Lignocellulolytic Activity of Soil Fungi Isolated from Different Scenarios of Conservation Agriculture

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Conservation agriculture (CA) aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource efficient or resource effective agriculture." (FAO http://www.fao.org/ag/ca/11.html)

Why Conservation Agriculture is needed?

(i) Overexploitation of groundwater resources:
leading to a decline in the groundwater table
increased energy cost of pumping water,
Detrioration of groundwater quality

(ii) declining soil organic matter and increasing multiple deficiencies of major nutrients (N, P, K, and S) and micronutrients (Zn, Fe, and Mn) due to their over mining from soils

(iii) excessive withdrawal of water for irrigation also led to impurities (heavy metal contamination etc.) and increasing salinity

(iv) the development of herbicide resistance and a shift in weed flora and pest populations

(v) poor management of crop residues, leading to their burning.

(vi) food and nutritional insecurity

Unsustainability mainly caused by:

- **Tillage**
  - Soil Organic matter decline
  - Soil structural degradation
  - Water and wind erosion
  - Reduced water infiltration rates
  - Surface sealing and crusting
  - Soil compaction
- **Insufficient return of organic material**
- **Mono cropping**

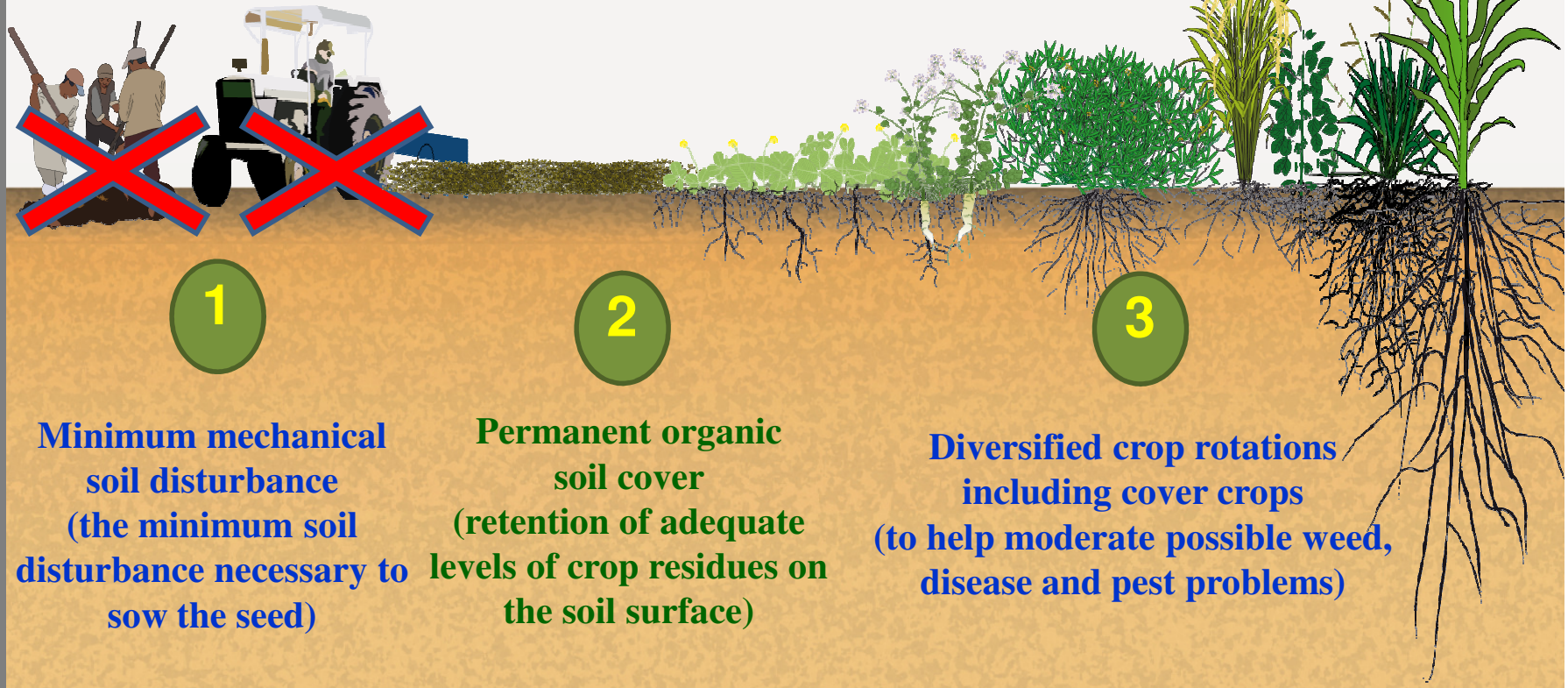
Unsustainable to Sustainable Agriculture
What components needs shift?

