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QUALITY OF SEED LOTS OF SOYBEAN [*Glycine max* (L.) MERRILL] GENOTYPES PRODUCED IN A GUINEA SAVANNA AGROECOLOGY OF GHANA

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ABSTRACT

Crop yield is a derivative of the number of plants harvested. In Ghana, soybean fields are mostly sparsely populated with less than the optimum number of plants, a phenomenon that contributes to poor yields of only 46% of the crop's potential in farmers' fields. The low plant population could be the result of the poor quality of the seed planted. Meanwhile, the quality of seed is determined by crop production practices, the environmental conditions of the mother plant, and postharvest handling technologies used. Over 90% of the country's soybean seed comes from the northern part of Ghana, predominantly the Guinea Savannah. In this study, seed lots of soybean genotypes produced within the Savanna Agroecological Zone of Ghana, were evaluated for physical and physiological traits, and the prevalence of seed borne fungi. Results showed that seed lots produced within the zone and stored under ambient conditions have medium-sized (100 to 140 g/1000 seeds) seeds with an average seed weight of 133 g/1000 seeds. The seed lots evaluated had physical purity values higher than the minimum certification standard of 98% for soybean seed in Ghana. Wrinkled seeds were the most dominant component of the seed with visual defects followed closely by seeds that were discoloured, cracked, and those with purple stains. *Aspergillus flavus*, *Aspergillus niger*, *Chaetomium globosum*, *Rhizopus sp* and *Macrophomina phaseolina* were the main fungi identified. Furthermore, the seed lots had an average germination percentage of 86%, which is within the acceptable minimum certification standards for soybean seed in Ghana. Though germination and vigour were variable among the seed lots tested, these parameters were not affected by the presence of the fungi species identified and the amount of seed with visual defects. The findings of this study strongly suggest that the low plant density and the resultant poor yields of soybean usually recorded in farmers' fields in Ghana are likely due to suboptimal seeding rates at planting coupled with the low use of good agronomic practices with only a small fraction attributable to poor seed quality.

Key words: Soybean, Ghana, fungi, savanna agroecology, viability, vigour, shrivelled seeds, germination

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INTRODUCTION

Soybean is one of the most widely cultivated leguminous crops across the world, grown for its oil, food and feed. World production is about 176.6 million tons per annum with an average yield of 2.8 t/ha [1]. In Ghana soybean cultivation is relatively new but is rapidly gaining popularity among both small and medium-scale farmers as an important cash crop. Apart from its monetary value, it is fast becoming a component of cropping systems due to its ability to fix atmospheric nitrogen. The biological nitrogen-fixing ability of the crop helps reduce the need for mineral nitrogen (N) fertilizers, hence farmers may be able to save part of their production cost. Soybean cultivation also reduces *Striga hermonthica* infestation in croplands when used in mixed cropping systems [2, 3]. Production has steadily increased over the years from 138,700 tons in 2013 to 170,490 tons in 2017, a 19% jump within a four-year period [4]. Despite the increased production, soybean yield in Ghana remains lower than the world average at 1.3 t/ha and productivity is only 43% of the potential achievable. Production systems are still characterized by low inputs and low outputs. Meanwhile, soybean farmers can improve their production by up to 41% through the planting of high-quality seed and adoption of best agronomic practices alone [5].

Plant population within a farm has a direct relationship with the expected output at harvest. However, soybean farms in Ghana are usually sparsely populated with less than the optimum number of plants and this contributes to poor yields attained at the farm level. One of the major inputs required for crop productivity is good quality seed to ensure good crop establishment. This is very important in soybean cultivation because low viability is common in the crop's seed lots. The low viability is caused by both pre- and postharvest production practices and weather conditions. Poor growing conditions of the mother plant, through exposure to many abiotic and biotic factors such as poor soil fertility, erratic rainfall, extreme temperatures and relative humidity, insect pests, and diseases affect the resultant quality of the seed [6]. For instance, wounds on soybean pods that serve as entry points for fungi to infect the seeds can be traced to insect pests' attacks on the pods. This usually occurs in the field during pod filling stage leading to infections that cause seed discoloration and shrivelling. Seed borne diseases such as *Phomopsis* and *Cercospora* reduce the germination and vigour of soybean seed. Mechanical damage during seed cleaning and other post-harvest handling processes also causes low viability and predisposes seed lots to diseases and insect pest attack.

