

## Response of Mungbean (*Vigna radiata* L Wilczek) Genotypes to Different Spacing Types in Derived Savannah Agroecology of Southeast Nigeria

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### Abstract

Population density is an important determinant of crop yield. For optimum crop production, the best spacing requirement must be adopted. Although the recommended spacing requirement of mungbean is abundant in literature globally, there is no such information on studies conducted within derived savannah agroecological zone of southeast Nigeria, despite the crop's usefulness as food, green manure, and nitrogen fixer. We hypothesized that the spacing requirement of mungbean may vary with genotype. Hence, this study was conducted to evaluate the response of three mungbean genotypes to four spacing types in derived savannah agroecology. The experiment was a split-plot design with genotype (Tvr18, Tvr65, and Tvr83) as the main plot treatment and plant spacing (30x10, 40x10, 30x15, and 40x15 cm) as the sub-plot treatment. Data were collected on 19 agronomic traits. Analysis of variance (ANOVA) showed that plant spacing of 30x10 cm influenced significantly higher ( $p < 0.05$ ) values in most agronomic traits measured while Tvr18 was higher in pod and seed attributes with higher seed-yield (0.80 t/ha) compared to Tvr83 (0.52 t/ha) which was the least. The interaction effect of Tvr18 by 30x10 cm gave a higher seed yield of (1.37) t/ha compared to Tvr83 by 30x10 cm (0.62 t/ha) which was the least. GGE biplot analysis showed a higher seed yield of the genotype-Tvr83 with wider spacing 40x15 compared to 30x10 cm.

**Keywords:** mungbean, spacing requirement, genotype effect, growth, seed-yield

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### Introduction

The spacing requirement of a crop is a critical component of crop productivity. Crop growth and yield are often influenced by the area of space available to a plant (Rafiei, 2009). Although several reports have recommended spacing of 30x10 cm as optimum for mungbean production across several regions of the world (Sarkar et al., 2004; Siraje et al., 2020), report on plant spacing recommendation in derived savannah agroecology of southeast Nigeria is non-existent in literature.

Mungbean ranks top as the most economically important crop of the *Vigna* group and doubles

as the most nutritious pulse in existence (Anjum, 2011), with over 30% protein, 45% carbohydrate, 65% fiber, and substantial concentrations of vitamins and minerals (Hueze et al., 2015; Ihejiofor et al., 2022). The seeds are reservoirs of digestible proteins for man in regions where animal protein is expensive, scarce, or lacking, and where people are mostly vegetarian (AVRDC, 2012). Due to its diverse use, it could be eaten fresh as a vegetable (Mogotsi, 2006), cooked into porridge or soups, or processed into noodles, flour, bread, and ice cream. Mungbean could provide an alternative and cheap source of plant-based non-flatulence

proteins, essential minerals, and vitamins, especially in areas where soybean and cowpea are not readily available.

Mungbean can fix atmospheric nitrogen up to 109 kg per ha in a symbiotic association with rhizobium bacteria (Mehandi et al., 2019) which enables it to meet its nitrogen requirements and benefit the succeeding crops.

Genotype (Ukwu and Olasanmi, 2018) and population density (Mondal et al., 2012) are key determinants of crop yield. According to Sekhon et al. (2002), the spacing requirement of a crop could vary with genotype. We hypothesized that different mungbean genotypes could vary in their requirement for space. As an introduced crop in the derived savannah agroecology, it is necessary to investigate its response to different spacing treatments.

Determining the genotype and corresponding population density or spacing with the most favorable yield could lead to a significant breakthrough in the struggle for discovering cheap alternative plant-derived protein sources. Hence, this study was therefore carried out to investigate the response of mungbean genotypes to different spacing treatments.

## Materials and Methods

### *Experimental Site*

The experiment was carried out at the Teaching and Research Farm of the Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka. The University is situated in the derived Savannah agroecological zone of Nigeria, at latitude 06°52'N, longitude 07°24'E, and 447 altitudes.

### *Experimental Materials and Treatments*

Three (3) genotypes of Mungbean (*Vigna radiata* (L) R Wilczek) sourced from the Genetic Resource Centre, International Institute of Tropical Agriculture (IITA), Ibadan were used for this study. The genotypes include:

- i. Tvr<sub>18</sub>
- ii. Tvr<sub>65</sub>
- iii. Tvr<sub>83</sub>

Four plant spacing types including 30×10 (S<sub>1</sub>), 40×10 (S<sub>2</sub>), 30×15 (S<sub>3</sub>), and 40×15 (S<sub>4</sub>), corresponding to population densities of 333

333, 250 000, 222 222, and 166 667 plants per hectare were used for the study.

