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An investigation into the life history, methods of control, competition and dispersal of Cyperus esculentus L. (yellow nutgrass) with special reference to the highveld region of South Africa.

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The sprays were applied as blanket treatments between the maize rows and as direct basal sprays in the rows to prevent excessive drift onto the maize plants. A spray volume of 50 gallons per acre was adequate to ensure thorough wetting. The weather was sunny and hot. No rain fell during the 24 hour period following spraying.

Trial (b) was sprayed on 22/1/65. The maize plants were approximately 18" high and the weeds were almost of similar height. The sprays were applied in the same manner as above, using a higher volume rate of water, namely, 100 gallons per acre to ensure adequate wetting. Directed basal spraying of the maize was difficult to achieve. The weather during spraying was very hot and sunny. Heavy rains fell over the site approximately 4 hours after spraying.

Results:

No assessment of the treatment effects on the maize was made. The maize stand in both trials was irregular. It was observed, however, that the maize plants which had been contacted by the spray were killed. The appearance and growth of the surviving maize, however, was markedly superior to the unsprayed plants.

Weed control ratings.

Weed control, which includes kill of nutgrass, annual grasses and broadleaf weeds, was assessed by rating the sprayed plots twice after spraying. Results for both trials are given in Appendix Table 53, and the mean values in Table 101 .

TABLE 101 : WEED CONTROL RATINGS.

Trial (a)

TREATMENTS	Period after spraying	
	2½ weeks	2 months
1.Linuron 1 lb + 0.5% Agral	9.0	5.0
2.Linuron 2 lb + 0.5% Agral	9.3	7.7
3. Control	0	0

Trial (b)

TREATMENTS	Period after spraying	
	2½ weeks	2 months
1. Linuron 1 lb + 0.5% Agral	8	6.8
2.Linuron 1.25 lb + 0.5% Agral	8.7	7.8
3.Linuron 1.5 lb + 0.5% Agral	8.3	7.7
4.Linuron 2.0 lb + 2.0% Agral	8.7	7.8
5.Control	0	0

Weed Counts

Two weed counts were made on Trial (a), the first on 28/1/65 (16 days after spraying) and the second 10/2/65 (29 days after spraying). For the first count, the total weeds per 2 square foot frame were counted, taking two frames per plot. Results are given in Appendix Table 54 and the means in Table 102. The second weed count consisted of counting the number of weeds per quadrat frame and recording respective weights immediately after cutting. The quadrat frame measuring 2 square feet was placed at random four times along the central line of each plot. The results are tabulated in Appendix Table 55 and the means are given in Table 102. An analysis of variance in respect of nutgrass counts was made on the Log. transformation. The results are given in Table 103.

TABLE 102: 1ST WEED COUNT (16 DAYS AFTER SPRAYING)
MEAN NUMBER OF WEED. PER 2 SQUARE FEET (QUADRAT)

TREATMENT	WEED SPECIES	NUMBER
1. 1 lb Linuron + 0.5% Agral	Cyperus	44
	Grasses*	6
	Broadleaf	0.5
	TOTAL	50.5
2. 2 lb Linuron + 0.5% Agral	Cyperus	17
	Grasses	4
	Broadleaf	0.5
	TOTAL	21.5
3. Control	Cyperus	231
	Grasses	47
	Broadleaf	130
	TOTAL	408

* Annuals.

The weed species in order of abundance were:-

1. Cyperus esculentus L.
2. Tagetes minuta L.
3. Eleusine indica Gaertn.
4. Cynodon dactylon Pers
5. Amaranthus retroflexus L.
6. Eragrostis spp.
7. Portulaca oleracea L.
8. Chenopodium album L.
9. Commelina africana L.

An inspection of the trial 7/2/65, i.e. 3 weeks after spraying, revealed a reinfestation of nutgrass. This reinfestation originated from freshly sprouted tubers and was not associated with regeneration of previously affected plants. The degree of resprouting was more pronounced on the 1 lb linuron than on the 2 lb linuron plots. Observations in Trial (b) showed an excellent kill of Xanthium pungens and Datura spp. with all levels of linuron.

TABLE 103 : 2ND WEED COUNT (29 DAYS AFTER SPRAYING DEAD, NUMBER AND WEIGHT (GMS OF WEEDS PER 2 SQ. FEET

TREATMENT	NUTGRASS		GRASSES		BROADLEAF	
	NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
1, 1 lb Linuron +0.5% Agr.	32.4	11.8	3.5	3.7	4.6	6.1
2, 2 lb Linuron + 0.5% Ag.	10.6	2.0	3.1	1.7	0.2	0.07
3. Control	53.0	74.6	15.3	30.3	30.9	136.1

LOG NUMBER OF NUTGRASS PER 2 SQUARE FEET TRANSFORMAT.	
1, 1 lb Linuron + 0.5% Agr	2.076
2, 2 lb Linuron + 0.5% Agr	1.624
3. Control	2.292
L.S.D p = 0.05	0.364

Based on the data in respect of nutgrass numbers in table 103 it is evident that 2 lbs of linuron was significantly better than the control and 1 lb with no difference between the latter two.

