Amaranth Collaborations at TSU

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Amaranth Institute, Nashville, TN USA

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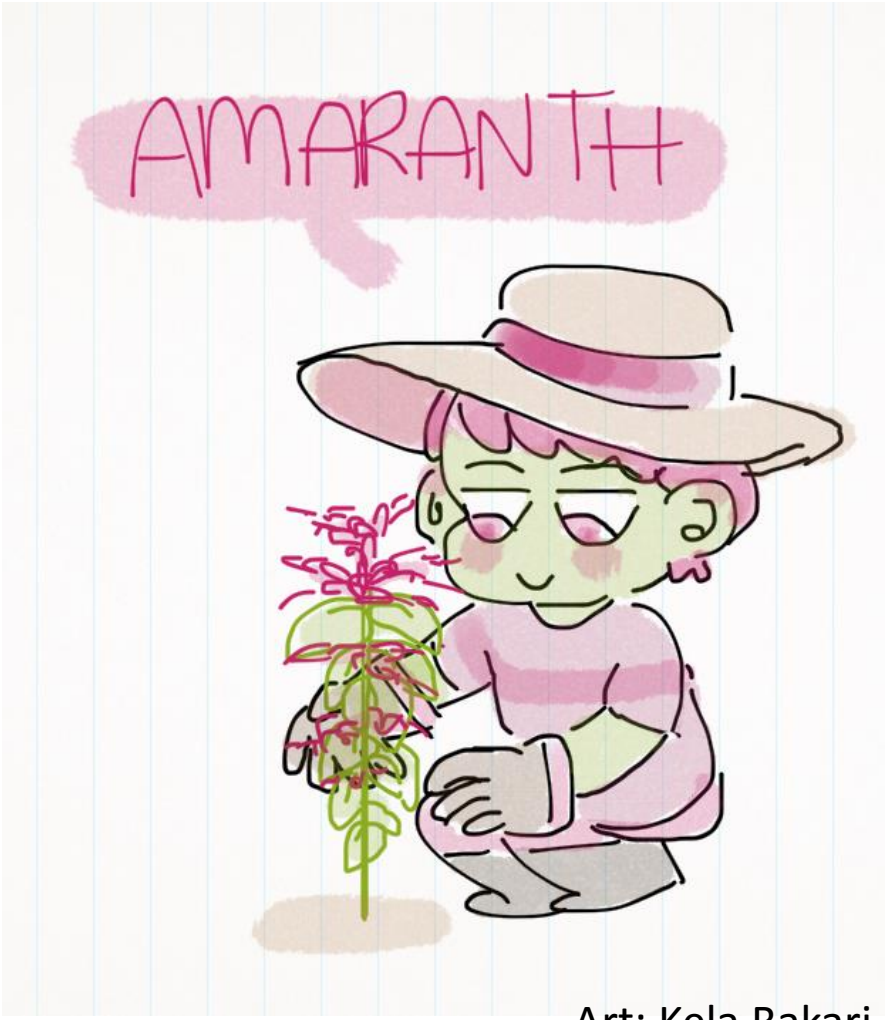
Why Amaranth?

My first job in plant breeding right after University was at Rodale Research Institute working on Amaranth research with various experts!



Art: Kela Bakari

My Other Jobs!

- **Geneticist / Bean Breeder** –breeding lines and varieties for the Andean region of South America, East Africa and the Caribbean.
- **Associate professor – Tennessee State University :** deploy tools of molecular biology for genetic diversity analysis of amaranth, marker assisted selection, and physiology studies.

Laboratory conditions

- Plant Genomics Laboratory – Ag. Biotech Bldg.
- Robotics for DNA marker amplification and fingerprinting
- Bench tops, DNA manipulation and tissue culture rooms

Present Research Focus

- Molecular marker studies of new crops (amaranth as one of the pseudocereals).
- Genes for daptation to climate change (drought and heat tolerance).
- Training of students and visiting researchers from USA, Bangl., China, Colombia, Ghana, Kenya, Ethiopia, Nepal and South Sudan.

Amaranth Collaborations

1) Seed Savers Exchange

(34 landrace varieties, from T. Johnson, Decorah, Iowa)

2) USDA – Core collection

(260 accessions, from David Brenner, USDA, Ames, Iowa)

3) Iowa State Semi-dwarf lines

4) RIL Mapping population

5) Chinese collab. in Shandong / Jilin

6) Future collaborations / areas

Field Plantings of 2016

1) Seed Savers Exchange

2 repetitions, 60 plants per plot in 2 rows.

