

Response of Grain Sorghum to Different Nitrogen Sources

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Abstract: Two field experiments were conducted in the new land of Ebshway, Fayoum governorate, Egypt during the two successive seasons of 2006 and 2007 to study the response of two sorghum cultivars (Meina and Horas) to different sources of Nitrogen fertilizers (Miena and Horas). Sorghum cultivars, i.e., Meina and Horas significantly differed in all growth characters under study at 70, 90 and 100 days from sowing and yield and its components except harvest index and K in grains (kg/fed.). Horas cultivar surpassed Meina cultivar in plant height (cm), No. of leaves/plant, LA/plant (dm²), SLA, RGR and CGA at all growth stages. On the other hand, Meina cultivar surpassed Horas in dry weight of plant (g), LAR, SLW at all growth stages. Horas cultivar surpassed Meina yield and its components except N, P, K % and protein content kg/fed. There were significant differences for growth characters and yield and its components owing to nitrogen fertilizers sources. Results showed that slow release nitrogen fertilizer gave the highest increment in plant height, No. of leaves/plant, No of internodes, dry weight of plant (g), LA/plant (dm²) and LAI beside all characters of yield and its components and N, P and K and protein content (kg/fed.). The effect of interaction between sorghum cultivars and nitrogen sources showed a significant effect on all characters under study, it is obvious from the results that Horas cultivar fertilized with slow-release nitrogen fertilizer gave the highest results at most characters under study.

Key words: Sorghum, cultivars, nitrogen, sources

INTRODUCTION

Grain sorghum [*Sorghum bicolor* L. Moench] is one of the most important crops in the world. It is considered the fourth cereal crops after maize, wheat and rice^[2]. Such crop can yield reasonably well under adverse conditions of low soil moisture and high temperature, although it responds well to irrigation. It is grown in different part of the tropical and subtropical regions in the world. In Egypt its concentrated in the middle and upper parts.

Nitrogen is the most nutrient required for high grain sorghum productivity^[9]. Exposing sorghum plants to stress of nitrogen at any phase of its life cycle might lead to detrimental effects on growth, yield and its components. Great efforts have been made by Egyptian scientists to improve sorghum productivity by new cultivars and increasing the efficiency of added fertilizers by controlling the release or minimizing the loss of nutrients. The use of slow-release N fertilizers reduced N leaching from crop land, which contributes to the increase in the nitrate (NO₃) level in ground and surface water^[13].

Recently, slow-release nitrogen fertilizer has been suggested as a potential N fertilizer for sandy soil that control N leaching and increase N use efficiency^[17]. Many investigators reported that sorghum cultivars varied significantly in growth characters and yield and its components^[23,5,20]. On the other hand Ayer^[4]

reported that N losses from the soil could be controlled by coating soluble fertilizer with insoluble materials, thereby reducing its solubility and release into the soil. Zeidan and El-Karamany^[24] reported that in wheat there were significant differences due to N sources in growth, yield and yield components.

Thus the objective of this study is to determine the potential of slow-release N fertilizer compared with urea, ammonium sulphate and ammonium nitrate in two sorghum cultivars.

MATERIALS AND METHODS

Two field experiments were carried out in the new land at Ebshway, Fayoum Governorate, Egypt during two successive seasons of 2006 and 2007 to study the response of two Sorghum cultivars plants to different sources of nitrogen fertilizer. The physico – chemical properties of the soil is presented in Table (1).

The experimental design was a split plot design with four replicates. Sorghum varieties were allocated in the main plots i.e (Meina and Horas), while the four nitrogen sources at rate of 80 Kg N/ fed. were allocated at random in the sub- plots i.e., urea 46% N, ammonium nitrate " NH₄ NO₃", 33.5 % N, ammonium sulphate " (NH₄)₂SO₄" 20.6 %N and Enciabein (40% N), as slow – release N fertilizer obtained from the General Organization for Agriculture Equalization fund (G. O. A. E. F.), Egypt. The plot size

Table 1: physical and chemical analysis of the experimental site(Average of 2006 and 2007 seasons)

sandy	Silt %	Clay %	Texture	Organic matter %	Ca CO ₃	E.C. mmhos.	pH	ppm.			
								N	P	K	Na
52.5	20	27.5	Sandy clay loam	0.84	20.9	2.9	8.02	74	4	0.28	15.62

was 21m² = 1/200 fed., the distance between each row was 60 cm. Each plot consisted of ten rows, five rows were devoted for plant growth sampling, while the other five rows were devoted for yield and its components. Sorghum grains were sown in 19th and 24th June in 2006 and 2007, respectively. Super phosphate (15.5% P₂O₅) was added at rate of 150 Kg/fed., before sowing. After three weeks, plants were thinned to two plants / hill. Four nitrogen sources were added in two split applications before 1st and 2nd irrigation.

