

ARBUSCULAR MYCORRHIZAL FUNGI FROM THE RHIZOSPHERES OF SOYBEAN CROPS IN LAMPUNG AND WEST JAVA*)

K. KRAMADIBRATA

Research and Development Centre for Biology - Indonesian Institute of Sciences, Bogor, Indonesia

E.I. RIYANTI and R.D.M. SIMANUNGKALIT

Central Research Institute for Food Crops, Agency for Agricultural Research and Development, Bogor, Indonesia

ABSTRACT

The occurrence of arbuscular mycorrhizal (AM) fungi in the rhizospheres of field-grown soybean crops in the provinces of Lampung and West Java was examined. Nineteen taxa of AM fungi were identified as follows: *Acaulospora delicata*, *A. Foveata*, *A. rehmi*, *A. scrobiculata* and *A. tuberculata*; *Gigaspora* cf. *gigantea* and *Gigaspora* sp. 1; *Glomus claviformis*; *Glomus* cf. *fasciculatum*, *Glomus micro-aggregatum*, *Glomus* sp. 1, *Glomus* sp. 2, *Glomus* sp. 3 and *Glomus* sp. 4; *Scutellospora* cf. *heterogama*, *Scutellospora* cf. *pellucida*, *Scutellospora* sp. 1, *Scutellospora* sp.2. and *Scutellospora* sp. 3.

Key words: Mycorrhizas/Soybean/Rhizosphere fungi/Identification.

INTRODUCTION

There are only a few reports on arbuscular mycorrhizal (AM) fungi derived from the rhizospheres of food crops in Indonesia. Widiastuti and Kramadibrata (1992) reported on some AM fungi from the acid soils of West Java, among others from the rhizospheres of corn. Soybean is one of the main staple foods in Indonesia. It is often grown on uplands as well as on lowlands after rice in the dry season. However, the information on AM species and its distribution has never been reported. Schenck and Smith (1982) investigated three AM fungi which occurred in soybean in Florida, U.S.A., i.e. *Glomus claroideum*, *G. tortuosum* and *Gigaspora albida*.

The purpose of this paper is to report on species and distribution of AM fungi from the rhizospheres of field-grown soybeans in the provinces of Lampung and West Java.

*)Paper presented at the Second Symposium on Biology and Biotechnology of Mycorrhizae and Third Asian Conference on Mycorrhizae (ACOM 111), 19-21 April 1994, Yogyakarta, Indonesia.

MATERIALS AND METHODS

The soybean-grown upland areas in Lampung (Central Lampung) and West Java (Garut and Bogor) have been selected for soil sampling. Soil samples were collected from ten locations (four in Central Lampung, two in Garut and four in Bogor). Some soil characteristics and number of AM propagules of each location are described in Table 1. pH of the soils measured in water suspension ranged from 4.78 to 6.94. P availability by Bray-2 ranged from 2.32 to 55.59 mg/100 g soil. Infective AM propagules were determined by the 'Most Probable Number' method as described by Sieverding (1991). The number of AM propagules ranged from 383 to 12 266 g air dried soil.

A total of three to five subsamples weighing about one kg were systematically taken from each location at a depth of 0-20 cm. Subsamples were then mixed

Table 1. Some soil characteristics and number of AM propagules in each site

No.	Location	Soil type	Soil pH	Available P (mg/100g soil)	Number of AM (propagules/100 g soil)
<i>Central Lampung</i>					
1.	New Sukadana Village, Sukadana Subdistrict (L1)	Red yellow podsolic	6.01	10.49	667
2.	Suryamataram Village, Sukadana Subdistrict (L2)	Red yellow podsolic	6.28	2.32	383
3.	Gantiwarno Village, Pekalongan Subdistrict (L5)	Red yellow podsolic	5.30	35.17	506
4.	Sidobinangun Village, Seputih Banyak Subdistrict (L6)	Red yellow podsolic	4.78	26.40	1 533
<i>Garut</i>					
5.	Karang Pawitan Central Seed Institute, Karang Pawitan Subdistrict (G1)	Andosol	4.78	26.40	1 162
<i>Bogor</i>					
6.	Cihuni Village, Wanaraja Subdistrict (G2)	Andosol	6.50	55.59	581
7.	Experimental Farm Cikeumeuh I (B1)	Latosol	6.30	13.82	2 324
8.	Experimental Farm Cikeumeuh II (B2)	Latosol	5.86	6.78	766
9.	Experimental Farm Muara I (B3)	Latosol	6.94	53.77	12 266
10.	Experimental Farm Muara II (B4)	Latosol	6.11	6.16	506

