PLANT GROWTH AND YIELD PERFORMANCE OF QUINOA (*CHENOPODIUM QUINOA* WILLD.) VARIETIES UNDER IRRIGATED AND RAINFED CONDITIONS OF MALAWI.

by

Moses F.A. Maliro[1], Jacinta Nyaika[2] and Peter Muhota[3]

[1 & 3] Department of Crop and Soil Sciences

[2] Department of Forestry and Horticulture

Bunda College Campus,

Lilongwe University of Agriculture and Natural Resources (LUANAR), P.O Box 219, Lilongwe, Malawi

A presentation at Quinoa International Symposium: from 12th to 14th August 2013 at Washington State University, Pullman, USA.

- Malawi is located in the Sub-Saharan region of Africa
- At 15^{o} latitude, north of tropic of capricon
- Over 70% of the population live in rural area and enganged in agriculture for their livelihoods
- Its economy is agrobased
- Agriculture mainly rainfed
- Major food crops: Maize, potatoes, rice, cassava
- Main cash crops: tobacco, tea and sugarcane

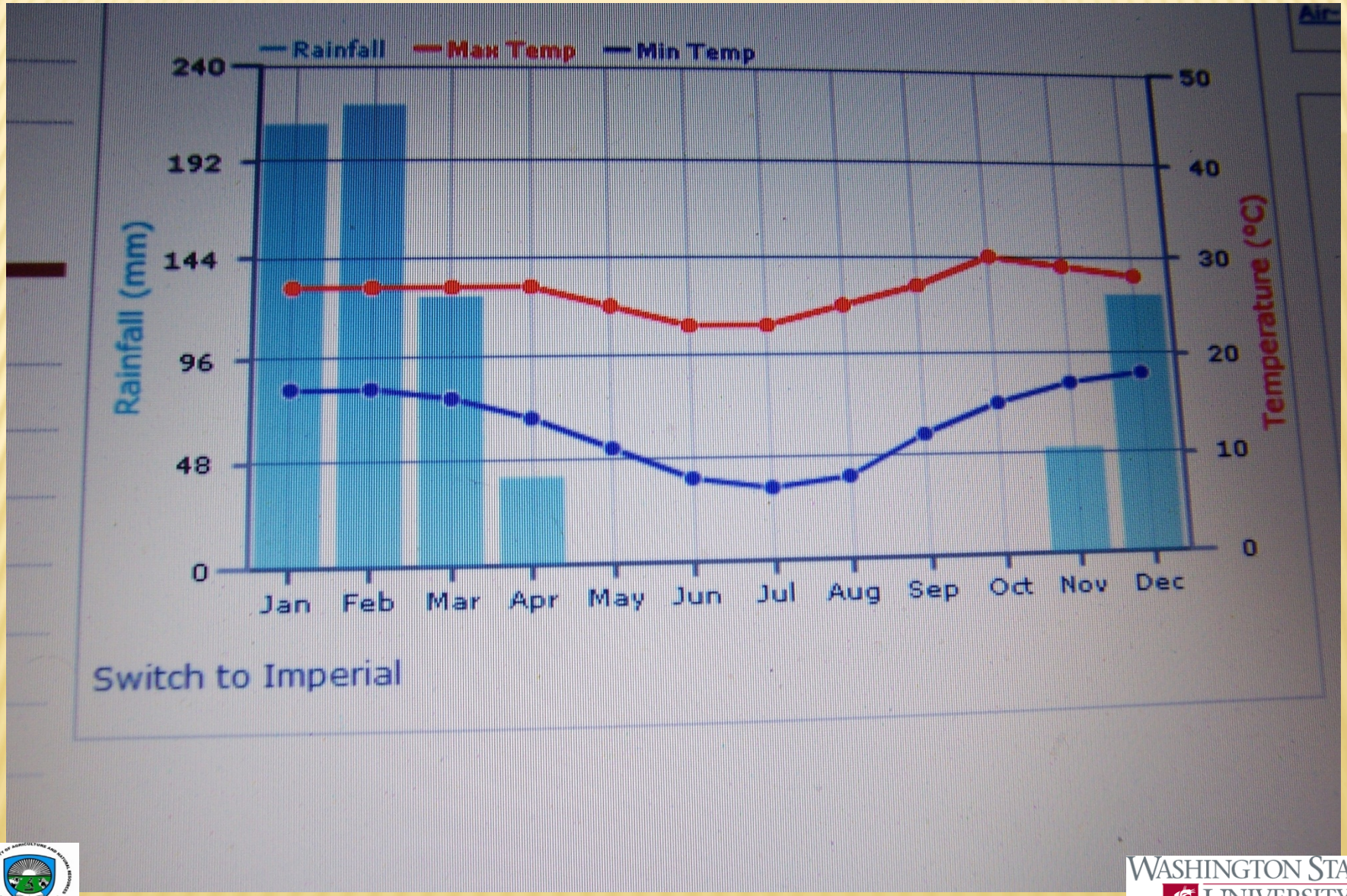
WASHINGTON STATE UNIVERSITY

Equator

Tropic of capricon

Malawi

Average rainfall (mm) annual distribution and temperature (°C) ranges of Malawi.



FOOD & NUTRITION SECURITY

- Among the challenges that Malawi faces, food insecurity is among the main ones.

- While the country does harvest enough maize grain to meet its national requirements real food security which goes beyond the adequate quantities of maize grain is a challenge

FOOD & NUTRITION SECURITY

- Malnutrition and stuntedness continues affect a large section of the population
  - Stunting is a real problem in Malawi, especially in households where there is inadequate dietary intake and high disease burden (e.g. in less privileged settings)
  - Prevalence of stunting in Malawi is currently at 47.1% according to the 2010 Malawi Demographic and Health Survey.

I'm 12 years old

I'm 12 years old

WASHINGTON STATE UNIVERSITY

14 vs. 41 yr old

So, what happened?

FOOD & NUTRITION SECURITY

- The impact of HVI/AIDS has:
  - Increase in statistics of orphans
  - Compromised immunity in children due to poor nutrition
- Climate change Impact

WHY INTRODUCE QUINOA IN MALAWI?

- Nutrition value and its potential to contribute to food security.
- Wide ecological adaptation – potential to contribute to climate change adaptation.
- Alternative source of income both locally and for export market.

GOAL OF QUINOA RESEARCH IN MALAWI

- To introduce and promote quinoa production by malawian farmers - high grain yielding variety(ies) of Quinoa.

OBJECTIVES

- To evaluate plant growth and grain yield performance of introduced thirteen (11) quinoa varieties in the mid-altitude and high altitude areas of Malawi

- To evaluate performance of quinoa vareties during irrigated and rainfed croppping conditions of Malawi.

