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Influence of Seed Size and Planting Date on the Growth, Development and yield of potato (*Solanum tuberosum L.*) Varieties in Bauchi.

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ABSTRACT

Field experiments were conducted on the effect of seed size and planting date on the growth, development of potato varieties during the cold season period in Bauchi. The treatments consisted of three varieties (Nicola, BR 63-18 and RC 7716-7) and four different seed sizes: Extra large (> 50mm), large (40-50mm), medium (20-39mm) and small (< 20mm). Two planting dates of 15th and 30th November were adopted. The treatments were then laid in a randomized complete block design with three replications. Variety RC 7716-7 performed significantly (P<0.01) better than the other varieties in plant height, number of sprouts, stolons, haulms weight, mature tubers and yield. Seed sizes, large (40-50mm) and medium (20-39mm) seed sizes performed significantly (P< 0.01) better in yield than the other seed sizes. Irrespective of the year, planting potatoes on 15th November was observed to be significantly (P<0.01) better in yield than when it was planted on the 30th of November.

KEYWORDS: Cold Season/ Harmattan Season

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a Solanaceous plant cultivated for its edible starchy tuber. Potato that is a native to the Andes Mountains of South America is presently grown throughout the world. On world scale, the crop ranks fourth in food production, following wheat, maize and rice. However, it ranks first among the worlds root crops (Hawkes, 1990).

In Nigeria, the tin miners in Jos Plateau first introduced potato during the later part of the 19th century. Among the potato producing areas in Nigeria, Plateau state accounts for 85% of the potato production, probably due to its high altitude and low temperature. Other states that produce potato include Adamawa, Taraba, Kano, Kaduna, Borno, Yobe, Sokoto and Bauchi. These states produce potato with irrigation during the cold season with sufficiently low temperature (Okonkwo, *et al.*, 1986).

Locally, potato is consumed either boiled or fried. Other uses include making of potato flour, potato starch and potato chips or French fries. It is also useful in making of alcohol and wine and also used as animal feed, especially for pigs.

Despite the progress made in increasing potato production in Nigeria, there are still problems that must be given some attention if production is to be further increased. The major production constraints include among others; lack of improved varieties, diseases, pests and unfavorable environmental conditions. Potato is restricted to areas with night temperatures below 15°C (Borah and Milthorpe, 1962) and in Nigeria, only few areas meet this requirement. These include Jos, Mambilla, Biu and Obudu Plateau and some States in the Guinea savanna that experience cold period, during the harmattan.

Farmers in Nigeria have been reported to plant more of small tuber seed due to lack of improved seeds (Ifenkwe and Nwokocha, 1986). Unfortunately this practice has led to the selection of virus-infected seeds, which is commonly observed in small tubers. Tuber sizes of 25mm or less or from 50mm and above in diameter are generally not recommended for planting because of their poor yield (Okonkwo, 1991). Similarly, many farmers retain and maintain the planting of some of the oldest varieties introduced into the country, thereby limiting the use of improved varieties.

In view of this, a field study was undertaken to investigate on the performance of three varieties of potatoes from four different seed sizes and two planting dates on the growth and yield of the crop.

MATERIALS AND METHODS

The study was carried out for two years during the harmattan periods of 2002 and 2003 at the Abubakar Tafawa Balewa University (ATBU), fadama field, Bauchi. Bauchi is located in the northern Guinea savanna of Nigeria 10^0 17"N, 9^0 49"E and 609m above sea level. Two seasons; the rainy and wet, are experienced in Bauchi. The rainy season falls between the months of June and October, while the dry season is between November and March. The hot period is between March and May. Dry season, which is usually accompanied by a cold period, popularly known as the harmattan, comes with dust that covers the sky. The day temperature during the period is about 20°C or less, while night temperature could be as low as 15°C.

Three varieties of potato, Nicola, BR 68-18 and RC 7716-7 were used in the present study. The three varieties are early maturing. Each variety was separated into four different seed sizes, and the seed sizes ranged from extra large (>50mm), large (40-50mm), medium (20-39mm) to small (<20mm) as recommended by the Potato Research Station of National Root Crop Research Institute (NRCRI) Kuru, Plateau state. The three varieties and the four seed sizes were laid out in a randomized complete block design with three replications. Two planting dates were used. The first planting was on 15 November 2002, while the second planting was on 30 November 2003. One-meter paths separated the blocks and plots and a plot size of 3.37 m^2 with 4 rows spaced at 75cm apart was used.

