An Experimental Case Study for Soil Health

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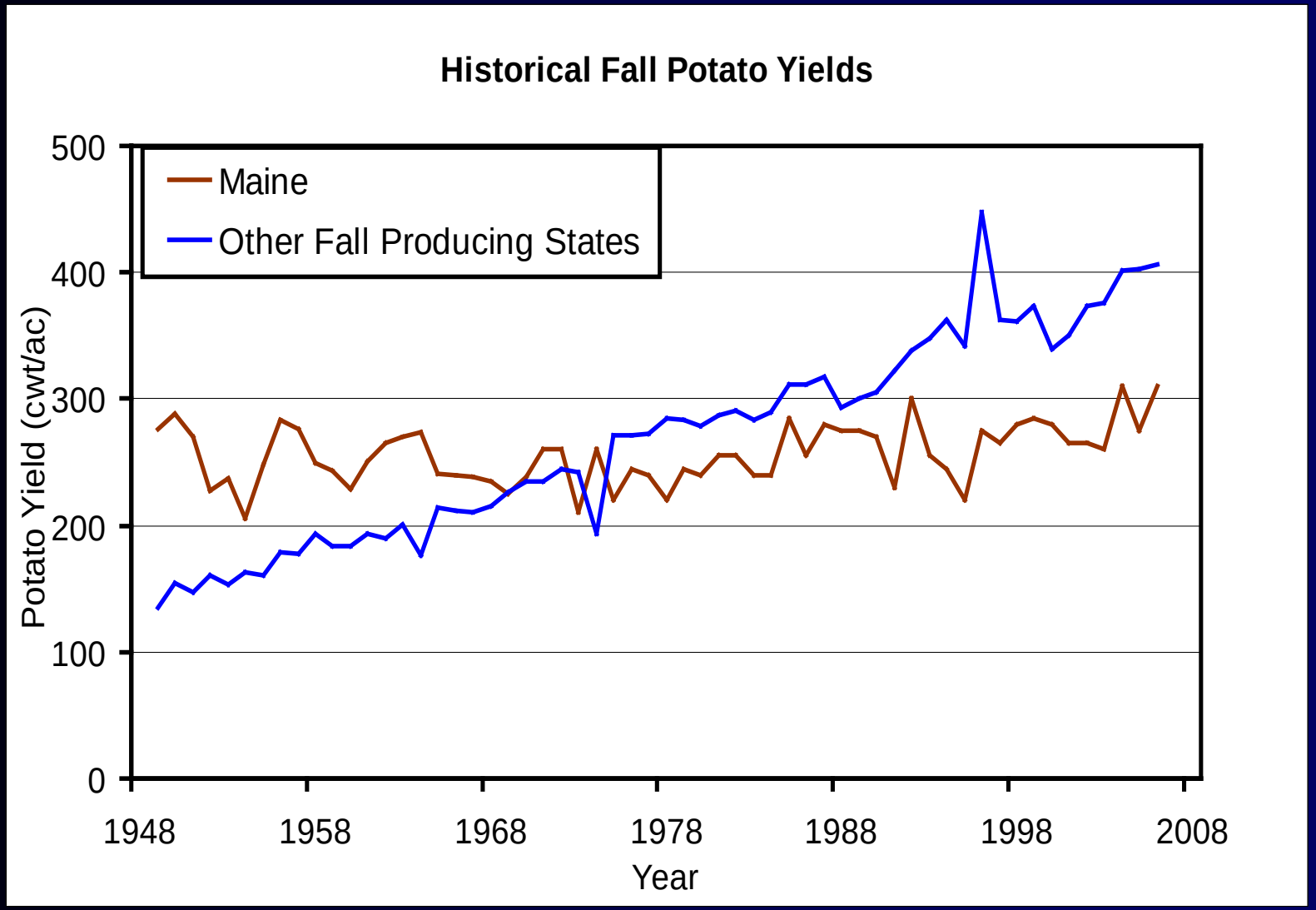

Historical Fall Potato Yields
Maine
Other Fall Producing States
Potato Yield (cwt/ac)
500
400
300
200
100
0
1948
1958
1968
1978
1988
1998
2008
Year

Cropping Systems (est. 2004, Presque Isle, ME)

Status Quo	**Barley (clover) – Potato** **(Fall tillage)**
Soil Conserving	**Barley (timothy) – Timothy – Potato** **(No-till Barley; Spring till Potato)**
Soil Improving	**Barley (timothy) – Timothy – Potato** **(No-till Barley; Spring till Potato; Compost added each year)**
Disease Suppressive	**Mustard GM/winter rapeseed – Sorghum Sudangrass/winter rye – Potato**
Non-rotation Control	**Potato - Potato**

All under both irrigated and rainfed management.