Post-emergence applications of 1 and 2 lbs linuron per acre, when applied in conjunction with a surfactant (Agral), at a concentration of 0.5% gave a high percentage kill of nutgrass as well as excellent control of a number of common annual weeds. The herbicidal activity of the linuron appeared to be of a systemic nature. This treatment did not exercise a residual effect against newly emerging nutgrass shoots sprouting from dormant tubers. Regrowth of effected nutgrass plants was not observed. Where a height differential between the maize crop and nutgrass prevailed directed basal row treatment permitted selective weed control.

6. Nutgrass Control in Turf

a) 2,4-D and MCPA

Selective control of nutgrass in turf is a problem of primary importence. Several trials were conducted to evaluate a number of promising herbicides. The experiments were conducted at the Fr...Kenneid Turf Research Station.

2,4-D (Amine salt) and MCPA were applied in increasing concentrations from 2 lbs to 10 lbs acid equivalent per acre to 4 turf varieties severely infested with nutgrass. The rates were 2,4,6, 8 and 10 lbs acid equivalent per acre. Treatments were applied at the end of summer to 1/100th acre plots arranged in 3 randomised blocks across the 4 turf varieties, namely, Digitaria swazilandensis, Bradley, Florida and Delita Selection. Foliar chlorosis followed by a systemic necrosis of the nutgrass shoot was observed two weeks after spraying. After die-back of the stem, a separation of shoots from the stem base was possible. At the severed surface there was evidence of a dark concentric ring. All concentrations of both 2,4-D and MCPA were phytotoxic to the nut...ass but proved non-injurious to the 4 turf varieties. The herbicidal effects were somewhat masked by the low prevailing temperatures subsequent to spraying.

b) Screening Trial - 1962.

Four herbicides, each at two concentrations, were applied to a newly established Skeapplaas turf heavily infested with a uniform stand of nutgrass. The trial was designed to evaluate the selective herbicidal behaviour of three compounds and compare their performance with a phenoxy-acetic hormone herbicide ... recommended for the control of nutgrass in established turf. The compounds in this trial were selected because of their particularly high degree of contact activity and low order of residual toxicity to perennial grasses. The treatments given in Table 104 were applied on 2/1/62 to 1/220th acre plots arranged in randomised blocks with 3 replications. The site was mown 14 days after spraying. Urea (200 lbs per acre) was applied 18 days after spraying.

The weather at spraying was warm and humid and the soil surface moist, the site having been well irrigated and subsequently mown prior to herbicidal application.

Control of nutgrass and phytotoxicity to the turf was determined by visual assessment of percentage turf cover and nutgrass infestation. The residual effect of the herbicide was evaluated by recording the number of surviving nutgrass plants in 3, 20" x 20" quadrats. Counts were made 55 days (26/2/62) and 90 days (2/4/62) after spraying. Results of ratings and nutgrass counts are given in Appendix Tables 56 and 57. The mean values are recorded in Table 104 and Table 105 respectively.

TABLE104 : INFLUENCE OF HERBICIDES ON NUTGRASS IN TURF
MEAN RATING PER 3 REPLICATIONS

TREATMENTS	TURF			NUTGRASS		
	PHYTOTOXICITY		% COVER	CONTROL		% COVER
	8 Days 10/1/62	22 Days 24/1/62	40 Days 11/2/62	8 Days 10/1/62	22 Days 24/1/62	40 Days 11/2/62
1.Dinoseb 2.76 lbs	6.7	1.3	3.7	7.3	3.0	6.3
2.Dinoseb 5.52 "	9.0	1.3	2.7	8.3	8.3	6.7
3.MCPA - 4 lbs a.e	1.3	1.3	6.7	3.0	7.3	3.3
4.MCPA - 8 " "	1.3	4.0	7.3	4.3	9.0	2.7
5.Linuron - 2 lbs	6.0	3.0	4.3	5.3	2.7	5.7
6.Linuron - 4 "	8.7	8.3	4.0	4.3	3.3	6.0
7.Monolinuron - 2 lbs	2.1	0.3	4.7	6.0	2.7	5.3
8. Monolinuron - 4 lbs	7.0	0.3	3.7	8.0	3.3	5.3
9. Control	0	0	8.7	0	0	6.0

TABLE 105 INFLUENCE OF HERBICIDES ON THE SURVIVAL OF NUTGRASS.
MEAN NUMBER OF SURVIVING NUTGRASS PLANTS PER FRAME.

HERBICIDES	DATE OF COUNT	
	26/2/62	24/4/62
1. Dinoseb 2.76 lbs	50.9	56.7
2. Dinoseb 5.52 "	47.8	52.0
3. MCPA - 4 lbs a.e	45.1	52.6
4. MCPA - 8 lbs a.e	35.3	41.7
5. Linuron - 2 lbs	44.0	49.9
6. Linuron - 4 lbs	52.2	54.7
7. Monolinuron 2 lbs	42.0	49.1
8. Monolinuron 4 lbs	50.0	52.3
9. Control	42.0	46.9

Results.

Nutgrass Control.

