arranged in randomized complete block design with three replicates.

Soil used during the experiment was obtained from Bacha khan University Charsadda. Analysis of soil was done by using the following method of [17-19]. Soil was analyzed for pot experiment having (70% sand, 25% silt, 10% clay, texture sandy loamy soil, 24.4% $CaCO_3$, pH 7.41, E. C. 1.2 dS m^{-1} and ionic concentrations were, Ca^{++} 11.9; Mg^{++} 8.1; Na^{+} 2.35; K^{+} 1.28; CO_3^{--} traces; HCO_3^{-} 8.52; Cl^{-} 1.6; NO_3^{-} traces and SO_4^{--} 6.1 mg Kg^{-1} soil. Total nitrogen and phosphorus were 2.21 and 1.43 mg Kg^{-1} soil, respectively. Proximate analysis of chick pea verities percent moisture, crud fat, ash, and crud fiber contents was determined using the method of association of official analytical chemists [20]. Protein and total nitrogen content was determined by Kjeldahl method with slight modification following Bremner, [21] and calculated by multiplying nitrogen by factor 6.25 [22]. Experimental data was statistically analyzed using the Statistical Analysis System program [23]. The means were subjected to LSD test at $P \leq 0.05$ upon significant after revealing differences among treatments [24].

3. Results and Discussion

3.1. Proximate Analysis

Arbuscular mycorrhizal inoculation not only increased growth and productivity of plants but also enhanced proximate composition of plant. Our results for proximate analysis were shown in (Table 1) and Figures (1.-7) AMF inoculation significantly increased protein, crud fibbers, dry matter, moisture and total carbohydrates contents of three different varieties of chick pea (Chana Punjab 2008, Chana Dasht and Chana Bakar 2011) of tested plants as compared to control.

Table 1. *Effect of AMF on proximate analysis of Chickpea varieties.*

Varieties	Treatment	Moisture%	Dry matter%	Ash %	Fibber%	Protein%	Carbohydrate%	Fat%
Chana Punjab (2008)	AMF	21.0±1.0	96.0±1.12	6.58±0.35	5.32±0.55	6.587±.35	58.05±0.27	2.37±0.45
	Control	11.34±1.1	66.4±2.08	3.39±0.01	4.58±0.56	3.39±0.01	74.37±0.54	2.00±0.80
Chana Dasht	AMF	14.5±0.50	99.0±1.00	5.49±0.44	5.80±0.15	5.49±0.44	67.02±0.36	2.11±0.18
	Control	12.7±0.57	97.0±1.00	3.84±0.01	3.46±0.28	3.85±0.01	74.53±0.75	2.03±0.41
Chana Bakar (2011)	AMF	17.0±1.00	99.7±0.57	5.67±0.56	1.72±0.04	5.67±0.56	69.77±4.53	2.61±0.63
	Control	8.67±0.57	95.0±4.35	5.17±0.05	0.26±0.02	5.17±0.05	77.7±0.71	2.04±0.14

Means ±SD (Means of four replicates).

3.2. Moisture Contents

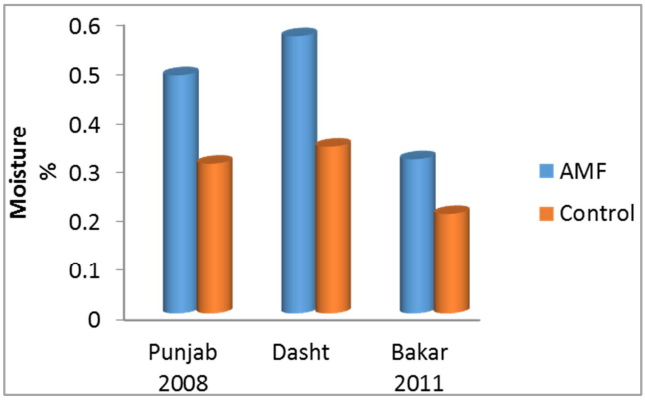

Figure 1. *Effect of AMF on moisture contents of Chickpea varieties.*

Results of AMF inoculation on moisture content of different varieties of *Cicer arietinum* (Chana Punjab, Chana Dasht and Chana Bakar 2011) are given in (Table 1) and (Figure 1). The results showed that moisture content were significantly ($P<0.0000$) affected by AM fungi inoculation. The interaction between treatments and varieties were also significant ($P< 0.0000$). According to LSD (Table 1) maximum mean value for tested plants was recorded in Chana Punjab 2008 with (21.00±1.00) followed by Chana Bakar 2011 (17.00±1.00) and Chana Dasht (14.50±0.50). Our results confirm that AM fungal inoculation significantly increased moisture content of inoculated plants than non-inoculated plants [11].

