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Effect of Nitrogen, Phosphorus and Storage Methods on Storability of Onion in Bauchi, Nigeria

I. .J. Dantata

Department of Agricultural Education,
School of Undergraduate Studies
(In Affiliation with University of Maiduguri),
College of Education, PMB 044 Azare, Bauchi, Nigeria
Email: ishiyakudjames {at} gmail.com

ABSTRACT--- ***Field experiment was conducted under irrigation during the 2003/04 dry season at Abubakar Tafawa Balewa University Teaching and Research Farm, Yelwa campus, Bauchi in the Northern Guinea Savanna ecological zone of Nigeria, to study the effect of nitrogen and phosphorus fertilizers with two storage methods on onions produced in a fadama area. The treatments consisted of four levels of both nitrogen (0, 55, 110 and 165 kg N ha^{-1}) and phosphorus (0, 45, 90 and 135 kg P ha^{-1}) fertilizers which were factorially combined in a randomized complete block design with three replications. At harvest bulbs were collected and allowed to cure for two weeks, bulked, and from each bulk, 60 healthy bulbs were selected at random and fixed on-floor and off-floor storage methods in a randomized complete block design with three replications. The storage experiment was carried out in the herbarium of the Bauchi State College of Agriculture, Bauchi for 12 weeks, between April to June, 2004. During this period, the temperature and relative humidity of the store were monitored. Onions bulb weight at storage and percent of rotted bulbs were significantly (P=0.05) influenced by experimental treatments, so also the percent of sprouted bulbs (P= 0.05). Storage losses due to rots and sprouts were as a result of higher levels of nitrogen and phosphorus with storage of onions on-floor.***

Keywords---- Nitrogen (N), phosphorus (P), storage methods, onion, Bauchi

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1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops grown and used throughout the world. Onion being among the high nutrient demanding vegetables, its productivity depends on use of optimum fertilizer rates and if not adequately fertilized, considerable yield losses are apparent (Balemi *et al.*, 2007). Accordingly, the amount of nitrogen needed is based on soil organic matter content, crop uptake and yield levels. Nitrogen uptake levels by onion crops may vary from less than 50 to more than 300 kg ha^{-1}, depending on the location, cultivar, fertilization and yield levels (Hegde, 1986; Sorensen, 1996; Suojala *et al.*, 1998; Salo, 1999; Pire *et al.*, 2001). Under sub-optimal supply of N, onions bulb size and marketable yields can be severely reduced. By contrast, too much nitrogen can result in increased susceptibility to diseases, increased double centre in onions, reduced dry matter contents and storability and, thus, result in reduced yield and quality of marketable bulbs (Sorensen and Grevsen, 2001).

In onions, phosphorus deficiencies reduced bulb size (Greenwood *et al.*, 2001). Results of long-term fertilizer trials on loamy sand soils in Germany have shown a strong response of onions to phosphorus fertilization in the range 0 -52 kg ha $^{-1}$ (Alt *et al.*, 1999). Depending on yield levels, phosphorus uptake rates in onions are estimated to be about 15-30 kg ha^{-1} (Alt *et al.*, 1999; Pire *et al.*, 2001; Salo *et al.*, 2002). Depending on soil phosphorus status, cultivar and plant density, phosphorus application rates of up to 200 kg ha^{-1} were found to maximize onion bulb weights (Abd El-Rehim, 2000; Singh and Singh, 2000) and reduce storage loss of bulbs (Singh *et al.*, 1998).

Storage techniques and conditions have great impact on the storage life of onion (Rahim *et al.*, 1983). Onions are generally stored in bulk on platforms made of split bamboo raised on wooden or bamboo poles to avoid the effect of dampness (Rahim *et al.*, 1992). Babatola and Lawal (2000) noted significant differences in weight loss of onion in relation to storage structures used; mean weight loss was least on slatted tray as compared with other storage structures.

