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Assessing the Effects of Planting Seasons on Seedling Damping-Off (*Aspergillus Niger*) for Sustainable Groundnut Production in the Semi-Arid Zone of Northeastern Nigeria

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Groundnut Production, Plabting Seasons, Assessing, Effect, Northeastern, Seedling.

Abstract

Groundnut (Arachis hypogaea L.) is not commonly grown in the dry season in northern Nigeria except for the preliminary trials on some improved groundnut varieties along with local checks which showed possibility of its production during this season. It has been traditionally a rainfed crop sown at the onset of the rainy season. Two trials were conducted during these periods to assess their effects and that of groundnut variety on pre-emergence damping-off and yield. Dry season trial was conducted from March 2 to June 10 (2016), and the rainy season trial was done between July 13 to September 26 (2016). Four varieties comprising two improved and two local varieties were laid out in Randomized Complete Block Design (RCBD) during each planting season and replicated three times. The results showed that planting seasons had significant (P≤0.01) effect on the seedling emergence, disease incidence and pod yield. Disease incidence ranged from 1.5 to 15.3 % and from 32.5 to 35.0 % in the dry and rainy seasons, respectively. Mean disease incidence across the varieties was reduced by 27.3 % and seedling emergence was increased by 30.9 % in

the dry season compared to rainy season. While rainy season increased pod yield by 853.8 kg/ha over the dry season. Variety also significantly (P≤0.05) affected the parameters measured in both seasons without any consistent pattern. The results suggest that with reduced disease incidence, an encouraging pod yield, available water for irrigation, and avoiding the hottest and the coolest months, dry season is an important second groundnut cropping option for sustainable groundnut production in the semi-arid zone of northeastern Nigeria.

Introduction

Groundnut (*Arachis hypogaea L.*) is a leguminous oilseed crop grown for its good source of protein, cooking oil and vitamins. The haulms are also good source of feed for livestock. Groundnut is grown on 26.4 million hectare worldwide, with a total production of 37.1 million metric tons and an average productivity of 1.4 metric tons/ha. Nigeria was the third highest producer of groundnut in the world after China and India with a production of 2.96 million metric tons (FAO, 2011). The country contributes 10% of total global production and 39% that of Africa (Ajeigbe *et al*., 2014). Nigeria is among the major exporting countries of the groundnut in shelled and unshelled forms. It is an important cash crop contributing to a large percentage of the country's foreign exchange. It also serves as food crop where large quantities are consumed locally in many parts of the country. The nuts can be eaten raw, whole roasted and salted, boiled or chopped in confectionaries or ground into groundnut butter (FAOSTAT, 2002).

Groundnut is traditionally grown sorely as a rainfed crop during the rainy season (May-October). Planting is usually done at the onset of the rainy season when there is adequate and consistent moisture in the soil for good germination and subsequent plant growth (Ajeigbe *et al*., 2014). This period falls between late June and early July in the semi-arid zone of northeastern Nigeria. The potential for groundnut to be grown as a dry-season crop in the Sudano-Sahelian zone of West Africa was explored by Ndunguru *et al*.

(1995); Sesay and Yarmah (1996); Ntare *et al*. (1998). It is not commonly grown in the dry season in northern Nigeria. But evaluations of some elite groundnut varieties along with local checks by ICRISAT-Kano on dry season groundnut production revealed that it can be successfully and profitably grown either at the end of the rainy season in October or early February (Ajeigbe *et al*., 2014).

