RESPONSE OF ACRIDID GRASSHOPPERS TO DIFFERENTIAL NITROGEN TREATMENTS ON TALLGRASS PRAIRIE

by

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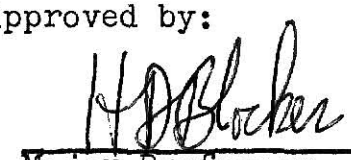

Major Professor

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INTRODUCTION

The Acrididae have been pests of importance since man tried to cultivate crops or raise domestic animals in grasslands. Ancient history tells of the hordes of "locusts" devouring all vegetation in an area. In modern times it is necessary to minimize damage to rangeland by insects, while maximizing yield to feed more livestock per hectare. Overgrazing is one of the major problems of grasslands today. By application of nitrogen to similar pastures primary productivity can be increased, thereby increasing the number of cattle that can be grazed. Another factor that must be considered is the effect of invertebrates. It has been estimated that a moderate infestation of grasshoppers of 6 to 7 per square meter over a 4.05 hectare plot will consume grass equal to that of one cow (Bullen 1966). Other estimates range from 10% to 25% of primary productivity consumed or destroyed by grasshoppers (Bailey and Riegert 1973; Mitchell and Pfadt 1974). Therefore, it is also important to know what effect nitrogen application may have on grasshopper populations. If nitrogen stimulated grasshopper population growth, the extra primary productivity gained through fertililization might be lost to a higher population of grasshoppers. On the other hand if nitrogen application limits or does not affect grasshopper populations, then the pasture should benefit by increased primary productivity especially

if there is a decrease in grasshopper numbers competing for the vegetation.

The objective of this study was to determine the effect of nitrogen application to tallgrass prairie in Eastern Kansas on grasshopper populations. Since it is necessary to know the diet of grasshoppers before they can be classified as pests or not, we utilized the data of Campbell et al. (1974), who published on plant ingestions by grasshoppers in the habitat under study.

REVIEW OF LITERATURE

A. Insects and Nitrogen

Most of the literature on Acrididae deals with chemical control measures, ecology or taxonomy. There is relatively little information available on the affects of a varied diet on the grasshoppers.

Grasshoppers were once thought to be omnivorous and feed on any plant that they contacted. These ideas changed following the work of Isley (1944), Pfadt (1949), Anderson and Wright (1952), Scharff (1954), Chu and Knutson (1970), Mulkern et al. (1969) and Campbell et al. (1974). They found that many species of grasshoppers are quite selective in what they eat. Several species are virtually monophagus such as Hypochlora alba which feeds almost exclusively on Artemesia spp. (sagewort). But most species are oligophagous, feeding on several select plants, or polyphagous, feeding on a wide range of plants.

As more is learned about the food habits of different species of grasshoppers it becomes evident that each species has different nutritional requirements. Creighton (1938) stated that the diet of various animals unquestionably affects their vigor and thereby their reproductive ability. The presence or absence of a certain mineral may deter presence of some insects and stimulate that of others. Haseman (1946) stated that each insect has its specific nutritional requirements for optimum development and reproduction, which may vary

greatly from that of vertebrates. He showed that the greenhouse thrips and chinch bug survive better and reproduce more on low nitrogen plants, while the common grain aphid (Toxoptera graminum) could not survive on plants deficient in nitrogen. Further studies have substantiated these ideas. Smith and Northcott (1951) showed, in the laboratory, that Melanoplus m. mexacanus (sanguinipes) had a higher survival rate when fed on plants of high nitrogen content. They also developed faster and had a higher fecunditity although percent hatch was the same. Smith (1960) showed that Melanoplus bilituratus (sanguinipes) had higher survival, development and fecundity when raised on plants which were low in phosphorus. Evans (1938) found that the cabbage aphid, Brevicoryne brassicae (L), produced more offspring on cabbage high in nitrogen. Rodriquez (1951) demonstrated that the reproductive potential of the two-spotted spider mite, Tetranychus bimaculatus, was increased when raised on tomato plants high in nitrogen. Taylor et al. (1952) reported that potato aphid populations did not react significantly to variations of nitrogen in the food plant. Pea aphid also showed no significant difference, though the populations tended to be higher on high nitrogen plants. They did not demonstrate a preference for high nitrogen plants, however. The European corn borer indicated slightly faster growth on plants with a balanced diet, and field survival was higher on vigorous plants. Adkisson (1958)

showed that high nitrogen resulted in higher populations of Heliothis zea (Biddie) after a certain date because the lusher growth of plants rich in nitrogen were more attractive to oviposition. Daniels (1957) found, in the greenhouse, fewer greenbugs per grain foliage and less damage on plants with higher nitrogen except where nitrogen was used in conjunction with calcium. He also found that, in the field, the density of greenbugs varied inversely with the amount of nitrogen. Dahms (1947) found that the chinch bug laid more eggs on plants while feeding on plants which were high in nitrogen. Although the female lived longer on plants low in nitrogen, fewer eggs per day were laid. Kindler and Staples (1970) worked with the resistance of alfalfa to the spotted alfalfa aphid at different nutrient levels. No treatment made the susceptible plants more resistant, but resistant plants became less resistant when nitrogen and magnesium levels were increased or when potassium or calcium was deficient.

The above work indicates that increasing the nitrogen levels have different effects on different species of insects, adversely affecting some and benefiting others. Very little work has been done in the field with grasshoppers. Pfadt and Dodd (1974) studied varying moisture and nitrogen levels on sections of shortgrass prairie and determined effects on the abundance of grasshoppers. They found that Cordillacris crenulata was significantly reduced by treatment of fertilizer,

while Psoloessa delicatula responded positively. In irrigated, fertilized plots there was a movement of pest species M. femur-rubrum, M. bivittatus and Chorthippus curtipennis from mesic habitats within one to two miles in every direction of the nitrogen-tested plots.

B. Nitrogen and Range

Frank et al. (1969) showed that, in a short grass prairie in Wyoming, increased nitrogen did not significantly increase the yield of warm season grasses. Yield of cool season grasses varied. The percent crude protein was increased by increased nitrogen. Mader (1956) used nitrogen, phosphorous and potassium to try to increase yield but found that only nitrogen increased yield significantly and that if adequate moisture is available in spring and supplemental nitrogen is added, cool season plants will be enhanced and reduce moisture and nutrients avaliable to warm season plants. In areas where warm season plants are predominant, spring burning is practiced to remove the cool season plants to release the moisture and nutrients to the warm season plants.

Huffine and Elder (1960) found, in Oklahoma, that there were two to five times as many weeds in nitrogen fertilized than in unfertilized pastures. Burglaff et al. (1968) showed that forage yields were increased significantly by 30 and 60 lb. of nitrogen per acre, and that the 30 lb. treatment was

relatively, more economical. Owensby et al. (1970) determined that nitrogen has the potential to increase herbage yield, but results in an increase of weeds and cool season grasses to the point where bluestem range is dominated by undesirable cool season plants.

Lorenz and Rogler (1967) found that 30 lb. per acre nitrogen application increased root weight of range grasses, benefiting uptake of moisture and nutrients. Reed and Dwyer (1971) reported shoot and root production may be increased by nitrogen application.

Woolfolk et al. (1973) found that nitrogen fertilization decreased the forage quality of rangeland and therefore reduced daily gains per steer but by increasing herbage yield, stocking rate may be increased therefore increasing gain.

At Kansas State University, treatments of 0, 45 kg/hectare, and 90 kg/hectare of nitrogen have been added to rangeland for three years. Owensby (personal communication) stated that in the Kansas State University research area, which is late spring burned, the highest return was in a plot with 45 kg of nitrogen per hectare, The 0 and 45 kg/hectare treatments have remained approximately the same, vegetatively, although the added nitrogen does promote broadleaf forb growth to some extent. Since nitrogen application began, the 90 kg/hectare plot has undergone a significant change. Bluestem has been reduced by 33%, probably because of the increased grazing rate. Broadleaf forbs have increased by a factor of 3.

MATERIALS AND METHOD

Studies were conducted in the Donalson Research Pastures, located Northwest of Manhattan, Kansas. They are representative of 1,600,000 hectares of native tallgrass prairie in Kansas.

Three adjacent 17.8 hectare pastures were used to determine effects of nitrogen, as ammonium nitrate, applied aerially. Pasture I recieved no nitrogen, pasture II 45 kgs/hectare and pasture III 90. Each pasture was grazed to its potential based on the level of nitrogen. Pasture I (no N_2) was grazed at 1.34 hectare/steer, pasture II (45 kg N_2/ha) at .97, and pasture III (90 kg N_2/ha) at .76.

Three collection sites were selected in each pasture as being nearly homogeneous as to soil type and vegetation by Dr. C.E. Owensby. It is assumed, therefore, that major difference in the insect activity was the result of nitrogen levels.

Two samples of fifty sweeps, with a standard fifteen inch sweep net, were taken at each collection site totaling six samples in each of the three pastures or eighteen total samples. Samples collected in the field were deposited into one quart cardboard cartons and kept in an ice chest to retard predation and other activity, until they could be placed in a freezer to kill the insects. The Acrididae were separated from other insects, counted and recorded. Each was identified

to genus or species and recorded by collection site. Then they were dried for several days at 86° C. for biomass determination.