Therefore, a better understanding of the nutrients requirements of onions is needed in order to develop management strategies, which optimizes fertilizer use of the crop and thereby increase returns to producers. Moreover, improved fertilizer management for onions may help to improve quality, particularly bulb size, bulb weight and storability, and thus offer farmers premium prices.

2. MATERIALS AND METHODS

Field experiment was conducted during dry season between September 2003 and April 2004 with irrigation at at Abubakar Tafawa Balewa University Teaching and Research Farm, Yelwa campus, Bauchi. The area is in the Northern Guinea savanna ecological zone of Nigeria (Kowal and Knabe, 1992). Soil physico-chemical properties of the experimental area are presented in table 1. The treatments consisted of four levels of nitrogen (0, 55, 110 and 165 kg N ha^{-1}) and four levels of phosphorus (0, 45, 90 and 135 kg P ha^{-1}), combined factorially and laid out in a randomized complete block design with three replications.

Urea (46%N) and single super phosphate (18% P_20_5) were used as sources of nitrogen and phosphorus, respectively. The phosphorus treatments were applied seven days to transplanting. While nitrogen fertilizer was applied in two equal split amounts at 2 and 6 weeks after transplanting (WAT). Crop maturity was indicated by fallen over of more than 50% of the leaves (Vince *et al.,* 2002). The crops in the fields were harvested on 17th and 18th of March, 2004 respectively, by hoe-digging and lifting from an area of 0.6 x 0.7m in the middle of the plot, and laid on their sides according to treatment and cured for two weeks.

The storage experiment was carried out in the herbarium of the Bauchi State College of Agriculture, Bauchi for 12 weeks between April to June, 2004. During this period, the temperature and relative humidity of the store were recorded (Table 2).

The onion bulbs were bulked treatment wise and from each bulk, 60 healthy, marketable and non-bolter bulbs were selected, and their initial weights obtained (Kale *et al.,* 1991). Two (2) storage systems were used viz: On-floor and off-floor. The bulbs were arranged in a randomised complete block design with three replications. The bulbs were periodically inspected at two weeks interval and observation made on bulb weight, percent of sprouted and rotted onion bulbs. The bulb weight was obtained by subtracting the weight of bulbs at interval of reweighing from the total initial weights recorded. Onion bulbs found to have rotten or sprouted are separated, counted, and their percent number recorded before they are discarded.

Data collected were statistically analyzed using Minitab computer software, where the 'F' test showed significance the means were compared using the least significance difference (LSD) at P= 0.05.

3. RESULTS AND DISCUSION

Bulb weight (Table 3) at storage and percent number of rotted bulbs (Table 4) and percent number of sprouted bulbs (Table 5) of onions are significantly affected by nitrogen and phosphorus application levels with storage methods during ambient storage. Bulb weight at storage decreases significantly with increasing levels of nitrogen and phosphorus with storage type. Intermediate levels of nitrogen and phosphorus checked rates of increase in bulb weights at storage; while higher levels did not, suggesting that these levels encourage reduction in weight of onion bulbs. Similar observation was made by Joubert and Strydom (1968), Singh and Singh (1969) and Amans *et al*. (1990) who found high rate of nitrogen to increase storage losses. However, within the phosphorus-supplied treatment, its influences on bulb weight, between the control treatment, and 45, 90 or 135 kg P are not significant.

This is because moderate rate of phosphorus application coupled with adequate curing before storage tended to reduce storage losses. Curing improves storage life of onion bulbs (Anon, 1990). Storage methods' effect on this parameter increased significantly in relation to the type of structure used. Significant losses were recorded on floor. This suggests that losses incurred during storage is associated with keeping method, hence on-floor storage of onion encourage reduction in weight of good bulbs, probably, due to constant diurnal changes in temperature of the floor which the bulbs are in contact with. Storage techniques have great impact on the storage life of onion (Rahim *et al*., 1983). Babatola and Lawal (2000) noted significant differences in weight change of onion in relation to storage structures used, and they reported high weight loss of bulbs on floor. Whereas, Amans *et al*. (1990) and Hussaini and Amans (2000) stored onion bulbs off- floor platform and recorded a minimum case of weight loss.

