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AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

DATE: 9/10

MEMORANDUM

TO: AID/PPC/CDIE/DI, room 209 SA-18

FROM: AID/SCI, Victoria Ose

SUBJECT: Transmittal of AID/SCI Progress Report(s)

Attached for permanent retention/proper disposition is the following:

AID/SCI Progress Report No. 2. A-04

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PR #4
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PDAAW-679

2. A. 04

PROGRESS REPORT No. 6

ROLE OF VA MYCORRHIZAE IN THE PHOSPHORUS NUTRITION OF ECONOMIC LEGUMINOUS CROPS IN THAILAND

Rec'd in SC DEC 16 1986

A RESEARCH PROJECT
USAID/PSTC PROGRAM
GRANT NO. 936-5542-6-SS-3038-00

YENCHAI VASUVAT

OMSUB NOPAMORNBODI

SUPAPORN THAMSURAKUL

SOIL MICROBIOLOGY BRANCH
SOIL SCIENCE DIVISION
DEPARTMENT OF AGRICULTURE
BANGKOK, THAILAND

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Country	:	Thailand
Grant No.	:	936-5542-6-ss-3038-00
Program	:	Program on Science and Technology Cooperation
Project title	:	Role of VA Mycorrhizae in the Phosphorus Nutrition of Economic Leguminous Crops in Thailand
Project Leader	:	Mrs. Yenchai Vasuvat
Organization	:	Soil Microbiology Research Group, Soil Science Division, Department of Agriculture
Co-investigators	:	Dr. Omsub Nopamornbodi Miss Supaporn Thamsurakul
Project Consultants	:	Dr. Jake Hallidays Dr. Norman Schenck Dr. Ben Bohlool Dr. John Menge

1. Background/Introduction

While mycorrhizae have been studied for many years, very little work has been done in tropical soil. Thailand is unique in growing legume grain crops especially soybean and mungbean which are the major protein component of the rural population. These legumes will be planted after flooded rice in the low phosphorus paddy field. A symbiosis VA mycorrhiza with plant growth can increase greatly the ability of these crops to take up phosphorus from low phosphorus soils, but their survival on their capacity for producing infection in these crops is not known and their effectivity for the legume growth is little known.

Studies are need to determine the extent to which these crops are mycorrhizae, the nature of the organisms involved, the constraints on mycorrhiza performance and the opportunity for enhancing the benefits of mycorrhizae in field-grown soybeans and mungbeans.

Research in mycorrhiza on soybean and mungbean from the last report had been done on pot culture multiplication and maintained the pure culture strains. Some of these strains were evaluated for the effectiveness on phosphorus absorbtion and soybean/mungbean growth. The experiments were done both in the glasshouse and field condition. Three locations : Chiangmai, Kalasin and Prachinburi were selected places to compare the species effectiveness on different kind of soil.

For soybean, some species such as Acaulospora scrobiculata gave the higher yield than uninoculated about 24 % at Chiangmai and 50 % at Kalasin. Mycorrhizal fungi showed more effective in low fertile soil in Kalasin than high fertile soil in Chiangmai. For mungbean the same specie Acaulspora scrobiculata gave the higher yield than uninoculated only 10 % at Kalasin and

gave less yield than uninoculated at Prachinburi. These results did not interpreted as no complete data were combined. Number of spores in soil and percent root colonization from the experiment has to be examined which will be shown in this report.

2. objectives

The overall objectives of this project is to improve the phosphorus nutrition of soybeans (Glycine max), mungbeans (Vigna radiata) in Thailand through assured symbiosis with phosphate absorbing mycorrhizal fungi. The study will be include.

A. Selected effective species of VA mycorrhizal fungi which improve the phosphorus nutrition of soybean and mungbean.

B. Determine the survival of mucorrhizae following flooding of soils for rice by inoculation studies on soybeans and mungbeans.

