Breeding beans for drought tolerance, multiple disease resistance, nutritional and canning quality in Kenya

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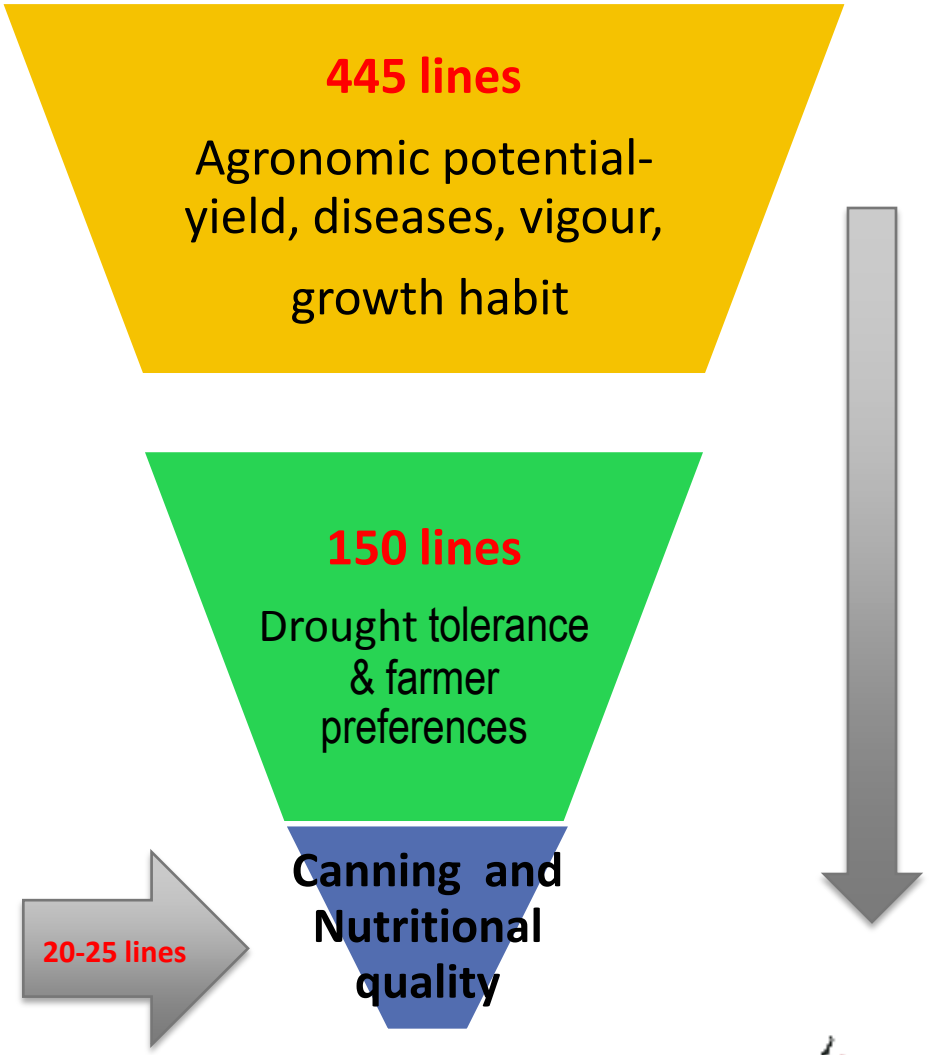
Overview of Breeding Canning Beans Adapted to Biotic and Abiotic stresses

Rationale

- Current variety more than 50 years old, susceptible to **biotic** and **abiotic** stresses
- Processing industry not able to meet **demand** e.g. 300 t /year for Trufoods
- **Erratic supply** and **poor quality** raw materials
- Industry demand for better varieties
- Demand for fast cooking or pre-cooked products –**high energy costs**
- **Changing eating habits** -wider range of preferences with urbanization
- Focus on 7 market classes for canning industry
  - **Fast cooking- for direct consumption**
  - **Pre-cooked products**
  - **Canned products**