Nitrogen and phosphorus rates significantly and consistently increase percent number of rotted bulbs. Quite a percentage number of rotten bulbs were recorded at the highest level of N (165 kg). Increase N rates led to increased storage rot. However, the positive effect of high rate of N on storability of onion by reducing losses due to rot (Bottcher *et al*., 1975) contradicts the present report. The periods of storage, which coincide with warm and more humid conditions (Table 2) compared with earlier periods of crop growth is responsible for this development. This agrees with Kale *et al*. (1991) who showed high storage temperatures of 32-34^{o}C to cause losses in onion bulbs due to rotting, as well as Singh and Kumar (1969) and Painter (1977) who observed an increase incidence in bulb rot with increasing levels of nitrogen fertilization and warmer and more humid storage conditions. The authors reported these as complicating factors in onion bulb decomposition during storage.

The performance of phosphorus in this study is not in conformity with the findings of Singh and Kumar (1969), Wayse (1967), Thompson *et al*. (1972), Brice *et al*. (1997) and Muoneke *et al*. (2003). This team of workers showed that post harvest rot in onion bulbs was reduced by phosphorus application. Storage methods in this study had a significant effect on the onion bulbs, more number of rots were realised when onions were stored on-floor. Among other factors, successful onion storage depends on the choice of storage methods (Jones and Mann, 1963). Denton and Ojeifo (1990) develops improved strategies to reduce losses in onions by storing onion bulbs off-floor on raised platforms with dry grasses, which replaces the traditional method of heaping bulbs on the floor. Also, onions are stored in bulk on raised platforms to avoid the effect on dampness (Rahim *et al*., 1992).

The treatments effect on the percent number of sprouted bulbs is consistently not significant throughout the weeks of storage (WOS), except with P rates at 12 WOS in both cases. The non significant effect of nitrogen, phosphorus and storage methods on this parameter in this study is because the bulbs were fully matured at harvest and well cured before storage and the storage temperature was ambient (Table 2), not high enough to induce sprouting. Poorly matured bulbs often exhibit increased rate of post-harvest sprouting (Painter, 1977). Sprouting in onion bulbs during storage indicates too high a storage temperature and poorly cured onion bulbs (Vince *et al*., 2002).

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Table 1: Physico-chemical properties of the soils at the experimental site

Soil properties	0-30cm depth
Physical analysis	
Particle size distribution (g kg^{-1})	
Sand	120.02
Silt	230.40
Clay	640.58
Texture	Clay loam
Chemical analysis	
pH water (1:1)	5.82
pH $Cacl_2$ (1:2)	5.31
Organic carbon (g kg^{-1})	1.80
Total nitrogen (g kg^{-1})	0.81
C:N	6.43
Available P (mg kg^{-1})	6.78
CEC Cmol (+) kg^{-1}	4.52
Exchangeable bases Cmol (+) kg^{-1}	
Ca	2.18
Mg	0.85
K	0.37
Na	0.03
BS (%)	75.86

Table 2: Temperature and relative humidity of the store during period of ambient storage at Bauchi, Nigeria

Period	Minimum	Maximum	Mean	Minimum	Maximum	Mean
	Temperature (^{O}C)			Relative humidity (%)		
April 2004						
04-10	32.0	37.6	34.8	20	34	27
11-20	31.0	37.2	34.1	20	38	29
21-30	31.0	37.4	34.2	20	48	34
May 2004						
01-10	29.0	36.2	32.6	20	49	34.5
11-20	21.8	35.2	28.5	27	54	40.5
21-31	26.8	33.3	30.1	31	59	45.0
June 2004						
01-10	25.9	31.2	28.6	36	55	45.5
11-20	27.4	33.0	30.2	35	50	42.5
21-30	27.2	33.2	30.2	32	54	43.0

Source: Store room data 2004

Table 3: Effects of N, P and storage methods on bulb weight (kg) of onion during period of ambient storage at Bauchi in 2004.