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In Ghana, 90% of soybean grain and certified seed is produced in the northern savannas of the country. The area has a unimodal rainfall pattern which typically begins in May and ends in October with annual precipitation of 1000 and 1200 mm [7, 8]. There are intermittent dry spells during the rainy season that sometimes lasts for up to 21 days. Daytime temperatures are generally high ranging between 33 to 39 ^{o}C [9]. In this study, we evaluated seed lots of 11 soybean genotypes produced within the Savanna Agroecological Zone of Ghana for physical and physiological quality and the prevalence of seed borne fungi.

MATERIALS AND METHODS

Experimental materials

The test seed lots in this study were made up of five (5) released soybean varieties and six (6) advanced breeding lines (Table 1). Seed samples of the genotypes were collected from seed lots produced during the main cropping season of 2018/2019 at Nyankpala in the Tolon District (9.3965° N, 0.9892° W). Nyankpala has an elevation of 182 m above sea level. Before planting, the field was ploughed and harrowed. The seed was planted by drilling in rows spaced at 60 cm apart and later thinned out to give 5 cm between plants in a row. Triple Super Phosphate (TSP) was applied at 125 kg/ha, one week after planting. Standard production and field management practices were carried out until harvest. The crop was harvested when the seed was between 12-13% moisture content, threshed and cleaned manually following farmers' practices. The harvested seed lots were sun-dried on a raised concrete drying platform to 8% moisture and stored under ambient conditions (approximate average temperature of 32 ^{O}C and 30% relative humidity) until the study on seed quality analyses commenced six months later. A seed sample weighing 1 kg was drawn from each seed lot for the analysis.

Measurement of Seed quality parameters

The seed samples were analysed for mechanical purity, seed weight, health, germination, and vigour.

Seed Physical purity analysis and appearance

This characteristic was measured using 1 kg of seed. The seed sample was separated into pure, diseased, cracked, purple and discoloured seed. The pure seed and inert matter components were weighed and expresses as a percentage of the total weight. Each of the other components was weighed and expressed in g per kg of seed.

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Determination of 1000 seed weight (g)

The pure seed component was divided into three portions. For each portion, 1000 seeds were counted out and weighed. The average of three replications was taken as the weight of the 1000 seeds for each sample.

Detection and identification of fungi on seed

The health status of the seed was investigated using the agar plate method in an experiment set up in a complete randomized design (CRD) in three replicates. A sample of 60 seeds per genotype was surface sterilized in 1% Sodium-hypochlorite for one minute, rinsed with three changes of sterile distilled water for 30 seconds and blotted dry on sterile blotter paper. Seeds were aseptically transferred onto freshly prepared streptomycin sulphate (1.5 g/L) containing potato dextrose agar (PDA) contained in 9 cm diameter Pyrex petri dishes. For each petri dish, 20 seeds were plated in a concentric circle following which they were incubated at 28 ± 1°C for 3-7 days under alternating daylight and night regime. Fungi sporulation and germination was recorded during the period. A stereo-binocular microscope was used to aid identification of the pathogens. Preparation and viewing of temporal slides under a compound microscope and sub culturing of fungi onto PDA to obtain pure cultures were also used for the accurate identification of fungal species in some situations. Pathogens were identified based on identification keys as described by Barnett and Hunter[10] and each fungal colony recorded including sporulation characteristics, colony morphology and colour. The percentage of infected seed was calculated as:

$$\text{In } (\%) = \frac{\text{Number of infected seeds}}{\text{Total number of seeds}} \text{ X } 100$$

To determine the frequency of each fungus, the proportion of seeds that yielded those isolates was determined and expressed as a percentage of the total number of seeds plated as:

$$\text{IF } (\%) = \frac{\text{Number of seeds showing the fungi species}}{\text{Total number of seeds}} \text{ X } 100$$

