IAEA/RCA Regional Coordination Meeting

Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RAS 5/070)

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Project Team Members

- Dr. W.M.W. Weerakoon (Director)
  - Overall technical and administration supervision as the principle investigator
- Dr. A.M. Perera (Addition Director)
  - Overall technical supervision of breeding component of the project
- Mr. M.A.P.W.K. Malaviarachchi (Senior Scientist – Agronomy)
  - Conceptualizing, designing and, implementation of the field trials of soil, nutrient and water management component of the project
- Mr. D.C.M.S.I. Wijewardana (Plant breeder)
  - Planning and implementation of field trials of mutation breeding
- Mr. R.A.C.J. Perera (Senior Scientist- Soils & water management)
  - Collaborative scientist in the soil, nutrient and water management component of the project
- Ms. W.A.R. Dhammika (Biotechnologist)

Sweet sorghum as an important crop…….

- New crop to Sri Lanka
- Relatively short crop duration (3 ½ - 4 months)
- Cultivable in marginal lands
    - Salinity prone (EC- 0.7 dS/m <)
    - Drought prone (Seasonal RF – 100-500 mm)
    - Water logged (during rainy season) ??

- Potential to use as
    - A bio-energy crop, food and feed (silage) crop
    - An alternative for juice/sugar production (home garden level)

Overview

Sub project 1:

Mutation Breeding and supportive techniques for the development of Sweet Sorghum as a Bio-energy crop for marginal lands in Sri Lanka

- Objective: To screen sweet sorghum lines and develop varieties through induced mutation breeding suitable for growing in marginal lands (salinity prone lands, water logged conditions & areas/seasons with severe water scarcity) as a bio-energy crop

- Expected output: Crop varieties suitable for marginal lands

- Current progress: Field evaluation trials are in progress

Overview contd.....

Sub project 2:

Improving the productivity of marginal lands by identifying suitable agronomic management strategies for the sweet sorghum varieties developed through mutation breeding

- Objective: To develop a package of practices including plant nutrients, soil & water management and optimum plant density along with suitable cropping patterns for the sweet sorghum lines as a bio-energy crop/food & feed crop identified for marginal lands

- Expected out put: A suitable crop management package and a cropping pattern for marginal lands

- Current progress: The study will be initiated once the selection procedure of mutated sweet sorghum lines is completed

Overview cont.....

Sub project 3:

Improving the productivity of upland maize-based and lowland rice-based cropping systems through efficient N management

- Objective: To increase the Nitrogen fertilizer use efficiency through a new fertilizer recommendation together with suitable water management practices for two different maize growing farming environments in the dry zone of Sri Lanka

- Expected out put: A new Nitrogen fertilizer recommendation for the two farming environments

- Current progress: A preliminary observational trial was initiated and waiting for N-15 to initiate the field trial in the next cultivating season

Field and Laboratory work carried out

- Sub project 1 (Mutation /Breeding)

  - Progeny selection using ear to row procedure from the population
  - Plot size is 400 m^2 for M_1 generation, 100 m^2 for M_2 generation & 5.1 m x 1.2 m for replicated trial (RCBD with 3 replicates)
  - Treatments: Number of lines with a local check variety
  - Irradiation - 5 doses (100, 150, 200, 250 and 300 Gy) at IAEA, Vienna, Austria during May 2016
  - Data to be collected – Plant height, Leaf characters, Stem girth, Inter-node length, Length of panicle, Maturity time, Yield & yield components, Brix value

Field and Laboratory work carried out

- Sub project 2 (Soil, nutrient and water - Sweet Sorghum)
  - Three N doses & three plant densities in a Factorial RCBD with 3 replicates
  - Irrigation intervals will be tested in a subsequent experiment once optimum Nitrogen and plant density levels are identified
  - Plot size – 3m X 3.6 m.
  - Data to be collected - Bulk density, Texture, EC, pH, N, P, K, OC contents as initial soil physical and chemical parameters. Total dry matter at 50% flowering and harvest, Plant N uptake (N-15 analysis), Grain yield & Yield components as growth and yield parameters

