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Research Article

Effect of crop rotation on distribution pattern of arbuscular mycorrhizal fungal and microbial population

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Abstract

In agriculture, a sequential cropping strategy is used to reduce soil pathogens and increase the productivity of next crops. It can, however, also affect the microbial populations in the soil, which is advantageous for plant development and arbuscular mycorrhizal fungi (AMF). For measuring the effect of sequential cropping (tomato and onion) on different arbuscular mycorrhiza (*Glomus mosseae, Glomus fasciculatum, Glomus hoi* and *Glomus intraradices*), the experiment was conducted in the screen house of the department of Plant Pathology, CCSHAU Hisar in 2020-2021. Seedling of tomato cv Selection 7 (Kharif season) was sown in the pots and sequential cropped with onion cv HO- 4 (Rabi season). When onion was grown sequentially after tomato, the study indicated that mycorrhizal colonisation in roots and sporocarp number in soil, plant growth parameters, mycorrhizal inoculation impact, and mycorrhizal count was highest in onion. In contrast to fertilization, cultivating specific crops in the previous season, such as tomatoes in this experiment, can stimulate arbuscular mycorrhizal colonization of onion roots, consequently enhancing plant growth.

Keywords: Arbuscular mycorrhizal fungi; Colonization; Crop rotation; Pathogen

1. Introduction

AMF has been shown to benefit plants in a variety of ways, including improved nutrient absorption and resistance to pests, diseases, and drought (Smith and Read, 2010; Kaur *et al.,* 2020). Approximately 80% of higher plants might be colonised by arbuscular mycorrhizal (AM) fungus, which could boost plant growth and seedling survival (Koide, 2000). AMF are associated with the majority of land plants including those in arid areas (Stutz *et al.,* 2000). According to different studies conducted in greenhouses and in the field, AMF inoculation has been shown to improve plant growth and yield (Adesemoye and Kloepper, 2009; Baslam *et al.,* 2011, Chen *et al.,* 2018). By expanding the amount of soil that is accessible to the plant, AMF's mycelial network enhances water and mineral absorption, particularly that of nitrogen and phosphorus (Boutaj *et al.,* 2022). Phosphorus (P) and other minor elements that are immobile or have a low availability to plants are supplied to the plant by the fungus. Because it frequently forms insoluble complexes with cations like iron (Fe), aluminium (Al), and calcium (Ca), phosphorus is relatively immobile in soil (Weil and Brady, 2017). A rapidly growing zone of depletion forms around plant roots as a result of the slow diffusion of P in the soil. The AMF develop a dense network of hyphae that substantially increases the surface

area for P absorption and transportation into the roots (Smith and Smith, 2012). AMF also protects against some plant diseases and improves soil structure by binding soil particles together with glomalin and hyphal networks to form aggregates (Finlay, 2004).

Crop rotation offers several advantages, including the preservation of soil structure and organic matter, heightened biological diversity and activity, a decrease in the presence of soil borne pathogens (Peters *et al.,* 2003; Hopkins *et al.,* 2004). One of the most significant impact of crop rotation pertains to soil microbial communities (Larkin and Honeycutt in 2006. Crop rotation plays a vital role in safeguarding environmental well-being through its capacity to enhance functional agro biodiversity (Wright *et al.,* 2017) and foster agricultural sustainability (Pretty and Bharucha, 2014). The benefits of varied crop rotations on a variety of ecological services, such as enhanced soil fertility, weed control, and pest management (Smith *et al.,* 2008), as well as a rise in the numbers of microorganisms that are beneficial to agriculture, such as nitrogen-fixing rhizobia and mycorrhizal fungi (Abawi and Widmer, 2000; Franchini *et al.,* 2007; Govaerts *et al.,* 2007; Aggarwal et al., 2024). The impact of crop rotation on soil biological activity primarily stems from its influence on soil organic matter (Bucher, 2002; Pallarès Vinyoles, 2008).

In the present investigation, we have conducted a comparative analysis of tomato-onion crop rotation and its impact on mycorrhizal colonization. Our aim is to identify the optimal crop rotation that maximizes the colonization of arbuscular mycorrhizal fungi (AMF) and, consequently, enhances the efficient acquisition of phosphorus by upland plants.

