GRAB
Groupe de Recherche en Agriculture Biologique

3rd International Symposium
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Summer green manuring in OGH under French Mediterranean climate

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BioGreenhouse

cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

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Horizon 2020

Why growing cover crops in OGH ?

One solution to some of the problems in greenhouses: crop rotation, soil structure, SOM improvement, crop nutrition, weed management, sanitary problems…

In the Mediterranean regions

- Low levels of SOM
- Increased SOM mineralization (soil tillage, climate, solarization…)
- Limited resources of animal manure
- Limited resources in good quality compost

→ a green manure can be used as a « soil building crop » to produce OM for incorporation into the soil between 2 crops

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When cultivating GM in OGH ?

Greenhouse occupation		Autumn	Winter	Spring	Summer
Cash crop					
					
					
					
Inter cropping	Cover crop	60 to 100 days			
			100 to 120 days		
				60 to 80 days	
					40 days
	Solarization				45 days

→ **SUMMER is a good option : some greenhouses are empty – short cultivation period**

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Summer experiments conducted at the GRAB experimental farm

Screening of different families/species: 2001-2002

To select those adapted to the high temperatures and short available period under GH

Evaluation of legume species: 2013 to 2015

Idem… with the goal to enhance nitrogen availability and farmers self-sufficiency

Effect of legume GM on a subsequent lettuce crop

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Summer experiments conducted at the GRAB experimental farm

Trials conditions

- Plastic tunnels in Southern France (Avignon)
- Sprinkler irrigation
- Soil : Deep calcareous clay loam with 2,5% organic matter, pH=8.1
- Sowing : may to july, 41 to 55 days

Performances

- Above ground fresh and dry biomass production
- N and C:N ratio as an indication of N availability
- Weed suppressiveness (weed cover and % in the biomass)
- Susceptibility to pests and deseases

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1. Evaluation of GM species

Species	Scientific name	Seeding rates (kg.ha^{-1}) 2001 28/5 to 18/7 (50 days)	2002-A 7/6 to 18/7 (41 days)	2002-B 24/7 to 17/9 (55 days)
	GM from the Poaceae family			
Sudangrass	*Sorghum sudanense*	50	50	
Sorghum-sudangrass	*Sorghum bicolor x Sorghum sudanense*	50	50	70
Sorghum	*Sorghum bicolor*		20	
German Foxtail Millet	*Setaria italica (L.) Beauv.*	30	30	40
Rye	*Secale cereale L.*	60		
Italian ryegrass	*Lolium multiflorum Lam.*	30	30	
Ryegrass	Lolium perenne L.		30	
	GM from the Brassicaceae family			
White mustard	*Sinapis alba*	20	20	
Fodder radish	*Raphanus sativus var. oleiformis*	20	20	
	GM from the Polygonaceae family			
Buckwheat	*Fagopyrum esculentum Moench*	60	60	80
	GM from the Asteraceae family			
Mexican marigold	*Tagetes minuta*	5		
	GM from the Hydrophyllaceae family			
Phacelia	*Phacelia tanacetifolia*	15		
	GM mixtures			
Wheat + Fenugreek	*Triticumsp. + Trigonella foenum-graecum*	60 + 30		
Wheat + sweetclover	*Triticumsp. + Melilotus officinalis (L.) Lam*		80 +20	
Wheat + berseem clover	*Triticumsp. + Trifolium alexandrinum*		80 + 20	
Oat + common vetch	*Avena sativa L. + Vicia sativa*	60 + 50	80 + 50	

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1. Evaluation of GM species

Poaceae Family

Species	Dry Biomass (t/ha)	Weeds (%)	C:N ratio
Sorghum-sudangrass	6 to 10	0 to 2	17 -18
Sudangrass	5 to 13 (2013)	0 to 15	15 to 57 (2013)
Pearl Millet (2013-2015)	6 to 16 (2013)	4 to 10	28 (2013)
Foxtail millet	4 to 7	2 to 22	16-27
Rye, Italian ryegrass, ryegrass, wheat, oat…	Outcompeted by weeds		

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1. Evaluation of GM species

Brassicacea Family

\+

Fast growth
High biomass (3 to 7 t Dry biomass/ha)
Lower C:N (16-18)
Weed suppression

\-

Diseases (rhizoctonia) and pests (flea beetle [delia radicum], diamondback moth [plutella xylostella], slugs…) risks

1. Evaluation of GM species

Polygonaceae Family : buckwheat

Fast growth
Good biomass (3.5 to 5 t Dry biomass/ha)
C:N (20-26)
Weed suppression