Process



Gene pools and Market Classes

Andean

Red mottled

Red kidney

Speckled sugar

Mesoamerican

Navy

Small Red

Pinto

Carioca

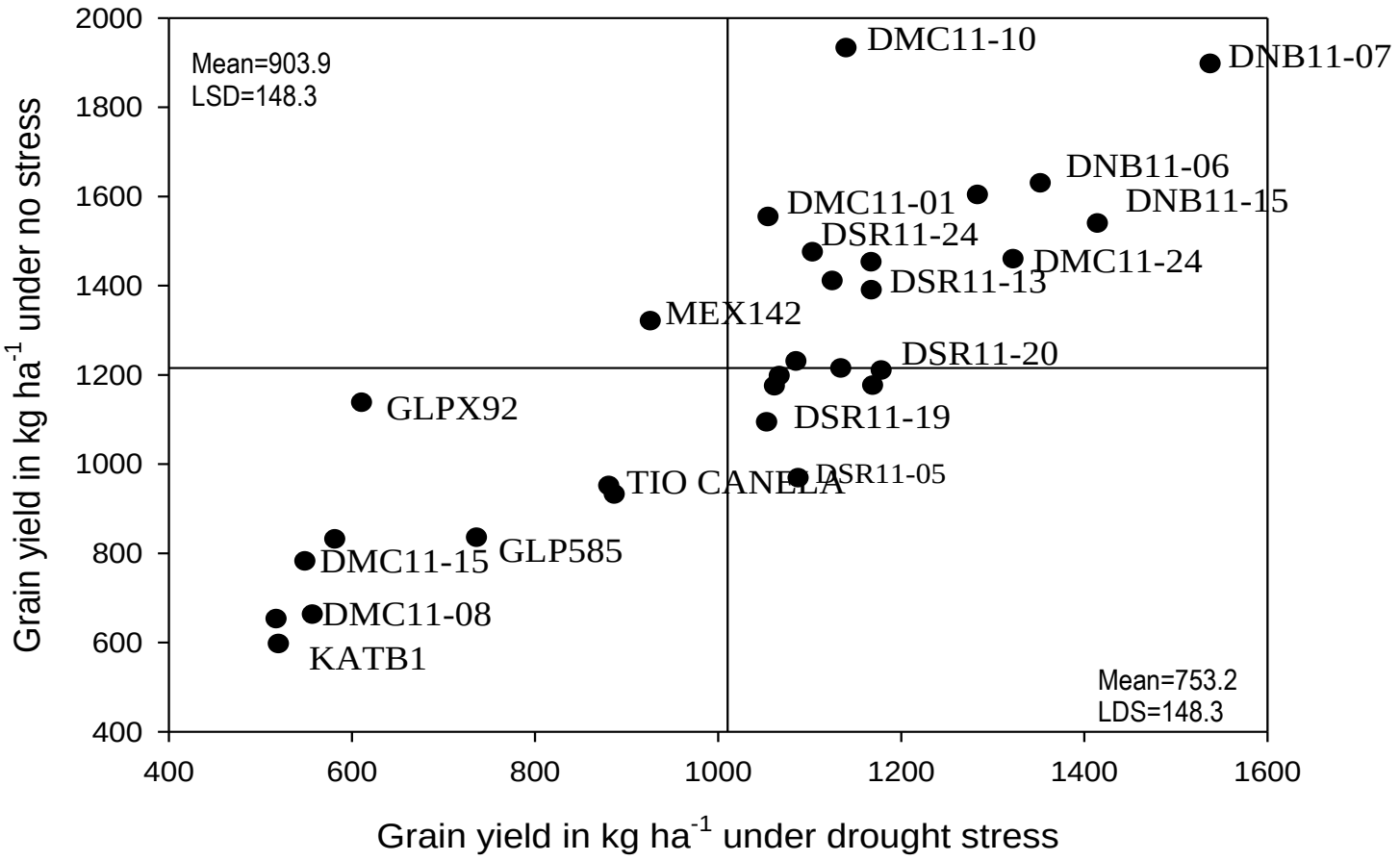
Yellow

Tan

BEIGE

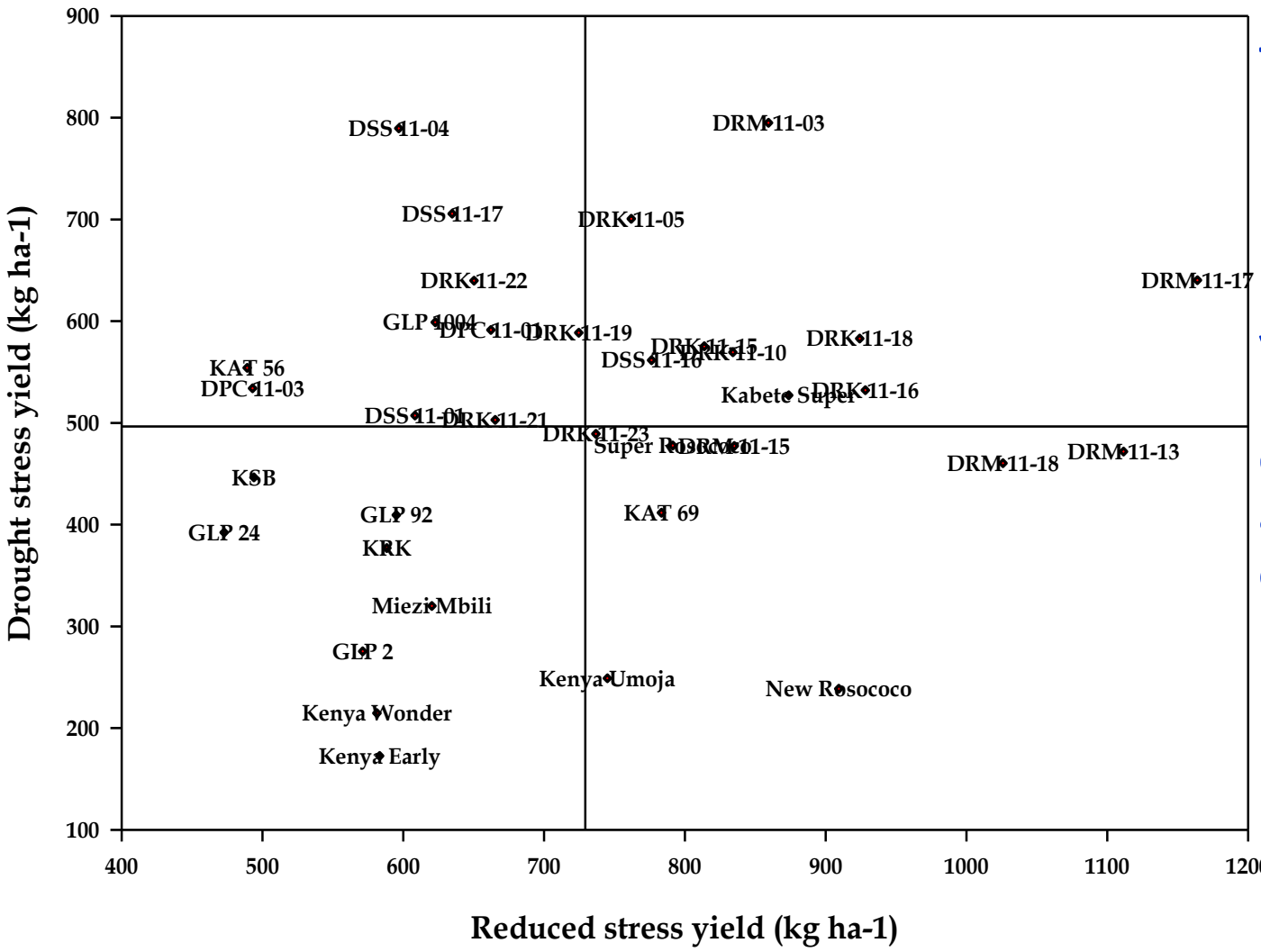
Green yellow

New drought tolerant Mesoamerican lines



- New Drought tolerant Navy, Small Red and Mixed colour lines are better yielding than local and international checks in drought stressed and non-stressed conditions

New drought tolerant Andean lines



- New Drought tolerant
- Red mottled,
- Red kidneys
- Speckled sugar lines are better yielding than local checks in drought stressed and non-stressed conditions at Kabete and Mwea

Mechanisms of Drought tolerance- Shoot traits

Plant traits	Irrigated	Rainfed (Stress)
Canopy biomass (kg/ha)	0.64***	0.25**
Pod harvest index (%)	0.62***	0.40***
Grain harvest index (%)	0.50***	0.39***
Pod partitioning index (%)	0.57***	0.89***
Pod wall biomass proportion (%)	0.26**	0.19*
Stem biomass reduction (%)	-0.18*	0.32**
Total chlorophyll content (SPAD)	0.24**	0.18**

*, **, *** Significant at $p<0.05$, $p<0.01$ and $p<0.001$ probability levels respectively.

Mechanisms of Drought tolerance- Root traits

Framework for root studies at Kabete Field Station, January 2013

No Stress treatment

Drought stressed plants

Tagging a young spread leaf for measurements

A tagged young spread leaf for measurements

Measuring chlorophyll content on leaf using SPAD

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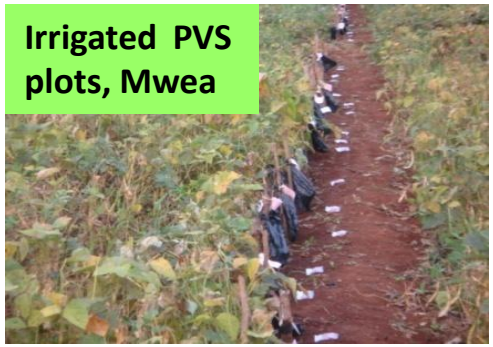
Stressed PVS plots, Mwea

Irrigated PVS plots, Mwea



Participatory selection for drought tolerance

- Mwea and Kabete for two seasons
- Gender disaggregated
- Selection under stress and no stress plots
- Ribbon method for preferred and non-preferred line

Key traits for farmers:

- **Yield**
- **Drought tolerance**
- **Earliness**
- **Marketability**
- **Fast cooking**
- **Taste**
- **Plant type**
- **Non shattering**
- **Foliage**

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PVS for drought tolerant lines conducted at Mwea and Kabete in 2011 and 2012

Bean program staff explains objective and technique of selection

Preferred line

Rejected line

Refreshments

Farmers select at Kabete Field Station, March 2012

Selection for Multiple Disease Resistance

BCB11-34 is a **small white** (navy canning bean) which showed high degree of resistance to ALS, anth, BCMV and CBB at Kabete during the LR 2012. Note that neighbouring lines were destroyed by the disease.

BCB 11-196, a **small red** showed high degree of resistance to anth, angular leafspot, BCMV and CBB at Kabete during the LR 2012-12-15(picture taken 10 July 2012). Note adjacent lines were devastated by the disease.

BCB 11-162 is highly disease resistant **red kidney** line with good vigour at Kabete, LR 2012

Photo: 10 July 2012 at 7.26 PM

BCB 11-400 is disease resistant **red mottled** line . Note adjacent lines were severly damaged by diseases at Kabet LR 2012

Photo : 10 July 2012 at 4.23 PM

Summary of Advanced lines with Multiple Disease resistance and high yield potential

Market Class	Lines select for MDR	Resistances
Red mottled	21	ALS, root rots, BCMV, anthracnose, CBB
Red kidney	23	
Speckled sugar	17	
Navy	24	
Small Red	22	
Pinto/carioca	19	
Mixed colours	24	

- **Lines currently in AYT at Kabete, Thika, Meru, Nakuru and Tigoni**

Fig 1. Water absorption by advanced navy bean canning bean lines over a 16 hour period.

