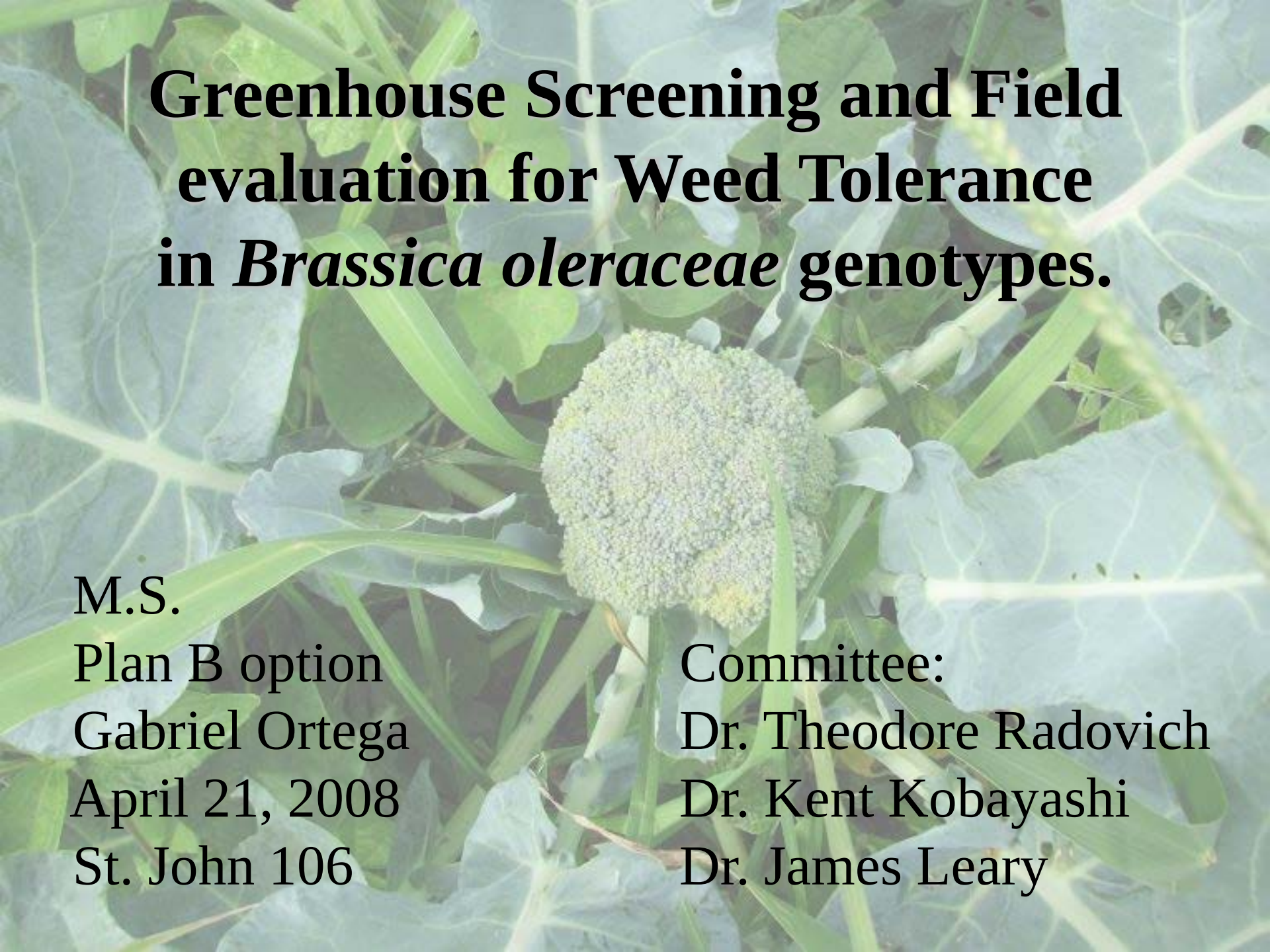
Greenhouse Screening and Field evaluation for Weed Tolerance in *Brassica oleraceae* genotypes.



M.S.
Plan B option
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St. John 106

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Outline

- Introduction to weed tolerance
- The Problem statement
- Objectives
  - Approach 1. Greenhouse
  - Approach 2. Field
- Project results and summary
- Acknowledgements
- References

Introduction

- Weed tolerance (WT) –ability to produce at optimal to high yields in the presence of weed populations.

  (Callaway, 1997)

- Genetic improvements – in crop tolerance to diseases, insects, & other stresses, reduce / eliminate applications.

- Limited research conducted for increasing tolerance to weeds.

- Cereal, grain and vegetables demonstrate weed tolerant attributes (Callaway, 1992; Ghersa, 2000, Lieberman et. al., 1997, Paolini et.al., 2006).

Introduction (cont.)

- Factors influencing (WT) abilities
  - 1.Characteristics of genotypes.
  - **Seedling establishment** - Rapid and high growth rate.
  - **Plant Height and Maturity** - High plant height index, Later maturity, Earlier maturity.
  - **Use of nutrients** – High rate of [N] absorption, efficient [P]utilization.

Introduction (cont.)

- **Canopy characteristics-** High leaf area, rapid formation.
- **Vigor and Productivity –** High yield, good intraspecific competitive ability.(adapted from Callaway, 1992)
- 2. Plant density / spacing arrangements.
- 3. Time of planting crop / relative to weed emergence. (Paolini,1998)
- 4. Environmental conditions.

Problem statement

- Weed control.
- Environmental concerns.
  - Cultivation
  - Pollution
- Growers costs, time, and labor.
- Rapid identification of traits is an important area to explore.

Objectives

- 1. Screen *Brassica oleraceae* seedlings for physiological traits associated with WT.
- 2. Evaluate selected cultivars for WT under field conditions and identify genotypes that demonstrate potential for high performance under weedy conditions.
- 3. Identify crop characteristics most closely associated with optimal performance under weedy conditions.