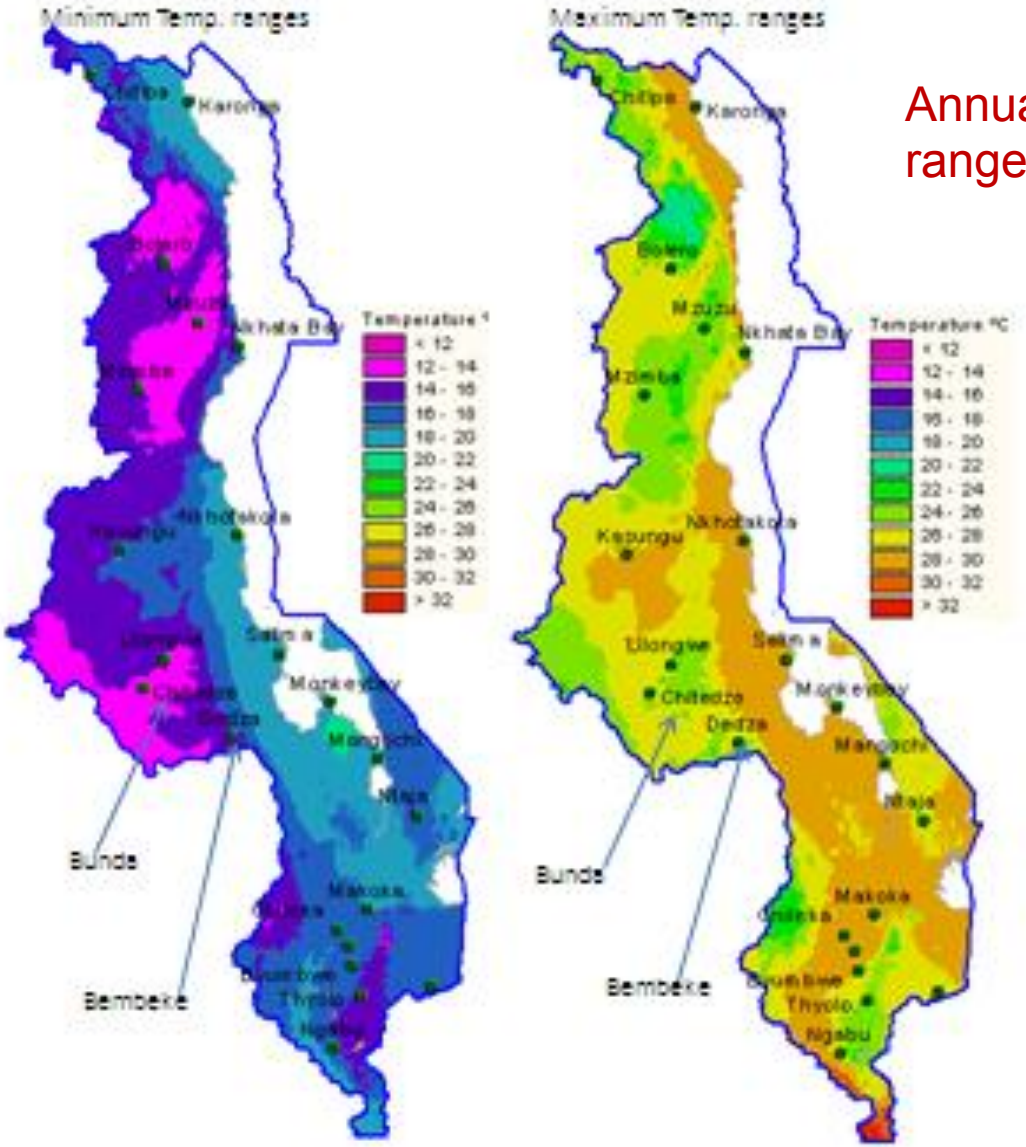
Table 1: A list of quinoa varieties/genotypes that were introduced in Malawi in 2012 for testing and their background information.

No.	Variety	Origin	Background
1	Ecuadorian	Ecuador	Not provided
2	Black-seeded	Colorado, US	Developed from cross between *Chenopodium quinoa* and *Chenopodium berlandieri*. Very tall variety (>2 m tall)
3	Inca Red (a.k.a. Pasankalla)	Bolivia	Member of the "Salares" ecotype of quinoa
4	Brightest Brilliant Rainbow	Oregon, US	Not provided
5	Bio-bio	Chile	Not provided
6	Cherry Vanilla	Oregon, US	Not provided
7	Multi-Hued	British Columbia, Canada	Not provided
8	Red Head	Oregon, US	Not provided
9	QQ74	Chile	Chilean landrace
10	Puno	Denmark	Bred by Sven-Erik Jacobsen
11	Titicaca	Denmark	Bred by Sven-Erik Jacobsen
12	QQ065	Chile	From extremely rainy region of southern Chile (>2500 mm annual precipitation). Has shown great resistance to post-harvest sprouting in our trials. Shortest variety we've seen (~0.8 m)
13	Rosa Junin	Peru	Not provided

EXPERIMENTAL SITES

1. Bunda (in Lilongwe District)
   - Altitude – 1200 metres above sea level (m.a.s.l)
   - Annual temperature

2. Bembeke (in Dedza District)
   - Altitude – 1560 m.a.s.l.
   - Temperature



Annual temperature ranges of Malawi in ^{o}C

Preparation and sowing quinoa 28th June, 1st July 2012

EXPERIMENTAL DESIGN, SOWING AND THINNING

- Eleven introduced varieties were evaluated
- Laid out in Randomized Complete Block Design
- Treatment plots were of 2m x 2m sizes
- Sowing was done in rows spaced at 20cm
- Thinning was done a week after germination to leaving plants spaced at 10cm
- Fertilizer (23:21:0/N:P:K) at the rate of 150kg/ha was applied following the thinning.

DATA COLLECTION

- Germination %
- Plant height – a week after thinning – weekly up to harvesting time.
- Colour of plants, leaves, were recorded
- Flowering time: Days to flowering, # days to 50% flowering, # of days to 100% flowering
- Biomass was determined
- Grain yield and seed characteristics determined

RAIN-FED EXPERIMENT

- The varieties + 1 (12) were evaluated under rain-fed conditions during the 2012/2013 rainy season (December to March) at Bunda Site only)

- The same data was collected and yield parameters determined

WASHINGTON STATE UNIVERSITY

General plant stand under rainfed conditions at Bunda Site

After thressing, winnowing and further drying to about 12% Moisture content of the grain:

- Grain yield (kg/ha) was determined
- Harvest Index calculated
- Seed size determined