C. Improve the method of producing the mycorrhizal inoculum for field trial.

The studies in this sixth report are concerned in project A or B and C which are included the studies of the following :-

1. Effect of VA mycorrhizal fungi on phosphorus absorbtion and growth of soybean and mungbean.
2. To determine the survival of mycorrhizal soybean and mungbean following flooding rice.

3. Materials and Methods

3.1 Effect of VA mycorrhizal fungi on phosphorus absorbtion and growth of soybean and mungbean grew in the field at Chiangmai, Prachinburi and Kalasin.

Six species of VA mycorrhizae were used in the experiment :-

Glomus mosseae (Nicol & Gerd) Mos 156 # 6

Glomus # 17 (Mosse)

Glomus intraradices (Schenck & Smith) INT # 26

Acaulospora scrobiculata (Trappe) ASCR # 22

Glomus etunicatum (Becker & Gerd) ETU # 31

Glomus deserticola (Trappe, Bloss and Menge) Des # 39

Two hundred spores of each species were used as inoculum at the bottom of plant hole. After plant germination 30, 60 and 90 days, the number of VA mycorrhizal spores in soil are determined. Five samples of soil were sampling from each plot and spores were extracted from the soil by wet-seiving and decanting method (Gerdemann & Nicolson 1963). Using sieves of 450, 250, 100 and 63 micron pore diameter, spores with 250, 100 and 63 micron were seperated from other debries by sucrose flotation technique (Jenkins 1964). Number of spores were counted under stereo microscope. Percent root colonization were examined by stained root with trypan blue (Phillips and Hayman 1970) to observe the hyphae, arbuscule or vesicle colonization.

The height and dry weight were sampled every 30 days up to harvested time and yield were recorded. All the data are analyzed by statistical comparison using ANOV and Duncan's multiple range test.

3.2 To determine the survival of mycorrhiza soybeans and mungbeans following flooding rice.

The experiments were done continuous to the study of the selected effective species of VA mycorrhizae. Rice variety RD 23

were grown with 25x25 spacing in the same plot with the first study without any inoculation. Ditches were made around each split plot to maintain the water level of 15-20 cms. height.

Every 30 days after transplant soil and root samples in each treatment were collected to determine the percentagae of survival mycorrrhiza spores in the flooded soil and percentage of root colonization. Rice yield from each plot were harvested and the data were analysed for statistic.

4. Results and Discussion

4.1 Effect of VA Mycorrhizal Fungi on Phosphorus Absorbtion and Growth of Soybean and Mungbean grew in the field.

Besides the height, dry weight and yield which were recorded, the percent root colonization and number of spore in soil were also examined which the conclusion of the result are following :-

soybeans :

The result at Chiangmai was shown in table 1 and 2 the mean data showed that soybeans roots were colonized by mycorrhizal fungi even in the uninoculated plot. Mycorrhizal fungi *Acaulospora scrobiculata* # 22 is the most effective species compare to the others. It is not only gave the highest yield but also had the highest percentage of root colonization and highest number of spore in the soil, *Glomus deserticola* # 39 also gave high number of spores and high coloniazation.

The same result was found at Prachinburi province as shown in table 3 and 4.

mungbeans :

The result at Kalasin in table 5 and 6 showed that VA mycorrhiza *Acaulospora scrobiculata* # 22 is also the best specie for mungbean same as in soybean which gave the highest yield, percentage of root colonization and higher number of spores in soil than the others and uninoculated.

At Prachinburi, result in table 7 and 8 showed that mungbean inoculated with *Glomus intraradices* 183 # 26 was better than *Acaulospora scrobiculata* # 22 which is the best at Kalasin might be dued to the low percent root colonization and low spores quantity of ASCR # 22 at Prachinburi compare to *Glomus intraradices* 183 # 26 which gave the highest number of spores in soil and highest percent root colonization.

These results showed that percent root colonization and number of spores in soil will effect the yield of both soybeans and mungbeans. ASCR # 22 having trend to be one promising isolates that can be used to increase crop yield in both soybeans and mungbeans if applied in sufficient amount to infect in high percentage of root colonization.

