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Responses of Seed Weight and Planting Location on the Growth and Yield of Soybean

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Abstract

Soybean (*Glycine max* (L.) is highly valuable as food crop and an industrial crop which has necessitated higher demand than supply. However, its production is constrained by abiotic and biotic factors. The planting seed is an important biotic factor affecting soybean productivity as it directly affects the vigor. Thus, this study assessed the productivity of soybean plants planted with different seed weights. Soybean seeds were sown in two (2) locations of Delta State (Asaba and Ozoro), and the soybeans were measured using weighing balance calibrated in grammes into seed weight categories as (T1: 0.120-0.129 g, T2: 0.130-0.139 g, T3: 0.140-0.149 g, T4: 0.150-0.159 g, T5: 0.160-0.169 g). The experiment was a 2 (location) by 5 (seed weight) factorial arranged in a randomized complete block design (RCBD) and replicated three times. Data were collected on the agronomic and number of pods produced. Data collected were analysed using analysis of variance and means were separated using least significant differences. At 12 weeks after planting, the plant height and number of leaves produced differed significantly and ranged from 28.29±0.77 (Asaba) to 32.36±0.77 (Ozoro), 23.26±2.07 (Asaba) to 40.55±2.07 (Ozoro), respectively between locations, while the plant height, number of leaves and number of pods produced ranged from 26.17±1.21 (T1) to 30.43±1.21 (T5), 21.60±3.28 (T1) to 39.50±3.28 (T2), and 9.14±2.45 (T1) to 23.97±2.45 (T5) amongst the treatments. Planting soybean plants with a seed weight range of 0.160 – 0.169 ensures higher plant establishment and productivity relative to lighter seed weights.

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Keywords: Seed weight, Soybean, Farm management, Productivity, Location, Caliberation

Introduction

Soybean (*Glycine max* (L.) is an annual, angiosperm (flowering plant) (Sedibe *et al.*, 2023) [20] grown in tropical, subtropical and temperate climates (Saryoko *et al.*, 2017) [19]. It is a dicotyledonous, short-day plant, normally bushy, erect and grown by seed (Department of Agriculture, Forestry and Fisheries, 2010). It is the second most planted crop after corn worldwide (De Maria *et al.*, 2020) [4] and is believed to occupy a crucial space in solving the problem of poverty and food security in sub-saharan Africa given the status of the crop as a multi-purpose crop (Opeyemi *et al.*, 2023). The crop is among the major industrial and food crops, grown in every continent and can be successfully grown in many states in Nigeria at a variety of planting dates if moisture is available and its cultivation has expanded as a result of its nutritive economic importance and diverse domestic uses (Omoigui *et al.*, 2020) [14]. It constitutes a vital source of vitamins and bioactive compounds such as isoflavones, saponins and phytic acids (Dukariya *et al.*, 2020) [6]. The crop is also known to provide health benefit of relieving sleep disorders as a result of its high content of magnesium, improving, blood circulation due to its content of copper and iron, maintaining pregnancy in women as it is rich in folic acid and vitamin B complex as well as promoting healthy bones as a result of its impressive levels of zinc, selenium, copper, magnesium and calcium (Dickson *et al.*, 2019) [5]. It has therefore come to be recognized as the 7th largest nutrient in medical and nutrient cycles and as an important component in preventing “rich diseases” such as hypertension, coronary heart diseases, and obesity. Despite the economic importance of this crop, its production is constrained by factors like pests and diseases, low germinability, plant vigor which translates into poor yield.

The poor health of some plants is worsened or predisposed by the pest attack and lack of access to sunlight for photosynthetic activities. Good quality seeds ensure good germination, rapid emergence and vigorous growth, while poor quality seeds enhance "skips", excessive thinning and yield reduction which diminish profitability (Hansanuzzama, 2015). In that regard, utilization of good quality seed can guarantee desired plant population, capacity to withstand adverse condition, vigorous and fast growth with the ability to resist pest and disease incidence to a large extent, uniform growth and maturity as well as the development of an efficient root system to absorb nutrients to result in higher yield.