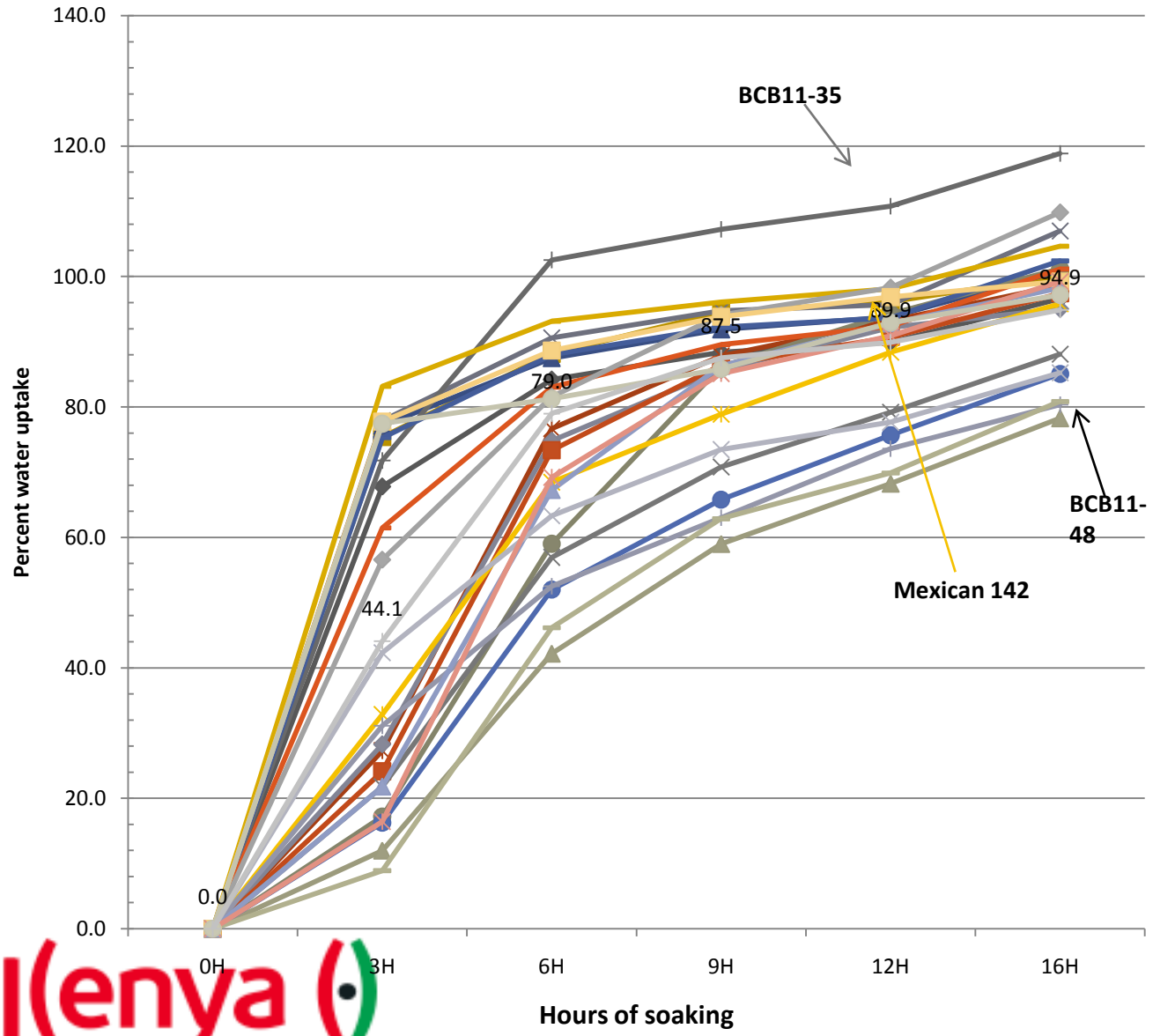

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Fig 2. Percent water absorption of advanced navy bean lines soaked for 16 hours

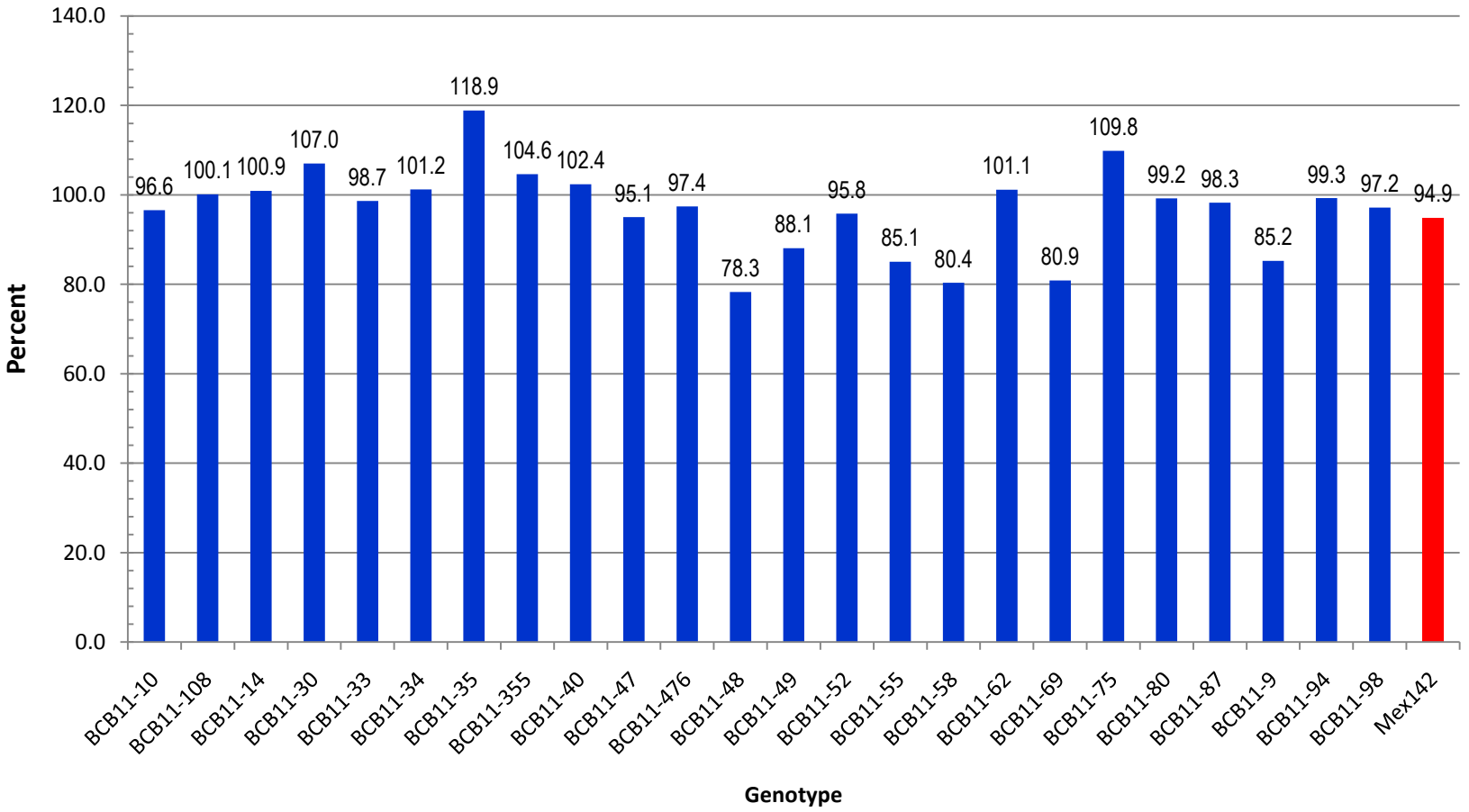

Fig 4. Water absorption of advanced small red lines over 16 hours.

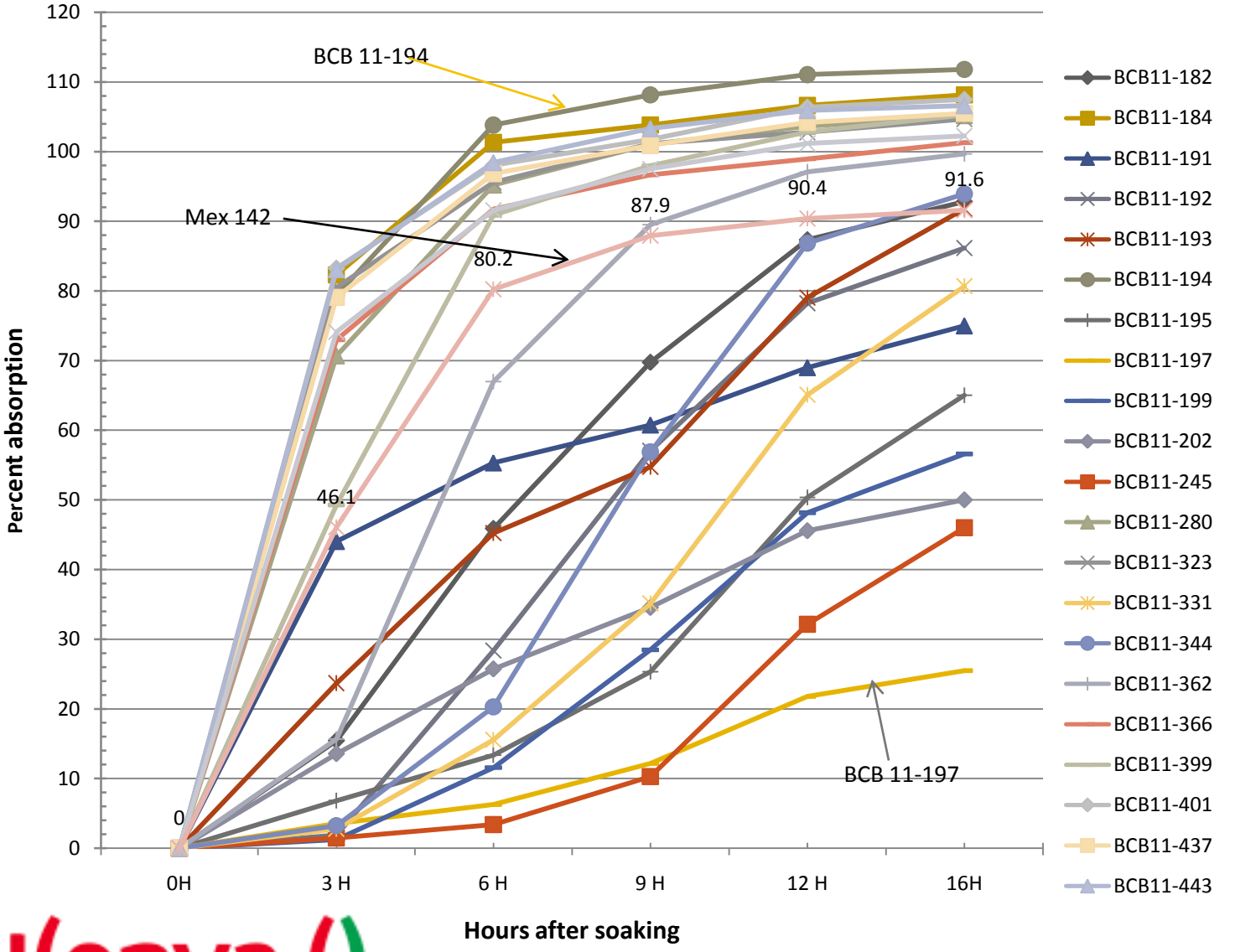

Fig 5. Water absorption of advanced small red lines after soaking for 16 hours.