Approach 1. Greenhouse

- Screen cultivars.
  - Validate / identify traits associated to WT.
  - Narrow cultivar candidates to be evaluated in Field.
  - Testing against weeds becomes more practical by identifying traits early in breeding program.

(Liebman et al. 2001)

1. Materials and Methods

- Plantings and genotypes:
  - 10/11/06 to 11/12/06 (GH Planting 1)
  - 12/20/06 to 01/19/07 (GH Planting 2).

  - 10 genotypes
    - (8) *var. italica* group, 'Arcadia', 'Barbados', 'DeCiccio' 'Green Goliath‘, 'Flash', 'Marathon', 'Packman', 'Waltham', and
    - (2) *var. botrytis* group 'Fremont', and 'Quasar'.

1. Methods (cont.)

- Experimental design : RCBD
  - 10 genotypes
  - 2 treatments - Low and high nutrient.
  - Each treatment had 4 replications with 12 sub-samples
- Measurements
  - Taken 30 days after emergence
  - 1. Leaf Area (cm^{-2}) portable Leaf Area meter model CI-202.

1. Methods (cont.)

- 2. Chlorophyll content- Minolta SPAD 502 meter.
- 3. Biomass production- fresh (fwt) and dry weight (dwt).
- 4. Number of true leaves.
- 5. Nitrogen concentration in aboveground biomass of the seedling.

- Statistical Analysis
  - Proc GLM analysis in SAS
  - Mean separation – Duncan's Multiple range test, alpha at 0.05.

1. Results

- Phenotypic traits varied among all genotypes.
  - Significant differences were observed among cultivars in leaf area (range: 30-115 cm^2)
  - Chlorophyll content (range: 30-51 SPAD units)
  - Dry matter production (35-410 mg per plant).

1. Cultivar ranking, Planting 1

Cultivar	LA	Chl	Fresh wt.	Dry wt.	No. True Lf.	Overall ranking
Marathon	1	4	2	2	3	1
Packman	3	5	1	4	6	2
Barbados	4	2	6	3	5	3
Arcadia	5	8	3	1	4	4
DeCiccio	2	7	4	9	1	5
Green Goliath	7	1	5	5	7	6
Quasar	6	6	7	6	2	7
Flash	8	3	9	7	6	8
Waltham	9	10	8	8	8	9
Fremont	10	9	10	10	9	10

1. Cultivar ranking, Planting 2

Cultivar	LA	Chl	Fresh wt.	Dry wt.	No. True Lf.	Overall ranking
Arcadia	1	3	1	1	4	1
Quasar	2	5	2	2	1	2
Barbados	3	1	4	5	2	3
Green Goliath	5	2	3	3	9	4
Flash	7	4	7	7	3	5
Marathon	4	7	5	4	8	5
Packman	6	6	6	6	4	5
Waltham	8	10	8	8	4	6
DeCiccio	9	8	9	9	7	7
Fremont	10	9	10	10	10	8

1. Results

- Barbados was overall ranked in the top 3 in both plantings.
- Arcadia, Marathon and Packman were ranked in the top three for either planting 1 or 2.
- Open-pollinated Waltham was ranked towards the bottom in both planting.
- Flash was intermediate in both plantings

1. Discussion

- Early seedling vigor is known to be a trait used in WT experiments.
- Cultivars in these trials differed significantly in several of these traits.
- High, mid and low ranking cultivars were selected to validate greenhouse screening for WT as a management tool.

