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Performance of quinoa (*Chenopodium quinoa* Willd) genotypes in different ecological areas of Malawi

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Background/Introduction

- Quinoa *(Chenopodium quinoa* Willd) is a species in the plant family *Amaranthaceae.*

- It is a pseudo cereal, originating from the Andean region of Chile, Peru, Bolivia, Ecuador and Colombia, (Garcia 2003).

- Quinoa is more nutritious than cereals that are staple food crops for many populations of the world.

Quinoa

Chenopodium quinoa

Why think of quinoa in Malawian agriculture?

Food and Nutritional security

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

- Malnutrition and stuntedness continues to affect a large section of the population especially in households where there is inadequate dietary intake and high disease burden.
- Prevalence of stunting in Malawi is at 47.1% according to the 2010 Malawi Demographic and Health Survey.

Climate change impact- Wide ecological adaptation (Malawi having several ecologies THUS warm to cool areas)

I'm 12 years old

I'm 12 years old

The problem of stuntedness is real!

Main objective

- To introduce and promote production of high grain yielding variety(ies) of Quinoa and its consumption in Malawian diets.

Specific objectives: Agronomic

- To evaluate plant growth and grain yield performance of introduced quinoa varieties in different environments (warm to cool areas/low to high altitude areas) of Malawi.

- To evaluate performance of different quinoa varieties under irrigated cropping conditions of Malawi.

Materials and Methods

- Evaluation experiments were conducted in six sites with varied altitudes, of Central region of Malawi (Figure 1).
- In each site two different experimental plots, close to a water source for irrigation, were identified.
- Nine varieties (Table 1) were evaluated in each experimental plot, laid out in a Randomized Complete Block Design (RCBD) replicated 3 times.
- The experiments were conducted from May to August, and repeated from September to November, 2015.

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

Initial sites tested in 2012

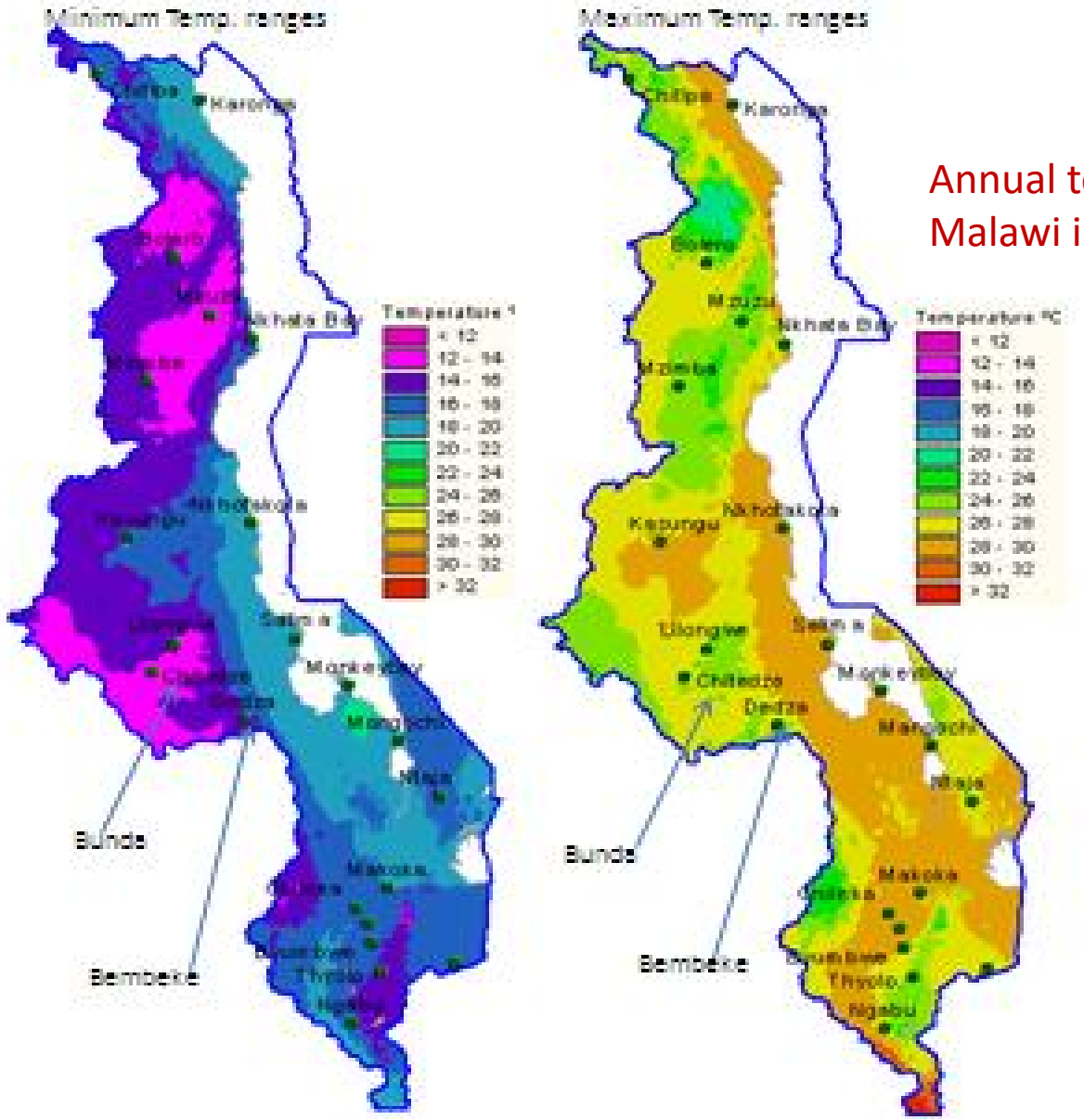
1. Bunda (in Lilongwe District)
   - Altitude – 1200 metres above sea level (m.a.s.l)
   - Annual temperature 18 o C