Unsustainable Agriculture	→	Sustainable Agriculture
Ploughing/tilling the soil	→	Minimum soil disturbance- *No-till/minimum till*
Removing all organic material	→	Rational soil cover- *Residue management*
Monoculture	→	Efficient crop rotations- *Crop diversification*

CA includes all of the other principles of sound crop management – we just need to remove the ills of the past

Conservation agriculture systems

CA is based on three principles applied simultaneously (FAO, 2009)



1

Minimum mechanical soil disturbance (the minimum soil disturbance necessary to sow the seed)

2

Permanent organic soil cover (retention of adequate levels of crop residues on the soil surface)

3

Diversified crop rotations including cover crops (to help moderate possible weed, disease and pest problems)

correlated with the improvement of soil structure

higher availability of organic substrates for microorganisms.

Improved soil structure allows

better soil aeration

diffusion of water and nutrients through the soil profile,

while the retention of crop residues

enhances microbial activity and

the soil microbial biomass content.

These improvements in soil quality can also increase soil microbial diversity, thus protecting crops against pests and diseases through competition for soil nutrients.

Drivers of agricultural change, crop rotation, tillage, crop establishment method, and residue management of different scenario :

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Drivers of change	Business as usual (current farmers' practice)	Increasing productivity and income by intensification and best management practices (integrated crop and resource management)	System designed to deal with water, labor, and energy scarcity and degrading soil health (Conservation agriculture based systems)	Futuristic intensive and diversified cropping systems to deal with water, labor, and energy scarcity and degrading soil health (Conservation agriculture based systems)
Crop rotation	Rice-wheat	Rice-wheat-mungbean	Rice-wheat-mungbean	Maize-wheat-mungbean

Tillage	Conventional till Rice- puddling Wheat- Conventional till	Conventional/Zero-till Rice- puddling Wheat- zero-till Mungbean- zero-till	Zero-till Rice- zero-till Wheat- zero-till Mungbean- zero-till	Zero-till Maize- zero-till Wheat- zero-till Mungbean- zero-till
Crop establishment method	Rice-transplanting Wheat- broadcast	Rice- transplanting Wheat- drill seeding Mungbean- drill/relay broadcast	Rice- drill seeding Wheat- drill seeding Mungbean- drill/relay broadcasted	Maize- drill seeding Wheat- drill seeding Mungbean- drill/relay broadcasted
Residue management	All residue removed	Partial rice residue (anchored) retained; partial wheat residue (anchored); and full mungbean residues incorporated during puddling in rice season	Full (100%) rice and mungbean whereas partial (anchored) wheat residue retained on soil surface	Full (100%) maize and mungbean whereas partial (anchored) wheat residue retained on soil surface