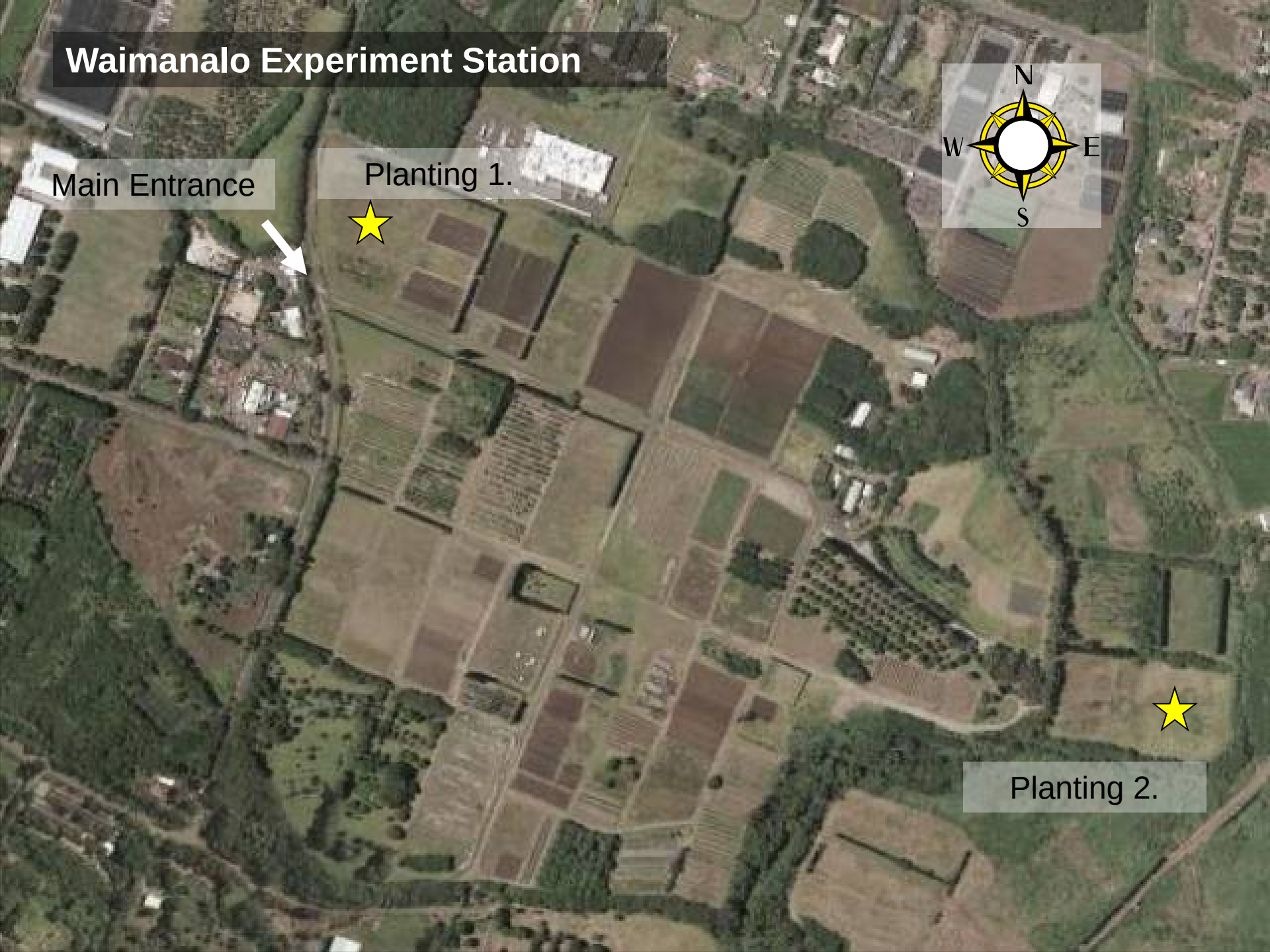
Approach 2. Field

- Evaluate yield and plant growth performance of genotypes selected from GH trials under low and high weed density.

- Identify crop characteristics most closely associated with optimal performance under weedy conditions.

2. Materials and Methods

- Plantings and genotypes:
  - 02/07/07- 04/17/07
  - 6 genotypes -'Arcadia', 'Barbados', 'Flash', 'Marathon', 'Packman', 'Waltham‘.
  - 11/09/07-02/13/08
  - 7 genotypes - 'Arcadia', 'Barbados', 'Flash', 'Gypsy', 'Marathon', 'Packman',‘ Waltham‘.
- Experimental design : RCBD
  - 6-7 genotypes.
  - 2 weed treatments - Low and high weed density.
  - Each treatment had 3 replications with 3 sub-samples.


Waimanalo Experiment Station
Main Entrance
Planting 1.
N
W
E
S
Planting 2.

2. Materials and Methods

- Weed simulation:
  - HWD plots were seeded with *Avena sativa* variety TAMO 405 (35 kg ha-1) target rate of 20 plants/m^2 .
  - Spontaneous weeds were allowed to persist in HWD plots.
  - LWD plots were hand weeded throughout trial to maintain low weed densities.

2.Methods

- Data at harvest included inflorescence weight (IW), leaf and stem weight (LSW), leaf area (LA) and weed species composition and biomass.
- Weed tolerance was quantified using the formulae: 1) IW_{HWD}/IW_{LWD} or 2) LSW_{HWD}/LSW_{LWD}.

2. Methods

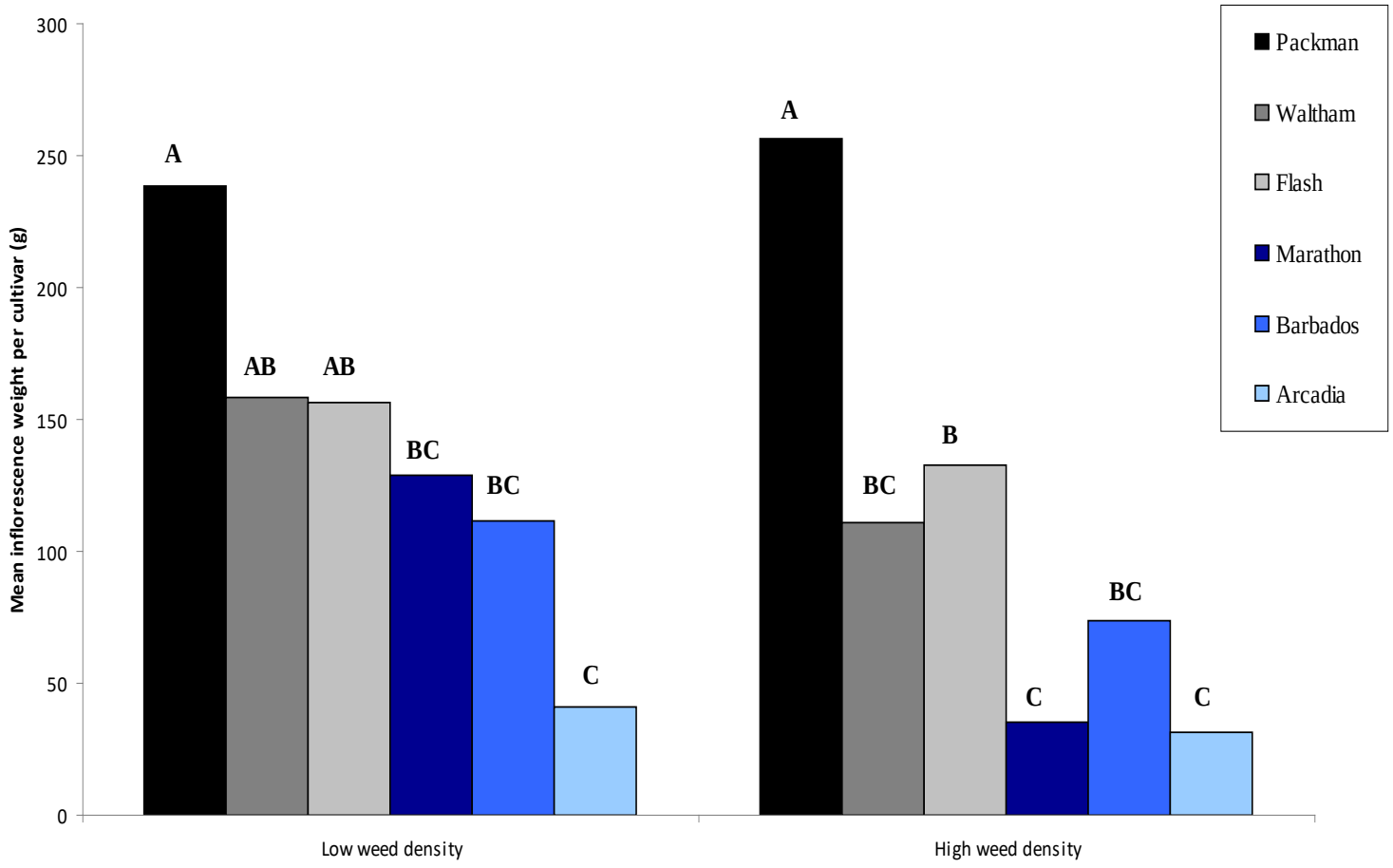
- Data collection
  - 1. Plant height and width
  - 2. Leaf length and width (Leaf Area cm^{-2})
  - 3. % Plant light interception (PAR) µmol m^{-2} s^{-1}
  - 4. Leaf count
  - 5. Inflorescence diameter.
  - 6. Biomass production – (fwt) and (dwt)
  - 7. Identification of major weed groups (grasses and broad leaves).
  - Weeds-total aboveground (fwt) & (dwt)