RESULTS AND DISCUSSION

The relationships of the mean numbers of grasshoppers collected in each treatment in 1973 and 1974 are shown in figs. 1 and 2, and the mean biomass in figs. 3 and 4. These actual figures are also given in tables 1 through 7 for 1973 and tables 8 through 16 for 1974. The mean biomass/number is also included.

There was no significant difference at the 95% level, between treatments for any of the 3 variables in 1973, both collectively for the year and separately for each collection date.

In 1974, no difference was found when the data were analyzed collectively. There was a significant difference in numbers for Collection 1 (April 19) but only ten individuals were collected in all three treatments. After the first collection, larger numbers were collected and there was no significant difference. Significant differences in biomass were found in collections 6 (August 16) and 7 (September 6). In collection 6 (August 16), the biomass of treatments 1 (no N_2) and II (45 kg N_2/ha) were significantly higher than treatment III (90 kg N_2/ha). In collection 7 (September 6), treatment

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Fig. 1. Numbers of all species of Grasshoppers collected in 1973.

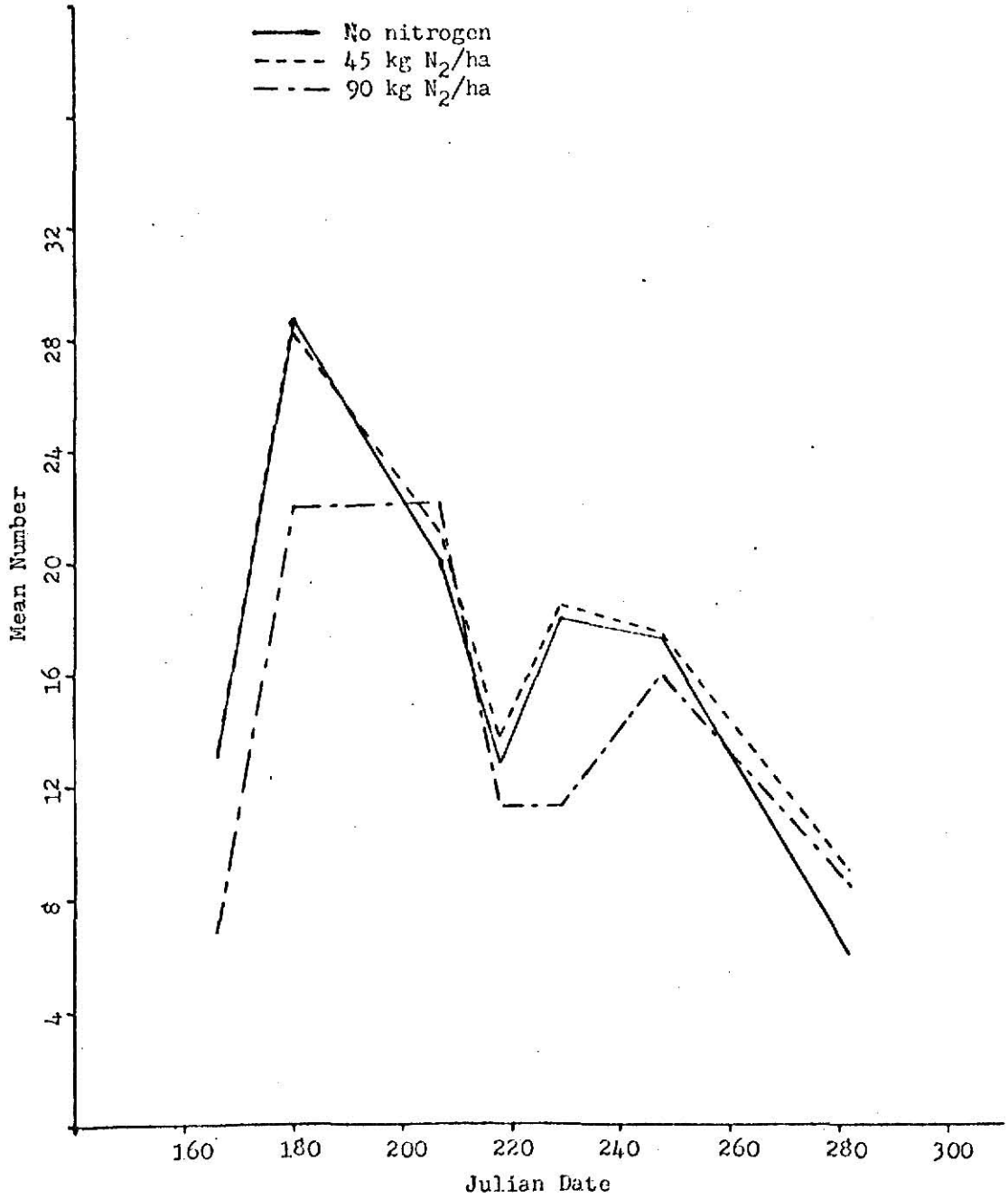

Fig. 2. Numbers of all Grasshoppers collected in 1974.

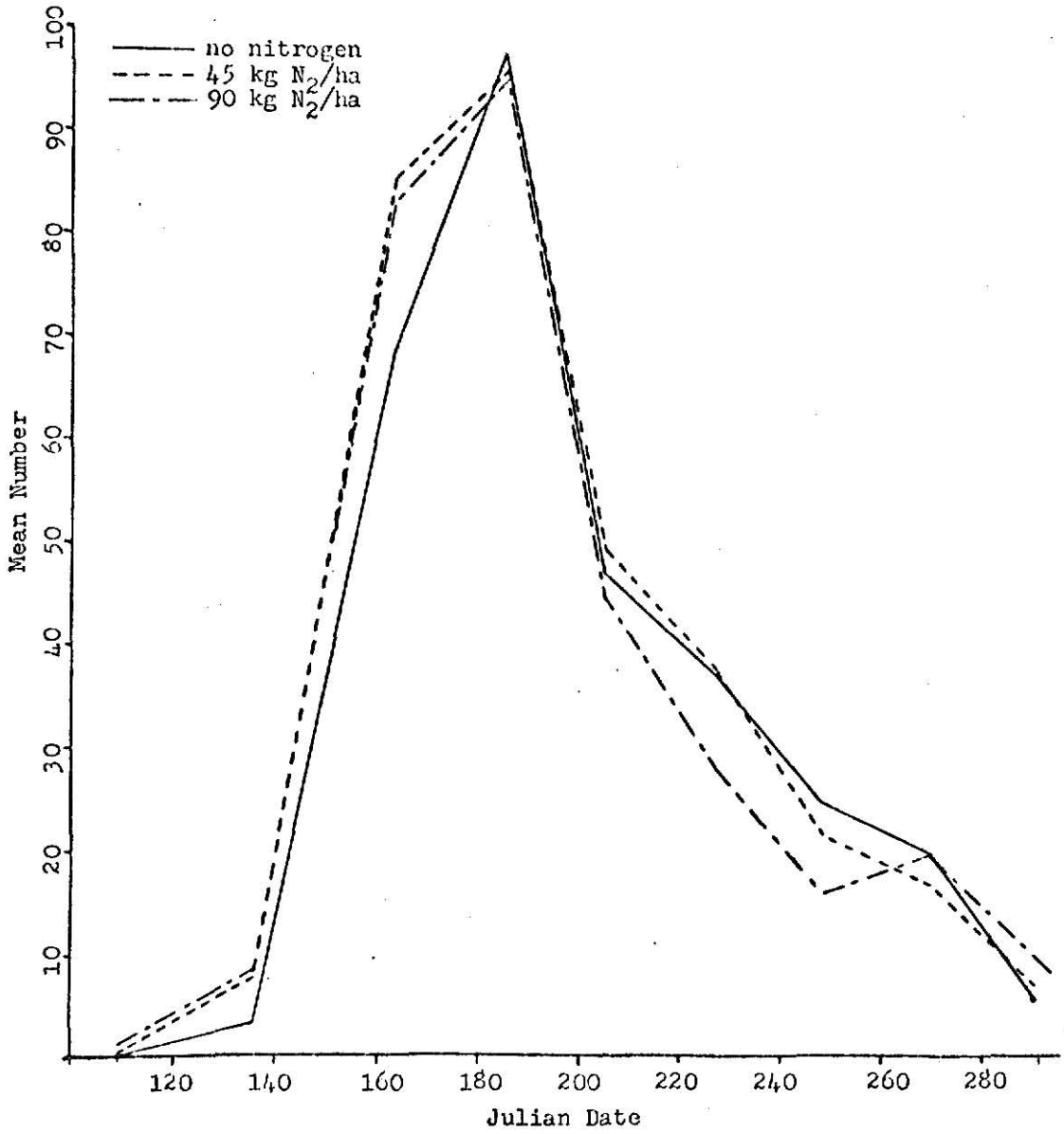

Fig. 3. Biomass of all Grasshoppers collected in 1973.

