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# Seed Abortion and Numerical Components of Seed Yield of Soyabean (*Glycine max* L. Merr.) in Three Contrasting Agroecologies

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**ABSTRACT** Two trials were conducted to study the components of yield. In one trial three genotypes were planted in three blocks with the objective of studying the dynamics of seeds/pod during seed maturation. Pods were dissected to reveal the developing seed 20 days after flowering (DAF) and at harvesting. In another trial, 14 genotypes were planted in RCBD in three contrasting environments: Bureti, Njoro and Lare with the objective of studying the components of yield. Seeds/pod was significantly different, both at 20 DAF and at harvesting. Although there were more pods at harvesting compared to 20 DAF, 3-seeded pods was the mode 20 DAF while the mode was 1-seeded pod at harvesting which may be explained by seed abortion. Seeds/pod was significantly different at the three sites. Yield and its components were highest at Bureti compared with Lare. It is apparent that seeds per pod are influenced by seed abortion.

## INTRODUCTION

Soyabean (*Glycine max* L. Merr.) is grown in different agroecological zones in Kenya (Thagana et al. 2006). Components of yield of soyabean include pods per plant, seeds per pod and seed weight (Ruhul Amin et al. 2009). The components of yield have been reported to be influenced by solar radiation (Mathew et al. 2000), light enrichment (Bing Liu et al. 2010), water stress (Souza et al. 1997), drought stress (Kobraei et al. 2011), disease infestation (Yang et al. 1991) and micronutrients (Behrouzi et al. 2012) among other factors. Reduction of water stress by irrigation increased seed yield mediated by pods per plant, seeds per pod and seed weight (Ruhul Amin et al. 2009). Board and Tan (1995) observed abortion of initiated pods and postulated that stresses should be avoided to optimise pod number and yield. Two trials were conducted to study the components of yield. In one trial three genotypes were planted in three blocks in one environment. In another trial, 14 genotypes were planted in Randomized Complete Block Design (RCBD) in three contrasting environments.

### Objectives

The objectives of the trial were to study:

(i) The dynamics of the seeds per pod during seed maturation.
(ii) The components of yield in three environments.

## MATERIAL AND METHODS

### Site Description

Bureti is located at an altitude of 2,000 metres above sea level (masl) and experiences relatively warm temperatures. It is predominantly wet throughout the year with mean annual rainfall of 1,300mm and is ideal for soyabean production. Njoro located at a higher altitude of 2143 masl experiences cool temperatures with a mean annual temperature of 16 C, temperature range of 9-24 C. It experiences moderate annual rainfall of 943 mm. Lare located at an altitude of 2120 msl is a relatively drought prone area and receives erratic rainfall with annual mean of 700 mm. Productivity of soyabeans in this zone is variable and is highly determined by the prevailing weather conditions.

### Experimental Description and Field Management

In one experiment; varieties Nyala, Gazelle and Gazelle irradiated at 100 Gy (Gazelle mutant) were planted in three blocks measuring 6 metres wide. The spacing between rows was 50 cm and within rows was 15 cm. Each genotype was planted in 10 rows. Twenty (20) days after flowering ten plants were harvested at random

from each block. Pods were removed and dissected in order to reveal the developing seeds. The number of developing seeds per pod was recorded. Plants were also harvested at maturity and seeds per pod recorded.

In another experiment 14 soyabean genotypes were planted in four replicates at three sites namely Njoro, Lare, and Bureti. Variety EAI 3600, Nyala and Gazelle were used as checks. Bureti is a high potential environment, Njoro-a medium potential environment and Lare-a low yielding drought prone environment. The plot size was 5 m x 2 m. The trial was managed using recommended agronomic package.