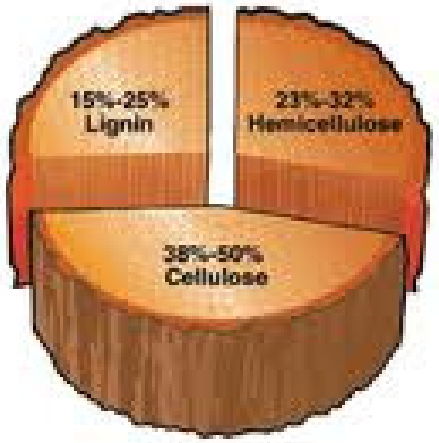

Scenario 1 Farmer's practice


Scenario 2 R-W-M CT/ZT


Scenario 3 R-W-M ZT/ZT


Scenario 4 M-W-M ZT

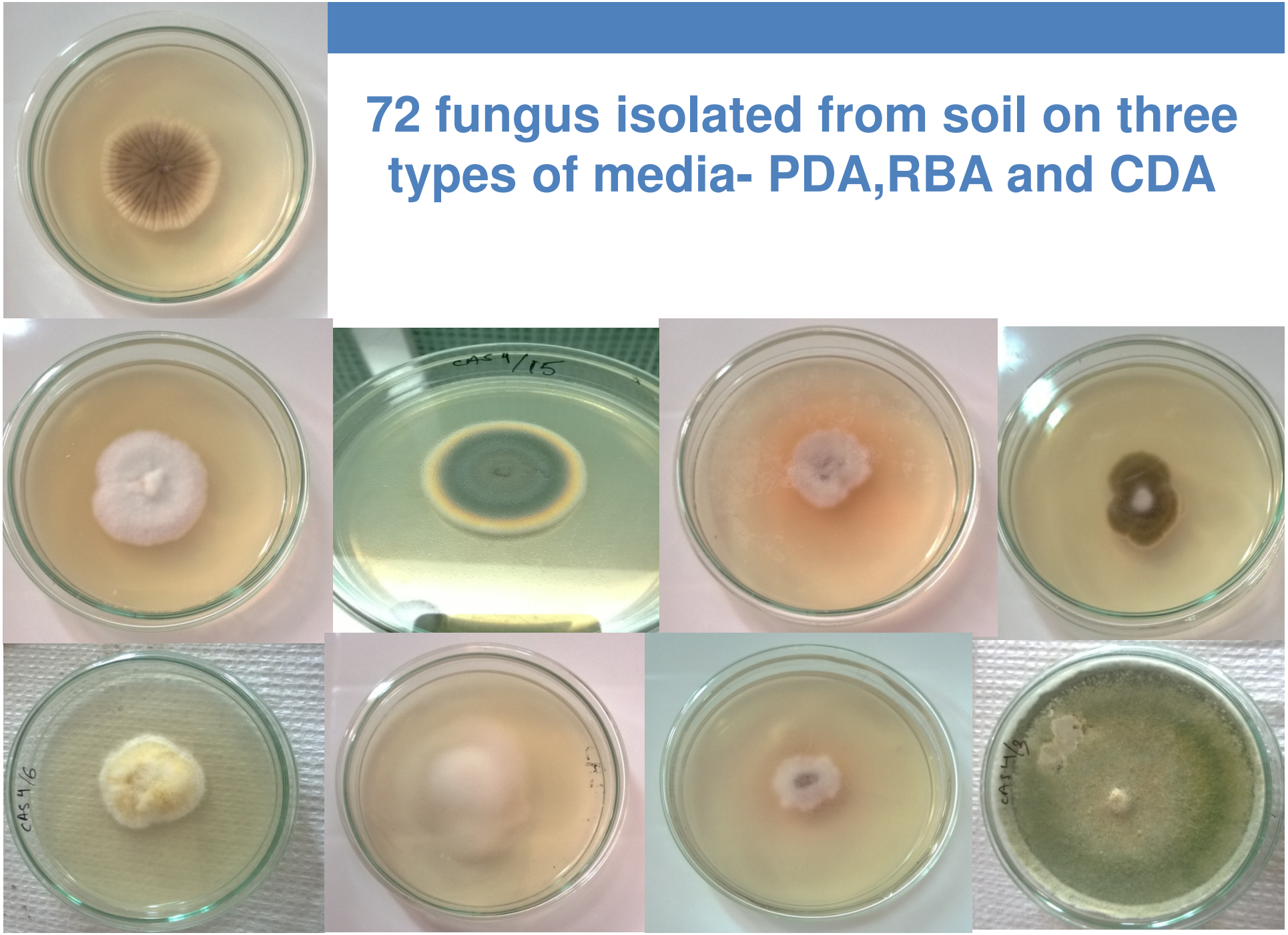
Lignocellulose is the major structural component of plants and represents a major source of renewable organic matter. Lignocellulose consists of lignin, hemicellulose and cellulose.



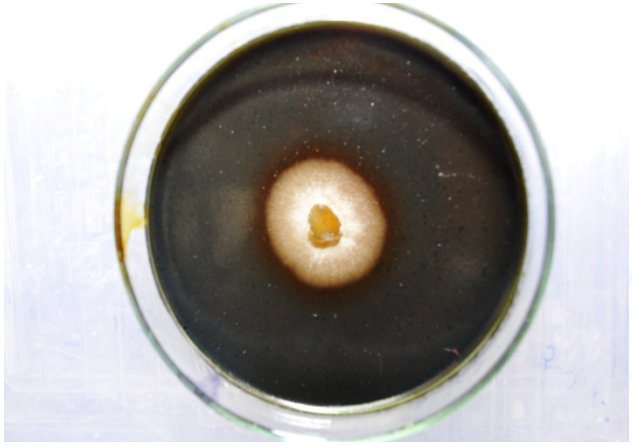
In systems where crop residue is left on the surface, saprophytic fungi dominate, slowly breaking down more resistant substrates (Moore et al., 2003).

- Isolation of fungus and their screening for cellulolytic activity
- Quantitative assay of lignocellulolytic activity of screened isolates.
- Study of selected fungus for decomposition of lignocellulosic residues in laboratory

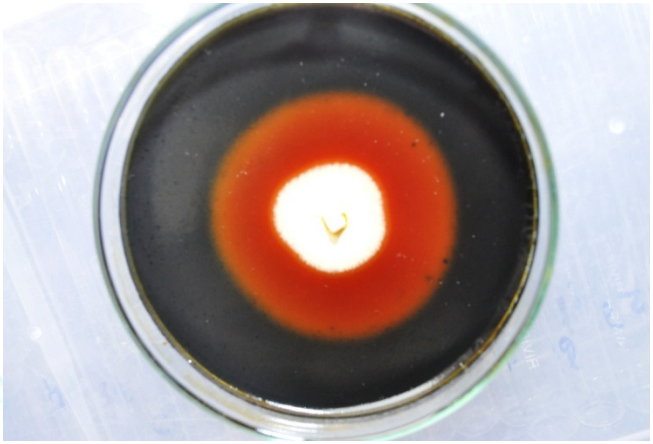
72 fungus isolated from soil on three types of media- PDA,RBA and CDA