However, yield per hectare remains a critical factor in either rainy or dry season production. It is affected by combination of factors such as drought, field diseases and molds. Some of the field diseases are caused by some species of *Aspergillus* found to be associated with groundnut seed (Aliyu and Kutama, 2007); Ibiam and Egwu, 2011; Nandeesha *et al*., 2013). Aspergillus niger *van Tieghem* is one of the most important soil- as well as seed-borne pathogens causing groundnut seedling damping-off at seed and seedling stages (Kolte, 1985; Bellgard, 2004). Pre-emergence damping-off occurs when seeds are affected immediately after sowing. The seeds may rot in the soil or be covered with sooty black masses of spore. On germination, the emerging hypocotyls are rapidly killed as soon as they come out of the seed coat by these spores. Post-emergence damping-off of seedlings occur when germinated seeds are invaded. During this stage the seedlings are out on the surface of the soil and the most obvious symptom is that seedlings topple over and lie on the surface of the soil. This is due to rotting of the crown area of infected seedlings just below the soil line which may be covered with a black, sooty mass of fungus growth. Initially the infected areas appear soft and water-soaked. With further growth of the pathogen the stem or the hypocotyl becomes constricted and the seedlings collapse (Nandeesha *et al.*, 2013; Mehak, 2019). Pre- and post-emergence death account for about 20 to 50 % reduction in plant population in the field (Nandeesha *et al*., 2013; Rajasekharam and Reddy, 2013; Jidda and Bulama, 2019). In Northern Nigeria, there is paucity of information on the relative frequency of pre-emergence damping-off in the two seasons now being adopted for groundnut production. The objective of this study was to assess the effects of dry and rainy seasons on incidence of pre-emergence damping-off and yield of groundnut in the Semi-arid zone of northeastern Nigeria.

MATERIALS AND METHODS

Experimental Site: The trials were conducted during the 2016 dry season and 2016 rainy season at the teaching and research farm, Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, (Latitude 11°15'N; 13°51'E) in Borno State, Nigeria.

Sources of Materials: Two local groundnut varieties, Kampala and Bomboi (mainly grown during rainy season) were obtained from Borno State Agricultural Development Program (BOSADP) in Maiduguri; varieties, Samnut-24 and Samnut-25 (tried during dry season) were obtained from Institute for Agricultural Research, Samaru, Zaria.

Dry and rainy season trials: The dry season trial was conducted under irrigation from the 20th February, 2016 to the 10th of June 2016 while the rainy season trial was conducted during the rainy period from 20th June to 26th September 2016.

Land preparation: The experimental field was cleared, harrowed with disc harrow mounted on a tractor, hoe was used to remove stumps left over from previous season. The soil was further raked to remove debris and pulverized into fine tilt and leveled.

Experimental design and treatments: Both dry and the rainy season trials were conducted using Randomized Complete Block Design (RCBD) with four varieties (Samnut-24, Samnut-25, Kampala and Bomboi) as the treatments which were replicated three times.

Seed sowing and spacing: Dry season trial was sown on 2nd March, 2016 and rainy season trial was on 13th July, 2016.The experimental area measured 20 m x 60 m giving the total area of 1200 m². Each plot measured 3m x 4m. The seeds were sown directly into the soil with spacing of 60cm between row and 30cm within rows, and a depth of 3cm.

Weeding and harvesting: Weeding was done manually using hoe. First weeding was done three weeks after planting and the second weeding at eight weeks after planting. Harvesting was done by hand pulling of mature groundnut plants.

Data Collection

Seedling emergence: Seedling emergence was recorded daily from 3days after sowing to 12 days after sowing. Emerged seedling were counted per plot and expressed as percentage of total number of seed sown.

Incidence of pre-emergence damping-off: Incidence of pre-emergence damping-off was observed on a daily basis, from emergence of the seedling to two weeks after emergence. The number of seeds that failed to emerge or number of emerged seedling with black mold that died within two weeks after

emergence were counted and divided by the total number of seeds sown, then multiplied by 100 to give the percentage pre-emergence damping off.

Plant height (cm): Plant height was measured from five randomly tagged plants per plot. Height was measured using a meter rule at harvest from the five plants tagged on each plot by measuring the distance from the ground level to the top of the canopy.

Number of pods per plant: The number of pods per plant was counted from the five randomly tagged plants per plot. Mean number of pods per plant was calculated by dividing the total number of pod by five.

Pod weight (Kg): Harvesting was done manually using hoe, digging and hand pulling of plants. Pods were removed from plants, sun-dried, and weighed using weighing balance in grams and subsequently converted to Kg/ha.

Data Analysis: The data collected were subjected to analysis of variance (ANOVA) based on the experimental design using statistical software Statistix version 8.0. Means were compared using Duncan's Multiple Range Test (DMRT) at $P \leq 0.05$ level of significance.