### *Experimental Design*

The experiment was laid out in a split-plot design with three replications. Three genotypes of mungbean and four plant spacing types constituted the main and sub-plot treatments, respectively.

### *Field Establishment*

The study was a field experiment carried out between June to October 2021. Thirty-six (36) beds were made on a land area measuring 20 × 30 m<sup>2</sup>. The land was cleared, and beds were made manually using a hoe. The land was divided into three blocks. Each block was partitioned into twelve (12) plots, each measuring 1.2 m × 1 m with spacing of 1 m between plots. A blanket dose of 10 t/ha poultry manure was applied 2 weeks before planting. Seeds were primed by soaking in water for 12 hours the night preceding the date of planting to accelerate germination and to ensure that only viable seeds are sown. Two seeds were sown per stand at a depth of 1.5 cm and later thinned to one at 2 weeks after planting (WAP). Manual weeding was done once at six weeks after planting using a hoe.

### *Data Collection*

Data were collected on plant height (PHt), leaf area (LA), stem diameter (SD), number of branches (NOB) plant<sup>-1</sup>, number of pods (NOP) plant<sup>-1</sup>, number of seeds (NOS) pod<sup>-1</sup>, pod length (PL), pod width (PW), seed weight plant<sup>-1</sup>, 100 seed weight (100-SW), seed yield (SY). All data were measured following the standard procedures used by Ihejiofor et al. (2021, 2022).

### *Statistical Analysis*

Data were tested for significance using analysis of variance (ANOVA) and significant treatment means were separated using Fisher's least significant difference (F<sub>LSD</sub>) at p<0.05. Results were presented in charts using GraphPad Prism 6.