Field and Laboratory work carried out

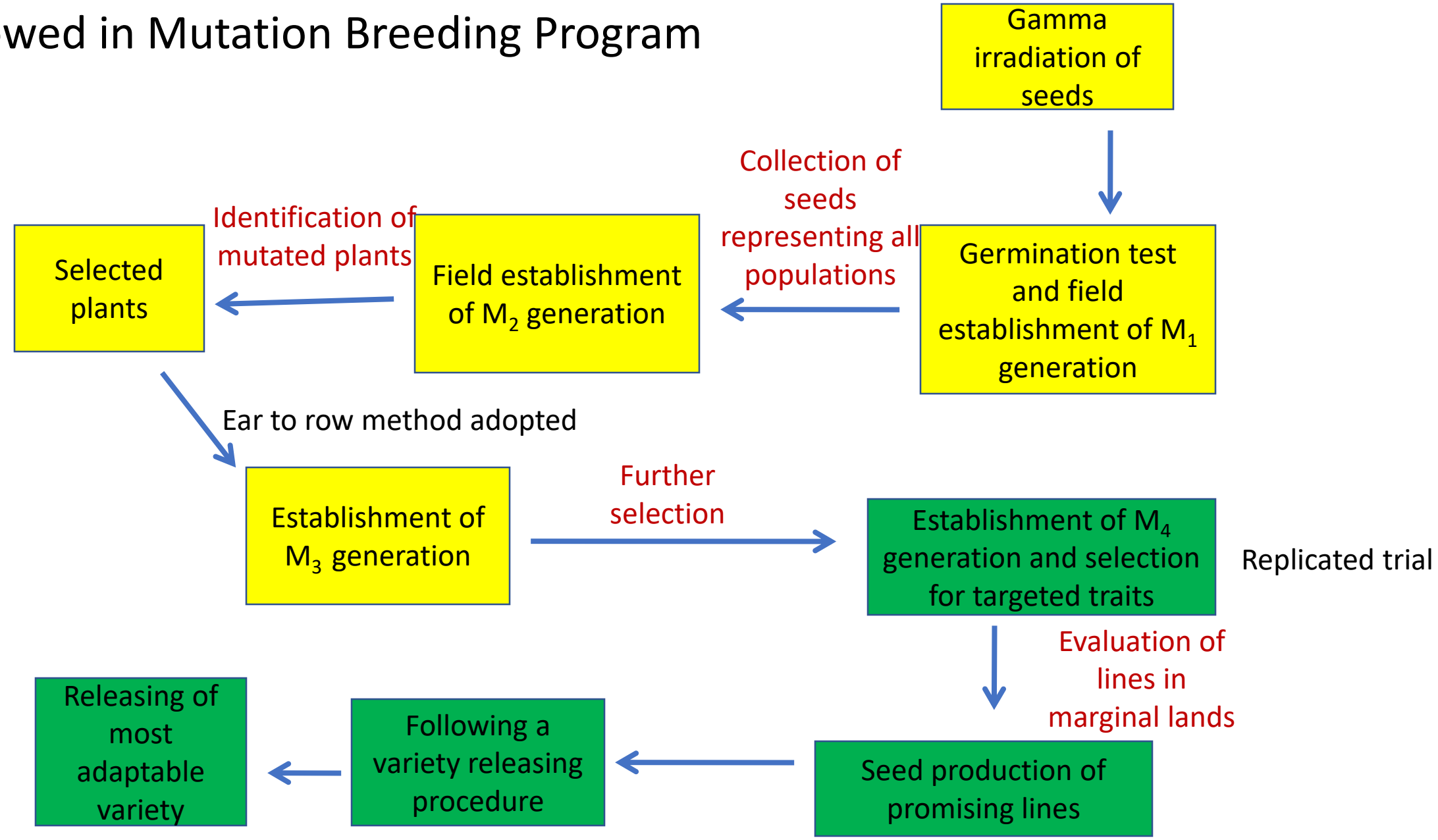
- Sub project 3 (Soil, nutrient and water- Maize)
  - Two N doses (100, 150 N kg/ha) and four split N application schedules in a RCBD with 3 replicates in two farming environments (rainfed well-drained soil and rice-based cropping)
  - While one local maize hybrid variety is used at the beginning few other local and exotic hybrids will be tested for their NUE in subsequent experiments based on the results of the initial experiment

Outputs / Key Results Achieved During the Past Years

Sub project 1:

Mutation Breeding and supportive techniques for the development of Sweet Sorghum as Bio-energy/food & feed crops for marginal lands in Sri Lanka

Steps followed in Mutation Breeding Program



The procedure in detail……..