4.2 To determine the survival of mycorrhiza soybeans and mungbeans following flooding rice.

Inoculated soybeans field

The mean results in table 9-13 of height, shoot dry weight and yield did not show much difference among species and species compare with uninoculated. No fungus colonization was found in the rice root

in every stage of rice growth. This showed that VA mycorrhizal fungi did not infect into the flooded rice root even though there were a number of mycorrhiza spores in every split plot. Number of spores seems to reduce with the time of flooding. All of the data will be interpreted statistically after all the data has been analyzed for statistics.

Inoculated mungbeans field :

Table 14-18 showed the results of flooded rice after mungeans field. The same incidence occurred in the rice field. These were some differences among the means of inoculated species and uninoculated on the rice yield and the number of spores remain in the soil. These data will be analyzed statistically and present in the next report. There was also no incidence of mycorrhizal colonization in the rice root. This can be concluded that mycorrhizal fungi are not infected the rice in the flooded condition.

Workplan for the next period :

All the data shown in this report will be analyzed for statistics then complete interpretation could be made. The percent of rice root colonization and number of spores left in the flooded soil will be determined. The following crop will be planted using soybean and mungbean without inoculation to observed the ability survival and infectivity of these fungi on the crop.

Table 1. Percent root colonization of soybean inoculated with mycorrhizae species at Chiangmai province. (1986)

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	52.8	50.0	51.4	76.0	80.5	78.3	80.0	78.0	79.0
Glomus # 17	58.3	50.8	54.6	45.0	47.5	46.3	43.0	44.0	43.5
INT 183 # 26	43.5	57.8	50.65	49.5	63.0	56.3	42.0	55.0	48.5
ASCR # 22	61.0	59.5	60.3	81.5	77.5	79.5	82.0	86.0	84
ETU 157 # 31	67.0	38.3	52.7	70.5	69.5	70.0	50.0	56.0	53.0
DES 160 # 39	57.0	61.3	59.15	68.5	79.0	73.75	80.0	84.0	82.0
Control	52.5	69.3	60.9	73.5	85.0	79.25	42.0	78.0	60.0
	56.0	55.3		66.4	71.7		59.9	68.7	

Table 2. Number of spore in 100 gram soil grown soybean inoculated with mycorrhizae species at Chiangmai province. (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	204	92	148	165	117	141	118	104	111
Glomus # 17	275	90	182.5	67	65	66	218	144	181
INI 183 # 26	185	141	163	81	87	84	177	164	170.5
ASCR # 22	209	119	164	177	124	150.5	323	168	245.5
ETU 157 # 31	125	199	162	126	94	110	124	89	106.5
DES 160 # 39	128	141	134.5	95	97	96	235	279	257
Control	109	80	94.5	134	100	117	144	178	161
Mean	176.4	111.7		120.7	97.7		191.3	160.9	

Table 3. Percent root colonization of soybean inoculated with mycorrhizae species at Prachinburi province. (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	32.2	23.5	27.9	67.6	56.5	62.1	79.0	86.5	82.8
Glomus # 17	56.9	44.5	50.9	62.0	51.3	56.7	77.5	84.0	80.8
INT 183 # 26	70.1	44.8	57.5	77.0	58.3	67.7	82.0	86.0	84.0
ASCR # 22	22.6	45.7	34.2	48.3	61.8	55.1	86.0	84.0	85.0
ETU 157 # 31	50.3	26.0	38.2	72.8	57.3	65.1	75.5	88.5	82.0
DES 160 # 39	34.0	28.3	31.2	53.3	59.8	56.6	80.0	88.0	84.0
Control	31.4	32.3	31.9	63.3	47.5	55.4	76.0	72.0	74.0
Mean	42.5	35.0		63.5	56.0		79.4	84.1	