The following growth attributes were recorded after 70, 85 and 100 days of sowing:

- Plant height (cm).
- Total dry matter accumulation (g).
- Leaf area/plant (cm²).
- Leaf area index LAI.
- Leaf area ratio (LAR): Blade leaf area in cm² / whole plant dry weight in gm.
- Specific leaf area (SLA): Blade leaf area in cm²/leaf dry weight in gram.
- Specific leaf weight (SLW): leaf dry weight in gm / Blade leaf area in cm².
- RGR (mg/gm / week): $\text{Loge } W_2 - \text{Loge } W_1 / (T_2 - T_1)$.
- CGR (g/g/week): $W_2 - W_1 / T_2 - T_1$.

Where W₁, T₁ and W₂, T₂ refer to dry weight of the whole plant at time T₁ and T₂ in weeks respectively.

Random samples of ten guarded plants from each plot were taken at harvest to estimate the following characters:-

- Weight of panicle (g).
- Grain weight/panicle (g).
- Straw yield/plant (g).
- Grain index (1000 grain weight in gm).
- Straw yield/plant (g).
- Biological yield / plant (g).

Whereas, on the basis of plot size the following traits were estimated: 1- Grain yield (ton/fed.). 2- Strew yield (ton/fed.). 3- Biological yield (ton/ fed.). 4- Harvest index (grain yield/biological yield × 100).

Grains chemical composition: Mature grains of two seasons were subjected to chemical analysis to determine nitrogen, protein, Phosphorus and potassium

contents (kg/fed.). Total Nitrogen was determined by "micro- Kjeldahl methods"^[1]. Crude protein was calculated by multiplying the N values by 5.75 factor according to Montgomery^[15]. The P content was determined according to the method described by Frei *et al.*^[10]. The potassium content was estimated in digest material by flamephotometer^[6].

Statistical analysis was performed according to Snedecor and Cochran^[21]. Treatments mean were compared by L.S.D test. Combined analysis was made from the two growing seasons hence the results of two seasons followed similar trend.

RESULTS AND DISCUSSIONS

Growth and Physiological Characters of Sorghum Plants as Affected by Varieties and Nitrogen Fertilizer Sources:effect of Sorghum Varieties:

The results in Table (2) and Table (3) indicates clearly that there were significant differences between sorghum varieties in growth characters, i.e. plant height, No. of leaves/plant, No. of internodes and dry weight of plant (g) at different stages of growth under study except dry weight of plant at 70 days from sowing. It is also clear from the data that Horas exceeded significantly Meina variety in plant height, No. of leaves/plant, No. of internodes and dry weight of plant (g).Data also revealed that there were significant differences between sorghum varieties in all physiological aspects at different stages of growth under study. Horas variety significantly surpassed Meina variety in LA, LAI, SLA, RGR and CGR. On the other hand Meina variety exceeded Horas variety in LAR and SLW. The differences might be attributed to variation in translocation rate of photosynthesis from leaves to the storing organs, i.e., the grains. Many investigators are in harmony with these results^[7,16].

Effect of Nitrogen Fertilizer Sources: Data in Tables (2) and (3) revealed significant differences due to N sources at all growth characters. Slow release N fertilizer (Enciabein) gave the highest value of plant height, No. of leaves/plant, No. of internodes/plant and dry weight of plant (g) followed by ammonium nitrate, ammonium sulphate and urea.Data presented in Table (3) showed that sorghum grown in soil amended with slow-release N fertilizer (Enciabein) gave significantly more LA/plant (dm²) and LAI in all growth stages than the other sources of N fertilizer, while ammonium nitrate gave significantly more SLA, RGR and CGR

Table 2: Effect of sorghum varieties and N fertilizer sources and their interaction on some growth characters at different growth stages.
(Combined analysis of 2006 and 2007 seasons)