2. Material and Methods

The experiment was conducted in the screen house of the Department of Plant Pathology, Chaudhary Charan Singh Agricultural University, Hisar, Haryana, India in 2020 and 2021. The soil type is sandy loam. In order to produce tomatoes in the sterile soil, tomato seeds were first surface sterilised using sodium hypochlorite. Four-true-leaf tomato seedlings were utilised for transplanting one month later. Steam sterilized soil was filled in 15 cm diameter earthen pots (one kg capacity). Mycorrhizal inoculum containing about 450-500 extrametrical chlamydospores and infected root bits were put in the upper 5 cm soil layer. Seedling of tomato cv Selection 7 was sown in the pots (four no. of sets were maintained). Seedling of onion cv HO- 4 was sown in same pots after tomato harvest. Plants were maintained as package practice of CCS HAU Hisar.

2.1 Mycorrhizal colonization

The process outlined by Phillips and Hayman (1970) for staining roots allowed for the calculation of mycorrhizal colonisation.

2.2 Staining of root

After cutting the roots into 1-centimeter sections, they underwent a number of treatments, including an hour-long heating in 10% KOH at 90°C and a fresh 10% KOH solution wash. For half an hour, the roots were submerged in alkaline hydrogen peroxide (H2O2). After that, the excess H2O2 was washed out with distilled water, and the mixture was acidified for 30 minutes using 5 N HCl. Trypan blue in lactophenol (0.05%) was simmered with roots for five minutes. Lastly, the roots were inspected under a microscope after being submerged in lactophenol to remove any leftover colour.

2.3 Estimation of sporocarp in soil

The Wet Sieving and Decantation Technique, as described by Gerdemann and Nicolson, was used to estimate the amount of sporocarp in soil (1963).

Prior to suspending 100 g of soil in pan A and adding one litre of water, the soil sample was well mixed. Waiting 30 seconds was then required. Pan B was filled with the filtrate after the suspension was run through a 20 mesh filter. Pan A's content was thrown out. A 60 grit sieve was used to filter the B pan suspension after it had been manually agitated and given a few seconds to settle. In pan C, the filtrate was collected. Pan C suspension was run through a 100 mesh filter. On a 100 mesh sieve, the maximum ripe sporocarps were gathered. After washing to get rid of extra dirt and other particles, 100 ml of mesh sieve residue was collected into a beaker. Using a stereomicroscope, one millilitre of this solution was placed in a counting dish, and the number of sporocarps in the soil was counted.

2.4 Mycorrhizal dependency (MD)

The amount that a plant depends on mycorrhizal conditions to develop or yield as much as possible at a particular soil fertility level is known as mycorrhizal dependence (MD). The formula provided by Plenchette *et al.,* (1983) was used to calculate mycorrhizal dependence.

2.5 Mycorrhizal Inoculation effect (MIE)

The Bagyaraj (1994) formula was used to assess the mycorrhizal inoculation impact.

2.6 Soil microflora

Estimation of microbial population in the mycorrhizosphere:

The rhizosphere population of different microbes as influenced by different AM fungi was observed. A soil sample of 10 g from all the treatments was collected. The soil sample was mixed in 90 ml of sterilized distilled water to make 10 per cent soil solution. Then serial dilution method was used and dilutions of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, and 10^{-7} were prepared. The population count of fungi, actinomycetes, and bacteria was taken at 10^{-3} and 10^{-4}, 10^{-5} and 10^{-6} and 10^{-6} and 10^{-7} respectively. For isolation, Kenknight agar media for Actinomycetes, nutrient agar for Bacteria, and Martin rose Bengal agar for Fungi were used. 100µl of each dilution was placed in the Petri plates with pre-set media and evenly spread using a stainless-steel spreader. The Petri plates were incubated at 27±1°C and the population count was taken.

3. Results

Fig 1: Effect of cropping system on arbuscular mycorrhizal fungi population in tomato, A: *Glomus fasciculatum,* B: *Glomus mosseae,* C: *Glomus intraradices,* D: *Glomus hoi* and E: *Control*

3.1 Tomato experiment

Mycorrhizal colonization in tomato sown pots significantly increased at 30, 45 and 60 days after transplanting (Table 1). Significantly highest mycorrhizal colonization per cent was recorded in *Glomus mosseae* (34.7 %, 54.7 % and 70.4 % respectively at 30, 45 and 60 days after transplanting) followed by *Glomus fasciculatum* (27.0 %, 47.7 % and 69.8 %, respectively) and minimum in *Glomus hoi* (31.3 %, 52.0 % and 64.3 %, respectively). No mycorrhizal colonization was recorded in control.

