



MINISTRY OF AGRICULTURE, LIVESTOCK AND IRRIGATION
DEPARTMENT OF AGRICULTURE
HORTICULTURE AND PLANT BIOTECHNOLOGY DIVISION



Gamma Ray Induced-Mutagenesis Enhanced Yield-related Traits and
Disease Resistant in Sesame (*Sesamum indicum* L.)

By

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Outlines

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- ❖ Significant of Study/ Problem Statement
- ❖ Application Status of Mutation Breeding
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Introduction

- ❖ One of the most important edible oilseed crops and widely grown (Asia and Africa) (Ashri, 1998)
- ❖ Queen of Oil Seed with 50% - 60% (highest and richest edible oil) (Pathak et al., 2014)
- ❖ Medicinal and nutritional values (protein, carbohydrates, fats, fibers, essential minerals, high content of polyunsaturated fatty acids, oleic, and linoleic acid) (Lyon, 1972; Bedigian et al. 1985)
- ❖ Myanmar – third important crop and 48% - 51% of oilseed crop area (1.6 M ha) (MOALI and FAOSTAT, 2018)
- ❖ Foreign income (94% earning) of total oilseeds exports (only 20%) (FAOSTAT, 2020)
- ❖ Domestic consumption (80% of total production) for several purposes (Han and Myint, 2013; Myint et al., 2020)

