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DISEASE RESPONSE OF TWO POTATO VARIETIES TO TIME OF WEEDING AND FERTILIZER RATES IN SUDAN SAVANNA OF NIGERIA

J. Alhassan[1] and A. Muhammad[2]

[1]Department of Crop Science, Usmanu Danfodiyo University, Sokoto, Nigeria
[2]Department of Crop Production, Kebbi State University of Science and Technology, Aliero, Nigeria

ABSTRACT

Field trials were conducted under irrigation, at Usmanu Danfodiyo University Teaching and Research Fadama Farm at Kwalkwalawa village, Sokoto during the 2001/02 and 2000/03 dry seasons. The objective was to determine the disease response of two potato varieties on time of wedding and fertilizer rates. The treatments consisted of two potato varieties (RB68-18 and RC 7716-17), four N.P.K. (20:10:10) fertilizer rates (0,80,160 and 240kg/ha) and three weeding regimes (zero-weeding, weeding at 4 weeks after planting and weeding at 6 weeks after planting) which were laid out in a split plot design replicated three times. Variety and fertilizer rate were allocated to the main plot while weeding regime was allocated to the subplots. Results revealed that Bacterial wilt disease was not influenced by all the treatments at all the stages considered. Significantly ($P<0.05$) highest percentage of Early blight disease was recorded on plots that were neither weeded nor applied any fertilizer (2.25 and 2.17% respectively). Lowest percentage of rotted potato tubers was obtained at zero fertilizer rate. The variety BR 68 – 18 produced significantly lowest rotted tubers (10.3%) compared with variety RC7716 – 17(25.96%). For common scab infection however, variety RC7716-17 recorded the lowest in both trials. The research concluded by recommending application of fertilizer at 80 kg/ha and weeding at 4WAP and improved disease control measures, particularly those that involve exclusion principles, like seed treatment and spray against the vectors.

Key words: Potato varieties; Fertilizer; Weeding; Diseases

INTRODUCTION

Potato (*Solanum Tuberosum L.*) is one of the most important food crops in the world after wheat, rice, maize and barley (CIP, 2002; Fageria *et al.*, 1999). It is the most efficient tuber crop in Nigeria in terms of yield and value (Okonkwo *et al.*, 1995). Potato production in Nigeria stood at 600,000 tonnes, and its cultivation covered 1.1 million hectres (FAO, 2003). Yields in the range of 10.25 t/ha are obtainable under farmers' conditions depending on the climate and agronomic practices (Okonkwo *et al.*, 1995).

The most important areas of potato production in Nigeria are Jos, Biu and Mambila plateaux, where potato can be grown both in dry and rainy seasons. In the low land Northern States of Nigeria such as Sokoto, potato is produced only during the harmattan (November-February) when temperatures are sufficiently low (Okonkwo *et al.,* 1995).

Potato is a high input crop, especially where irrigation is needed. In most production fields, adequate cultural practices such as appropriate weeding regime and fertilizer level are inevitable, and must be provided for the crop to express its full yield potential. Often, like most crops, potato is faced with one disease or the other which could be physiological (climatic or nutritive) or pathogenic in nature. Physiological diseases can easily be corrected by planting in appropriate environment and adequate supply of the deficient nutrients.

Pathogenic diseases of potato such as bacterial wilt (*Pseudomonas solanacearum*), early blight, potato tuber rot (*Erwinia carotovora*) and common scab disease (*Streptomyces scabies*) can be corrected by a well planned integrated disease management system (Efenkwe *et al.*, 1992; Harris, 1978). Researches like in Harper (1999), Okonkwo *et al.* (1995) and Mathew and Karikari (1990) have shown disease incidence to cause 40-80% loss in potato yield especially in the tropical environments where the climate favours the growth and spread of diseases. The production of the crop should therefore make adequate provision for protecting crops from attack by diseases, through identifying the type and range of diseases in a given area and time of production. This study aimed at determining whether fertilizer rate and weeding regime have influence on disease incidence on RC 7716-17 and BR 68-18 varieties of potato.

MATERIALS AND METHODS

Site Description

Two experiments were conducted during the 2001/02 and 2002/03 dry seasons at the Usmanu Danfodiyo University Teaching and Research Fadama Farm, Sokoto (latitude 13^{o}9'N and 5^{o}15'E longitude). The climate of the area is semi-arid with rainfall range of 550-660 mm per annum, spread over a period of 4-5 months (May-September). A mean monthly temperature range of 14^{o}C-41^{o}C was recorded between 2000 and 2003 (Source: SERC). The soil of the study area was clay loam and seasonally flooded (during rainy season). The physico-chemical analysis of the soil at the experimental site revealed that the soils were low in total N, available P and organic carbon and was slightly acidic in nature (pH = 5.61- 6.35). The soil at the experimental site was loamy in 2001/02 and clay loam in 2002/03 cropping season (Table 1).