Total sporocarp number was calculated in soil at 30, 45 and 60 days after transplantation. Among all the four mycorrhizal species (*Glomus fasciculatum, Glomus mosseae, Glomus hoi* and *Glomus intraradices*) maximum sporocarp number was found at 60 days after transplanting. Significantly highest sporocarp numbers were recorded in *Glomus mosseae* (28.0, 46.3 and 88.7, respectively at 30, 45 and 60 days after transplanting) followed by *Glomus fasciculatum* (24.0, 34.7 and 76.3, respectively) and minimum in *Glomus intraradices* (21.7, 48.0 and 57.0, respectively).

Table 1: Effect of different mycorrhizal species on mycorrhizal colonization and sporocarp population

Treatments	Mycorrhizal colonization (%)				Sporocarp population			
	30 DAT	45 DAT	60 DAT	Mean	30 DAT	45 DAT	60 DAT	Mean
Glomus mosseae	34.7 (36.0)	54.7 (47.7)	70.4 (57.1)	53.3 (46.9)	28.0	46.3	88.7	54.3
Glomus fasciculatum	27.0 (31.3)	47.7 (43.6)	69.8 (56.7)	48.1 (43.9)	24.0	34.7	76.3	45.0
Glomus intraradices	23.0 (28.6)	46.3 (42.9)	65.4 (53.9)	44.9 (41.8)	21.7	48.0	57.0	42.2
Glomus hoi	31.3 (34)	52.0 (46.1)	64.3 (53.3)	49.2 (44.5)	19.3	30.7	58.3	36.1
Control	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0	0.0	0.0	0.0
Mean A	23.2 (26)	40.1 (36.1)	54 (44.2)		18.6	31.9	56.1	
CD at 5% level	**Days after transplanting** = 1.41 **Species** = 1.83 **Days after transplanting × Species** = 3.16				**Days after transplanting** = 2.93 **Species** = 3.79 **Days after transplanting × Species** = 6.57			

3.2 Onion experiment

After completion of tomato experiment onion seedlings were sown in the same pots and second set was transplanted in new pots.

Plant height of mycorrhizal inoculated onion plants was higher in comparison to control. Plant height was maximum in *Glomus mosseae* (41.50 cm and 38.20 cm in the old inoculum pots and fresh inoculum pots respectively) followed by *Glomus hoi* (41.03 cm and 37.50 cm in the old inoculum pots and fresh inoculum pots respectively) and it was lowest in control (28.70 cm and 28.13 cm in the old inoculum and fresh inoculum respectively) at 60 days after transplanting (Fig 2).

Highest dry shoot weight was observed in *Glomus mosseae* inoculated plants (Fig 4). Dry shoot weight was more in onion transplanted in the same tomato pots (old inoculum) as compared to onion transplanted in the pots filled with fresh inoculum. At 60 days after transplanting, *Glomus mosseae* had the highest dry shoot weight (3.24 g and 3.01 g respectively) followed by *Glomus hoi* (3.14 g and 3.01 g, respectively), while the control had the lowest dry shoot weight (2.26 g and 2.13 g in the old inoculum and fresh inoculum, respectively).

Glomus mosseae inoculated plants had the highest dry root weight *i.e.* 1.13 g and 1.04 g, respectively followed by *Glomus hoi i.e.* 1.09 g and 0.96 g at old and fresh inoculated plants respectively. *Glomus fasciculatum i.e.* 1.03 g and 0.89 g, respectively, *Glomus intraradices i.e.* 1.00 g and 0.86 g, respectively, while the control had the lowest dry root weight *i.e.* 0.63 g and 0.61 g, respectively (Fig 5).