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Table 1: Influence of variety, seed size and planting date on emergence and growth of potatoes in Bauchi.

Treatments	Emergence percentage/plot		Number of leaves/plant		Plant height		No. of sprouts/plant
	2WAP	4WAP	4WAP	At Harvest	4WAP	At Harvest	4WAP
Variety							
Nicola	67.1	87.5	7	20	6.9	30.1	3
BR 63-18	63.8	82.9	6	19	8.7	26.2	4
RC 7716-7	72.7	90.8	7	22	9.7	34.8	6
SE (±)	6.35	4.9	0.26	2.51	0.75	2.80	0.69
LSD (P< 0.01)	NS	NS	NS	NS	1.87	5.89	1.51
Seed size							
Extra large	63.1	82.2	6	19	8.8	29.8	5
Large	74.4	86.1	6	22	8.4	33.8	4
Medium	70.0	90.6	6	21	8.4	33.5	4
Small	63.9	89.4	6	20	8.0	24.4	4
SE (±)	7.33	5.65	0.30	2.90	0.92	2.96	0.74
LSD (P<0.01)	NS	NS	NS	NS	NS	6.80	NS
Planting Date							
Nov. 15th	67.5	88.3	6	18	8.7	31.0	4
Nov. 30th	68.2	85.8	6	20	8.2	29.7	5
SE (±)	5.18	3.99	0.22	2.05	0.65	4.72	0.52
LSD (P<0.01)	NS	NS	NS	NS	NS	11.81	NS

The land was ploughed and harrowed using tractor. It was then made into raised beds for each plot. Watering can was used to irrigate the plots.

Uniform intra and inter-row spacing of 30 X 75cm, was used. The seeds were placed vertically with the eye/bud facing upwards at 5cm depth. This was done so as to facilitate emergence of sprouts. Only properly filled, healthy looking seeds were sown while shrunken seeds and those seeds without eyes were discarded. Weeding was carried out with hoe at 4 and 8 weeks after planting (WAP). A compound fertilizer, N.P.K (20:10:10) was applied broadcast at the rate of 100 kg N, 100 kg P and 40 kg K_2O/ha. Irrigation was carried out once every two days using watering can.

Percentage emergence was taken at 2 and 4 WAP. The number of sprouts per seed was taken only at 4 WAP. Other parameters such as number of leaves/plant, plant height, number of stolons/plant and haulm dry weight/plot was taken at 4 WAP and at harvest. Plant height was measured by the use of a tape taken from the base of the stem to the tip of the shoot. Biomass weight was also taken at 9WAP and at harvest. Post harvest parameters include number of immature and mature tubers. Weight of harvested tubers was taken by weighing ware tubers and the inedible tubers and the diameter of the tubers was also measured using the venier caliper. Marketable tubers known as ware tubers (usually > 20mm) were separated from the unmarketable tubers (<20mm). Growth indices such as crop growth rate (CGR) and tuber growth rate (TGR) were determined using the formulae of Coffelt *et al.* (1989) as shown below:

$$\text{Crop growth rate} = \frac{\text{Final biomass weight - Initial weight of biomass}}{\text{Final time - Initial time}}$$

$$\text{Tuber growth rate} = \frac{\text{Weight of tuber at harvest - Weight of tuber at 9WAP}}{\text{Final time - Initial time (9WAP)}}$$

Initial time = 9WAP (period of tuberization)

Final time = at harvest

Combine analysis of variance was used to study the significant effect of the treatments for all the data collected over the two years, among the varieties, seed size and the different planting dates.

RESULTS AND DISCUSSION

Physiological stage of tubers and the planting of pre-sprouted seeds have been known to influence early and uniform emergence of potato seeds (Beukema and Zaag, 1979). Uniformity in emergence, which was observed in the present study, may not be unrelated to the fact that the varieties were pre-sprouted before planting. Uniform planting depth of 5cm used in the present study could also have influenced uniformity in emergence (Okonkwo *et al.*, 1995). Similarly, number of leaves was observed to be uniform irrespective of varieties, seed size and date of planting.

The variety RC 7716-7 was observed to be taller than the other varieties (Table 1). Differences in plant height among the varieties could be genetically determined. Similarly, influence of the growing condition like nutrient deficiency might have also caused the reduced growth rate of the different varieties towards maturity.