2. Bembeke (in Dedza District)
   - Altitude – 1560 m.a.s.l.
   - Temperature 11 oC

3. Zomba – Sitima and Namitembo – 900 m.a.s.l 24 oC

4. Blantyre – Lunzu- 1100 m.a.s.l 21 oC

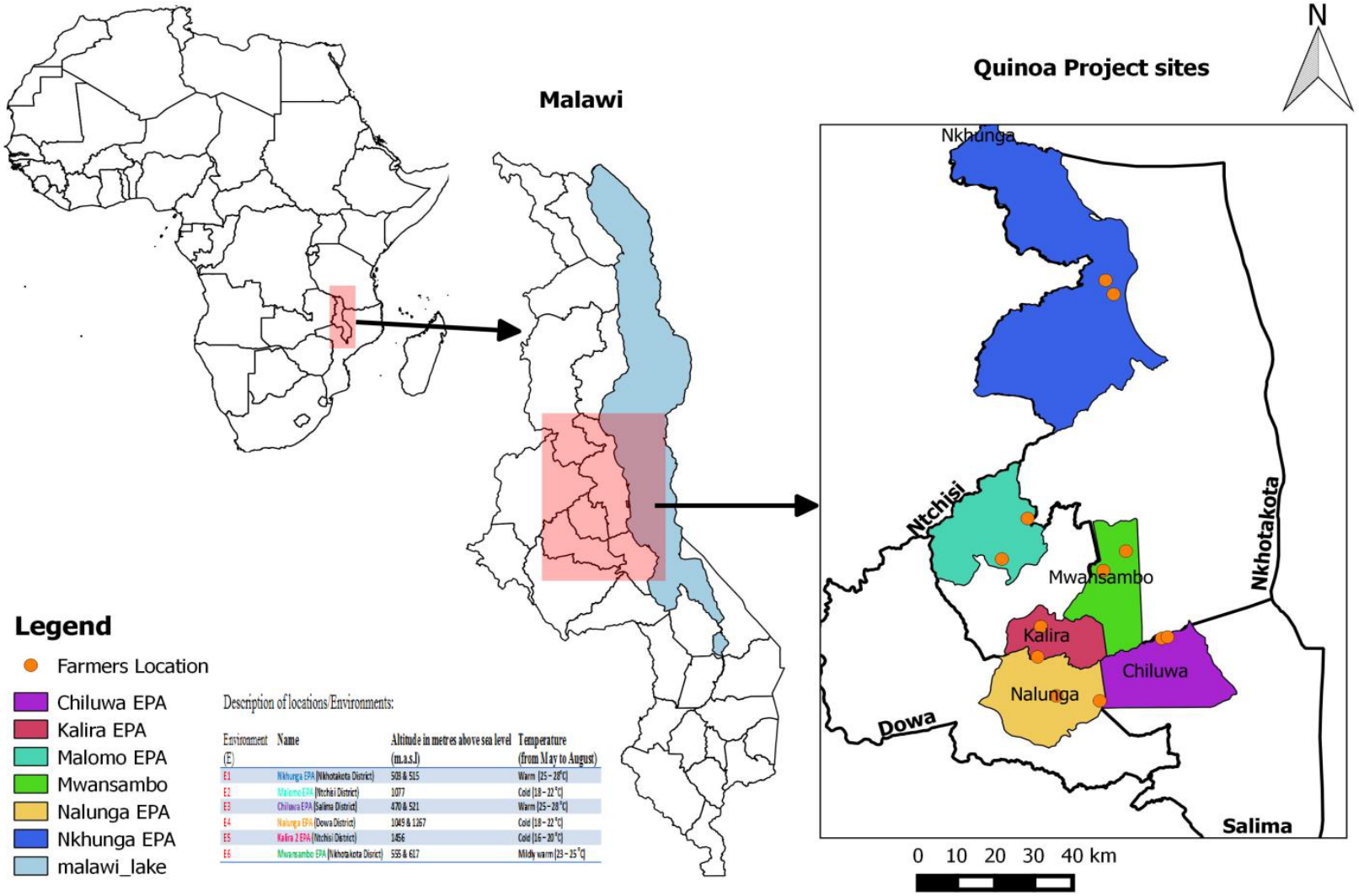
Sites where quinoa has been tested



Annual temperature ranges of Malawi in ^{o}C

However Malawi has diverse environments/ecologies

Specific sites (districts) in central Malawi where quinoa was tested



Description of locations/Environments:

Environment (E)	Name	Altitude in metres above sea level (m.a.s.l)	Temperature (from May to August)
E1	Nkhunga EPA (Nkhotakota District)	503 & 515	Warm [25 – 28°C]
E2	Malomo EPA (Ntchisi District)	1077	Cold [18 – 22°C]
E3	Chiluwa EPA (Salima District)	470 & 521	Warm [25 – 28°C]
E4	Nalunga EPA (Dowa District)	1049 & 1167	Cold [18 – 22°C]
E5	Kalira 2 EPA (Ntchisi District)	1456	Cold [16 – 20°C]
E6	Mwansambo EPA (Nkhotakota District)	535 & 617	Mildly warm [23 – 25°C]

Experimental plot sizes used

Harvesting of quinoa at Bunda

Materials and Methods

- Data collected included number of days to flowering, to maturity, plant height and panicle length at harvest and grain yield. The data was subjected to analysis of variance.

- Additive main effects and multiplicative interaction (AMMI) and Genotype main effect and genotype x environment interaction (GGE) were employed in the evaluation of genotypes.