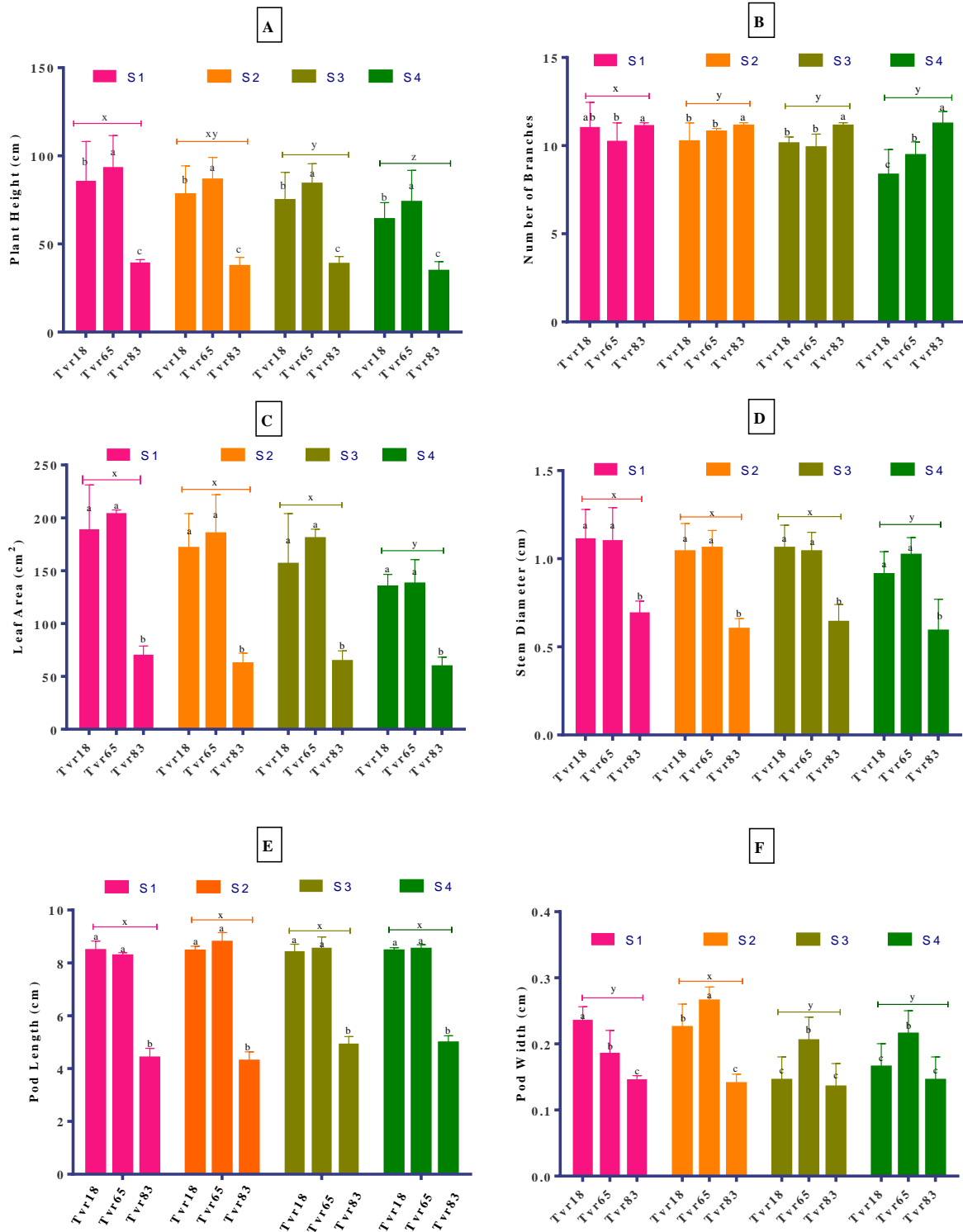
## Results

Variations in agronomic traits as influenced by genotype and plant spacing are shown in Fig 1 and 2. Plant height, LA, SD, PL, and PW were significantly higher ( $p < 0.05$ ) in Tvr65 and Tvr18 than in Tvr83, respectively (Fig 1). In contrast, Tvr83 recorded a higher mean NOB plant<sup>-1</sup> (11.25) than Tvr65 (9.95) and Tvr18 (9.75) (Fig 1B). Plant spacing S1 consistently influenced higher PHT, NOB, and LA while plant spacing S2 influenced higher pod width than S1, S3, and S4 in Fig 1. Stem diameter (Fig 1D) and PL (Fig 1E) were not significantly affected by spacing type.

Plant height ranged from 37.31 – 84.28 cm in Tvr83 to Tvr65, and 57.37 – 72.48 cm in S4 to S1 (Fig. 1A). Number of branches ranged from 9.21 – 11.54 in Tvr18 to Tvr83, and 9.11 – 11.63 in S4 to S1 (Fig. 1B). The leaf area ranged from 63.74 – 176.55 cm<sup>2</sup> in genotypes Tvr83 to Tvr65, and 110.41 – 153.77 in S4 to S1 (Fig. 1C). Stem diameter ranged from 0.63 – 1.06 cm in Tvr83 to Tvr65, and 0.84 – 0.95 cm in S4 to S1 (Fig. 1D). Pod length ranged from 4.67 – 8.52 cm in Tvr83 to Tvr18, and 7.17 – 7.2 cm in S3 to S2 (Fig. 1E). Pod width ranged from 0.11 – 0.19 cm in Tvr83 to Tvr65, and 0.14 – 0.19 cm in S3 to S2 (Fig. 1F). Pod weight plant<sup>-1</sup> ranged from 14.50 – 18.00 g in Tvr83 – Tvr65,