Significant difference (P<0.01) was also observed in seed size and planting date at harvest. Plants that originated from the large and medium sized seeds were observed to be taller than plants that originated from the extra large and small seeds. Susceptibility of plants that originated from small seeds to viral infection has been reported (Okonkwo *et al.* 1986). Potato plants originating from small seeds resulted in poor growth and vigour. Similarly, taller plants were observed more when the crop was planted on 15th than on 30th of November.

Significant differences (P< 0.01) were observed among the varieties in seed size and planting date. The variety, RC 716-7 was observed to consistently produce higher haulm weight than the rest of the varieties (Table 2). Although differences in haulm dry weight could be due to genetic differences among other factors, Winkler (1961) earlier reported that when plants are exposed to higher temperature above 25°C toward maturity, ability of the plant to grow

Table 2: Influence of variety, seed size and planting date on weight of haulm, crop and tuber growth of potato in Bauchi.

Treatments	Dry Weight of Haulm			
	4WAP	At harvest	CGR	TGR
Variety				
Nicola	1.4	8.5	0.2	0.2
BR 63-18	1.7	6.8	0.1	0.1
RC 7716-7	3.4	10.6	0.3	0.3
SE(±)	0.02	0.90	0.16	0.16
LSD(P< 0.01)	0.24	2.25	NS	NS
Seed Size				
Extra large	2.3	8.0	0.3	0.3
Large	2.8	10.6	0.3	0.3
Medium	2.3	8.0	0.1	0.1
Small	1.3	76.9	0.1	0.1
SE (±)	0.10	0.90	0.18	0.18
LSD (P< 0.01)	0.24	2.25	NS	NS
Planting date				
Nov. 15th	1.9	6.6	0.3	0.3
Nov. 30th	2.3	10.6	0.3	0.3
SE (±)	0.07	0.60	0.17	0.17
LSD (P< 0.01)	0.17	1.58	NS	NS

vegetatively increases. Therefore, effect of temperature among the varieties might have differed that RC 716-7 was affected more than the others. Potato plants from the large seed size consistently had higher haulm weight than the rest. Physiological stage and surface area of the tubers might have caused the difference. Significantly (P<0.01) higher dry weight of haulm was observed from planting on the 15th of November than on the30th of November (Table 1).

Significant difference (P<0.05) was only observed among the varieties on number of immature tubers, while varieties, seed size and planting date differed significantly on mature tubers per plant. The variety, RC 7716-7 produced the highest number of immature and mature tubers per plant. Okonkwo *et al.* (1995) identified RC 7716-7 as an early maturing variety with high yield potential when grown under low temperature conditions. BR 63-18 that is an early maturing variety also, produced less number of mature and immature tubers than the rest. Sensitivity of different varieties to the environment could be advanced as a reason for their differences since all the varieties are not adapted varieties. The number of mature tubers also differed among the different seed sizes and date of planting. Plants that originated from the larger seeds had higher number of mature tubers than the rest The result is in conformity with the findings of Okonkwo (1991) who reported that seed tubers of between 40-50mm in size, yield about 15% higher than seed tubers of 25-40 mm. Potato seeds of less than 25mm or greater than 50mm in size are generally not recommended for planting because they yield less. Similarly, it could be possible that potato seeds of less than 25mm are meant for planting while seed sizes of higher than 50mm are meant for cooking.

The production of mature tubers was more favored by the November 15 planting. This could be due to the fact that when the crop is planted early in November, when the hamattan has fully established, expected time of harvest tends to fall within the cold period with lower temperature as required by the plant. Under such condition, it is expected that the tubers will be fully filled since the environmental conditions of temperature has at least been attained. However, when the crop was planted two weeks later, the crop tends to mature outside the cold period and as Winkler (1961) earlier reported, potato tends to grow vegetatively under such conditions at the expense of tuber yield.

At harvest, only small, medium and a few of the large seed sizes were recovered. Large and extra-large seed sizes

Table 3: Influence of variety, seed size and planting date on yield and yield related characters of potato in Bauchi

