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Urea Fertilizer and Ammonia Produced by Khartoum Refinery Used to Increase the Sorghum (Sorghum BicolorL.) Production in Sudan

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***Abstract*— The objective of the study was to investigate the effect of the time and depth of application of aqueous waste ammonia, as a nitrogen fertilizer, on growth and yield of forage sorghum (Sorghum bicolor L.) and its efficiency as compared to urea fertilizer. A field experiment was conducted at the University of Khartoum farm, Shambat, Sudan, for two seasons (2006-2007) and (2007-2008). The split block design was adopted for the layout of 76 experimental plots representing 19 treatments replicated four times each. Eighty kg N/ha of urea and of ammonia were applied at different depths: 5, 10, and 15cm into the soil at different times of application: one week before sowing , two weeks after sowing and four weeks after sowing . The results revealed that the 15cm depth of application significantly ($p \leq 0.05$) increased the fresh and dry weight of the plant for both urea and ammonia through the two seasons as compared to other depths. The results of the experiment also showed that two weeks after sowing was found to be the best time of nitrogen fertilizer application for both urea and ammonia compared to other times.However, the results showed that yield was better in urea than that of ammonia, but the differences were quantitatively small (about one ton fresh weight ha-1).In conclusion, waste ammonia produced by Khartoum Refinery can be disposed of safely in soil by using it as a cheap nitrogen fertilizer for forage sorghum and that it is practically as efficient as urea fertilizer.**

***Index Terms*— Time of application, Depth of application, aqueous waste ammonia, Urea, Nitrogen fertilizer, Growth, Sorghum.**

I. Introduction

Industrialization is essential for the prosperity of nations. It improves the standard of living which in turn increases the purchasing power, resulting in a higher demand for products. Consequently, the consumption of resources increases causing an economic boom. While industrialization, on the one hand, proves to be highly beneficial to economy, on the other it can also have detrimental effects on the environment such as air, land and /or water pollution. Pollution is caused by the improper treatment of water–borne, soil-borne and air-borne effluents before being disposed of. One of the main industrial activities that contribute highly to the pollution of the environment is the petrochemical one. The emission of poisonous and harmful fumes, accidental spills, and inadequate disposal of waste products are only some examples that cause a huge disruption in the earth remispheres as well as in the lifestyles of human beings and all living organisms.

Improper disposal of waste aqueous ammonia produced by Khartoum Refinery can be one of the main causes of pollution in Khartoum state. Crude oil is produced in the south western Sudan and is refined by Khartoum Refinery. During refining into different commercial products, anhydrous ammonia is produced, and then injected into sour water to maintain a pH level of around 6.5, which assists in preventing corrosion of the pipes in the refinery, before its final disposal. The resulting aqueous ammonia (NH4 OH) is diluted with water to reduce its concentration between 10 % to 18% before it is disposed of. Every year around 1500 tons of ammonia are disposed of, causing problems to both refinery workers and villagers residing nearby. One precautionary measure taken by the administration of the refinery is the dumping of the waste aqueous ammonia around 2 am into a nearby semi-desert land to avoid the toxicity effects. This discharge may potentially contaminate the surrounding area, damage the soil and pollute the surface and underground water as well as the air. In this study the problem of waste aqueous ammonia produced by Khartoum Refinery may be solved via careful experimental testing of the research hypotheses outlined hereunder. It is well known that, the soils of Khartoum state are poor in nitrogen content, thus crop husbandry can only be economically feasible through the application of chemically synthesized N–fertilizer, and in this regard the imported urea is widely used for this purpose. However, for sustainable and economic crop production, proper fertilization strategy is needed in such a way as to make possible the provision of cheap local sources of nitrogen fertilizers. This can be one way for increasing farm production and at the same time reducing the cost of crop production. Petroleum industry in Sudan provides a steady foundation for introduction of petrochemical industry. Therefore, there is a need for best utilization of the agriculturally useful petrochemical products, particularly, nitrogen fertilizers such as ammonium sulfate, ammonium nitrate, urea, anhydrous ammonia and aqueous ammonia. The latter which is a by–product of petroleum refining at Khartoum refinery is of special interest in this study.

A lacuna exists in studies made on waste aqueous

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ammonia in (Adam and El Mahi,2012; Ahmed et al., 2016).