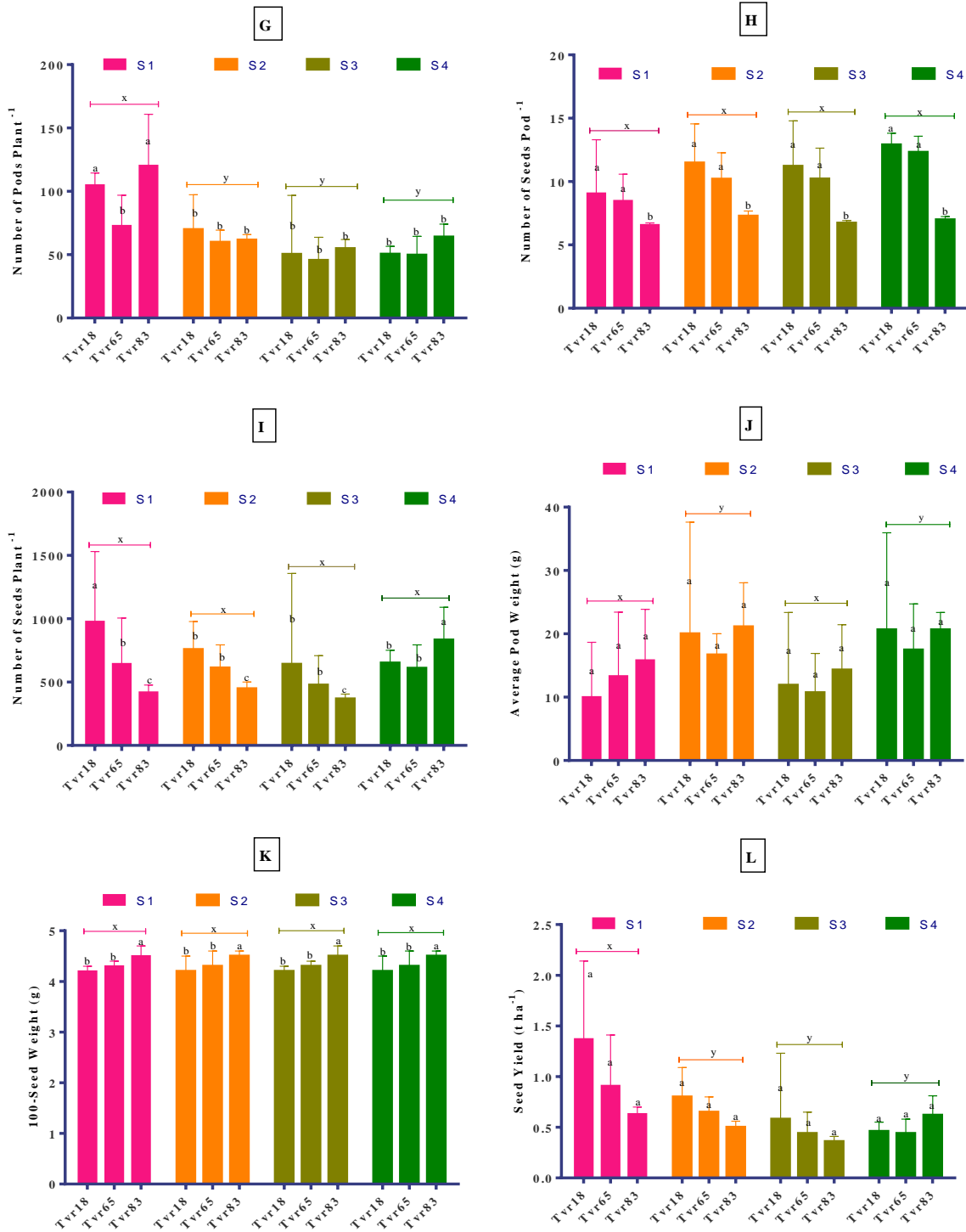
and 12.3 – 19.6 g in S3 to S4. The interaction effect of Tvr65 and S1 was superior to other combinations in PHT, LA, and SD, while the interaction of Tvr18 and S1 was higher in PL and PW. However, it was the interaction of Tvr83 and S1 that produced the highest NOB plant<sup>-1</sup>.

In Figure 2, NOP plant<sup>-1</sup> was significantly higher ( $p < 0.05$ ) in Tvr83 (75.1) compared to Tvr65 (56.9) while the spacing of S1 influenced higher ( $p < 0.05$ ) NOP plant<sup>-1</sup> than S2, S3 and S4. The combined effect of Tvr83 and S1 also showed superiority for NOP plant<sup>-1</sup> (121.50) relative to the other combinations. The genotype Tvr18 consistently gave higher ( $p < 0.05$ ) NOS pod<sup>-1</sup> across the four plant spacing types. However, NOS pod<sup>-1</sup> was not significantly affected by plant spacing as the response of the genotypes to the four spacing types was similar (Fig. 2H). Genotype Tvr18 (757.00) and spacing S4 (698.00) had the best sole performance in NOS plant<sup>-1</sup>. Significantly higher ( $p < 0.05$ ) NOS plant<sup>-1</sup> was recorded for Tvr18 across S1-S3 spacing whereas it was Tvr83 that was superior in S4. NOS plant<sup>-1</sup> was not affected by plant spacing ( $p > 0.05$ ) (Fig. 2I).