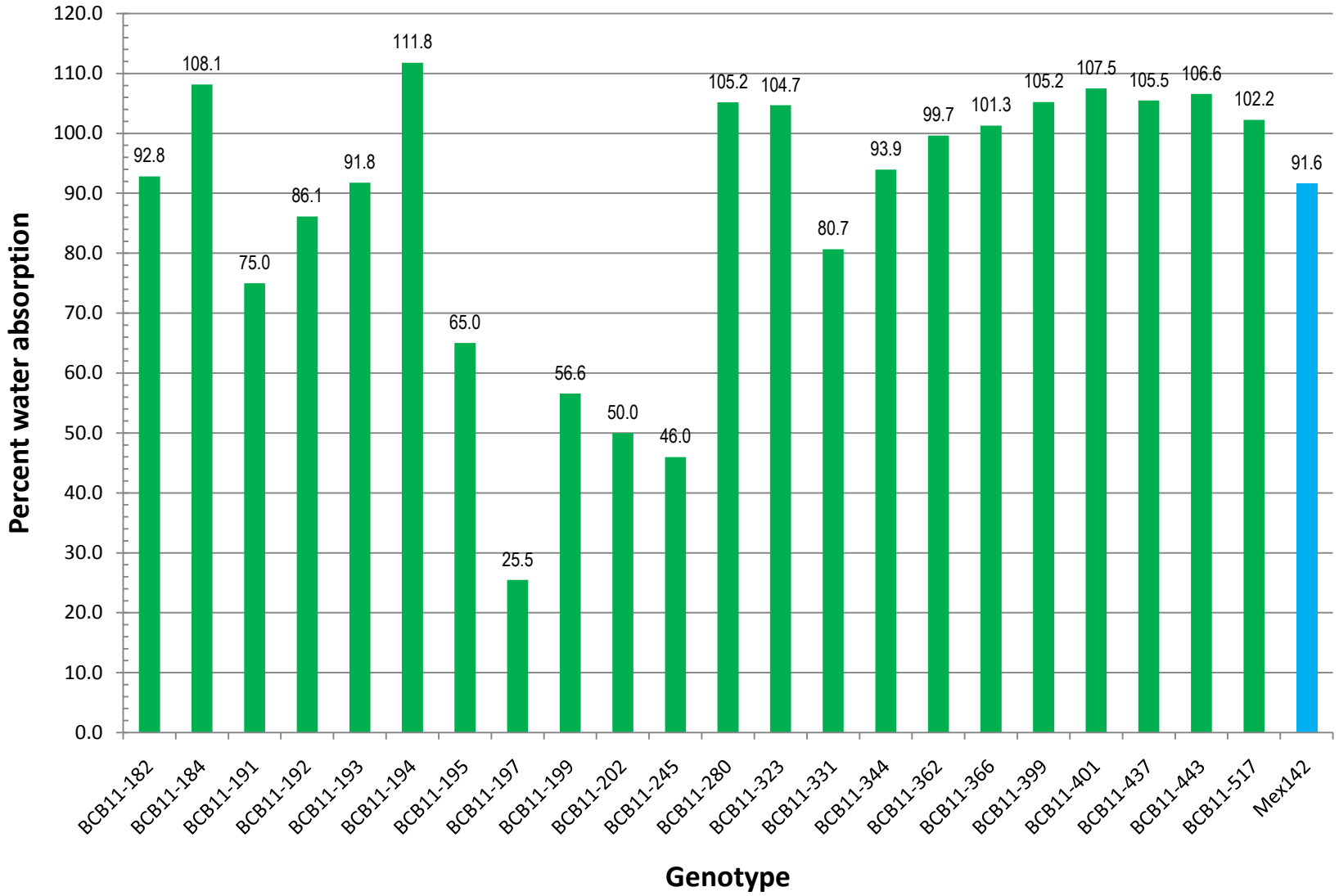

Fig 10. Water absorption trends of advanced red kidney bean lines soaked over 16 hours

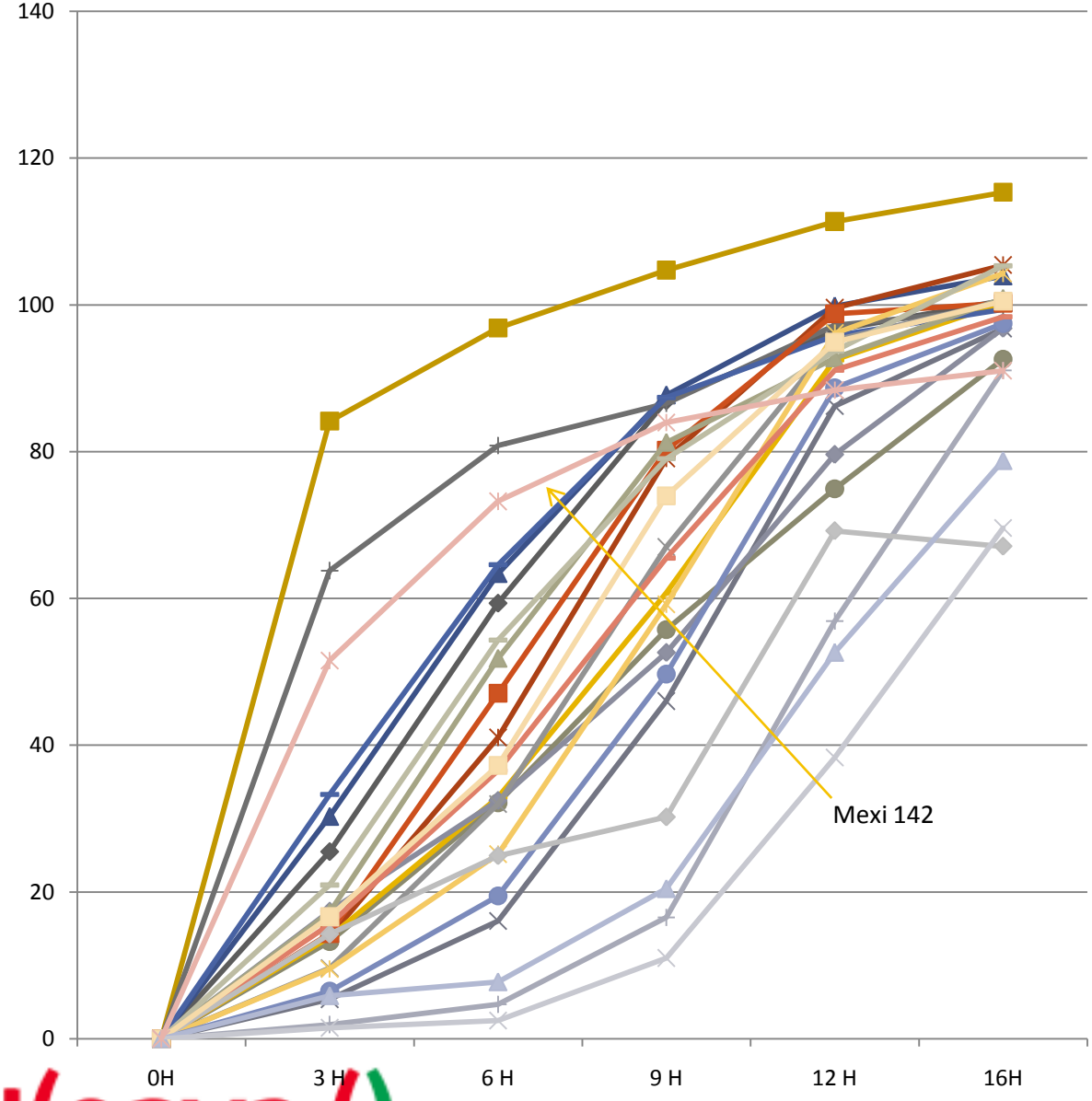

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Fig 12. Water uptake patterns of advanced red mottled lines over 16 hours