RESULTS

SOIL PROPERTIES

Labile C and N

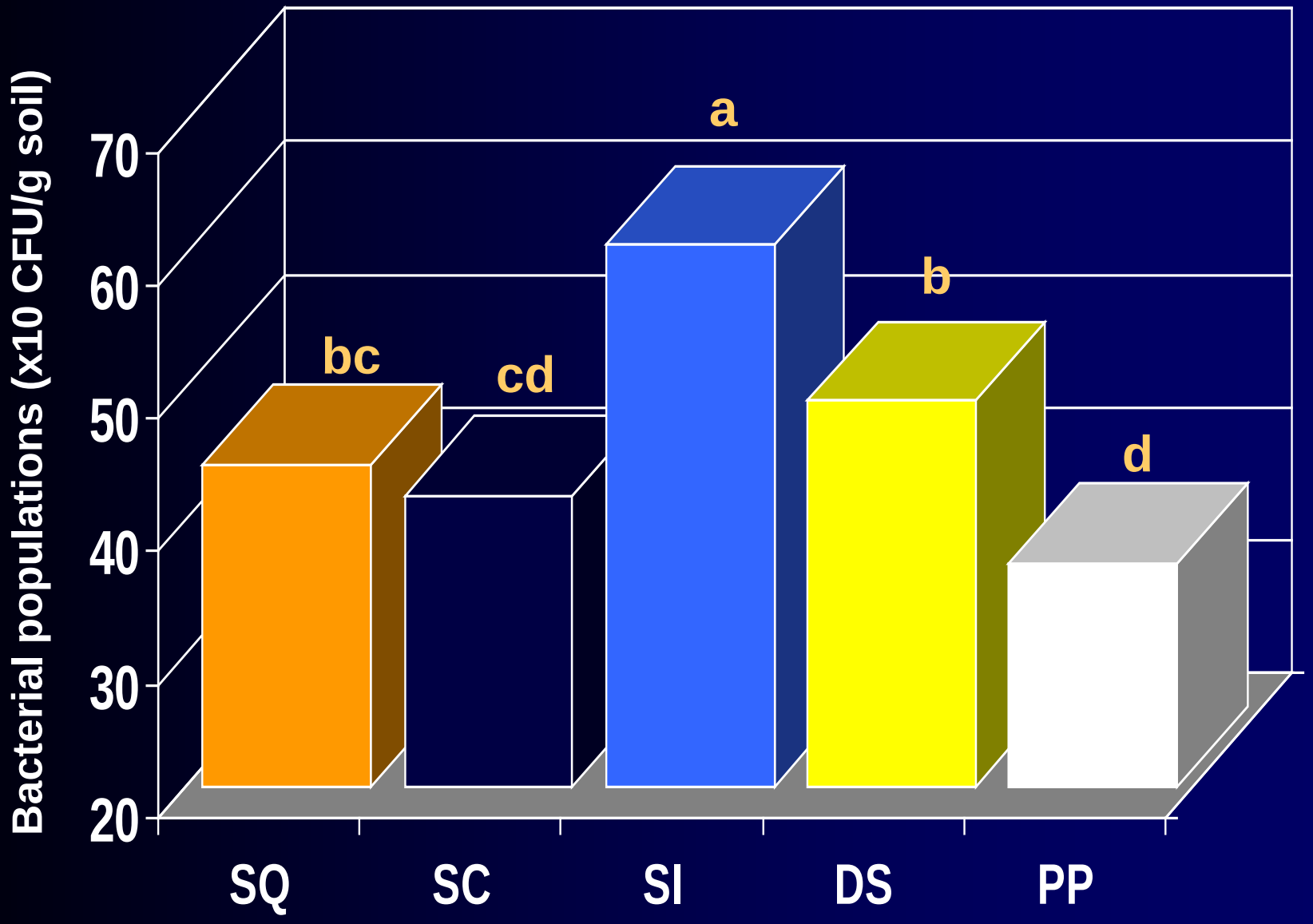
	Active C	POM - C	POM-N
	mg C kg^{-1} soil	% of Total C	% of Total N
Potato - Potato	430	20.5	19.7
Status Quo	451	19.8	19.5
Soil Conserving	438	21.4	20.4
Soil Improving	523	34.7	30.4
Disease Suppressive	435	20.6	19.6

Soil Aggregation

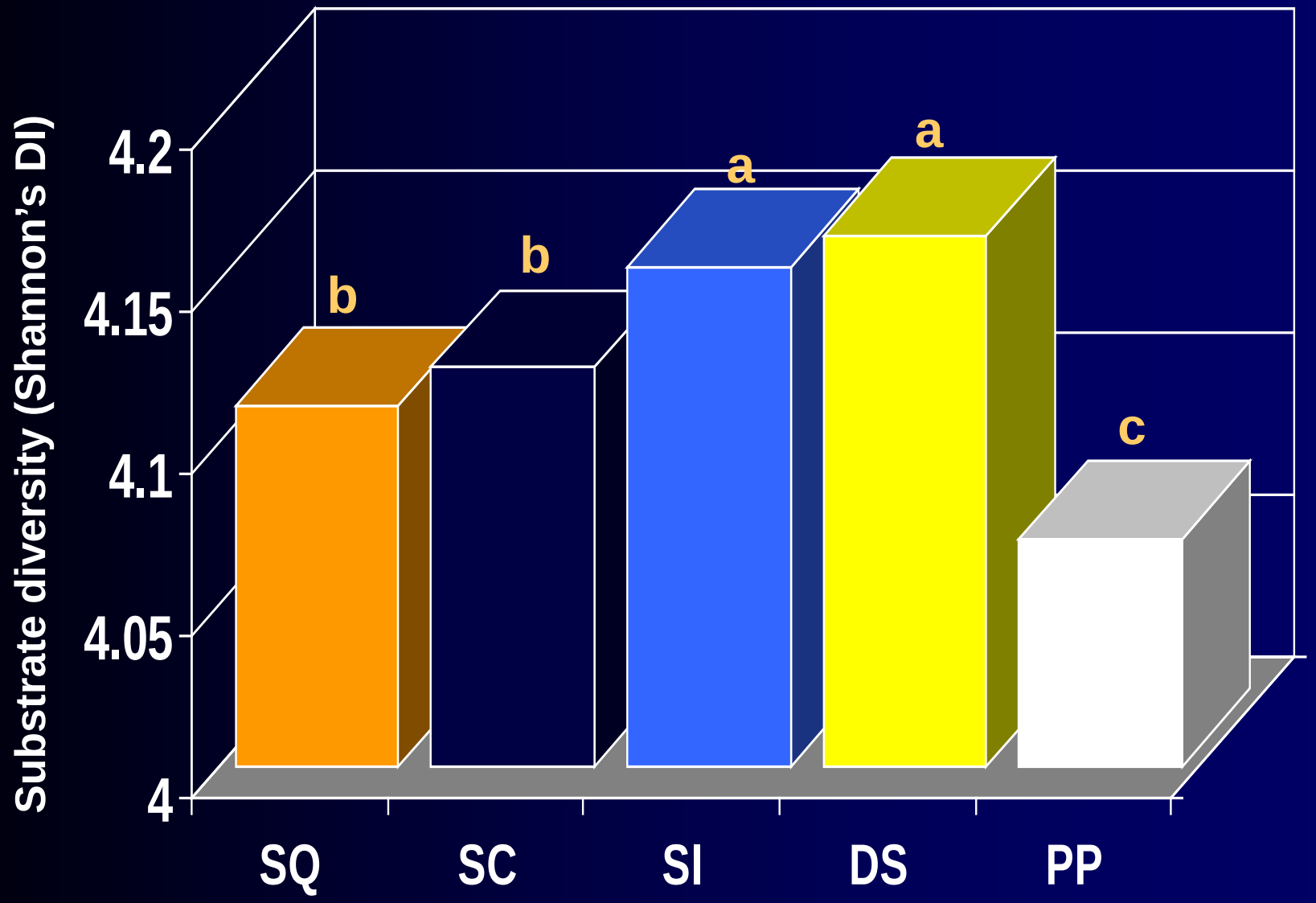
	% Water Stable Aggregates 0.5 - 2 mm
Potato - Potato	50
Status Quo	54
Soil Conserving	60
Soil Improving	62
Disease Suppressive	55