Seed size in terms of seed weight is expected to have significant effect on crop performance. Big seeds contain a higher amount of energy, grow faster, and form bigger and longer root systems promoting early growth (Prado *et al*, 2021) [16]. Different criteria have criteria have been used in classifying seed weight. Khan, and Shankar (2001) classified seeds into small (<5g), intermediate (5-8g) and heavy (>8g). Erdal *et al.,* (2017) [7] classified weed seeds into three categories based on 100 seed weight as 3.35g, 4.05g and 4.98g 100 seeds and for beans, they grouped into four categories as 30.01, 45.18, 54.01 and 58.60g 100 seeds. Coelho *et al*. (2019) [3] classified soyabean seeds into four non-overlapping classes containing seed weights, 0.009-0.015, 0.016-0.020, 0.021-0.025 and 0.026 to 0.030 respectively. In consideration with the above classification, this study thus assessed the performances of different seed weights of soybean in two locations of Delta State, Nigeria, in order to select the best performing class for improved production of soybean.

Materials and Methods

- **Experimental site:** The experiment was conducted in two locations; 1. Teaching and Research Farm of the Department of Crop science of the Faculty of Agriculture in the Dennis Osadebay University, Asaba, located at Latitude 05° 32'N to 06° 10'N and Longitude 06° 49'E to 13° 12'E. 2. Teaching and Research Farm of Department of crop science, Faculty of Agriculture, Delta state university of science and technology, Ozoro, located at latitude 06° 15'N and longitude 07°10'E.
- **Experimental site:** The experiment was conducted in two locations; 1. Teaching and Research Farm of the Department of Crop science of the Faculty of Agriculture in the Dennis Osadebay University, Asaba, located at Latitude 05° 32'N to 06° 10'N and Longitude 06° 49'E to 13° 12'E. 2. Teaching and Research Farm of Department of crop science, Faculty of Agriculture, Delta state university of science and technology, Ozoro, located at latitude 06° 15'N and longitude 07°10'E.
- **Land preparation and tillage**: The land was cleared of all vegetation and debris, packed and burnt. The land was subsequently tilled to a depth of 10 cm using hoe.
- **Selection and grading of seeds by weight**: The seed weight was obtained by weighing the seed on a sensitive weighing balance calibrated in grammes. The categorized seed weight forms part of the treatment (T1: 0.120-0.129g, T2: 0.130-0.139g, T3: 0.140-0.149g, T4: 0.150-0.159, T6: 0.160-0.169g).
- **Sowing:** The soybean seeds were sown in plots at a rate of one seed per hole at a depth of 2cm by dibble method using a recommended standard spacing of 10 x 75 cm.
- **Plot layout:** Each plot measured 3m x 3m and contained one hundred and fifty seedlings. Each plot was separated from another by 0.5m pathway, while the replicates were separated by lm pathway to allow for proper management.
- **Weeding:** Weeding was done manually using hand held hoe at 3, 6, and 9 weeks after planting.
- **Experimental design**: The experiment was laid in a 2 (location) by 5 (seed weights) factorial arranged in a randomized complete block design and replicated three times.
- **Sampling of experimental units:** Within each plot, five soybean seedlings were selected from the net plot and tagged for sampling. From these units appropriate data specified were collected over defined periods.
- **Data collection and statistical analysis**: Data were collected on the plant emergence, plant height, number of leaves, leaf area, number of branches, internode length at 2, 4, 6, 8, 10, and 12 weeks after planting, while the number of pods produced were recorded at 8, 10 and 12 weeks after planting. Data collected were subjected analysis of variance, and differences in treatment means were separated using the least significant differences at 5% level of significance.

Results

Results obtained on the emergence of planted soybean seeds showed that the effect of location and the interaction between location and seed weights was not statistically significant (Table 1). However, the seedling emergence in T3 (55.61±1.83) was significantly higher than T1 (46.67±1.83) and T5 (48.78±1.83).

Table 2 showed that the plant height increased gradually from 2 WAS to 12 WAS across the locations and seed weight treatments. At 12 WAS the plants grown in Ozoro (32.36±0.77) was significantly taller than Asaba (28.29±0.77). Also at the 12WAS, T5 (30.43±1.21) was significantly taller than T1 (26.17±1.21).

Table 3 showed that the number of leaves produced increased gradually from 2 WAS to 12 WAS across the locations and seed weight treatments. At 12 WAS the plants grown in Ozoro (40.55±2.07) was significantly taller than Asaba (23.26±20.7). Also at the 12WAS, leaf production in T2 (39.50±3.28) was significantly higher than T4 (28.30±3.28) and T1 (21.60±3.28).

