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ASSESSMENT OF ARBUSCULAR MYCORRHIZAL ASSOCIATION IN SOME FRUIT AND SPICE PLANTS OF RANGAMATI HILL DISTRICT

M. A. H. Bhuiyan[1], M. B. Banu[2] and M. Rahman[3]

Abstract

Rhizosphere soils of some fruit and spice plants from the Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Raikhali, Rangamati were collected during 2011-12 and 2012-13 for counting Arbuscular Mycorrhizal (AM) spore population, determining colonization (%) in their roots and studying AM structure. Assessment of spore population was done by following the Wet Sieving and Decanting Method. The percentage of AM infection was estimated by root slide technique. The spore number of 100g rhizosphere soil was recorded ranging from 120 in rhizosphere soil of Malta plant to a maximum of 410 in Atafal and Sofeda plants during 2011-12 and from 75 in rhizosphere soil of Phalsa plant to a maximum of 327 in Amlaki plant during 2012-13. Different fruit and spice plants showed different percentages of root colonization by AM fungi. Among the fruit and spice plants, the highest colonization (40%) was found in Jabotica, Phalsa and Sofeda plant, and the lowest colonization (6.6%) was found in Rambutan plant during 2011-12, but in 2012-13 the highest (61.3%) was result was observed in Bilatigab plant and the lowest (18.7%) was in Misti lebu, Malta and Tetul plant. The AM fungal structure in the root system of the selected fruit and spice plants varied in irrespective of fruit and spice species. Some plants had vesicles. Hyphae were present in most of the plants. Some plant species recorded Arbuscules. Both oval and spherical shape vesicles were found in this study.

Keywords: Arbuscular mycorrhiza, spore population, root colonization, fruit & spice plants

Introduction

Mycorrhizae are symbiotic association between beneficial soil fungi and plant roots. Vesicular-arbuscular mycorrhizae (VAM) are the mycorrhizae of crop plants and most annual and woody natives. They do not produce visible mushroom-type reproductive structures, but form spores that are the largest of any fungi. They cannot be grown in laboratory conditions, but they can grow with a wide variety of host plants. They have an important role in increasing plant uptake of poorly mobile nutrients such as P, Zn and Cu (O'Keefe and Sylvia, 1991). Mycorrhizal plants are more resistant to some pathogens, have altered production of plant hormones, and have more highly branched root systems than non-mycorrhizal plants. Cuttings of some species have an improved

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[1]Principal Scientific Officer, Soil Microbiology Laboratory, Bangladesh Agricultural Research Institute (BARI), Gazipur-1701, Bangladesh, [2&3]Scientific Officer, Soil Microbiology Laboratory, BARI, Gazipur-1701, Bangladesh.

rooting ability when the medium contains mycorrhizal fungi. Many of the benefits, even those which seem unrelated to phosphorus, appear to actually be side benefits of improved phosphorus nutrition. The soil, as well as the plants, is affected by mycorrhizal fungi. The hyphae are an important component of soil structure, holding together crumbs that allow penetration of water and air, and encourage the growth of roots through the soil. Out of the different types of mycorrhizae, the AM fungi are the most widely occurring mycorrhizae and are very important in relation to the improvement of agricultural and horticultural crops and forest trees in hilly areas (Mridha and Xu, 2001).

Arbuscular mycorrhizal fungi (AMF) that form symbiotic relationships with the roots of most terrestrial plants are known to improve the nutritional status of their host and to protect plants against several soil-borne plant pathogens (Smith and Read, 1997; Harrison, 1999; Bi *et al*., 2007). The major effect of mycorrhizal fungi in undisturbed ecosystems is to improve by the growth of mycorrhizal plants compared to non-mycorrhizal plants (Plenchette *et al*., 1983). It covers the root of plants so it makes protective physical barrier against diseases also (McAllister *et al.*, 1997; Karagiannidis *et al*., 2002).