Introduction

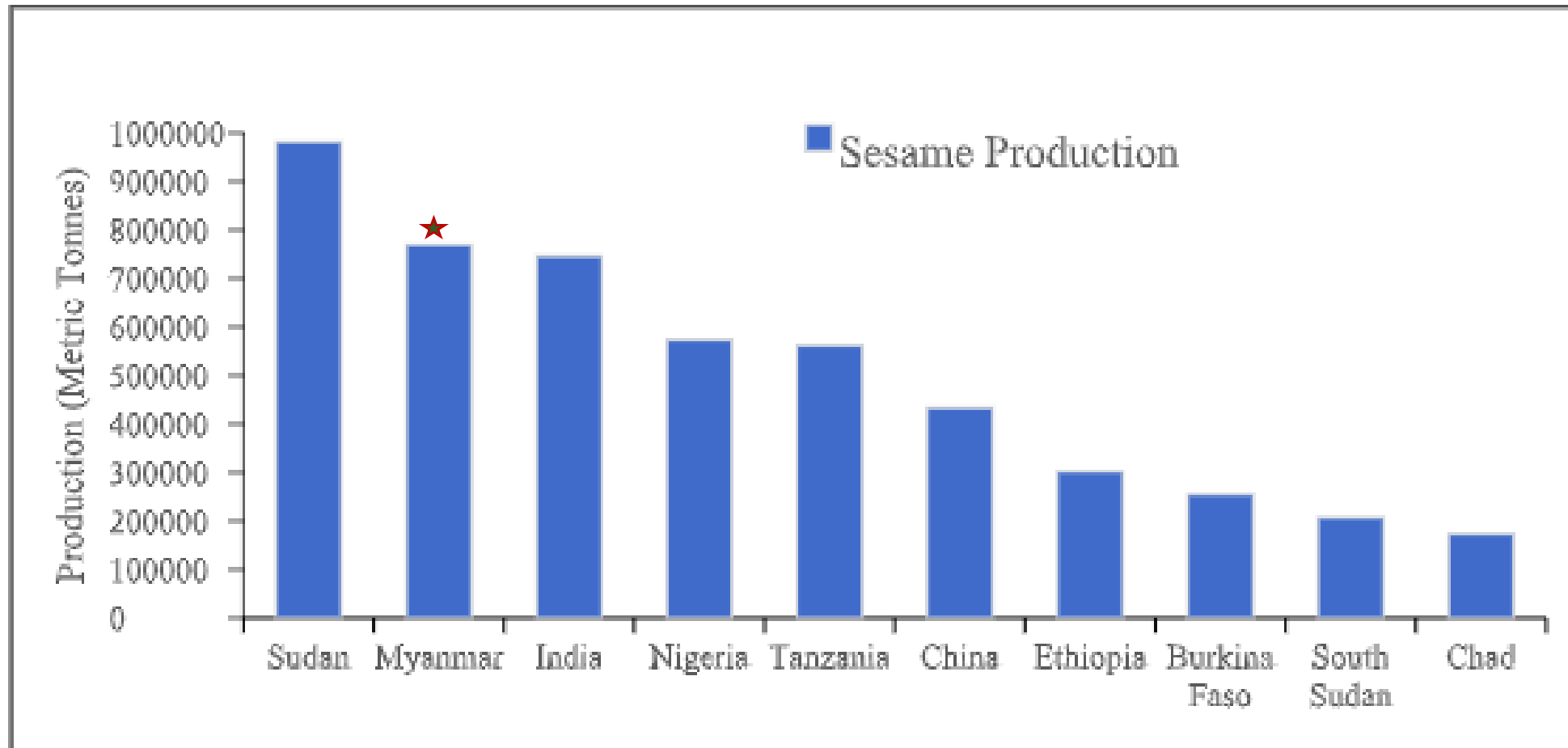


Figure 2.1. Top 10 sesame producers in the world in 2018. *Source: Food and Agriculture Organization Statistical Databases (FAOSTAT, 2020) (Ye Win Aung – Ph.D Thesis, 2022)*

Introduction

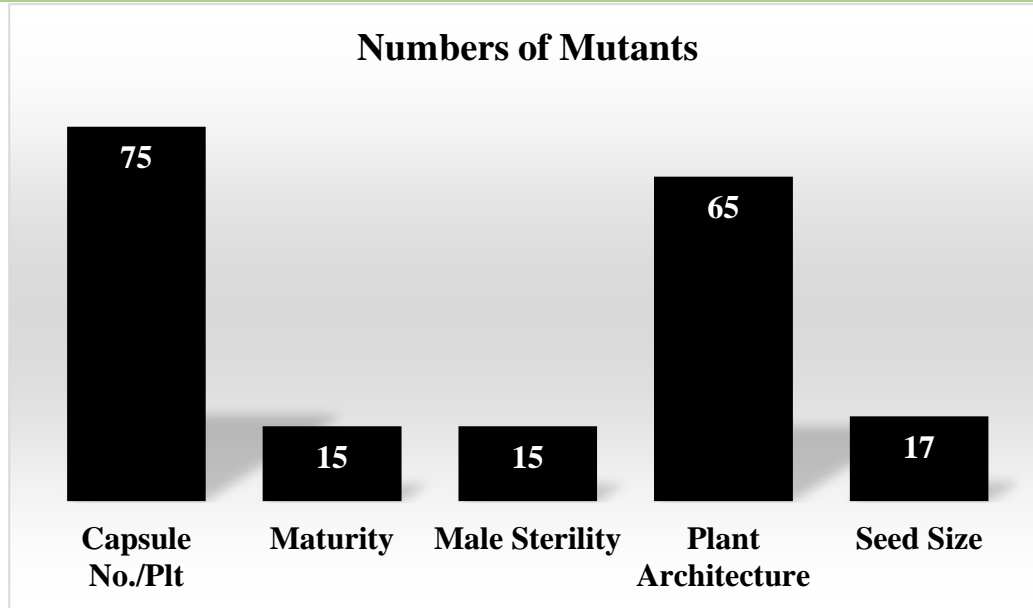
Figure 1. Trend of sesame production values in top producing countries during the last twenty years (Average 1999–2018) Source: Food and Agriculture Organization Statistical Databases (FAOSTAT), 2020. (Ye Win Aung – Ph.D Thesis, 2022)