Cropping System	Surface Soil (7.5 cm) Bulk Density ($Mg\ m^{-3}$)
Potato – Potato	0.875 b
Status Quo	0.887 b
Soil Conserving	0.874 b
Soil Improving	0.771 a
Disease Suppressive	0.866 b
Irrigated	0.834
Non-irrigated	0.871

Soil Bacterial Populations (2-yr avg)

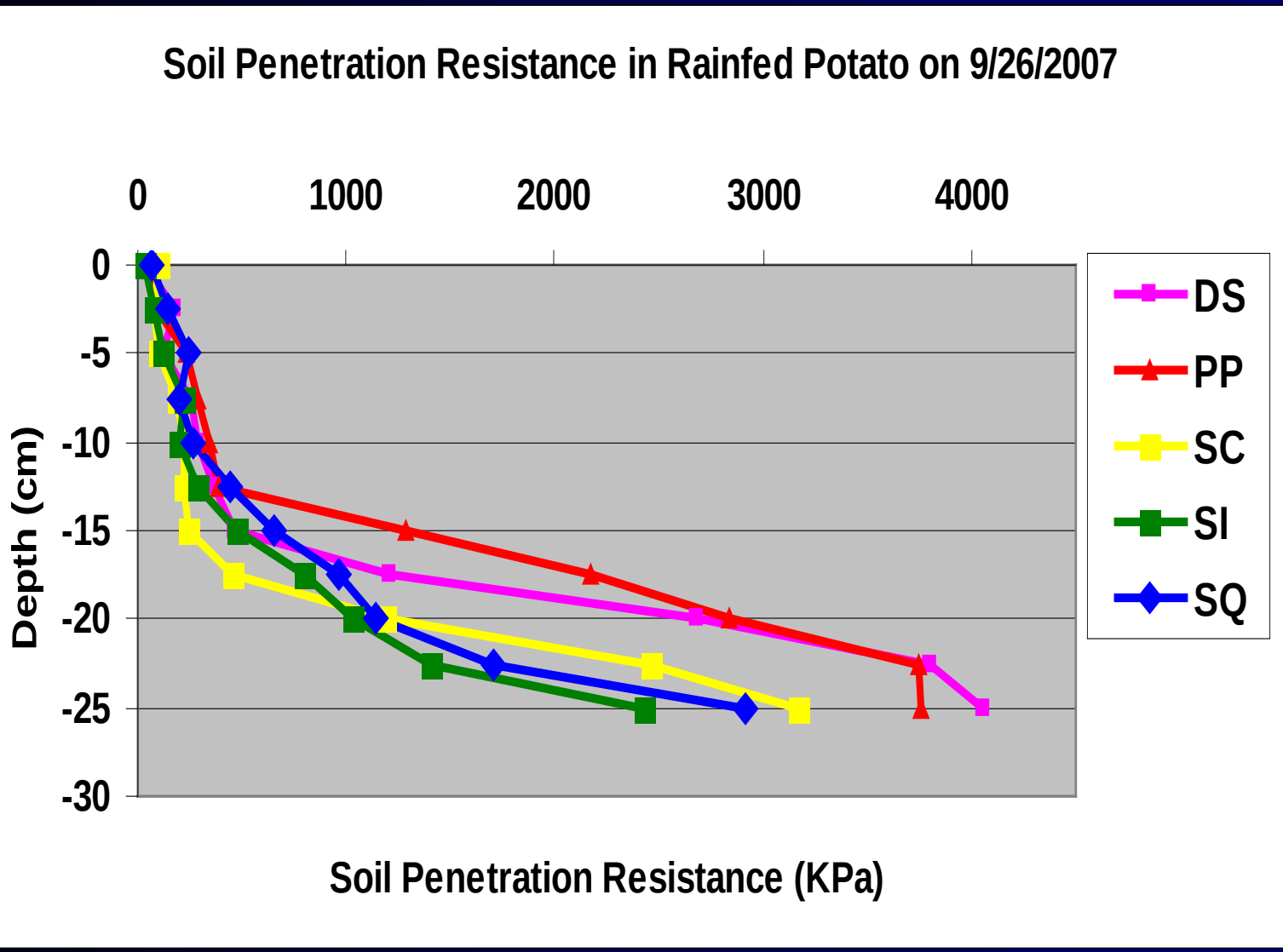


Soil Substrate Diversity (Shannon's index – BIOLOG, 2006)