Field Planting 2. 30 Days after transplant

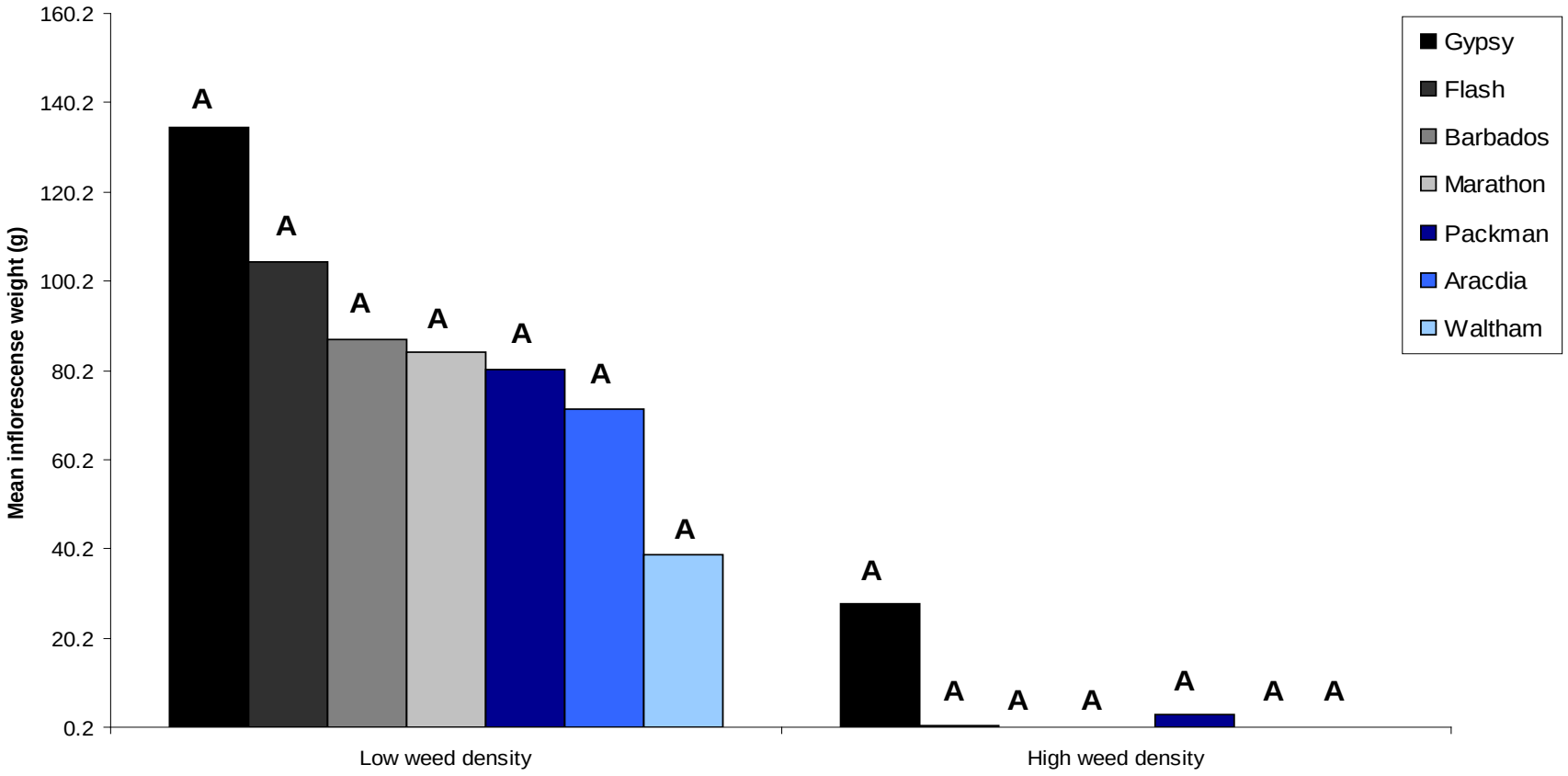
2. Results

- Overall, there was significant difference in growth, yield, and ratio in weed tolerance in Field Planting 1.
- No significant differences for most traits in Field Planting 2.
- Lack of ability to detect significance in Field Planting 2 due to high variability (cv=60-80%)
  - Weed pressure
  - Variable seedlings
  - Excessive rain during establishment.
  - High Insect pressure