thoroughly and air dried. From each sample 100 g of soil were used for spore examinations. Spores were extracted by wet sieving and decanting methods in combination with 48% sucrose (Walker *et al.* 1982), mounted on slides in polyvinyl alcohol-lactic acid-glycerol (PVLG) and then examined under a compound microscope for spore details (100-1000x).

Spores were identified by using the species description of Walker (1983, 1986), Walker and Koske (1987) and Walker and Sanders (1986). Melzer's reagent was used to determine spore wall reaction when necessary. Spore preparations were coded KRS (abbreviations of family names of the authors) and deposited partly at the Central Research Institute for Food Crops and partly at the "Herbarium Bogoriense", Research and Development Centre for Biology-Indonesian Institute of Sciences; both are located in Bogor.

RESULTS AND DISCUSSION

All soil samples collected from Lampung and West Java contained AM fungal spores. However, the species were not distributed evenly as shown in Table 2. Thirteen were identified from the rhizospheres of soybean in Central Lampung, three in Garut, nine in Bogor. The sampling locations New Sukadana and Suryamataram yielded six AM species (highest) each; the Experimental Farm Cikeumeuh I and Cikeumeuh II had five species each; Gantiwarno had four species; Sidobinangun, Experimental Farm Muara I and Muara II had three species each; Karang Pawitan and Cihuni (both located in Garut) had only two AM species each.

Some spores could be identified well because they bore very specific characteristics. Some identified species showed very similar characteristics with known species like *Gigaspora* cf. *gigantea*, *Glomus* cf. *fasciculatum*, *G.* cf. *microaggregatum*, *Scutellospora* cf. *heterogama* and *Scutellospora* cf. *pellucida*. The species of some spores could not be identified due to some problems such as poor condition and the limited number. Species identification will be done after pot cultures of the related soil samples are established. The soil samples from Sukadana contained extramatrical cells of *Scutellospora*, while that from Gantiwarno contained extra-matrical cells of *Gigaspora*.

However, the three species reported by Schenck and Smith (1982) on AM fungi from the rhizospheres of soybean in Florida were not found in soil samples collected from Lampung and West Java.

Table 2. Arbuscular mycorrhizal fungi species from rhizospheres of soybean crop in Lampung and West Java