Soil Penetration Resistance

Measured in center of Potato hill

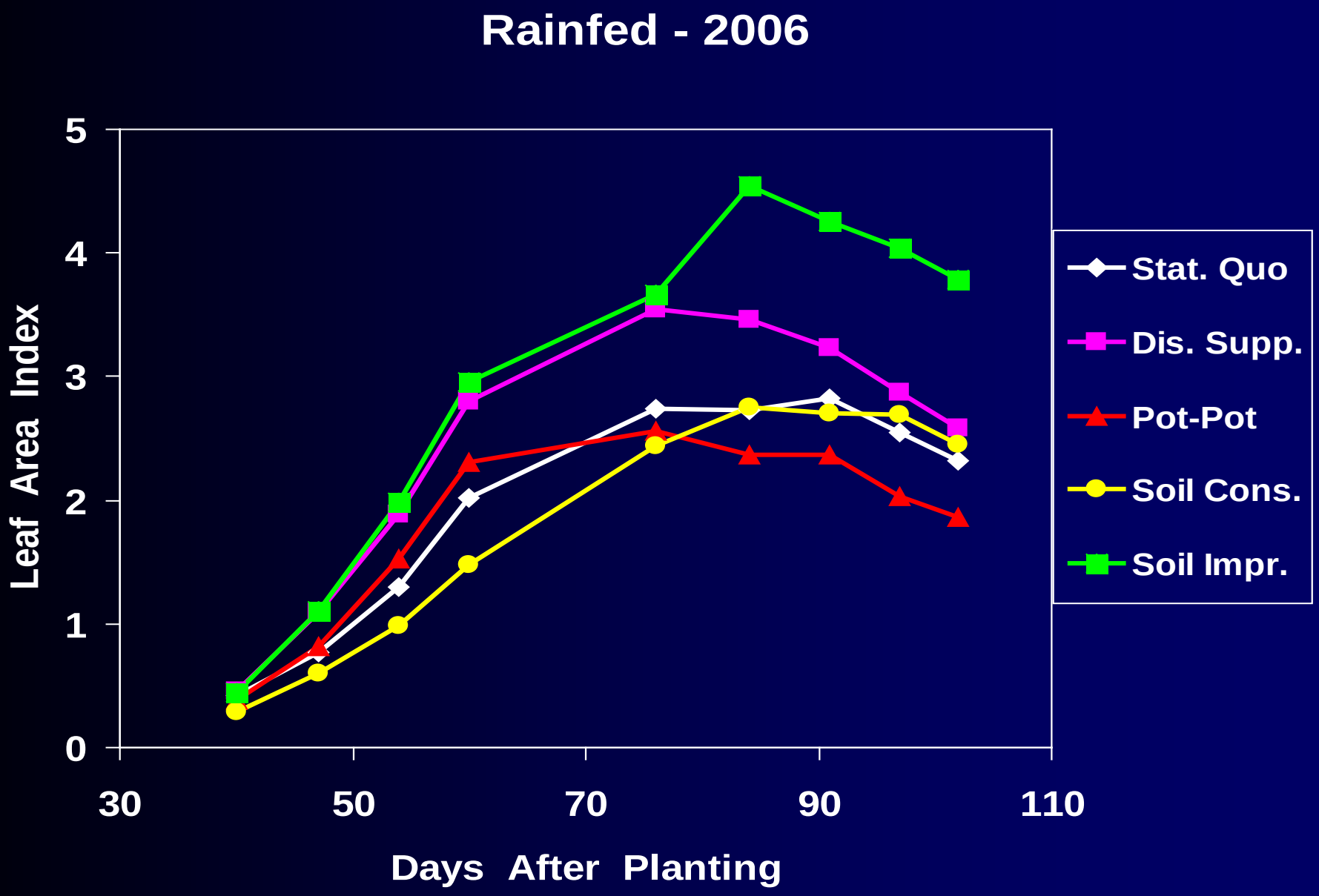

Soil Penetration Resistance in Rainfed Potato on 9/26/2007
0
1000
2000
3000
4000
0
-5
-10
-15
-20
-25
-30
Depth (cm)
DS
PP
SC
SI
SQ
Soil Penetration Resistance (KPa)