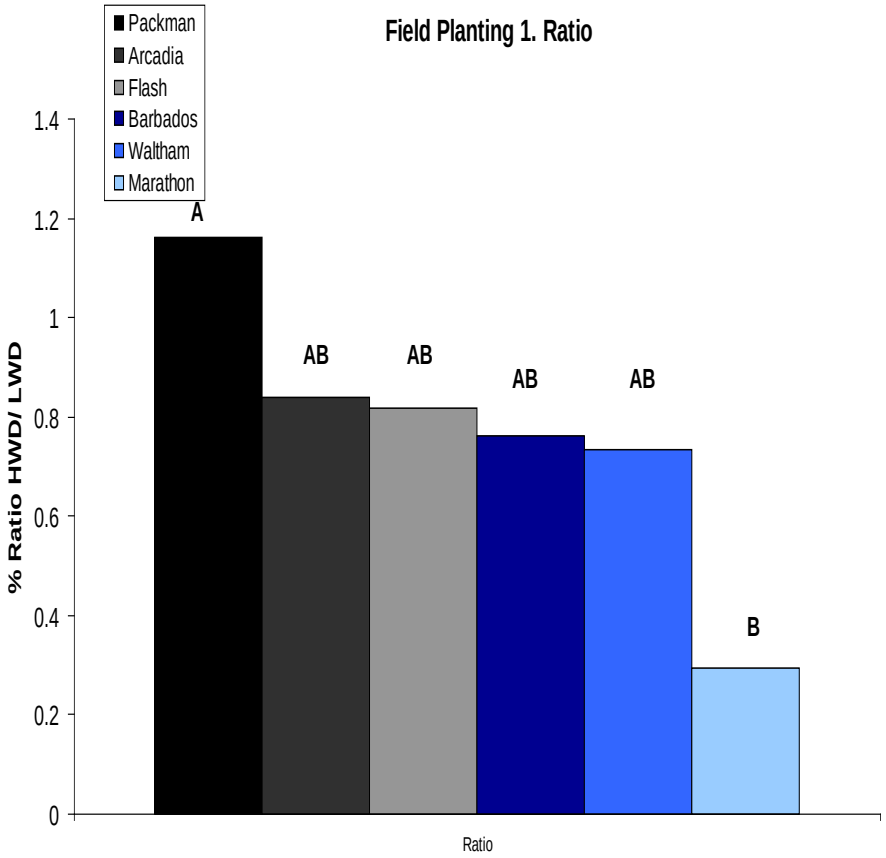
2. Field Planting 1.