Treatments	Number of stolons		Number of tubers/plant		Ave.tuber size/plot		Yield kg/ha
	4WAP	At harvest	Immature	Mature	Small (mm)	Medium (mm)	
Variety							
Nicola	3	4	3	17	16.1	25.2	2228.7
BR 63-18	2	6	4	26	14.4	26.7	4968.1
RC 7716-7	4	5	4	29	15.9	30.3	5163.9
SE (±)	0.49	0.57	0.6	3.42	1.64	2.59	1370.71
LSD (P<0.05)	1.12	1.26	1.26	7.52	NS	NS	3152.64
Seed size							
Extra large	2	5	3	21	14.3	26.8	3505.4
Large	3	5	5	28	16.2	28.3	5658.5
Medium	3	5	4	27	15.7	26.6	5611.0
Small	2	5	3	21	15.6	25.3	1706.2
SE (±)	0.59	0.26	1.02	4.13	1.13	1.79	1582.77
LSD (P<0.05)	1.30	NS	NS	8.68	NS	NS	3640.36
Planting Date							
Nov. 15th	2	4	3	31	15.4	29.0	5458.4
Nov. 30th	3	6	4	18	15.5	24.5	2782.1
SE (±)	0.43	0.44	0.73	2.79	0.80	1.43	1170.05
LSD (P< 0.01)	0.91	1.03	NS	6.14	NS	3.00	2574.12

were, not recovered at the end of the experiment. Reason for the production of fewer large seeds from the present investigation could be due to the lower altitude that is relative to higher temperature, fluctuation in day temperatures during the months of January and February, nutrient status of the soil and possibly the amount of water supplied to the crop. Higher temperatures among the factors mentioned above could greatly reduce production of tubers in potato (Borah and Milthorpe, 1962) especially during tuberization (Ifenkwa and Nwokocha, 1986). Time of planting may also have influenced the size of the tubers produced, as it is evident from the present investigation (Table 3). Studies on time of planting in Plateau state showed that yield declined with delay in date of planting as a result of premature killing of the plants by late blight and high temperature (Ifenkwe and Nwokocha, 1986).

In the present study, Nicola and RC 7716-7 produced significantly ($P<0.05$) higher tuber yield than BR 63-18. The low performance of BR-63-18 in tuber yield could be due to the sensitivity of the variety to the environmental factors, which could be below or above its requirement. Environmental factors like water given to the plants might have been too low for the variety. Similarly, the variety could be a high fertilizer feeder than the rest. Performance of different seed sizes in tuber yield showed that plants that originated from the large and medium sizes produced significantly higher yield than the rest of the sizes. Tubers of less than 25mm or 50mm in size are generally not recommended for planting because of the small tuber yield. Okonkwo *et al.* (1995) also showed a similar trend with tuber seed sizes in yield of potatoes. The significantly low yield exhibited by the small sized tubers could be as a result of less food reserve within the seed, which has been known to affect plants that originate from small tubers during growth and development of the crop (Ifenkwe and Nwokocha, 1986).

Significantly ($P<0.01$) higher yield was obtained when the crop was planted on the 15th than when it was planted on the 29th of November. This was attributed to the fact that when the crop was planted in November, it was able to grow, develop and produce appreciable yield during the period. However, planting late in November, where the crop experiences higher temperature during floral induction and tuberization, number and size of tubers decreases.

CONCLUSION

Based on yield performance, the varieties, RC 7716-7 and Nicola seem promising and could be suitable for potato production during the cold period in Bauchi and its environs. Although these varieties are early maturing, they did not conform to the recommendation of the NRCRI as high yielding with production potential of 13-15 tones per hectare. The very low yield of 5163.9 and 4968.1 kg/ha produced by these varieties as obtained in the present study was far below their expected yield even though their maturity duration fell within the hamattan period. However, with proper and timely planting during the harmattan and other agronomic practices effectively carried out, higher yield could be expected. Agronomic practice like the application water during irrigation, which may not have been sufficient for the formation of sizeable tubers due to the fact that the land was not properly leveled as water was noticed to accumulate at certain areas in the field, might have led to the lower yield. Despite the shortfall in yield, in order to avoid uncertainties in vagaries of the cool harmattan weather, the early maturing types should be the only hope for a sustainable potato production in this locality, since the onset and cessation of the harmattan period is so erratic. However, a continued collaboration between breeders and agronomists is needed which should be centered toward exploring potato production possibilities to its fullest extent.

In choosing potato seeds for planting, medium and large seed sizes ranging from 20-50mm in size should be sown since these two sizes have proven to be of high yield. It is possible that the extra large seeds gotten after harvest are meant for market purposes while the small size seeds are discarded or crushed and fed to animals. Similarly, despite the lower altitude of Bauchi, potato production can be improved in this area if the relatively low temperature experienced during the harmattan is effectively harnessed. Hence planting the crop when the harmattan has fully commenced will be the ultimate period for planting potato.

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