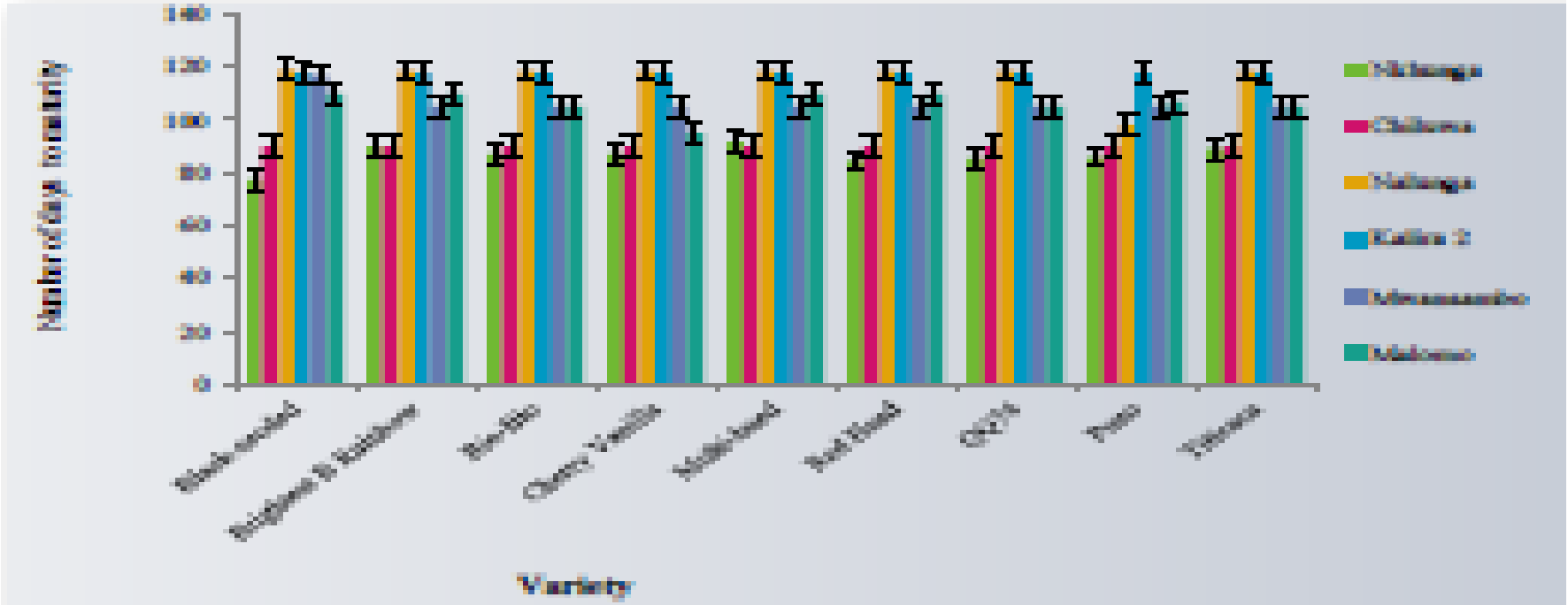
Results

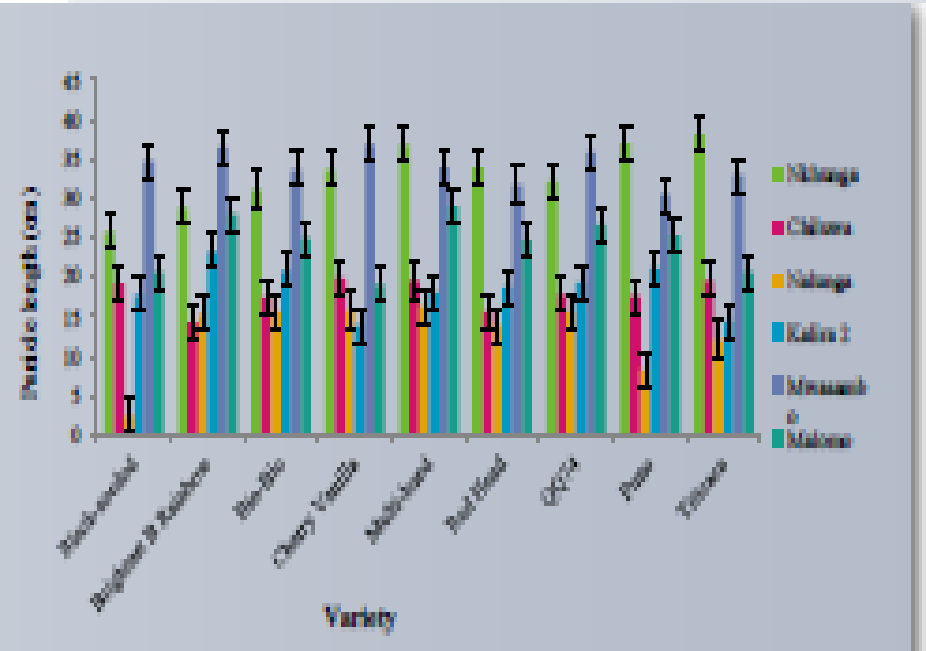
- Maturity period of quinoa varied ($p<0.001$) among sites.