Table 4 showed that the plants leaf area increased gradually from 2 WAS to 12 WAS across the locations and seed weight treatments. At 12 WAS the plants grown in Asaba (25.98±0.81) cm^2 was significantly larger than Ozoro (15.50±0.81). Also at the 12WAS, the largest leaf area was observed in T5 (22.25±1.28) which was only significantly larger than T1 (16.31±1.28).

Table 5 showed that the number of branches increased gradually from 2 WAS to 12 WAS across the locations and seed weight treatments. At 12 WAS the number of branches in Asaba (11.83±0.70) was significantly higher than Ozoro (6.36±0.770. However, the seed weights and location by seed weights were not significant.

Table 6 showed that the internode lengths increased gradually from 2 WAS to 12 WAS across the locations and seed weight treatments. At 10 WAS the internode length of plants grown in Ozoro (20.05±0.82) was significantly taller than Asaba

(17.63±0.82). However, at 12WAS, T5 (23.62±1.53) was statistically similar to the rest treatments except T1 (16.91±1.53).
Table 7 showed that the number of pod production increased gradually from 8 WAS to 12 WAS across the locations and seed weight treatments. At 12 WAS the number of pods produced by plants grown in T5 (23.97±2.45) was significantly higher than T1 (9.14±2.45).

Table 1: Effect of seed weight and planting locations on the emergence of soybean seeds

Location	Emergency
Asaba	50.51a
Ozoro	51.31a
LSD(0.05)	3.41
SE	1.16
Treatments*Location	51.58ns
Treatments	
T1	46.67c
T2	52.83ab
T3	55.61a
T4	50.67abc
T5	48.78bc
LSD(0.05)	5.39
SE	1.83

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. T1: 0.120-0.129g, T2: 0.130-0.139g, T3: 0.140-0.149g, T4: 0.150-0.159, T6: 0.160-0.169g.

Table 2: Effect of seed weight and planting locations on the height of soybean plants

Location	**PH2**	**PH4**	**PH6**	**PH8**	**PH10**	**PH12**
Asaba	8.67b	14.37b	18.24b	22.04b	23.69b	28.29b
Ozoro	11.77a	18.76a	25.84a	31.85a	31.46a	32.36a
LSD(0.05)	1.58	1.2	2.9	2.57	2.87	2.26
SE	0.54	0.41	0.98	0.87	0.97	0.77
Trt*Loc	2.73ns	2.80ns	9.54ns	23.60ns	16.99ns	27.45ns
Treatments						
T1	9.98a	15.47c	20.37a	24.92a	26.12a	26.17b
T2	11.01a	17.60ab	23.15a	28.25a	29.03a	29.47ab
T3	9.92a	16.08bc	23.20a	27.30a	26.50a	27.40ab
T4	9.94a	15.38c	21.45a	25.87a	27.13a	28.17ab
T5	10.25a	18.31a	22.03a	28.50a	29.10a	30.43a
LSD(0.05)	2.5	1.89	4.59	4.07	4.55	3.57
SE	0.85	0.64	1.55	1.38	1.54	1.21

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. Trt*Loc: Interaction between treatments and location

Table 3: Effect of seed weight and planting locations on the number of leaves produced by soybean plant**s**

Location	**NOL2**	**NOL4**	**NOL6**	**NOL8**	**NOL10**	**NOL12**
Asaba	3.51b	7.15b	13.00b	18.83b	21.44b	23.26b
Ozoro	7.93a	13.87a	23.65a	44.80a	48.95a	40.55a
LSD(0.05)	0.8	1.56	3.8	6.88	6.96	6.12
SE	0.27	0.53	1.29	2.33	2.36	2.07
Trt*Loc	0.84ns	8.68ns	68.72ns	283.62ns	458.50ns	352.20ns
Treatments						
T1	5.90a	8.82b	15.80a	22.20b	23.53c	21.60c
T2	6.07a	11.19ab	19.83a	36.47a	43.70a	39.50a
T3	5.33a	10.50ab	18.07a	31.77ab	34.13abc	31.30ab
T4	5.33a	10.40ab	16.63a	30.30ab	32.00bc	28.30bc
T5	5.97a	11.53a	21.30a	38.33a	42.60ab	38.87a
LSD(0.05)	1.26	2.47	6.01	10.87	11	9.68
SE	0.43	0.84	2.04	3.69	3.73	3.28

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. Trt*Loc: Interaction between treatments and location

Table 4: Effect of seed weight and planting locations on the leaf area of soybean plants