There are many disease management methods such as crop rotation, use of resistant varieties and chemical pesticides. However, frequent and indiscriminate use of these pesticides affects the physical, chemical and biological property of the soil. It also affects the non-target organisms and has developed resistance among the pathogen against these chemicals (Arwry and Quandt, 2003). Biocontrol potential of AM fungi against various phytopathogens is well documented (Singh *et al*., 2000; Kasiamdari *et al*., 2002; Azcón-Aguilar *et al*., 2002; Bodker *et al*., 2002; Xavier and Boyetchko, 2014; St-Arnaud and Elsen, 2005; St-Arnaud and Vujanovic, 2007). Arbuscular Mycorrhizal Fungi (AMF) are the major component of the rhizosphere of most of the plants and play a very important role as biocontrol agent and help in decreasing plant disease incidence (Akthar and Siddiqui, 2008).

They form three-way associations involving plants, fungi and soils. Bangladesh produces a variety of fruits and spices. It seems that there is an important role of arbuscular mycorrhizal fungi in nutrient availability for these fruit and spice plants. But still no work has been done to assess the mycorrhizal association with different fruit plants. So, this present work was undertaken to know the percent root colonization of fruit and spice plants and the number of AM spores in the rhizosphere soils for producing suitable inoculum for future use in different crops.

Materials and Method

Rhizosphere soils of some fruit and spice plants from the Hill Agricultural Research Station (HARS), Bangladesh Agricultural Research Institute (BARI), Raikhali, Rangamati were collected during 2011-12 and 2012-13 for the assessment of arbuscular mycorrhizal association. Rhizosphere soils with thin roots were collected from the plants, the list is presented in Table 1.

Table 1. List of plants collected from HARS, Raikhali, Rangamati during 2011-12 and 2012-13

Local name	English name	Scientific name	Family
Aam	Mango	*Mangifera indica*	Anacardiaceae
Amlaki	Aonla	*Phyllanthus emblica*	Euphorbiaceae
Amra	Hog plum	*Spondias mangifera*	Anacardiaceae
Anar	Pomegranate	*Punica granatum*	Punicaceae
Alubukhara	Pulm/Peach	*Prunus persica*	Rosaceae
Arboroy	Star gooseberry	*Phyllanthus acidus*	Euphorbiaceae
Ashfal	Longan	*Nephelium longana*	Sapindaceae
Atafal	Bullock’s heart	*Annona reticulata*	Annonaceae
Avocado	Avocado	*Persea americana*	Lauraceae
Batabilebu	Pummelo	*Citrus grandis*	Rutaceae
Bael	Wood apple/Bael	*Aegle marmelos*	Rutaceae
Bilatigab	Velvet apple	*Diospyros discolor*	Ebenaceae
Bilimbi	Bilimbi	*Averrhoa bilimbi*	Oxalidaceae
Bokful	Heron flower	*Sesbania grandiflora*	Fabaceae
Chalta	Indian dillenta	*Dillenia indica*	Dilleniaceae
Cherryfal	Cherry	*Prunus avium*	Rosaceae
Coco	Cocoa	*Theobroma cocoa*	Malvaceae
Cowfal	Cowa	*Garcinia cowa*	Clusiaceae
Dalim	Pome granate	*Punica granatum*	Punicaceae
Dewa	Monkey jackfruit	*Artocarpus lakoocha*	Moraceae
Gab (Deshi)	River ebony	*Diospyros peregrina*	Ebenaceae
Golapjam	Rose apple	*Syzygium jambos*	Myrtaceae
Jabotica	Jabuticaba	Myrciaria cauliflora	Myrtaceae
Jalpai	Indian oliva	*Olea europaea*	Oleraceae
Jam	Jamun	*Syzygium cumini*	Myrtaceae
Jamrul	Wax jambu	*Syzygium samarengense*	Myrtaceae
Jamir	Rough lemon	*Citrus jambhiri*	Rutaceae
Jilapifal	Jungle jalebi	*Pithecellobium dulce*	Fabaceae
Kamranga	Carambola	*Averrhoa carambola*	Oxalidaceae
Karamcha (Misti)	Carunda (sweet)	*Carissa carandas*	Apocynaceae
Khejur	Date palm	*Phoenix dactylifera*	Palmae
Kodbel	Elephant apple	*Feronia elephantum*	Rutaceae
Komola	Orange/Mandarin	*Citrus reticulata*	Rutaceae
Lebu (Misti)	Sweet lime	*Citrus limettioides*	Rutaceae