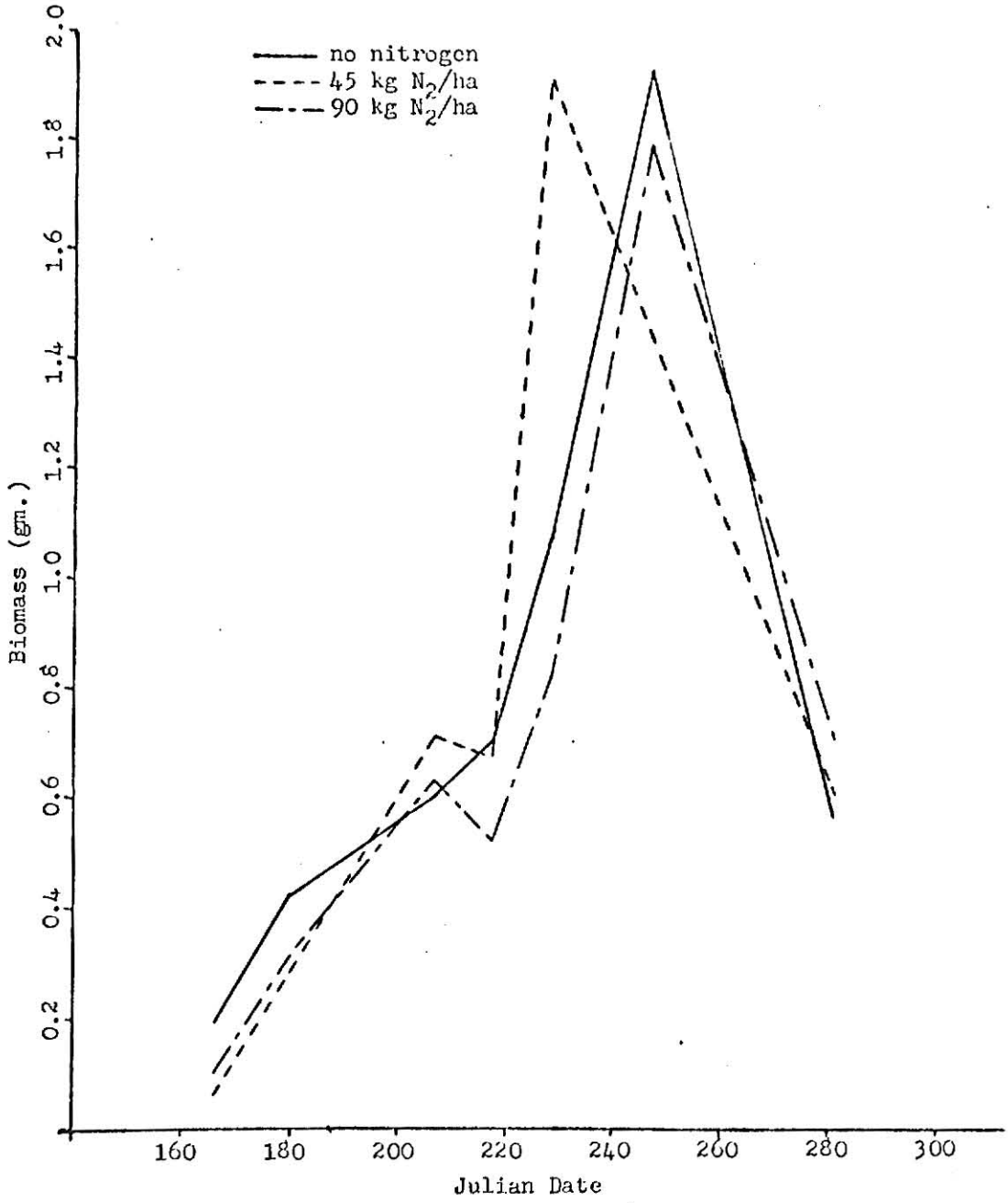

Fig. 4. Biomass of all Grasshoppers collected in 1974.

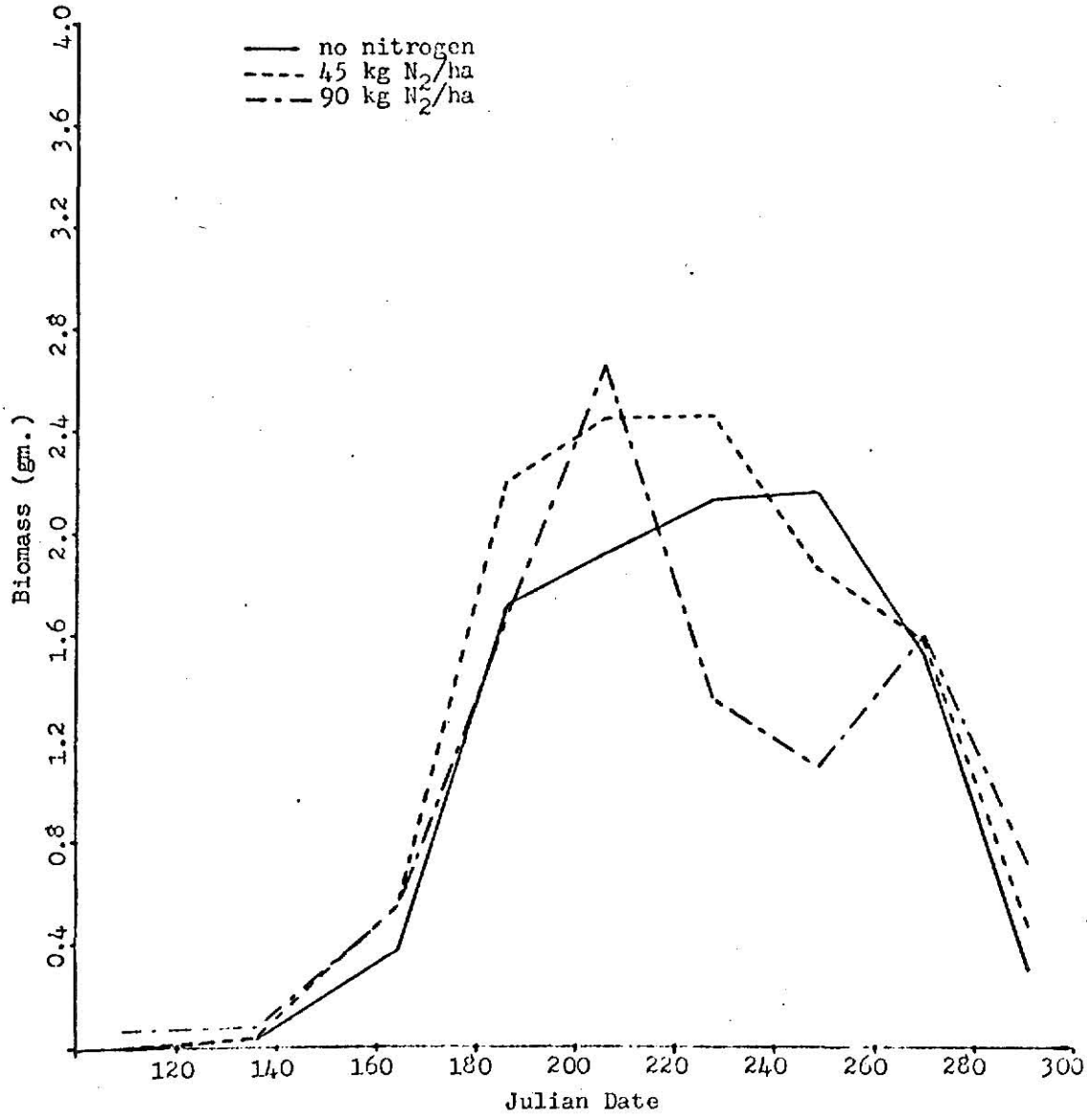

Table 1. Numbers and biomass of all species of Acrididae collected June 15, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/ No. Grasshoppers(gm.)
	No nitrogen treatment		
1	13	.045	
2	9	.295	
3	7	.035	
4	29	.141	
5	5	.026	
6	15	.598	
total	78	1.140	.015
	45 kg/ha nitrogen treatment		
1	17	.058	
2	25	.141	
3	14	.096	
4	5	.024	
5	9	.034	
6	8	.025	
total	78	.378	.004
	90 kg/ha nitrogen treatment		
1	0	.000	
2	8	.044	
3	11	.150	
4	17	.261	
5	4	.022	
6	1	.001	
total	41	.478	.030

Table 2. Numbers and biomass of all species of Acrididae collected June 29, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	70	.426	
2	37	.309	
3	16	.194	
4	25	1.117	
5	12	.362	
6	13	.105	
total	173	2.513	.018
	45 kg/ha nitrogen treatment		
1	29	.377	
2	32	.264	
3	28	.150	
4	19	.206	
5	32	.316	
6	25	.359	
total	165	1.672	.010
	90 kg/ha nitrogen treatment		
1	15	.249	
2	9	.190	
3	29	.255	
4	30	.413	
5	30	.538	
6	19	.193	
total	132	1.838	.015

Table 3. Numbers and biomass of all species of Acrididae collected July 26, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	41	1.114	
2	28	.718	
3	11	.320	
4	15	.687	
5	10	.254	
6	16	.521	
total	121	3.614	.031
	45 kg/ha nitrogen treatment		
1	34	1.201	
2	27	1.164	
3	25	.657	
4	12	.491	
5	13	.214	
6	16	.504	
total	127	4.231	.032
	90 kg/ha nitrogen treatment		
1	20	.524	
2	29	1.049	
3	34	1.259	
4	18	.250	
5	18	.473	
6	14	.250	
total	133	3.805	.026