Of the four compounds tested, dinoseb gave the most effective initial control of nutgrass followed closely by monolinuron at the higher rate of application. An assessment made three weeks after spraying revealed that the high dosage MCPA treatment gave excellent control of the weed, despite poor initial performance. Similarly, the low MCPA rate also gave good control. This pattern of control was maintained for a further 18 days when the percentage area infested by nutgrass was estimated. Plots receiving 8 lbs of MCPA showed the greatest reduction in nutgrass infestation. Assessments made one year after spraying revealed that nutgrass had reinvaded all the sprayed plots, with indications of an increase in nutgrass population density, possibly induced by previous herbicidal toxicity to the turf.

Phytotoxicity to turf.

All the treatments with the exception of MCPA and the lower monolinuron application were injurious to the turf. Toxicity of dinoseb was of a transient nature.

Based on the above results, MCPA applied at a rate of 8 lbs acid equivalent per acre proved to be safe for use on a Skaapplaas turf giving effective nutgrass control for a period of 6 weeks after treatment. To ensure complete eradication, repeated spraying during the active growing period would probably be necessary.

c) TCA trial.

Sodium trichloracetate (TCA) is a herbicide principally employed for the control of perennial grasses and particularly rhizomatous species such as Cynodon dactylon (L.) Pers. The latter, nevertheless exhibits considerable tolerance to low dosage levels of this herbicide and is unaffected by rates below 40 lbs per acre. At these low dosage rates, however, nutgrass shows considerable susceptibility. A trial was therefore designed to screen low dosage levels of sodium trichloracetate with regard to nutgrass susceptibility and turf tolerance.

Three levels of TCA, 15, 25 and 35 lbs per acre, were applied to a well established and actively growing Royal Cape turf, infested with a uniform stand of nutgrass.

Herbicidal treatments were applied on 25/1/60, arranged in randomized blocks, interspersed with unsprayed check plots and replicated three times. Plot size was 1/300th acre. (See Fig. 59).

Hot, humid conditions prevailed at spraying. The soil was moist, light rain having fallen the day prior to treatment.

Results.

1) Pre- and post-treatment counts of nutgrass plants were carried out 1 day prior to and 15 days after spraying. Total number of living nutgrass per 20" x 20" quadrat was recorded. The nutgrass population per 3 quadrats are given in Appendix Table 58 and the mean values in Table 106.

2)a Post treatment rating of herbicidal efficacy was made 35 days after spraying. Results are given in Appendix Table 58 and the mean values in Table 106.

2)b Phytotoxicity to turf was assessed 35 days after spraying and the subjective ratings are given in Appendix Table 59 and the mean values in Table 107.

3) Control of nutgrass and phytotoxicity to turf. Approximately 12 months after spraying, the plots were examined and rated both in respect of turf survival and nutgrass control. Results are given in Appendix Table 60 and the means in Table 108.

TABLE 105: MEAN PRE- AND POST-TREATMENT NUTGRASS POPULATIONS. NUMBER OF PLANTS PER 20" x 20" QUADRAT.

TABLE 105: MEAN PRE- AND POST-TREATMENT NUTGRASS POPULATIONS. NUMBER OF PLANTS PER 20" x 20" QUADRAT.		
15 lbs	63.4	19.8
25 "	54.2	13.8
35 "	68.3	12.6
CONTROL	53.5	46.2



FIGURE 59 : Sodium trichloroacetate damage to pine



ium trichloracetate damage to turf.

TABLE 107 : POST-TREATMENT RATING OF NUTGRASS CONTROL AND TURF PHYTOTOXICITY (35 DAYS AFTER SPRAYING).

TREATMENT	NUTGRASS CONTROL*	TURF PHYTOTOXICITY×
15 LBS	7.3	8.0
25 "	8.3	9.0
35 "	9.0	9.3
CONTROL	0	0

* 10 = Complete kill of nutgrass

× 10 = Complete kill of turf.

TABLE 108 : LATE POST-TREATMENT RATING OF NUTGRASS CONTROL AND PHYTOTOXICITY TO TURF (49 WEEKS AFTER SPRAYING).

TREATMENT	NUTGRASS CONTROL*	TURF PHYTOTOXICITY×
15	8.3	1.3
25	8.3	2.0
35	8.6	4.0
CONTROL	9.4	0

* 10 = Complete regrowth.

× 10 = Complete kill of turf - bare patches.

Summary and Conclusions.

Increasing levels of sodium trichloracetate applied to a Royal Cape turf, heavily infested with nutgrass, caused marked initial reductions in the nutgrass populations. The highest dosage (35 lbs per acre) gave the most effective and persistent control. The herbicidal action was of a transient nature, being confined to the first three months subsequent to treatment. Rapid regrowth of the nutgrass was evident during the following summer season.

The severe degree of damage caused by all the herbicidal concentrations, coupled with short herbicidal persistence, renders sodium trichloracetate completely unsuitable for selective herbicidal control of nutgrass in turf. *Pre-planting* treatments with this herbicide at the lowest levels, followed by an interval of 6 - 8 weeks prior to planting, is a method which warrants further investigation.

d) EPTC trial - 1963.

Four rates of EPTAM 5% Granules were applied to disturbed strips in a nutgrass-infested Skeappless turf after the sods had been excavated. The granules were applied at rates of 0, 0.25, 0.5 and 1 oz per square yard, equivalent to 75, 150 and 300 lbs per acre, at the end of November, 1963.