**Data Analysis**

Data was recorded on pods per plant, seeds per pod, seed yield per plant, seed yield per plot and 100-seed weight and statistically; Chi-square and ANOVA were performed using SAS version 8.1. Further analyses were done using Duncan's multiple range test (DMRT) at $P<0.05$

## RESULTS AND DISCUSSION

Chi-square revealed that seeds per pod at 20 days after flowering (DAF) were significantly different ($P<0.01$) from seeds per pod at harvesting (harvest maturity) for the 3 genotypes combined (Table 1). At twenty (20) DAF, seeds per pod ranged from 1 to 4 but at harvesting they ranged from 0 to 4. Although all pods contained developing seeds at 20 DAF, about 7 % of the pods were empty and did not contain any seeds at harvest maturity. Furthermore at twenty (20) DAF most of the pods had 3 seeds (500), but at harvesting the majority of the pods had 1 seed (600). For the 3 genotypes, 20 DAF some pods had 4 developing seeds but at harvesting there were no 4-seeded pods; which implies that at 20 DAF all seeds were developing but later they stopped developing (aborted) therefore the modal class for seeds per pod dropped from 3-seeded pods to 1-seeded pods and at harvesting there was no 4-seeded pods. It was also observed that 20 DAF 3-seeded pods and 4-seeded pods were more than the mean of the two treatments whereas 1-seeded and 2-seeded pods were more than the mean at harvesting. The total number of pods was more at harvesting compared to 20 DAF because the plants were yet to complete flowering. Similarly, Chi-square revealed that seeds per pod 20 DAF were significantly different ($P<0.01$) from seeds per pod at harvesting for Gazelle (Table 2), Nyala (Table 3) and Gazelle mutant (Table 4) when the genotypes were analysed individually. Three-seeded pods were the modal class 20 DAF when the three genotype were analysed individually whereas the modal class was 1-seeded pods at harvesting.

Seeds per pod were highly significant ($P<0.01$) for the three sites and ranged from 0 seeds per pod to 4 seeds per pod (Table 5). Plants at Bureti had the highest number of pods (6,828), whereas Lare (5,436) had the lowest number of pods. Most of the plants at Bureti and Njoro produced 2-seeded pods whereas at Lare a majority of the plants produced 1-seeded pods. At Bureti, 2-seeded pods, 3-seeded pods and 4-seeded pods were more than the mean of the three sites whereas at Njoro, 4-seeded pods were less than the mean of the three sites but 2-seeeded and 3-seeded pods were more. At Lare, only 1–seeded pods were more than the mean of the three sites. Chi-square test revealed that

**Table 1: Frequency of pod categories at 20 DAF and at harvest maturity for genotypes Nyala, Gazelle and Gazelle mutant**

| *Treatment* | *0-seeded pod* | *1-seeded pod* | *2-seeded pod* | *3-seeded pod* | *4-seeded pod* | *Total* |
|---|---|---|---|---|---|---|
| 20 DAF | 0 | 17 | 196 | 500 | 4 | 717 |
| At harvest maturity | 125 | 611 | 292 | 43 | 0 | 1,071 |
| | 125 | 628 | 488 | 543 | 4 | 1,788 |

$\chi^2 = 1{,}066.047 (P<0.01)$

**Table 2: Frequency of pod categories at 20 DAF and at harvest maturity for variety Gazelle**

| *Treatment* | *0-seeded pod* | *1-seeded pod* | *2-seeded pod* | *3-seeded pod* | *4-seeded pod* | *Total* |
|---|---|---|---|---|---|---|
| 20 DAF | 0 | 3 | 36 | 118 | 1 | 158 |
| At harvest maturity | 20 | 124 | 66 | 10 | 0 | 216 |
| | 20 | 123 | 102 | 128 | 1 | 374 |

$\chi^2 = 228.748 (P<0.01)$

**Table 3: Frequency of pod categories at 20 DAF and at harvest maturity for variety Nyala**

| *Treatment* | *0-seeded pod* | *1-seeded pod* | *2-seeded pod* | *3-seeded pod* | *4-seeded pod* | *Total* |
|---|---|---|---|---|---|---|
| 20 DAF | 0 | 4 | 93 | 173 | 3 | 273 |
| At harvest maturity | 37 | 161 | 104 | 17 | 0 | 319 |
| | 37 | 165 | 197 | 190 | 3 | 592 |

$\chi^2 = 316.422$ ($P<0.01$)