Where IF is isolation frequency

Seed germination, vigour, and seedling dry weight

An experiment was set up using a completely randomized design with three replicates in the seed testing laboratory of CSIR-SARI, Nyankpala. A sample, comprising 100 seeds were planted in a 15 x 12 cm plastic container with sterilized sand for each pure seed sample. The containers were placed in a walk-in

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germination room maintained at 25 ± 2 °C. The number of germinated seeds was recorded five days after planting and a final evaluation of seedlings on the 8th day. The seedlings were separated into normal seedlings, abnormal seedlings, dead and hard seeds. The germination percentage was determined as:

$$GE\% = \frac{\text{Number of normal seedlings at final count}}{\text{Number of seeds planted}} \text{ X } 100$$

Where GE% is the germination percentage of the sample.

Seed vigour was determined by counting the normal emerged seedlings, five days after planting. The figure obtained was expressed as a percentage of the total number of seeds planted. The seed vigour expressed as germination percentage at first count was calculated using the formula below.

$$\text{First count } (\%) = \frac{\text{Number of normal seedlings (five DAP)}}{\text{Number of seeds planted}} \text{ X } 100$$

The normal seedlings were oven dried at 70 °C for 48 hours and weighed. The weight was then divided by the total number of seedlings to obtain seedling dry weight (g/plant).

Data analysis

Analysis of variance of data taken on physical parameters such as 1000 seed weight and mechanical purity, germination and its related components, and seed vigour as well as disease infection was analysed using the R statistical software version 3.4.3 [11]. Where there were significant differences among scores for the various factors under consideration, the means were separated using the Fisher's protected Least Significant Difference (LSD) test at 0.05 probability. Before the analysis of variance was performed, the assumptions of ANOVA, for each parameter, were checked using the diagnostic plots in R.).

RESULTS AND DISCUSSION

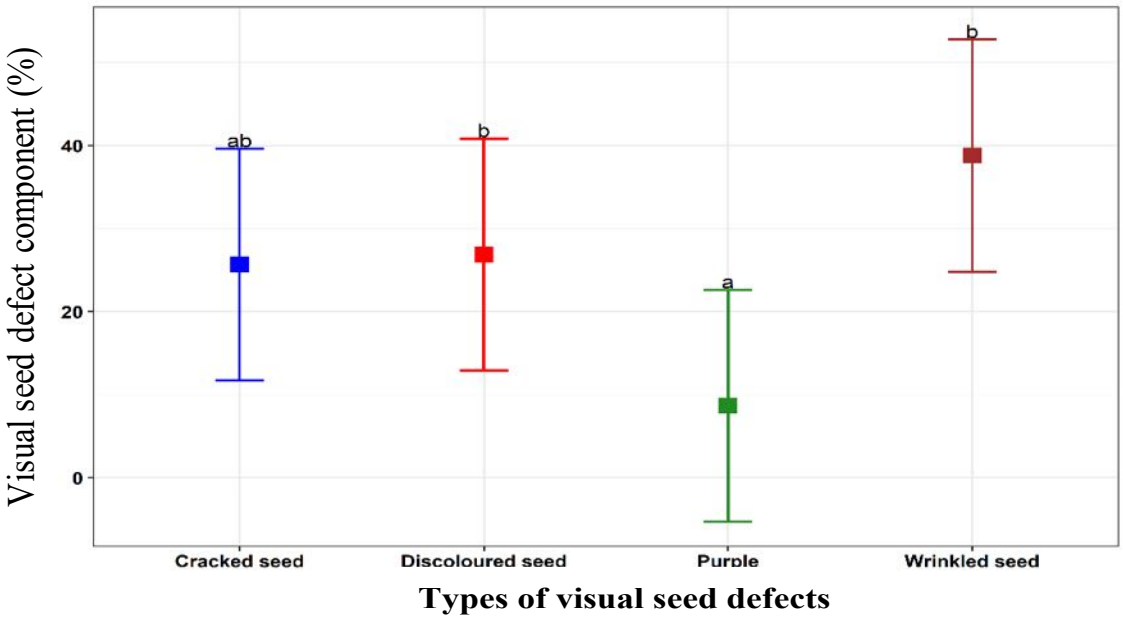
Weight and appearance of the soybean seed