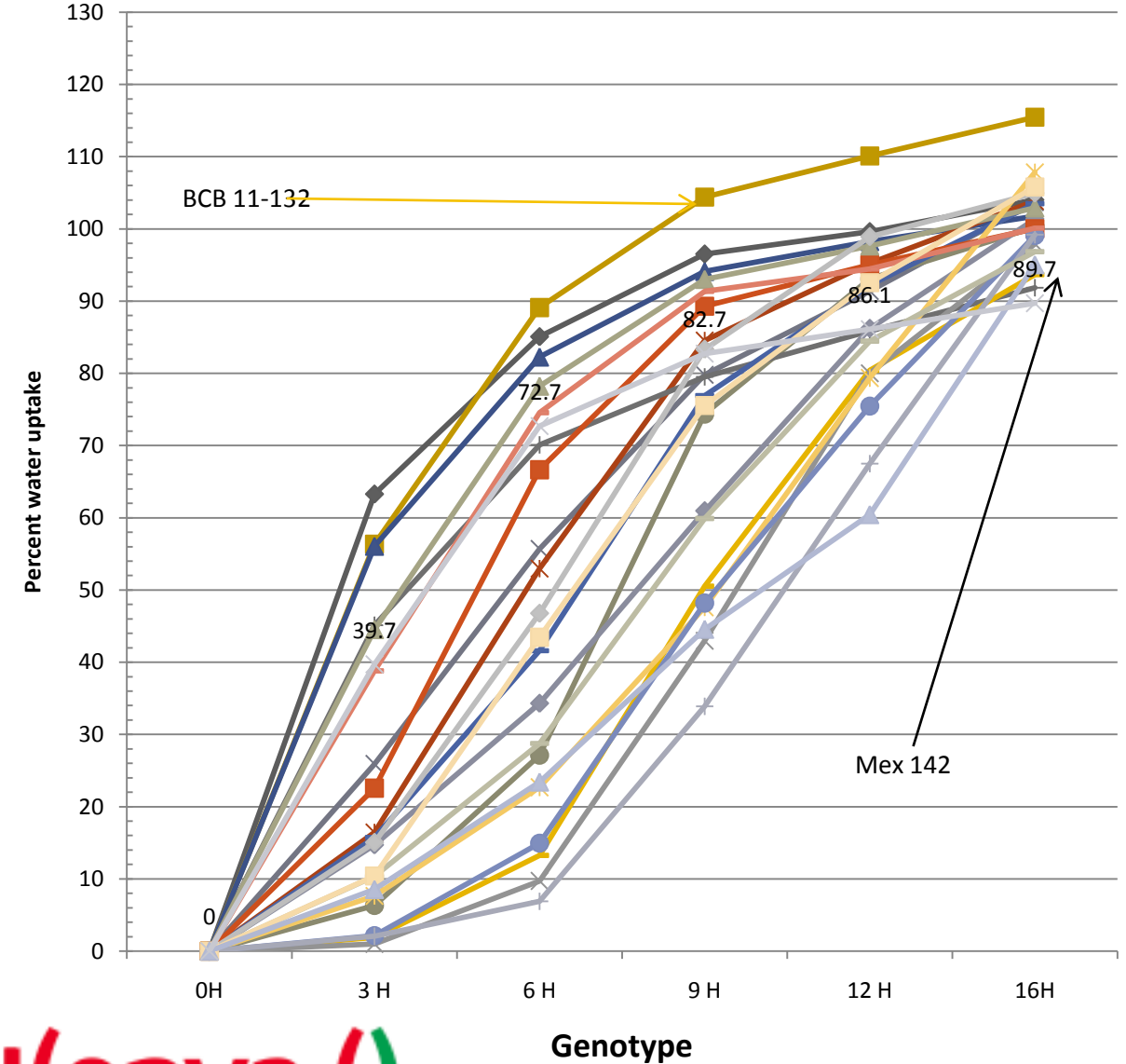

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Fig 13. Water absorption of advanced Red Mottled lines soaked for 16 hours

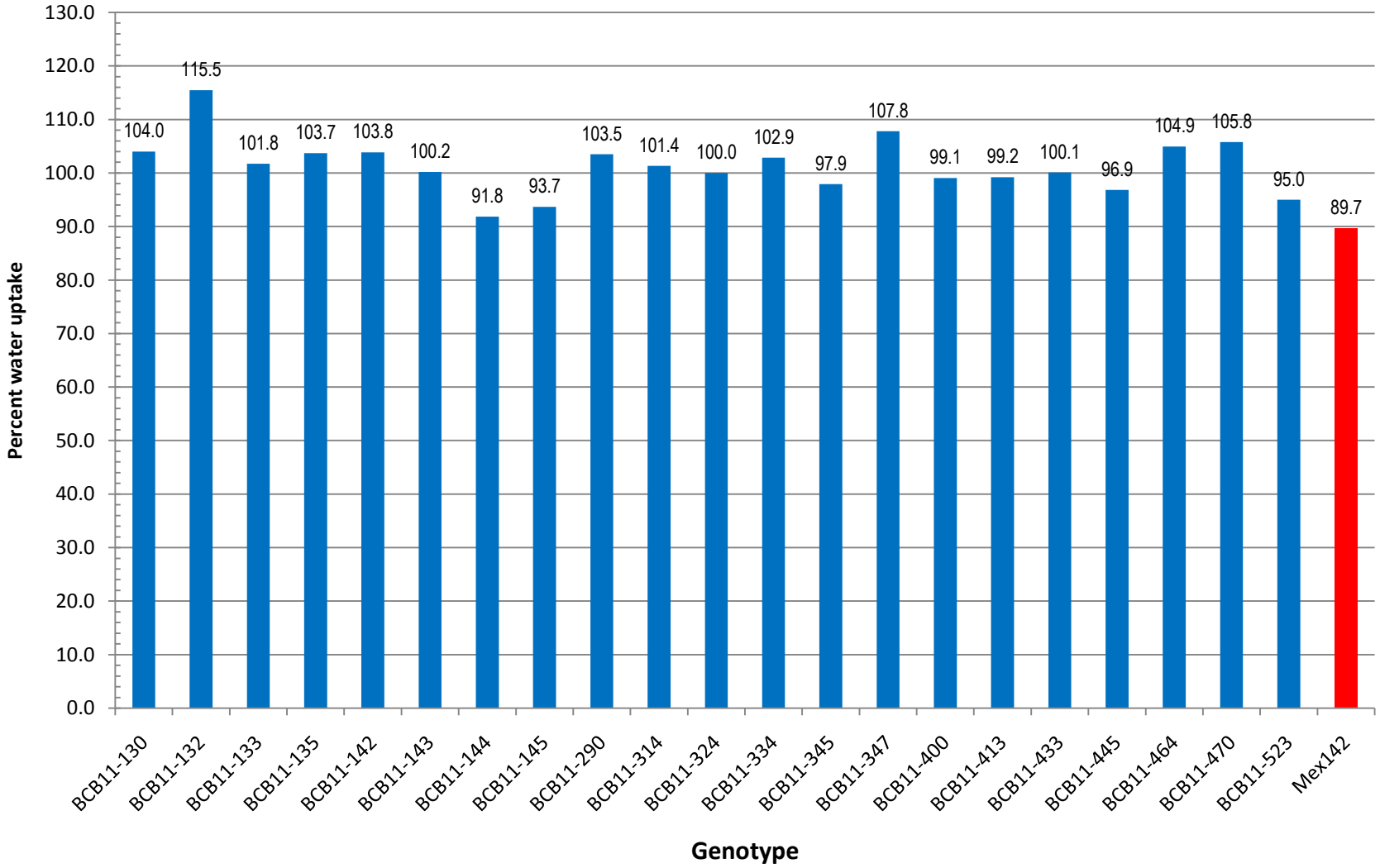


Fig 14. Water absorption patterns of advanced speckled sugar lines soaked for 16 hours.