Primary screening of isolates for cellulolytic activity

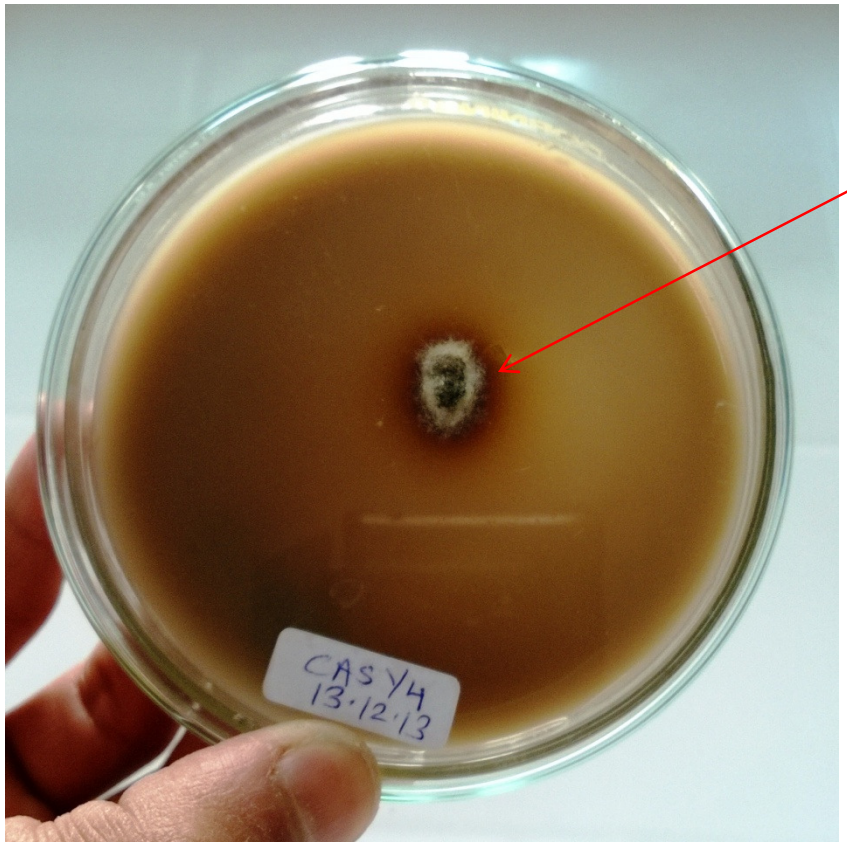


No zone



Clearing zone around growth

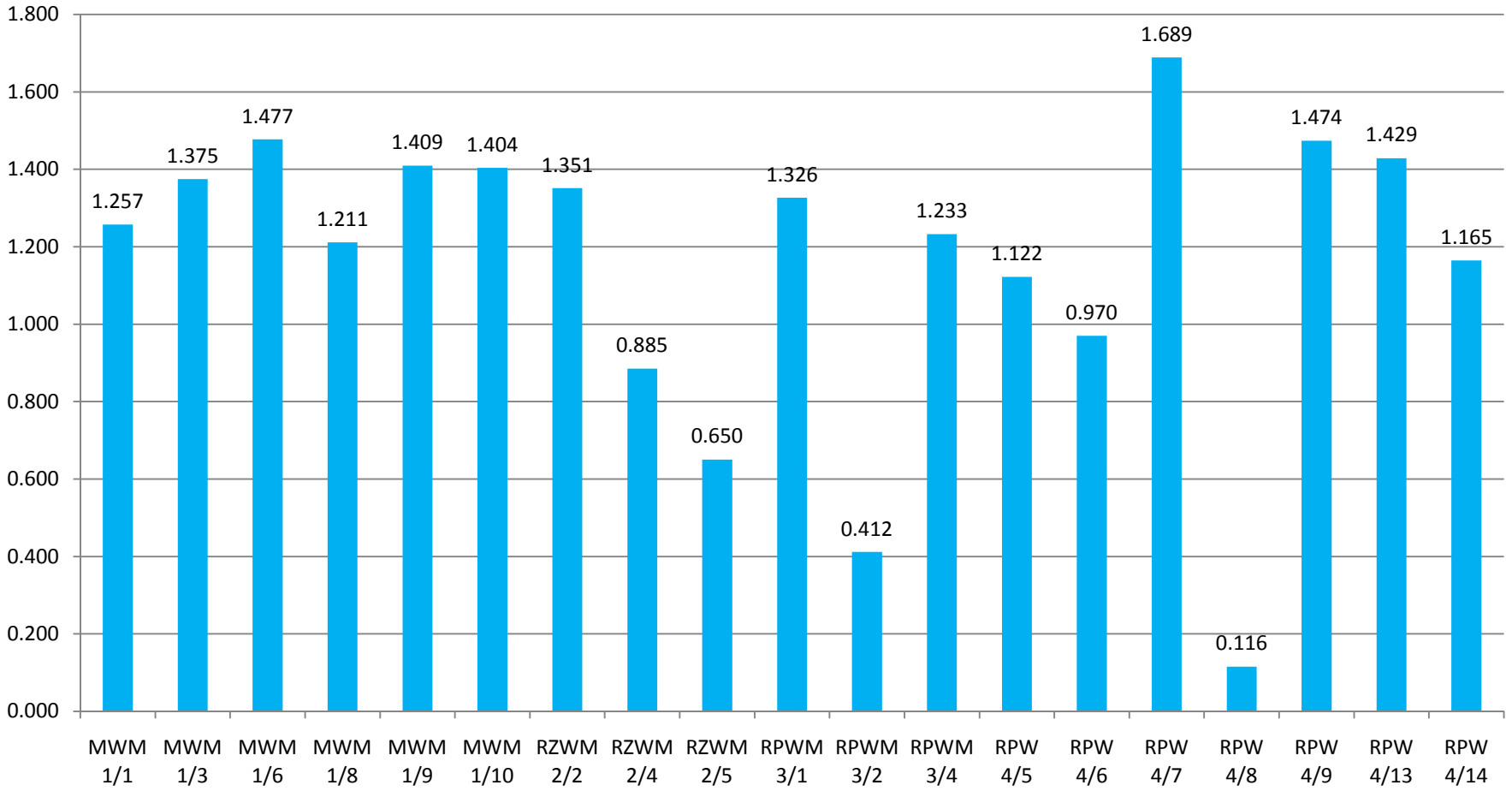
Growth of fungus on Carboxy Methyl Cellulose agar plates showing cellulolytic activity