Weight and purity are important characteristics of crop seed lots and they vary between and within species. Seed weight serves as an important component of yield and a measure during planting in determining the seeding rate and resultant plant population on a farm. Seed weight in this study, measured as 1000 seed weight (g), varied significantly ($p < 0.05$) among the seed lots. The overall average

weight of the test seed lots was 133 g per 1000 seeds. The least seed weight was 117.8 g/1000 seeds while the highest was 150.9 g/1000 seeds recorded in Salintuya-1 and PE 308, respectively. Genotypes PE 207 and PE 306 also had a statistically similar 1000 seed weight as that of PE 308. Following the classification by Krisnawati and Adie [12], only three of the seed lots, PE 308, PE 207 and PE 306, in this study were large seeded (>140 g/1000 seeds) while the majority were medium (between 100 to 140 g/1000 seeds). The seed lots of the genotypes tested generally had seed weight less than the average reported for the varieties, Salintuya-1, Jenguma, Favour, Afayak and Suong-pungun in the Catalogue of Crop Varieties Released and Registered in Ghana [13]. In the catalogue, the average weight of the soybean varieties ranged between 126 to 177 g/1000 seeds. The differences in the seed weight of the test seed lots are because different genotypes portray different characteristics and also respond differently to the environment. This phenomenon has been reported in soybean genotypes from different environments [12, 14, 15]. To ensure the right plant population, it is advisable to determine the 1000 seed weight of a particular seed lot at the time of planting to be able to decide the correct seeding rate. The general seeding rate given for soybean in production manuals should be taken as a guide.

The highest physical purity was observed in Afayak, PE 207, PE 214 and Suong-pungun at 99.9% while the least (99.4%) was recorded in Salintuya-1. The reverse was true for the undesirable seed components (Table 2) showing various visual defects. The portion with visual defects comprised wrinkled seed, cracked seed, discoloured and those showing purple stain (Table 3). These varied significantly ($p < 0.05$) among the test genotypes. The seed lot component with visual defects as high as 33 g/kg of seed (Table 3) with genotype PE 308 having the highest. The seed lot of the genotype Afayak had no wrinkled and purple seeds (0.0 g/kg seed) and showed the least amount of seed with visual defects at 3.8 g/kg of seed. In general, the wrinkled seeds were the most dominant category as shown in Figure 1. Seed appearance is an indication of quality, though there have been times unattractive looking seed has proven to be of good physiological quality. The percentage purity of the seed lots tested was high and met the minimum certification standards for soybean as specified in the Ghana Seed Certification and Regulations of 2018 [16] The highest pure seed component was observed in Afayak, PE 207, PE 214 and Suong-pungun at 99.9% while the least (99.4%) was recorded in Salintuya-1. The reverse was true for the inert matter content. The high percentage purity of these seed lots resulted from the hand method used in threshing the soybean [17]. Meanwhile, the differences in physical purity among the seed lots could be due to the varying ability of the test genotypes to withstand pressure from the impact of threshing. Other undesirable components, comprising

seeds with wrinkles, cracks, discoloration (including green seeds) or stains as well as purple seeds (Table 3) analysed in 1 kg of seed was as high as 33 g/kg with wrinkled seeds being dominant (Figure 1). The high proportion of wrinkled seeds within the seed lots is attributable to the dryness and high temperatures of the Savanna Agroecological zone where they were produced [18.19]. This area



typically has high temperatures and experiences intermittent dry and wet spells during the rainy season. These conditions promote seed coat wrinkling in soybean.

Figure 1: Proportion of different undesirable seed classes. Boxes indicate the least square (LS) mean. Error bars indicate the 95% confidence interval of the LS mean. Means sharing a letter are not significantly different (Tukey-adjusted comparisons).