Problem Statement/ Significant of the Study

- ❖ Gambling crops (unstable yield) and inadequate good quality seed availability
- ❖ Farmers – different sesame varieties cultivation and traditional varieties use
- ❖ Keeping their own seed and from neighboring farm for next season (Ye Win Aung – Ph.D Thesis, 2022)

Application Status of Mutation Breeding



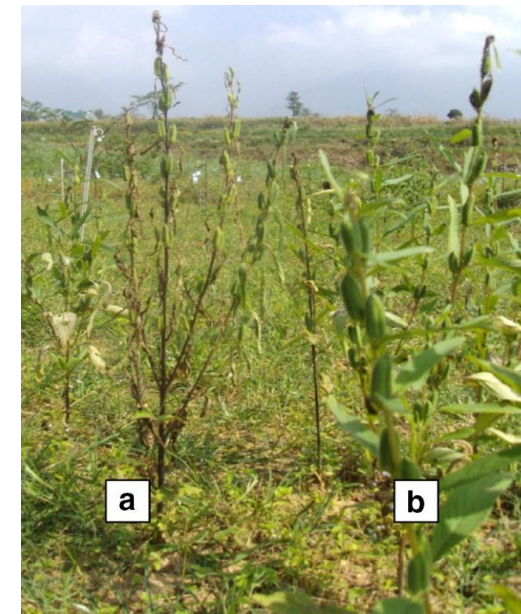
(La Ven et al., 2001)

Biotic and Abiotic Stress Resistant
 Higher Yield
 More Developed Root System
 Proline Content
 Higher Chlorophyll Content
 Higher Stomata Content

(Mohamed K. et al., 2022)

	Country	Number of Mutants	Crops
1	China	810	Rice
2	Japan	479	Barley
3	India	341	Chrysanthemum
4	Russian Federation	216	Wheat
5	The Netherlands	176	Soybean
6	Germany	171	Maize
7	United States	139	Groundnut
8	Bulgaria	76	Rose
9	Bangladesh	75	Common bean
10	Viet Nam	58	Cotton

Source: FAO/IAEA Mutant Database



Phytophthora Blight Resistant Sesame Variety through Gamma Ray Induced Mutagenesis (Kumari et al., 2018)

Objectives

- ❖ Observing for the better performed breeding lines at morphological and yield related traits
 - Investigation on the trait performances of mutant lines in comparison with control
 - Evaluation on the interaction of traits in mutant lines
 - Selection the homogeneous and homozygous lines for the upcoming generation