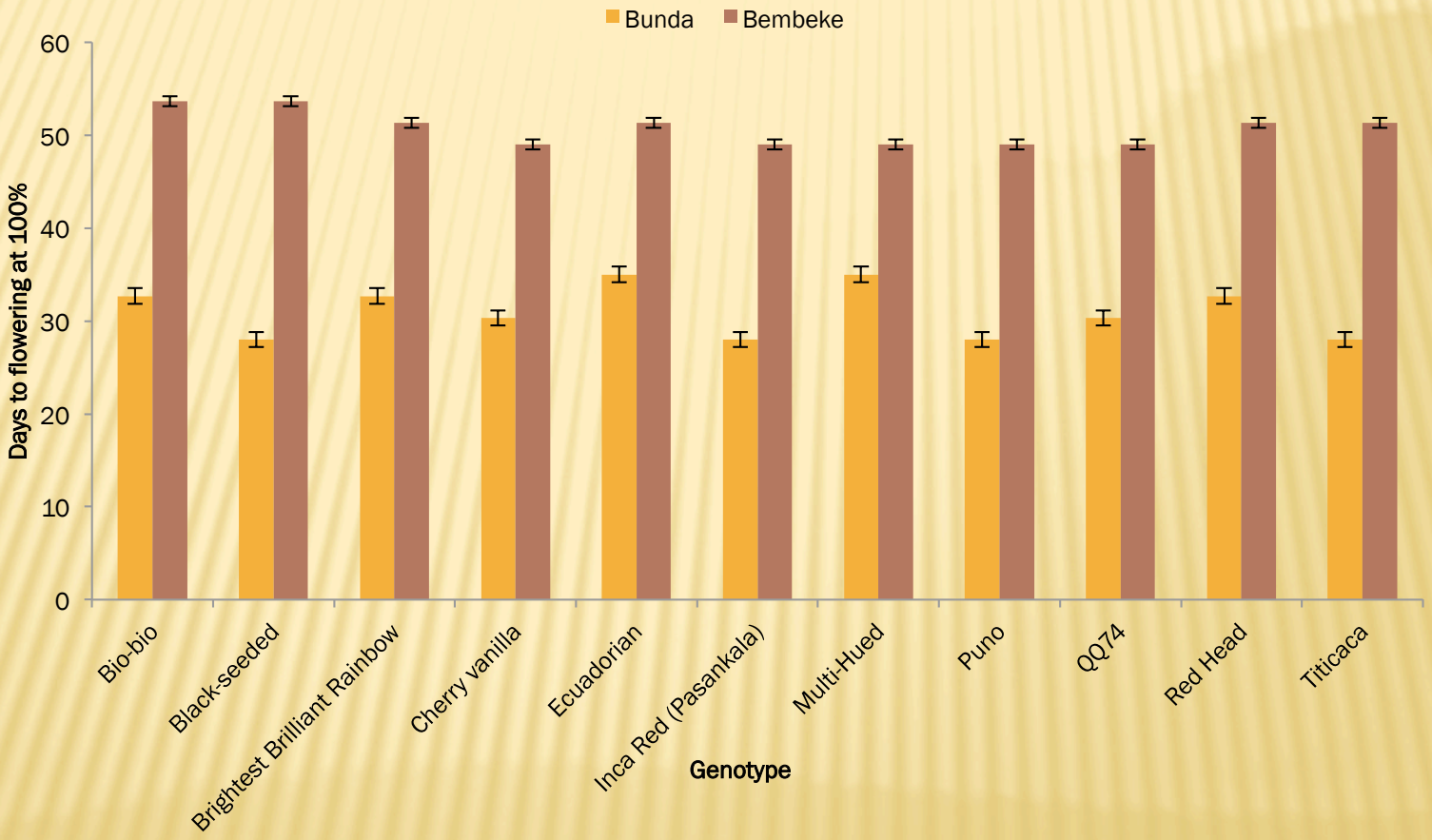
WASHINGTON STATE UNIVERSITY

DATA ANALYSES

- Analysis of variance
- Correlations and regression

NUMBER OF DAYS TO 100% FLOWERING

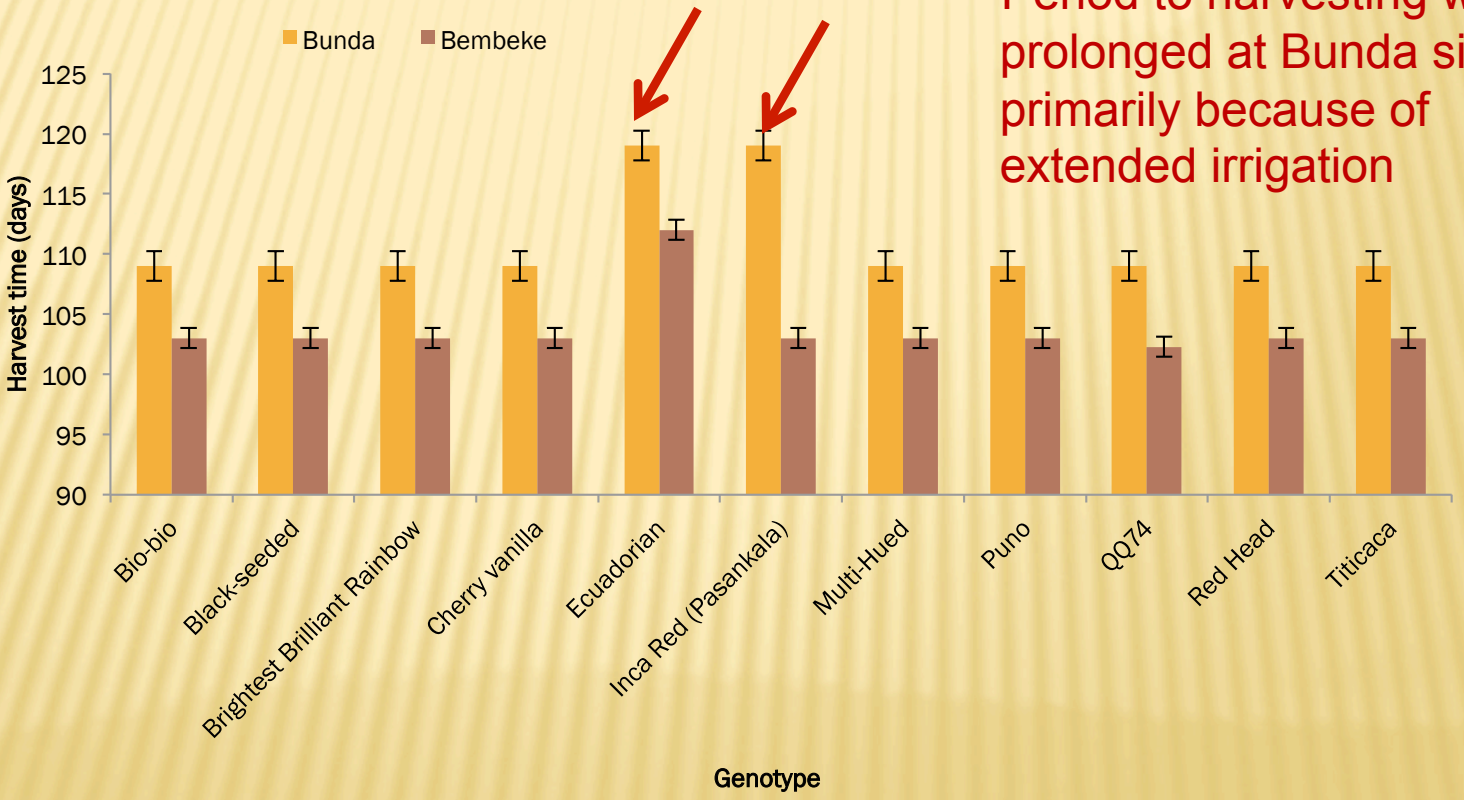
Irrigated experiment from July to Oct. 2012