Seed health among the lots

Seed borne diseases have been known to cause huge crop losses due to their effects on the planting value. Seed of the test genotypes in this study recorded five main fungal pathogens based on the morphological characteristics of the microbes. The species identified were *Aspergillus flavus, Aspergillus niger, Chaetomium globosum, Rhizopus sp* and *Macrophomina phaseolina* (Table 4). A few incidences of *Cercospora kikuchii* and *Aspergilus fumigatus* were also recorded. Genotypes Favour and PE 306 had the highest ($p > 0.05$) *A. flavus* infection but were similar statistically to that of TGX 1740-2F. Also, TGX 1740-2F had the highest percent seed infected by *A. niger* and *C. globosum* although the score was similar to that of genotypes PE 214 and Afayak, respectively. The range of total fungal infection among the soybean genotypes was between 33 and 87 % (Table 4). Among the test genotypes, PE 306 had the highest proportion of infected seeds with at least

one of the fungi found (87 %) and was similar to that of TGX 1740-2F (80 %), Salintuya-1 (63 %), PE 214 (57 %) and PE 207 (53 %).

The identified fungi species in the current study were previously isolated in farmer-saved seed grown in a similar environment in northern Ghana [14]. In an earlier study, fungi species including those identified in this experiment were found in other soybean seed lots [15, 16]. It was reported that the percentage of germinated seeds was directly related to the level of disease prevalence in the seed lots. Also, over 13 million tons of soybean were lost in the USA in only four years as a result of seed-borne diseases with fungi being one of the most problematic [21, 22]. This is unlike the present work where there was no significant correlation between disease prevalence and germination percentage. While some of the fungi isolated from the test seed lots such as *M. phaseolina* and *C. kikuchi*, are known to affect young seedlings causing poor crop stand, the others are saprophytes. For instance, *C. kikuchi* in an earlier study was shown to infect soybean seeds, pods, stems and leaves. In seeds, it causes purple seed stain. Seeds heavily infected with purple seed stain, could produce diseased seedlings and cause reduced plant stand. In this experiment, only traces of the purple seed stain were recorded among the seed lots and there was no visible effect of the diseases on germination and seedling stand. *A. flavus* on the other hand is a saprophyte on soybean seed. The fungus, *A. flavus*, was earlier reported to promote seedling growth under stress conditions through the secretion of secondary metabolites at elevated temperatures [23]. In addition, the prevalence of *A. flavus* and *A. niger* did not have any effect on germination when recorded among surface sterilized and non-sterilized soybean seed samples although the fungi load was reduced by the treatment [24]. Furthermore, *C. globosum* on some of the seeds is a beneficial fungus that may be explored as a biological control agent for some parasitic fungi. Considering the number of pathogens found in the seed lots tested and the extent of the infection, treatment of seed before planting, though useful in enhancing germination and field performance is not necessary in seed produced within the Guinea Savanna Agroecological Zone of Ghana if the seed was dried to the appropriate moisture level before storage under ambient conditions.

Germination and vigour of soybean seed lots

The percentage of germinated seedlings recorded during the first count five (5) days after planting, termed as the seed vigour in the current study, was significantly higher in Salintuya-1 and lowest in PE 214 (Table 5). Germination percentage among the genotypes at the final count (that is 10 days after planting) ranged from 55% in PE 214 to 98% in TGX1844-19F. However, the germination

percentage score for genotype TGX 1844-19F was similar statistically ($p \geq 0.05$) to that of genotypes PE 207, PE 308, Salintuya-1 and Suong-pungun. Indicators of seed vigour expressed as the first count of germination and seedling vigour index were significantly different among the genotypes. The seedling dry weight did not differ significantly among the seed lots tested. The seed lot of genotype TGX1844-19F, which recorded the highest germination and first count values, was also seedlings with the highest seedling vigour index. The genotypes did not differ significantly in seedling dry weight (Table 5).