Table 4. Numbers and biomass of all species of Acrididae collected August 6, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	20	.969	
2	25	1.008	
3	10	.757	
4	5	.173	
5	7	.904	
6	10	.381	
total	77	4.192	.061
	45 kg/ha nitrogen treatment		
1	20	.908	
2	7	.395	
3	8	.493	
4	11	.670	
5	20	.967	
6	17	.610	
total	83	4.043	.051
	90 kg/ha nitrogen treatment		
1	7	.498	
2	14	.570	
3	17	.770	
4	14	1.053	
5	11	.098	
6	5	.107	
total	68	3.096	.044

Table 5. Numbers and biomass of all species of Acrididae collected August 17, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	21	1.116	
2	28	1.744	
3	9	.515	
4	21	1.055	
5	11	.809	
6	18	1.198	
total	108	6.437	.060
	45 kg/ha nitrogen treatment		
1	18	1.261	
2	15	.713	
3	14	.855	
4	19	1.380	
5	13	5.269	
6	32	2.064	
total	111	11.542	.120
	90 kg/ha nitrogen treatment		
1	11	.776	
2	18	1.339	
3	9	.842	
4	15	.764	
5	4	.165	
6	11	1.044	
total	68	4.930	.071

Table 6. Numbers and biomass of all species of Acrididae collected September 5, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	25	2.091	
2	30	2.666	
3	15	1.297	
4	11	1.320	
5	10	1.261	
6	13	2.921	
total	104	11.556	.122
	45 kg/ha nitrogen treatment		
1	23	1.938	
2	16	1.661	
3	19	1.564	
4	14	1.068	
5	22	1.249	
6	12	1.091	
total	105	8.571	.083
	90 kg/ha nitrogen treatment		
1	12	1.724	
2	24	2.041	
3	16	2.185	
4	21	2.810	
5	9	1.107	
6	15	.850	
total	96	10.717	.115

Table 7. Numbers and biomass of all species of Acrididae collected October 8, 1973.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	9	.709	
2	8	.759	
3	6	.432	
4	6	.749	
5	2	.079	
6	5	.619	
total	36	3.347	.089
	45 kg/ha nitrogen treatment		
1	6	.546	
2	4	.205	
3	16	1.066	
4	5	.162	
5	9	.505	
6	14	1.184	
total	54	3.668	.064
	90 kg/ha nitrogen treatment		
1	7	.803	
2	7	.568	
3	9	1.412	
4	11	.869	
5	6	.218	
6	11	.442	
total	51	4.312	.085

Table 8. Numbers and biomass of all species of Acrididae collected April 19, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	0	.000	
2	0	.000	
3	0	.000	
4	1	.002	
5	0	.000	
6	0	.000	
total	1	.002	.000
	45 kg/ha nitrogen treatment		
1	0	.000	
2	0	.000	
3	0	.000	
4	0	.000	
5	0	.000	
6	2	.026	
total	2	.026	.002
	90 kg/ha nitrogen treatment		
1	1	.002	
2	1	.034	
3	1	.056	
4	2	.264	
5	1	.004	
6	1	.042	
total	7	.402	.044

Table 9. Numbers and biomass of all species of Acrididae collected May 16, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	5	.015	
2	4	.056	
3	4	.101	
4	2	.015	
5	2	.012	
6	2	.009	
total	19	.208	.010
	45 kg/ha nitrogen treatment		
1	6	.023	
2	1	.011	
3	4	.029	
4	6	.024	
5	14	.096	
6	14	.055	
total	45	.238	.006
	90 kg/ha nitrogen treatment		
1	7	.020	
2	7	.060	
3	23	.082	
4	5	.113	
5	3	.089	
6	5	.145	
total	50	.509	.016

Table 10. Numbers and biomass of all species of Acrididae collected June 13, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	111	.615	
2	98	.441	
3	33	.255	
4	41	.266	
5	65	.287	
6	62	.386	
total	410	2.250	.006
	45 kg/ha nitrogen treatment		
1	76	.529	
2	130	.683	
3	80	.375	
4	66	.820	
5	107	.438	
6	56	.436	
total	515	3.281	.007
	90 kg/ha nitrogen treatment		
1	97	.843	
2	102	.675	
3	114	.417	
4	111	.564	
5	43	.259	
6	28	.472	
total	495	3.230	.008

Table 11. Numbers and biomass of all species of Acrididae collected July 5, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	136	1.838	
2	152	2.111	
3	59	1.349	
4	47	.962	
5	86	2.116	
6	102	1.951	
total	582	10.327	.019
	45 kg/ha nitrogen treatment		
1	68	1.862	
2	94	1.895	
3	101	2.736	
4	79	1.815	
5	132	3.364	
6	98	1.581	
total	572	13.253	.023
	90 kg/ha nitrogen treatment		
1	79	2.134	
2	191	2.963	
3	114	2.076	
4	37	.571	
5	72	1.202	
6	73	1.073	
total	566	10.019	.018

Table 12. Numbers and biomass of all species of Acrididae collected July 25, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	65	2.014	
2	52	1.949	
3	29	1.111	
4	43	2.017	
5	61	2.942	
6	29	1.542	
total	279	11.575	.043
	45 kg/ha nitrogen treatment		
1	64	2.940	
2	44	2.143	
3	41	2.166	
4	53	2.322	
5	39	2.170	
6	54	2.998	
total	295	14.739	.051
	90 kg/ha nitrogen treatment		
1	74	4.991	
2	41	1.755	
3	60	2.956	
4	26	1.187	
5	38	1.775	
6	26	3.345	
total	265	16.009	.063

Table 13. Numbers and biomass of all species of Acrididae collected August 16, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	44	2.438	
2	58	2.880	
3	32	2.202	
4	31	1.713	
5	37	2.457	
6	18	1.158	
total	220	12.848	.060
	45 kg/ha nitrogen treatment		
1	38	2.899	
2	55	2.873	
3	27	1.595	
4	32	2.153	
5	46	3.502	
6	27	1.809	
total	225	14.831	.067
	90 kg/ha nitrogen treatment		
1	37	1.070	
2	27	.917	
3	28	1.529	
4	27	2.339	
5	25	1.344	
6	22	.928	
total	166	8.127	.050

Table 14. Numbers and biomass of all species of Acrididae collected September 6, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	47	2.820	
2	25	2.914	
3	18	2.052	
4	10	.957	
5	27	2.394	
6	19	1.886	
total	146	13.023	.096
	45 kg/ha nitrogen treatment		
1	27	2.736	
2	25	2.077	
3	22	1.762	
4	14	.951	
5	23	2.275	
6	16	1.440	
total	127	11.241	.087
	90 kg/ha nitrogen treatment		
1	28	2.009	
2	15	1.887	
3	16	1.091	
4	9	.418	
5	8	.213	
6	17	.901	
total	93	6.519	.065

Table 15. Numbers and biomass of all species of Acrididae collected September 27, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	42	3.029	
2	27	2.119	
3	9	.685	
4	11	1.263	
5	16	.994	
6	12	1.141	
total	117	9.231	.083
	45 kg/ha nitrogen treatment		
1	30	2.625	
2	18	1.655	
3	8	.780	
4	11	1.041	
5	13	.931	
6	19	2.518	
total	99	9.550	.096
	90 kg/ha nitrogen treatment		
1	23	2.439	
2	23	2.728	
3	22	1.364	
4	11	1.202	
5	17	.728	
6	20	1.226	
total	116	9.687	.083

Table 16. Numbers and biomass of all species of Acrididae collected October 18, 1974.

Collection Sites	Number of Grasshoppers	Biomass (gm.)	Biomass/No. of Grasshoppers (gm.)
	No nitrogen treatment		
1	7	.326	
2	9	.632	
3	1	.058	
4	8	.360	
5	5	.270	
6	2	.133	
total	32	1.779	.057
	45 kg/ha nitrogen treatment		
1	8	.410	
2	9	.556	
3	2	.035	
4	3	.129	
5	4	.251	
6	14	1.453	
total	40	2.834	.057
	90 kg/ha nitrogen treatment		
1	13	1.493	
2	13	1.113	
3	10	.204	
4	10	.617	
5	6	.572	
6	5	.262	
total	57	4.261	.072

I (no N_2) was significantly higher than treatment III (90 kg N_2/ha), treatment II (45 kg N_2/ha) was intermediate but not significantly different from either treatments I (no N_2) or III (90 kg N_2/ha). The order of the values of biomass follow the same order as the numbers, and the biomass/numbers data show no significant differences. These results make the differences in biomass less convincing. Also, on these two dates in treatment III (90 kg N_2/ha), many Arphia conspersa and Eritettix simplex were taken which are, at this time, early instar nymphs with a reduced biomass. Significance levels are in tables 17 and 18.

Results suggest that numbers and biomass of the Acrididae as a whole are not affected by nitrogen application to rangeland. But when considering the economic importance of grasshoppers, each species must be considered separately, since some feed on valuable range plants and others feed on plants that are less valuable. Also, individual species may be affected differently by nitrogen application.

Counts of each species were made for each collection (Tables 19 - 26, 1973; Tables 27 -36, 1974). Statistical probabilities are given in tables 37 through 39.

In 1973, three species were significantly different between treatments (Table 37). Eritettix simplex reacted positively to the nitrogen application. Treatment I (no N_2) had a mean of 2.4, treatment II (45 kg N_2/ha) 7.4, and

Table 17. Significance levels, 1973 collections.