The main objective of this study is to investigate the possibility of useful and environmentally safe disposal "in soil" of ammonia produced by Khartoum refinery. This may be achieved by:

a. Minimizing atmospheric pollution by ammonia volatilization through

b. Investigating the time of application of aqueous ammonia to obtain the best yield of crops, taking forage sorghum as a test crop.

c. Comparing the efficiency of ammonia with urea as a fertilizer for sorghum, under irrigation.

II. Materials and Methods

A. *Description of the Field trial site*

The trial was carried out in two successive growing seasons (2006–2007 and 2007–2008) in the University of Khartoum Experimental farm (latitude 15°40′N and longitude 32°32′E), Shambat, Khartoum, Sudan. The climate of the study area is a semi- desert type. The rainfall occurring mostly during July and August with annual Average of 160 mm (Whiteman, 1971). Average minimum and maximum temperatures range for both seasons between 27°C and 36°C in august (autumn-Kharif-season) and between 25°C and 41°C in May (summer season). (Shambat Agro-meteorological observatory).

Analysis of waste aqueous NH_3 Khartoum Refinery is located North of Khartoum City at a distance of about 70 Km. The refinery is owned by Khartoum Refinery Company Limited. The company is a joint venture established with investment by China National Petroleum and Gas Corporation, and Ministry of Energy and Mining of the Sudan. The daily processing capacity of the Refinery started at 5000 barrels of crude oil (2.5 million tons as an annual processing capacity).The total annual output of gasoline, kerosene, diesel and liquefied petroleum gas is 2.2 million tons (El Tayeb, personal communications).

According to El Tayeb (2005) NH_3 and H_2S produced during the refining process can dissolve into water and be ionized .The solubility of ammonia in water is higher than that of H_2S (the solubility of both being inversely proportional to temperature. NH_3 gas and then withdrawn (from tray 24) and the NH_3vapour pressure is thereby reduced to facilitate the flow of more and more NH_3 gas towards the middle of the tower. This process will result in decreasing the pH of sour water by getting rid of sour H_2S gas through the flare and in the production of anhydrous ammonia (1500 tons/year). The anhydrous ammonia is then mixed with water and its concentration is thus reduced to about 9-10%, where it is stored in a tank before its disposal. The resulting aqueous ammonia is pumped out of these tanks and fed into pipe 503/ABC extending from the refinery site to the liquid waste ammonia dumping site located far from the refinery area. In the dumping site aqueous ammonia is discharged into an open land of semi- desert.

B. *Soil analysis*

Prior to sowing, soil samples were taken from the experimental site at 0- 30 and 30- 60 cm depths. The soil samples were air dried and ground to pass a 2 mm sieve. Particle size distribution was determination of the hydrometer method (Hesse, 1971). Soil pH was measured by using Analogue pH meter. The electrical conductivity of soil extract was obtained by Electrical conductivity meter. Soluble cations and anions were determined according to the procedure of (Richards,1969; Hesse,1971). Phosphorus was determined by using spectrophotometer, Soil nitrogen was determined by micro Kjeldahl (Hesse, 1971). The method used for the determination of organic carbon was described by Jackson (1958). Cation exchange capacity was determined by the method described by Richards (1969). Selected chemical and physical properties of soil are presented in Table 1.

C. *.Land preparation and layout of the experiments*

Three times of fertilizer application were used for both aqueous ammonia and urea. The first application (T1) was one week before sowing, the second application (T2) was two weeks after sowing, and the third application (T3) was four weeks after sowing. One rate of fertilizer application used for both waste ammonia and urea was 80kgN/ha. Three depths of application were used for both ammonia and urea fertilizer: 5cm depth into the soil (D1), 10 cm(D2), and 15cm(D3), into thesoil. The fertilizer was applied about threedaysafter irrigation in each case. About 60kg/ha seed of forage sorghum were drilled manually on a side of each ridge, at the specific depths. Sowing was done on the middle of august 2006 with respect to the first season (autumn - Kharif -season) and on March.2007 with regards to the second season (summer season). The sowing operation was done 7 days after the date of fertilizer application. Weeding was performed manually twice when needed during the growing season.

III. Statistical Analysis

Analysis of variance and test of significance were done according to standard procedure for split plot design (Gomez and Gomez, 1976). Means were differentiated according to Duncan's Multiple Range Test (DMRT).