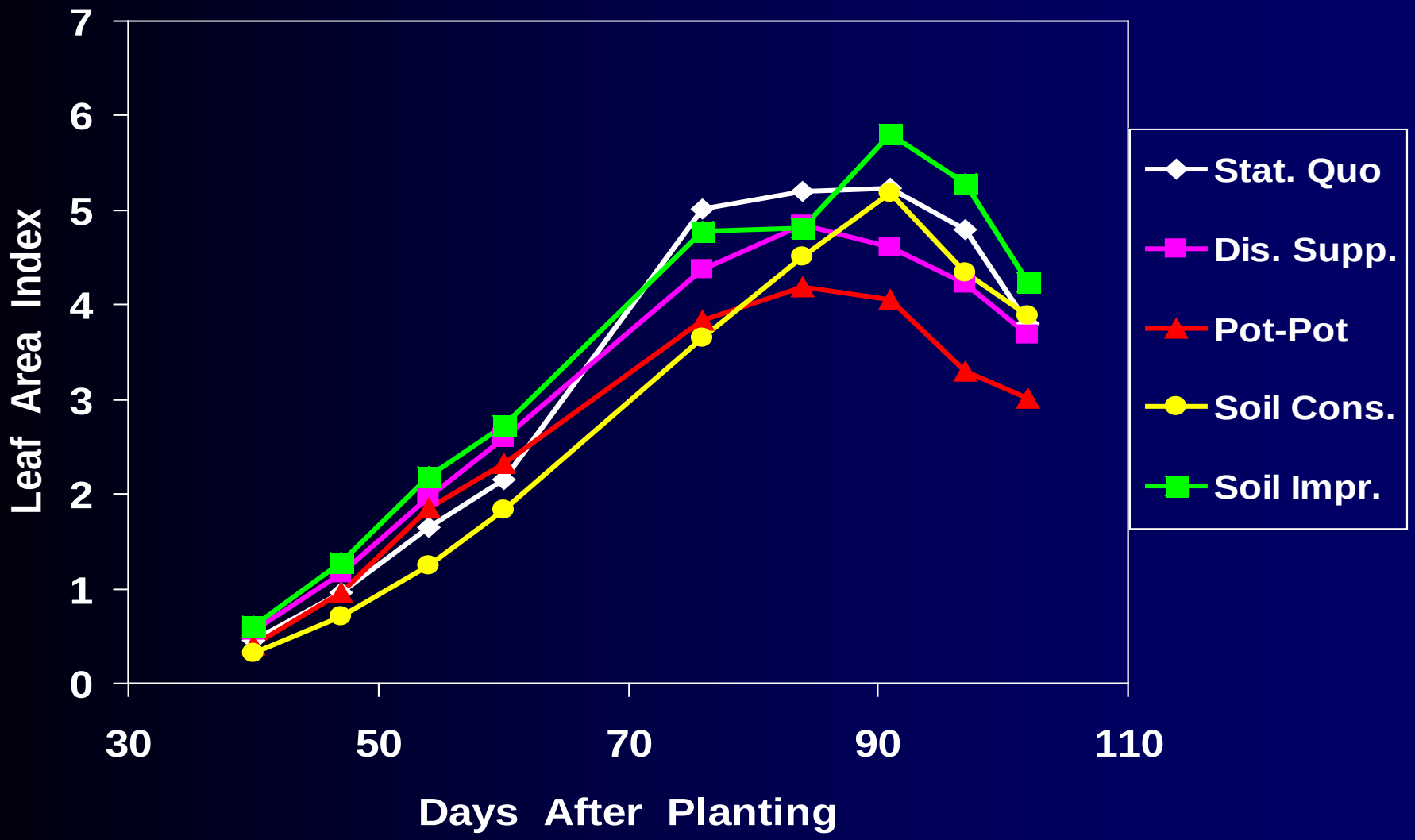
Plant Growth and Yield

Potato – Potato, Rainfed - 2007

Status Quo, Rainfed - 2007

Soil Improving, Rainfed - 2007


Rainfed - 2006
Leaf Area Index
0
1
2
3
4
5
30
50
70
90
110
Days After Planting
Stat. Quo
Dis. Supp.
Pot-Pot
Soil Cons.
Soil Impr.

