

Effect of time and split application of nitrogen on bulb yield of onion at Kassala

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Abstract

This investigation was prompted by the unique method of applying urea on wet soil after irrigation practiced by many farmers in Kassala area. Their justification was to minimize washing and leaching of urea by incoming water if applied before irrigation. Also the nature of urea hydrolysis and volatilization, in addition to the light soil of Kassala with good permeability can all enhance nitrogen losses. This study was carried out to suggest means to minimize nitrogen losses and improve response of onion yield to the applied urea. A fixed dose of 86 kg.N/ha from urea was either applied as one or split in two, or three doses before or after irrigation. Nitrogen application after irrigation (farmers practice) reduced bulb yield by 10.2%, i.e. application before irrigation increased the yield by 11.4%. Splitting the 86 kg.N/ha from urea into 2 or 3 applications raised onion yield by 11% when applied before irrigation. It was recommended to apply urea for onions in 2 doses 4+4 weeks before irrigation.

Introduction

Many farmers in Kassala area used to apply urea fertilizer the second day after irrigation. They believe that in this way the fertilizer will not be drifted to the one side of the flat bed by the incoming water if applied before irrigation, and the high soil humidity during the second day and night is enough to dissolve the urea granules. Kassala soils are silty clay loams with good permeability. Farmers consider this practice as a safeguard against washing and leaching of urea if applied before irrigation.

The good soil permeability and the problem of urea volatilization necessitated this study to investigate means to increase fertilizer use efficiency as measured by yield response of onions to the time of application and to the splitting of a fixed dose of nitrogen.

Materials and methods

This investigation was carried out during the three seasons 1989-90, 1990-91 and 1991-92 with a different set of treatments as outlined in table 1. Nitrogen was applied at a fixed rate of 86 kg.N/ha from urea, applied either immediately before irrigation or the early morning of the second day of irrigation in all seasons. Urea was either given as one full dose, or split in 2 or 3 applications at different intervals. The time and splitting are the 2 factors tested in 8 combinations in a randomized complete block design, factorially arranged in 3 replicates. Seedlings of the white dehydration cultivar ELHilo were raised in open field nurseries for 7 weeks before transplanted at the spacing of 20x10 cm in flat beds 3x7 m². The plots were irrigated at 7 days intervals. Thrips and weeds were chemically controlled. At harvest, the total weight and number of bulbs were recorded besides sorting bulb size bolters and double/split bulbs.

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Results

Total Bulb Yield

The effect of the time of nitrogen application on bulb yield was statistically highly significant ($P = 0.01$). The farmers method of applying urea after irrigation caused a reduction of 10.2% in bulb yield compared to the application before irrigation. Likewise, the effect of splitting nitrogen doze on yield was statistically highly significant ($P = 0.01$). Splitting of urea into 2 applications 4+4 weeks after irrigation increased the yield by 44%, while 3 applications at 2+2+2 weeks after irrigation further raised the yield by 11.2% over the one doze application (Table 2). However, splitting into 2 or 3 doses had similar effects on yield when urea was applied before irrigation.

Percent medium/large bulbs

All treatments recorded a high percentage of medium/large size bulbs (diameters > 3 cm) of over 90%, (Table 3). But the highest percentages of 95.1% and 94.3% were recorded when urea was split into 3 doses 2+2+2 weeks or 2 doses at 4+4 weeks after transplanting. The same effect was observed whether urea was applied before or after irrigation.

Perccn double/split bulbs

The recorded effect of time and split application of nitrogen on percentage of doubles and split bulbs was noticeable (Table 4). Applying urea before irrigation increased doubling by 21.9% as compared with application after irrigation. Splitting the dose into 2 at 4+4 weeks or into 3 at 2+2+2 weeks after transplanting increased the percentage of doubling by 37.1% and 45.7% respectively. The effect was more pronounced when urea was applied before irrigation, where splitting into 3 doses increased doubling to 71%. Splitting had no effect on doubling when urea was applied after irrigation.

Discussion

The results of this investigation confirmed the beneficial effects on onion yield of the split application of urea into 2 or 3 doses. Yield increment caused by split application in 2 or 3 doses was 11% when urea was applied before irrigation. Along the same lines of increasing fertilizer use efficiency, it was proved that farmers practice of applying urea on wet soil on the second day after irrigation rather than before irrigation caused a yield loss of 10.2%.