Local name	English name	Scientific name	Family
Lotkan	Burmese grape	*Baccaurea sapida*	Euphorbiaceae
Macadamia	Macadamia nut	*Macadamia integrifolia*	Proteaceae
Mahuafal	Butter fruit	*Madhuka indica*	Sapotaceae
Malta	Sweet orange	*Citrus sinensis*	Rutaceae
Panifal	Water chestnut	*Trapa bispinosa*	Trapaceae
Peachfal	Peach	*Prunus persica*	Rosaceae
Persimmon	Persimmon	*Diospyros kaki*	Ebenaceae
Peyara (Thai)	Guava	*Psidium guajava*	Myrtaceae
Peyara (Seedless)	Guava	*Psidium guajava*	Myrtaceae
Phalsa	Phalsa/Dhamani	*Grewia asiatica*	Tilaiaceae
Rambutan	Rambutan	*Nephelium lappaceum*	Sapindaceae
Sajna	Drumstick	*Moringa oleifera*	Moringaceae
Satkara	Satkara	*Citrus macroptera*	Rutaceae
Sharifa	Custard apple	*Annona squamosa*	Annonaceae
Sofeda	Sapota	*Manilkara achras*	Sapotaceae
Tarokafal	Star apple	*Chrysophyllum cainito*	Sapotaceae
Tetul	Tamarind	*Tamarindus indica*	Fabaceae
Tuthfal	Mulberry	*Morus indica*	Moraceae

Assessment of spore population density

Assessment of spore population was done by following the Wet Sieving and Decanting Method (Gerdemann and Nicolson, 1963). Soil samples from the rhizosphere of the respective plant species were mixed thoroughly by breaking up any large lumps. Any large unwanted particles such as stone, roots, twigs etc. were removed. Then 100 g of mixed soil was kept in a series of buckets (8-litre) and filled three quarters with tap water. The soil with water was agitated by stirring vigorously by hand and left to settle for some minutes. Two sieves (400 μm and 100 μm mesh) were used throughout the experiment. The supernatant was poured through a 100 μm sieve into the second bucked (10-litre) to avoid the loss of useful materials. The supernatant was decanted into the 400 μm sieve. This time water was discarded and the material was back washed from the sieve into a beaker (250 mL) with a small quantity of water. The solution with spores was distributed in 4 equal size test tubes evenly and balanced up the tubes with water for equal weight. The tubes were plugged properly and then centrifuged for 4 minutes at 3,000 rpm. The supernatant was poured in test tubes and the test tubes were filled with sucrose solution and stirred vigorously with the round-ended spatula to re-suspend the precipitate. The plugged test tubes were centrifuged for 15 seconds at 3,000 rpm. After centrifuge, the sucrose supernatant was poured through a 400 μm sieve and rapidly washed with water to remove the sucrose from AM spores by back washing the materials from the sieve into watch glass for observation.

Counting of AM spores

All the AM spores were isolated from the extract with the help of a fine forcep into a watch glass with small quantity of water. The extract, with AM spores, was observed under stereomicroscope and the number of spores was counted. Spore numbers from the three replicates per samples were averaged and the result was expressed as number per 100 g of dry soil basis.

Assessment of root colonization infection

The percentage of AM infection was estimated by root slide technique (Read *et al*., 1976). One hundred root segments were examined for each sample. The stained root pieces were mounted in acidic glycerol on slides and the cover slip was placed, and slightly pressed. The roots were observed under microscope. A root segment was considered as positively infected, if it showed mycelium, vesicles and arbuscules or any other combination of these structural characteristics of AM infection. The presence or absence of infection in the root pieces was recorded and the percent infection was calculated as follows:

$$\% \text{ root colonization} = \frac{\text{Number of AM positive segments}}{\text{Total number of segments observed}} \times 100$$

Methods of chemical analysis:

Soil pH was measured by a combined glass calomel electrode (Jackson, 1958). Organic carbon was determined by wet oxidation method (Page *et al.*, 1982). Total N was determined by modified Kjeldahl method (Page *et al.*, 1982). Calcium, K and Mg were determined by NH_4OAc extraction method. Copper, Fe, Mn and Zn were determined by DTPA extraction followed by AAS reading. Boron was determined by $CaCl_2$ extraction method. Phosphorus was determined by Bray and Kurtz method. Sulphur was determined by $CaH_4(PO_4)_2.H_2O$ extraction followed by turbidimetric turbidity method with $BaCl_2$. The soil had pH value 5.7 with organic matter 1.83%, exchangeable Ca 6.0 meq $100g^{-1}$, exchangeable Mg 2.1 meq $100g^{-1}$, exchangeable K .18 meq $100g^{-1}$, Total N 0.10%, available P 16 µg g^{-1}, available S 12 µg g^{-1}, available B 0.16 µg g^{-1}, available Cu 1.90 µg g^{-1}, available Fe 48 µg g^{-1}, available Mn 10.4 µg g^{-1}, available Zn 2.87 µg g^{-1}.