**Table 4: Frequency of pod categories at 20 DAF and at harvest maturity for genotype Gazelle mutant**

| *Treatment* | *0-seeded pod* | *1-seeded pod* | *2-seeded pod* | *3-seeded pod* | *4-seeded pod* | *Total* |
|---|---|---|---|---|---|---|
| 20 DAF | 0 | 10 | 67 | 209 | 0 | 286 |
| At harvest maturity | 68 | 330 | 122 | 16 | 0 | 536 |
| | 68 | 340 | 189 | 225 | 0 | 822 |

$\chi^2 =$ ($P<0.01$)

the total number of seeds from different pod categories were highly significant ($P<0.01$) (Table 6). Two-seeded pods contributed the highest number of seeds to the sum total of seeds for all sites and plants at Bureti produced more seeds because of the relatively high frequency of higher-order seeded pods (2-seeded pods, 3-seeded pods, 4-seeded pods). ANOVA revealed that seeds per pod, pods per plant, seeds per plant and seed yield per plant were significant ($P<0.05$) for the three sites (Table 7). Seeds per pod was highest at Bureti (1.89), Njoro (1.81), and lowest at Lare (1.61). Seeds per pod values are comparable to those reported elsewhere (Ruhul Amin et al. 2009). All the three sites were significantly ($P<0.05$) different using Duncan's multiple range test (DMRT). Pods per plant were highest at Bureti (49), Njoro (47) and lowest at Lare (39). Site effects varied and Bureti was significantly ($P<0.05$) different from Lare but the effect was not ($P<0.05$) significantly different from Njoro. Seeds per plant were highest at Bureti (93), Njoro (86) and Lowest at Lare (65). Again, site effect showed differences, with Bureti being significantly ($P<0.05$) different from Lare but not ($P<0.05$) significantly different from Njoro. Combined analyses for seed yield per plant for the 3 sites revealed that sites and varieties were highly significant ($P<0.05$). However, the variety and site interaction were not significant ($P<0.05$). Seed yield per plant at the Bureti site (10.4 g) was significantly different from Lare (4.9 g) but was not significantly different from Njoro (7.8 g). ANOVA also revealed that seeds per pod, pods per plant, seeds per plant and seed yield per plant were significant ($P<0.05$) for the varieties (Table 8). Seeds per pod were highest (2.18) for variety EAI 3600 and lowest (1.44) for entry 910/5/24. There was variability in the pods per plant, which ranged from 62 for variety 952/5/26 to 34 for variety Nyala. There was variability in the seeds per plant, which ranged from 122 for variety 952/5/26 to 59 for variety 910/5/22. Genotype 952/5/26, which had the highest seeds per plant, was significantly ($P<0.05$) different from all the check varieties. Seed yield per plant was significantly different ($P<0.05$) and ranged from 11 grams for genotype 931/5/38 to 4.9 grams for genotype 910/5/24. Genotypes were highly significantly different ($P<0.01$) for 100-seed weight. Hundred seed weight for seeds derived from 1-seeded pods, 2-seeded pods and 3-seeded pods were not significantly different ($P<0.05$) but hundred seed weight for seeds derived from different varieties were significantly different ($P<0.05$). Significant correlation between seed yield and seed weight has been reported in soyabean (Ziska et al. 2001). Varieties differed in seed yield per hectare which ranged from (398) for variety EAI 3600 to (1,834) for variety 931/5/38. Components of yield such as seeds per pod, pods per plant, seeds per plant were high at the most favourable soybean site (Bureti) and were lowest at the least favourable soyabean site Lare. Those components of yield contributed to the relatively high yield per plant observed at Bureti compared to Njoro and Lare. Xiaobing et al. (2005) observed that pod number and seed number were high in high yielding varieties. Similarly, Ruhul Amin et al. (2009) associated high yield performance with seeds per pod. Seeds per pod may be easily scored in the field in order to evaluate the agronomic performance of a variety in a particular site (or season). Seeds per pod are also indicative of the