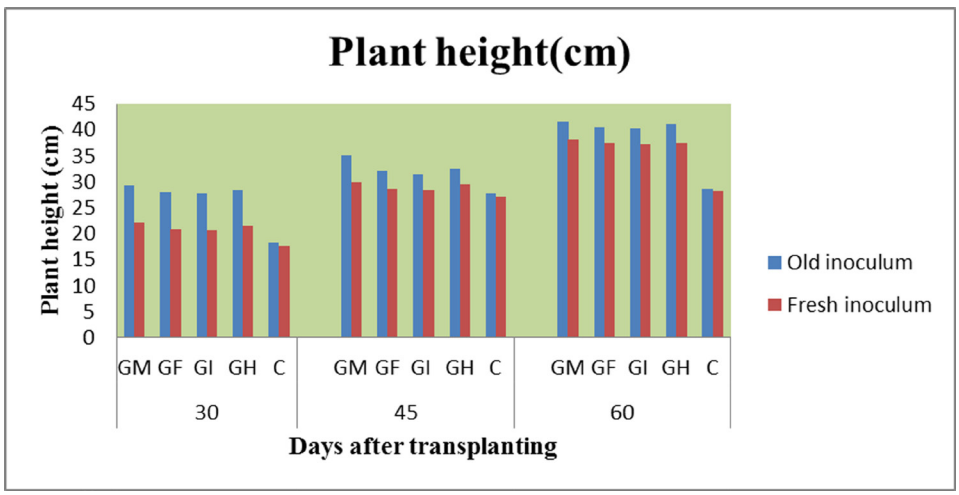

Fig 2: Effect of crop rotation on plant height of onion plants at 30, 45 and 60 days after transplanting
GM= *Glomus mosseae,* GF= *Glomus fasciculatum,* GI= *Glomus intraradices,* GH= *Glomus hoi,* C= *Control*

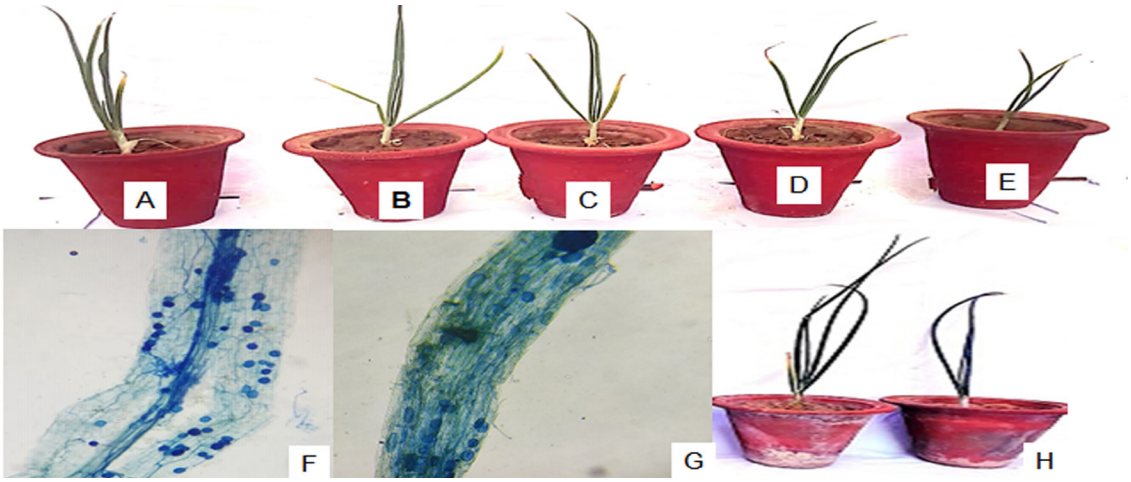

Fig 3: Effect of crop rotation on arbuscular mycorrhizal fungi population in onion, A: *Glomus mosseae,* B: *Glomus fasciculatum,* C: *Glomus hoi,* D: *Glomus intraradices* and E: *Control,* F: Mycorrhizal colonization in old inoculum, G: Mycorrhizal colonization in fresh inoculum, H: Effect of old and fresh inoculum on plant height of onion