Collection Number	Number Collected	Biomass	Biomass/ Number
1	29	32	41
2	64	54	34
3	93	89	49
4	78	57	54
5	12	19	42
6	90	39	21
7	29	75	42
total	27	76	92

Table 18. Significance levels, 1974 collections.

Collection Number	Number Collected	Biomass	Biomass/ Number
1	02	11	02
2	22	7	18
3	62	19	60
4	99	36	13
5	86	37	22
6	24	02	15
7	24	04	11
8	81	98	58
9	18	27	53
total	95	55	74

Table 19. Numbers and Species of Acrididae collected in 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	14	9	15
Arphia conspersa	4	13	8
Arphia simplex	2	8	1
Arphia xanthoptera	1	0	0
Boopedon avriventris	3	4	0
Brachystola magna	0	0	1
Campylocantha olivacea olivacea	6	22	15
Chortophaga viridifasciata	6	2	0
Encoptolophus sordidus	0	0	1
Eritettix simplex	12	37	59
Hadrotettix trifasciatus	0	0	3
Hesperotettix speciosus	20	45	30
Hesperotettix viridis pratensis	0	3	6
Hippiscus rugosus	3	2	1
Hypochlora alba	25	8	15
Melanoplus bivittatus	10	12	10
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	160	16	39
Melanoplus keeleri luridus	56	98	96
Melanoplus sanquinipes	3	4	1

Table 19. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	5	6	7
Mermeria bivittatus maculipennis	7	17	10
Mermeria picta neomexicana	10	20	15
Opeia obscura	2	9	6
Orphulella speciosa	200	211	144
Paradalophora haldemanii	5	15	5
Phoetaliotes nebrascansis	108	136	71
Schistocerca sp.	2	2	3
Syrbula admirabilis	33	25	25

Table 20. Numbers and Species of Acrididae collected June 15, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	4	7	3
Arphia conspersa	1	0	0
Arphia simplex	2	0	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	3	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	1	1	1
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	0	0	0
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	1	0	0
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	0	0	0
Hypochlora alba	0	0	1
Melanoplus bivittatus	4	6	6
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	14	8	11
Melanoplus keeleri luridus	3	6	1
Melanoplus sanquinipes	3	3	1

Table 20. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	0	0	2
Mermeria bivittatus maculipennis	2	3	2
Mermeria picta neomexicana	0	0	0
Opeia obscura	0	0	0
Orphulella speciosa	28	32	12
Paradalophora haldemanii	0	0	0
Phoetaliotes nebrascansis	6	8	1
Schistocerca sp.	1	0	0
Syrbula admirabilis	6	4	0

Table 21. Numbers and Species of Acrididae collected June 29, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	6	0	6
Arphia conspersa	0	0	0
Arphia simplex	0	0	1
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	2	0
Brachystola magna	0	0	1
Campylocantha olivacea olivacea	1	4	4
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	0	0	0
Hadrotettix trifasciatus	0	0	2
Hesperotettix speciosus	3	7	4
Hesperotettix viridis pratensis	0	2	2
Hippiscus rugosus	0	0	1
Hypochlora alba	9	1	2
Melanoplus bivittatus	1	3	3
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	50	2	9
Melanoplus keeleri luridus	20	27	27
Melanoplus sanquinipes	0	0	0

Table 21. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	0	0	0
Mermeria bivittatus maculipennis	5	10	7
Mermeria picta neomexicana	0	1	0
Opeia obscura	0	0	0
Orphulella speciosa	58	62	42
Paradalophora haldemanii	0	0	0
Phoetaliotes nebrascansis	14	39	19
Schistocerca sp.	1	2	2
Syrbula admirabilis	5	3	0

Table 22. Numbers and Species of Acrididae collected July 26, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	3	0	2
Arphia conspersa	0	1	1
Arphia simplex	0	0	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	2	7	6
Chortophaga viridifasciata	1	1	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	2	16	15
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	2	2	6
Hesperotettix viridis pratensis	0	1	3
Hippiscus rugosus	0	0	0
Hypochlora alba	1	2	3
Melanoplus bivittatus	0	1	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	23	0	2
Melanoplus keeleri luridus	8	17	20
Melanoplus sanquinipes	0	0	0

Table 22. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	0	0	0
Mermeria bivittatus maculipennis	0	3	0
Mermeria picta neomexicana	2	5	3
Opeia obscura	0	2	5
Orphulella speciosa	40	34	41
Paradalophora haldemanii	3	6	0
Phoetaliotes nebrascansis	25	22	14
Schistocerca sp.	0	0	0
Syrbula admirabilis	9	7	12

Table 23. Numbers and Species of Acrididae collected August 6, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	0	0
Arphia conspersa	1	2	0
Arphia simplex	0	0	0
Arphia xanthoptera	0	0	1
Boopedon avriventris	0	1	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	4	0
Chortophaga viridifasciata	2	1	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	1	4	11
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	6	14	9
Hesperotettix viridis pratensis	0	0	1
Hippiscus rugosus	0	0	0
Hypochlora alba	5	0	3
Melanoplus bivittatus	2	0	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	20	0	6
Melanoplus keeleri luridus	4	6	7
Melanoplus sanquinipes	0	1	0

Table 23. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	0	1	0
Mermeria bivittatus maculipennis	0	1	0
Mermeria picta neomexicana	1	5	1
Opeia obscura	0	0	0
Orphulella speciosa	15	13	17
Paradalophora haldemanii	1	2	2
Phoetaliotes nebrascansis	12	21	8
Schistocerca sp.	0	0	1
Syrbula admirabilis	7	7	1

Table 24. Numbers and Species of Acrididae collected August 17, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	1	2	0
Arphia conspersa	1	2	0
Arphia simplex	0	1	0
Arphia xanthoptera	0	0	1
Boopedon avriventris	0	1	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	2	4	2
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	2	3	7
Hadrotettix trifasciatus	0	0	1
Hesperotettix speciosus	3	15	7
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	1	1	0
Hypochlora alba	7	1	4
Melanoplus bivittatus	3	1	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	20	6	7
Melanoplus keeleri luridus	10	18	9
Melanoplus sanguinipes	0	0	0

Table 24. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	0	0	0
Mermeria bivittatus maculipennis	0	0	0
Mermeria picta neomexicana	1	3	3
Opeia obscura	0	1	0
Orphulella speciosa	24	24	7
Paradalophora haldemanii	0	1	2
Phoetaliotes nebrascansis	29	26	11
Schistocerca sp.	0	0	0
Syrbula admirabilis	4	1	7

Table 25. Numbers and Species of Acrididae collected September 5, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	0	4
Arphia conspersa	1	6	5
Arphia simplex	0	0	0
Arphia xanthoptera	1	0	1
Boopedon avriventris	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	0	0
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	1
Eritettix simplex	2	6	12
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	4	7	4
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	2	1	0
Hypochlora alba	2	3	2
Melanoplus bivittatus	0	0	1
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	33	0	3
Melanoplus keeleri luridus	8	15	23
Melanoplus sanguinipes	0	0	0

Table 25. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	3	4	4
Mermeria bivittatus maculipennis	0	0	0
Mermeria picta neomexicana	3	6	3
Opeia obscura	0	5	0
Orphulella speciosa	23	33	15
Paradalophora haldemanii	0	6	0
Phoetaliotes nebrascansis	19	11	12
Schistocerca sp.	0	0	0
Syrbula admirabilis	2	3	4

Table 26. Numbers and Species of Acrididae collected October 8, 1973.

Genus and Species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	0	0
Arphia conspersa	0	2	2
Arphia simplex	0	7	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	2	2
Chortophaga viridifasciata	3	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	5	8	14
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	1	0	0
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	0	0	0
Hypochlora alba	1	1	0
Melanoplus bivittatus	0	1	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	0	0	1
Melanoplus keeleri luridus	3	9	9
Melanoplus sanquinipes	0	0	0

Table 26. Cont'd

Genus and species	Nitrogen treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus sp.	2	1	1
Mermeria bivittatus maculipennis	0	0	1
Mermeria picta neomexicana	3	0	2
Opeia obscura	2	1	1
Orphulella speciosa	12	13	10
Paradalophora haldemanii	1	0	1
Phoetaliotes nebrascansis	3	9	6
Schistocerca sp.	0	0	0
Syrbula admirabilis	0	0	1

Table 27. Numbers and Species of Acrididae collected in 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	14	29	21
Arphia conspersa	35	46	75
Arphia simplex	9	6	4
Arphia xanthoptera	4	1	0
Boopedon avriventris	4	2	2
Boopedon gracile	0	0	1
Brachystola magna	0	0	1
Campylocantha olivacea olivacea	47	132	156
Chortophaga viridifasciata	4	7	3
Encoptolophus sordidus	0	0	1
Eritettix simplex	13	23	39
Hadrotettix trifasciatus	1	1	1
Hesperotettix speciosus	50	181	292
Hesperotettix viridis pratensis	5	5	7
Hippiscus rugosus	5	7	6
Hypochlora alba	39	52	56
Melanoplus augustipennis	19	5	7
Melanoplus bivittatus	17	25	25
Melanoplus confusus	3	2	4
Melanoplus femurrubrumfemurrubrum	236	33	97