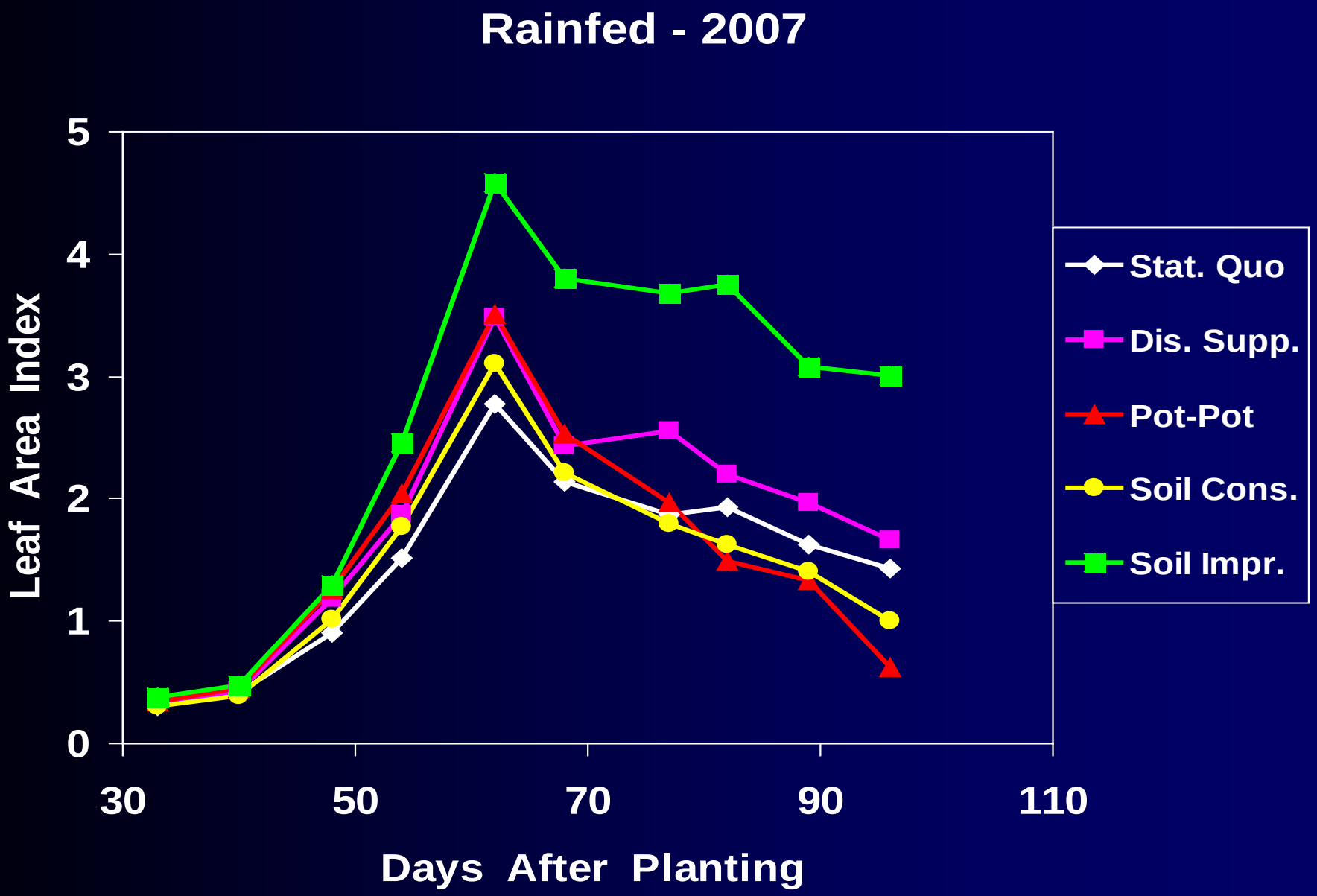

Irrigated - 2006
Leaf Area Index
0
1
2
3
4
5
6
7
30
50
70
90
110
Days After Planting
Stat. Quo
Dis. Supp.
Pot-Pot
Soil Cons.
Soil Impr.

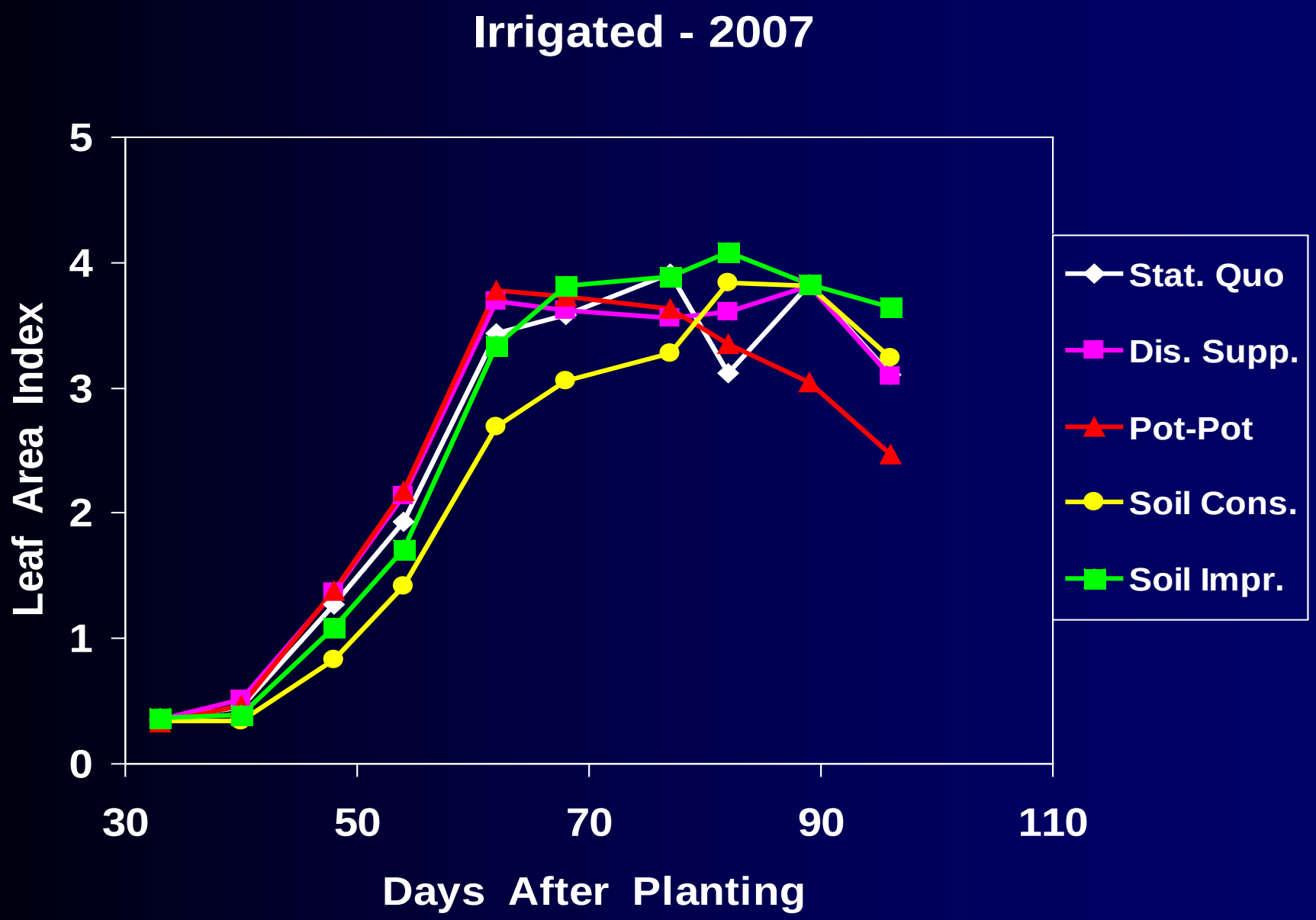
2006

Cropping System	Leaf Area Duration	
	Rainfed	Irrigated
Potato – Potato	123 b	179 a
Status Quo	130 b	214 a
Soil Conserving	117 b	181 a
Soil Improving	195 a	228 a
Disease Suppress.	167 a	204 a

Total Yield - 2006

Cropping System	Rainfed (cwt/ac)	Irrigated (cwt/ac)	Irrigation Response (%)
Potato-Potato	290 c	340 a	17
Status Quo	308 ab	397 a	29
Soil Conserving	249 bc	331 a	33
Soil Improving	371 a	386 a	4
Disease Suppress.	327 ab	399 a	22


Rainfed - 2007
Leaf Area Index
0
1
2
3
4
5
30
50
70
90
110
Days After Planting
Stat. Quo
Dis. Supp.
Pot-Pot
Soil Cons.
Soil Impr.