Treatment	Weeks of storage					
	2	4	6	8	10	12
Nitrogen (kg ha^{-1})						
0	0.90	0.85	0.85	0.81	0.76	0.70
55	1.19	1.12	1.07	1.01	0.95	0.88
110	1.29	1.23	1.17	1.11	1.06	0.93
165	1.43	1.36	1.30	1.24	1.17	1.04
LSD (0.05)	0.13	0.13	0.11	0.12	0.12	0.12
Phosphorus (kg ha^{-1})						
0	1.14	1.08	1.02	0.97	0.92	0.83
45	1.20	1.14	1.08	1.03	0.96	0.87
90	1.24	1.18	1.12	1.07	1.01	0.92
135	1.23	1.17	1.13	1.10	1.04	0.93
LSD (0.05)	NS	NS	NS	NS	NS	NS
Storage methods						
On-floor	1.15	1.09	1.03	0.98	0.92	0.83
Off-floor	1.25	1.20	1.16	1.11	1.04	0.94
LSD (0.05)	0.09	0.09	0.08	0.08	0.08	0.08

NS = Not significant

Table 4: Effects of N, P and storage methods on percent of rotted onion bulbs during period of ambient storage at Bauchi in 2004

Treatment	Weeks of storage					
	2	4	6	8	10	12
Nitrogen (kg ha^{-1})						
0	3.13	3.13	3.13	3.13	3.13	3.13
55	3.13	3.13	3.13	3.13	3.13	3.13
110	3.13	3.13	3.13	3.13	2.89	2.67
165	2.23	1.55	0.74	0.74	0.81	0.98
LSD (0.05)	0.24	0.33	0.22	0.05	0.24	0.23
Phosphorus (kg ha^{-1})						
0	3.13	3.01	2.68	2.49	2.47	2.52
45	3.01	2.66	2.47	2.50	2.53	2.57
90	2.79	2.67	2.46	2.54	2.55	2.62
135	2.68	2.59	2.50	2.59	2.40	2.19
LSD (0.05)	0.24	0.33	0.22	0.05	0.24	0.23
Storage methods						
On-floor	2.73	2.57	2.57	2.57	2.52	2.51
Off-floor	3.07	2.90	2.49	2.48	2.45	2.43
LSD (0.05)	0.17	0.23	0.16	0.04	0.17	0.16

Table 5: Effects of N, P and storage methods on percent of sprouted onion bulbs during period of ambient storage at Bauchi in 2004

Treatment	Weeks of storage					
	2	4	6	8	10	12
Nitrogen (kg ha^{-1})						
0	3.13	3.13	3.13	3.13	3.13	2.89
55	3.13	3.13	3.13	3.13	3.13	3.01
110	3.13	3.13	3.13	3.13	2.89	2.89
165	3.13	3.13	3.13	3.01	3.01	2.77
LSD (0.05)	NS	NS	NS	NS	NS	NS
Phosphorus (kg ha^{-1})						
0	3.13	3.13	3.13	3.13	3.13	3.01
45	3.13	3.13	3.13	3.13	3.13	3.13
90	3.13	3.13	3.13	3.13	3.13	2.89
135	3.13	3.13	3.13	3.01	3.01	2.54
LSD (0.05)	NS	NS	NS	NS	NS	0.44
Storage methods						
On-floor	3.13	3.13	3.13	3.07	3.07	2.95
Off-floor	3.13	3.13	3.13	3.13	3.13	2.83
LSD (0.05)	NS	NS	NS	NS	NS	NS

NS = Not significant