Treatment and Experimental Design

The treatments consisted of four NPK (20:10:10) fertilizer rates (0, 80, 160 and 240kg/ha), three weeding regimes (zero weeding, weeding at 4WAP and weeding at 6WAP) and two potato varieties (BR 68-18 and RC 7716-17). The treatments were factorially combined and laid out in a split plot design, replicated three times. Variety and fertilizer were allocated to the main plots while weeding regimes ware allocated to the subplots. The gross and net plot sizes were 3.75m × 6.5m (17.5 m^2) and 1.2 m × 2.25 m (2.7 m^2), respectively.

Experimental Set-Up, Data Collection and Analysis

Planting was done at the rate of 1 seed per hill at a depth of about 5cm using a hand hoe and spacing of 75 × 30cm. The fertilizer was applied in two splits, at planting and at 4 WAP by side dressing at about 10cm away from the stand. Irrigation was done at an interval of 5-9 days depending on the need of the crop. Bacterial wilt disease was scored at 6 and 8 WAP, using visual observation by counting the number of infected stands. Early blight was scored at 8 and 11 WAP also by visual observation. The levels of infection on the vines were scored at scale of 1-5 where:1 (stands for 0%), 2 (stands for 1-25%) 3 (stands for 26-50), 4 (stands for 51-75%) and 5 (stands for 76-100% infection).

Table 1: Physico-chemical properties of the soil at the experimental site in 2001/02 and 2002/03 cropping seasons.

Physical and chemical characteristics	2001/02	2002/02
Chemical properties		
pH (water)	6.35	5.61
pH ($CaCl_2$)	5.92	5.56
Organic carbon (g/kg)	0.27	0.74
Total N (g/kg)	0.056	0.77
Available P (ppm)	0.025	0.024
CEC (Cmol/kg)	3.16	3.16
Exchangeable bases		
Ca	0.095	0.040
Mg	0.065	0.040
K	1.025	1.051
Na	1.080	0.113
Physical properties		
Sand (g/kg soil)	44.2	33.8
Silt (g/kg soil)	44.4	35.0
Clay (g/kg)	11.4	31.2
Textural class	Loam	Clay loam

Tubers infected with rot and/or scab diseases were recorded in both years. Tubers infected with each or both diseases from the total number of tubers within the net plot were recorded and data were expressed in percentage. The crop was harvested when the vines turned yellow. The data generated were analysed using analysis of variance (ANOVA) and means were separated using least significant difference (LSD).

RESULTS AND DISCUSSION

Bacterial Wilt Disease

Bacterial wilt disease (*Pseudomonas solanacearum*) was not influenced by all the treatments (Table 2). The disease is a soil borne disease and can remain in the soil for four years or more (Harris, 1978; Okonkwo *et al.,* 1995). This could be the reason for low

infection as potato crop has not been grown in the area in the previous years and hence no build up of and spread of the disease in subsequent plantings.

Table 2: Bacterial wilt disease as influenced by fertilizer rates, weeding regime and potato varieties in 2002/03 cropping season

Treatment	Bacterial Wilt	
	6WAP	8WAP
Fertilizer NPK (20: 10:10) (kg/ha)		
0	2.006	2.817
80	4.056	3.389
160	1.794	2.294
240	3.333	1.328
LSD	2.4876	2.1475
Significance	Ns	Ns
Weeding		
No weeding	3.971	3.333
4 WAP	1.804	2.258
6 WAP	2.617	1.779
LSD	2.1544	1.8598
Significance	Ns	Ns
Variety		
BR 68-18	2.6000	2.6556
RC 7716 – 17	2.9944	2.6583
LSD	1.7590	1.5185
Significance	Ns	Ns

Ns = not significant, WAP = weeks after planting.

Early Blight Disease

The highest level of infection of early blight was recorded in plots where no fertilizer was applied (Table 3). This might be connected to the possible low vigour of crops in unfertilized plots which made the crops more susceptible to the disease. The disease is known to defect potato crop with low vigour and grown in soils deficient in nutrients, especially nitrogen (Okonkwo *et al.*, (1995). The same reason could be attributed to the high level of infection in plots that were left weed infested throughout. Weeds competed with the crops for nutrients, light and other resources, thereby making them weaker and hence more susceptible to diseases.

Potato Rot

The potato tuber rot caused by *Erwinia carotovora* was found to be significantly ($P<0.05$) influenced by fertilizer in both trials (Table 4). The level of infection was generally low with the highest level being 22% attained when fertilizer rate of 160 kg/ha NPK (20: 10: 10) was applied. This could be attributed to the influence of nitrogen in

increasing moisture absorption in tuber as reported by Harper (1999) thereby making them more susceptible to disease. It could also be as a result of higher temperature (32-36^{o}C) during the time of harvesting.