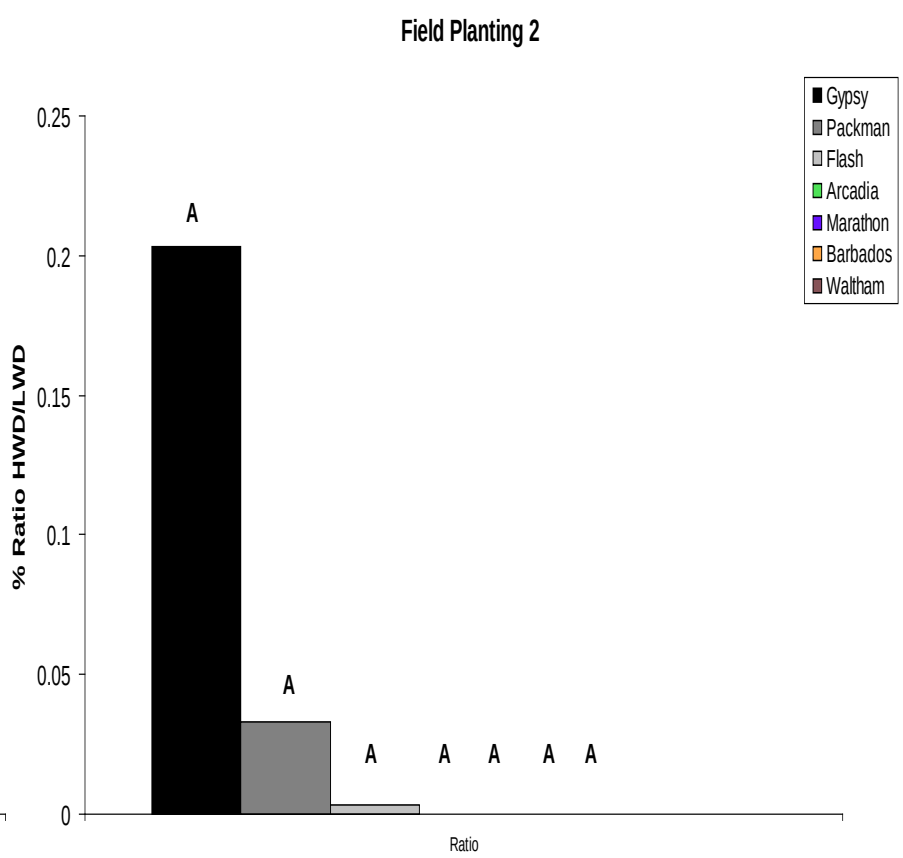


2. Field Planting 2.

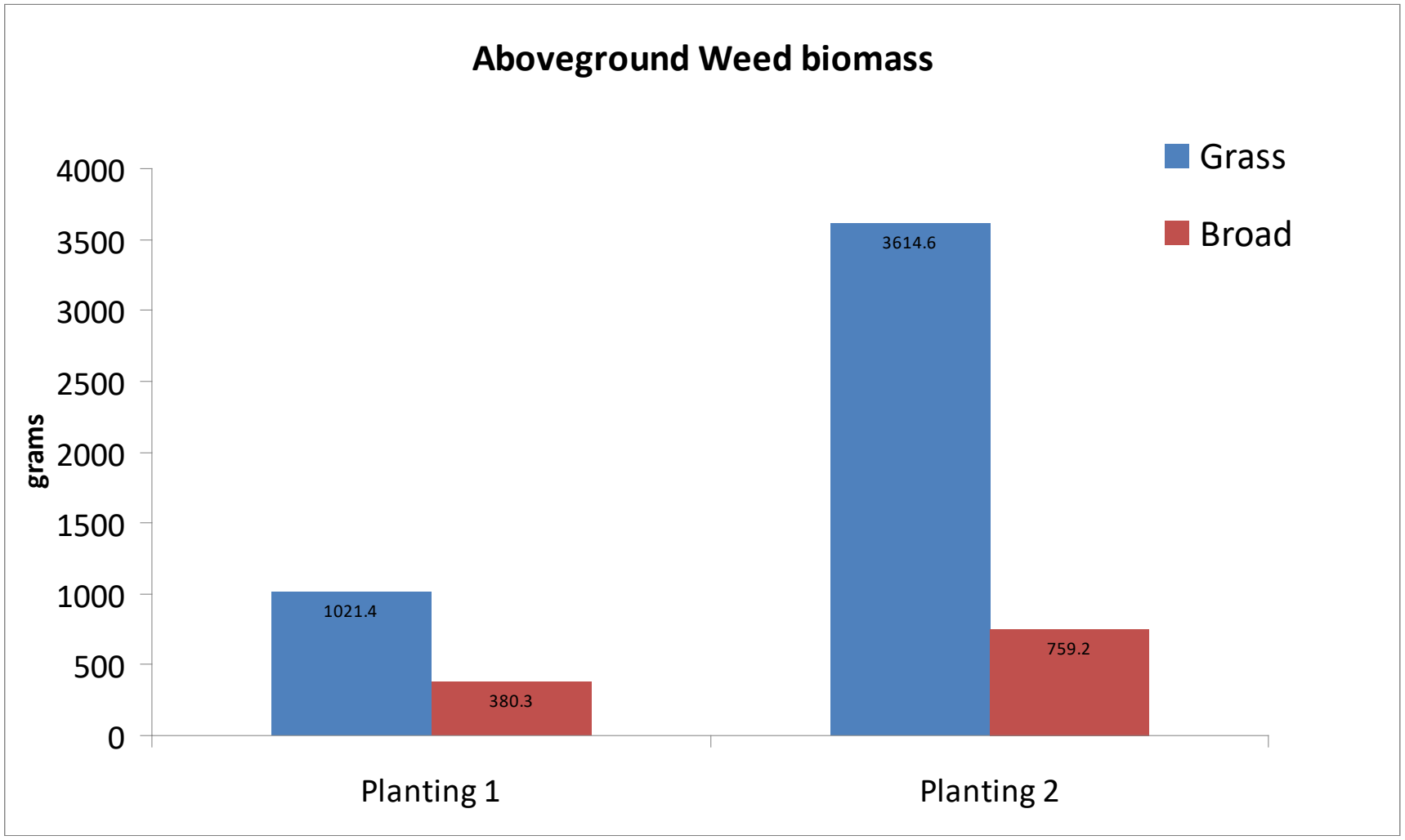


2. Ratio among cultivars

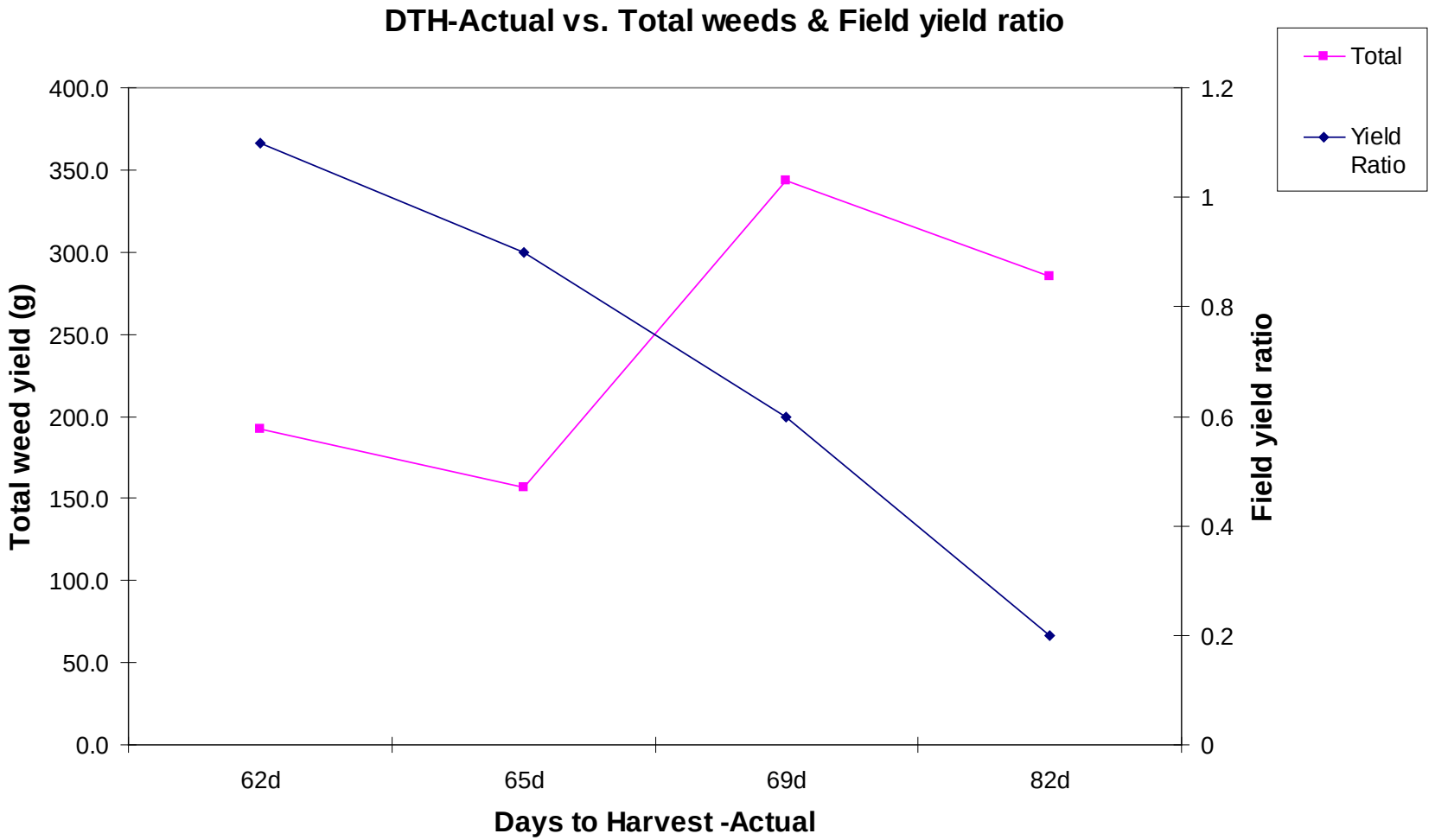




2. Results


Aboveground Weed biomass
Grass
Broad
grams
4000
3500
3000
2500
2000
1500
1000
500
0
1021.4
380.3
3614.6
759.2
Planting 1
Planting 2