The test seed lots showed germination percentage within the allowable range of the quality standard for the crop. Apart from genotype PE 214 which had a germination percentage of 55%, all seed lots met the minimum germination percentage for soybean seed of 75% as stated in the seed law and regulations of Ghana [16]. Seed vigour measured by the first count of the standard germination test was high among the seed lots tested. Seed vigour ranged between 54 to 93% with PE 214 showing the least while the highest was recorded in Salintuya-1. The germination percentage of the seed lots ranged from 55 to 98% in this study. Similar germination percentages ranging between 32 to 93% for soybean seed were reported in an earlier study [25]. Meanwhile, soybean seed germination percentage and vigour under ambient conditions in southern Ghana was about 92% but reduced within six months of storage time up to 38% [26]. The Southern part of Ghana is characterized by higher relative humidity compared to the Guinea Savannah Agroecological Zone where the current study was carried out. In their work, seeds stored for three months under ambient conditions recorded an average germination percentage of 72% which is lower than was found in the test seed lots in the present study which were stored for six months [26]. These differences are due to genotypic differences that exist among the test seed lots and the environment. Different genotypes have inherent qualities and differ in the ability to germinate and produce vigorous seedlings mainly due to characteristics such as seed coat permeability, integrity, and the chemical composition of the seed. The high germination percentage of test seed lots is mainly due to the dry nature of the savannah agroecology where the mother plants were cultivated, the low moisture content of the seed before storage, as well as the dry and low relative humidity storage conditions. Seeds maintain their germinability for longer when stored under conditions of low relative humidity as pertains to Northern Ghana where most of the seed in the country is produced.

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CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The soybean seed lots produced were generally of good quality and above the minimum certification standards for soybean seed in Ghana. They varied in terms of weight, purity and germination percentage. Also, various fungi species, with the ability to reduce seed quality and plant performance when they occur at high incidence and severity, were identified in the seed lots. Hence, it is advised that, in addition to good agronomic practices, farmers need to weigh and test soybean seed before planting to ensure the right seeding rate is used. Routine treatment of soybean seed with fungicides before planting is recommended as a precautionary step to improve germination and plant stand.

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Table 1: List of genotypes used in the study

No.	Genotype	Maturity group	No. of days to maturity
1.	PE 207	Medium	120
2.	PE 214	Medium	120
3.	PE 306	Medium	120
4.	PE 308	Medium	120
5.	TGX 1740-2F	Medium	120
6.	TGX 1844-19F	Medium	120
7.	Afayak	Medium	115
8.	Favour	Medium	120
9.	Jenguma	Medium	120
10.	Salintuya-1	Medium	120
11.	Soung-pungun	Early	105

Table 2: Seed weight and physical purity of soybean seed

Genotype	1000 seed weight (g)	Physical Seed purity (%)	
		Pure seed	Undesirable seed lot components (including Inert matter)
Afayak	130.1^{de}	99.9^{a}	0.1^{e}
Favour	118.7^{e}	99.8^{b}	0.2^{d}
Jenguma	130.1^{de}	99.8^{b}	0.2^{d}
PE 207	149.4^{ab}	99.9^{a}	0.1^{e}
PE 214	134.9^{bcd}	99.9^{a}	0.1^{e}
PE 306	147.6^{abc}	99.7^{c}	0.3^{c}
PE 308	150.9^{a}	99.5^{d}	0.5^{b}
Salintuya-1	117.8^{e}	99.4^{e}	0.6^{a}
Suong-pungun	134.3^{cd}	99.9^{a}	0.1^{e}
TGX 1740-2F	118.1^{e}	99.5^{d}	0.5^{b}
TGX 1844-19F	131.5^{de}	99.7^{c}	0.3^{c}
Mean	133.0	99.7	0.3

Values followed by the same letters are not significantly different at $p \leq 0.05$

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Table 3: Seed with visual defects (g/kg of seed) of the seed lots