Table 27. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	1	2	0
Melanoplus keeleri luridus	151	212	373
Melanoplus packardii	0	3	0
Melanoplus sanquinipes	0	4	0
Melanoplus scudderi	11	5	5
Melanoplus sp.	58	53	53
Mermeria bivittatus maculipennis	11	19	8
Mermeria picta neomexicana	38	16	16
Opeia obscura	11	9	15
Orphulella speciosa	642	688	291
Paradalophora haldemanii	14	27	35
Phoetaliotes nebrascansis	223	182	149
Schistocerca sp.	8	1	5
Spharagemon sp.	1	1	0
Syrbula admirabilis	125	106	55
Xanthippus sp.	0	1	0
Unidentified	7	29	12

Table 28. Numbers and Species of Acrididae collected April 19, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	0	0
Arphia conspersa	0	1	2
Arphia simplex	0	0	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	0	0
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	0	0	2
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	0	0	0
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	0	0	0
Hypochlora alba	0	0	0
Melanoplus augustipennis	0	0	0
Melanoplus bivittatus	1	0	0
Melanoplus confusus	0	1	1
Melanoplus femurrubrumfemurrubrum	0	0	0

Table 28. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	0	0	0
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	0	0	1
Mermeria bivittatus maculipennis	0	0	0
Mermeria picta neomexicana	0	0	0
Opeia obscura	0	0	0
Orphulella speciosa	0	0	0
Paradalophora haldemanii	0	0	1
Phoetaliotes nebrascansis	0	0	0
Schistocerca sp.	0	0	0
Spharagemon sp.	0	0	0
Syrbula admirabilis	0	0	0
Xanthippus sp.	0	0	0

Table 29. Numbers and Species of Acrididae collected May 16, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	4	14	4
Arphia conspersa	1	0	1
Arphia simplex	0	0	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	7	5
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	1	0	2
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	0	5	13
Hesperotettix viridis pratensis	0	2	2
Hippiscus rugosus	0	0	0
Hypochlora alba	0	0	0
Melanoplus augustipennis	0	0	0
Melanoplus bivittatus	6	9	8
Melanoplus confusus	3	1	3
Melanoplus femurrubrumfemurrubrum	3	2	2

Table 29. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	0	0	0
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	2	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	1	3	9
Mermeria bivittatus maculipennis	0	0	0
Mermeria picta neomexicana	0	0	0
Opeia obscura	0	0	0
Orphulella speciosa	0	0	0
Paradalophora haldemanii	0	0	0
Phoetaliotes nebrascansis	0	0	0
Schistocerca sp.	0	0	0
Spharagemon sp.	0	0	0
Syrbula admirabilis	0	0	0
Xanthippus sp.	0	0	0

Table 30. Numbers and Species of Acrididae collected June 13, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	3	4	10
Arphia conspersa	0	1	0
Arphia simplex	9	3	4
Arphia xanthoptera	0	0	0
Boopedon avriventris	3	2	1
Boopedon gracile	0	0	1
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	7	12	42
Chortophaga viridifasciata	1	2	3
Encoptolophus sordidus	0	0	0
Eritettix simplex	0	0	0
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	11	9	22
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	0	0	0
Hypochlora alba	0	0	2
Melanoplus augustipennis	0	0	0
Melanoplus bivittatus	6	12	13
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	0	3	0

Table 30. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	94	105	217
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	1	0	0
Mermeria bivittatus maculipennis	0	8	1
Mermeria picta neomexicana	0	0	0
Opeia obscura	10	0	1
Orphulella speciosa	148	276	141
Paradalophora haldemanii	0	0	1
Phoetaliotes nebrascansis	35	22	30
Schistocerca sp.	0	0	0
Spharagemon sp.	0	0	0
Syrbula admirabilis	82	55	6
Xanthippus sp.	0	0	0
Unidentified	0	1	0

Table 31. Numbers and Species of Acrididae collected July 5, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	2	1
Arphia conspersa	6	9	0
Arphia simplex	0	0	0
Arphia xanthoptera	0	1	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	35	96	95
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	0	0	0
Hadrotettix trifasciatus	1	1	0
Hesperotettix speciosus	3	26	70
Hesperotettix viridis pratensis	2	1	1
Hippiscus rugosus	0	0	0
Hypochlora alba	8	21	18
Melanoplus augustipennis	0	0	0
Melanoplus bivittatus	0	0	2
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	122	18	54

Table 31. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	1	0	0
Melanoplus keeleri luridus	19	48	93
Melanoplus packardii	0	1	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	1	3	0
Mermeria bivittatus maculipennis	7	6	4
Mermeria picta neomexicana	19	6	12
Opeia obscura	0	7	1
Orphulella speciosa	251	196	97
Paradalophora haldemanii	0	3	2
Phoetaliotes nebrascansis	75	72	69
Schistocerca sp.	7	1	4
Spharagemon sp.	0	0	0
Syrbula admirabilis	21	26	31
Xanthippus sp.	0	0	0
Unidentified	4	27	12

Table 32. Numbers and Species of Acrididae collected July 25, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	1	3	4
Arphia conspersa	1	1	2
Arphia simplex	0	0	0
Arphia xanthoptera	2	0	0
Boopedon avriventris	1	0	1
Boopedon gracile	0	0	0
Brachystola magna	0	0	1
Campylocantha olivacea olivacea	5	13	13
Chortophaga viridifasciata	0	1	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	2	3	7
Hadrotettix trifasciatus	0	0	1
Hesperotettix speciosus	13	63	78
Hesperotettix viridis pratensis	1	0	1
Hippiscus rugosus	1	2	2
Hypochlora alba	12	15	17
Melanoplus augustipennis	1	0	1
Melanoplus bivittatus	1	2	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	54	10	24

Table 32. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	2	0
Melanoplus keeleri luridus	22	26	35
Melanoplus packardii	0	2	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	1	7	11
Mermeria bivittatus maculipennis	1	2	2
Mermeria picta neomexicana	9	6	3
Opeia obscura	0	0	12
Orphulella speciosa	88	79	16
Paradalophora haldemanii	0	2	1
Phoetaliotes nebrascansis	50	43	25
Schistocerca sp.	0	0	0
Spharagemon sp.	1	1	0
Syrbula admirabilis	9	12	8
Xanthippus sp.	0	0	0
Unidentified	3	0	0

Table 33. Numbers and Species of Acrididae collected August 16, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	3	3	1
Arphia conspersa	7	14	22
Arphia simplex	0	2	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	4	1
Chortophaga viridifasciata	1	3	1
Encoptolophus sordidus	0	0	0
Eritettix simplex	5	9	8
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	12	39	41
Hesperotettix viridis pratensis	1	1	1
Hippiscus rugosus	1	3	1
Hypochlora alba	12	12	10
Melanoplus augustipennis	0	0	0
Melanoplus bivittatus	1	0	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	49	0	14

Table 33. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	7	11	9
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	2	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	14	15	7
Mermeria bivittatus maculipennis	1	3	1
Mermeria picta neomexicana	5	2	1
Opeia obscura	0	2	0
Orphulella speciosa	47	69	23
Paradalophora haldemanii	1	3	4
Phoetaliotes nebrascansis	42	18	14
Schistocerca sp.	0	0	0
Spharagemon sp.	0	0	0
Syrbula admirabilis	9	9	6
Xanthippus sp.	0	0	0
Unidentified	0	1	0

Table 34. Numbers and Species of Acrididae collected September 6, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	3	0	1
Arphia conspersa	5	7	18
Arphia simplex	0	0	0
Arphia xanthoptera	1	0	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	0	0
Chortophaga viridifasciata	1	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	3	2	6
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	6	22	28
Hesperotettix viridis pratensis	0	1	0
Hippiscus rugosus	2	0	1
Hypochlora alba	7	4	5
Melanoplus augustipennis	10	4	2
Melanoplus bivittatus	2	1	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	8	0	2

Table 34. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	4	8	5
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	20	11	4
Mermeria bivittatus maculipennis	1	0	0
Mermeria picta neomexicana	4	1	0
Opeia obscura	0	0	1
Orphulella speciosa	43	45	10
Paradalophora haldemanii	4	0	5
Phoetaliotes nebrascansis	10	16	1
Schistocerca sp.	1	0	1
Spharagemon sp.	0	0	0
Syrbula admirabilis	3	3	2
Xanthippus sp.	0	0	0
Unidentified	0	1	0

Table 35. Numbers and Species of Acrididae collected September 27, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	3	0
Arphia conspersa	11	9	19
Arphia simplex	0	1	0
Arphia xanthoptera	1	0	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	0	0
Chortophaga viridifasciata	1	1	0
Encoptolophus sordidus	0	1	1
Eritettix simplex	1	5	12
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	4	14	33
Hesperotettix viridis pratensis	1	0	1
Hippiscus rugosus	1	2	1
Hypochlora alba	1	0	4
Melanoplus augustipennis	6	1	3
Melanoplus bivittatus	0	0	2
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	0	0	1

Table 35. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	5	10	7
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	0	0	0
Melanoplus sp.	15	10	12
Mermeria bivittatus maculipennis	1	0	0
Mermeria picta neomexicana	1	1	0
Opeia obscura	1	0	0
Orphulella speciosa	51	19	4
Paradalophora haldemanii	5	9	9
Phoetaliotes nebrascansis	10	10	4
Schistocerca sp.	0	0	0
Spharagemon sp.	0	0	0
Syrbula admirabilis	1	1	2
Xanthippus sp.	0	0	0

Table 36. Numbers and Species of Acrididae collected October 18, 1974.