Table 4. Number of spore in 100 gram soil grown soybean inoculated with mycorrhizae species at Prachinburi province (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	114	78	96	119	95	107	221	190	205.5
Glomus # 17	135	83	109	50	77	63.5	81	90	85.5
INT 183 # 26	86	101	93.5	109	115	112	97	127	112
ASCR # 22	92	105	98.5	108	155	131.5	247	227	237
ETU 157 # 31	58	197	127.5	149	103	126	188	153	170.5
DES 160 # 39	186	58	122	41	108	74.5	123	120	121.5
Control	113	132	122.5	102	121	111.5	188	101	144.5
Mean	112	107.7		96.9	110.6		163.6	144	

Table 5. Percent root colonization of soybean inoculated with mycorrhizae species at Kalasin province. (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	11.9	9.2	10.6	29.4	23.4	26.4	43.8	29.0	36.4
Glomus # 17	13.0	9.7	11.4	21.8	19.2	20.5	31.3	25.8	28.6
INT 183 # 26	12.4	9.8	11.1	27.4	33.1	30.3	36.5	39.0	37.6
ASCR # 22	13.3	16.1	14.7	31.4	35.6	33.5	36.8	33.8	35.3
ETU 157 # 31	10.1	8.7	9.4	24.6	27.1	25.9	21.8	30.3	26.1
DES 160 # 39	8.6	13.5	11.1	20.4	34.3	27.4	37.5	34.0	35.8
Control	5.8	12.1	9.0	16.8	21.3	19.1	17.3	23.3	20.3
Mean	10.7	11.3		24.5	27.7		32.1	30.7	

Table 6. Number of spore in 100 gram soil grown mungbean inoculated with mycorrhizae species at Kalasin province. (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	44.3	99.0	71.7	83.3	130.8	107.1	157.3	169.5	163.4
Glomus # 17	41.5	82.8	62.2	80.0	126.8	103.4	188.5	199.5	194
INT 183 # 26	41.8	92.3	67.1	137.5	121.8	129.7	196.5	188.8	192.7
ASCR # 22	44.3	119.0	81.7	101.3	148.8	125.1	211.5	255.0	233.3
ETU 157 # 31	29.5	68.8	49.2	107.0	113.5	110.25	217.3	164.8	191.1
DES 160 # 39	80.0	146.8	113.4	110.5	141.3	125.9	288.0	206.0	247
Control	70.8	42.3	56.6	136.5	107.8	122.2	219.3	125.5	172.4
Mean	50.3	93		108.0	127.3		211.2	187.0	

Table 7. Percent root colonization of mungbean inoculated with mycorrhizae species at Prachinburi province. (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	14.9	14.3	14.6	19.6	17.2	18.4	15.8	37.9	26.9
Glomus # 17	21.3	24.7	23	31.6	15.7	23.7	34.0	24.2	29.1
INT 183 # 26	27.9	16.3	22.1	45.7	16.6	31.15	39.8	39.8	39.8
ASCR # 22	19.9	24.6	22.3	16.8	21.6	19.2	31.2	25.0	28.1
ETU 157 # 31	19.1	15.2	17.15	23.6	18.2	20.9	26.3	35.5	30.9
DES 160 # 39	15.3	15.4	15.35	12.9	21.3	17.1	30.7	33.0	31.9
Control	12.1	20.8	16.5	14.8	25.6	20.2	30.0	30.0	30
Mean	18.6	18.8		23.6	19.4		29.7	32.2	

Table 8. Number of spore in 100 gram soil grown mungbean inoculated with mycorrhizae species at Prachinburi province. (1986)

Species	30 days			60 days			90 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	102	86	43	87	60	73.5	33	110	71.5
Glomus # 17	81	69	34.5	50	82	25.41	138	134	136
INT 183 # 26	72	62	31	100	100	100	123	141	132
ASCR # 22	53	59	56	51	113	56.5	108	106	107
ETU 157 # 31	79	64	71.5	68	83	75.5	129	103	116
DES 160 # 39	74	79	76.5	110	70	90	161	151	156
Control	13	68	40.5	74	83	78.5	170	99	134.5
Mean	73.5	69.6		77.1	84.4		123.1	120.6	