NUMBER OF DAYS TO HARVESTING

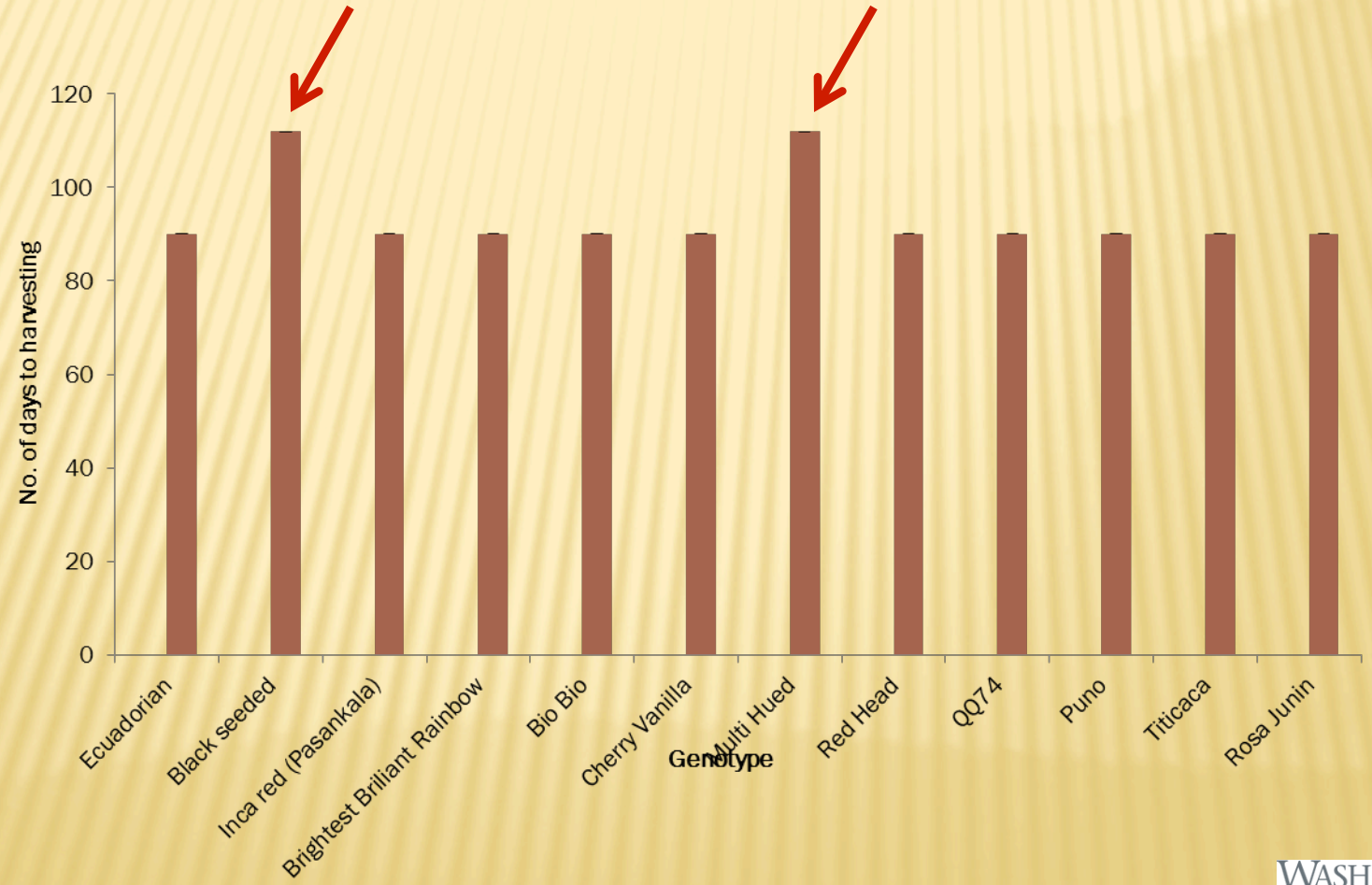
Irrigated experiment from July to Oct. 2012

- Ecuadorian and Inca red (pasankala) had longer maturation period than the rest
- Period to harvesting was prolonged at Bunda site primarily because of extended irrigation