Genus and species	Nitrogen Treatments		
	0 kg/ha	45 kg/ha	90 kg/ha
Ageneotettix deorum	0	0	0
Arphia conspersa	4	4	11
Arphia simplex	0	0	0
Arphia xanthoptera	0	0	0
Boopedon avriventris	0	0	0
Boopedon gracile	0	0	0
Brachystola magna	0	0	0
Campylocantha olivacea olivacea	0	0	0
Chortophaga viridifasciata	0	0	0
Encoptolophus sordidus	0	0	0
Eritettix simplex	1	4	2
Hadrotettix trifasciatus	0	0	0
Hesperotettix speciosus	0	3	7
Hesperotettix viridis pratensis	0	0	0
Hippiscus rugosus	0	0	1
Hypochlora alba	0	0	0
Melanoplus augustipennis	2	0	1
Melanoplus bivittatus	0	1	0
Melanoplus confusus	0	0	0
Melanoplus femurrubrumfemurrubrum	0	0	0

Table 36. Cont'd

Genus and species	Nitrogen treatment		
	0 kg/ha	45 kg/ha	90 kg/ha
Melanoplus foedus fluviatilis	0	0	0
Melanoplus keeleri luridus	0	4	7
Melanoplus packardii	0	0	0
Melanoplus sanquinipes	0	0	0
Melanoplus scudderi	1	2	1
Melanoplus sp.	5	4	9
Mermeria bivittatus maculipennis	0	0	0
Mermeria picta neomexicana	0	0	0
Opeia obscura	0	0	0
Orphulella speciosa	14	7	0
Paradalophora haldemanii	4	10	12
Phoetaliotes nebrascansis	1	1	6
Schistocerca sp.	0	0	0
Spharagemon sp.	0	0	0
Syrbula admirabilis	0	0	0
Xanthippus sp.	0	0	0

Table 37. Significance levels of Acrididae collected 1973.

Genus and species	Significance level
Ageneotettix deorum	.87
Arphia conspersa	.31
Arphia simplex	.85
Arphia xanthoptera	1.00
Boopedon avriventris	.13
Campylocantha olivacea olivacea	.21
Chortophaga viridifasciate	.27
Eritettix simplex	<.01
Hesperotettix speciosus	.02
Hesperotettix viridis pratensis	.59
Hippiscus rugosus	.62
Hypochlora alba	.17
Melanoplus bivittatus	.80
Melanoplus femurrubrumfemurrubrum	<.01
Melanoplus keeleri luridus	.30
Melanoplus sanquinipes	.71
Melanoplus sp.	.92
Mermeria bivittatus maculipennis	.93
Mermeria picta neomexicana	.21
Opeia obscura	.90
Orphulella speciosa	.49

Table 37. Cont'd

Genus and species	Significance level
Paradalophora haldemanii	.28
Phoetaliotes nebrascansis	.19
Schistocerca sp.	.46
Syrbula admirabilis	.77

A value of less than .05 is considered a significant difference.

Table 38. Significance levels of Acrididae collected 1974.

Genus and species	Significance level
Ageneotettix deorum	.62
Arphia conspersa	.20
Arphia simplex	.06
Arphia xanthoptera	.67
Boopedon avriventris	.62
Boopedon gracile	1 specimen
Campylocantha olivacea olivacea	.84
Chortophaga viridifasciata	.08
Encoptolophus sordidus	2 specimens
Eritettix simplex	.14
Hadrotettix trifasciatus	1.00
Hesperotettix speciosus	.05
Hesperotettix viridis pratensis	.93
Hippiscus rugosus	.03
Hypochlora alba	.49
Melanoplus augustipennis	.37
Melanoplus bivittatus	.47
Melanoplus confusus	.42
Melanoplus femurrubrumfemurrubrum	.16
Melanoplus foedus fluviatilis	3 specimens
Melanoplus keeleri luridus	.61

Table 38. Cont'd.

Genus and species	Significance level
Melanoplus packardii	3 specimens
Melanoplus sanquinipes	1.00
Melanoplus scudderi	.34
Melanoplus sp.	.99
Mermeria bivittatus maculipennis	.23
Mermeria picta neomexicana	.46
Opeia obscura	.93
Orphulella speciosa	.52
Paradalophora haldemanii	.74
Phoetaliotes nebrascansis	.73
Schistocerca sp.	.78
Spharagemon sp.	2 specimens
Syrbula admirabilis	.65
Xanthippus sp.	1 specimen

A value of less than .05 is considered a significant difference.

Table 39. Combined significance levels of Acrididae collected in 1973 and 1974.

Genus and species	Significance level
Hesperotettix speciosus	.05
Hippiscus rugosus	.23
Orphullella speciosa	.40
Eritettix simplex	.00
Melanoplus femurrubrumfemurrubrum	.01

A value of less than .05 is considered a significant difference.

treatment III (90 kg N_2/ha) 11.8. There was no difference between treatments II (45 kg N_2/ha) and III (90 kg N_2/ha), but both II (45 kg N_2/ha) and III (90 kg N_2/ha) were significantly different from treatment I (no N_2). Eritettix simplex overwinters as a nymph. In a spring burned pasture nearly all are killed by fire. Therefore, those found in burned pastures are immigrants from surrounding unburned areas. Eritettix simplex is gramnivorous and feeds primarily on Bouteloua (grama grass). After spring burning all the pastures begin regrowth at nearly the same time, but within 2 to 3 days the fertilized plots have more forage and may attract more E. simplex from surrounding areas. Once there, they may stay throughout the season. Differences may be the result of varying degrees of attraction to the grasshopper at the time forage regrowth occurs.

Hesperotettix speciosus was more abundant in treatment II (45 kg N_2/ha) in 1973 (mean 9.0), followed by treatment III (90 kg N_2/ha) (mean 6.0) and treatment I (no N_2) (mean 2.9). Treatment II (45 kg N_2/ha) was significantly different from treatment I (no N_2) but treatment III (90 kg N_2/ha) was intermediate and not significant from either of the others. Hesperotettix speciosus is forbivorous, feeding mainly on low value forbs such as Ambrosia and Solidage, which are known to increase when nitrogen is added to prairie. Increased populations in treatments II (45 kg N_2/ha) and III (90 kg N_2/ha)

may result, in part, from increased forb growth. This would not, however, explain why treatment III (90 kg N_2/ha) was intermediate and not significant from treatment I (no N_2) or II (45 kg N_2/ha). This will be considered subsequently when 1974 data are discussed.

Melanoplus femurrubrumfemurrubrum, unlike the previous species, reacted inversely to nitrogen application: treatment I (no N_2) (mean of 26.7), treatment II (45 kg N_2/ha) (mean of 5.3), and treatment III (90 kg N_2/ha) (mean of 5.6). It is a polyphagus, mixed forbiverous feeder (Mulkern et al. 1969), and of limited importance in grasslands. Numbers were significantly higher in treatment I (no N_2) than in either treatment II (45 kg N_2/ha) or III (90 kg N_2/ha), with no difference between the latter. This difference may be the result of a preference for a quality present in non-fertilized plants. Several factors may be responsible. Application of nitrogen fertilizer increases neutral detergent fiber, hemicellulose, crude fiber content, and lignin values, while it decreases the digestability of dry matter, nitrogen, free extract and dilutes protein (Woolfolk et al. 1973). Further research would be necessary to determine if one or a combination of these factors are responsible.

In 1974, numbers of Hippiscus rugosus were found to be significantly higher in treatment II (45 kg N_2/ha) with a mean of 2.3 compared to 1.3 and 1.2 in treatments I (no N_2) and

III (90 kg N_2/ha) respectively. Only 18 Hippiscus rugosus were taken in 1974, too small a sample for conclusive statistical analysis.

The three species that showed difference between treatments in 1973 were not significantly different in 1974, although numbers followed the trends of 1973. Higher variances in 1974 data may account for the absence of difference. Data from 1973 and 1974 for 5 species were combined and analyzed (Table 39). Orphulella speciosa was included because of large but non-significant differences in both years with treatments I (no N_2) and II (45 kg N_2/ha) containing higher numbers than treatment III (90 kg N_2/ha).

The three grasshopper species that were significantly different in 1973 were also significantly different when the two years' data were combined. Eritettix simplex was significantly higher in treatments II (45 kg N_2/ha) and III (90 kg N_2/ha) (means of 6.0 and 8.2 respectively) than in treatment I (no N_2) (mean 2.3). This corresponds to the 1973 data.

Hesperotettix speciosus was significantly higher in treatment III (90 kg N_2/ha) than in treatment I (no N_2). This does not exactly correspond to 1973 data, but may better explain differences. The means were 24.8 for treatment III (90 kg N_2/ha), 17.4 for treatment II (45 kg N_2/ha) and 5.3 for treatment I (no N_2). Since initiation of nitrogen application on the three test pastures the broadleaf forbs have increased

by 1/3 in treatment III (90 kg N_2/ha), while forbs have been comparatively stable in pastures I (no N_2) and II (45 kg N_2/ha), indicating that the increased forb growth may be responsible for higher populations of H. speciosus.

Melanoplus femurrubrumfemurrubrum was significantly higher in treatment I (no N_2) (mean of 36.0), than treatment II (45 kg N_2/ha) (7.0) and treatment III (90 kg N_2/ha) (10.4). This also corresponds with the 1973 data. No other species were shown to be significant by combining the two years data.