Results and Discussion

Spore population of AM fungi

Arbuscular mycorrhizal spores were assessed from different fruit and spice plants (Tables 2 and 3). During 2011-12, the highest spore number (410 per 100 g soil) was obtained from the rhizosphere soil of Atafal and the lowest spore number (120 per 100 g soil) was obtained from Malta plant (Table 2). Some of the fruit and spice plants like Anar, Atafal, Bael, Bilimbi, Jam, Jamrul, Jilapifal, Kamranga, Khejur, Peyara (Thai), Rambutan, Sajna, Sofeda and Tetul plants recorded more than 300 spores per 100 g rhizosphere soil during the first year (2011-12). During 2012-13, the highest spore number (327 per 100 g soil) was obtained from the rhizosphere soil of Amlaki plant and the lowest spore number (75 per 100 g soil) was obtained from Phalsa plant (Table 3). Some of the plants like Amlaki, Cherryfal and Lotkan plant recorded more than 300 spores per 100 g rhizosphere soil during the second year. There were wide variations in shape, size and colour of spores. Different shape and sizes of spore like round, oval, spherical etc. were found among the rhizosphere soils of different fruit and spice plants. In case of colours, like deep brown, light brown, radish, black, etc. were recorded in rhizosphere soils of different fruit and spice plants.

Table 2. Spore population of arbuscular mycorrhizae in rhizosphere soil and root infection of different fruit and spices plants of HARS, Raikhali, Rangamati during 2011-12.

Local name	English name	Spore number per 100 g soil[a]	Root colonization[a] (%)	AM structure[b]			
				H	A	V	VS
Aam	Mango	205.0 ± 8.7	10.0 ± 1.2	+	+	-	-
Amlaki	Aonla	185.0 ± 11.5	9.3 ± 1.2	+	-	-	-
Amra	Hog plum	280.0 ± 11.5	38.0 ± 4.2	+	-	-	-
Anar	Pomegranate	322.0 ± 12.7	20.0 ± 2.9	+	-	-	-
Alubukhara	Pulm/Peach	325.0 ± 8.7	10.0 ± 1.2	+	-	-	-
Arboroy	Star gooseberry	210.0 ± 11.5	28.7 ± 1.9	+	-	-	-
Ashfal	Longan	275.0 ± 8.7	20.0 ± 2.3	+	-	+	O
Atafal	Bullock's heart	410.0 ± 11.5	10.0 ± 1.2	+	-	-	-
Avocado	Avocado	250.0 ± 8.7	20.0 ± 2.9	+	-	-	-
Batabilebu	Pummelo	270.5 ± 11.5	18.7 ± 1.9	+	-	-	-
Bael	Wood apple/Bael	350.0 ±11.5	20.0 ± 2.9	+	-	-	-
Bilatigab	Velvet apple	195.0 ± 8.7	20.0 ± 2.9	+	-	-	-
Bilimbi	Bilimbi	320.0 ± 11.5	18.7 ± 4.1	+	-	-	-
Bokful	Heron flower	170.0 ± 8.7	20.0 ± 2.9	+	-	-	-
Chalta	Indian dillenta	180.0± 11.5	10.7 ± 1.2	+	-	-	-
Cherryfal	Cherry	140.0 ± 8.7	9.3 ± 0.6	+	+	-	-
Coco	Cocoa	195.0 ± 8.7	6.9 ± 1.2	+	-	-	-
Cowfal	Cowa	265.0 ± 8.7	30.0 ± 2.9	+	-	-	-
Dalim	Pome granate	225.0 ± 14.4	20.0 ± 2.9	+	-	-	-
Dewa	Monkey jackfruit	290.0 ± 17.3	10.0 ± 1.2	+	-	-	-
Gab (Deshi)	River ebony	210.0 ± 5.8	30.0 ± 2.9	+	-	-	-