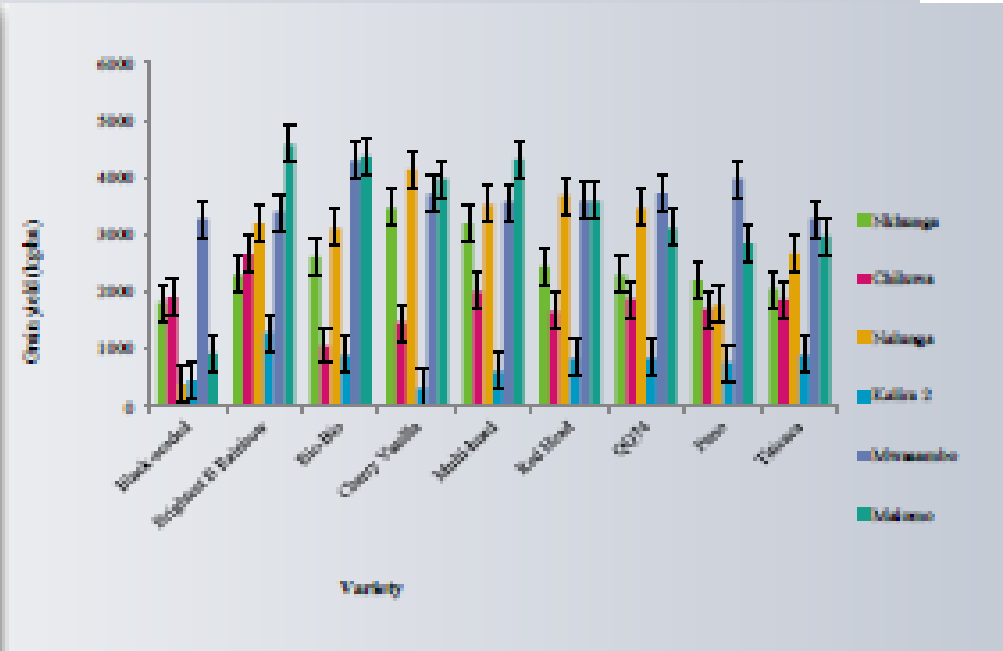
- In the low altitude sites quinoa matured within 90 days, in the Mid altitude quinoa matured in 100 -110 days while in the high altitude took up to 120 days.

- Grain yields varied ($p<0.001$) among sites and with significant site X variety interactions.