**Figure 1:** Effect of Genotype and Plant Spacing on Plant Height, Number of Branches, Leaf Area, Stem Diameter, Pod Length, and Pod Width of Mungbean. The graph shows mean values and standard

deviations. Bars with different letters are significantly different at  $p < 0.05$ . The horizontal lines above the bars compare plant spacing types. S1: 30x10; S2: 40x10; S3: 30x15; S4: 40x15.



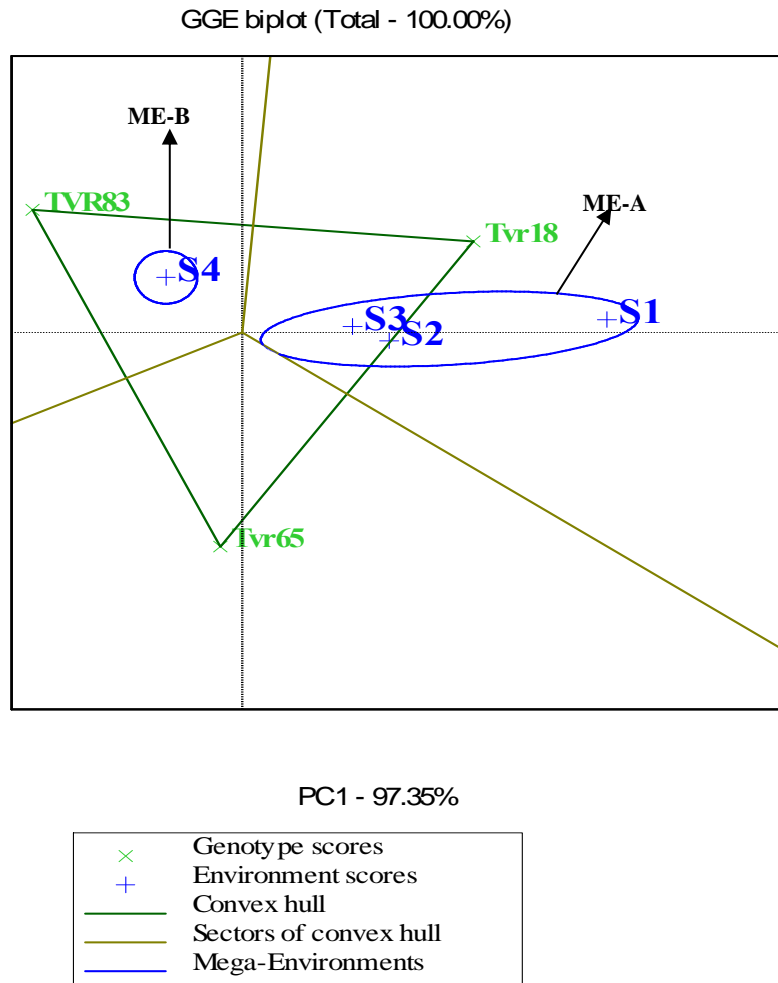
**Figure 2:** Effect of Genotype and Plant Spacing on Number of Pods, Number of Seeds, Pod Weight, 100-Seed Weight, and Seed Yield of Mungbean.

The graph shows mean values and standard deviations. Bars with different letters are significantly different at  $p < 0.05$ . The horizontal lines above the bars compare plant spacing types. S1: 30x10; S2: 40x10; S3: 30x15; S4: 40x15.

Variations in pod and seed characteristics were also observed. Pod weight  $\text{plant}^{-1}$  was not significantly influenced by genotype as all three genotypes were comparable. However, plant spacing S2 (19.60) and S4 (19.74) recorded higher pod weight  $\text{plant}^{-1}$  than S1 (13.45) and S3 (12.30) (Fig. 2J). 100-SW was significantly higher ( $p < 0.05$ ) in Tvr83 across all spacing types with a mean of 4.50 g. There was no significant difference in 100-SW ( $p > 0.05$ ) as a function of plant spacing (Fig. 2K). Seed yield

was insignificantly higher in Tvr18 and was consistent across the spacing types with a mean SY of  $0.8 \text{ t ha}^{-1}$ . Plant spacing S1 produced a higher ( $p < 0.05$ ) seed yield ( $1.0 \text{ t ha}^{-1}$ ) compared to S3 ( $0.46 \text{ t ha}^{-1}$ ) which was the least.