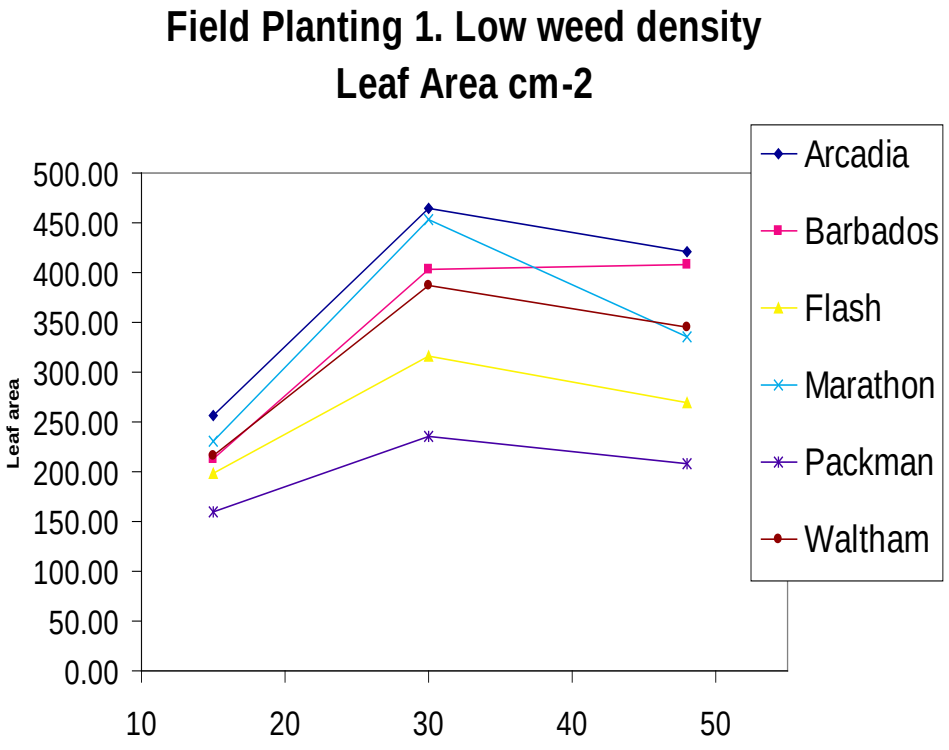
2. Results

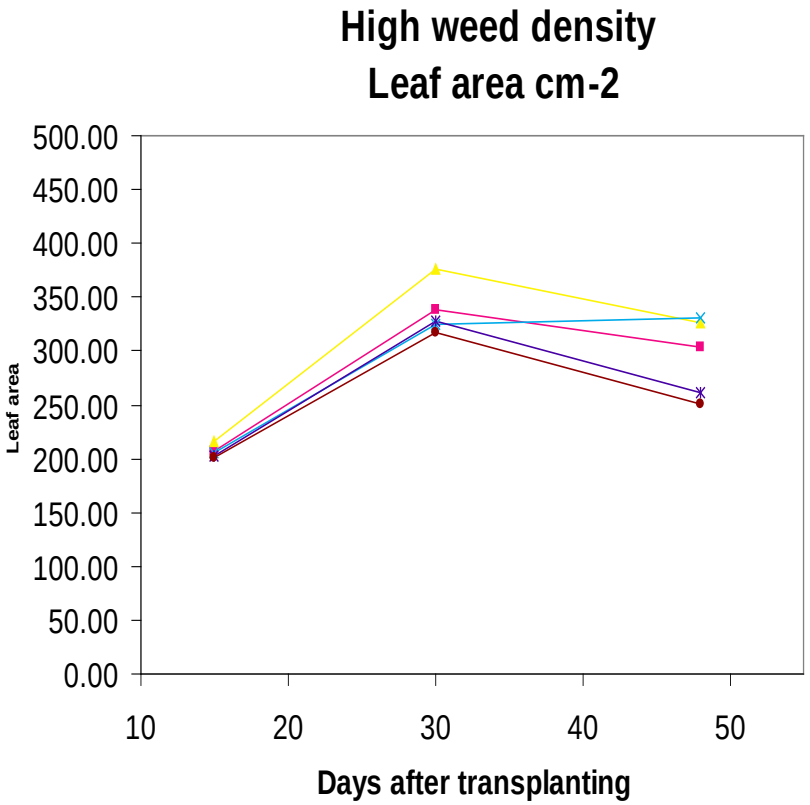

DTH-Actual vs. Total weeds & Field yield ratio
Total
Yield Ratio
Total weed yield (g)
Field yield ratio
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1.2
1
0.8
0.6
0.4
0.2
0
62d
65d
69d
82d
Days to Harvest -Actual