Ayoub (1984) stated that urea is highly soluble in water and moves easily into the soil. Once dissolved in soil moisture, urea hydrolyzes into ammonium carbonate which is highly unstable, and decomposes into ammonia, carbon dioxide and water. He confirmed that the gaseous nitrogen losses from Gezira soils would significantly affect fertilizer use efficiency. He found that the gaseous nitrogen losses amounted to 54% of the added ammonium fertilizer. He quoted the finding of Jewitt (1942) that ammonium volatilization in Gezira soil was considerable and was associated with water loss (drying) of the soil. Musa (1969) attributed N-losses in Gezira soils to denitrification at soil moisture > 50%.

Jewitt (1956) reported a low recovery of nitrogen fertilizer [120 lb N of $(\text{NH}_4)_2 \text{SO}_4$] by cotton amounting to 10%, while Hassan and Ayoub (1978) reported a recovery of 35% by onions from 90 kg/ha urea nitrogen. This low recovery of urea nitrogen by crops caused by losses due to volatilization and de-nitrification can be

minimized by manipulating the application method. An effective method to increase crop recovery of nitrogen is to apply urea and immediately irrigate to ensure dissolving urea and removing it from the soil surface where it is exposed to quick loss of moisture (drying) which enhances nitrogen losses.

On the other hand, the silty clay loams of Kassala derived from the Gash river sedimentation are known for good permeability. Hence, the easily soluble urea can be quickly leached out of the top soil. Applying urea as one dose is apt to cause high loss of nitrogen by continuous leaching with regular irrigations. Split application is expected to minimize losses by leaching, and hence increase the nitrogen available to the crop. This was reflected by the significant positive response of bulb yield of onions to splitting 86 kg.N/ha from urea into 2 or 3 doses applied before irrigation. Since the yield increments affected by splitting into either 2 or 3 doses were similar, hence the conventional split application of urea into 2 equal doses is advocated for practical and economic reasons.

Recommendation

To increase fertilizer use efficiency, and improve onion yield response to nitrogen, it is recommended to apply 86 kg.N/ha from urea fertilizer split into 2 equal doses 4+4 weeks after transplanting and immediately irrigate after application.

References

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Table 1. Specification.

Season	1989-90 - 1990-91 - 1991-92
Urea	86 kg.N/ha
Time of application:	A. After irrigation B. Before irrigation
Single application:	1. 4 wks after transplanting
2 split	2. 4 wks + 4 wks
2 split	3. 3 wks + 3 wks
3 split	4. 2 + 2 + 2 wks
Plant spacing	20 x 10 cm
Subplot size	3 x 7 m ²
Variety	Hilo
Seedling age	7 wks
Transplanting date	3 Dec. 1989, 2 Dec 1990, 18 Nov 1991
Irrigation	7 days
Weed control	Ronstar 25
Pests / diseases	Thrips
Harvest date	8/4/90, 15/4/91, 21/4/92

Table 2. Effect of time and split application of nitrogen on bulb yield of onions at Kassala.

Treatment	1989-90		1990-91		1991-92		Means T/ha	% change
	T/ha	% change	T/ha	% change	T/ha	% change		
A. After Irrig:								
4 wks	21.13		25.89		31.18		26.06	
4+4 wks	22.60	+ 6.9	27.52	+6.3	31.48	+0.9	27.20	+4.4
3+3 wks	23.54	+11.4	28.51	+10.1	30.33	-2.7	27.46	+5.4
2+2+2 wks	24.44	+15.6	28.58	+10.4	33.92	+8.8	28.98	+11.2
B. Before Irrig:								
4 wks	26.96		28.33		31.21		28.83	
4+4 wks	27.46	+1.8	30.76	+8.6	37.83	+21.2	32.02	+11.1
3+3 wks	25.21	-6.5	27.92	-1.4	34.03	+9.0	29.05	+0.7
2+2+2 wks	28.72	+6.5	31.03	+9.5	37.02	+18.6	32.52	+11.8
C.V (%)	14.70		7.18		7.43		4.22	
S.E (±)	2.123		1.185		1.432		0.706	
Means								
Time								
A. After Irrig:	22.93	-15.4	27.62	-6.4	31.73	-9.4	27.42	-10.2
B. Before Irrig:	27.09	+18.1	29.51	+6.8	35.02	+10.3	30.54	+11.4
S.E (±)	1.061		0.592		0.715		0.353	
Split:								
4 wks	24.04		27.11		31.20		27.45	
4+4 wks	25.03	+4.1	29.14	+7.5	34.65	+11.0	29.61	+7.8
3+3 wks	24.38	+1.4	28.21	+4.1	32.18	+3.1	28.26	+2.9
2+2+2 wks	26.58	+10.5	29.81	+10.0	35.47	+13.6	30.62	+11.5
S.E (±)	1.501		0.838		1.012		0.499	