A. *Fresh weight*

Table 2 and 3 showed a significant difference ($P \leq 0.05$) between effects of times of application on fresh weight: fresh weight in T2 (23.781tons/ha) is higher than that T1 (22.30ton/ha) and T3 (20.0 ton/ha) in first season, Whereas in the second season, fresh weight in T2 (22.229tons/ha) is higher than that in T1 (20.777ton/ha) and in T3(20.825ton/ha) for both urea and ammonia. Table 2 and 3 also show a significant ($P \leq 0.05$) effect of depth of application on yield in both seasons, as D3 was better than D1 and D2 for both urea and ammonia. The mean effect of depth for both fertilizers increased from 21.0 and 22.0 ton/ha for D1and D2, respectively, to 23.40 ton /ha for D3 for the first season, while the mean effect of depth for both fertilizers increased from 19.8470 and 21.50 ton/ha for D1 and D2, respectively, to

22.485 ton /ha for D3. Urea as the source of nitrogen fertilizer was the better than ammonia. The average main effect of both fertilizers was significantly different from the control which gave 12.40 ton/ha as compared to 26.3 and 27.7 ton/ha given by ammonia and urea, respectively. While the average main effect of both fertilizers was significantly different ($P \leq 0.05$) from the control which gave 11.00 ton/ha as compared to 28.58 and 29.181 ton/ha given by ammonia and urea, respectively. Although the differences between ammonia and urea are statistically significant with respect to fresh yield, these differences were quantitatively small.

B. Dry weight

Table 4 showed a significant difference ($P \leq 0.05$) between effects of times of application on dry weight: dry weight in T2 (7.271tons/ha) is higher than that T1 (6.76ton/ha) and T3 (6.30ton/ha) for both urea and ammonia. While, in the second season Table 5 showed a significant difference ($P \leq 0.05$) between effects of times of application on dry weight: dry weight in T2 (6.836tons/ha) is higher than that T1 (6.483ton/ha) and T3 (6.426ton/ha) for both urea and ammonia. In first season, Table 4 also shows a significant effect ($P \leq 0.05$) of a depth of applications on yield, as D3 was better than D1 and D2 in both urea and ammonia. In second season Table 5 also shows a significant effect ($P \leq 0.05$) of depth of application on yield, as D3 was better than D1 and D2 in both urea and ammonia. The mean effect of depth for both fertilizers increased from 6.124 and 6.6961 ton/ha for D1 and D2 respectively, to 6.926 ton /ha in D3. In the first season, the mean effect of depth for both fertilizers increased from 6.53.and 6.61ton/ha for D1 and D2, respectively, to 7.220 ton /ha in D3. Urea as the source of fertilizer was the better than ammonia. The average main effect of both fertilizers was significantly different ($P \leq 0.05$) from the control which gave 3.80ton/ha as compared to 9.188 and 9.800 ton/ha given by ammonia and urea, respectively in first season the average main effect of both fertilizers was significantly different ($P \leq 0.05$) from the control which gave 3.472 ton/ha as compared to 8.75 and 9.30 ton/ha given by ammonia and urea, respectively. Although the difference between ammonia and urea was statistically significant it is quantitatively small.

IV. Discussion

A. Depth of application

Effect of depth of fertilizer application is shown in Tables 2, 3,4 and 5 it is clear that both fresh and dry weight of forage sorghum significantly increased ($P \leq 0.05$) with depth , with D3 producing the highest fresh weight and dry weight for both fertilizers. This may be due to soil depth affects both soil temperature and moisture content (U.S.EPA, 1998), since soil temperature decreases and with moisture increasing with depth.