1. Seeds were irradiated with 5 different doses 100 ,150, 200, 250, 300 of Gamma rays
2. Established M_0 generation of irradiated seeds in field in *yala 2016* season (April-July 2016)
3. Agronomic data were collected at M_1 generation for each treatment

4. 10 plants from 200 Gy population and 14 plants from 300 Gy were selected comparing with parent population

5. Seeds of each selected plant were harvested separately

6. Harvested seeds from M_1 generation were established in the field as ear to row method to advance as M_2 generation during *Maha* (October- February) 2016/17 along with the parent population

7. Seeds from 14 morphologically different plants from M_2 generation (9 plants from 200 Gy and 5 plants from 300 Gy) were collected for establish M_3 generation

8. M_3 generation was established in the field as ear to row method during *Yala* 2017 for further selection

9. A replicated trial will be established to evaluate yield and bio- mass simultaneously

Germination percentage for irradiated sorghum seeds with control

Treatment	Germination (%)
100 Gy	86
150 Gy	79
200 Gy	73
250Gy	70
300 Gy	65
Control	96

Morphological characteristics of 14 selected sweet sorghum plants at M_2 generation and control during *Maha* 2016/17.

Character (measured in cm)	Treatment														
	200 Gy									300 Gy					
	Plant number									Plant number					
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	Normal popl
Plant height	265	240	265	237	220	248	210	225	250	245	235	210	198	236	161.2
Head length	20	20	24	25	21	21	35	30	22	30	27	30	24	23	25.2
Leaf length	75	56	65	66	55	57	73	67	70	75	82	75	70	60	60.5
Leaf width	20	23	23	22	20	21	20	18	20	21	25	20	18	20	19.2
Stem girth	6.5	6.4	6.6	7.2	5.9	6.4	6.8	7.2	6.9	7.2	7.5	7.8	6.9	6.8	5.4

Future Work Plan of the Project

1. Continuation of mutation breeding component towards releasing a variety

- M_4 generation will be tested under different marginal soil conditions in the coming seasons to screen the mutant lines at FCRDI, Mahailluppallama based on targeted traits (Oct 2017- Dec 2018)

  Saline soils EC >4 dS/m

  Water logged soils with heavy precipitation

  Areas/ Cropping seasons with severe water scarcity (RF – 250 mm)

  Identify lines suitable for bio-energy, grains & silage

- Seed multiplication of promising lines (Oct 2018- Feb 2019)

- Adopting the variety release procedure (Apr 2019- Jan 2020)

Future Work plan contd……

- Finding the possibility of using Sweet Sorghum as a source for sugar production in a small scale
- Further selected mutated lines will be evaluated at dairy farm fields for adaptability and suitability as a fodder crop (silage) in collaboration with Vetenary Research Institute

The same techniques will be used to develop other crop varieties

- Development of blast resistance finger millet line (Variety) using induced mutation
- Creation of variability in promising maize inbred lines using induced mutation techniques and use that variability in inbred lines development program

2. Initiation of the sub project 2 (March 2018)

Improving the productivity of marginal lands by identifying suitable soil and water management strategies for the Sweet Sorghum varieties developed through mutation breeding

- Optimum management practices for the specific environment will be identified
- Introduction of suitable cropping patterns to fit into the annual cropping calendar
- The field experiments will be started soon after the promising mutants of sorghum crop for marginal lands are identified

3. Sub project 3 (October 2017-August 2018)

Improving the productivity of upland Maize-based and lowland rice-based cropping systems through efficient N management