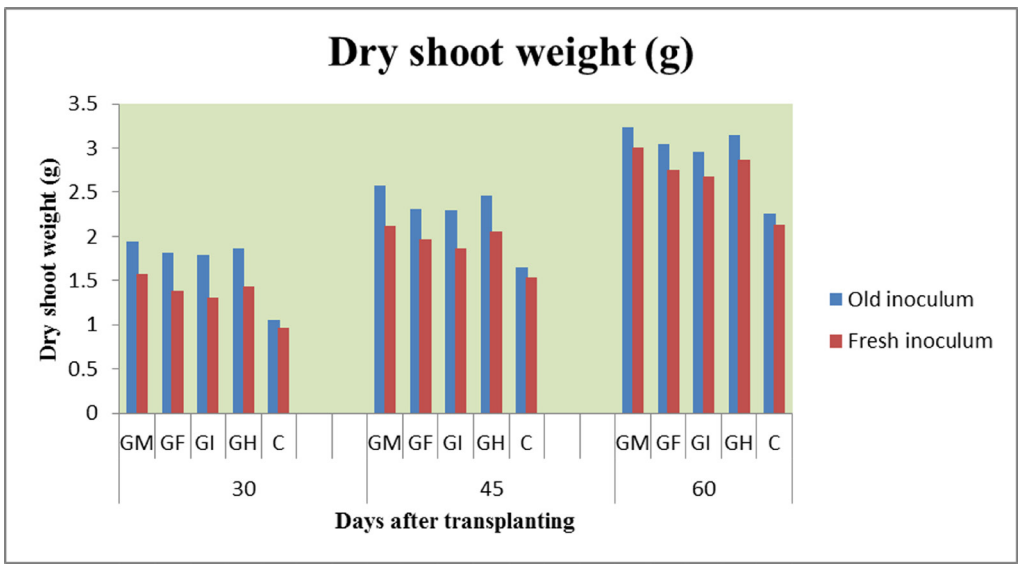

Fig 4: Effect of crop rotation on dry shoot weight of onion plants at 30, 45 and 60 days after transplanting
GM= *Glomus mosseae,* GF= *Glomus fasciculatum,* GI= *Glomus intraradices,* GH= *Glomus hoi,* C= *Control*

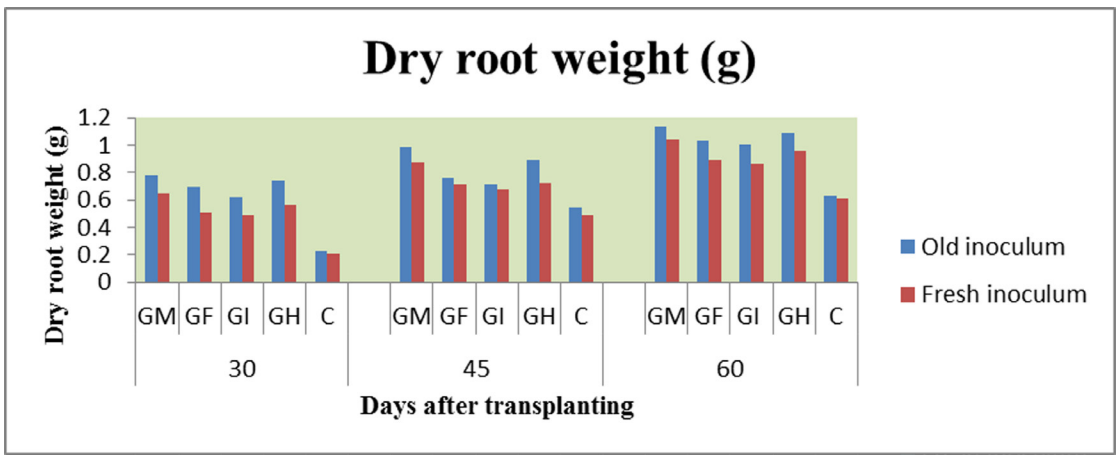

Fig 5: Effect of crop rotation on dry root weight of onion plants at 30, 45 and 60 days after transplanting
GM= *Glomus mosseae,* GF= *Glomus fasciculatum,* GI= *Glomus intraradices,* GH= *Glomus hoi,* C= *Control*

Mycorrhizal colonization was more in onion transplanted in the same tomato pots (old inoculum) as compared to onion transplanted in pots filled with the fresh inoculum pots at 30, 45, and 60 days after transplant (Table 2). Mycorrhizal colonization was maximum when plants were inoculated with *Glomus mosseae* (79.87 % and 58.69 % in the old inoculum and fresh inoculum respectively) and *Glomus hoi* (75.68 % and 53.23 % in the old inoculum and fresh inoculum respectively) while *Glomus intraradices* (74.65 % and 50.03 % in the old inoculum and fresh inoculum respectively) had the lowest mycorrhizal colonization among all treatments.