2) USDA – Core collection

70 accessions selected for augmented design experiment with additional 112 unreplicated

3) Iowa State – Semi Dwarf Lines

4 breeding lines in replicated

4) RIL Population Development

110 F3:4 lines developed from simple cross

Preparing transplants

Seedlings ready for Field Transfer

Kela Bekari

MLK
High School
Intern at
TSU

2015-16

Two types of seedlings : from Trays and Pots

Trays – Growth cycle

Seedlings grown for 20 to 25 days

Transplanted to the field after they fill the cell completely with root mass

Set out in two rows of 36 plants each with rows at 4 feet centers based on tractor and tire width

Spacing determined by a transplanter pulled behind a tractor with six inch spacing between plants

Trays – 72 wells

Half trays – 36 plants produced

General Conditions

- Unfertilized, no pesticide use, 15 feet long rows
- Plots made of 2 rows separated by 4 feet spacing
- Greenhouse planted Late April
- Field planted Late May to early June (by transplants)
- Harvesting will be by hand in September (at 4 months)
- Harvest will be dried in a hoophouse for 1 week
- Biomass and length of panicle
- Biomass and height of stems
- Biomass and size of grain

Yield Traits to measure

- Observation of disease and insect damage

Field Design I - 2016

Seed Savers Exchange

A total of 33 accessions of American gardener Amaranths (unclassified species) planted on June 4th, 2016

Double Rows for each genotype

Commercial Control Variety = Burgundy (native seeds)

Extra Space for *A. australis* (Tree Amaranth) from Australia .. Currently 3 m tall!!

Extra space for *A. cannibinus* (Water hemp) from East Coast of USA .. The largest seeded amaranth in the world

Planted on 6/4/2016				
SSE Amaranths				
A. australis	burgundy	132	119	117
A.cannib.	burgundy	132	119	117
115	112	108	104	99
115	112	108	104	99
93	92	86	80	79
93	92	86	80	79
42	39	38	35	34
42	39	38	35	34
31	30	29	24	22
31	30	29	24	22
15	10	9	8	7
15	10	9	8	7
6	5	4	3	1
6	5	4	3	1

Figure 1. *Scans of* SSE *Amaranth seeds*

Two Row Plot

Mechanical weed control with hand tillers (BCS, Husqvarna, Troy-built)

Field Design II

USDA genotypes planted as trays

Total of 79 plots with augmented design of 6 repeated accessions,
71 individual accessions, plus *A. australis* and *A. cannibinus*.
Planted May 19th, 2016 and bordered by cowpea and maize.
Each double row plot had two treatments: with ridge and without

USDA TRAYS WITH CONTROL																
ROAD	planted May 19-21															
ROAD	First strip with plots of 32 plants in ridge and 32 plants in tilled from 72 well trays															
ROAD																
ROAD	border	102	217	216	59	147	92	145	141	129	115	42	114	113	border	**ridge with holes**
ROAD	border	102	217	216	148	147	92	145	141	129	115	42	114	113	border	**tilled**
ROAD	border	92	112	134	111	110	109	108	107	106	105	103	102	100	border	**ridge with holes**
ROAD	border	92	112	134	111	110	109	108	107	106	105	103	102	100	border	**tilled**
ROAD	border	91	94	91	90	89	88	87	91	86	85	84	83	80	border	**ridge with holes**
ROAD	border	91	94	91	90	89	88	87	91	86	85	84	83	80	border	**tilled**
ROAD	border	61	A. Australi	79	75	73	69	65	64	61	59	58	38	57	border	**ridge with holes**
ROAD	border	61	A. cannabi	79	75	73	69	65	64	61	59	58	38	57	border	**tilled**
ROAD	border	42	56	55	54	102	53	48	47	44	61	43	42	41	border	**ridge with holes**
ROAD	border	42	56	55	54	102	53	48	47	44	61	43	42	41	border	**tilled**
ROAD	border	92	40	38	37	33	31	25	10	9	7	5	4	2	border	**ridge with holes**
ROAD	border	92	40	38	37	33	31	25	10	9	7	5	4	2	border	**tilled**
			32 plant long													

Selected accessions from USDA

Many medium-stature, high yielding types
With single stems and large panicles

Other Species

A. australis and *A. cannabinus*.

Field Design III

USDA genotypes planted as pots

Total of 112 plots with single repetition planted in double row plots on May 26th, 2016 and bordered by maize.
Each double row plot had two treatments: with ridge and without