NUMBER OF DAYS TO HARVESTING

Rainfed experiment



Bembeke site

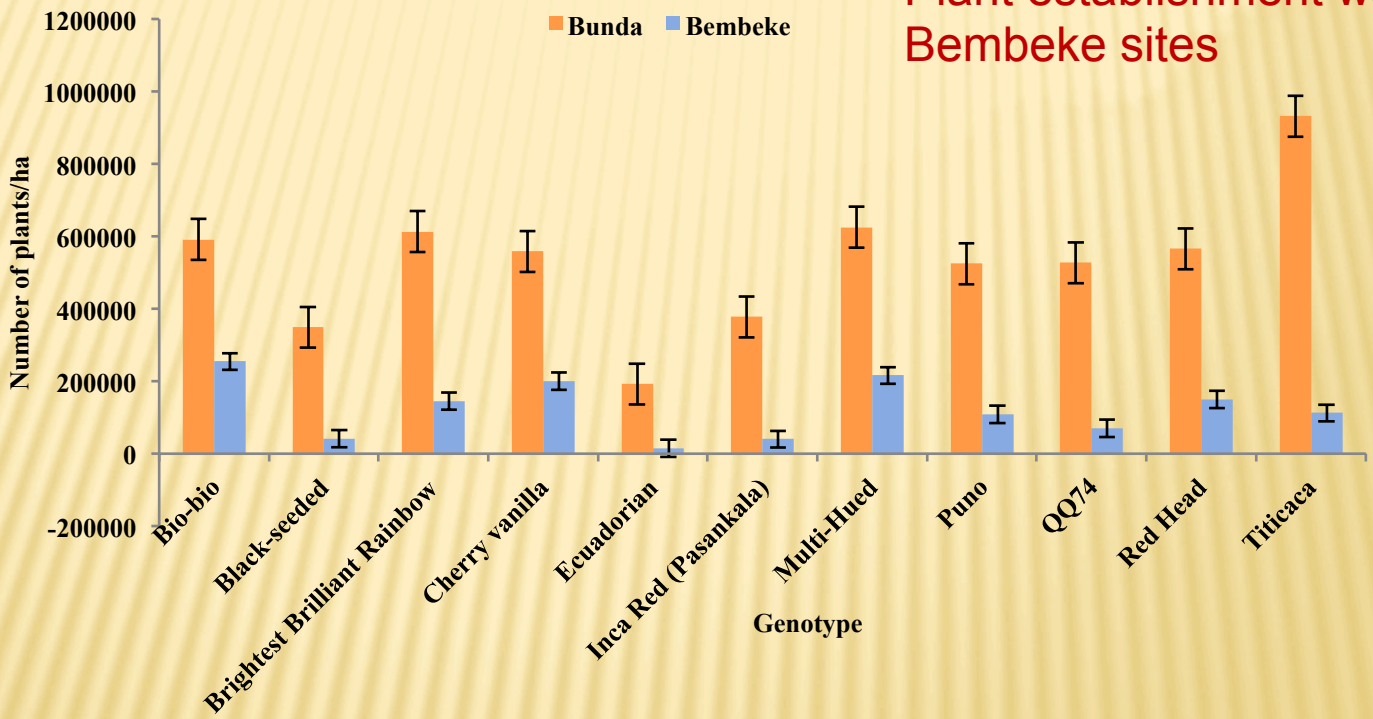
Bunda site

WASHINGTON STATE UNIVERSITY

PLANT STAND COUNT AT HARVESTING

Irrigated experiment from July to Oct. 2012

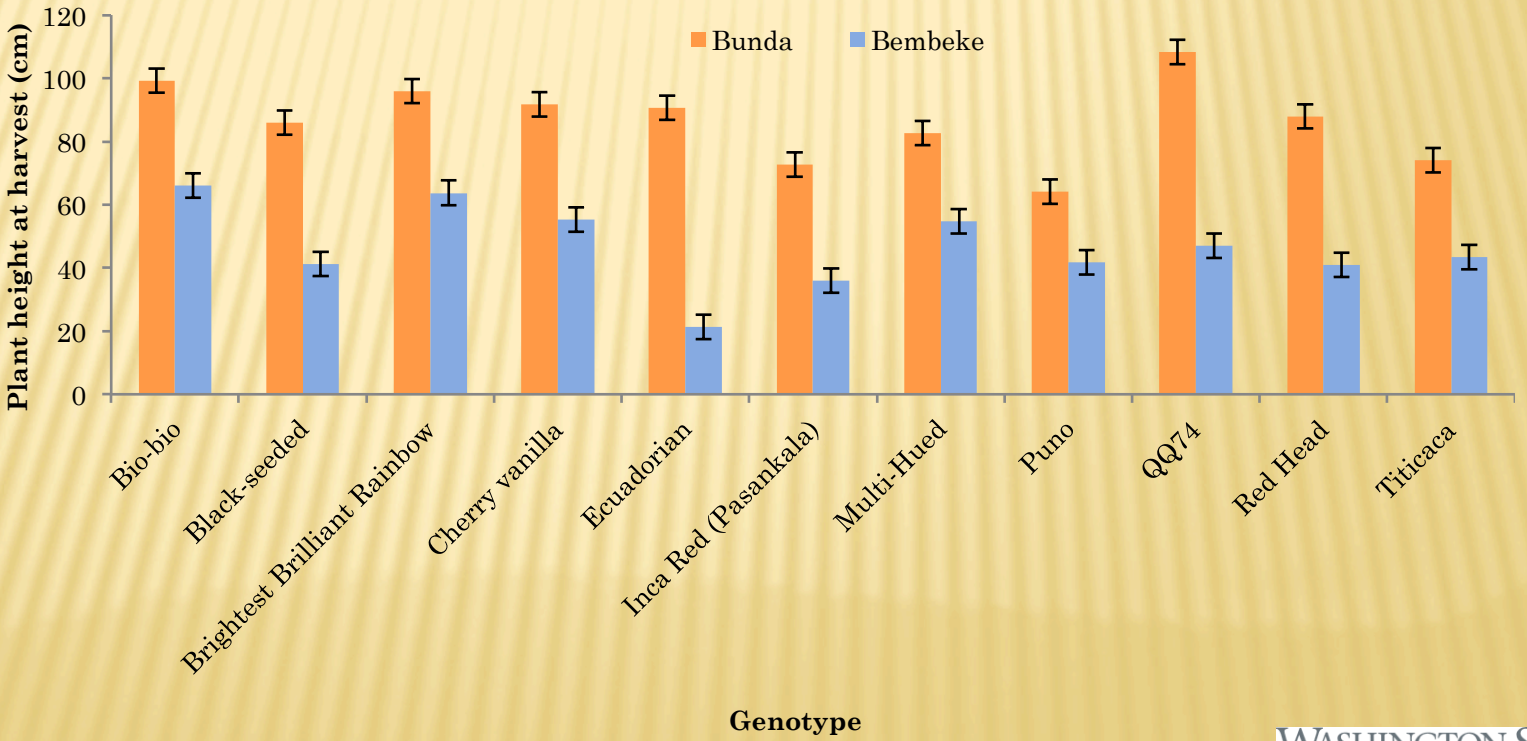
Plant establishment was poor at Bembeke sites



PLANT HEIGHT

Irrigated experiment from July to Oct. 2012

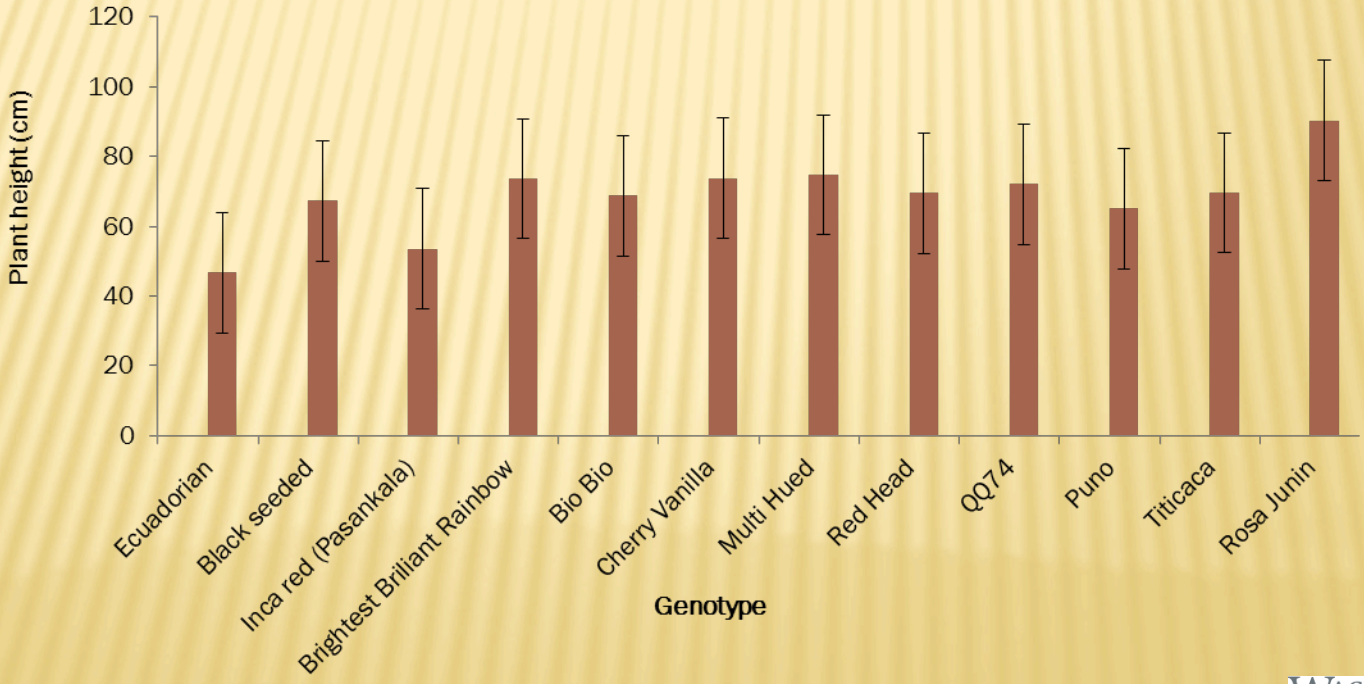
Plants at Bunda grew taller than at Bembeke site. Height also significantly varied among the varieties



PLANT HEIGHT

Rain-fed conditions

Plants grew shorter under irrigated conditions and the means had also larger standard errors.