The granules were raked into the plots measuring 9' x 1' and the treatments were arranged at random with untreated strips serving as controls.

Four months after application, the number of nutgrass plants per 3, 18" x 6" quadrats were recorded. The plants were clipped and the green aerial nutgrass weight per 3 frames determined. Results are given in Appendix Table 60 and the means in Table 109 .

4 soil cores, 6" diameter and 5" deep were removed from each plot. The soil was removed by washing and the total turf weight per 4 cores recorded. Results are given in Appendix Table 60 and Table109. respectively. These weights include roots, rhizomes and stolons.

TABLE 109 : CONTROL OF NUTGRASS IN TURF WITH EPTC 5% GRANULES. MEANS OF 4 REPLICATIONS.

RATE OF APPLICATION PER SQ. YD	NUTGRASS PER 3(18"x6" FRAMES)		TURF GREEN WEIGHT
	NUMBER	GREEN WT.	
1. ½ oz	10	9.50	13.55
2. ¾ oz	0	0	6.65
3. 1 oz	1	0.3	8.15
4. Control	48.25	92.50	29.30

EPTC granules were highly effective in controlling nutgrass invading disturbed sites in turf, particularly at the high rate of application. At this level, however, EPTC was extremely toxic to the turf and prevented regrowth of the grass. The lowest rate of application reduced the infestation of nutgrass but grass growth was still markedly retarded. All rates of EPTC gave good control of annual weeds.

a) EPTC trial - 1964.

EPTC 5% Granules were applied to a well prepared seedbed, heavily infested with nutgrass, as pre-planting soil treatments. The granules were applied at two rates, namely, $\frac{0.5}{3}$ oz and 1.5 oz per 25 square feet, equivalent to 75 and 150 lbs per acre, and incorporated into the soil. Two turf varieties, Skeappleas and Royal Cape, were planted at 4 Planting dates after treatment viz. 0, 1, 2 and 4 weeks after planting. Plot size was 8' x 5'. The treatments were arranged in randomized blocks and replicated 3 times. The same weight of grass runners were planted in each plot. Treatments were applied 5/3/64 and the plots received

additional irrigation whenever necessary. Periodic observations of the plots were made.

From the results obtained, it was evident that the high rate of EPTC was injurious to both grass varieties whereas the low application rate was tolerated. The growth rate of Skaspplas was more rapid and less effected by the herbicide than the slower growing Royal Cape. Delayed planting caused less herbicidal toxicity to the turf grass. Both rates of EPTC gave excellent control of nutgrass during the first season.

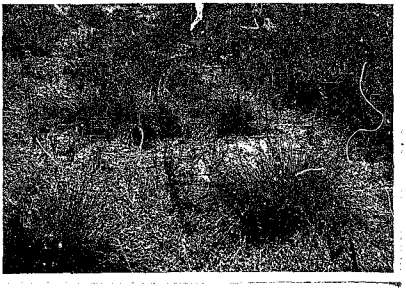


FIGURE 60: Rodent denudation of Eragrostis curvula pasture.

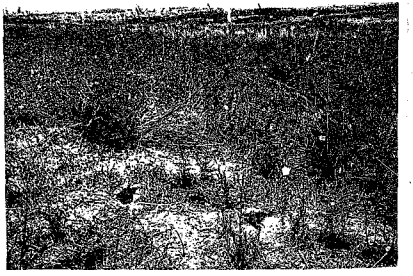
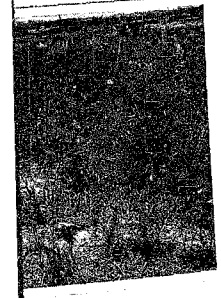


FIGURE 61: Rodent activity in Eragrostis curvula pasture.



of Eragrostis curvula



n Eragrostis.

CHAPTER XII

ECOLOGICAL STUDIES

A. DISTRIBUTION OF NUTGRASS IN CERTAIN PLANT COMMUNITIES

The stages of succession on the sandy soils of the Transvaal Highveld have been outlined by Davidson (1960 b). A number of plant communities at Frankenwald, representative of various stages of succession, were examined with regard to the presence of nutgrass. These communities included the following:

1. Natural Veld
   a) Undisturbed Purple Veld.
   b) Lightly grazed Purple Veld.
   c) Heavily grazed Purple Veld.
   d) Hyparrhenia grass stage.
   e) Eragrostis - Cynodon stage.
2. Stoebe vulgaris
3. Cultivated areas - Eragrostis curvula Nees

Natural Veld

No nutgrass was found in the Purple Veld or grazed Purple Veld. However, nutgrass was found in both the Hyparrhenia as well as in the Eragrostis-Cynodon stages, but only where disturbance had occurred. In the case of Hyparrhenia communities, it was found near rodent (presumably gerbilline) workings and in the Eragrostis-Cynodon communities only at old kraaling sites, where build up of dung had occurred, or near watering or feeding points. In the Hyparrhenia camp, there were patches of continuous grass denudation, the grass tussocks revealing a progressive die-back, becoming completely necrotic. The denuded areas were covered with a thick grass litter and colonised by nutgrass growing vigorously from tubers. These nutgrass infestations appear to have originated from tubers, probably introduced by the rodents as a fodder reserve.