Table 3: Potato early blight disease as affected by fertilizer rate, weeding regime and variety in 2002/03 trial

Treatment	Early blight (%)	
	8WAP	11WAP
Fertilizer NPK (20: 10: 10) (Kg/ha)		
0	1.3333	2.1667[a]
80	1.2778	1.7778[b]
160	1.2222	1.7778[b]
240	1.1111	1.6667[b]
LSD	0.2593	0.3299
Significance	Ns	*
Weeding		
No weeding	1.3333	2.2500[a]
4 WAP	1.1667	1.6250[b]
6 WAP	1.2083	1.6667[b]
LSD	0.2246	0.2857
Significance	Ns	*
Variety		
BR 68 – 18	1.4166	1.8889
RC 7716-17	1.0555	1.8056
LSD	0.3833	0.2333
Significance	Ns	Ns

Means followed by same letter (s) within a treatment group in a column are not significantly different (P>0.05).

Weeding did not have significant (P>0.05) effect on the percent number of tubers infected with potato tuber rot disease. High amount of moisture content in large tubers of RC 7716-17 might be the reason for the higher susceptibility to potato tuber rot. It could also be that BR 68-18 had higher resistance to tuber rot than RC 7716-17.

Number of Potato Tuber Infected with Common Scab Disease

Both fertilizer and weeding did not influence potato common scab disease (*Streptomyces scabies*) in both trials (Table 5). As pointed out by Okonkwo *et al.* (1995) and Harris (1978) potato scab disease is encouraged by alkaline soils, water stress during tuber development and lack of crop rotation. Absence of alkaline soils and water stress during the conduct of the experiment could justify the insignificant and low level of infection in both years.

Table 4: Potato tuber rot as influenced by fertilizer rate, weeding regime and variety in 2001/02 and 2002/03 trials

Treatment	Potato rot	
	2001/02	2002/03
Fertilizer NPK (20: 10: 10) (kg/ha)		
0	8.950[b]	2.4610
80	21.239[a]	3.8000
160	22.117[a]	4.0110
240	21.061[a]	2.9500
LSD	7.5016	2.7249
Significance	**	Ns
Weeding		
No weeding	15.167	3.0290
4 WAP	18.354	3.9040
6 WAP	20.992	2.9830
LSD	6.4966	2.3598
Significance	Ns	Ns
Variety		
BR 68 – 18	10.725[b]	3.1611
RC 7716 – 17	25.958[a]	3.4500
LSD	5.3044	1.9268
Significance	**	Ns

Means followed by same letter (s) within a treatment in a column are not significantly different ($P>0.05$).

Variety was observed to have significantly ($P<0.05$) influenced the percentage of potato tubers infected with potato scab disease in the two trials (Table 5). Variety RC 7716 -17, which had higher level of infestation of potato tuber rot was found to have lower level of potato common scab disease compared to BR 68-18 in both trials. This response of the two varieties to different diseases may be attributed to the inherent genetic constitution of the varieties (Harris, 1978).

Although neither fertilizer nor weeding had significant influence on the level of potato scab infection, their interaction was found to be significant (Table 6). When fertilizer was combined with weeding, the highest level of infestation was recorded in crop supplied with 240 kg/ha NPK (20: 10: 10) and weeded at 4WAP. The lowest level of infection was recorded when 80 kg/ha NPK was applied to the crop that was weeded at 4 WAP. This suggests that for minimum level of infection of potato scab, potato should not be supplied with more than 80 kg/ha NPK and should not be allowed to be interfered by weeds for more than 4WAP.

Table 5: Potato tubers Infected with Common scab disease as influenced by fertilizer rate, weeding regime and variety in 2001/02 and 2002/03 seasons.

Treatments	Common scab	
	2001/02	2002/03
Fertilizer NPK (20: 10: 10) kg/ha		
0	2.8560	11.567
80	1.2060	10.933
160	3.1390	13.272
240	2.4780	14.900
LSD	3.2510	5.717
Significance	Ns	Ns
Weeding		
No weeding	2.1830	9.767
4 WAP	3.1330	12.600
6 WAP	1.9420	15.638
LSD	2.8155	4.951
Significance	Ns	Ns
Variety		
BR 68-18	4.8390[a]	16.281[a]
RC 7716-17	0.0000[b]	9.056[b]
LSD	2.2988	4.042
Significance	**	**
Interaction		
Fertilizer and Weeding	Ns	*

Means followed by same letter (s) within a treatment group in a column are not significantly different (P>0.05).

Table 6: Interaction between fertilizer and time of weeding as it affects the number of potato tubers infected with common scab disease in 2002/03 trial.

Fertilizer kg/ha	Weeding		
	No weeding	4WAP	6WAP
0	13.32	7.17	14.22
80	11.43	6.32	15.05
160	5.27	15.58	18.97
240	9.05	21.33	14.32
$LSD_{0.05}$		3.22	

Ns = not significant, WAP = weeks after planting.

CONCLUSION

From the findings of this study, fertilizer (NPK) application and weeding drastically reduced the early blight disease incidence. Potato tuber rot was enhanced by fertilizer (NPK) application. Potato variety RC 7716-17 was more susceptible to tuber rot than variety BR 68 -18 and vice-versa in terms of common scab disease. NPK (20: 10: 10) fertilization at 80kg/ha and weeding at 4WAP may be recommended especially with variety RC 7716-17. Also, improved disease control measures that involve exclusion principles could be adopted to maximize yield.

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