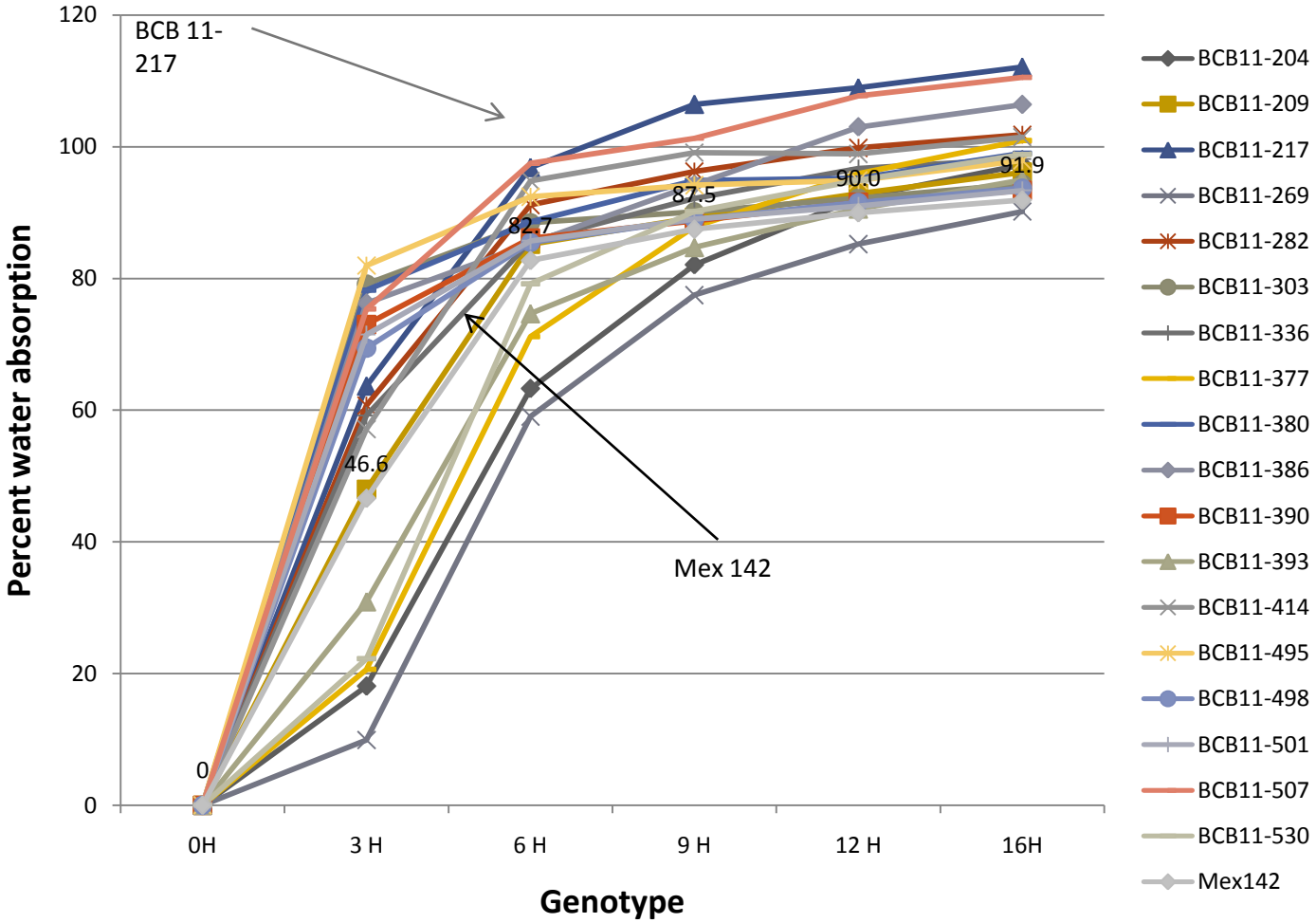
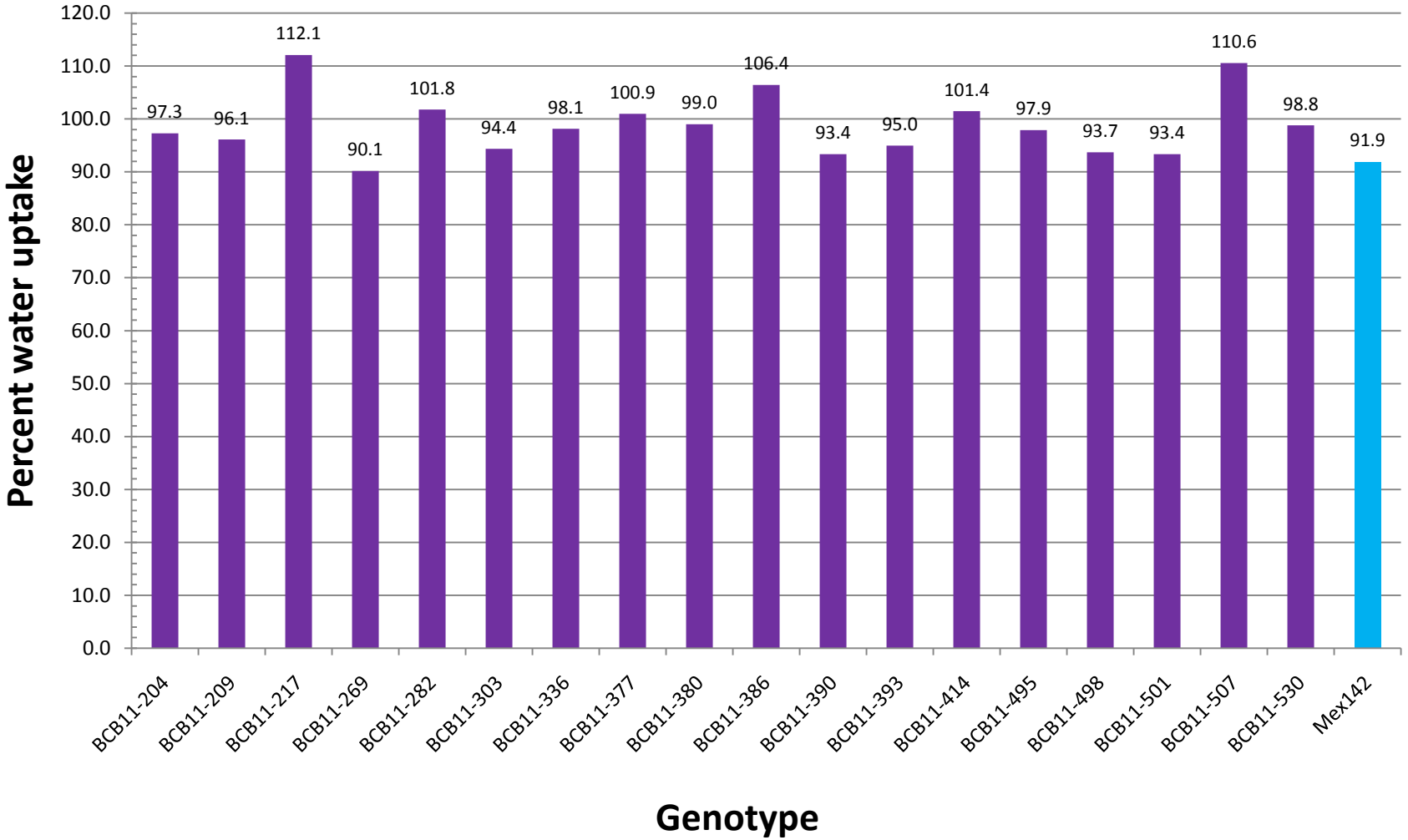


Fig 15. Water absorption of advanced speckled sugar bean lines soaked for 16 hours



Cooking Time

Fig 1. Cooking time of advanced Red Mottled canning bean lines grown at Kabete Field Station, 2012