Stoebe vulgaris Levyns.

No evidence of nutgrass could be found in these communities.

Cultivated areas - Eragrostis curvula Nees,

In the Eragrostis curvula Nees, camps which had been established for a number of years and subjected to heavy grazing pressure, the soil was compacted and no evidence of nutgrass could be found. Where disturbance had occurred and heavy dung deposits were evident, e.g. near feeding racks, dense colonies of nutgrass were found. In one particular camp where rodent activity was very pronounced, nutgrass had invaded and occupied the denuded areas. As a result of rodent activity an unbroken belt of denudation was evident. This belt consisted of a system of interconnecting subterranean tunnels and nests, the soil subsiding readily when subjected to slight pressure. (Figures 60 and 61).

In one camp (Spacement Studies - A Camp), a large number of Cyperus rotundus L. colonies were located. The colonies were within close proximity of each other, occupying the inter spaces between the Eragrostis tussocks. It is pertinent to mention that this would appear to be the first time that Cyperus rotundus L. has been recorded at Frankenwald. Glover (1937) in his survey of the flora at Frankenwald, refers solely to C. esculentus L. It is possible that the seed of the Eragrostis curvula Nees, used in the Spacement Trial, may have been contaminated with C. rotundus L.

From the observations made at Frankenwald, it would therefore appear that nutgrass is confined solely to the early stages of succession and in disturbed areas within plant communities higher in the succession.

9. RELATIONSHIP BETWEEN NUTGRASS AND DUNG.

The presence of nutgrass adjacent to or within decomposed dung patches poses the question as to whether the seed had been introduced by means of an animal agent or whether it was more tolerant to high nitrogen levels than the competing grasses.

Evidence in support of the second theory is unfortunately lacking, as no data is available regarding the susceptibility of the young nutgrass seedling to N concentrations. On filter paper treated with 0.2% KNO_3, Rahn et al.(1962) have shown a 66 percent germination of nutgrass seed, while Jong and Roux (1955) have suggested that the degree of tolerance of different grass seedlings to ammonium sulphate diminishes as their place in the succession advances.

This evidence would seem to favour the supposition that most ruderals tolerate high nitrogen concentrations. This indeed has been confirmed where industrial water effluents, containing high concentrations of N, have been applied to cultivated land. In one project undertaken by Messrs. African Explosives & Chemical Industries, Ltd., the equivalent of 2000 lbs N per acre was applied to a plantation of trees which, after the effluent treatment, was prepared and seeded to maize. The principal weed problem on this site was nutgrass (McKenzie 1965).

In an attempt to establish the reason for the absence of nutgrass in most of the plant communities at Frankenwald, a number of pot experiments were carried out. In the experiments, nutgrass tubers or seed were respectively planted or sown in soils sampled from a number of representative plant communities.

C. GROWTH AND DEVELOPMENT OF NUTGRASS IN SOILS FROM DIFFERENT PLANT COMMUNITIES.

A series of pot experiments were conducted in the glasshouse to compare the growth and development of sprouted and unsprouted nutgrass tubers planted in soils removed from different grassland communities at Frankenwald. The standard comparison in all these tests consisted of an arable soil sample which had been removed from a continuously cultivated site. Each soil sample consisted of 9, 6" cores taken at random in each community. The samples were bulked, passed through a 2 mm screen and sub-sampled. The pots or trays were then filled with an equal volume of soil. All the experiments were conducted in the glasshouse.

Test 1.

12 clay pots were filled with soils from 4 communities (3 replications per community), namely,

1. Trachypogon - Other Species.
2. Themeda triandra (Sampled at Bothal) Forest.
3. Arable.
4. Eragrostis lay.

15 grams of unsprouted nutgrass tubers (± 75 - 100 tubers) were planted in each pot 18/1/62. Nutgrass emergence was recorded over a period of 13 days and the stems clipped 11 weeks after planting. The number of nutgrass plants, the number of inflorescences and the fresh aerial weights of nutgrass are given in Appendix Table 61. Green aerial weights have been subjected to an analysis of variance. Mean values are given in Table110.

TABLE110: MEAN NUMBER AND WEIGHTS OF NUTGRASS STEMS

I PLANT NUMBER PER POT	PLANT COMMUNITY			
DATE	Trachypogon	Themeda	Arable	Eragrostis
1. 25/1/62	0.7	0.7	1.7	0
2. 26/1/62	1.7	3.0	4.3	2
3. 28/1/62	7.7	9.3	16.3	5.7
4. 31/1/62	24.0	21.0	30	20
II NUMBER OF INFLORESCENCES PER POT				
12/3/62	5	7.7	7	1
III GREEN AERIAL WEIGHTS IN GRAMS PER POT				
7/4/62	6.1	5.8	4.1	9.6

The green weights of nutgrass stems, grown in soils sampled from 4 different communities, did not differ significantly from each other.

Test 2.

18 white polythene pots were filled with soil from the following 3 sites.

1. Arable
2. Trachypogon
3. Eragrostis

5 sprouted and 35 unsprouted tubers were planted in each soil type and replicated three times.

a) Sprouted tubers test.