No.	AM fungi species	Lampung					West Java				
		L1	L2	L5	L6	G1	G2	B1	B2	B3	B4
1.	<i>Acaulospora delicata</i>	-	-	+	-	-	-	-	+	+	+
2.	<i>Acaulospora foveata</i>	-	-	-	-	-	+	-	-	-	-
3.	<i>Acaulospora rehmi</i>	-	-	-	-	-	-	+	-	-	-
4.	<i>Acaulospora scrobiculata</i>	-	+	+	+	-	-	+	-	+	-
5.	<i>Acaulospora tuberculata</i>	-	+	-	-	-	-	+	-	-	+
6.	<i>Gigaspora</i> cf. <i>gigantea</i>	+	+	-	-	-	-	-	-	-	-
7.	<i>Gigaspora</i> sp.1.	+	+	+	-	-	-	-	-	-	-
8.	<i>Glomus clavisporum</i>	-	+	-	-	-	-	-	-	-	-
9.	<i>Glomus</i> cf. <i>fasciculatum</i>	+	-	-	-	-	-	+	+	+	+
10.	<i>Glomus</i> cf. <i>micro-aggregatum</i>	+	-	-	-	-	-	-	-	-	-
11.	<i>Glomus</i> sp.1.	-	+	-	-	-	-	-	-	-	-
12.	<i>Glomus</i> sp.2.	-	-	+	-	-	-	-	-	-	-
13.	<i>Glomus</i> sp.3.	-	-	-	-	+	-	-	-	-	-
14.	<i>Glomus</i> sp.4.	-	-	-	-	-	-	+	-	-	-
15.	<i>Scutellospora</i> cf. <i>heterogama</i>	-	-	-	-	-	-	-	+	-	-
16.	<i>Scutellospora</i> cf. <i>pellucida</i>	-	-	-	-	-	-	-	+	-	-
17.	<i>Scutellospora</i> sp.1.	+	-	-	-	-	-	-	-	-	-
18.	<i>Scutellospora</i> sp.2.	+	-	-	+	+	+	-	+	-	-
19.	<i>Scutellospora</i> sp.3.	-	-	-	+	-	-	-	-	-	-
Number of fungal species		6	6	4	3	2	2	5	5	3	3

The AM fungi from the rhizospheres of soybean in Lampung and West Java are described as follows:

1. *Acaulospora delicata* Walker, Pfeiffer & Trappe

The spores were globose to subglobose, yellow, 94- 116 x 96- 101 μm . The spore surface was smooth. A sporiferous saccule was not observed in any collections made during the study.

Collections examined: KRS#41, KRS#42, KRS#43, KRS#44 and KRS#53, Gantiwarno Village, Pekalongan Subdistrict, Central Lampung District; KRS#82, Experimental Farm Cikeumeuh I, Bogor; KRS#83, Experimental Farm Muara I, Bogor; KRS#94 and KRS#98, Experimental Farm Muara II, Bogor.

2. *Acaulospora foveata* Trappe & Janos

The spore was pale yellow to greenish yellow, globose, 200 x 200 µm. The spore surface was covered with round to oblong sometimes irregular depressions with curved bottom, separated by ridges. A sporiferous saccule was not observed in any collections made during the study.

Collections examined: KRS#60, Cihuni Village, Wanaraja Subdistrict, Garut District.

3. *Acaulospora rehmii* Sieverding & Toro

The spores were yellow, globose to subglobose, 180 - 190 x 190 – 200 µm. The spore surface had labyrinthi form folds with ridges and depressions between ridges. A sporiferous saccule was not observed in any collection made during the study.

Collections examined: KRS#66 and KRS#68, Experimental Farm Cikeumeuh I, Bogor.

4. *Acaulospora scrobiculata* Trappe

The spores were pale yellow to yellow, globose to subglobose, 96-125 x 96 - 135µm. The surface was uniformly pitted with depressions, separated by ridges with a circular, linear or y-shaped pattern. A sporiferous saccule was not observed in any collections made during the study.

Collections examined: KRS#23, Suryamataram Village, Sukadana Subdistrict, Central Lampung District; KRS#55, Sidobinangun Village, Seputih Banyak Sub-district, Central Lampung District; KRS#65 and KRS#69, Experimental Farm Cikeumeuh I, Bogor; KRS#87, Experimental Farm Muara I, Bogor.

5. *Acaulospora tuberculata* Janos & Trappe

The spores were light yellowish brown to light brown, globose to subglobose 220-240 x 210-240 µm. The surface was covered by tubercules. A sporiferous saccule was not observed in any collections made during the study.

Collections examined: KRS#31, Suryamataram Village, Sukadana Subdistrict, Central Lampung District; KRS#70, Experimental Farm Cikeumeuh I, Bogor; KRS#91, KRS#92, KRS#93 and KRS#96, Experimental Farm Muara II, Bogor.

6. *Gigaspora cf. gigantea* (Nicol. & Gerd.) Gerd. & Trappe

The spores were pale yellow, globose to subglobose, 288 - 403 x 384 - 403 μm . The surface was smooth. A bulbous suspensor \pm 40 μm diameter was found on every spore.