Materials and Methods

Gamma Ray Treatment – 250 Gy, 350 Gy, 450 Gy

Sesame Variety - Sinyadana-14

Research Design – Simple

Collected Data – Quantitative and Qualitative Traits

Biometric Analysis – R software Version 4.2.0

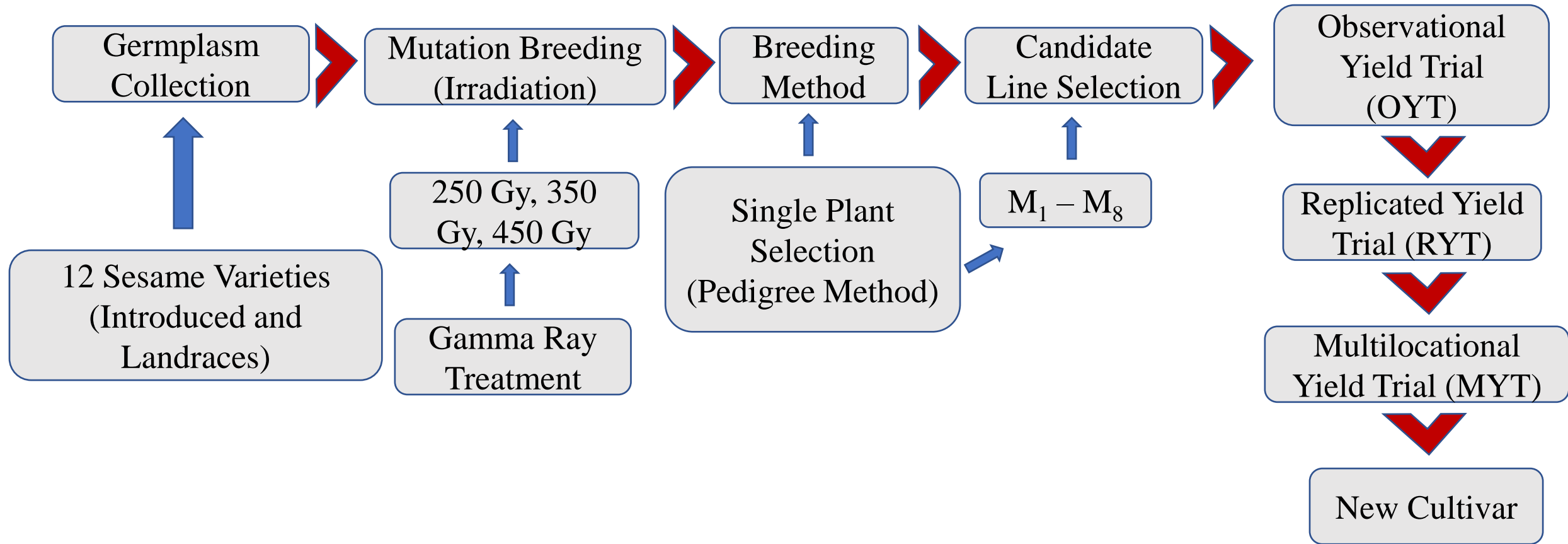
Research Duration (2020 – 2022)

- Monsoon (May – June)
- Post-monsoon (Oct – Nov)

Spacing – 4” x 12”

Research Destination – Plant Biotechnology Center (PBC), Horticulture Division, DOA

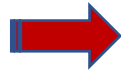
Flow Chart of Mutation Breeding Pipeline



Flow Chart of Mutation Breeding Pipeline



M₁ Generation
May, 2020
(Monsoon season)



M₂ Generation
Nov, 2020
(Post-Monsoon season)



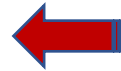
M₃ Generation
May, 2021
(Monsoon season)



M₄ Generation
November, 2021
(Post-monsoon season)



Four Candidate
Mutants
(Line-6, Line-7,
Line-8 & Line-9)



Sinyadana – 14 (350 Gy)

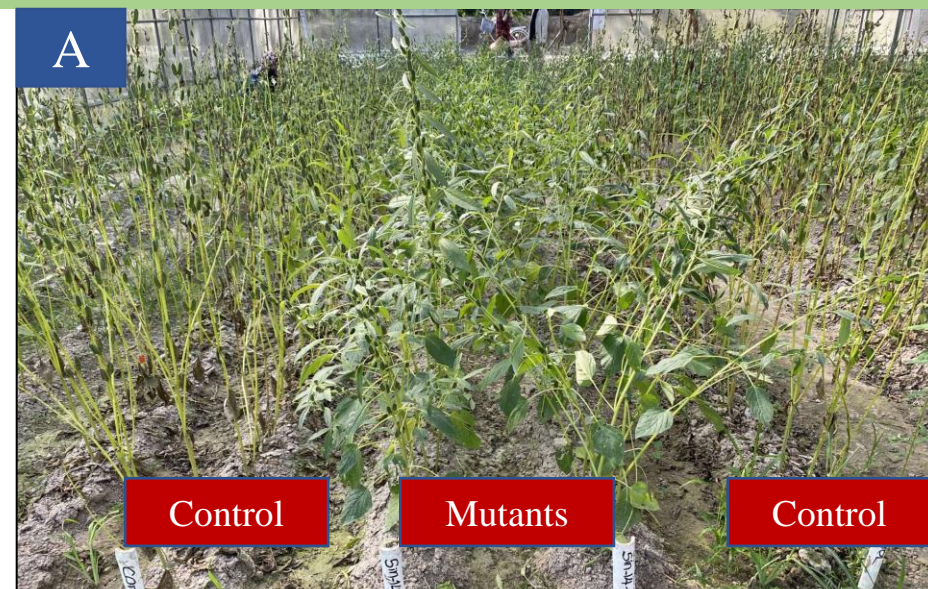


M₅ Generation
November, 2022
(Post-monsoon season)