Location	LA2	LA4	LA6	LA8	LA10	LA12
Asaba	4.76a	10.96a	14.09a	18.07a	22.10a	25.98a
Ozoro	4.91a	11.16a	13.94a	15.98a	15.30b	15.50b
LSD(0.05)	0.76	1.34	2.05	2.69	2.29	2.39
SE	0.26	0.45	0.69	0.91	0.77	0.81
Trt*Loc	0.04ns	6.17ns	15.13ns	20.47ns	22.21ns	25.32ns
Treatments						
T1	4.38a	9.10b	11.27b	14.91a	15.53b	16.31b
T2	5.18a	12.02a	15.80a	17.97a	20.19a	21.97a
T3	4.56a	11.63a	14.40ab	16.21a	19.41a	21.77a
T4	4.80a	11.34a	14.01ab	18.65a	19.11ab	21.40a
T5	5.40a	11.23a	14.61a	17.39a	19.27a	22.25a
LSD(0.05)	1.2	2.11	3.25	4.25	3.61	3.78
SE	0.41	0.72	1.1	1.44	1.23	1.28

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. Trt*Loc: Interaction between treatments and location

Table 5: Effect of seed weight and planting locations on the number of branches of soybean plants

Location	NOB2	NOB4	NOB6	NOB8	NOB10	NOB12
Asaba	1.00a	2.00a	4.64a	6.72a	9.63a	11.83a
Ozoro	1.00a	1.00b	3.45b	6.88a	6.57b	6.36b
LSD(0.05)	0	0	0.87	0.99	1.31	2.05
SE	0	0	0.29	0.34	0.44	0.7
Trt*Loc	0.00ns	0.00ns	1.79ns	4.40ns	7.27ns	8.04ns
Treatments						
T1	1.00a	1.50a	4.13a	5.87a	7.04b	8.01a
T2	1.00a	1.50a	4.13a	6.53a	9.60a	8.99a
T3	1.00a	1.50a	4.13a	6.33a	7.82ab	9.85a
T4	1.00a	1.50a	3.80a	6.40a	8.15ab	9.12a
T5	1.00a	1.50a	4.02a	6.37a	7.89ab	9.49a
LSD(0.05)	0	0	1.37	1.58	2.07	3.24
SE	0	0	0.46	0.54	0.7	1.09

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. Trt*Loc: Interaction between treatments and location

Table 6: Effect of seed weight and planting locations on the internode length of soybean plants

Location	IL2	IL4	IL6	IL8	IL10	IL12
Asaba	4.36b	9.56b	11.62b	14.92b	17.63b	20.11a
Ozoro	6.06a	10.81a	16.07a	22.32a	22.05a	20.43a
LSD(0.05)	1.14	1.04	2.22	2.06	2.42	2.85
SE	0.39	0.35	0.75	0.7	0.82	0.97
Trt*Loc	3.10ns	0.93ns	12.99ns	11.46ns	15.83ns	21.42ns
Treatments						
T1	4.83a	8.00b	10.92b	15.42b	16.39b	16.91b
T2	5.63a	10.99a	15.20a	20.10a	21.07a	22.18a
T3	5.94a	10.39a	13.12ab	18.64ab	19.54ab	19.13ab
T4	4.38a	10.12a	13.76ab	17.99ab	19.46ab	20.52a
T5	5.28a	11.44a	16.22a	20.95a	22.74a	23.62a
LSD(0.05)	1.79	1.64	3.5	3.27	3.83	4.51
SE	0.61	0.56	1.19	1.11	1.3	1.53

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. Trt*Loc: Interaction between treatments and location

Table 7: Effect of seed weight and planting locations on the number of branches of soybean plants

Location	NoPod8	NoPod10	NoPod12
Asaba	4.94a	13.70a	16.27a
Ozoro	5.16a	14.05a	16.45a
LSD(0.05)	0.81	4.36	4.57
SE	0.28	1.48	1.55
Trt*Loc	0.41ns	24.38ns	101.63ns
Treatments			
T1	2.35d	7.57b	9.14c
T2	4.33c	13.13ab	18.74ab
T3	4.88bc	14.77a	14.92bc
T4	5.66b	14.55a	15.03bc
T5	8.06a	19.35a	23.97a
LSD(0.05)	1.29	6.89	7.22
SE	0.44	2.34	2.45

Means with the same alphabet down the groups are not significantly different from each other at 5% level of significance. LSD: Least significant differences. SE: Standard error. Trt*Loc: Interaction between treatments and location.