**Table 5: Frequency of pod categories at Bureti, Njoro and Lare at harvesting**

| *Site* | *0-seeded pod* | *1-seeded pod* | *2-seeded pod* | *3-seeded pod* | *4-seeded pod* | *Total* |
|---|---|---|---|---|---|---|
| Bureti | 365 | 1,779 | 2,892 | 1,731 | 61 | 6,828 |
| Njoro | 423 | 1,902 | 2,779 | 1,496 | 32 | 6,632 |
| Lare | 130 | 2,362 | 2,128 | 807 | 9 | 5,436 |
| | 918 | 6,043 | 7,799 | 4,034 | 102 | 18,896 |

$\chi^2 = 626.516$ ($P<0.01$)

**Table 6: Total number of seeds derived from different pod categories for 14 entries at Bureti, Njoro and Lare**

| | *1-seeded pod* | *2-seeded pod* | *3-seeded pod* | *4-seeded pod* | *Total* |
|---|---|---|---|---|---|
| Bureti | 1,779 | 5,784 | 5,193 | 244 | 13,000 |
| Njoro | 1,902 | 5,558 | 4,488 | 128 | 12,076 |
| Lare | 2,362 | 4,256 | 2,421 | 36 | 9,075 |
| | 6,043 | 15,598 | 12,102 | 408 | 34,151 |

$\chi^2 = 889.433$ ($P<0.01$)

relative occurrence of abortion at a particular site (or season). Since there was variability among the varieties for seeds per pod, it may be an important criterion for the development of superior soyabean varieties. Of the fourteen genotypes tested in the three agroecologies, genotype 931/5/34, which had the second highest seed yield per plant (9.6 g) and seeds per pod (2.02) across the three environments was released for commercial production in the year 2010.

**Table 7: Yield component characteristics of soyabean plants at Bureti, Njoro and Lare**

| *Site* | *Seeds per pod* | *Pods per plant* | *Seeds per plant* | *Seed yield (g) per plant* |
|---|---|---|---|---|
| Bureti | 1.89 A | 49 A | 93 A | 10.4 A |
| Njoro | 1.81 B | 47 A | 86 A | 7.8 AB |
| Lare | 1.61 C | 39 AB | 65 AB | 4.9 B |

Means followed by same letter (s) are not significantly different $P<0.05$ using Duncan's multiple range test (DMRT)

## CONCLUSION

Occurrence of abortion was observed among soyabean genotypes. Seeds per pod are an important criterion for increasing soyabean productivity and selection of superior varieties.

## RECOMMENDATIONS

Based on the results from the three agroecologies there is need to study the environmental factors that influence abortion rates and seeds per pod in order to increase soyabean productivity.

**Table 8: Characteristics of entries planted at the three sites**

| *Variety* | *Seeds per pod* | *Pods per plant* | *Seeds per plant* | *Seed yield (g) per plant* |
|---|---|---|---|---|
| 931/5/38 | 1.93 B | 45 DC | 90 CD | 11.0 A |
| 931/5/34 | 2.02 B | 47 BC | 99 BC | 9.6 AB |
| EAI 3600 | 2.18 A | 39 DC | 85 BECD | 9.5 AB |
| 917/5/16 | 1.71 CD | 48 BC | 82 FBECD | 8.1 BC |
| 952/5/26 | 1.94 B | 62 A | 122 A | 7.8 BCD |
| 932/8/38 | 1.81 C | 58 AB | 103 BA | 7.7 BCD |
| 925/5/21 | 1.74 CD | 40 DC | 70 FGED | 7.0 BCD |
| 916/5/19 | 1.72 CD | 45 DC | 79 FGECD | 6.7 CD |
| Nyala | 1.74 CD | 34 D | 62 FG | 6.6 CD |
| 932/5/11 | 1.71 CD | 45 DC | 78 FGECD | 6.6 CD |
| Gazelle | 1.67 D | 41 DC | 70 FGECD | 6.4 CD |
| 914/5/39 | 1.71 CD | 43 DC | 74 FGED | 6.4 CD |
| 910/5/22 | 1.47 E | 40 DC | 59 G | 5.3 CD |
| 910/5/24 | 1.44 E | 44 DC | 66 FGE | 4.9 D |

Means followed by same letter (s) are not significantly different $P<0.05$ using Duncan's multiple range test (DMRT)

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