Reports in the literature have shown that both urea and ammonia are subject to nitrogen loss by NH_3 volatilization (Wangner and Smith 1985). Therefore, it is expected that nitrogen loss in the form of NH_3 will decrease with depth of application due to higher moisture and lower temperature with depth. The result of the present experiment agreed with those of Rao and Dao (1996) who found a greater nitrogen use efficiency with depth of application as grain nitrogen content was found to increase 33% as compared to crop grown under surface application of NH_3. Potter et al., (2001) stated that at 15cm depth decreased of nitrogen loss on cotton crop to 3.9% from total amount of nitrogen applied as compared to surface application .Hamid and Mahler, (1994) found that up to 70% from total amount of nitrogen applied can be lost to the atmosphere by volatilization. Fenn and Kissel, (1974) reported that ammonia volatilization can be significant with surface broadcast of diammonium phosphate and ammonium sulphate. Swart et al., (1971) found that anhydrous ammonia moves more in sandy soils with low CEC and low moisture than finer textured soils with high CEC, but not under moist conditions and at depths over 10 cm. High rates of anhydrous ammoniathere in could be applied with little or no loss from volatilization. Sommer and Ersboll (1994) reported that surface application of nitrogen fertilizer to the soil (not incorporated into the soil through tillage) increases NH_3 loss, but acidification gradually slows the loss, as each molecule of NH_3 oxidized generates one molecule of H^+ (acidity). Crutzen (1976) found that ammonia loss with anhydrous NH_3 is usually not significant because this source must be injected 10 to 25 cm (4 to 10 in.) below the soil surface. Shankarachary and Mehta (1969) found that the loss due to volatilization of ammonia from soil surface treated with urea was up to 58.4% at 15%water holding capacity (WHC) and 34% at 75% WHC during 14 days. Achorn and Broder, (1984) reported that compared to surface broadcast-applied nitrogen, any nitrogen containing fertilizer or manure that is applied to the subsurface will reduce the quantity of nitrogen emitted to the atmosphere. However, gaseous emissions related to volatilization and denitrification still occur regardless of placement. Thus, the weight of literature supports the present finding that deeper (D3) fertilizer application was superior to shallower D2 and D1 depths of application.

B. Time of application:

The effect of time of application is shown in Tables 2, 3,4 and 5. It is clear that both fresh and dry weight of forage sorghum have been significantly effected ($P \leq 0.05$) with time, T2 producing the highest fresh weight and dry weight in both seasons. It is known that nitrogen application affects active crop growth during critical periods of plant need for nitrogen and loss of nitrogen by ammonia volatilization occur at too early application. Kabata - Pendias and Pendias, (1984) reported that the quantity of nutrient absorbed or used by the plant, the nutrient source and the rate, method, and time of application can influence the magnitude and rate of gaseous emissions of the nutrient. Nutrient management can impact all four of the emission mechanisms (NH_3, nitrogen oxides and N) and loss by leaching with time. Alcozet al., (1993), Sowers et al. (1994), and Ayoubet al.,(1995) reported that nitrate movement in the soil and leaching were affected by many factors, such as crop N uptake dynamics, N fertilizer management, rainfall, irrigation management, soil texture, and N transformation in the soil. However, nitrogen rate and time of application are the two main factors influencing the potential for N leaching that can be controlled by the grower. Also Alcozet al., (1993), Sowers et al., (1994) and Ayoubet al.,(1995) found that the best management practices for N fertilization usually contain a common statement that N fertilizer be applied in split application or timed according to crop needs. Nitrogen uptake efficiency is greatest with split N application to wheat which presumably lowers the potential for NO3 leaching. According to the present study T2 shows higher fresh and dry weight, this may be due to the fact that application at T2 satisfies the active growth period, Loomis and Conner, (1992) reported that plants have their greatest need for nutrient during the vegetative phase to support leaf growth, to make full use of the growing season. The easiest procedure is to apply all of the needed material at or before planting although some loss occurs during the lag phase of seedling growth when nutrient uptake is small. Losses can be reduced for row crops by splitting the application between a (starter) and a second dressing just before canopy closure. Scharf and Lory (2007) found that the best management practice for timing of nitrogen fertilizer application is to apply fertilizer as close as possible to the period of rapid crop uptake. Managing N in this way will minimize losses of N from the field and will ensure adequate N availability to the crop during critical growth periods. Khalifaet al, (1977) studied the effect of time of nitrogen application on an open – pollinated variety of corn which was given 60kg/fed as ammonium nitrate applied at different dates from sowing to the 5th irrigation as a whole dose, or in 2 equal split applications. Grain yield was highest with all the nitrogen applied at the 3rd irrigation. Application date also affected the number of days to mid- silking, shelling percentage and 1000 – grain weight. Late application may cause less yield as the active growth period is missed. Loomis and Connor, (1992) reported that application of nitrogen late in the vegetative period or after flowering favor nutrient accumulation in reproduction organs. Responses are species specific, wheat, for example, can absorb considerable nitrogen after flowering and responded with an increased protein content in grain. Ahmed, (1992) found that application at sowing had significant effects on crop yield/m2, number of seeds/cob, cob weight and seed yield / unit area. On the other hand, application at tasseling had significantly affected leaf protein content only. Loomis and Connor, (1992) stated that late application of nitrogen has an unfavorable effect on sugar beet since it stimulates vegetative growth rather than sucrose accumulation and lead to higher content of non- sucrose material in the beet. In general, late application of nitrogen increase the risk of greater carry- over of mineral nitrogen and thus, of greater losses of nitrogen. Thus, N application at T2 suits the purpose of Abu 70 (Sorghum) growth as a forage to produce high vegetative growth with high nitrogen and thus high protein content. Kohanomoo and Mazahery (1995) reported that the three-phase distribution of nitrogen fertilizer has the best effect on total dry weight, protein and height of plant. Almodares, (1996) found that the best method and time of nitrogen fertilizer application will significantly improve both quantity and quality of crops as well as NUE (Nitrogen Use Efficiency). Bationoet al. (1990) reported that nitrogen application of 30kg N/ha in splits achieved good yield in wet years, with only a small yield reduction in dry years. Gautam and Kaushik ,(1984) concluded that pearl millet yield was significantly higher with N applied in two split dressings, at sowing and three week after sowing, than that when applied in two split dressings 3 and 6 weeks after sowing. Singh and Randhawa (1979) concluded that the full dose of N application at tillering was decidedly better than its application at sowing and ear initiation. Split application of N increased the grain yield so much, so that application of half the dose each at tillering and ear initiation was significantly better than full application at sowing. Wrigley (1969) stated that the most effective time for application could be early in the rain when crop has developed sufficient roots to take up the nitrogen before it is leached away rather than at planting.