Treatments	Characters	Plant height (cm)			No. of leaves/plant			No. of internodes			Dry weight of plant (g)		
		70	85	100	70	85	100	70	85	100	70	85	100
Varieties	Meina	129.19	138.88	146.38	6.25	6.06	5.50	7.31	7.25	7.25	150.88	167.15	191.49
	Horas	137.81	152.19	157.81	7.25	6.94	6.50	8.19	8.25	8.25	146.88	181.21	209.27
L.S.D. at 5 %		6.13	10.38	7.22	0.25	0.05	0.25	0.13	0.50	0.23	2.11	4.15	6.27
N fertilizer sources	Ammonium nitrate	143.63	156.25	158.25	7.50	7.25	7.13	8.50	8.50	8.50	161.55	190.72	213.91
	Slow-release	145.25	158.50	159.75	7.50	7.38	6.88	8.50	8.50	8.50	167.05	194.43	220.13
	Ammonium sulphate	125.63	141.25	147.38	6.50	6.00	5.50	7.75	7.50	7.50	136.34	163.02	191.03
	Urea	119.50	131.13	147.44	5.50	5.38	4.50	6.50	6.50	6.50	130.58	148.57	176.45
L.S.D. at 5 %		1.75	2.40	1.22	0.12	0.15	0.25	0.25	0.38	0.24	4.41	3.10	5.36
Varieties	N fertilizer sources												
Meina	Ammonium nitrate	137.75	149.75	151.50	7.00	6.75	6.50	8.00	8.00	8.00	158.36	179.60	200.46
	Slow-release	140.00	151.50	153.50	7.00	7.00	6.50	8.00	8.00	8.00	163.47	182.66	210.04
	Ammonium sulphate	122.00	137.00	143.00	6.00	5.50	5.00	8.00	8.00	8.00	163.47	182.66	210.04
	Urea	117.00	127.25	137.50	5.00	5.00	4.00	6.00	6.00	6.00	136.10	144.11	167.54
Horas	Ammonium nitrate	149.50	162.75	165.00	8.00	7.75	7.75	9.00	9.00	9.00	164.74	201.83	227.35
	Slow-release	150.50	165.50	166.00	8.00	7.75	7.25	9.00	9.00	9.00	170.63	206.19	230.21
	Ammonium sulphate	129.25	145.50	151.75	7.00	6.50	6.00	7.75	8.00	8.00	127.07	163.79	194.16
	Urea	122.00	135.00	148.50	6.00	5.75	5.00	7.00	7.00	7.00	125.06	153.03	185.35
L.S.D. at 5 %		4.22	6.39	7.27	0.05	0.25	0.13	0.15	0.18	0.90	3.17	10.23	12.15

Table 3: Effect of sorghum varieties and N fertilizer sources and their interaction on some physiological characters at different growth stages.
(Combined analysis of 2006 and 2007 seasons)