3.3. Dry Matter

Data from the results for dry matter content are given in

(Table 1) and (Figure 2). The result indicated that mycorrhizal inoculation significantly (P<0.0000) increased dry matter content of tested plants as compared with un-inoculated plants. Maximum mean value (99.7±0.57) were recorded in Chana Bakar 2011 followed by Chana Dasht and Chana Punjab respectively. The data revealed that interaction between treatment and varieties were also significant. Our results are agree with Egberongbe *et al*., [11] studied that AM fungal inoculation significantly increases dry matter of inoculated plants than non- inoculated plants. Similar results are also given by Beltrano *et al*., [25] stated that mycorrhiza inoculation significantly increases plants dry matter than non-inoculated plants Zaidi, [26] studied that AM fungus (*Glomus fasciculatum*) inoculation enhanced dry matter content in green gram than non-inoculated plants.

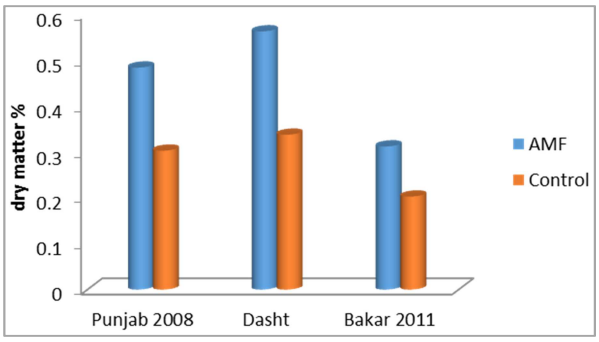

Figure 2. *Effects of AMF on Dry matter contents of Chickpea varieties.*

3.4. Ash Content

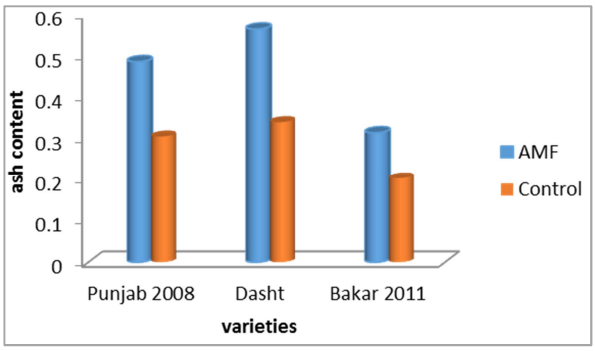

Figure 3. *Effect of AMF on Ash content of Chickpea varieties.*

Result of AMF inoculation on ash content of different varieties of *Cicer arietinum* Chana (Punjab, Chana Dasht and Chana Bakar 2011) following two treatments inoculated and control are given in (Table 1) and (Figure 3). The results showed that AMF inoculation significantly (P<0.003) increased ash content in tested plants as compared to control. It indicate that interaction between treatments were significant but a non-significant interaction (P<0.8644) was found among studied varieties. Maximum mean value (6.58±0.35) was showed in Chana Punjab and (5.67±0.56) for Chana Bakar 2011 and (5.49±0.44) for Chana dasht in SD (Table 1) and Figure 3). Our results in line with Omomowo *et al.* [9] stated that the direct effect of *Glomus mosseae* on cowpea plant which showed significantly increases ash content than non-inoculated plants. Similarly fungal inoculation significantly increases ash content than non-inoculated plants [27].