Short cycle : flowers in 30 days

1. Evaluation of GM : conclusions

- **The best results** were obtained with species from the **poaceae** and **polygonaceae** families, which are not cultivated in the vegetable systems : real break in the crop rotation
- The above ground Biomass can reach 60 tonnes of fresh biomass (7-9 dry) with quite high C:N ratio → interesting level of OM

- Species of the **brassicaceae** family have good results but too risky because of the sanitary problems

- Species of the **fabaceae** family tested in the first round of trials are not adapted : fenugreek, sweetclover, berseem clover, vetch





2. Evaluation of legume species

FAMILY	Specie	*Scientific name*	Seeding rates (kg.ha^{-1})	
			Alone	***in mixtures***
Poacea sp.	Sudangrass	Sorghum sudanense	50	20
	Pearl millet	*Pennisetum glaucum*	30	12
	Bristle oat	*Avena strigosa*	60	
	German Foxtail Millet	*Setaria italica (L.) Beauv.*		15
Polygonaceae sp.	Buckwheat	*Fagopyrum esculentum*		30
Fabaceae sp.	Cowpea	*Vigna unguiculata, Vigna sinensis*	80	60
	Lablab	*Lablab purpureus, Dolichos lablab*	80	60
	Field pea	*Pisum arvense*		90
	Grass pea	*Lathyrus sativus*		18
	Sweet clover	*Melilotus arvensis*		11
	Common vetch	*Vicia sativa*		40
	Purple vetch	*Vicia benghalensis*		18
	Berseem clover	*Trifolium alexandrinum*		20
	Persian clover	*Trifolium resupinatum*		10

40 %

75 %

Species evaluated in summer 2013

2. Evaluation of legume species

Results in summer 2013 (50 d)

Species	Above ground fresh biomass		Dry biomass		C/N	Nitrogen kg.ha^{-1}
	t.ha^{-1}	% weeds	t.ha^{-1}	% N		
Sudangrass	77,3	5,4	13,4	0,8	57	107
Cowpea	22,2	40,7	3	1,3	44	39
Lablab	48,4	31,1	6,8	1,4	32	96
Pearl millet (+ pea)	127,9	4,0	16,5	1,5	28	247
Foxtail millet (+clover)	31,5	39,3	6,6	1,2	37	79
Buckwheat (+ vetch)	22,9	48,0	3,8	1,1	42	42

- Weed competition is very high when legumes alone
- Low legume rates (<10%) in mixtures with 40 % grasses
- Low N contents and high C:N ratio : limited nitrogen supply ?
- No nodules on the roots…





2. Evaluation of legume species

Results in summer 2014 (42 d)

- Higher legume rates (10-27%) in mixtures with 20 % grasses and full seeding rates for legumes
- % legumes: Cowpea > Lablab > Field pea
- nodules on the roots…
- Pearl millet 6kg/ha in mixtures : limited weed control

Sudangrass+ FIELD PEA
(Pisum sativum arvense*)*

Sudangrass + COWPEA
(Vigna sinensis*)*

Buckwheat + LABLAB
(Dolichos lablab*)*

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2. Evaluation of legume species

Results in summer 2015 (42 d)

Species	Seeding rates (kg.ha^{-1})	Above ground fresh biomass			Dry biomass t.ha^{-1}	C : N	Nitrogen (kg.ha^{-1})
		t.ha^{-1}	% weeds	% legume			
Sudangrass	50	53.3	3.4		7.1	34	92.5
Cowpea + sudangrass	80 + 10	46.7	20.4	26.6	6.6	28	107.5
Cowpea + pearl millet	110 + 10	54.6	4.2	31	5.9	27	91.7
Cowpea (+ berseem clover)	110 + 10	48.7	24.5	75.5	4.9	22	94.9