All pots received a fertilizer dressing of 2 grams of Complesal per pot to cancel out nutrient variations between the 3 soil samples. The stems were clipped 8 weeks after planting and air-dried. Weight of stems, roots, tuber weights and tuber numbers are given in Appendix Table 62 and the means in Table 111 .

TABLE 111 : AIR DRY WEIGHTS OF NUTGRASS

TREATMENTS	STEM	TUBER		ROOT + TUBER
	WEIGHT	WEIGHT	NUMBER	WEIGHT
Arable	2.36	3.41	35	7.0
Eragrostis	2.74	2.55	29	9.4
Trachypogon	2.91	3.65	40	7.1

b) Unsprouted tuber test.

The final number of shoots, inflorescences and foreign species invading the pots are given in Appendix Table 63 and the means in Table 112 .

TABLE 112 : AIR-DRY WEIGHTS OF NUTGRASS

TREATMENT	STEM		ROOT	TUBER		FOREIGN SPP.	
	NUMBER	WEIGHT	WEIGHT	NUMBER	WEIGHT	GRASSES	BROADL.
Arable	3	1.51	1.05	4.7	0.61	6.7	0
Eragrostis	7	1.75	1.41	8.7	0.83	14.7	8.7
Trachypogon	5.7	0.59	0.53	8	0.48	0	0

In the unsprouted tuber test, the air-dry stem weight of nutgrass grown on Trachypogon soil was significantly lower. Because of the experimental variation and the small number of degrees of freedom for error, yield differences are not reliable.

Test 3

White polythene pots were filled with soils from the following 3 sites:-

1. Arable

2. Eragrostis

3. Trachypogon.

Half the pots were planted to 10 sprouted and the remainder to 20 unsprouted nutgrass tubers. Treatments were replicated 3 times. The pots were harvested 8 weeks later and the green aerial weights of nutgrass recorded. Results are given in Appendix Table64 and the means in Table113.

TABLE 113 : MEAN GREEN STEM WEIGHTS OF NUTGRASS.

TREATMENT	SPROUTED	UNSPROUTED		
	WEIGHT STEMS	WEIGHT STEMS	NUMBER STEMS	NO. FOREIGN WEEDS.
1. Arable	6.5	4.0	3	2.7
2. Eragrostis	5.5	0.3	1.3	24.0
3. Trachypogon	9.2	3.9	2.7	-

There were no significant differences among the different treatments. Where unsprouted tubers were planted in the Eragrostis soil, annual grasses emerged in considerable numbers. These annual weeds consisted primarily of Setaria verticillata and Eleusine indica. Sprouted nutgrass tubers appeared to grow more vigorously on the Trachypogon soil.

Test 4.

The soils and method of sampling were similar to those described for the preceding experiment, Test 3. Galvanised sheet metal trays were filled with equal volumes of soil and sown to Bidens pilosa and nutgrass seed. The trays were subdivided into two sections and the seeds sown uniformly over each section.

The seeds were sown and covered with ¼" of soil and placed on laboratory tables adjacent to a window. Bidens germinated within 2 days. Nutgrass was considerably slower to emerge. Due to the rapid growth of the Bidens, the seedlings were counted 5 days after sowing. Three germination counts of emerged nutgrass seedlings are presented in Table 114.

TABLE 114 : NUMBER OF BIDENS PILOSA AND NUTGRASS SEEDLINGS PER SECTION.

TREATMENT	NUMBER OF BIDENS PILOSA 5 DAYS	NUMBER OF NUTGRASS AFTER		
		7 DAYS	8 DAYS	44 DAYS
Trachypogon	214	23	38	240
Eragrostis	224	11	25	180
Arable	228	13	25	204

Nutgrass and Bidens pilosa germinated in all 3 soils. The results confirm that seeds of ruderal weeds can, if present, germinate under a wide range of edaphic conditions.

Test 5.

Tussocks of similar diameter of Eragrostis curvula and Trachypogon spicatus were removed from their respective communities with adhering soil. Two tussocks of each grass were planted during mid-January in deep asbestos trays. The grasses were trimmed back to a height of 2" and 30 nutgrass tubers planted in 3 rows between the grass tussocks in each tray. Growth and development of the nutgrass was compared with that of nutgrass grown on arable soil. The treatments were replicated three times and the pots arranged at random in the open.

Results.

Emergence of nutgrass shoots was recorded one month after planting. Three months after planting, the nutgrass and grass herbage was clipped, air-dried and weighed. Underground fractions were washed out, dried and weighed. Results of shoot emergence and weights of plant fractions are given in Table 115 .

TABLE 115 : MEAN AIR DRY WEIGHTS AND NUMBER OF NUTGRASS AND GRASS STEMS. GRAMS PER TRAY.

COMMUNITY	Shoot emergence after 1 month	WEIGHT OF Grass herbage	Grass + Nutgrass Roots	Nutgrass stems.
Trachypogon	31.0	48.1	129.2	1.6
Eragrostis	31.3	92.1	222.5	0.3
Cultivated	36.0	-	-	11.4

The stem growth of nutgrass in the Eragrostis and Trachypogon trays was markedly lower than in the control trays.