Growth of fungus on Tannic acid agar plates showing lignolytic activity

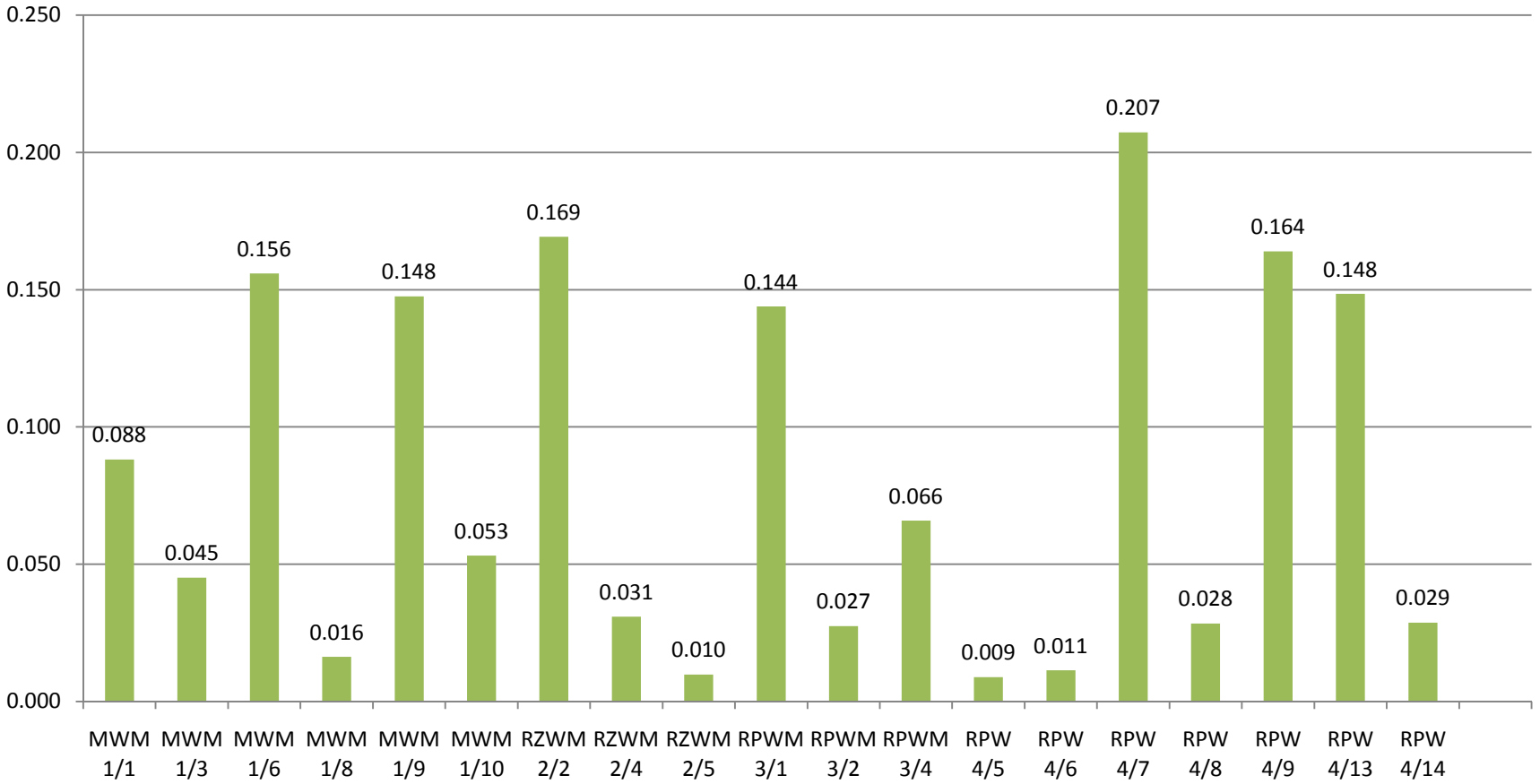
After primary screening Isolates having I_{CMC} > 0.5 were selected. These 19 cultures were grown in broth containing powdered straw as a sole source of carbon. Culture filtrate was used for estimation of different enzyme activity. Activity of CMCase is recorded upto 0.479 IU/ml, Cellobiase activity upto 0.379 IU/ml, Fpase activity upto 0.207 IU/ml and Xylanase activity is upto 1.6849 IU/ml.