Collections examined: KRS#11, KRS#13 and KRS# 18, New Sukadana Village, Sukadana Subdistrict, Central Lampung District; KRS#25 and KRS#27, Surya-mataram Village, Sukadana Subdistrict, Central Lampung District.

7. *Glomus clavisorum* (Trappe) Almeida & Schenck

Sporocarps were brown to dark brown, globose to subglobose, 300-400 x 300-380 μm . Spores were brown to dark brown 100- 120 x 20-40 μm , clavate to subcylindric, tapering to a cylindrical subtending hypha.

Collections examined: KRS#20, KRS#21, KRS#22, KRS#28, KRS#29 and KRS#30, Suryamataram Village, Sukadana Subdistrict, Central Lampung District.

8. *Glomus cf. fasciculatum* (Thaxter *sensu* Gerd.) Gerd. & Trappe emend. Walker & Koske

The spores were pale yellow to pale yellow brown, globose to subglobose, 90-110 x 100- 110 μm . The surface was smooth.

Collections examined: KRS#2, KRS#3 and KRS#19, New Sukadana Village, Sukadana Subdistrict, Central Lampung District; KRS#63, KRS#64 and KRS#71, Experimental Farm Cikeumeuh I, Bogor; KRS#78, KRS#79 and KRS#81; Experimental Farm Cikeumeuh II, Bogor; KRS#84, KRS#86 and KRS#88, Experimental Farm Muara I, Bogor.

9. *Glomus cf. microaggregatum* Koske, Gemma & Olexia

The spores were found as loose aggregate. They were yellow, globose to sub-globose, 39-54 x 35-43 μm . The surface was smooth.

Collections examined: KRS#1, New Sukadana Village, Sukadana Subdistrict, Central Lampung District.

10. *Scutellospora cf. heterogama* (Nicol. & Gerd.) Walker & Sanders

The spores were brown to dark brown, globose to subglobose, 200-300 x 200—300 μm . The surface was ornamented or covered by spines. A suspensor-like cell was found on spore, it was pale brown, \pm 40 μm .

Collections examined: KRS#73 and KRS#74, Experimental Farm Cikeumeuh II, Bogor.

11. *Scutellospora cf. pellucida* (Nicol. & Schenck) Walker

The spores were hyaline to pale yellow, pear-shaped, 160 - 204 x 80 – 102 μm . The surface was smooth. A suspensor-like cell was found on spore, it was hyaline, $\pm 40 \mu\text{m}$

Collections examined: KRS#76 and KRS#77, Experimental Farm Cikeumeuh II, Bogor.

Collections which could not be identified due to poor conditions and the small number of spores are listed below:

12. *Gigaspora* sp.1.

Spores were globose to subglobose, brown to dark brown, 172.8-480 x 211.2-480 μm . The spore had one group of wall consisting of a thin unit wall, $< 1 \mu\text{m}$, hyaline and a brown laminated wall, 10-48 μm thick. The muronym is A(UL). One specimen had a germ tube.

Collections examined: KRS#4, KRS#7, and KRS#17, New Sukadana Village, Sukadana Subdistrict, Central Lampung District; KRS#45, KRS#46, KRS#47, and KRS#52, Gantiwarno Village, Pekalongan Subdistrict, Central Lampung district.

13. *Glomus* sp.1.

Spores were globose or sometimes subglobose, yellow, $\pm 97 \mu\text{m}$, in groups. However, the spores of the specimens were deflated so that spore forms were not distinct, irregular; wall arrangement could not be examined.

14. *Glomus* sp.2.

Spore forms could not be determined because it was deflated; it was pale yellow and in loose aggregate.

Collections examined: KRS#49, Gantiwarno Village, Pekalongan Subdistrict, Central Lampung District.

15. *Glomus* sp.3.