Amaranth transferred from pots, planted on 26 May 2016																			
road		USDA																	
road	border	198	190	236	235	231	226	224	223	222	221	220	219	216	214	213	212	border	**ridge with holes**
road	border	198	190	236	235	231	226	224	223	222	221	220	219	216	214	213	212	border	**tilled**
road	border	197	189	211	210	209	207	204	202	201	200	179	178	177	176	175	173	border	**ridge with holes**
road	border	197	189	211	210	209	207	204	202	201	200	179	178	177	176	175	173	border	**tilled**
road	border	196	188	172	170	166	164	162	158	157	156	155	154	151	149	148	146	border	**ridge with holes**
road	border	196	188	172	170	166	164	162	158	157	156	155	154	151	149	148	146	border	**tilled**
road	border	195	184	144	142	137	135	134	133	132	131	130	128	126	125	124	123	border	**ridge with holes**
road	border	195	184	144	142	137	135	134	133	132	131	130	128	126	125	124	123	border	**tilled**
road	border	194	182	122	121	120	119	118	116	107	104	102	101	99	97	95	92	border	**ridge with holes**
road	border	194	182	122	121	120	119	118	116	107	104	102	101	99	97	95	92	border	**tilled**
road	border	193	181	85	83	82	77	73	68	67	66	65	64	63	62	58	57	border	**ridge with holes**
road	border	193	181	85	83	82	77	73	68	67	66	65	64	63	62	58	57	border	**tilled**
road	border	191	136	54	52	49	48	45	42	39	38	36	35	32	25	11	11	border	**ridge with holes**
road	border	191	136	54	52	49	48	45	42	39	38	36	35	32	25	13	11	border	**tilled**

RIL Population in Greenhouse

PI654437 (*A. hybridus*) **weed** x **D136-1**
relative of PI558499 “Plainsman” cultivar

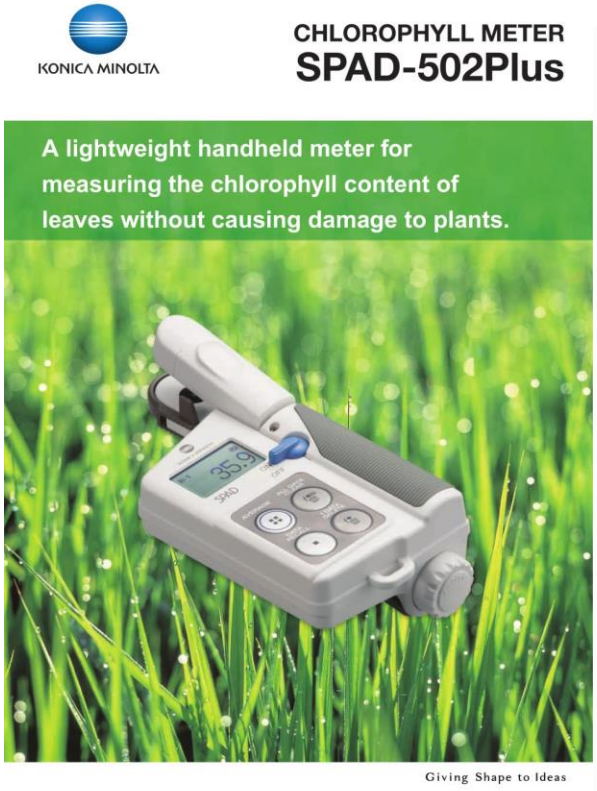
Future Work

Genomics and Genetics Laboratory

- Genotyping with various markers
- SSR (simple sequence repeat)
- SNP (single nucleotide polymorphism)
- Analysis of GBS data, QTL analysis
- Marker conversion from GBS and seq.
- Association Mapping Genetic Studies

Future work

Photosynthesis Equipment



SPAD reader

LICOR 6400

Future Work = Aluminum Tolerance

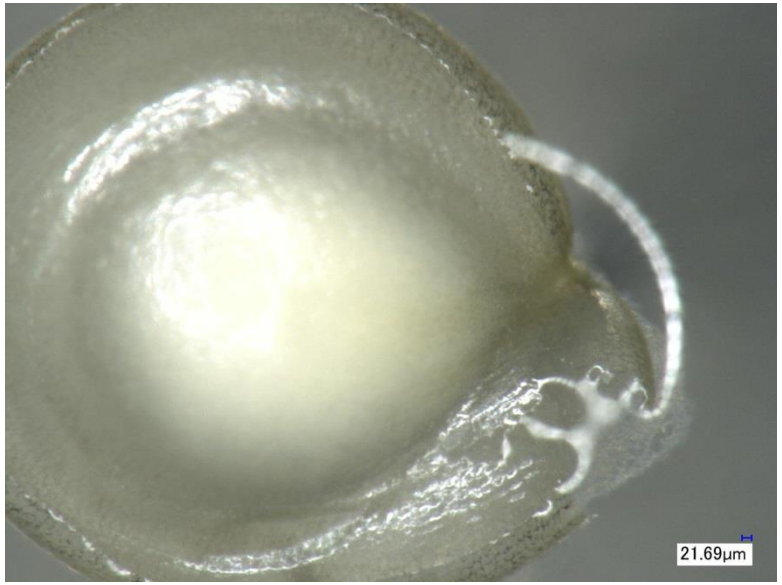
25Um Al sulfate

(root and Hypocotyl)

Leaves emerge at 25 uM but are bent out of their normal shape & try to grow out of Al solution.

50 uM Al sulfate

(seed)



No root tips at 50 Um Al sulfate in Amaranth…seed is trying to germinate but does so at a very slow rate.

Thanks very much for your attention!