RESULTS

The effects of groundnut variety and planting seasons on seedling emergence are presented in Table 1. The differences in seedling emergence between the effects of variety in both seasons were highly significant ($P \leq 0.01$). Samnut-25 and Bomboi had the highest emergence (98.33 %) during the dry season trial. None of the varieties had less than 90 % emergence during the dry season. In the rainy season trial, Kampala had the highest (69.39 %) emergence while sam-25 had the lowest (62.08 %) emergence. Means across the varieties in the dry season was 95.86 % and in the rainy season was 64.99 %.

TABLE 1. EFFECT OF VARIETY AND PLANTING SEASON ON SEEDLING EMERGENCE (%) OF GROUNDNUT

VARIETY	Season		Mean
	Dry	Rainy	
SAMNUT-24	96.11b	80.5	80.5
SAMNUT-25	98.33a	80.1	80.1
KAMPALA	90.67c	80.0	80.0
BOMBOI	98.33a	81.0	81.0
MEAN	95.86	64.99	

SE±	0.43**	0.74**

MEANS FOLLOWED BY THE SAME LETTER(S) WITHIN THE COLUMN ARE NOT SIGNIFICANTLY DIFFERENT AT P≤0.05 USING DUNCAN'S MULTIPLE RANGE TEST (DMRT); ** SIGNIFICANT AT P≤0.01

The effects of variety on pre-emergence damping-off during the dry season trial was highly significant (P≤0.01) (Table2). The lowest incidences were recorded in Samnut-25 and Bomboi. However, the differences in the disease incidence among the varieties during the rainy season trial were not significant. Pre-emergence damping-off incidence was higher during the rainy season but seedling emergence was lower in the same season.

Table 2. Effect of variety and planting season on pre-emergence damping-off (%) in groundnut

VARIETY	**SEASON**		**MEAN**
	Dry	Rainy	
SAMNUT-24	6.38b	34.99	20.7
SAMNUT-25	1.54c	34.60	18.1
KAMPALA	15.29a	32.46	23.9
BOMBOI	2.38c	32.85	17.6
MEAN	6.40	33.70	
SE±	1.17**	1.00^{NS}	

Means followed by the same letter(s) within the column are not significantly different at P≤0.05 using Duncan's Multiple Range Test (DMRT); ** significant at P≤0.01; NS= not significant

Table 3 shows the effect of variety on groundnut height during the dry and rainy season trials. Significant differences occurred in the height of groundnut during both dry and rainy season trials. Samnut-24 recorded the highest height (30.39 cm) in the dry season while Bomboi had the highest (31.13 cm) during the rainy season trial. Kampala had the lowest height in both the dry and the rainy season trials. On the average, there was no significant effect of planting seasons on plant height. Variety differences were observed in plant height for both dry and rainy season sown crops.

TABLE 3. EFFECT OF VARIETY AND PLANTING SEASON ON GROUNDNUT HEIGHT (CM)

VARIETY	Season		Mean
	Dry	Rainy	
SAMNUT-24	30.39a	29.84b	30.1
SAMNUT-25	28.37b	27.91c	28.1
KAMPALA	18.36c	18.03d	18.2
BOMBOI	28.33b	31.13a	29.7
MEAN	26.36	26.73	
SE±	0.25**	0.34**	

MEANS FOLLOWED BY THE SAME LETTER(S) WITHIN THE COLUMN ARE NOT SIGNIFICANTLY DIFFERENT AT P≤0.05 USING DUNCAN'S MULTIPLE RANGE TEST (DMRT); ** SIGNIFICANT AT P≤0.01

Number of groundnut pods per plant varied significantly among the varieties in both dry and rainy season trials (Table 4). The highest (40.91) number of pods per plant was produced by Bomboi during the dry season trial, while Samnut-24 produced the highest (40.01) number of pods in the rainy season trial. The least number of pods per plant were from Kampala in both dry and rainy season trials.