Discussion

Soybean as an important food and industrial crop is gaining wide cultivation due to its varieties of uses (Gai *et al*., 2025) [8]. This necessitates increased production to meet industrial and direct consumption needs (Obidiebube *et al*., 2013) [13]. With the advances made in promoting soybean, and the primary means of propagation being the seed, there are deliberate attempts in selecting quality seeds for soybean production (Santos *et al*., 2018) [18]. This is important as the soybean seed size is an important indicator in the assessment of a quality seed which translates to an improved yield (Ambika *et al*., 2014; Yang *et al*., 2023) [1, 23]. Also, soybean production is influenced to a high degree by several environmental factors, siting the location for its cultivation and management becomes critical (Bianchi *et al*., 2022) [2].

In response to the above climatic and biotic factors militating the cultivation of soybean in Delta State, Nigeria, it is important to consider a healthy seed in planting any crop of choice, and this study revealed that the heavy seeds emerged better than the lighter ones and even developed physiologically better than the lighter ones with better yield. Several authors have supported the idea that bigger seeds of soybean plants are healthier and invariably gives higher yield (Wang *et al*., 2025) [22].

One of the pre-requisite to establishing a healthy plant is the use of a healthy seed during the planting stage. This is the reason much effort is devoted into the development of a quality seed by plant breeders over the years that can withstand both biotic and abiotic stresses (Swarup *et al*., 2021) [21]. Although, the size of the seed might not necessarily be a direct indicator of a healthy seed, it can serve as a physical evaluation in assessing a healthy seed due to the weight of the embryos (Santos *et al*., 2018) [18]. Contrary to the wide held view of selecting heavier weighing seeds for planting, the findings of this research showed that lesser weight range of 0.140 to 0.149 g gave the optimum seedling emergence relative to higher seed weights.

This finding contradicts the findings of Bianchi *et al*. (2022) [2] who reported that bigger seed sizes used in planting gave higher seedling emergence. However, their criteria for measuring the seed sizes was based on the use of sieve sizes ranging from 5.5 mm to 6.5 mm which is denominated in size instead of weight. Wang *et al*. (2025) [22] had also stated that the use of bigger seeds in planting soybean leads to a higher plant germination rate and vigor of the plant, and that the optimum seed sizes for planting soybean should be from medium to large seeds. Hence, it could be that the seed size range regarded as the smallest in this study could be in the range of medium in the above described study by Wang *et al*. (2025) [22] because there is a positive correlation between seed sizes and seed weight (Liu *et al*., 2020; Hu *et al*., 2023) [12].

There was a steady increase in all the growth / agronomic parameters of the soybean plants from 2 WAS to 12 WAS with a better growth rate observed in the plant stands emanating from the 0.140 to 0.149 seed weight range which also had the better emergence rate relative to other lesser planting seed weights. This showed that the improved emergence was an indicator of a better planting seed as it was reflected in the growth rate of the plants. This supports the findings of several authors who stated that the bigger the seed sizes, the better the growth and yield parameters obtained as bigger seed sizes has better plant vigor than the smaller seed sizes used in planting (Ambika *et al*., 2014; Yang *et al*., 2023; Wang *et al*., 2025) [1, 23, 22]. It has also been established that the seed quality of soybean has a direct and positive correlation with the planting seed size, as the bigger seed sizes has more protein and carbohydrate deposit that gives the seedling emerged from it more vigor than the less weighted seeds (Yang *et al*., 2023) [23].

In this study, the variation in the agronomic and yield performances of the soybean plants in Ozoro and Asaba showed that Ozoro is considered the most favourable climatic condition for soybean production. This variation could be attributed to the slight climatic condition differences between the two locations in Delta State (Samuel *et al*., 2022) [17].

Conclussion

Soybean cultivation has gained wide spread attention due to its economic importance derived from the direct consumption and the industrial utilization of its proceeds and bye-products. However, despite the cultivation expansion, various biotic (grain sizes and quality seeds for planting, and weed competition) and abiotic factors (micro and macro climatic conditions) militate against the full utilization of the crops proceeds. However, environmental location played an important role in the performances of the soybean plants. This shows that despite planting in both locations based in Delta State, Nigeria, microclimate played a major role in determining the growth and yield of the soybean plant, with Ozoro enhancing the growth and yield of the soybean plants relative to Asaba.

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