The most abundant species in both 1973 and 1974 was Orphulella speciosa. Totals of 200, 211 and 144 were recorded for treatments I (no N_2), II (45 kg N_2/ha) and III (90 kg N_2/ha), respectively in 1973 and 642, 648 and 291 respectively in 1974. Although these numbers were not statistically significant, treatments I (no N_2) and II (45 kg N_2/ha) are noticeably higher. Orphulella speciosa is gramnivorous, feeding on a variety of grasses, including Andropogan and Bouteloua. Lower numbers in treatment III (kg N_2/ha) may have resulted from the decrease in bluestem in that treatment.

Phoetaliotes nebrascansis was another major species with totals of 108, 136 and 71 for treatments I (no N_2), II (45 kg N_2/ha) and III (90 kg N_2/ha) respectively in 1973 and 233, 182 and 149 in 1974. These numbers indicate no appreciable difference, or trend, except that treatment III (90 kg N_2/ha) was low possibly because of the reduction of bluestem grass,

which is the preferred food of P. nebrascansis.

Melanoplus keeleri luridus numbers in 1973, totaled 56, 98 and 96 for treatments I (no N_2), II (45 kg N_2/ha) and III (90 kg N_2/ha), respectively and 151, 212 and 373 respectively in 1974. Numbers of M. keeleri luridus increased in response to nitrogen application possibly because of the resulting increase in broadleaf forbs. The chief foods of M. keeleri luridus are Ambrosia (ragweed) and Artemisia (sagewort).

Syrbula admirabilis feeds mainly on grasses but shows little preference, feeding generally on what is most abundant. In 1973, 33 25 and 25 were taken from treatments I (no N_2), II (45 kg N_2/ha) and III (90 kg N_2/ha), respectively and 125, 106 and 55 respectively in 1974. Syrbula admirabilis may have been reacting to some plant response to the application of nitrogen such as a decrease in digestability and nitrogen free extract, an increase of neutral detergent fiber, hemicellulose, crude fiber content lignin values, or the dilution of protein. Reduction of bluestem grass occurred primarily in treatment III (90 kg N_2/ha) and probably would not explain the lower numbers in treatment II.

Hypochlora alba also occured in sufficient numbers to be considered a major species in both seasons. In 1973, 25, 8 and 15 were recorded for treatments I (no N_2), II (45 kg N_2/ha) and III (90 kg N_2/ha), respectively, 1974 totals were 39, 52 and 56 respectively. They feed almost exclusively on Artemisia

ludoviciana (louisiana sagewort), and is rarely found away from this plant. Therefore, the numbers collected correlate highly with the numbers of its host. As nitrogen is increased, forb cover is also increased. The third year of nitrogen application, 1974, began to show this correlation.

In 1974 Campylacantha olivacea olivacea occurred in high enough numbers to be considered. Totals were 47, 132 and 156 for treatments I (no N_2), II (45 kg N_2/ha) and III (90 kg N_2/ha), respectively. They are specific feeders, mainly on Ambrosia psilostachya (western ragweed), a broadleaf forb, that increases as nitrogen applications increase. This increase is well demonstrated by the number of C. o. olivacea present in treatments II (45 kg N_2/ha) and III (90 kg N_2/ha).

All other species were collected in small numbers and were not considered major species. All species and specimens collected are given in tables 19 through 36. Totals for 1973 are given in table 19 and for 1974 in table 27.

Although all species of Acrididae did not react similarily to the nitrogen treatments, certain species did react significantly between treatments. As these species were examined, the largest single determining factor in their population difference appeared to be the relative abundance of their preferred host plant. Other factors could include behavior, grazing pressure, or microclimate. With M. femurrubrumfemurrubrum and S. admirabilis, nitrogen may be directly related to

population differences.

Of the nine major species taken in the two years, three decreased as nitrogen was increased: M. femurrubrumfemurrubrum, O. speciosa and S. admirabilis. Populations of P. nebrascansis were lower in treatment III (90 kg N_2/ha) both years, but showed no consistant preference between I (no N_2) and II (45 kg N_2/ha). The remaining 5 species increased in numbers as nitrogen increased: C. o. olivacea, E. simplex, H. speciosus, H. alba and M. k. luvidus. Of these species all but E. simplex are forb or mixed feeders and are relatively unimportant as pests of grasslands. With the exception of E. simplex all major grassland pests decrease in number, with increased application of nitrogen.

From this two year study it appears that grasshopper populations react indirectly to the nitrogen applications. Total populations for the three treatments were relatively consistent for each season although, over longer periods, nitrogen could have an effect on Acridid populations. If application of nitrogen becomes an accepted practice, grasshopper populations should be monitored for detection of long term effects or stress factors such as drought and overgrazing. Although nitrogen application may not have an effect in years when populations are low to moderate, epidemic populations may introduce a stress factor which would alter this effect. The results of this two year study indicate that applying

nitrogen to Kansas tallgrass prairie should not result in an increase in the populations of grasshoppers which are of economic importance.

SUMMARY

Acridid grasshoppers were collected for two years from three tallgrass prairie treatments to determine any differential responses to nitrogen application. Treatments were no nitrogen (control), 45 kg/ha, and 90 kg/ha. Three homogeneous sites were selected in each pasture. Two samples of fifty sweeps were taken at each site on each collection date. Grasshoppers were identified and dry weight recorded.

In 1973 there were no significant differences between treatments for total numbers of grasshoppers or biomass. In collection 1 (April 19) in 1974, numbers were significantly higher in treatment III (90 kg N_2/ha) than in treatments I (no N_2) or II (45 kg N_2/ha), but sample size was very small. No other collections showed any difference in numbers. Biomass data in collection 1 (April 19) was also significantly higher in treatment III (90 kg N_2/ha). In collections 6 (August 16) and 7 (September 6) biomass in treatment III (90 kg N_2/ha) was also significantly higher. This may be the result of great numbers of early instar Eritettix simplex and Arphia conspersa, in treatment III (90 kg N_2/ha).

The major grass feeding species collected were Eritettix simplex, Orphulella speciosa, Phoetaliotes nebrascansis, and Syrbula admirabilis. Eritettix simplex was significantly higher in treatments II (45 kg N_2/ha) and III (90 kg N_2/ha), probably because overwintering nymphs were eradicated in the

treatments when they were burned in late April and more nymphs subsequently immigrated into the lusher new growth of the fertilized pastures. All other species decreased with the addition of nitrogen, possibly preferring the higher quality grass in the less fertilized plots.

The major forb feeders, Campylocantha olivacea olivacea, Hesperotettix speciosus, Hypochlora alba, and Melanoplus keeleri luridus, had increased populations with the addition of nitrogen. Increases of Hesperotettix speciosus were significant. This may be due to the increased forb growth in the fertilized plots.

Melanoplus femurrubrumfemurrubrum, a mixed feeder, was collected in significantly higher numbers in treatment I (no N_2). This response is probably a preference for the higher quality forage in the non-fertilized plot.

This two year study appears to demonstrate that nitrogen has little effect on the total populations of Acridid grasshoppers. When individual species were considered, population differences occurred in some species. These differences may be the result of response by the grasshoppers to the effects of nitrogen on quantity and/or quality of their preferred host plants.

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RESPONSE OF ACRIDID GRASSHOPPERS TO DIFFERENTIAL NITROGEN TREATMENTS ON TALLGRASS PRAIRIE

by

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Acridid grasshoppers were collected near Manhattan, Kansas for two years from three tallgrass prairie treatments of 0, 45 and 90 kg N_2/ha (0, 40 and 80 lbs/acre). Thirty seven species of grasshoppers were collected, including 9 major species. Numbers and biomass of combined Acrididae were examined to determine any differential responses to nitrogen treatment. Subsequently, numbers and biomass of each of the major species were analyzed.

In 1973, there was no significant difference in numbers or biomass of the combined Acrididae among the 3 treatments. In 1974, there were no differences in numbers among the 3 treatments except early in the season when few specimens were present. In 1974 2 collections were significantly different in biomass, although biomass/number was not significant.

In 1973, 3 species were significantly different between treatments. There were more Eritettix simplex in the two pastures which received nitrogen, more Hesperotettix speciosus in the intermediate treatment than in the control, and more Melanoplus femurrubrumfemurrubrum in the control.

In 1974, Hippiscus rugosus was the only species showing significant difference. There were more in treatment II (45 kg N_2/ha), but the sample size was too small for statistical analysis to be conclusive.

Species data for 1973 and 1974 were combined and three species were found to be significantly different over the two

year period. There were higher populations of E. simplex in treatments II (45 kg N_2/ha), and III (90 kg N_2/ha), possibly because they overwinter as nymphs and are killed in late April when the pastures are burned. Nymphs which subsequently immigrate into the treated pastures are probably attracted to the lusher regrowth of the fertilized plots. Numbers of H. speciosus were significantly higher in treatment III (90 kg N_2/ha), probably due to the increased forb growth caused by nitrogen application. Numbers of M. femurrubrumfemurrubrum were significantly higher in treatment I (no N_2). This may be due to preference for a quality present in non-fertilized plants.

In this two year study, the family Acrididae did not respond significantly to the differential nitrogen treatments. At the species level population differences were noted. These differences are thought to be a response to the differential effects of nitrogen on the quantity and/or quality of the preferred host plants of the affected species.