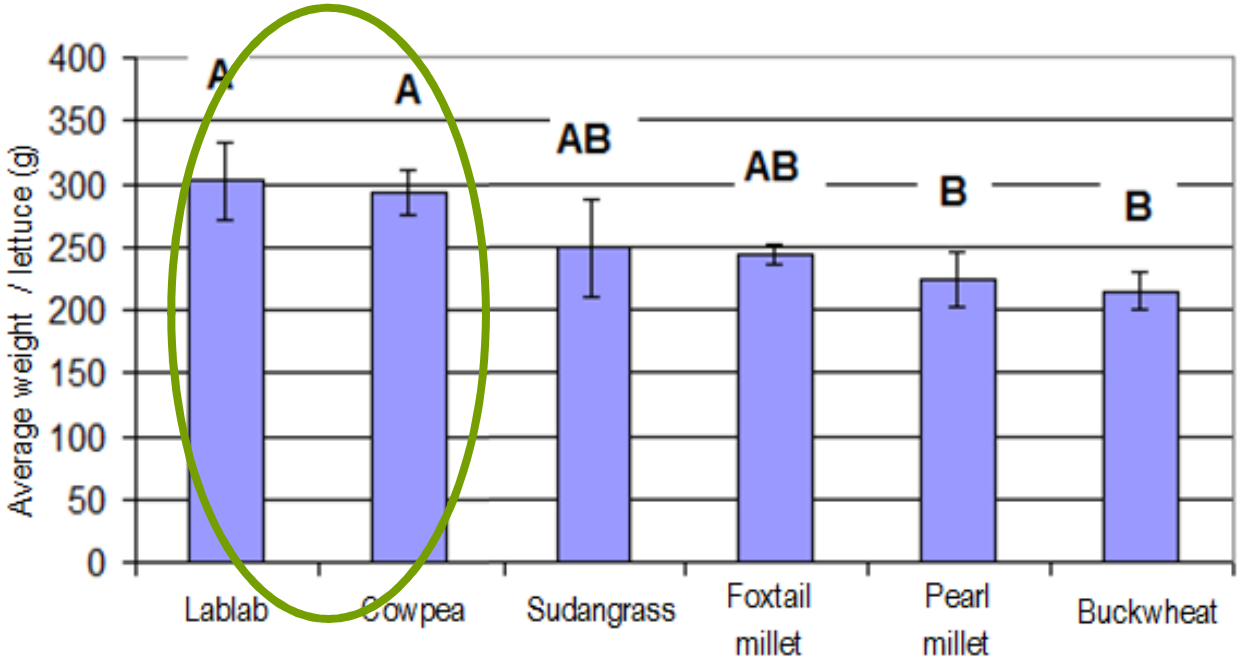
- Good legume rates in mixtures with 10 kg/ha grasses and full seeding rates^{+} for legumes
- Similar nitrogen contents in the above ground biomass control
- Very few nodules…





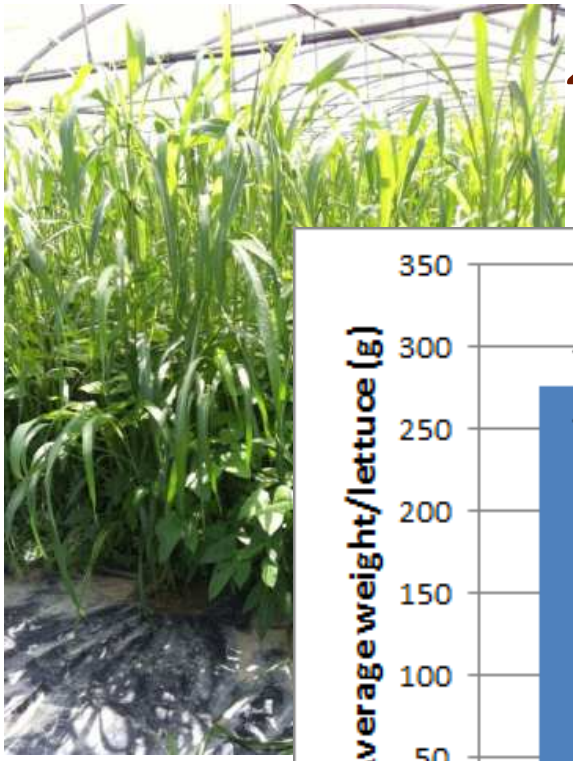
3. Effect on lettuce crop's productivity

2013 (1st oct ->5th dec)