Xylanase IU/ml



MWM – Maize- Wheat- Mungbean
RZWM- Rice Zerotill- Wheat- Mungbean
RPWM- Rice Puddled- Wheat- Mungbean
RPW- Rice Puddled- Wheat

Fpase



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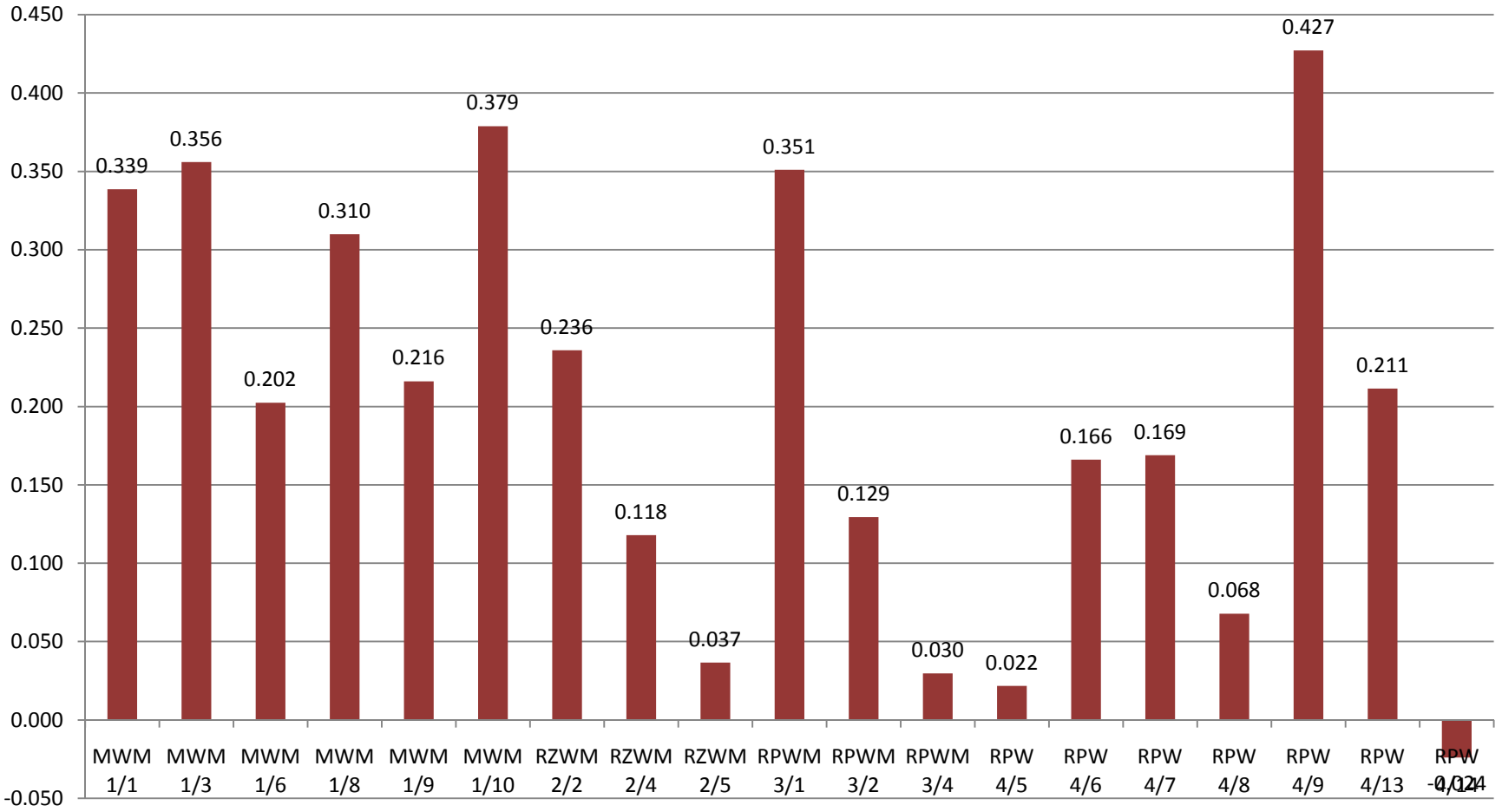
Cellobiase