Summary of Results. From the results obtained in the preceding pot experiments, it is evident that the growth of nutgrass is not adversely affected when planted or sown in soils sampled from the higher stages of plant succession on the Highveld. The absence of nutgrass in these communities does not appear to be due to a relationship involving allelopathy. It is concluded that edaphic factors, e.g. availability,

which influence the cause and nature of the subsere (Davidson 1969 b), may be responsible.

B. NUTGRASS POPULATION DENSITIES IN TWO ADJACENT ARABLE FIELDS.

An inspection during mid-December 1965 of two adjacent fields (Site I and Site II) at Frankenwald, revealed a marked difference in nutgrass infestation levels. The two camps were formerly seeded to Eragrostis curvula. Site I had been under continuous cultivation since 1958. An Eragrostis nursery established on Site II, was ploughed over for the first time during 1964. Both sites were ploughed and disced during October 1964, fertilised with 150 lbs of superphosphate per morgen and sown to babala (Pennisetum typhoides). Nutgrass infestations almost entirely absent on Site I, were widely distributed on Site II. Furthermore, it was evident that in the nutgrass infested zones within Site II where the weed had formed unbroken, continuous colonies, the babala and/or annual weed species had been completely suppressed. Where babala or dicotyledonous weed species were present, nutgrass was totally absent. An analysis of plant density, weight and composition was undertaken during mid-January 1965. Site II was sub-divided into two zones, viz. a babala-dominated zone and a non-babala zone. 8, 20" x 20" square quadrats were sampled at random in each site and zone.

A further two zones within Site II were also selected and sampled These consisted of almost complete stands of Physalis angulata and Datura stramonium. The mean total number of all plants, fresh and air dry weights of stems and roots per 8, 20" x 20" frame are given in Table 116 .

A chemical analysis of the above samples, derived from composite samples of herbage and roots, was carried out. Results reflecting the composition of the aerial and underground fractions are shown in Table 117 . The total weight of each fraction (air dry weight x percentage) per quadrat is given in Table 118 .

TABLE 116 : MEAN NUMBER FRESH AND AIR-DRY WEIGHTS OF NUTGRASS, BABALA AND OTHER SPECIES (8, 20" x 20" QUADRATS)

ORIGIN OF SAMPLE	BABALA						NUTGRASS OR ALIEN SPECIES					
	STEMS			ROOTS			STEMS			ROOTS		
	NO.	Fr.Wt	AD Wt	Fr.Wt	AD	Wt	No.	Fr.Wt	AD Wt	Fr.Wt	AD Wt	
Site I Cult. 7 years	37	2.04	141.5	58.1	24.6		1.7*	2.7	0.5	0.8	0.22	
Site II Cult. 1 year												
a) Babala zone	62	1.97	168.0	58.4	27.0		16	42.6	11.0	7.9	3.6	
b) Non-babala zone Nut.	"	"	"	"	"		205	308.8	82.8	103.5	44.0	
c) " " " Phys.	"	"	"	"	"		21	2.21*	152.2	36.2	13.9	
d) " " " Dat.	"	"	"	"	"		5	2.68*	143.0	39.1	11.7	

ND = Number of plants. Fr.Wt = Fresh weight babala stems only in lbs. Other fractions in grams
AD WT = Air-dry weight in grams. *Alien weeds weighed in lbs per 20" x 20" quadrat.

TABLE 117: CHEMICAL COMPOSITION OF NUTGRASS AND ALIEN WEEDS

ORIGIN OF SAMPLE	% PROTEIN	% PHOSPHORUS	% CALCIUM	% ASH
Site I Cult.7 years				
Nutgrass stems	7.0	0.35	0.44	11.98
Nutgrass roots	3.2	0.18	0.60	26.58
Site II Cult. 1 year				
a) Babala zone				
Nutgrass stems	5.4	0.31	0.26	18.0
Nutgrass roots	2.6	0.09	0.26	60.04
b) Non babala zone				
Nutgrass stems	10.2	0.36	0.80	24.50
Nutgrass roots	3.2	0.10	0.18	57.9
Physalis stems	5.2	0.20	0.86	7.56
Physalis roots	4.6	0.17	0.36	15.14
Datura stems	3.2	0.31	0.95	7.72
Datura roots	3.4	0.22	0.73	11.26

TABLE 118 : TOTAL UPTAKE OF CERTAIN MACRO ELEMENTS IN NUTGRASS, PHYSALIS ANGULATA AND DATURA STRAMONIUM. GRAMS PER 20" x 20" QUADRAT X 100.

ORIGIN OF SAMPLE	GRAMS PROTEIN	GRAMS PHOSPHORUS	GRAMS CALCIUM	GRAMS ASH
Site I. Cult. 7 years				
Nutgrass stems	3.50	175	.220	5.99
Nutgrass roots	.704	.0396	.132	5.848
Total	4.204	.2146	.352	11.838
Site II. Cult. 1 year				
a) Babala zone				
Nutgrass stems	59.4	3.41	2.86	198.99
Nutgrass roots	9.36	.324	.936	216.144
Total	68.76	3.734	3.796	415.134
b) Non-Babala zone				
Nutgrass stems	844.56	29.808	66.24	2028.60
Nutgrass Roots	140.80	4.40	7.92	2547.60
Total	985.36	34.208	74.16	4576.20
Physalis stems	791.44	30.44	130.892	1120.192
Physalis roots	63.94	2.363	5.004	210.446
Total Physalis	855.38	32.803	135.896	1330.638
Datura stems	457.60	44.33	135.85	1103.96
Datura roots	46.58	3.014	10.001	154.262
Total Datura	504.18	47.344	145.851	1258.222

Plant numbers.