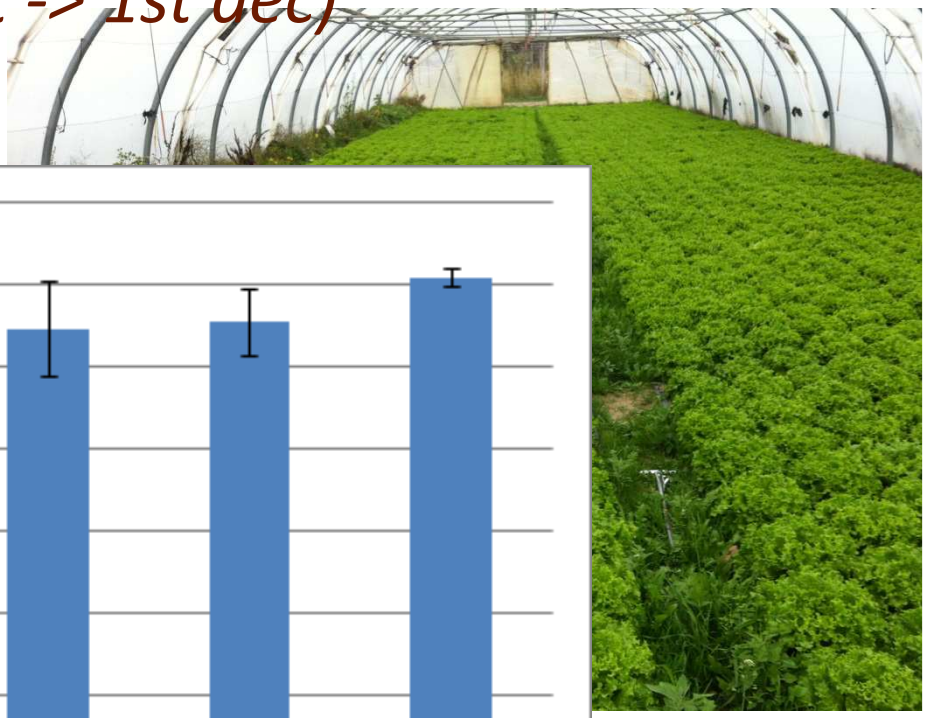


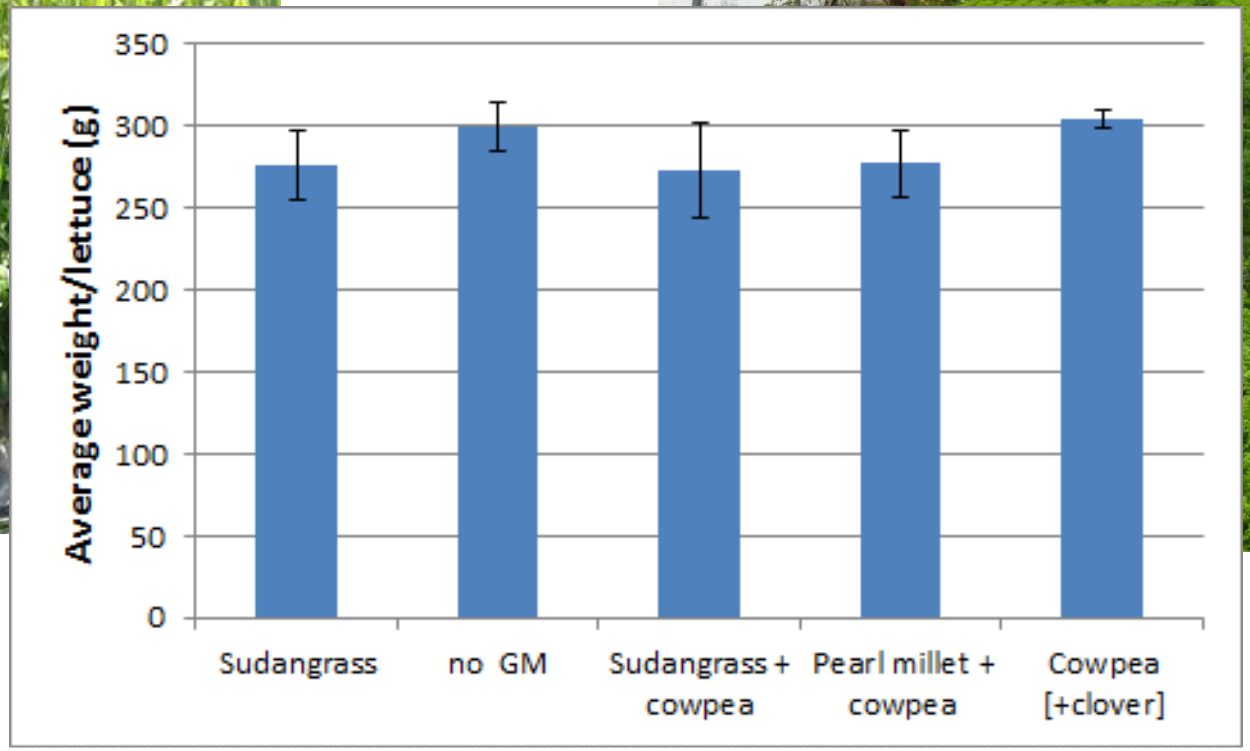
- Potential interest of legumes
- No relationship between lettuce weight and GMs' N content or C:N ratio… or [NO_3^-] in the soil

3. Effect on lettuce crop's productivity



2015(1st oct -> 1st dec)





Similar GMs' characteristics → Similar N mineralization ?

No nutrient deficiencies / control without GM (higher [NO_3^-] in the soil)

Conclusions

- Tropical species of grasses (sudangrass, sorghum, pearl millet) or legumes perform much better
- Some temperate species (Buckwheat, foxtail millet, field pea) are also adapted but their cycle is fast
- High biomasses can be produced in 40-50 days : a summer GM can improve SOM and soil fertility
- Legumes have to be mixed with other plants to ensure a good weed control
- Interest of short cycle-summer legumes to improve subsequent crop N nutrition ??? (nodules ?)





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Thank you for your attention !

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