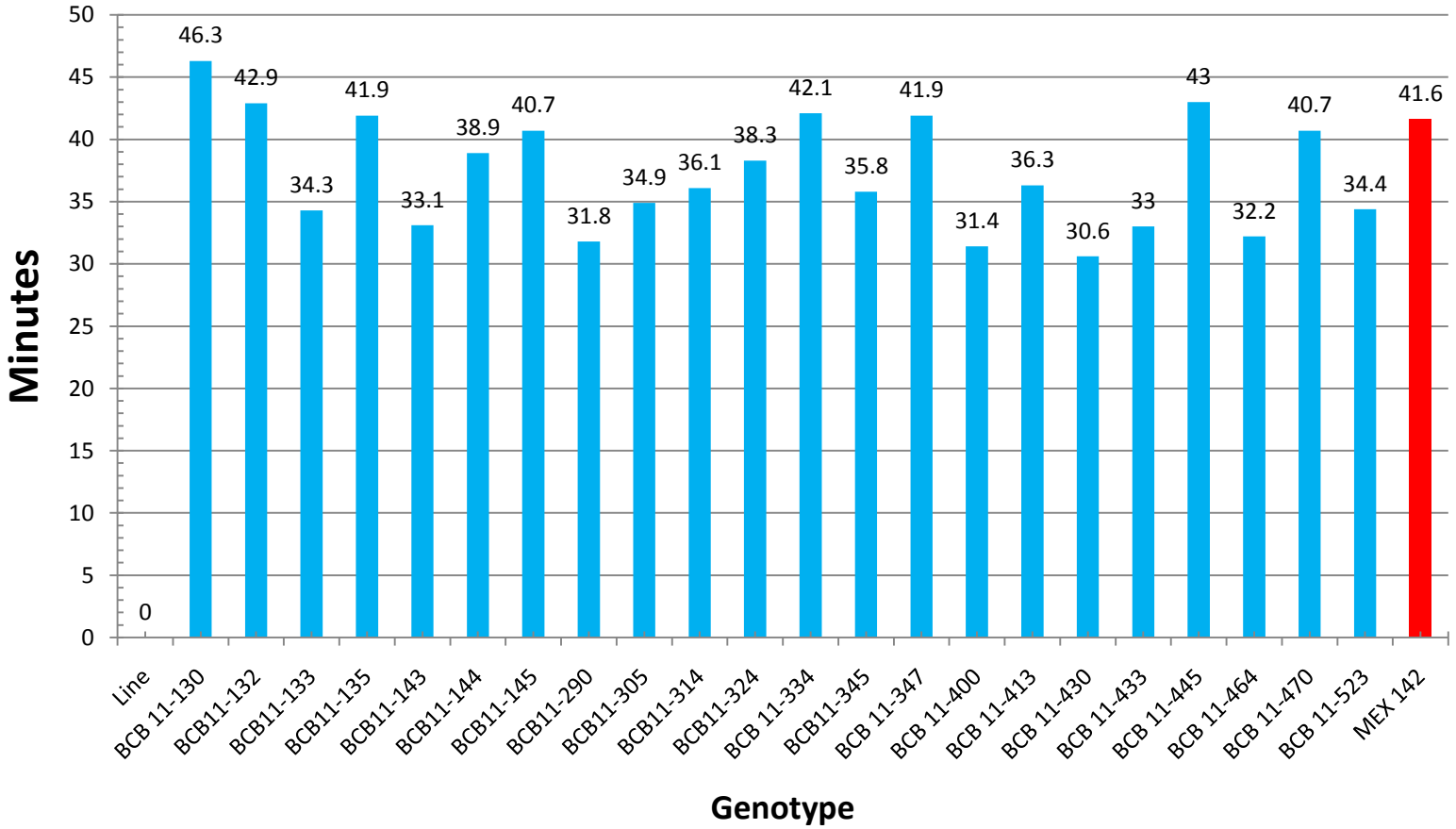


Fig 2. Cooking time of advanced Red Kidney canning bean lines

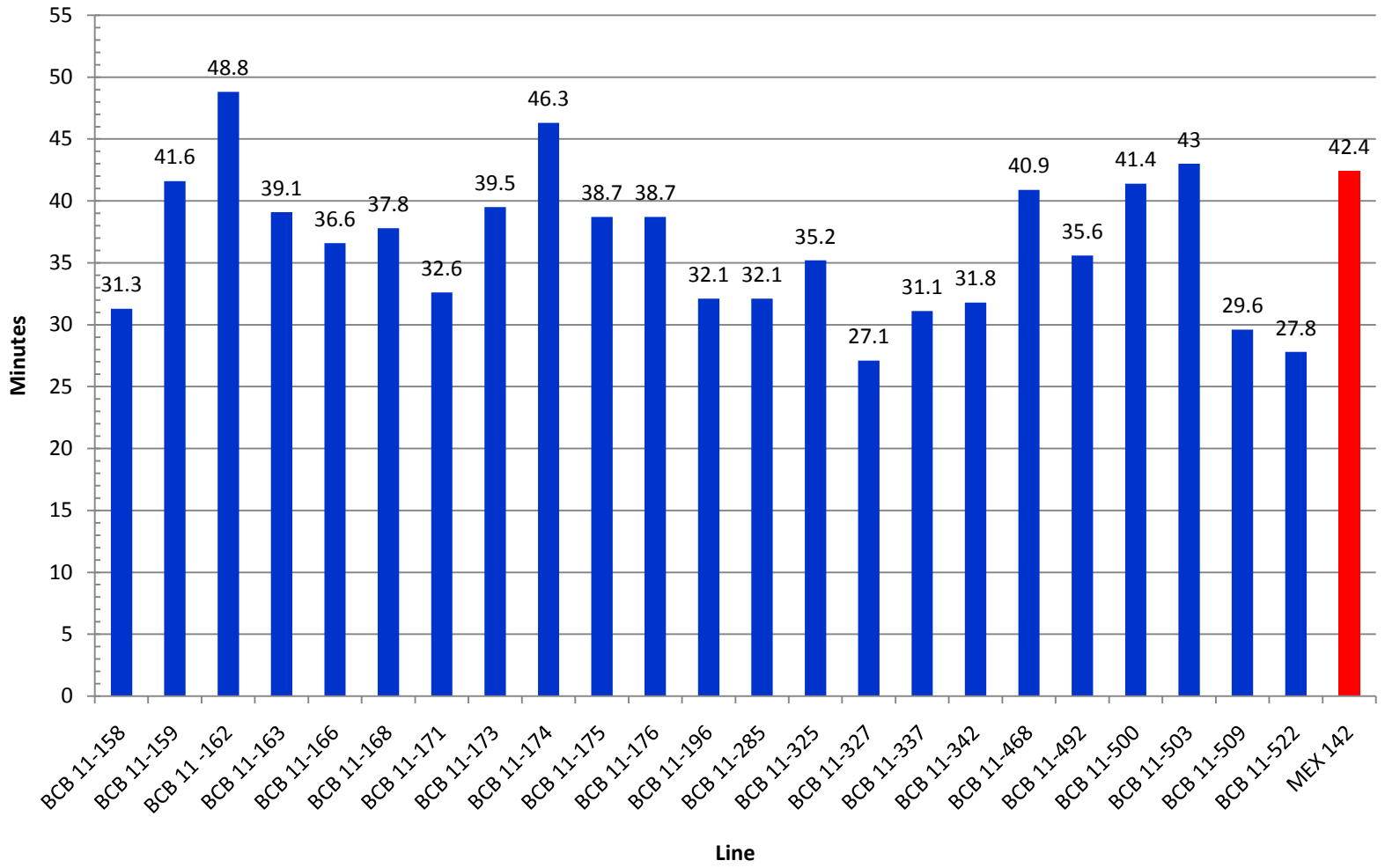


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Fig 3 . Cooking time of advanced Speckled Sugar canning bean lines

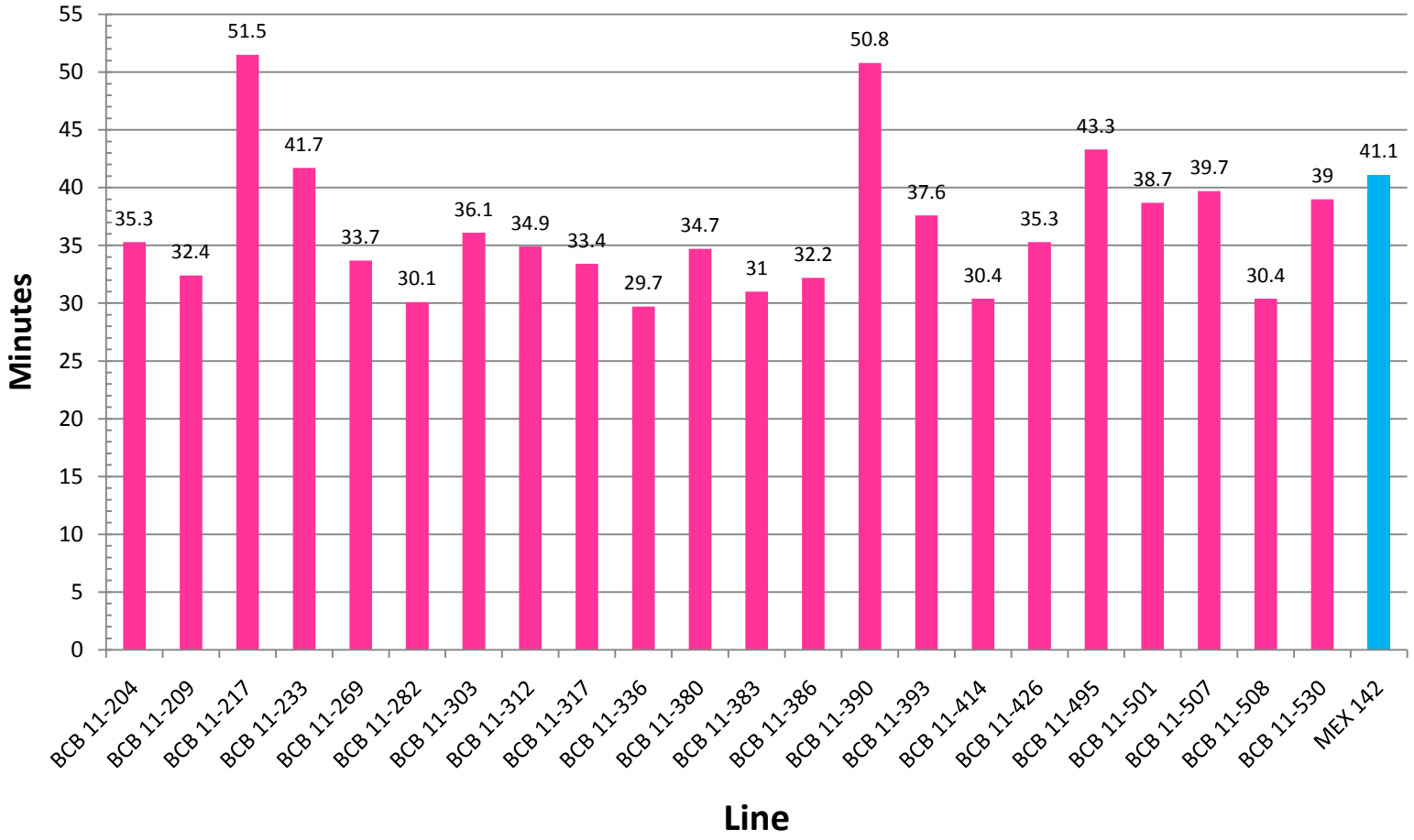


Fig 5. Cooking time of advanced Navy Bean lines grown at Kabete Field Station, 2012