Genotype	Wrinkled seed	Cracked seed	Discolored /stained seed	Purple	Total
Afayak	0.0^{f}	1.3^{de}	2.5^{d}	0.0^{b}	3.8^{f}
Favour	3.5^{d}	2.0^{c}	2.5^{d}	0.9^{b}	8.9^{de}
Jenguma	8.9^{b}	2.4^{c}	1.3^{ef}	0.0^{b}	12.6^{b}
PE 207	6.8^{c}	1.4^{d}	1.8^{e}	0.7^{b}	10.7^{cd}
PE 214	3.1^{d}	0.8^{e}	3.0^{c}	0.8^{b}	7.7^{e}
PE 306	2.8^{de}	3.4^{b}	2.5^{d}	2.5^{b}	10.9^{cd}
PE 308	15.6^{a}	5.5^{a}	0.9^{f}	11.6^{a}	33.6^{a}
Salintuya-1	1.6^{e}	5.9^{a}	4.1^{b}	0.0^{b}	11.6^{bc}
Suong-pungun	3.0^{d}	1.2^{de}	0.8^{f}	1.6^{b}	6.6^{e}
TGX 1740-2F	2.2^{de}	5.4^{a}	6.1^{a}	0.0^{b}	13.7^{b}
TGX 1844-19F	6.5^{c}	3.2^{b}	2.1^{de}	0.0^{b}	11.8^{bc}
Mean	4.9	3.0	2.5	1.6	12.0

Values followed by the same letters are not significantly different at $p \leq 0.05$

Table 4: Level of infection (% of seed) and frequency of fungi species identified in soybean seed

Genotype	*A. flavus*	*A. niger*	*Chaetomium globosum*	*M. phaseolina*	*Rhizopus sp*	Infected seeds
Afayak	14^{bc}	13^{cde}	13^{a}	0^{e}	10^{ab}	33^{e}
Favour	30^{a}	3^{e}	0^{b}	40^{a}	13^{ab}	53^{cde}
Jenguma	23^{ab}	13^{cde}	4^{b}	7de	8^{ab}	47^{cde}
PE 207	13^{bc}	14^{cde}	0^{b}	33^{a}	8^{ab}	53^{abcd}
PE 214	7^{c}	27^{ab}	0^{b}	27^{ab}	12^{ab}	57^{abc}
PE 306	30^{a}	17^{bcd}	10^{a}	37^{a}	12^{ab}	87^{a}
PE 308	10^{bc}	13^{cde}	0^{b}	30^{ab}	5^{b}	50^{bcde}
Salintuya-1	17^{abc}	23^{abc}	10^{a}	20^{bc}	12^{ab}	63^{abc}
Suong-Pungun	13^{bc}	7de	0^{b}	10^{cd}	15^{a}	40^{cde}
TGX 1740-2F	26^{a}	40^{a}	13^{a}	10^{cd}	5^{b}	80^{ab}
TGX 1844-19F	20^{ab}	17^{abcd}	0^{b}	0^{e}	15^{a}	33de

Values followed by the same letters are not significantly different at $p \leq 0.05$

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Table 5: Germination percentage and seedling parameters of soybean seed

Genotype	1st count (%)	Germination (%)	Seedling dry weight (g/seedling)	Seedling vigour index
Afayak	71^{e}	78^{d}	0.29^{a}	0.17^{de}
Favour	74de	87^{bcd}	0.33^{a}	0.20^{abcd}
Jenguma	79^{cde}	82^{cd}	0.37^{a}	0.19^{cd}
PE 207	85^{abc}	95^{ab}	0.33^{a}	0.23^{ab}
PE 214	54^{f}	55^{e}	0.27^{a}	0.14^{e}
PE 306	77^{cde}	83^{cd}	0.34^{a}	0.20^{bcd}
PE 308	84^{abc}	93^{ab}	0.31^{a}	0.20^{abcd}
Salintuya-1	93^{a}	95^{ab}	0.26^{a}	0.20^{bcd}
Suong-pungun	83^{bcd}	91^{abc}	0.34^{a}	0.22^{abc}
TGX 1740-2F	85^{abc}	89^{bc}	0.32^{a}	0.21^{abc}
TGX1844-19F	91^{ab}	98^{a}	0.30^{a}	0.24^{a}
Mean	80	86	0.34	0.20

Values followed by the same letters are not significantly different at $p \leq 0.05$

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