Treatments	Characters	LA/plant (dm ²)			LAI			LAR (cm ² /g)			SLA (cm ² /g)			SLW (g/cm ²)			RGR (mg/g/week)		CGR (g/g/week)	
		70	85	100	70	85	100	70	85	100	70	85	100	70	85	100	70-85	85-100	70-85	85-100
Varieties	Meina	22.84	27.17	30.57	1.91	2.27	2.55	15.03	16.16	15.92	71.99	62.52	49.37	1.36	1.61	1.92	0.08	0.03	14.80	12.17
	Horas	23.38	28.42	32.28	1.95	2.37	2.69	14.70	15.63	15.34	78.89	70.44	58.12	1.27	1.39	1.72	0.09	0.07	17.17	14.03
L.S.D. at 5 %		0.95	0.63	1.34	0.03	0.06	0.11	0.72	0.30	0.02	5.21	6.40	7.21	0.02	0.03	0.01	0.01	0.01	2.50	1.30
N fertilizer sources	Ammonium nitrate	24.05	31.11	35.23	2.01	2.60	2.94	12.74	12.18	11.39	90.57	83.73	82.26	1.11	0.65	1.09	0.12	0.09	14.59	12.31
	Slow-release	27.40	32.21	35.95	2.29	2.69	3.00	16.41	14.35	13.81	75.74	76.97	79.31	1.33	1.36	1.21	0.11	0.08	13.69	11.31
	Ammonium sulphate	21.00	26.49	28.78	1.75	2.21	2.40	16.59	16.25	14.39	64.17	67.22	70.38	1.59	1.49	1.37	0.10	0.08	13.34	12.20
	Urea	17.99	21.37	25.75	1.50	1.79	2.15	16.34	15.07	14.63	56.34	53.37	50.39	1.79	1.90	1.81	0.09	0.06	12.01	11.23
L.S.D. at 5 %		2.13	1.40	3.15	0.01	0.14	0.12	1.30	1.17	0.70	2.11	5.21	6.21	0.02	0.10	0.20	0.01	N.S.	0.10	N.S.
Varieties	N fertilizer sources																			
Meina	Ammonium nitrate	25.02	30.45	33.70	2.09	2.54	2.81	15.80	16.95	16.81	69.29	62.99	55.96	1.44	1.59	1.79	0.23	0.11	11.62	10.43
	Slow-release	27.73	30.99	34.47	2.31	2.58	2.87	16.96	16.96	16.41	70.29	55.13	51.36	1.42	1.81	1.95	0.25	0.11	13.60	9.60
	Ammonium sulphate	20.85	26.28	28.46	1.74	2.19	2.37	14.32	16.20	15.51	70.07	64.72	47.52	1.43	1.55	2.10	0.08	0.07	21.26	12.83
	Urea	17.76	20.94	25.66	1.48	1.75	2.14	13.05	14.53	15.32	78.31	67.24	44.06	1.16	1.49	1.85	0.09	0.08	11.72	11.35
Horas	Ammonium nitrate	23.07	31.76	36.75	1.92	2.65	3.06	14.00	15.74	16.16	76.21	65.31	55.21	1.31	1.53	1.81	0.10	0.06	18.55	12.76
	Slow-release	27.07	33.43	37.43	2.26	2.79	3.12	15.86	16.21	16.26	81.18	73.20	61.32	1.23	1.37	1.63	0.10	0.06	17.78	12.01
	Ammonium sulphate	21.14	26.70	29.10	1.76	2.23	2.43	14.37	16.30	14.94	77.86	69.71	59.21	1.28	1.43	1.69	0.13	0.09	18.60	15.19
	Urea	18.22	21.80	25.84	1.52	1.82	2.15	14.57	14.25	13.94	80.31	73.52	56.72	1.25	1.24	1.76	0.10	0.10	16.17	13.98
L.S.D. at 5 %		2.14	3.15	1.48	0.11	0.02	0.10	0.05	0.02	0.03	1.40	3.11	2.13	0.02	0.11	0.04	0.01	0.03	2.13	2.52

than slow-release, ammonium sulphate and urea at all growth stages. On the other hand ammonium sulphate surpassed other N resources in LAR and urea in SLW

at all growth stages under study. Similar results were obtained by Sonbol *et al.*,^[22] Ramirez-cano *et al.*,^[19] and Zeidan and El Karamany^[24].

Effect of Interaction: The data listed in Tables (2) and (3) showed significant interaction between sorghum varieties and N fertilizer sources in all growth and physiological characters at all growth stages under study. Variety Horas fertilized with slow-release N fertilizer gave the highest value of plant height (cm), No. of leaves/plant, No. of internodes/plant and dry weight of plant (g) at all growth stages. On the other hand, a slight increase was observed in a few traits due to Horas variety with slow-release N fertilizer such as LA / plant, LAI and SLA, while the same variety with ammonium sulphate gave the highest value of CGR. Meina variety with slow-release N fertilizer exceeded significantly Horas variety, also other N fertilizer sources in SLW and RGR at all growth characters, while LAR at 70 days from sowing only. Furthermore, Meina with ammonium nitrate gave the highest LAR at 70 and 100 days from sowing.

Yield and its Components of Sorghum Plants as Affected by Varieties and Nitrogen Fertilizer Sources: effect of Sorghum Varieties:

It is obvious from Table (4) that there were significant differences between sorghum varieties in dry weight/panicle (g), grain yield/panicle (g), straw yield/plant (g), biological yield/plant (g), grain index, shelling percentage, productivity score, grain yield ton/fed., straw yield ton/fed. and biological yield ton/fed. Moreover, Horas variety significantly surpassed Meina in dry weight / panicle, grain yield/panicle, straw yield/plant, biological yield/plant, grain index, shelling percentage, productivity score, grain yield/fed., straw yield/fed., and biological yield/fed. The differences might be attributed to the variation in translocation rate of photosynthesis from leaves to the storing organs, i.e., the grains. Numerous studies confirmed our positive trend for the variety differences^[14,23,5,20].