At 60 days after transplanting, maximum sporocarp number were observed when inoculated with *Glomus fasciculatum* (142.0 and 106.0 in the old inoculum and fresh inoculum respectively) followed by *Glomus mosseae* (123.0 and 98.0 in the old inoculum and fresh inoculum respectively), *Glomus hoi* (103.0 and 87.0 in the old inoculum and fresh inoculum respectively) while, *Glomus intraradices* (98.0 and 81.0 in the old inoculum and fresh inoculum respectively) had minimum sporocarp number among all the inoculated treatments (Table 2).

The highest mycorrhizal inoculation effect was observed in plants inoculated with *Glomus mosseae* (52.9 % and 46.8 % in the old inoculum and fresh inoculum respectively) followed by *Glomus hoi* (51.0 % and 40.7 % in the old inoculum and fresh inoculum respectively) and lowest was observed in *Glomus intraradices* (46.9 % and 34.4 % in the old inoculum and fresh inoculum respectively) at 30 days after transplanting. The trend was similar at 45 and 60 days after transplanting (Table 3).

The highest mycorrhizal dependency was observed in plants inoculated with *Glomus mosseae* (212.5 and 188.1 in the old inoculum and fresh inoculum respectively) followed by *Glomus hoi* (203.9 and 168.6 in the old inoculum and fresh inoculum respectively) and lowest was observed in *Glomus intraradices* (188.3 and 152.5 in the old inoculum and fresh inoculum respectively) at 30 days after transplanting. Same trend was observed at 45 and 60 days of transplanting (Table 3).

Effect of crop rotation on bacteria, fungi and actinomycetes population in onion plants at 90 days after transplanting was observed. Highest microbial population was recorded in onion plants transplanted in old inoculum as compared to fresh inoculum. Maximum bacterial population in old

Table 2: Effect of crop rotation on mycorrhizal colonization of onion plants

Treatments	Mycorrhizal colonization (%)						Sporocarp number/ 100g soil					
	30 Days After transplanting			45 Days After transplanting			60 Days After transplanting			30 Days After transplanting			45 Days After transplanting			60 Days After transplanting		
	Old inoculum	Fresh inoculum	Mean	Old inoculum	Fresh inoculum	Mean	Old inoculum	Fresh inoculum	Mean	Old inoculum	Fresh inoculum	Mean	Old inoculum	Fresh inoculum	Mean	Old inoculum	Fresh inoculum	Mean
Glomus mosseae	38.54 (38.34)	29.61 (32.86)	34.08 (35.60)	56.42 (48.69)	46.52 (42.98)	51.47 (45.83)	79.87 (63.81)	58.69 (50.02)	69.28 (56.91)	56.0	46.0	51.0	86.0	65.0	75.5	123.0	98.0	110.5
Glomus fasciculatum	35.63 (36.61)	26.89 (31.15)	31.26 (33.88)	51.47 (45.83)	43.12 (41.00)	47.30 (43.42)	75.63 (60.51)	50.21 (45.10)	62.92 (52.81)	51.0	36.0	43.5	81.0	62.0	71.5	142.0	106.0	124.0
Glomus intraradices	34.89 (36.17)	25.47 (30.25)	30.18 (33.21)	50.13 (45.06)	40.21 (39.27)	45.17 (42.16)	74.65 (59.99)	50.03 (45.00)	62.34 (52.50)	42.0	30.0	36.0	80.0	51.0	65.5	98.0	81.0	89.5
Glomus hoi	37.81 (37.90)	28.54 (32.20)	33.17 (35.05)	53.68 (47.12)	45.24 (42.24)	49.46 (44.68)	75.68 (60.78)	53.23 (46.86)	64.46 (53.82)	39.0	26.0	32.5	78.0	57.0	67.5	103.0	87.0	95.0
Mean	29.37 (29.80)	22.10 (25.29)		42.34 (37.34)	35.02 (33.10)		61.17 (49.02)	42.43 (37.40)		37.6	27.6		65.0	47.0		93.2	74.4	
CD at 5% Level	**Inoculum** = 2.18 **Species** = 3.45 **Inoculum × Species** = NS			**Inoculum** = 3.04 **Species** = 4.81 **Inoculum × Species** = NS			**Inoculum** = 3.72 **Species** = 5.88 **Inoculum × Species** = NS			**Inoculum** = 6.87 **Species** = 10.87 **Inoculum × Species** = NS			**Inoculum** = 4.74 **Species** = 7.50 **Inoculum × Species** = 10.60			**Inoculum** = 7.57 **Species** = 11.98 **Inoculum × Species** = NS		