3.5. Crud fiber Contents

Results of AM fungi inoculation on crud fiber content of chickpea varieties with two treatments inoculated and control are given in Table (1) and (Figure 4). Data showed that inoculated plants were significantly (P<0.0000) affected by fungal inoculation when compared with control plants. The interaction between treatments were (100%) significant (P<0.0000) and the interaction between varieties were also significant (P< 0.0407). Maximum mean value in SD (Table 1) were recorded in inoculated plants than non-inoculated plants mean value of Chana Punjab 2008 was (5.32±0.55) followed by Chana Dasht with (5.80±0.15) and Chana bakar 2011 with (1.725±0.04969) mean value. Our results are correlate with Oladele, [27] who investigated that AM fungal inoculation significantly improved crude fiber contents in plants than non-inoculated plants. Similar results are also given by Egberongbe *et al*., [11] who find out that AM fungal inoculation significantly increases crud fibbers of inoculated plants than non- inoculated plants.

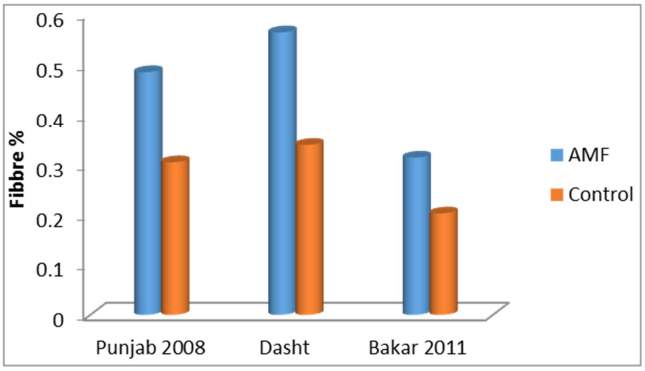

Figure 4. *Effect of AMF on Fibber contents of Chickpea varieties.*

3.6. Crud Protein (CP)

Data regarding for AM fungi inoculation on crud protein content of three different varieties of chickpea along with two treatments inoculated and control are given in (Table 1) and (Figure 5). Results of the data reveald that arbuscular mycorrhizal inoculation significantly increased crud protein content of Chickpea varieties in tested plants as compared with control plants. The interaction between treatments were 100% significant (P< 0.0000) and the interaction between varieties were also highly (P< 0.0000) significant. Maximum mean value was recorded in inoculated plants than non-inoculated plants. Our results are correlate with Amiri, [28] who investigate that arbuscular mycorrhizal fungi (AMF) significantly improve protein and oil content of *Glycine max* and *Helianthus annuus.* Our results are also correlate with Yaghoub, [4] investigate that the effect of two different indigenous AM fungi i.e. *Glomus mosseae* and *Acaulospora laevis* enhanced protein content of groundnut under polyhouse conditions. Our results are in line with Khalil *et al.* [29] who investigate that AM fungal inoculation significantly

increases protein content as compared to control plants. Arbuscular mycorrhizal AM fungi (*Glomus fasciculatum*) inoculation into green gram plants enhanced protein content than non-inoculated plants [26]. Our results are in line with the outcomes of other workers who stated that the crude protein content were higher in inoculated plants than non-inoculated plants [30, 31].