Local name	English name	Spore number per 100 g soil[a]	Root colonization[a] (%)	AM structure[b]			
				H	A	V	VS
Golapjam	Rose apple	180.0 ± 5.8	20.0 ± 2.9	+	-	-	-
Jabotica	Jabuticaba	185.0 ± 14.4	40.0 ± 5.8	+	-	-	-
Jalpai	Indian oliva	195.0 ± 8.7	28.7 ± 3.2	+	-	-	-
Jam	Jamun	320.0 ± 11.5	21.6 ± 0.9	+	-	-	-
Jamrul	Wax jambu	320.0 ± 17.3	10.0 ± 1.2	+	-	-	-
Jamir	Rough lemon	250.0 ± 5.8	28.7± 3.2	+	+	+	S
Jilapifal	Jungle jalebi	300.0 ± 28.9	20.0 ± 2.3	+	-	-	-
Kamranga	Carambola	325.0 ± 14.4	18.7 ± 2.2	-	+	-	-
Karamcha (Misti)	Carunda (sweet)	190.0 ± 11.5	10.0 ± 0.6	+	-	+	O
Khejur	Date palm	321.7 ± 14.8	20.0 ± 1.2	+	-	-	-
Kodbel	Elephant apple	210.0 ± 5.8	18.7 ± 0.9	+	-	-	-
Komola	Orange/Mandarin	215.0 ± 8.7	28.7 ± 1.3	+	-	-	-
Lebu (Misti)	Sweet lime	185.0 ± 8.7	28.3 ± 1.2	+	-	-	-
Lotkan	Burmese grape	210.0 ± 17.3	28.7 ± 0.9	+	-	-	-
Macadamia	Macadamia nut	190.0 ± 17.3	20.0 ± 1.2	+	+	-	-
Mahuafal	Butter fruit	200.0 ± 23.1	20.0 ± 1.7	+	-	-	-
Malta	Sweet orange	120.0 ± 8.7	18.7 ± 1.3	+	+	-	-
Panifal	Water chestnut	270.0 ± 8.7	20.0 ± 1.7	+	-	-	-
Peachfal	Peach	230.0 ± 5.8	10.0 ± 1.2	+	-	-	-
Persimmon	Persimmon	220.0 ± 11.5	10.0 ± 1.2	+	-	+	S
Peyara (Thai)	Guava	300.0 ± 23.1	30.0 ± 1.7	+	-	-	-
Peyara (Seedless)	Guava	251.7 ± 41.1	20.0 ± 2.9	+	-	-	-
Phalsa	Phalsa/Dhamani	292.0 ± 4.6	40.0± 2.9	+	-	-	-
Rambutan	Rambutan	318.0 ± 6.9	6.6 ± 0.9	+	+	-	-
Sajna	Drumstick	300.0 ± 17.3	30.0 ± 1.7	+	-	-	-
Satkara	Satkara	190.0 ± 5.8	18.3 ± 3.3	+	-	-	-
Sharifa	Custard apple	172.0 ± 4.6	10.0 ± 0.6	+	-	-	-
Sofeda	Sapota	410.0 ± 11.5	40.0 ± 2.9	+	-	-	-
Tarokafal	Star apple	250.0 ± 28.9	20.0 ± 1.7	+	-	-	-
Tetul	Tamarind	327.0 ± 15.6	18.7 ± 1.7	+	-	-	-
Tuthfal	Mulberry	175.0± 8.7	30.0 ± 1.7	+	-	-	-

[a]Percent root colonization & spore population are the means ± S.E. of three independent counts.

[b]H= Hypae, A=Arbuscle, V=Vesicle, VS= Vesicle Shape, O=Oval, S=Spherical

Table 3. Spore population of arbuscular mycorrhizae in rhizosphere soil and root infection of different fruit and spices plants of HARS, Raikhali, Rangamati during 2012-13.