The GGE biplot analysis (Figure 3) grouped the spacing types into two mega environments, where S1, S2, and S3 were clustered into mega environment A (ME-A), and only S4 in mega environment B (ME-B). In addition, the biplot graph was partitioned into three convex sectors with each genotype occupying a sector. Sector A contained the genotype Tvr18 and three plant spacing types - S1, S2, and S3, sector B contained only the genotype Tvr65 while sector C contained the genotype Tvr83 and plant spacing - S4.



**Figure 3:** Which Won Were View of Treatment Interactions. S1: 30x10; S2: 40x10; S3: 30x15; S4: 40x15; ME-A: mega environment A; ME-B: mega environment B

## Discussion

Two genotypes, Tvr65 and Tvr18 showed similarity in the NOB plant<sup>-1</sup>, LA, SD, PL, NOS pod<sup>-1</sup>, pod weight, 100-SW, and SY in contrast to Tvr83. The similarity in agronomic traits recorded in Tvr65 and Tvr18 could be as a result of ancestral proximity in contrast to Tvr83 which could be a distant relative. Tvr83 recorded thinner leaves, shorter pods, shorter plants, more branches, and brighter colored seeds in contrast to Tvr65 and Tvr18 which had broader leaves, longer pods, and taller plants (Fig. 1 and 2). Genotypes from closely related parents tend to exhibit similar phenotypic traits which will differ from a distant relation. Variation in the growth and yield characteristics such as plant height, leaf area, stem diameter, NOS plant<sup>-1</sup>, pod length, and seed yield as a function of genotype has also been reported by Yimram et al. (2009) and Sultana (2014).

Plant spacing significantly influenced some growth and yield parameters like plant height, NOP plant<sup>-1</sup>, NOS plant<sup>-1</sup>, pod width, seed width, and seed yield with the plant spacing S1 and S2 producing significantly taller plants, higher NOP plant<sup>-1</sup>, higher NOS, wider pods, higher pod weight and higher seed yield. The plant spacing S1 was superior in most growth and yield traits in contrast to the plant spacing S2, S3, and S4. This agrees with Sarkar et al. (2004) and Kassaye et al. (2020) who reported higher growth and yield traits of mungbean with a plant spacing of 30x10 cm.

The clustering of Tvr18 and ME-A in sector A by the GGE biplot analysis is an indication that the genotype - Tvr18 was the best-performing genotype in seed yield across the plant spacing types – S1, S2, and S3 which constitute the ME-A, thus inferring stability within the ME-A in contrast to ME-B where it performed least. The clustering of the genotype-Tvr83 and ME-B in sector C reflects the genotype's preference for a wider spacing requirement which could be implicated in its high branching characteristics as evident in Fig. 1B. The isolation of genotype-Tvr65 in sector C suggests that it has moderate performance across the three spacing environments (Fig. 3). Genotype by environment interaction is an important component in plant breeding experiments that influences the accuracy and precision of genetic and environmental variables. The differential

responses of the mungbean genotypes to different spacing treatments suggest different preferences for spacing requirements which confirms our hypothesis. This report is in tandem with Agudamu and Tatsuhiko (2016), Nassir et al. (2021), and Goa et al. (2022)

## Conclusion

The study showed that genotype could influence the spacing requirement of a plant. In this study, we reported that the seed yield of mungbean was influenced by genotype and plant spacing. The genotype-Tvr18 was the best seed-yielding genotype across plant spacing – S1, S2, and S3 types. In contrast, Tvr83 had its highest seed yield in the S4 spacing environment which infers its preference for wider spacing. In general, S1 spacing favored higher growth and yield traits than the other treatments and was the best.

The interaction effect of Tvr18 with plant spacing S1 produced significantly higher growth and yield attributes than the other interactions.

## Recommendations

The genotype Tvr18 was the best in seed yield while S1 was the best plant spacing; Tvr18 and S1 are therefore recommended for mungbean production for higher yield in the study area. However, the genotype Tvr83 should be evaluated further with wider spacing to determine its optimal spacing requirement since pod and seed traits increased with wider spacing.

## Conflict of Interest

The authors have declared no conflict of interest.

## Acknowledgment

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## Abbreviations

DAP: days after planting; WAP: weeks after planting; NOD: number of days; NOL: number of leaves; NOB: number of branches; NOP: number of pods; NOS: number of seeds; PHT: plant height; LA: leaf area; SD: stem diameter; PL: pod length; PW: pod width; 100-SW: 100 seed weight; SY: seed yield; AVRDC: Asian Vegetable Research and Development Center; IITA: International Institute for Tropical Agriculture;

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