Effect of N Fertilizer Sources: Regardless of sorghum varieties data in Table (4) showed that there were significant differences between N fertilizer sources in all characters under study except harvest index. It is clear from Table (4) that slow-release nitrogen exceeded significantly the other sources in dry weight/panicle, grain yield/panicle, straw yield/plant, biological yield/plant, grain index, shelling percentage, grain yield/fed., straw yield/fed., and biological yield/fed., followed by ammonium nitrate, ammonium sulphate and at last urea. On the other hand, the difference between ammonium nitrate and slow-release did not reach to significant level. Slow-release nitrogen fertilizers were compared with the other soluble and the scientists emphasized their superiority in increasing yield and its components of many crops^[11,8]. The

superior of slow-release than ammonium nitrate can be attributed to the slow-release of N to meet plants requirement, where it has a low dissolution rate than the others which reduces nitrogen loss from soil profile and gives a chance for more nitrogen uptake by plant root. Similar finding were reported by Kolhe and Mitra^[12], who found that slow-release nitrogen fertilizer gave the highest yield of wheat. Ragasits and Berecz^[18] and Zhang *et al.*,^[25] also showed that slow-release urea increased wheat yields by 18.3 – 27.8 % and rice yields by 27.5 – 50.4 % as compared with common urea. Perrin *et al.*,^[17] showed that amending sandy soils with slow-release N can reduced leaching, increase plant growth and increase N concentration compared with sweet corn grown in soil amended with ammonium nitrate. Sonbol *et al.*, (2000) told that, slow-release N fertilizer overcame soluble N fertilizer. Wheat grown in soil amended with slow-release N fertilizer (Enciabein) gave significantly more yield and its components that wheat grown in soil amended with ammonium-nitrate or ammonium sulphate^[24].

Effect of Interaction: Data listed in Table (5) showed significant interactions between sorghum varieties and N fertilizer sources in all characters under study except harvest index. It is clear from Table (5) that Horas variety with slow-release N fertilizer (Enciabein) was the best treatment in all characters under study especially dry weight/panicle, grain yield/panicle, straw yield/plant, biological yield/plant, shelling percentage and grain yield/fed. While the differences between Horas variety with slow-release and Horas variety with ammonium nitrate did not reach to significant level in grain index, productivity score, straw yield/fed. and biological yield/fed.

Chemical Composition of Sorghum Grain as Affected by Varieties and N Fertilizer Sources:

Effect of Sorghum Varieties: Data in Table (6) revealed that there were significant differences between sorghum varieties in N, P, K and crude protein content kg/fed., in grains. It is clear from the data that Meina variety exceeded Horas variety in N, P and crude protein content kg/fed., in grains. The differences might be attributed to the variation in translocation rate of photosynthesis from the leaves to the storing organs, i.e., the grains. These results are in agreement with those obtained by Torbalinejad^[23].

Effect of N Fertilizer Sources: It is obvious from Table (6), regardless of sorghum variety, that there were significant differences between N fertilizer sources in N, P, K and crude protein content in grains, Slow-release N fertilizer exceeded the other sources followed

Table 4: Effect of sorghum varieties and N fertilizer sources on yield and its components.(Combined analysis of 2006 and 2007 seasons)

Treatments	Characters	Dry weight / panicle (g)	Grain yield / panicle (g)	Straw yield / plant (g)	Biological yield/ plant (g)	Grain index	Shelling %	Productivity score	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index %
Varieties	Meina	78.48	47.87	222.24	300.72	21.79	60.72	34.59	2.43	13.58	16.01	15.94
	Horas	85.70	53.87	235.07	320.77	23.98	62.62	36.84	2.81	15.34	18.15	15.75
L.S.D. at 5 %		3.72	4.23	5.72	9.11	1.34	1.20	1.48	0.03	1.17	1.37	N.S.
N fertilizer sources	Ammonium nitrate	89.94	55.61	243.82	333.76	27.21	62.16	39.55	3.11	17.00	20.11	16.02
	Slow-release	92.02	59.54	246.99	339.01	28.70	64.67	40.30	3.35	17.68	21.03	16.05
	Ammonium sulphate	78.18	49.21	218.41	296.59	19.30	62.97	33.57	2.15	12.81	14.95	15.91
	Urea	68.22	39.12	205.39	273.61	16.52	56.89	29.45	1.87	10.36	12.23	15.36
L.S.D. at 5 %		2.18	3.54	2.93	5.63	1.30	2.00	2.01	0.13	0.06	1.04	N.S.