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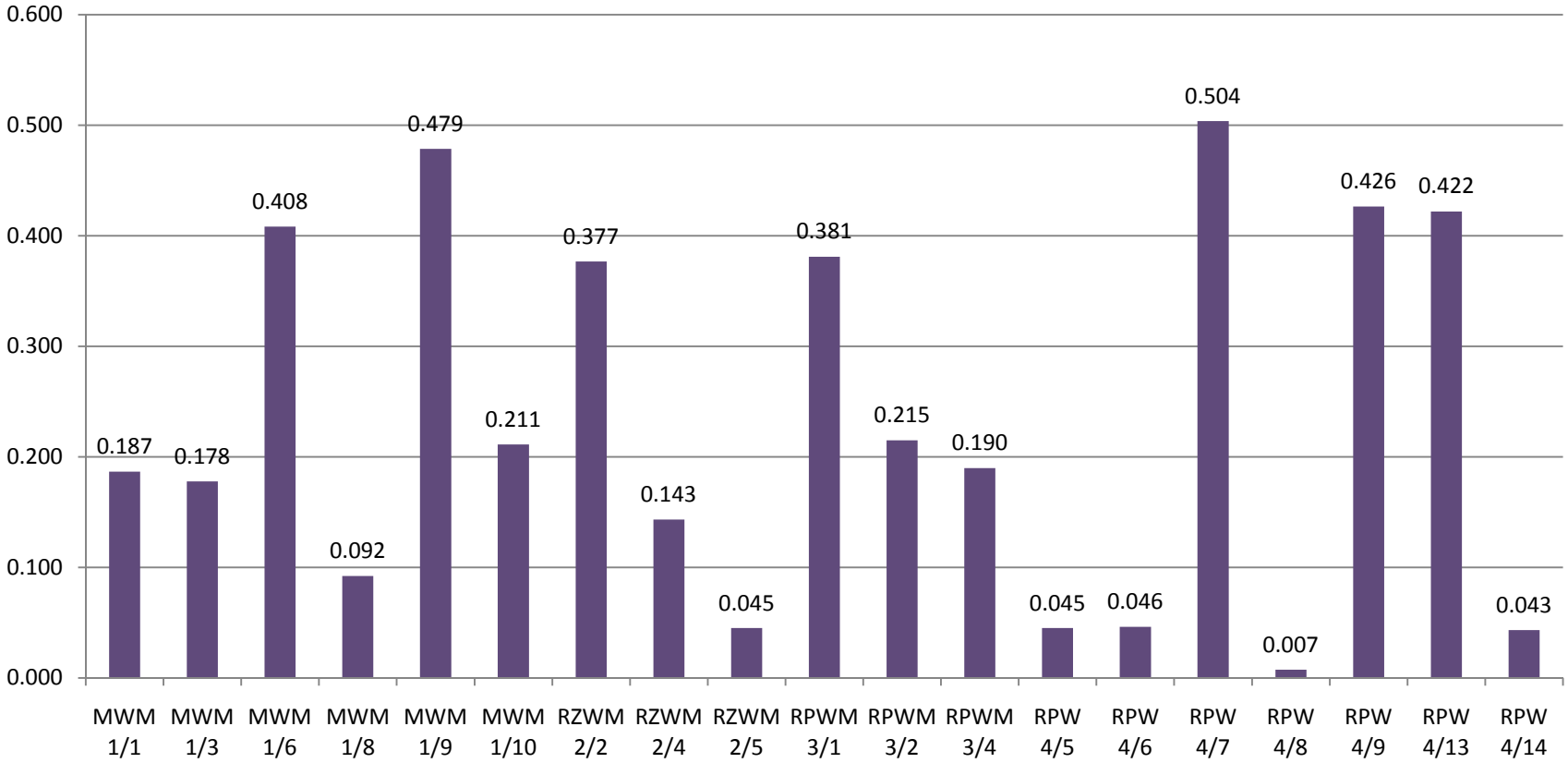
CMCase