PANICLE LENGTH

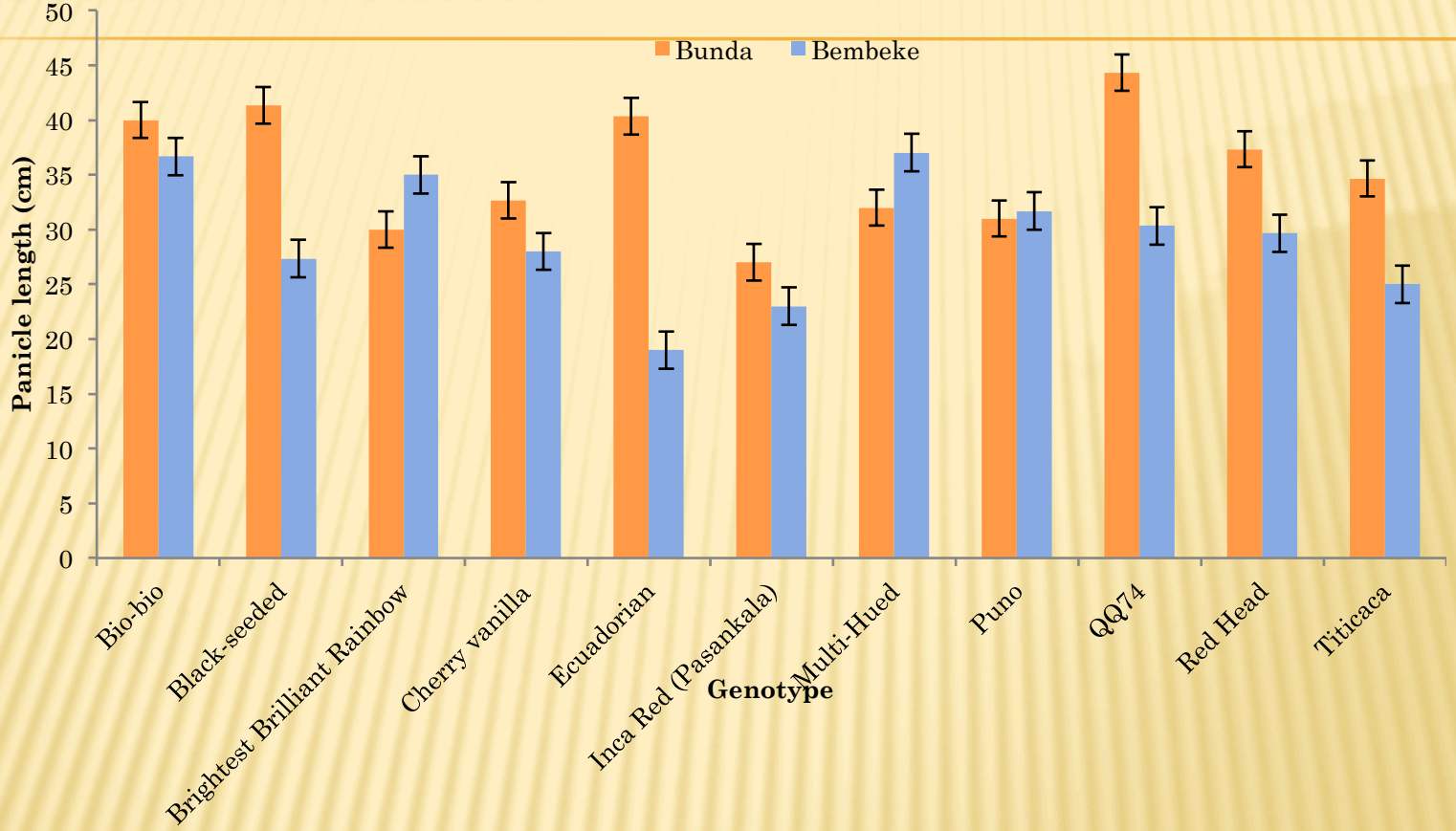
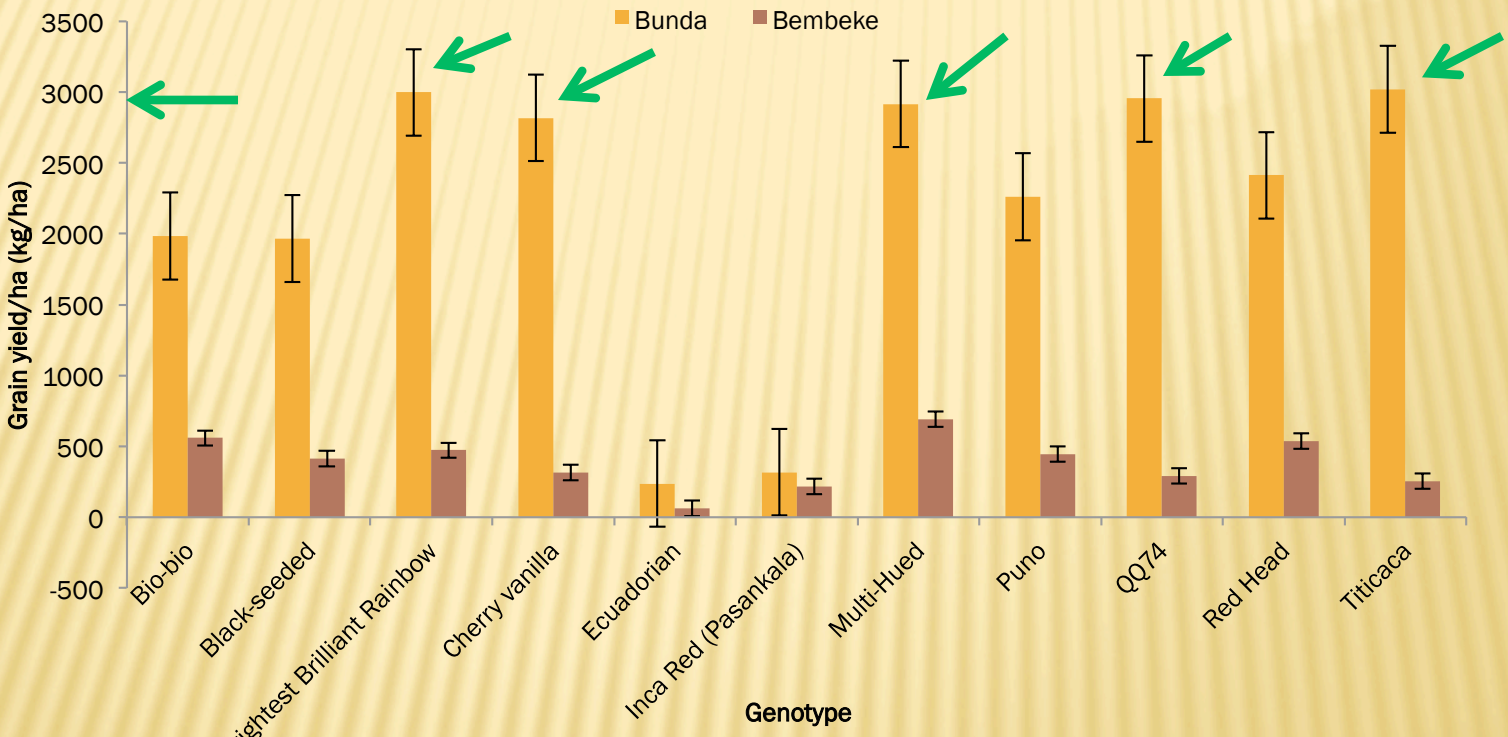