Table 5: Effect of interaction between sorghum varieties and N fertilizer sources on yield and its components.(Combined analysis of 2006 and 2007 seasons)

Treatments	Characters	Dry weight /panicle (g)	Grain yield /panicle (g)	Straw yield /plant (g)	Biological yield/ plant (g)	Grain index	Shelling %	Productivity score	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index %
Varieties	N fertilizer sources											
Meina	Ammonium nitrate	86.82	57.65	238.28	325.10	25.52	61.36	38.22	3.02	15.93	18.95	16.20
	Slow-release	88.12	56.00	242.22	330.34	22.67	63.56	37.61	3.26	17.04	20.30	16.30
	Ammonium sulphate	75.93	47.63	217.72	293.70	18.16	62.78	31.91	1.65	12.30	13.95	15.21
	Urea	62.99	35.19	195.67	258.66	15.62	55.19	28.57	1.73	9.05	10.78	16.06
Horas	Ammonium nitrate	93.00	58.56	249.36	342.36	28.89	62.96	40.83	3.15	18.06	21.21	15.93
	Slow-release	95.91	63.07	251.70	347.61	29.72	65.78	40.98	3.43	18.32	21.45	15.80
	Ammonium sulphate	80.43	50.79	224.10	304.53	19.90	63.16	35.22	2.65	13.32	15.97	16.61
	Urea	73.45	43.04	215.11	288.56	17.42	58.58	30.33	2.01	11.67	13.68	14.65
L.S.D. at 5 %		2.34	1.52	1.11	4.62	1.24	0.67	0.24	0.03	1.05	1.40	N.S.

by ammonium nitrate, ammonium sulphate and urea, respectively. On the other hand the differences between slow-release and ammonium nitrate in K content kg/fed., did not reach significant level. Similar findings were obtained by Sonbol *et al.*,^[22] and Zeidan and El Karamany^[24]. Slow-release N fertilizer may help positively in vigorous growth, which was reflected on N, P and K content in plant.

Effect of Interaction: Data in Table (6) showed significant interaction between sorghum varieties and N fertilizer sources in N, P, K and protein content kg/fed. It is clear from the data that Meina variety with slow-release N fertilizer gave the highest value of N, P, K and protein content kg / fed., in grains.

Conclusions: There were significant differences between sorghum varieties. In addition, amending sandy soil with slow-release nitrogen reduces N leaching and increases the yield of sorghum in such poor soil. Also the effect of slow-release N is positive from both environmental and economical aspects. At present in sorghum production the split application of traditional N fertilizers is cheaper, but slow-release N fertilizers, when applied in optimal doses at the right time, minimize the risk of N losses by leaching. Slow-release N fertilizer has long – term effects including reduced leaching losses and enhanced N uptake, as well as positive effects on both health and soil nutrient levels. Therefore amending poor soil with slow-release N fertilizer could be effective in eliminating mid-season N deficiency.

Table 6: Effect of sorghum varieties and N fertilizer sources and their interaction on N, P, K and crude protein content in sorghum grains (kg/fed.).

(Combined analysis of 2006 and 2007 seasons)					
Treatments	Characters	N (kg/fed.)	P (kg/fed.)	K (kg/fed.)	Protein content (kg/fed.)
Varieties	Meina	59.50	13.66	11.17	342.10
	Horas	56.48	12.57	11.20	324.73
L.S.D. at 5 %		2.17	1.02	N.S.	10.23
N fertilizer sources	Ammonium nitrate	61.12	14.27	12.64	351.44
	Slow-release	65.85	16.29	13.65	378.64
	Ammonium sulphate	55.32	11.78	10.25	318.06
	Urea	49.66	9.71	8.22	285.52
L.S.D. at 5 %		3.21	2.07	1.32	20.46
Varieties	N fertilizer sources				
Meina	Ammonium nitrate	62.13	15.32	13.17	357.25
	Slow-release	68.43	17.18	14.13	393.47
	Ammonium sulphate	56.31	12.11	10.17	323.78
	Urea	51.11	9.21	7.21	293.88
Horas	Ammonium nitrate	60.11	13.21	12.10	345.63
	Slow-release	63.27	15.40	13.16	363.80
	Ammonium sulphate	54.32	11.45	10.32	312.34
	Urea	48.20	10.21	9.23	277.15
L.S.D. at 5 %		2.17	1.07	4.02	25.17

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