V. Conclusion

Waste ammonia damage to human health and/or environment can be reduced by suitable application of NH3 in soil as fertilizer for forage sorghum and possibly for other crops. Injection can also be an excellent management option for urea or ammonia solution because it may reduce volatile loss in the form of NH3. Ammonia injection at 10-15cm depth was found suitable at moderate moisture in the soil and possibly in other medium to heavy textured soils characterized by low loss by leaching. Aqueous ammonia as fertilizer used should be applied when the soil is relatively wet at a depth 10-15cm, and in this case it is as efficient as urea in terms of N content in sorghum and increase in crop yield. The best time of nitrogen fertilizer application was found during the stable period of rapid growth and hence rapid crop uptake, two weeks after sowing, according to the result of this study. Stop disposing of NH3 by dumping in desert land and use it as nitrogenous fertilizer at least for forages. Study suitability of ammonia as compared to urea for other crops.

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APPENDIX

Table 1. Some Physical and Chemical Properties of the soil.

The properties	**0-30cm**			**30-60cm**		
Particle size distribution%	clay	Silt	sand	clay	Silt	sand
	47.62	33.38	19.00	44.92	36.08	19.00
pH(25°C)	8.10			7.9		
EC_e at 25°C (dSm^{-1})	0.9			0.25		
CEC meq/100g.	61.95			67.40		
Ca (me/l)	5.0			1.6		
Mg (me/l)	1.0			0.2		
K (me/l)	0.13			0.13		
Na (me/l)	5.3			6.3		
CO_3 (me/l)	0.00			0.00		
HCO_3 (me/l)	7.0			7.0		
Cl (me/l)	67.5			57.5		
P mg/kg^{-1}	4.2			4.00		
Organic matter%	1.88			0.54		
SAR	3.07			7.08		
Total nitrogen %	0.020			0.0060		
Air-dry moisture content%	5.00			5.20		

Table 2: The effect of time, depth of application and fertilizer source on sorghum growth (fresh weight), season 2006-2007.