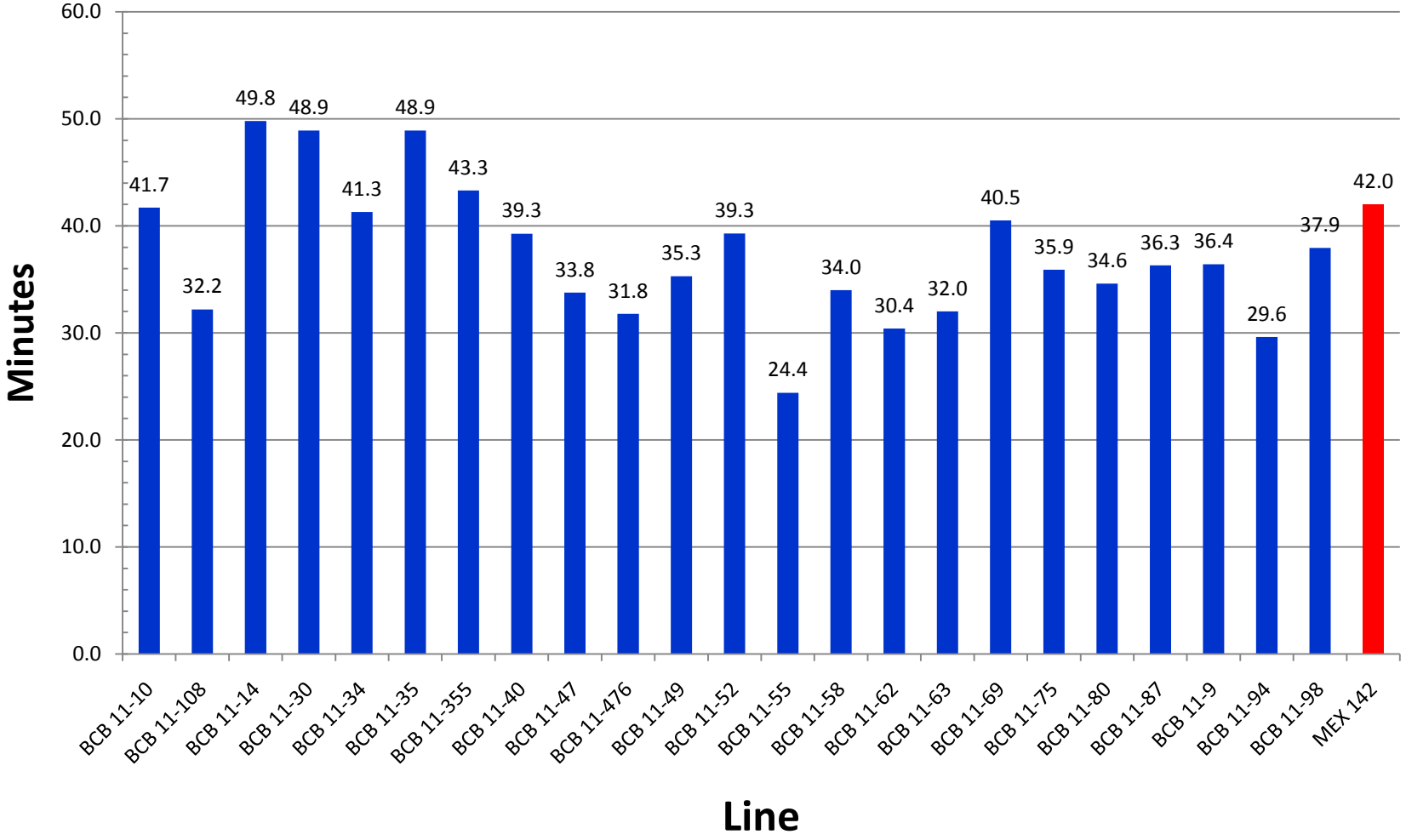
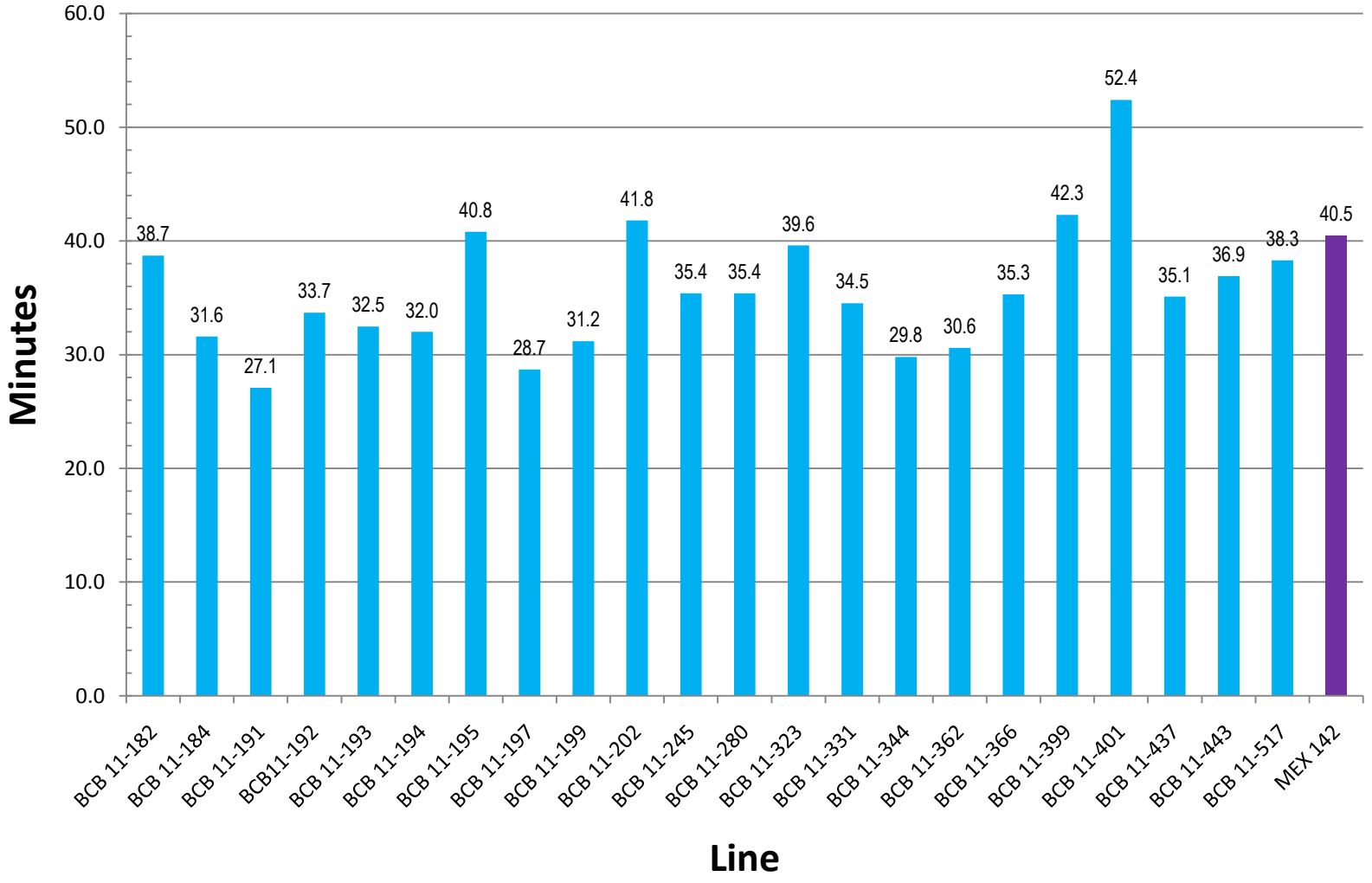


Fig 4. Cooking time of advanced Small Red canning bean lines



Certified Seed Production

Season	Category of Seed	Quantity (kg)	Remarks
LR 2011	Nucleus	350	Stage I, II
	Breeder	4,129	Isiolo, Naivasha, Kabete
	Basic	4,562	
	Total	**9,041**	
SR 2011	Nucleus	800	Stage I, II and III
	Breeder	8,000	Used by Simlaw Ltd as pre-basic and planting certified seed
	Basic	12,667	
	Total	**21,467**	
LR 2012	Nucleus	1.2 ha	Kabete (stages I,II andIII)
	Breeder	7 ha	Kabete (SEMI)
	Basic	73 ha	Diverse areas (see semi-annul report)
	Certified	100	Simlaw Production Dept

8 May 2012

Pilot food processing Plant-CAVS

Blanching

Seaming

Retort

Cooling system

Recorder

Steam generation and regulation

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Future Directions

- Complete lab canning tests
- Industrial canning- grain production
- NPT
- Fe-Zn analysis
- Root studies
- Graduate students- complete work
- Bio-innovate conference
- Publications

Conclusions

- New dry bean varieties meant for canning should possess **good canning qualities while ensuring uniform and complete water uptake** in order to prevent further expansion of beans in the can .
- The **new advanced drought tolerant and disease resistant dry bean lines** posses the physical suitability for **direct consumption, pre-cooked and canned bean** products.
- **Water uptake**, **percent volume increase** and **cookability** after soaking are critical characteristics of dry beans destined for the canning industry.
- Most genotypes took up at least **90% water** and qualify for canning purposes, with seven lines in seven **market classes** picking up water and cooking **faster** than the control.
- The new lines compared well, some even better, with the control navy bean variety, the **Mexican 142** which is imported, and popular for its taste and short cooking time.
- These new drought and disease resistant varieties have a clear potential for enhancing **productivity**, **nutrition and food security** and livelihoods of smallholder farmers and **new products** for processing industry.

Acknowledgements

- **Government of Kenya**
- **UON**
- **BioInnovate/SIDA**
- **TRUFOODS LTD**
- **SIMLAW SEEDS LTD**
- **Ministry of Agriculture**
- **Farmer Groups**
- **Graduate and undergraduate students**
- **Bean Program Technical staff**

PVS for drought tolerant canning beans in Mwea

THANK YOU