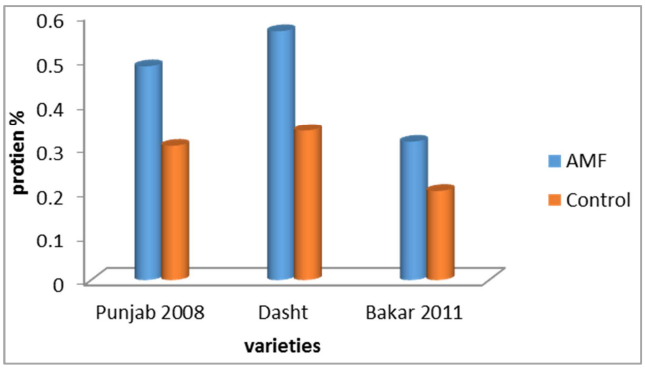

Figure 5. *Effects of AMF on Protein contents of Chickpea varieties.*

3.7. Fat Contents

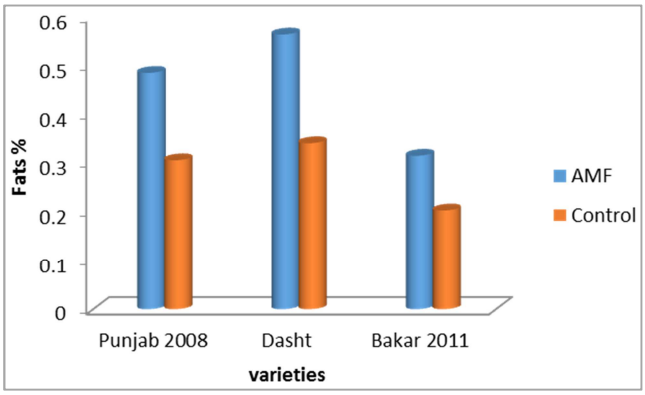

Figure 6. *Effects of AMF on fat contents of Chickpea varieties.*

Our finding for fat contents are showed in (Table 1) and (Figure 6) for three different varieties of chickpea varieties such as Chana Punjab 2008, Chana Dasht and Chana Bakar 2011. Results of the data showed that fat content of the studied plants with AM fungi inoculation were not significantly (P< 0.2890) affected as compared with un-inoculated plants. The interaction between treatments were not significant (P< 0.2890) and the interaction between varieties were significant (P<0.0038). Maximum mean value were recorded in inoculated plants than non-inoculated plants mean value of Chana bakar 2011 was (2.70±0.52) followed by Chana Punjab 2008 with mean value (2.63±0.15) and Chana Dasht with (2.43±0.35) in inoculated plants. Our results are correlate with Omomowo *et al*. [9] who investigate that the inoculation of *Glomus mosseae* and *Bradyrhizobium japonicum* enhanced proximate composition (crud fats and protein contents) of cowpea than non-inoculated plants. Our results are correlate with Oladele, [27] investigated that AM fungal inoculation significantly improved fats contents in plants than non-inoculated plants. Our results are also in line with Yaseen *et al*., [15] stated that fat contents of different legumes were significantly ($P \leq 0.05$) increased with inoculation of fungal spores as compared rock phosphate alone.

3.8. Total Carbohydrates Content

Results of AMF inoculation on carbohydrates contents of chickpea (*Cicer arietinum* L) having three different varieties (Chana Punjab 2008 Chana Dasht and Chana Bakar 2011) following two treatments inoculated and control are showed in SD (Table 1) and (Figure 7). The result showed that AM fungi significantly (P< 0.0000) or 100% effects on carbohydrates contents of tested plants as compared with control plants. Interaction between varieties were significant (P< 0.013) and the interaction between varieties and treatments were also (P< 0.0083) significantly affected. It is clear from our result that the treatments enhanced carbohydrates contents in plants. Maximum mean value were recorded in Chana Punjab 2008 (58.05±0.27) followed by Chana Dasht (67.02±0.36) and Chana Bakar 2011 (69.77±4.53). Our results deviate from Oladele, [27] that fungal inoculation suggestively reduced the carbohydrate content. This might be recognized to the high absorption of nitrogen presented to the plant which improved the protein content in inoculated plants. The low content of carbohydrate in inoculated plants is directly correlated to the high protein content as compared to the un-inoculated plants.

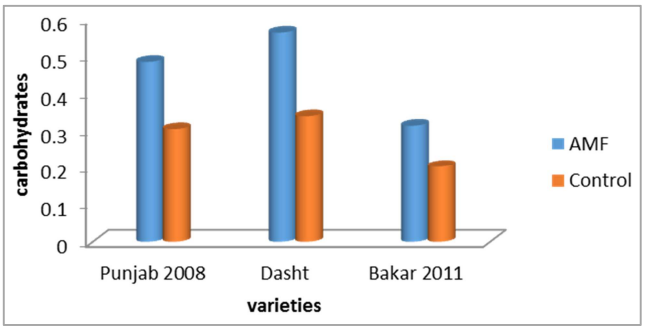

Figure 7. *Effect of AMF on Carbohydrate contents of Chickpea varieties.*

4. Conclusion

The present study revealed that application of arbuscular mycorrhizal fungi (AMF) increase proximate composition of chickpea varieties in phosphorous deficient soil. Mycorrhizal inoculated plants performed well in terms of nutritional value than un-inoculated plants. Therefore, inoculation of AMF enhanced growth, productivity by the increase uptake of nutrient from soil and is recommended for higher production of cereal crops.

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