Treatments		Control	Urea	Ammonia	Means of Time	
T1	D1	12.408^{c}	26.503^{a}	25.083^{a}	22.309^{b}	
	D2	12.408^{c}	27.069^{a}	26.170^{a}		
	D3	12.408 ^{c}	30.069d	28.663^{b}		
	Means of Day	21.016^{C}				
T2	D1	12.408^{c}	28.987^{bd}	27.350^{ae}	23.781^{a}	
	D2	12.408^{c}	30.620^{bd}	28.763^{b}		
	D3	12.408 ^{c}	31.000^{d}	30.085^{d}		
	Means of Day	21.016^{C}				
T3	D1	12.408^{c}	22.613^{g}	21.388^{f}	20.329^{c}	
	D2	12.408^{c}	24.933^{ah}	23.431^{g}		
	D3	12.408 ^{c}	27.443^{a}	25.930^{h}		
	Means of Day	23.379^{a}				
Fertilizers Means		12.409^{c}	27.693^{a}	26.318^{b}	C.V%	10.912

Means in each column having the same latter's are not significantly different at 0.05 level of probability, according to the Duncan s Multiple Range Test

Table 3: The effect of time, depth of application and fertilizer source on sorghum growth (fresh weight), season 2007-2008.

Treatments		Control	Urea	Ammonia	Means of Time	
T1	D1	11.000^{d}	23.490^{e}	21.625^{a}	20.777^{b}	
	D2	11.000^{d}	27.475^{cf}	25.288^{b}		
	D3	11.000^{d}	28.694^{cg}	27.418^{c}		
	Means of Day	21.016^{C}				
T2	D1	11.000^{d}	27.078^{c}	24.506b^{c}	22.229^{a}	
	D2	11.000^{d}	29.181^{cg}	26.569^{bcg}		
	D3	11.000^{d}	31.150^{h}	28.581^{c}		
	Means of Day	21.500^{b}				
T3	D1	11.000^{d}	25.419^{b}	23.502^{e}	20.825^{b}	
	D2	11.000^{d}	26.294^{bc}	25.688^{b}		
	D3	11.000^{d}	27.403^{cg}	26.119^{bc}		
	Means of Day	23.379^{a}				
Fertilizers Means		11.000^{d}	25.477^{b}	27.354^{a}	C.V%	11.3

Means in each column having the same latter's are not significantly different at 0.05 level of probability, according to the Duncan s Multiple Range Test

Table 4: The effect of time, depth of application and fertilizer source on sorghum growth (Dry weight), season 2006-2007.

Treatments		Control	Urea	Ammonia	Means of Time	
T1	D1	3.800^{b}	8.050^{a}	7.275^{a}	6.759^{b}	
	D2	3.800^{b}	8.138^{a}	7.856^{a}		
	D3	3.800^{b}	9.700^{c}	8.409^{a}		
	Means of Day	6.353^{c}				
T2	D1	3.800^{b}	8.667^{a}	8.088^{da}	7.271^{a}	
	D2	3.800^{b}	9.575^{ac}	8.719^{a}		
	D3	3.800^{b}	9.800^{c}	9.188^{ac}		
	Means of Day	6.761^{b}				
T3	D1	3.800^{b}	7.233^{ae}	6.456^{e}	6.305^{c}	
	D2	3.800^{b}	7.898^{a}	7.263^{a}		
	D3	3.800^{b}	8.400^{a}	8.081^{a}		
	Means of Day	7.220^{a}				
Fertilizers Means		3.800^{b}	8.608^{a}	7.926^{b}	C.V%	1 4.05

Means in each column having the same latter's are not significantly different at 0.05 level of probability, according to the Duncan s Multiple Range Test

Table 5: The effect of time, depth of application and fertilizer source on sorghum growth (Dry weight), season 2007-2008.

Treatments		Control	Urea	Ammonia	Means of Time	
T1	D1	3.472^{c}	7.245	6,617^{a}	6.483^{b}	
	D2	3.472^{c}	8.718^{ad}	8.083^{b}		
	D3	3.472^{c}	8.779^{b}	8.493^{b}		
	Means of Day	6.124^{c}				
T2	D1	3.472^{c}	8.203^{ab}	7.758^{bd}	6.836^{a}	
	D2	3.472^{c}	8.950^{b}	8.130^{b}		
	D3	3.472^{c}	9.315^{b}	8.750^{b}		
	Means of Day	6.696^{b}				
T3	D1	3.472^{c}	7.706^{bd}	7.168^{ab}	6.426^{b}	
	D2	3.472^{c}	8.145^{b}	7.818^{bd}		
	D3	3.472^{c}	8.508^{b}	8.069^{bc}		
	Means of Day	6.926^{a}				
Fertilizers Means		3.472^{c}	8.396^{a}	7.876^{b}	C.V%	13.67

Means in each column having the same latter's are not significantly different at 0.05 level of probability, according to the Duncan s Multiple Range Test