Local name	English name	Spore number per 100 g soil [a]	Root colonization[a] (%)	AM structure[b]			
				H	A	V	VS
Aam	Mango	266.0 ± 22.5	31.0 ± 3.8	+	-	+	O
Amlaki	Aonla	327.0 ± 1.7	30.0 ± 2.9	+	-	-	-
Amra	Hog plum	257.3 ± 29.2	20.0 ± 2.9	+	-	-	-
Anar	Pomegranate	96.0 ± 6.4	20.7 ± 3.5	+	-	-	-
Alubukhara	Pulm/Peach	140.3 ± 14.1	20.7 ± 3.5	+	-	-	-
Arboroy	Star gooseberry	195.0 ± 14.4	20.0 ± 2.9	+	-	-	-
Ashfal	Longan	200.0 ± 17.3	21.3 ± 4.1	+	-	-	O
Atafal	Bullock's heart	175.0 ± 17.3	21.3 ± 4.1	+	-	-	-
Avocado	Avocado	223.0 ± 7.5	20.0 ± 2.9	+	-	-	-
Batabilebu	Pummelo	205.3 ± 14.1	20.0 ± 2.9	+	-	-	-
Bael	Wood apple/Bael	190.0 ± 23.0	21.3 ± 1.9	+	-	-	-
Bilatigab	Velvet apple	240 ± 11.5	61.3 ± 4.1	+	-	-	O
Bilimbi	Bilimbi	92.3 ± 7.2	20.0 ± 2.9	+	+	+	+
Bokful	Heron flower	155.3 ± 11.8	21.0 ± 3.8	+	-	-	-
Chalta	Indian dillenta	198.3 ± 4.9	21.0 ± 4.1	+	-	-	-
Cherryfal	Cherry	316.7 ± 23.3	20.0 ± 2.9	+	+	+	S
Coco	Cocoa	82.3 ± 7.2	21.0 ± 3.8	+	-	-	-
Cowfal	Cowa	156.0 ± 17.9	21.3 ± 4.1	+	-	-	-
Dalim	Pome granate	262.3 ± 38.9	30.0 ± 2.9	+	-	-	-
Dewa	Monkey jackfruit	287.3 ± 47.6	20.0 ± 2.9	+	-	-	-
Gab (Deshi)	River ebony	134.7 ± 35.0	20.7 ± 3.5	+	-	-	-
Golapjam	Rose apple	158.3 ± 0.9	21.0 ± 3.8	+	-	-	-
Jabotica	Jabuticaba	125.0 ± 2.9	20.0 ± 2.9	+	-	-	-
Jalpai	Indian oliva	291.7 ± 20.5	20.0 ± 2.0	+	-	-	-
Jam	Jamun	217.3 ± 7.2	30.0 ± 2.9	+	-	-	-
Jamrul	Wax jambu	215.3 ± 26.0	30.0 ± 2.9	+	-	-	-
Jamir	Rough lemon	204.0 ± 44.5	20.0 ± 2.9	+	-	-	-
Jilapifal	Jungle jalebi	89.3 ± 8.3	20.7 ± 3.5	+	-	-	-
Kamranga	Carambola	155.0 ± 1.2	20.0 ± 2.9	+	-	-	-
Karamcha (Misti)	Carunda (sweet)	280.0 ± 5.8	28.7 ± 1.9	+	-	-	-
Khejur	Date palm	283.0 ± 27.1	21.0 ± 3.8	+	-	-	O
Kodbel	Elephant apple	154.0 ± 0.6	28.7 ± 1.9	+	-	-	-
Komola	Orange/Mandarin	122.3 ± 21.7	18.7 ± 1.9	+	+	-	-