Background and present status

- Upon the completion of the training program on 'Nutrient and water management for bio-energy crops in marginal lands held in Kathmandu during 11-22 July 2016" a research proposal was developed

- The proposal was primarily reviewed by the resource persons of the above training

- The field experiment will be established in the next cultivation season in Sri Lanka (*maha* 2017/2018 – October -January) once N-15 is received from IAEA
- Until N-15 is received an initial observational trial was planned and it is now in the field

  Two N doses (100, 150 N kg/ha) and four split N application schedules

- Suitable water management practices would be included once the new N recommendation is found for different maize growing farming environments in the dry zone of Sri Lanka

Preliminary observational trial

Capacity building opportunities associated with this project

- Identified the opportunity and the potential of mutation breeding as a tool to develop new improved crop varieties
- Uses of isotopic techniques in evaluating water and nutrient use efficiencies of crops
- Exposure to use of isotopes in agriculture development

Expected impacts received after implementing the project in the country

- Utilization of marginal lands (low productive lands) in Sri Lanka
- Contribution to the bio-energy industry
- Contribution to human and animal food security by introducing sweet sorghum as a food and fodder crop
- An alternative source for juice/sugar production in small-scale

Effect of Environmental Balanced Device (EBD) on growth and yield of maize

Field Crops Research and Development Institute
Department of Agriculture
Mahailluppallama
Sri Lanka