Table 3: Effect of crop rotation on mycorrhizal inoculation effect and mycorrhizal dependency in onion plants

Treatments	Mycorrhizal inoculation effect						Mycorrhizal dependency					
	30 Days After transplanting		45 Days After transplanting		60 Days After transplanting		30 Days After transplanting		45 Days After transplanting		60 Days After transplanting	
	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum
Glomus mosseae	52.9(46.6)	46.8(43.2)	38.5(38.3)	32.8 (34.9)	33.6(35.4)	32.3(34.6)	212.5	188.1	162.6	146.6	150.7	147.8
Glomus fasciculatum	48.6(44.2)	37.6(37.8)	28.7(32.4)	23.6(29)	28.9(32.5)	24.7(29.8)	194.5	160.2	140.2	130.9	140.7	132.8
Glomus intraradices	46.9(43.2)	34.4(35.9)	27(31.3)	19.7(26.3)	26.8(31.1)	22.6(28.4)	188.3	152.5	137.0	124.5	136.6	129.2
Glomus hoi	51(45.6)	40.7(39.6)	34.6(36)	26.4(30.9)	31.4(34)	28.3(32.1)	203.9	168.6	153.0	135.8	145.9	139.4
CD at 5% Level	2.099	2.437	2.654	1.758	2.263	2.554	4.543	3.634	3.54	4.328	3.842	2.07

*Figures in the parenthesis are angular transformed values

inoculum was found in *Glomus fasciculatum* (13.13) and it was less in control (3.56). Highest bacterial population in fresh inoculum was observed in *Glomus mosseae* (13.33) and lowest was noted in control (2.41) (Table 6). Maximum fungal population in old inoculum was observed in *Glomus mosseae* (12.67) and *Glomus hoi* (12.67) whereas, minimum in control (3.56). Maximum fungal population in fresh inoculum was recorded in *Glomus intraradices* (7.31) and minimum in control (2.33). The actinomycetes population in old inoculum was more in *Glomus fasciculatum* (14.24) and less in control (11.67). While higher actinomycetes population in fresh inoculum was found in *Glomus mosseae* (11.30).

Fig 6: Effect of crop rotation on mycorrhizal colonization at 90 days after colonization

Discussion

The impact of tomato and onion sequential cropping on arbuscular mycorrhiza (*Glomus mosseae, Glomus fasciculatum, Glomus hoi*, and *Glomus intraradices*) was investigated as part of biological control strategies. It was discovered that, in comparison to a non-sequential crop rotation, onion showed the highest mycorrhizal population (mycorrhizal colonisation and sporocarp number), plant growth parameters (plant height, fresh weight of shoot and fresh weight of root, as well as dry weight of shoot and dry weight of root), mycorrhizal inoculation effect, and mycorrhizal dependency. The results of the present investigation conform to the findings of Hage-AHM-ed et al. (2013). The results indicated that intercropping tomatoes with leek had a 20% greater colonisation level than intercropping tomatoes with tomato, whereas intercropping tomatoes with fennel had a 13% lower AM colonisation level. When compared to the tomato/tomato (TT) combination, there were no variations in the AM colonisation level when tomatoes were interplanted with cucumber or basil, respectively. After intercropping huge size of the tomato rooting system and, as a result, the faster colonization of the root system and establishment