Disease Resistance Analysis


Disease Scores of Mutants by comparing with their control (Sinyadana – 14)

Mutants	Resistant (R)	Susceptible (S)
Line-6	R	-
Line-7	R	-
Line-8	R	-
Line-9	R	-
Control	-	S




Part – I: Disease and Causal Organism Identification

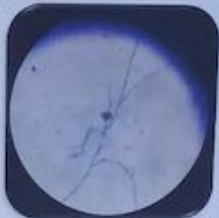
ကွင်းဆင်းစစ်ဆေးမှု မှတ်တမ်းဓာတ်ပုံ




စိုက်ခင်းတွင်တွေ့ရှိရသော ရောဂါလက္ခဏာနှင့် ဓါတ်ခွဲခန်းတွင် စစ်ဆေးတွေ့ရှိရသော ရောဂါသက်ရှိ (မှို) များ





(၁) နှမ်းရိုးမည်း






(၂) နှမ်းရွက်ပြောက်





(၃) ပါးညှို့



Sr. No	Disease in English	Disease in Myanmar	Causal Organism
1	Black Stem	နှမ်းရိုးမည်း	<i>Rhizoctonia bataticola</i>
2	Corynespora Leaf Spot/blight	နှမ်းရွက်ပြောက်/ရွက်ခြောက်	<i>Corynespora cassicola</i>
3	Powdery Mildew	ပါးညှို့	<i>Oidium spp.</i>

မြေဆောင်နှင့်မျိုးစေ့ဆောင်ရောဂါကာကွယ်နှိမ်နင်းရန်

- နှမ်းရိုးမည်းရောဂါနှင့် ရွက်ပြောက်/ရွက်ခြောက်ဖြစ်စေသော *Rhizoctonia bataticola* နှင့် *Corynespora cassicola* သက်ရှိများသည် မြေဆောင်ရောဂါနှင့် မျိုးစေ့ဆောင်ရောဂါတို့ဖြစ်စေပါသည်။
- ၎င်းရောဂါကျရောက်သော စိုက်ခင်းတွင် ပြန်လည်စိုက်ပျိုးပါက ရောဂါကျရောက်နိုင်ပါသည်။
- မြေဆောင်ရောဂါနှင့် မျိုးစေ့ဆောင်ရောဂါတို့အတွက် မျိုးစေ့လူးနယ်မှုသတ်ဆေးတစ်မျိုးမျိုးဖြင့် လူးနယ်စိုက်ပျိုးခြင်းဖြင့် ငယ်ရွယ်စဉ် ရောဂါကျရောက်မှုကို ကာကွယ်ပေးနိုင်ပါသည်။

- ❖ Mutants – resistant to Black Stem (*Rhizotonia bataticola*), Corynespora Leaf Spot/Blight (*Corynespora cassicola*)
- ❖ Gamma ray (300) expressed the resistant mechanism to Phytophthora Blight (Kumari et al., 2018).