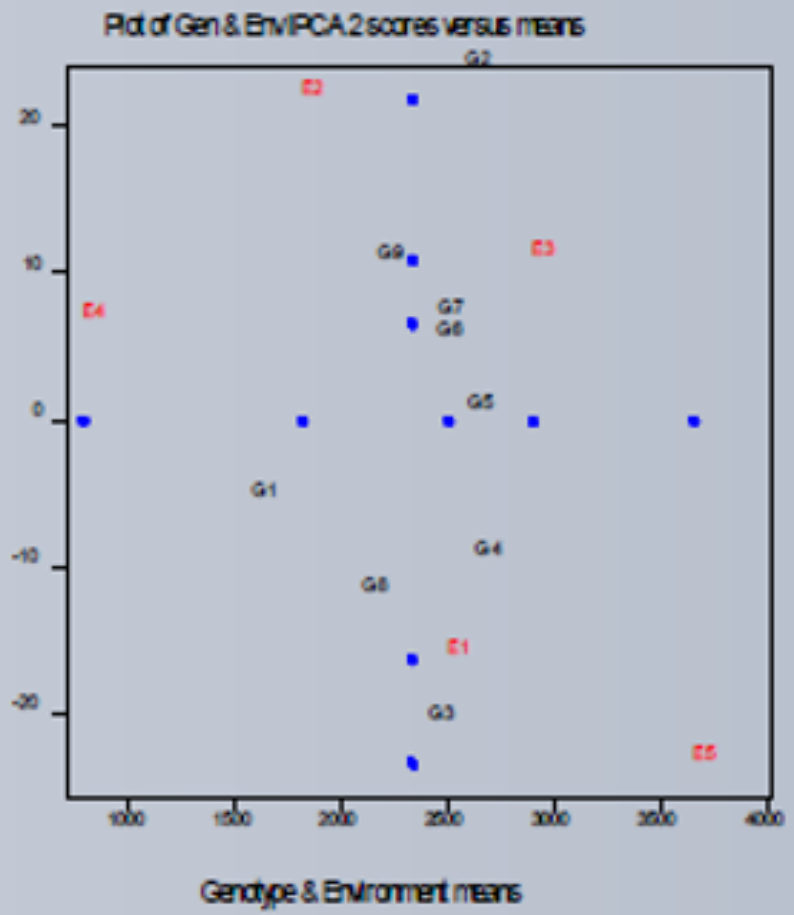
Maturity period

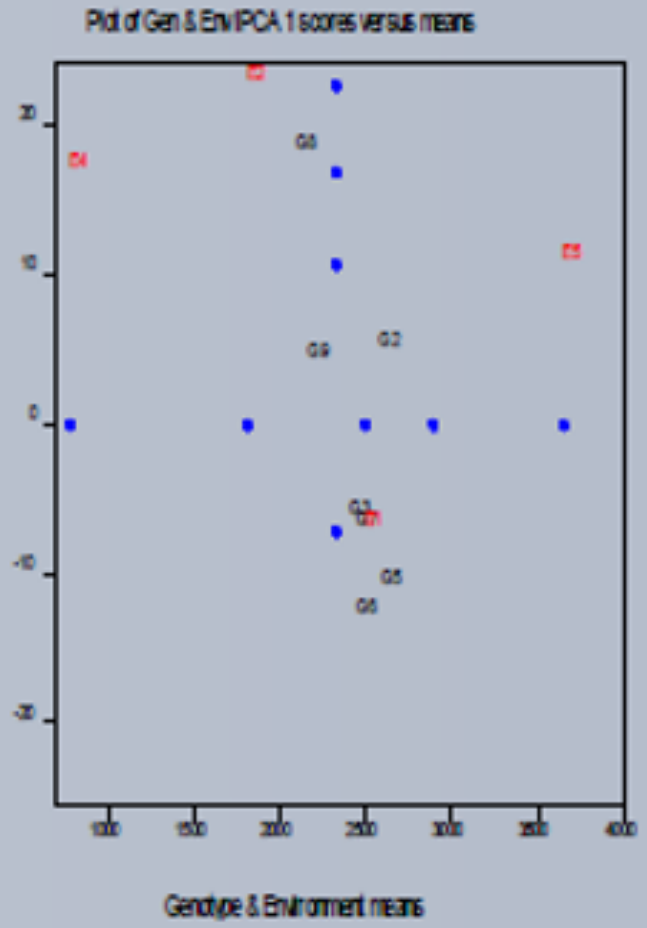






AMMI Analysis





GGE-biplots showing varieties and their ideal environments for yield performance such that black and red numbers stand for varieties and environments (sites), respectively.

Best varieties by site/district

District	Variety
Dowa	BBR
Nkhotakota	Multihued
Salima	Titicaca
Ntchisi	QQ 74
Lilongwe	Red head

Conclusions

- The results showed that quinoa can be grown in all environments of central Malawi ranging from warm ecological areas to the cool areas.

- Grain yields up to 4 tonnes/ha are achievable under irrigated conditions.

Thanks