Figure 4: Pannicle length (cm) of quinoa genotypes at harvesting stage from the irrigated experiments (July to October 2012) at Bunda and Bembeke sites

GRAIN YIELD (KG/HA)

Irrigated experiment from July to Oct. 2012

All genotypes yielded poorly at Bembeke site due to very low plant stand which affected grain yield per unit area

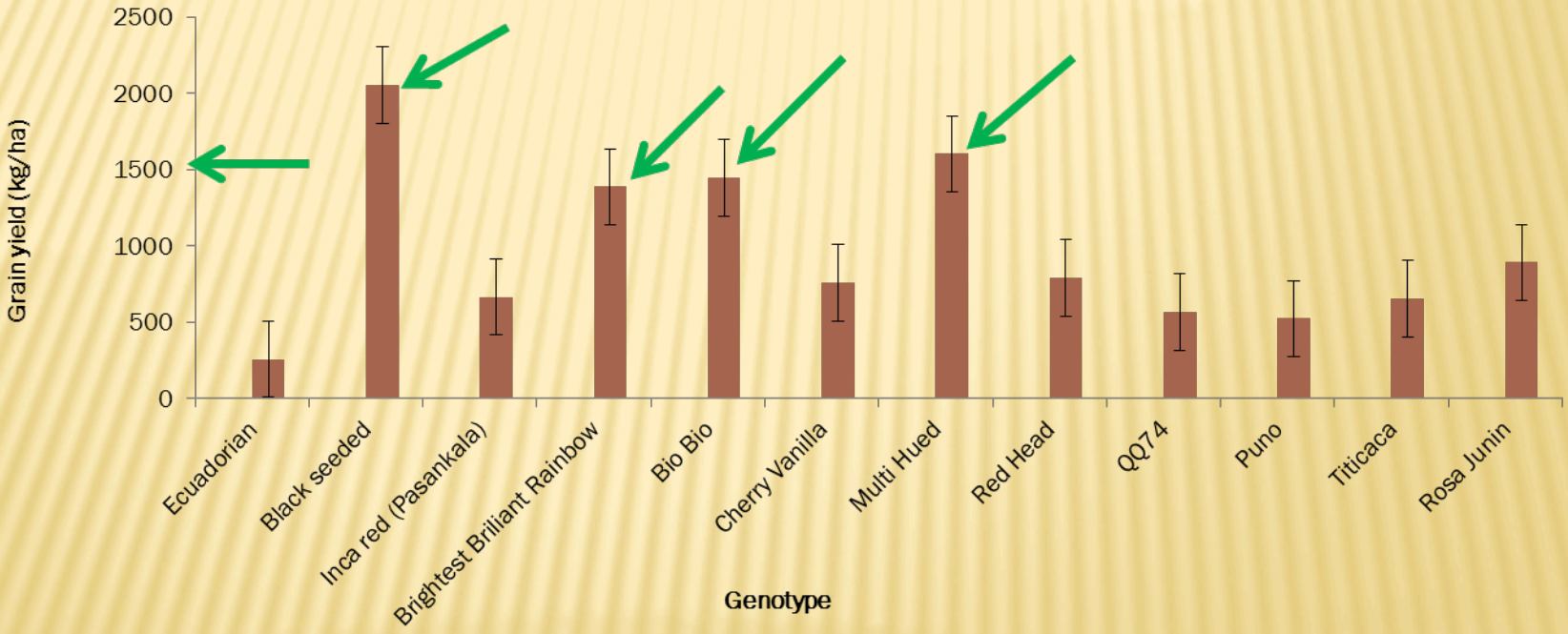


WASHINGTON STATE UNIVERSITY

GRAIN YIELD (KG/HA)

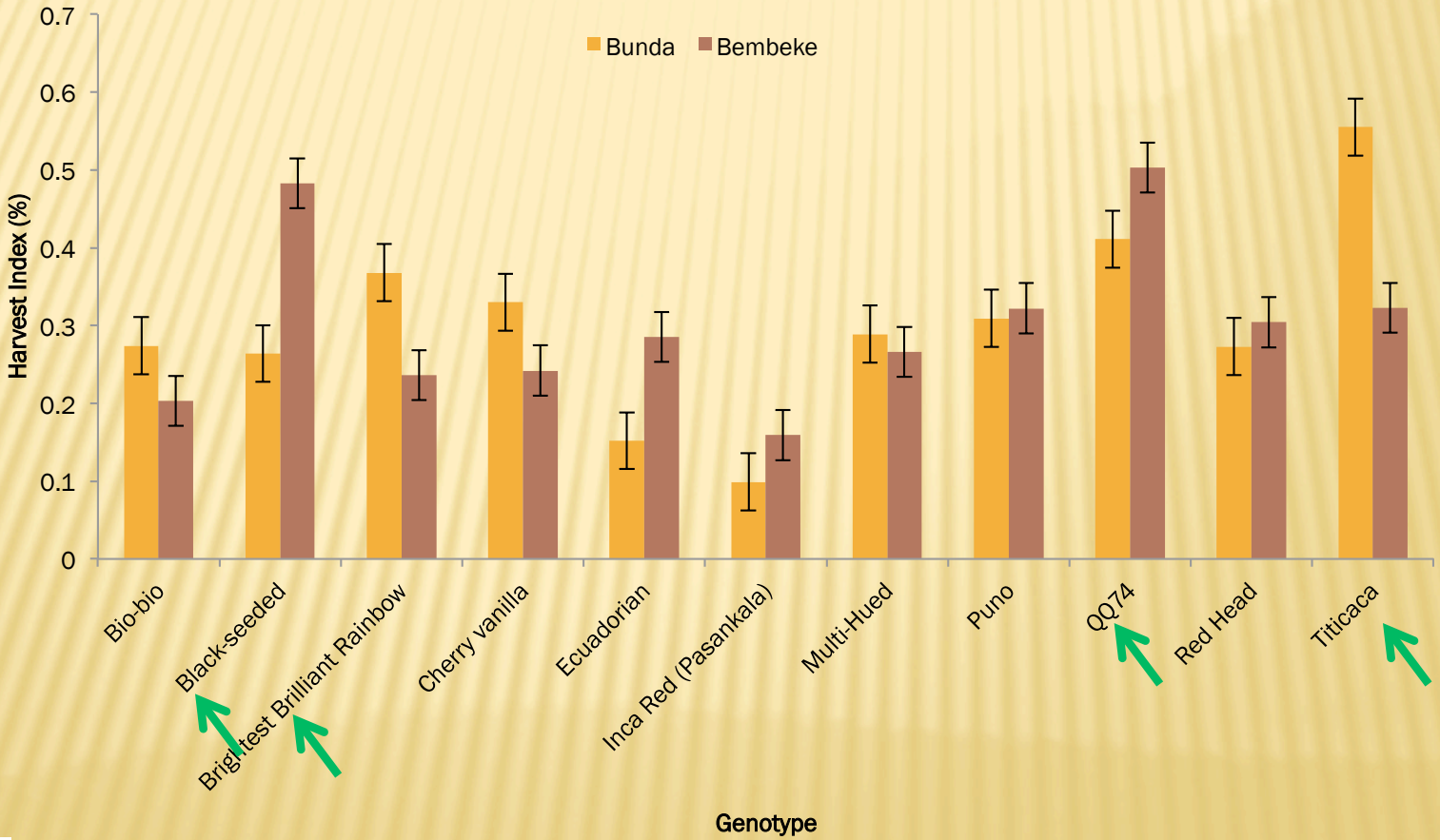
Rainfed experiment from December 2012 to March. 2013 at Bunda site