Table 3. Effect of Time and split application of nitrogen on bulb size of onions at Kassala.

Treatment	1989-90		1990-91		1991-92		Means	
	% Med- large	% change	% Med- large	% change	% Med- large	% change	% Med- large	% change
A. After Irrig:								
4 wks	96.1		93.9		90.5		93.5	
4+4 wks	97.0	+0.9	94.6	+0.7	95.0	+4.9	95.5	+2.1
3+3 wks	96.3		94.3		93.6	+3.4	94.7	+1.3
2+2+2 wks	96.7	+0.6	94.4	+0.5	93.6	+3.4	94.9	+1.5
B. Before Irrig:								
4 wks	95.7		94.2		92.2		94.0	
4+4 wks	91.3		96.6	+2.5	91.5		93.1	
3+3 wks	91.8		93.0		88.5		91.1	
2+2+2 wks	96.7	+1.0	95.4	+1.3	94.0	+1.9	95.4	+1.5
C.V (%)	3.42		1.92		5.41		1.60	
S.E (±)	1.882		1.048		2.888		0.869	
Means								
Time								
A. After Irrig:	96.5	+2.7	94.2		93.2	+1.7	94.7	+1.4
B. Before Irrig:	93.9		94.8		91.6		93.4	
S.E (±)	0.940		0.524		1.444		0.434	
Split:								
4 wks	95.9		94.1		91.4		93.8	
4+4 wks	94.2		95.6	+1.6	93.3	+2.1	94.3	+0.5
3+3 wks	94.1		93.6		91.1		92.9	
2+2+2 wks	96.7	+0.8	94.9	0.8	93.8	+2.6	95.1	+1.4
S.E (±)	1.330		0.741		2.042		0.614	

Table 4. Effect of time and split application of nitrogen on percentage of double bulbs.

Treatment	1989-90		1990-91		1991-92		Means	
	% Doubles	% change	% Doubles	% change	% Doubles	% change	% Doubles	% change
A. After Irrig:								
4 wks	2.4		5.8		2.4		3.5	
4+4 wks	4.7	+95.0	6.1	+5.2	2.0		4.3	+22.9
3+3 wks	4.1	+71.0	6.1	+5.2	2.4		4.2	+20.0
2+2+2 wks	2.6		7.2	+24.1	2.9	+20.8	4.2	+20.0
B. Before Irrig:								
4 wks	4.4		4.2		1.9		3.5	
4+4 wks	3.3		10.0	+	2.8	+47.3	5.4	+54.2
3+3 wks	5.5	+25	6.9	+64.2	2.6	+36.8	5.0	+42.8
2+2+2 wks	6.2	+40.9	8.4	+100	3.4	+78.9	6.0	+71.4
C.V (%)	42.44		34.54		40.87		26.25	
S.E (±)	1.017		1.362		0.603		0.684	
Means								
Time								
A. After Irrig:	3.4		6.3		2.4		4.1	-18
B. Before Irrig:	4.8	+41.1	7.4	+17.5	2.7	+12.5	5.0	+21.9
S.E (±)	0.508		0.681		0.301		0.342	
Split:								
4 wks	3.4		5.0		2.1		3.5	
4+4 wks	4.0	+17.6	8.1	+62.0	2.4	+14.2	4.8	+37.1
3+3 wks	4.8	+41.1	6.5	+30.0	2.5	+19.0	4.6	+31.4
2+2+2 wks	4.4	+29.4	7.8	+56.0	3.2	+52.4	5.1	+45.7
S.E (±)	0.719		0.963		0.426		0.484	