Table 4: Effect of crop rotation on microbial population of onion plants

Bacteria, fungi and actinomycetes population in soil						
	Bacteria (CFU/ml) 1×10^5		Fungi (CFU/ml) 1×10^4		Actinomycetes (CFU/ml) 1×10^6	
Treatments	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum	Old inoculum	Fresh inoculum
Glomus mosseae	12.33	11.62	12.67	6.67	12.31	11.30
Glomus fasciculatum	13.13	10.63	11.00	6.66	14.24	10.56
Glomus intraradices	12.00	10.33	12.00	7.31	14.00	9.35
Glomus hoi	12.09	10.14	12.67	7.23	13.45	10.25
Control	3.56	2.41	5.00	2.33	11.67	10.23

of hyphal networks are of great significance in AM root colonization. The results of the present investigation are in line with findings of Smith and Read (2008). In Sri Lanka's seasonally dry regions, Paranavithan *et al.,* (2021) found that crop rotation with the highland crop species soya bean increased AMF sporulation and root colonization of lowland paddy. This observation is consistent with the soy cropping upland system reported by Vallino *et al.,* (2014). Additionally, the current study concurs with Oruru and Njeru (2016) and Higo *et al.,* (2010) that AMF sporulation and root colonization in seasonally dry regions may vary with the associated plant species. Rotating rice and legume crops causes increases the incidence of AMF in the soil (Maiti *et al.,* 2012). Similarly, Rana *et al.,* 2002 found that intercropping rice with pigeon pea (*Cajanus cajan* L.) and peanut (*Arachis hypogea* L.) not only sustained robust populations of indigenous arbuscular mycorrhizal fungi (AMF) during the fallow period spanning from October/ November to May/June of the following year but also led to a noticeable augmentation in mycorrhizal colonization of rice roots during the wet season growing period.

An increase in plant height, fresh weight of shoot and fresh weight of root and dry weight of shoot and root were documented in control (sequential crop after tomato) as compared to control (without sequential crop after tomato), this may be due to sequential cropping which improves soil health. Higher mycorrhizal colonization leads to a positive impact on growth parameters. The results of the present investigation are in agreement with the findings of Reddy 2017. When sugarcane was planted after Crotalaria spectabilis, as demonstrated by Caceres and Alcarde (1995) and Mascarenhas *et al.,* (1998), it had a favourable impact on stalk yields. Sugarcane was also planted after sunnhemp and velvet bean.

In the present study, the soils of the pots were examined for microbial population. The population of fungi, actinomycetes and bacteria were observed and found that AMF contributed to significant quantitative changes. Microbial population was higher in both the treatments as compare to control. This may be due to arbuscular mycorrhizal fungi, being obligate are usually maintained on a suitable host in pot cultures and these pot cultures often get contaminated with other soil microorganisms (Secilia and Bagyaraj 1987). Soil microbial population was more in tomato-onion rotation as compare to without rotation. Similarly Sileshi *et al.,* (2008) found an increase in soil macrofaunal richness and abundance in maize-legume rotations when compared to continuously cropped maize. Changes in the soil's physico-chemical composition brought on by more diverse cropping could be one of the main factors for this rise in belowground microbial diversity (Dias *et al.,* 2015). Crop rotations are known to affect the soil's physical composition, improve the efficiency of the soil's water consumption, and reduce temperature fluctuations by increasing the amount of ground cover and soil organic matter. Additional research has demonstrated that some bacterial and fungal species are host-specific in agricultural environments (Smalla *et al.,* 2001; Wardle *et al.,* 2004; Berg and Smalla, 2009).

Conclusion

The implementation of the sequential cropping system affected the amount of arbuscular mycorrhizal fungi in the soil, particularly following tomato cultivation during the kharif season. This resulted in an increase in mycorrhizal

colonisation, spore count, and mycorrhizal reliance, as well as in plant development. The results of our study demonstrate that AMF boosting break crops has a greater production impact than fertilisation (e.g., phosphorus), which provides important insights to enhance agricultural practices in the face of growing drought occurrences and shortages in fertiliser supplies. Despite the paucity of research on plant-soil interactions in agricultural settings, we draw attention to the potential assistance that favourable plant-soil feedbacks may provide in the creation of a more sustainable food production system.

Author contributions

The conceptualization of research (S.S., N.S., S.K. and S.K.A.); Designing of the experiments (S.S., N.S., R.K.C. and S.K.); Execution of field experiments and data collection (S.S., R.K.C., H.K. and S.U.N.); Analysis of data and interpretation (N.S., S.K., S.K.A. and S.U.N.); writing–original draft preparation, S.S., N.S., S.K. and H.K.; writing–review and editing, S.S., R.K.C., S.K. and S.U.N.; Preparation of the manuscript (S.S., S.K. and S.K.A.).

Conflict of interest

No

Declaration

The authors declare no conflict of interest.

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