Large variation in grain yield



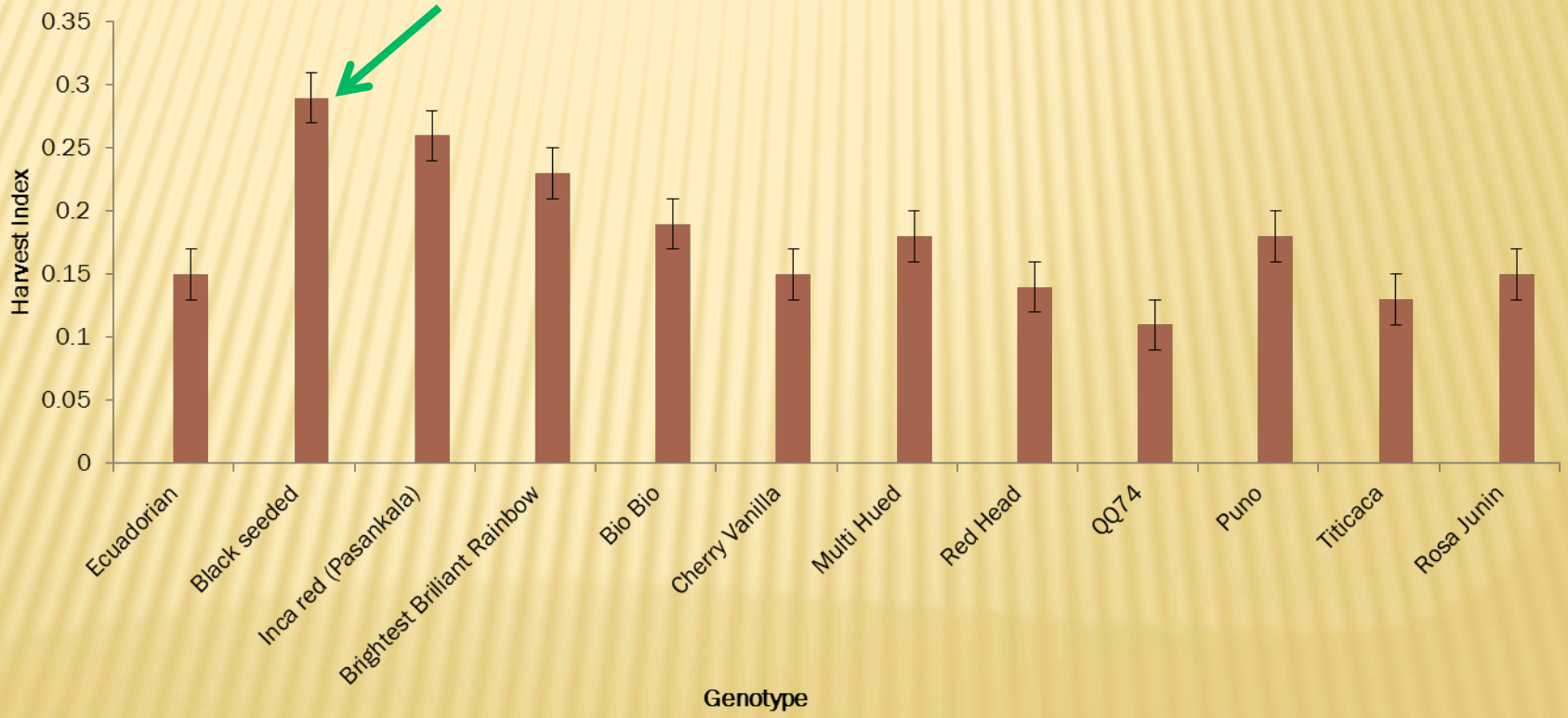
HARVEST INDEX

Irrigated experiment from July to Oct. 2012



HARVEST INDEX

Rainfed experiment from December 2012 to March 2013 at Bunda



PESTS AND DISEASES

- White grabs
- Aphids
- Stink bugs

PESTS AND DISEASES

- Aphids

PESTS AND DISEASES

- White grabs

CONCLUSION

- Quinoa crop production is possible under Malawi climatic conditions
- Five of the tested varities are promissing: Brightest Briliant, Cherry Vanilla, Multihued, QQ74 and Titicaca
- Irrigated cropping from July to October gave higher grain yields than the rain-fed cropping from December to March

EXPECTED CHALLENGES TO PROMOTION OF QUINOA IN MALAWI

- Acceptability into the people's diets

WHAT NEXT?

- Acquire more diverse germplasm /cultivars and continue with the evaluation across the seasons and sites (depending on resources).
- Adapt or develop agronomic technologies that are appriate to the local conditions/practices
- Nutrient composition analysis
- Development of locally acceptable recipes

There is potential to achieve good plant growth with animal manure application and even better than inorganic fertilizer.

Mulching to save soil moisture

ACKNOWLEDGEMENTS

- Kevin Murphy & his team at WSU and WSU financial support for the irrigated trials
- LUANAR – Dept. of Crop and Soil Sciences
- Bob Leong - from Seattle

THANK YOU!!!

WASHINGTON STATE UNIVERSITY