Part – II: Quantitative Traits Analysis Results and Discussion

Student *t*-test Analysis of Agronomic and Yield Components of Sinyadana - 14 Mutants

Traits	Df	Minimum	Maximum	Mean	p-Value
PH	19	80	140	106.15	**
FBH	19	28	46	37.65	**
FBFCH	19	9	30	12.45	ns
INLEN	19	6.6	9.2	7.6	*
NPB	19	0	2	1.9	ns
CPL	19	2.3	2.78	2.5	**
CPW	19	0.7	0.84	0.76	ns
CT	19	0.5	0.66	0.57	ns
NCP	19	20	41	29.2	***
TSW	19	2.17	3.13	2.77	***
NSC	19	42	69	58.9	***
SYP	19	3.15	8.19	4.77	***

PH – Plant Height (cm), FBH – First Branch Height (cm), INLEN – Internode Length (cm), FBFCH – First Branch to First Capsule Height (cm), NPB – Numbers of Primary Branches, CPL – Capsule Length (cm), CPW – Capsule Width (cm), CT – Capsule Thickness (cm), TSW – Thousand Seed Weight (g), NSC – Numbers of Seed/Capsule, SYP – Seed Yield/Plant (g)

Results and Discussion

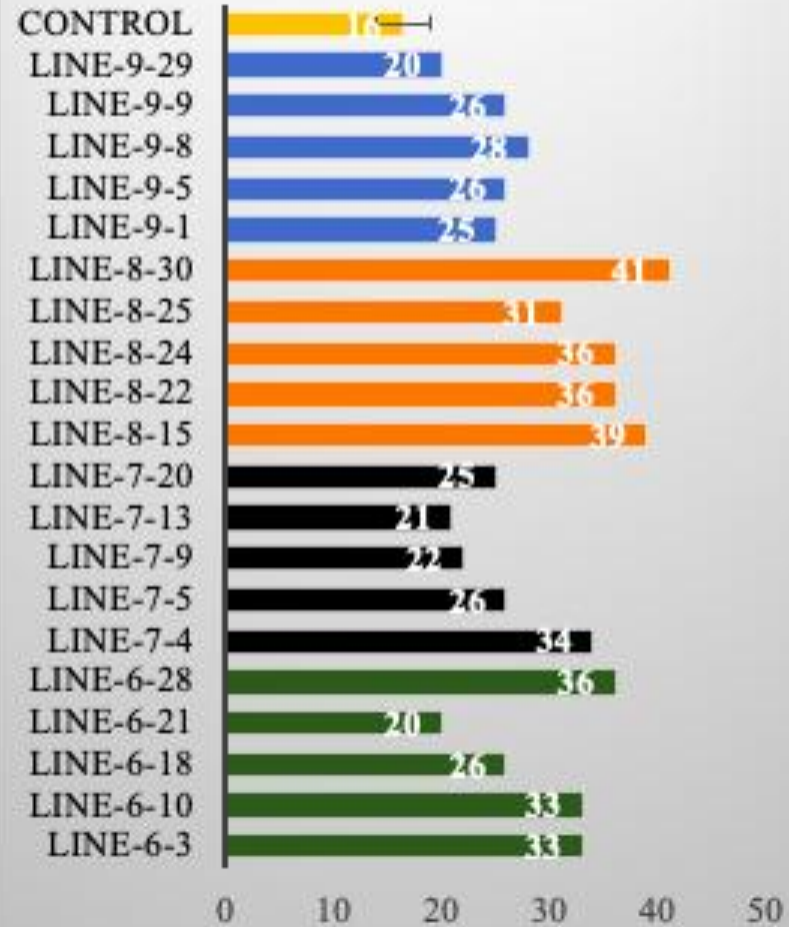
- ❖ **Plant height** influenced the **length first branch height to first capsule, internode length, capsule length, capsule numbers/plant, seed numbers/capsule, and seed yield/plant** (Mawcha et al., 2022; Myint Aye et al., 2019 and El Harfi et al., 2018).
- ❖ **Capsule length** was **positively and significantly** correlated with **seed numbers/capsule, and seed yield/plant** (Myint Aye et al., 2019; Haibru et al., 2018 and Eryigit et al., 2016).
- ❖ **The significant and positive correlation** between **capsules/plant and yield (seeds/capsule and seed yield/plant)** was observed. (Ye Win Aung, 2022 and Akbar et al., 2011).