TABLE 4. EFFECT OF VARIETY AND PLANTING SEASON ON NUMBER OF PODS PER PLANT OF GROUNDNUT

VARIETY	Season		Mean
	Dry	Rainy	
SAMNUT-24	39.62b	40.01a	39.8
SAMNUT-25	35.86c	34.27c	35.1
KAMPALA	29.76d	32.40d	31.1
BOMBOI	40.91a	38.16b	39.5
MEAN	36.54	36.20	
SE±	0.43**	0.38**	

Means followed by the same letter(s) within the column are not significantly different at P≤0.05 using Duncan's Multiple Range Test (DMRT); ** significant at P≤0.01

The effects of variety and planting season on groundnut pod yield are presented in Table 5. Pod yield varied significantly (P≤0.01) among varieties in both dry and rainy season trials. Bomboi produced the highest (3126.6 kg/ha) pod yield during the dry season trial, while Kampala had the highest (3696.6 kg/ha) pod yield during the rainy season trial. Samnut-25 produced the lowest pod yield in the two seasons. The average pod yield across the varieties in the rainy season trial was higher than the dry season trials. Pod yield increased by 33.9 % over the dry season yield.

TABLE 5. EFFECT OF VARIETY AND PLANTING SEASON ON POD YIELD (KG/HA) OF GROUNDNUT

VARIETY	Season		Mean
	Dry	Rainy	
SAMNUT-24	2646.6b	3403.4b	3025.0
SAMNUT-25	1727.4c	2756.8c	2242.1
KAMPALA	2562.2b	3696.6a	3129.4
BOMBOI	3126.6a	3621.3ab	3374.0
MEAN	2515.7	3369.5	
SE±	131.5**	92.06**	

Means followed by the same letter(s) within the column are not significantly different at P≤0.05 using Duncan's Multiple Range Test (DMRT); ** significant at P≤0.01

DISCUSSION

The results of the present study show significant differences between the disease incidences as affected by dry and rainy plantings. Weather conditions prevailing during the rainy season tended to favour the disease development more than conditions in the dry season. Many of such conditions are environmental and soil factors (Kumari and Singh, 2017). In a moist soil environment seeds may be attacked and killed leading to a pre-emergence rotting (Subrahmanyam *et al.,* 2012). On the other hand, groundnut grown in dry period (March) developed little or no disease due to the high temperatures experienced during the period.

Despite the high disease incidence, pod yield increased during the rainy. Groundnut grown during the rainy season utilizes the rain that falls during the

season (Sesay and Yarmah (1996) whereas groundnut planted in the dry season only makes use of irrigation water under varying environmental temperatures (Ntare *et al*., 1998; Ajeigbe *et al*., 2014). Hence the decline in not only pod yield, but haulm yield, number of mature pods, crop growth rate and partitioning in the dry (minor) season (Sesay and Yarmah, 1996). However, Ajeigbe *et al*. (2014); Kumar and Palanisamy (2016) observed to the contrary that the average pod and fodder yields of dry season groundnut were higher than rainy season production due to lower incidence of the disease in the former than the later season (RAKHOLIYA *et al*., 2012)

In the present study, significant differences in seedling emergence, disease incidence, plant height, number of pods per plant and pod yield were observed between varieties in both seasons without any consistent pattern. These could be interpreted as genotypic differences among varieties reflecting their sensitivity to environmental conditions (Sesay and Yarmah, 1996). However, across planting seasons, local variety Bomboi recorded the lowest (17.6 %) pre-emergence damping-off incidence and had the highest pod yield of 3374.0 kg/ha, suggesting that it could be relatively more suitable to both dry and rainy season cultivation than the other varieties. The pod yields of 2646.6, 1727.4, 2562.2 and 3126.6 kg/ha recorded in the dry season by Samnut-24, Samnut-25, Kampala and Bomboi, respectively, has supported the findings of (Ajeigbe *et al*., 2014) that groundnut can be successfully and profitably grown in northern Nigeria during the dry season.

Conclusion

The results of this study suggest that, with pod yield range above that of on-farm yield range, reduced disease incidence, available water for irrigation, and avoiding the hottest and the coolest months, dry season is an important second groundnut cropping option for sustainable groundnut production in the semi-arid zone of northeastern Nigeria.

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