2. Results

- Packman yield highest in Planting 1 and Gypsy was numerical largest Planting 2.
- Based on screening Barbados was expected to perform well and Waltham poorly.
- Waltham and Barbados in Field Planting 1. performed intermediately with regard to weed tolerance.

2. Results –Growth data





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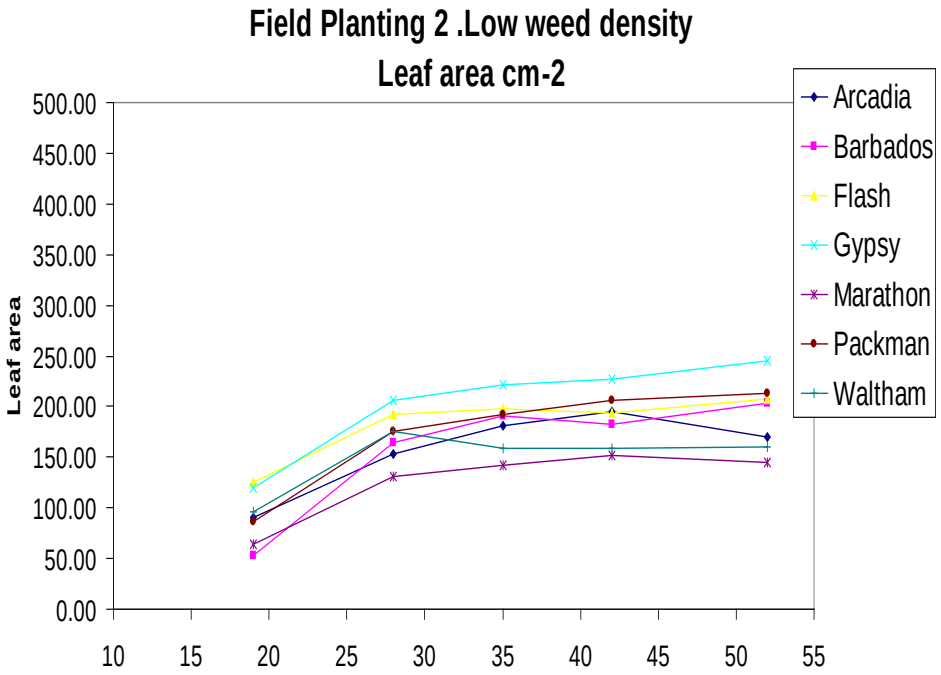

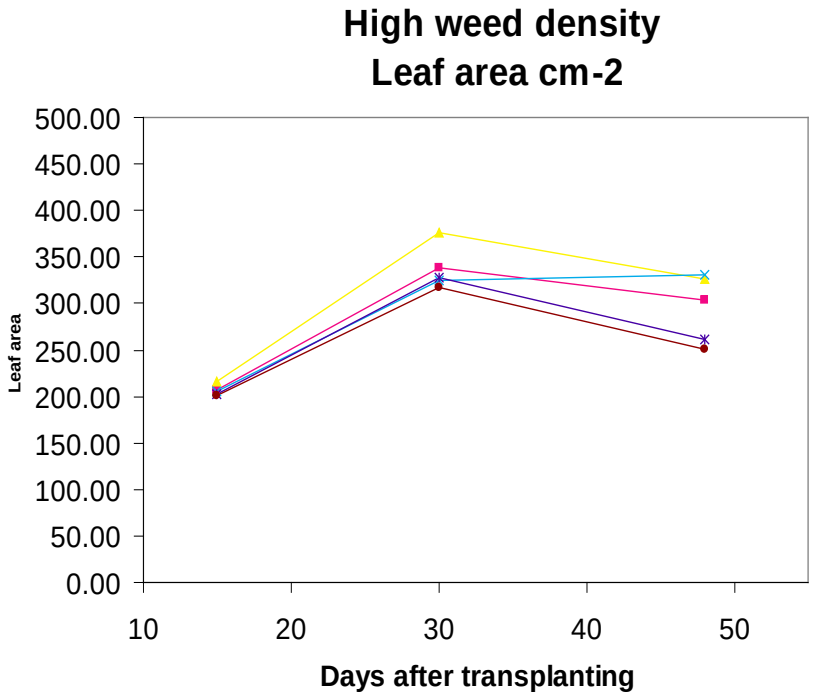

Summary

- Able to distinguish traits associated to WT in GH.
- Differences in Cultivars observed in P1.
- Although, overall ranking selection was not confirmed in the field, still suspect WT is possible.
- Simple ranking method may not be adequate
- May need to focus on specific traits.
- Agronomic performance under LWD most important for growers (Packman Field Planting 1 and Gypsy Field Planting 2).

Conclusions

- WT potential value under low/moderate weed populations.
- Maybe useful tool integrated into other management strategies to reduce weed populations.
- Employing WT cultivars may help reduce growers costs in weed management programs.

References

- Callaway, M.B. 1992. A compendium of crop varietal tolerance to weeds. *American Journal of Alternative Agriculture* 7 (4): 169-180.
- Ghersa, C.M. and J.S. Holt. 1995. Using phenology predictions in weed management: a review. *Weed Research* 35: 461-470.
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Thank you…