Table 9. Average height (cm) of rice grown after mycorrhizae inoculated soybean at Chiangmai province

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	70.9	68.3	69.6	79.0	80.4	79.7	111.2	108.5	109.85
Glomus # 17	69.8	68.3	69.05	79.7	79.6	79.75	110.2	110.2	110.2
INT 183 # 26	71.7	70.2	70.95	79.8	80.2	80.00	112.0	108.7	110.35
ASCR # 22	68.3	72.8	70.55	79.3	79.2	79.25	105.3	108.0	106.65
ETU 157 # 31	68.7	66.0	67.35	79.5	79.7	79.6	108.8	107.0	107.9
DES 160 # 39	68.4	70.2	69.3	79.7	78.8	79.25	110.2	108.9	109.55
Control	69.1	66.4	67.75	82.0	79.6	80.9	110.1	107.8	108.85
Mean	69.55	68.88	69.22	79.85	79.67	79.77	109.68	108.41	109.05

Table 10 . Average shoot dry weight (gm/Pl) of rice grown after mycorrhizae inoculated soybean at Chiangmai province.

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	14.4	8.6	11.5	35.7	25.3	30.5	30.1	24.1	27.1
Glomus # 17	18.3	10.8	14.55	29.1	29.6	29.35	29.2	29.7	29.45
INT 183 # 26	14.6	12.5	13.55	26.1	33.9	30.00	25.2	28.6	26.9
ASCR # 22	14.5	11.3	12.9	26.1	28.3	27.2	30.7	24.8	27.75
ETU 157 # 31	16.9	13.7	15.2	28.8	28.7	28.75	31.3	21.9	26.6
DES 160 # 39	15.0	15.7	15.35	27.9	35.2	31.55	30.4	22.3	26.35
Control	19.2	15.0	17.1	27.6	24.1	25.85	27.2	30.2	28.7
Mean	16.12	12.51		28.75	29.3		29.15	25.9	

Table 11. Average yield of rice grown after mycorrhizae inoculated soybean at Chiangmai province.

Species	Yield (kg/ha)		
	P1	P2	Mean
Mos 156 # 6	4908.6	4471.4	4690
Glomus # 17	4883.5	4508.2	4695.85
INT 183 # 26	4815.5	4802.1	4808.8
ASCR # 22	4385.8	4496.5	4441.15
ETU 157 # 31	4816.7	4575.0	4695.85
DES 160 # 39	4939.0	4671.4	4805.2
Control	4725.7	4506.5	4616.1
Mean	4782.11	4575.87	

Table 12. Percent root colonization of rice grown after inoculated soybean at at Chiangmai province. (1986)

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	0	0	0	0	0	0	0	0	0
Glomus # 17	0	0	0	0	0	0	0	0	0
INT 183 # 26	0	0	0	0	0	0	0	0	0
ASCR # 22	0	0	0	0	0	0	0	0	0
ETU 157 # 31	0	0	0	0	0	0	0	0	0
DES 160 # 39	0	0	0	0	0	0	0	0	0
Control	0	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0	0

Table 13. Number of spore in 100 gram soil grown rice after mycorrhizae inoculated soybean at Chiangmai province. (1986)

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	103	90	96.5	61	53	57.0	58	36	47.0
Glomus # 17	158	109	133.5	50	59	54.5	42	71	56.5
INT 183 # 26	273	118	195.5	79	67	73.0	88	80	84.0
ASCR # 22	152	121	136.5	59	73	66.0	72	53	62.5
ETU 157 # 31	90	69	79.5	66	54	60.0	81	64	42.5
DES 160 # 39	185	169	177.0	73	83	78.0	116	73	94.5
Control	106	125	115.5	65	74	69.5	106	59	82.5
Mean	152.4	114.4		64.7	66.1		80.4	62.3	

Table 14. Average height (cm) of rice grown after mycorrhizae inoculated mungbean at Kalasin province.