NPB	0.04	-0.18	-0.02	-0.06	1.00							
CPL	0.73***	0.36	0.22	0.23	0.10	1.00						
CPW	0.12	0.30	0.23	-0.02	-0.27	0.07	1.00					
CT	-0.05	-0.30	-0.03	-0.06	0.02	-0.05	-0.01	1.00				
NCP	0.70***	0.07	-0.03	0.25	0.24	0.66**	-0.06	-0.05	1.00			
TSW	-0.08	0.15	0.17	-0.17	-0.29	-0.14	0.10	0.15	-0.26	1.00		
NSC	0.50*	0.16	0.21	0.17	0.13	0.50*	0.03	-0.08	0.47*	-0.04	1.00	
SYP	0.70***	0.09	0.05	0.22	0.20	0.65**	-0.02	-0.04	0.96***	-0.08	0.70***	1.00

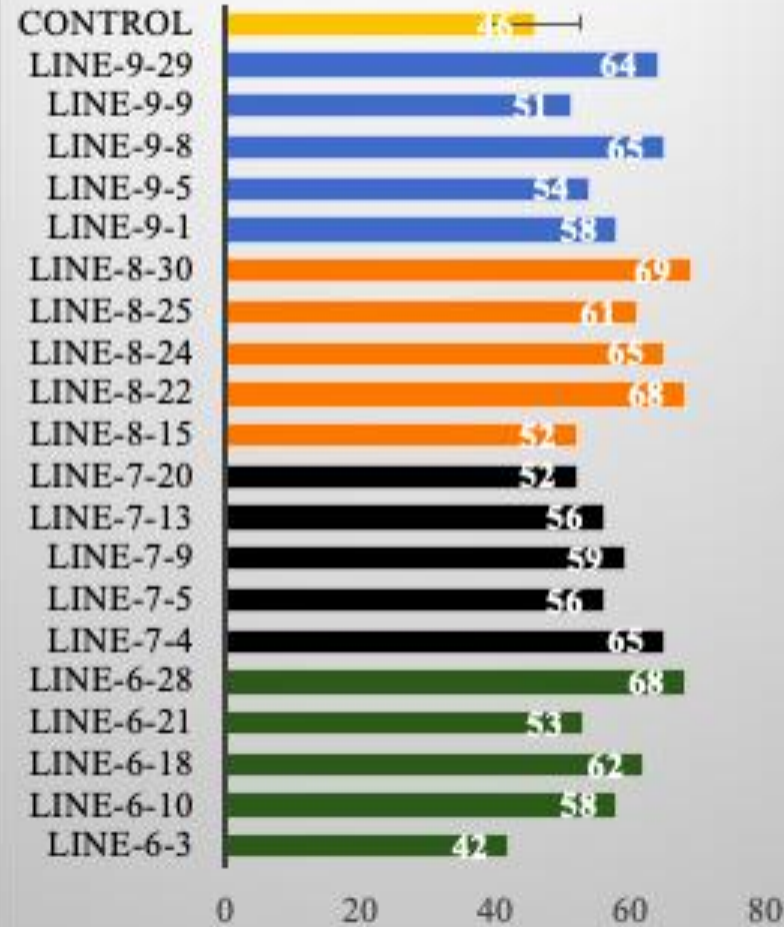
PH – Plant Height (cm), HBFb – Height from Base to First Branch (cm), IN Length – Internode Length (cm), HFBFC – Height from First Branch to First Capsule (cm), NPB – Numbers of Primary Branches, CPL – Capsule Length (cm), CPW – Capsule Width (cm), CT – Capsule Thickness (cm), TSW – Thousand Seed Weight (g), NSC – Numbers of Seed/Capsule, SYP – Seed Yield/Plant