Treatments

1. No fertilizer (control) - T1

2. Department of Agriculture fertilizer recommendation (inorganic fertilizer + organic manure) - T2

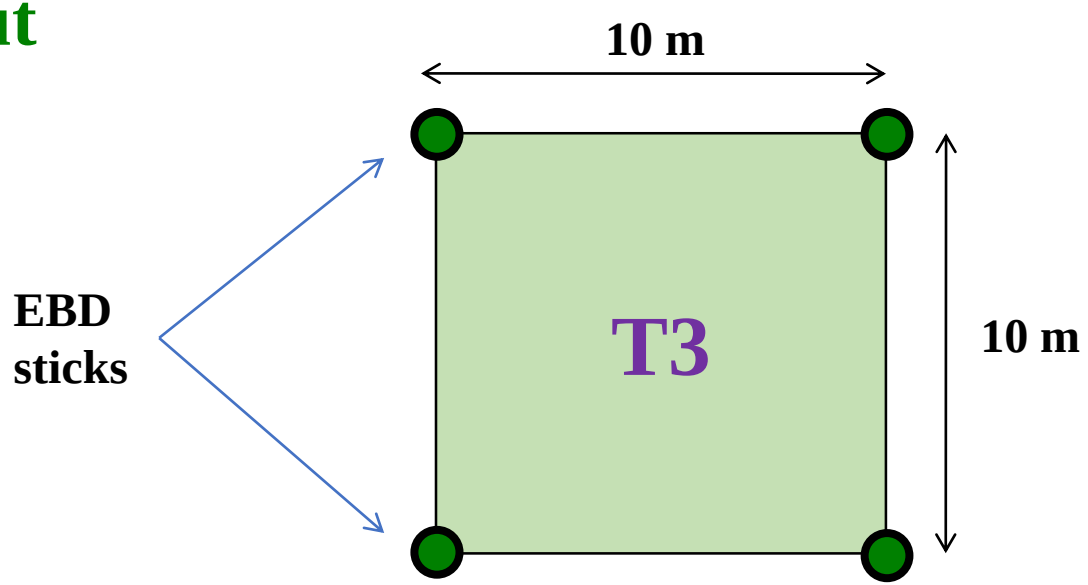
3. EBD (without fertilizer) - T3

Experimental Layout

Field layout

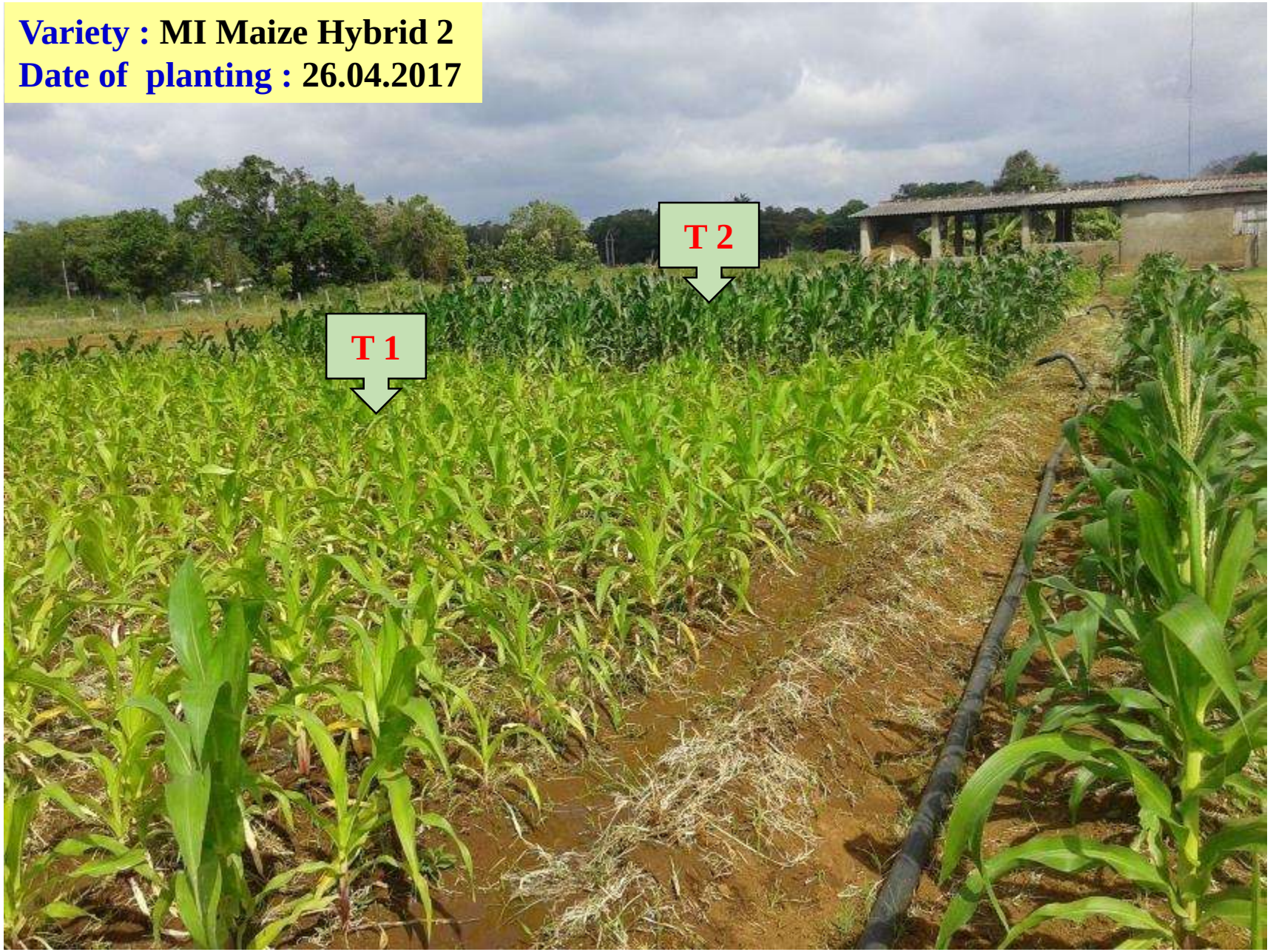
R1 T3	R1 T2	R1 T1	R2 T2	R2 T1	R2 T3

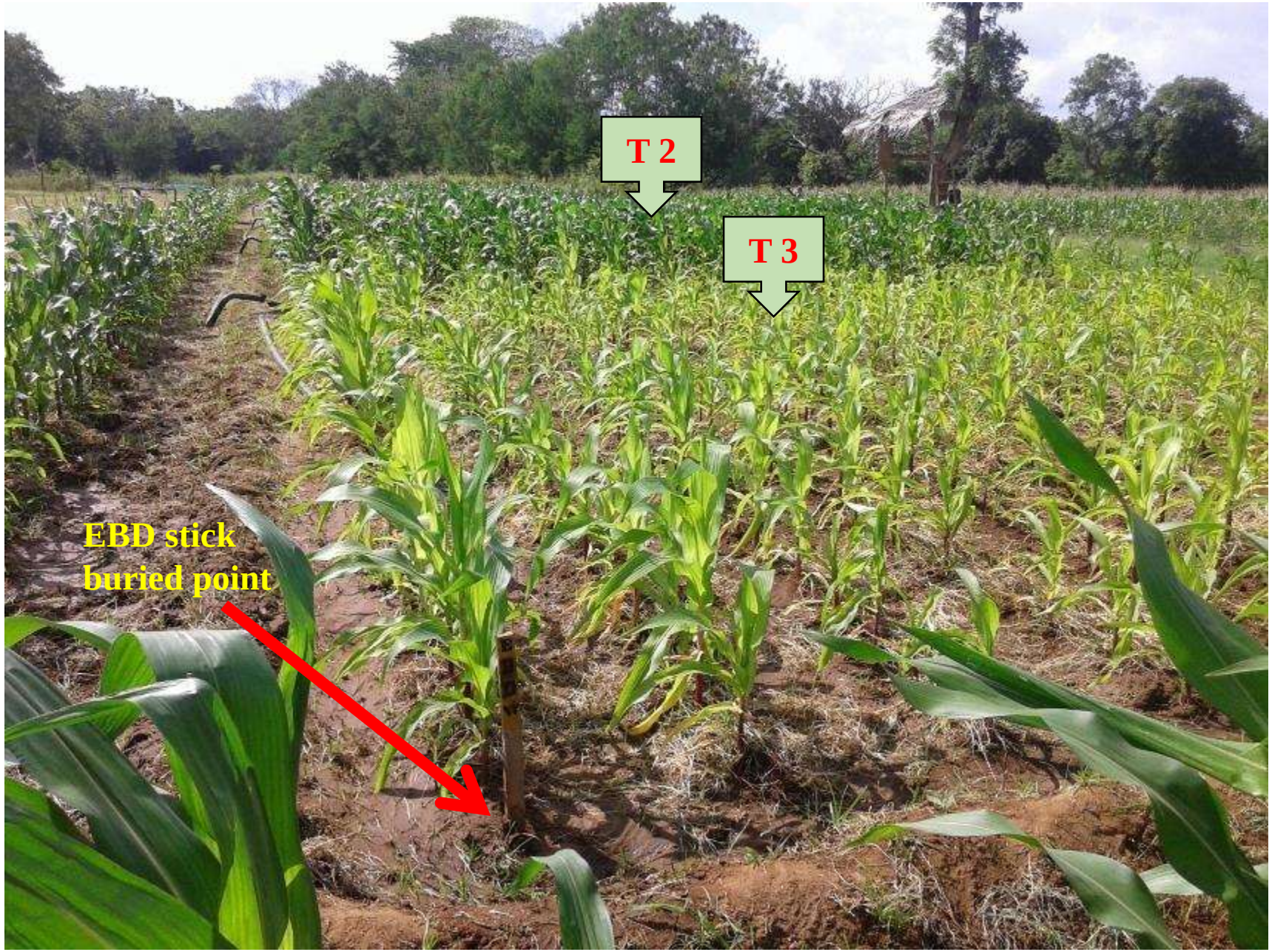
Plot layout



Installation of EBD sticks

Variety : MI Maize Hybrid 2
Date of planting : 26.04.2017




T 2
T 3
EBD stick
buried point

Growth performance

Treatment	Plant Height (cm)*
1. No fertilizer (control) - T1	55 b
2. Department of Agriculture fertilizer recommendation (Inorganic fertilizer + Organic manure) - T2	83 a
3. EBD (without fertilizer) - T3	55 b
LSD	12
CV %	4

* at 1 month after planting

Observations to be made:

1. **Plant dry matter weight**
2. **Yield**
3. **Soil fertility parameters**

Thank You