Local name	English name	Spore number per 100 g soil [a]	Root colonization[a] (%)	AM structure[b]			
				H	A	V	VS
Lebu (Misti)	Sweet lime	310.0 ± 11.5	20.0 ± 2.9	+	-	-	-
Lotkan	Burmese grape	239.0 ± 19.6	18.7 ± 1.9	+	-	-	-
Macadamia	Macadamia nut	188.3 ± 10.7	20.0 ± 2.9	+	-	-	O
Mahuafal	Butter fruit	202.3 ± 4.3	30.0 ± 2.9	+	-		-
Malta	Sweet orange	215.0 ± 31.8	18.7 ± 1.9	+	-	-	-
Panifal	Water chestnut	188.3 ± 18.2	20.0 ± 2.9	+	-	-	-
Peachfal	Peach	220.0 ± 5.8	30.0 ± 2.9	+	-	-	-
Persimmon	Persimmon	167.3 ± 4.3	21.3 ± 4.1	+	-	-	-
Peyara (Thai)	Guava	108.3 ± 10.7	30.0 ± 2.9	+	-	-	-
Peyara (Seedless)	Guava	182.3 ± 13.0	20.0 ± 2.9	+	-	-	-
Phalsa	Phalsa/Dhamani	75.0 ± 11.5	21.3 ± 4.1	+	-	-	O
Rambutan	Rambutan	97.3 ± 4.3	30.0 ± 2.9	+	-	-	-
Sajna	Drumstick	131.3 ± 2.6	20.0 ± 2.9	+	-	-	-
Satkara	Satkara	290.3 ± 11.6	28.7 ± 1.9	+	-	-	-
Sharifa	Custard apple	160.3 ± 12.7	20.0 ± 2.9	+	-	-	-
Sofeda	Sapota	282.3 ± 7.2	20.0 ± 2.9	+	-	+	S
Tarokafal	Star apple	101.3 ± 3.8	30.0 ± 2.9	+	-	-	-
Tetul	Tamarind	186.7 ± 19.3	18.7 ± 1.9	+	-	-	-
Tuthfal	Mulberry	166.0 ± 22.5	30.0 ± 2.9	+	-	-	-

[a]Percent root colonization & spore population are the means ± S.E. of three independent counts.

[b]H= Hypae, A=Arbuscle, V=Vesicle, VS= Vesicle Shape, O=Oval, S=Spherical.

In the present study, the spore density in the rhizosphere soil varied in different fruit and spice plants which were supported by Howeler *et al*. (1987) who reported that the intensity of spore density varied on different factors like plant species and genera and nature of rhizosphere soil. Moreover, higher spore population was observed in some fruit and spice plants. The stimulating effects of organic matter, comparatively higher level of N and P might have created a favourable condition for the maximum sporulation of AM fungi in that particular field.

Root colonization

Different fruit and spice plants showed different percentages of root colonization by Arbuscular mycorrhizal fungi (Tables 2 and 3). During the first year study (2011-12), the root colonization varied from 6.6% to 40.0% (Table 2). More than 30% colonization was recorded with Amra, Cowfal, Gab, Jabotica, Peyara

(Thai), Phalsa, Sajna, Sofeda and Tuthfal rhizospheres. The lowest colonization (6.6%) was recorded in Rambutan plants. During the second year (2012-13), root colonization varied from 18.7% to 61.3% (Table 3). Similar to the first year, above 30% colonization was noted with Aam, Amlaki, Bilatigab, Dalim, Jam, Jalpai, Mahuafal, Peyara (Thai), Rambutan, Tarakafal and Tuthfal plants. Among them, the highest colonization (61.3%) was found in Bilatigab plant. The lowest colonization (18.7%) was recorded in Malta, Lebu (Misti) and Tetul plant. A large variation was observed in the colonization among different fruit and spice plants. This variation might be due to the differences in the structure of root system and P uptake (Hetrick *et al*., 1992) and also might be due to genetic variations (Mercy *et al*., 1990).

AM structure

The AM fungal structure in the root system of the selected fruit and spice plants varied in irrespective of fruit and spice species (Tables 2 and 3). There were some plants which had vesicles. Hyphae were present in most of the plants. Some plant species recorded Arbuscules. Both oval and spherical shape vesicles were found in this study, which was supported by Khanam *et al*. (2003, 2004).

Spore number and root colonization varied from plant to plant in the present study. But variations in spore number in different plants were not related to per cent root colonization which is in agreement with Khalil *et al*. (1992). As a wide range of host, fungal and environmental factors are known to influence AM formation and subsequent spore production; these two phenomena may not necessarily be related.

Conclusion

It is evident from the study that spore number and root colonization varied from plant to plant. Variations in spore numbers in different plants were not related to per cent root colonization. The AM fungal structure in the root system of the selected spices and fruit plants also varied in irrespective of fruit and spice species. A wide range of host, fungal and environmental factors might have influenced AM formation and subsequent spore production. Higher root colonization of fruit and spices plants and higher number of AM spores in the rhizosphere soils can be selected for producing suitable inoculum for future use.

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