Results and Discussion

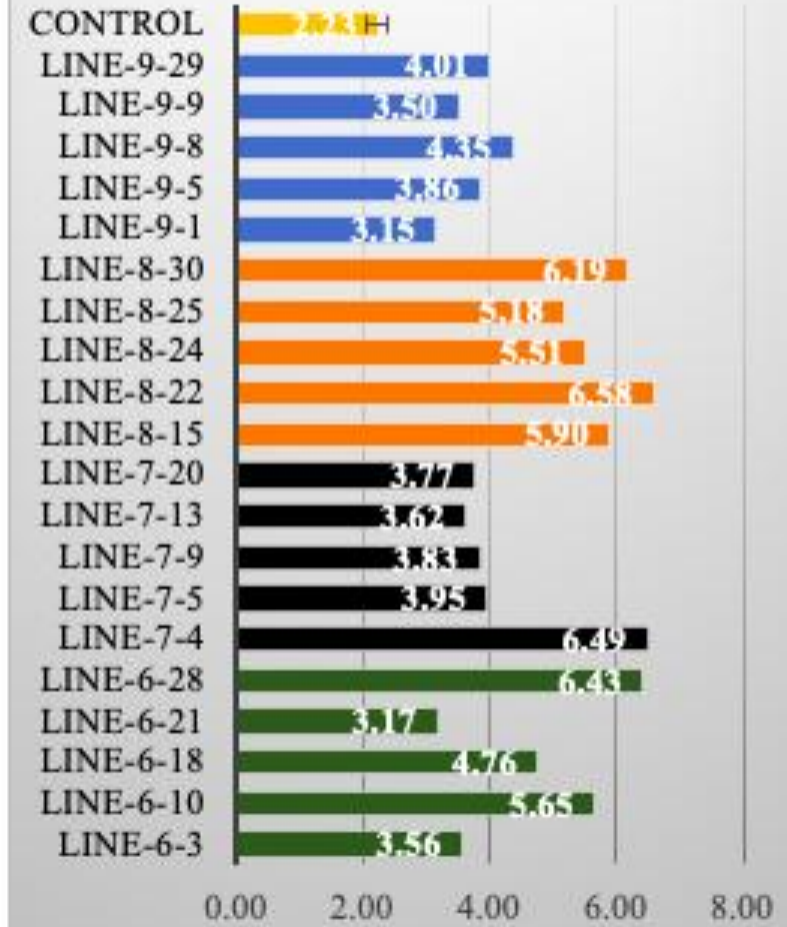
Capsule Numbers/Plant



Seed Numbers/Capsule



Seed Yield/Plant (g)



Summary and Conclusion

- ❖ Mutant lines – higher plant height, higher first branch height, longer internode length, longer capsule length than control (Sinyadana – 14)
 - more capsule numbers/plant, more seeds/capsule and higher seed yield / plant than control (Sinyadana – 14)
- ❖ The higher plant height > longer internode length > more capsule number plant
- ❖ The longer capsule length > the more numbers of seed/capsule > higher seed yield
- ❖ Resistant to Black Stem (*Rhizotonia bataticola*), Corynespora Leaf Spot/Blight (*Corynespora cassicola*) in mutants with better performances in yield components

Future Work Plan

- ❖ Trait specific molecular marker analysis for the homogeneous and homozygous candidate lines before release
- ❖ Assessment on the performance of candidates for the next generation evaluating on agronomic and yield related traits
- ❖ Conducting preliminary yield trial experiments for the homogeneous and homozygous candidate lines
- ❖ Multilocational yield trials in the widely sesame growing area
- ❖ Application in crop improvement program as genetic materials



Acknowledgement

- ❖ Director General of Department of Agriculture (DOA)
- ❖ Director of Horticulture and Biotechnology Division (HBD)
- ❖ Director and Dr. Win Than (Assistant Director) of Plant Protection (PP)
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- ❖ Head and Colleagues of Plant Biotechnology Center (PBC)



Thank you so much!