Spores were globose to subglobose, yellow; hyphae were hyaline to pale yellow. Spore sizes were 100- 115 x 90- 104 μm . Wall arrangements could not be analyzed.

Collections examined: KRS#58, Central Seed Institute Karang Pawitan, Karang Pawitan Subdistrict, Garut District.

16. *Glomus* sp.4.

Spores were globose, pale yellow, 172 x 172 μm ; wall was 2 μm thick. Wall arrangements could not be analyzed.

Collections examined: KRS#62 and KRS#67, Experimental Farm Cikeumeuh I, Bogor.

17. *Scutellospora* sp.1.

Spores were ellipsoid, brownish yellow, 288 x 355 μm . Spore wall possibly consisted of two wall groups, A and B. Wall group A consisted of two unit walls, wall 1 was thinner than wall 2, both were brownish yellow. Wall group B had one membranous wall, hyaline and very thin ($< 1 \mu\text{m}$). The muronym is temporarily A (UU) B(M).

Collections examined: KRS#12, New Sukadana Village, Sukadana Subdistrict, Central Lampung District.

18. *Scutellospora* sp.2.

Spores were globose or subglobose, pale brown 220.8 - 280 x 201.6 - 288 μm . The wall may have been structured in two wall groups, A and B. Wall group A consisted of wall 1 and 2. Wall 1 was a unit wall and wall 2 was thicker than wall 1; both were hyaline. Wall 2 appeared to be laminated. Wall group B had one membranous wall. The muronym is A (UU) B(M). Some specimens clearly had a germ shield and an initial germ tube.

Collections examined: KRS#5, KRS#6, KRS#14, KRS#15 and KRS#16, New Sukadana Village, Sukadana Subdistrict, Central Lampung District; KRS#57, Sidobinangun Village, Seputih Banyak Subdistrict, Central Lampung District; KRS059, Karang Pawitan Central Seed Institute, Garut District; KRS#61, Cihuni Village, Wanaraja Subdistrict, Garut District; KRS#75, Experimental Farm Cikeumeuh II, Bogor.

19. *Scutellospora* sp.3.

Spores were globose, brownish yellow, 326 x 326 µm. It has two wall groups, A and B. Wall group A consisted of wall 1, laminated and brown. Wall group B had one membranous wall. The muronym is A(L) B(M).

Collections examined: KRS#56, Sidobinangun Village, Seputih Banyak Sub-district, Central Lampung District.

REFERENCES

- SCHENCK, N.C. & G.S. SMITH. 1982. Additional new and reported species of mycorrhizal fungi (Endogonaceae) from Florida. *Mycologia* 74(1): 771-92.
- SIEVERDING, E. 1991. Vesicular-arbuscular mycorrhiza management in tropical agrosystems. Technical Cooperation, Federal Republic of Germany, Eschborn.
- WALKER, C. 1983. Taxonomic concepts in the Endogonaceae: spore wall characteristics in species description. *Mycotaxon* 18: 443-445.
- WALKER, C. 1986. Taxonomic concepts in the Endogonaceae: II A fifth morphological wall type in Endogonaceous spores. *Mycotaxon* 25: 95-99.
- WALKER, C. & R.E. KOSKE. 1987. Taxonomic concepts in the Endogonaceae: IV *Glomus fasciculatum* redescribed. *Mycotaxon* 30: 253-262.
- WALKER, C., C.W. MAIZE and H.S. McNABB Jr. 1982. Populations of endogonaceous fungi at two locations in Central Iowa. *Canadian Journal of Botany* 60: 2518-2529.
- WALKER, C. & F.E. SANDERS. 1986. Taxonomic concepts in the Endogonaceae: III The separation of *Scutellospora* gen. nov. from *Gigaspora* Gerd. & Trappe. *Mycotaxon* 27: 169-182.
- WIDIASTUTI, H. & K. KRAMADIBRATA. 1992. Jamur mikoriza bervesikula arbuskula di beberapa tanah masam dari Jawa Bar at. *menara Perkebunan* 60: 73-77.