Irrigated - 2007
Leaf Area Index
0
1
2
3
4
5
30
50
70
90
110
Days After Planting
Stat. Quo
Dis. Supp.
Pot-Pot
Soil Cons.
Soil Impr.

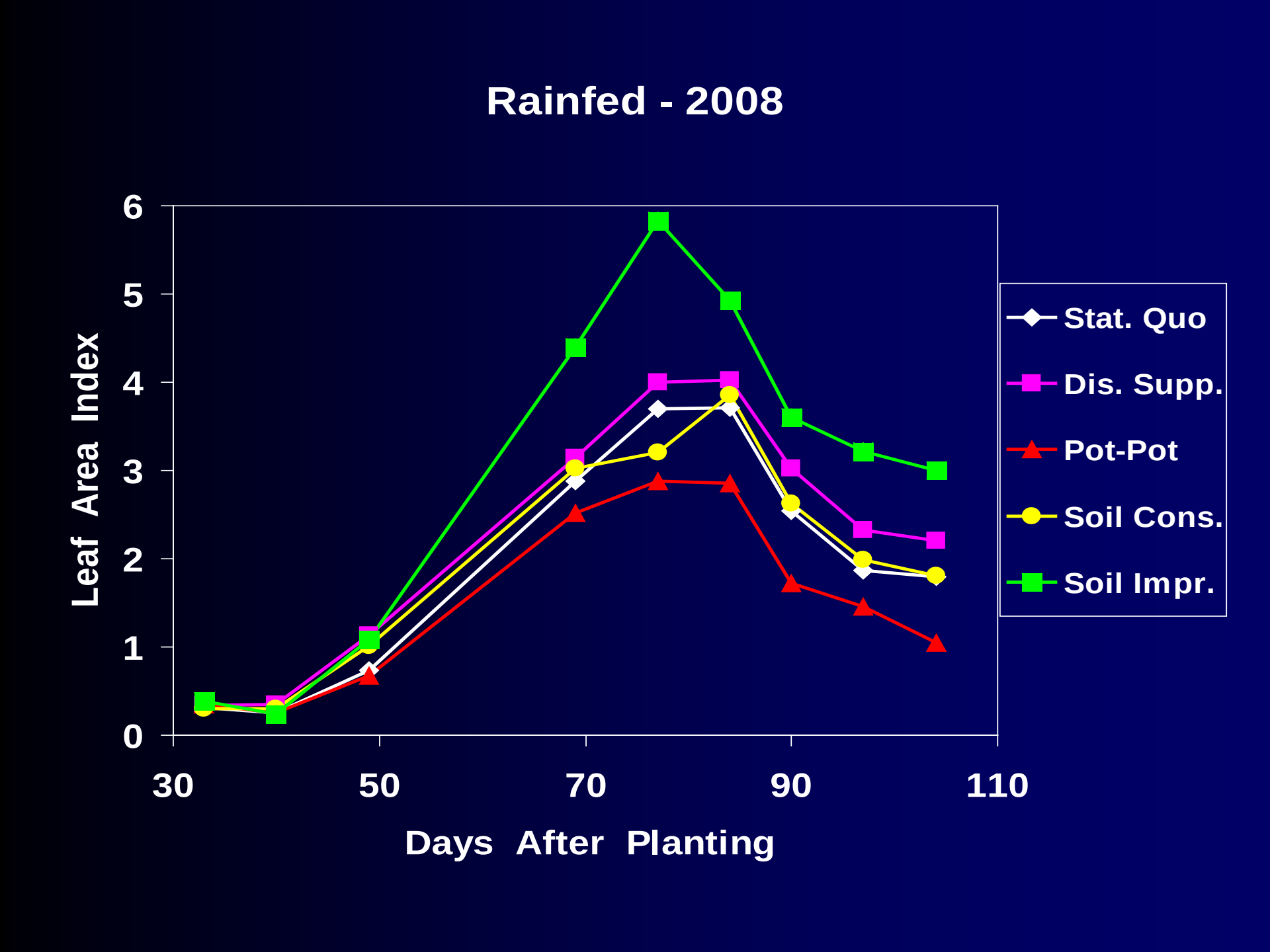
2007

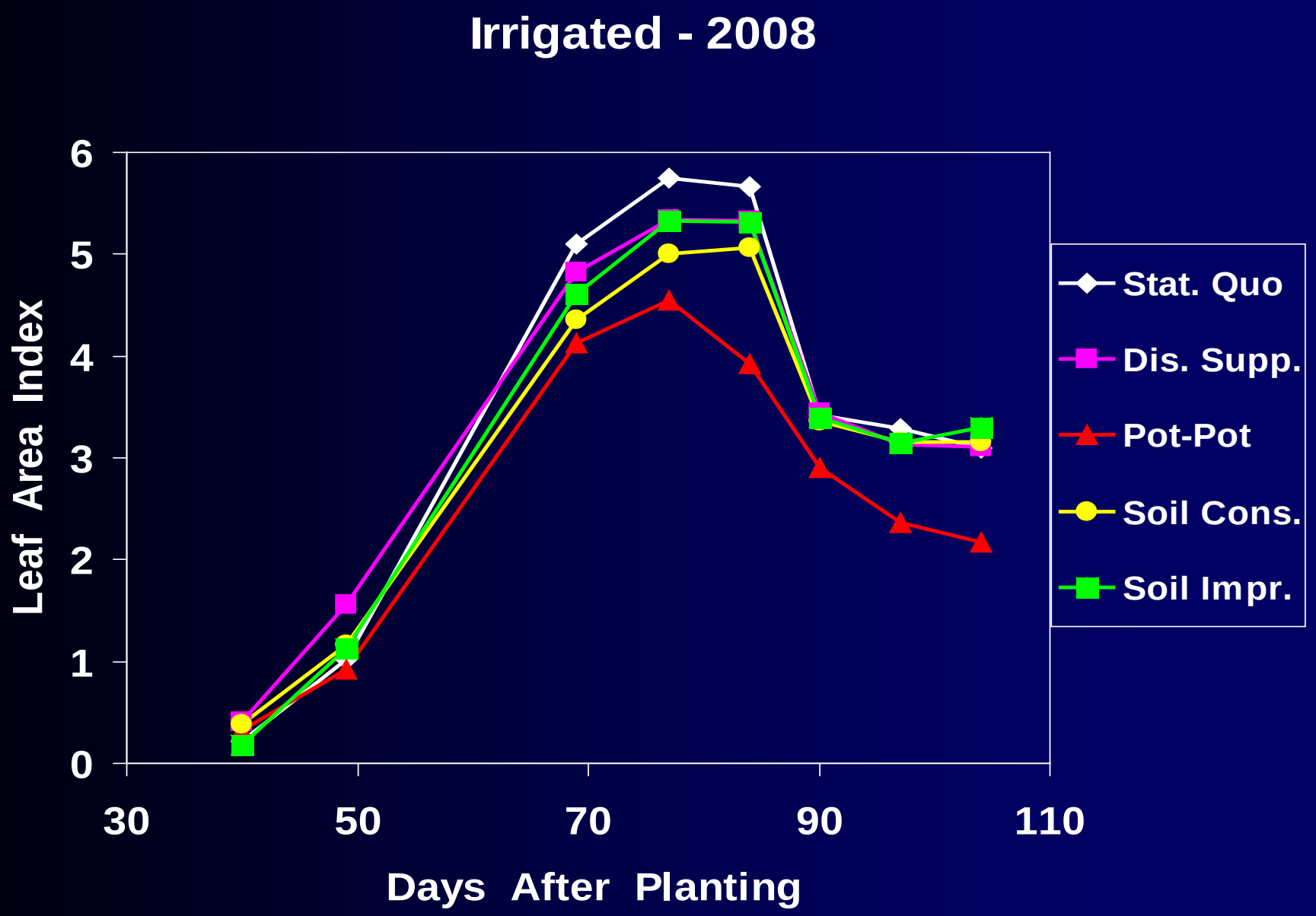
Leaf Area Duration

Cropping System	Rainfed	Irrigated
Potato – Potato	170 b	226
Status Quo	141 c	213
Soil Conserving	149 bc	191
Soil Improving	244 a	217
Disease Suppress.	174 b	223

Total Yield - 2007

Cropping System	Rainfed (cwt/ac)	Irrigated (cwt/ac)	Irrigation Response (%)
Potato-Potato	249 c	304 b	22
Status Quo	280 bc	351 ab	25
Soil Conserving	295 bc	348 b	18
Soil Improving	394 a	384 a	-3
Disease Suppress.	318 b	401 ab	26


Rainfed - 2008
Leaf Area Index
0
1
2
3
4
5
6
30
50
70
90
110
Days After Planting
Stat. Quo
Dis. Supp.
Pot-Pot
Soil Cons.
Soil Impr.


Irrigated - 2008
Leaf Area Index
0
1
2
3
4
5
6
30
50
70
90
110
Days After Planting
Stat. Quo
Dis. Supp.
Pot-Pot
Soil Cons.
Soil Impr.

2008

Leaf Area Duration

Cropping System	Rainfed	Irrigated
Potato – Potato	118 c	187 b
Status Quo	152 b	237 a
Soil Conserving	152 b	217 ab
Soil Improving	224 a	222 ab
Disease Suppress.	173 b	233 a

Total Yield - 2008

Cropping System	Rainfed (cwt/ac)	Irrigated (cwt/ac)	Irrigation Response (%)
Potato-Potato	203 b	265 b	31
Status Quo	265 b	292 ab	10
Soil Conserving	272 b	332 a	22
Soil Improving	297 a	303 ab	2
Disease Suppress.	281 b	326 a	16

SUMMARY

Impacts on Soil Properties:

- Soil Improving System had more labile soil C and N, and higher soil bacterial populations.
- Soil Improving & Disease Suppressive Systems had highest soil substrate diversity.
- Soil Improving System had lowest soil bulk density.
- Soil Improving & Soil Conserving Systems had higher soil aggregate stability.

SUMMARY

Impacts on Plant Growth & Yield:

- Soil Improving System increased Leaf Area Index, Leaf Area Duration, and Yield in all 3 years.

- Differences in Leaf Area Index, Leaf Area Duration, and Yield attributed to Cropping System were reduced through irrigation in all 3 years.

CONCLUSIONS

- Management systems that improve soil health can significantly enhance plant growth and yield.

- Management systems that improve soil health can be as effective as irrigation for enhancing plant growth and yield.