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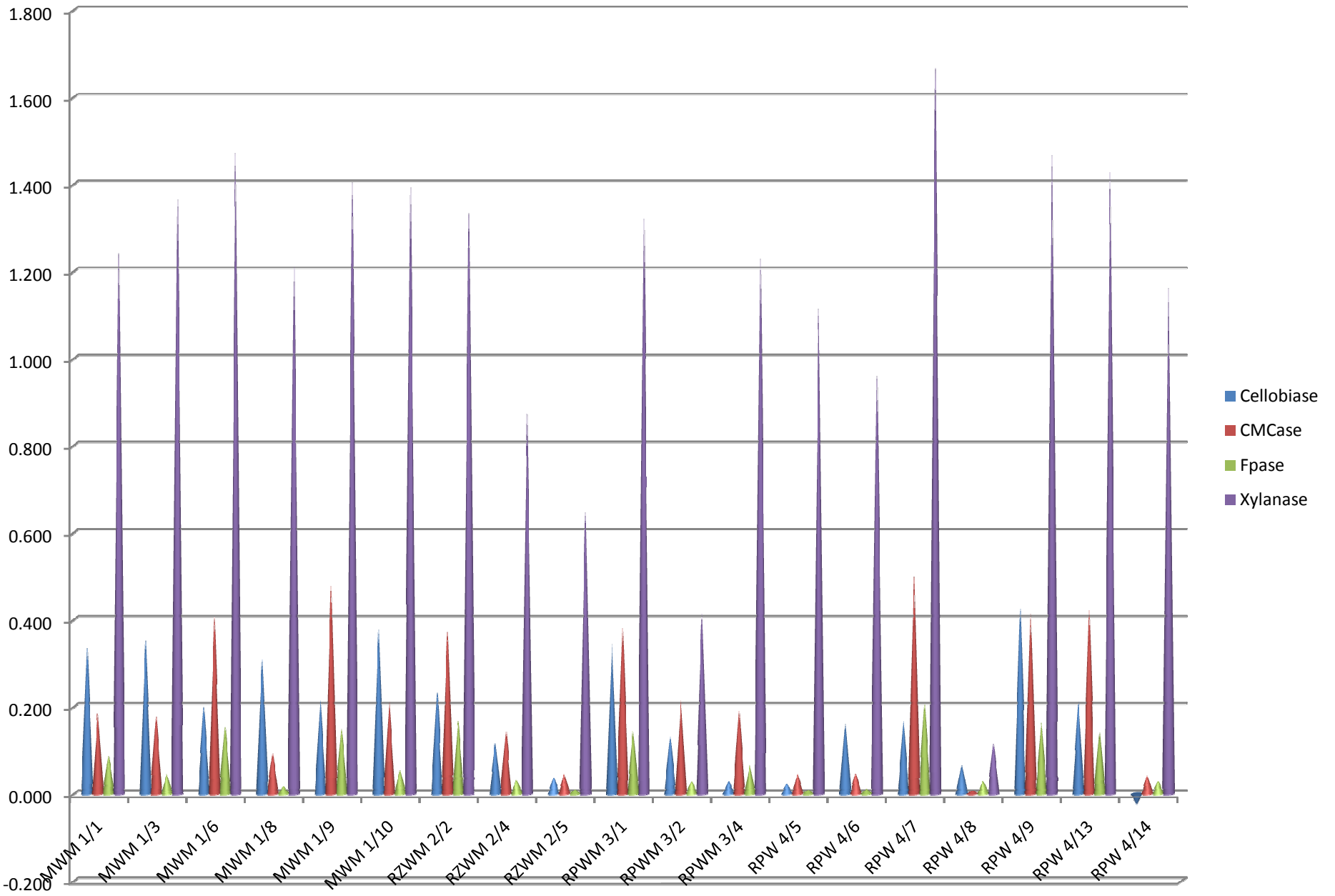
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
MWM 1/1
MWM 1/3
MWM 1/6
MWM 1/8
MWM 1/9
MWM 1/10
RZWM 2/2
RZWM 2/4
RZWM 2/5
RPWM 3/1
RPWM 3/2
RPWM 3/4
RPW 4/5
RPW 4/6
RPW 4/7
RPW 4/8
RPW 4/9
RPW 4/13
RPW 4/14
Cellobiase
CMCase
Fpase
Xylanase

On the basis of comparative study of enzyme activities 11 isolates are selected for further research. Selected fungus were inoculated on solid media composed of chopped straw and having 70 % moisture.

Enzyme activities in Solid State

Isolate	Cellobiase	CMCase	FPase	Xylanase
MWM 1/3	1.338	4.617	1.051	21.938
MWM 1/6	0.325	4.326	0.745	18.244
MWM 1/9	4.840	4.410	0.709	18.866
MWM 1/10	1.275	3.528	0.656	22.060
RZWM 2/2	1.533	4.960	1.413	22.400
RPWM 3/1	2.007	4.430	0.678	17.871
RPWM 3/2	2.685	2.455	1.093	19.924
RPW 4/7	0.403	2.270	0.320	18.173
RPW 4/9	1.635	1.938	0.407	10.683
RPW 4/13	1.733	2.133	0.220	12.701
RPW 4/14	0.047	.807	0.138	2.359

Activities are in IU/gm
MWM – Maize- Wheat- Mungbean
RZWM- Rice Zerotill- Wheat- Mungbean
RPWM- Rice Puddled- Wheat- Mungbean
RPW- Rice Puddled- Wheat

Morphological identification of Isolates

Isolate number	Isolate name
MWM 1/3	*Aspergillus flavus*
MWM 1/6	*Aspergillus terreus*
MWM 1/9	*Aspergillus terreus*
MWM 1/10	*Aspergillus flavus*
RZWM 2/2	*Penicillium janthinellum*
RPWM 3/1	*Aspergillus niger*
RPWM 3/2	*Alternaria alternata*
RPW 4/7	*Aspergillus terreus*
RPW 4/9	*Penicillium oxalicum*
RPW 4/13	*Penicillium oxalicum*
RPW 4/14	*Cladosporium cladosporoides*

Solid media was filtered by muslin cloth and residual straw was collected. Residual straw was dried and further analysis for ADF, NDF, cellulose and lignin is going on.

- THANK YOU