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	65.7	62.7	31.35	99.1	86.9	93	107.5	102.1	104.8
Glomus # 17	69.0	61.6	65.3	96.8	94.5	95.65	105.7	101.8	103.75
INT 183 # 26	66.3	68.7	67.5	97.7	97.5	97.6	104.7	103.0	103.85
ASCR # 22	68.6	62.6	65.6	98.1	93.1	95.6	105.4	102.9	104.15
ETU 157 # 31	68.7	62.4	65.55	97.4	90.1	93.75	104.7	101.8	103.25
DES 160 # 39	67.7	65.0	66.35	95.2	92.6	93.9	105.2	104.7	104.95
Control	67.6	65.4	66.5	96.4	97.2	96.8	105.7	105.7	105.7
Mean	67.65	64.05		97.24	93.12		105.55	103.14	

Table 15. Average shoot dry weight (gm/pl) of rice grown after mycorrhizae inoculated mungbean at Kalasin province.

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	30.3	22.1	26.2	23.9	14.8	19.35	24.6	17.6	21.1
Glomus # 17	21.0	17.1	19.05	20.4	20.2	20.3	17.5	16.0	16.75
INT 183 # 26	21.1	25.8	23.45	19.0	19.4	19.2	19.4	19.9	19.65
ASCR # 22	27.4	19.3	23.35	22.9	18.9	20.9	21.9	18.3	20.1
ETU 157 # 31	21.2	24.5	22.86	16.7	16.1	16.4	17.2	17.9	17.55
DES 160 # 39	26.1	20.4	23.25	17.2	17.5	17.35	21.0	18.9	19.95
Control	21.0	23.4	22.2	17.3	19.2	18.25	17.9	22.6	20.25
Mean	24.0	21.8		19.6	18.0		19.9	18.7	

Table 16. Average yield of rice grown after mycorrhizae inoculated mungbean at Kalasin province.

Species	Yield (kg/ha)		
	P1	P2	P3
Mos 156 # 6	4053.9	3523.7	3788.8
Glomus # 17	3676.0	3336.0	3506.0
INT 183 # 26	3899.5	4241.8	4070.65
ASCR # 22	4333.7	3482.0	3907.85
ETU 157 # 31	3565.5	3189.7	3377.6
DES 160 # 39	3765.9	4083.2	3924.55
Control	3991.3	3882.8	3937.05
Mean	3897.97	3677.03	

Table 17. Percent root colonization of rice grown after inoculated mungbean at Kalasin province. (1986)

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	0	0	0	0	0	0	0	0	0
Glomus # 17	0	0	0	0	0	0	0	0	0
INT 183 # 26	0	0	0	0	0	0	0	0	0
ASCR # 22	0	0	0	0	0	0	0	0	0
ETU 157 # 31	0	0	0	0	0	0	0	0	0
DES 160 # 39	0	0	0	0	0	0	0	0	0
Control	0	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0	0

Table 18. Number of spore in 100 gram soil grown rice after mycorrhizae inoculated mungbean at Kalasin province.

Species	60 days			90 days			120 days		
	P1	P0	Mean	P1	P0	Mean	P1	P0	Mean
Mos 156 # 6	74	34	54	48	70	59	18	20	19
Glomus # 17	57	41	49	29	41	35	37	28	32.5
INT 103 # 26	113	72	92.5	24	58	41	48	22	35
ASCR # 22	42	50	46	42	36	39	21	56	38.5
ETU 157 # 31	50	50	50	42	158	100	12	50	31
DES 160 # 39	54	58	56	50	39	44.5	20	35	27.5
Control	56	64	60	34	44	39	25	23	24
Mean	63.7	52.7		38.4	63.7		25.9	33.4	

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