It will be noted that the number of nutgrass shoots recorded in Site I (continuous cultivation) was extremely low when compared to the population density on non-babala zone (308 per quadrat frame). Nutgrass drops sharply on the babala zone of Site II indicating that where *babala* is able to compete, nutgrass invasion has been restricted. Also of interest is the fact that for a given area, the number of nutgrass shoots is much larger than that of both *dicotyledonous weed* species.

Weight.

Fresh air-dry weights of stems of both dicotyledonous weeds are higher than those of *nutgrass* on non-babala zones within Site II. The differences regarding air-dry weights are less pronounced. The reverse situation is evident as far as root weights are concerned. Nutgrass root weight *per given area* is approximately 3 times as high as that of both dicotyledonous species.

Chemical Composition.

Based on the results in Table117, it is possible to compare the composition of nutgrass when grown under conditions of inter or intra species competition. Generally, the percentage of protein, phosphorus and calcium in the roots remained low, while ash content was very high. There were no marked differences between the three nutgrass root samples. In the case of nutgrass stems, however, the highest protein, calcium and ash contents were located in nutgrass sampled in the non-babala zones. Where nutgrass was growing in competition with babala, i.e. babala zone Site II or Site I, the quality of the nutgrass herbage with the exception of phosphorus, decreased very markedly.

Comparing the composition of three weed species sampled in the non-babala zones, it is quite clear that the percentage of protein, phosphorus and ash is of a much higher order in the stems of nutgrass than in those of Physalis or Datura. The calcium content of Datura is particularly high. With the exception of ash, the roots of Physalis and Datura are higher in phosphorus, calcium and to a lesser degree in protein.

Total nutrient uptake.

Differences between the three weed species with regard to the total nutrient uptake are again very striking. Of interest is the high concentration of plant foods in the aerial fractions of all three species. The high nutrient uptake by nutgrass plants growing in the absence of competition is clearly demonstrated.

CHAPTER XIII

DISCUSSION

From an ecological point of view, an essential feature of man's activities in agriculture is the production of open or at least disturbed habitats (Bunting, 1960). The weeds invading these habitats are pioneers of secondary succession. In order to establish, grow and reproduce in such an environment, clearly requires a degree of specialization. An efficient mode of vegetative reproduction may therefore be as valuable as the production of viable seed, since it makes the species less dependant on the chances of germination and greatly assists in invading new habitats. Where adaptability to diversive environmental conditions is combined with efficient dispersal of seed and tubers, the invasion of new habitats is greatly accelerated and the species is capable of assuming pest status shortly after introduction. Such reproductive behaviour displayed by nutgrass, to a large extent accounts for the rapid spread of this species throughout the Highveld Region of South Africa.

In an attempt to define the ecological requirements of nutgrass a number of studies were undertaken to investigate the response of this weed to certain environmental factors and to critically examine those physiological adaptations concerned with survival, reproduction and competition. It is expected that the results from these investigations will ultimately contribute towards an improved approach to and a better understanding of the control measures which are essential to achieve ultimate eradication of the weed.

A. RESPONSE TO ENVIRONMENTAL CONDITIONS.

1. Plant Nutrients.

Nutgrass responded positively to applications of nitrogen, particularly in the presence of phosphate. Fertilizer responses in terms of herbage yields obtained in the field, were confirmed in the glasshouse studies. A significant correlation between the two series of experimental results was established. A significant correlation between air-dry and green aerial weights was also demonstrated. Glasshouse investigations may thus be used for predicting fertilizer responses of nutgrass in the field.

There was evidence of a differential response to nitrogen carrier, and a remarkable ability to tolerate heavy dressings of nitrogen. Growth response to nitrogen measured both in the glasshouse and the field revealed that the herbage yields increased with dressings up to 200 lbs of N per acre.

Altering the edaphic conditions of turf plots which have been established for the past 32 years were responsible for some interesting flora changes which epitomize the response of nutgrass to certain soil nutrients. Annual applications of nitrogen and phosphate (NP) and applications of nitrogen, phosphate and potash (NPK) not only improved the growth and vigour of the grass, but permitted a population of nutgrass to establish a perfect co-ecesis with the turf. Unfertilized, or plots receiving only phosphates, supported poor turf growth and were free of nutgrass. Over a long term period it appears that an NPK interaction would be more favourable for the growth and development of nutgrass.

The results presented above suggest that the response of nutgrass to fertilizers is similar to that of ruderals such as annual grasses, which constitute the first stages of the subsere. This response would appear to be independent of drastic changes in soil reaction. It seems clear, therefore, that one of the principal edaphic factors influencing the distribution and, especially the growth of nutgrass, is the soil nitrogen status. The dominance of nutgrass in the ruderal stages of disturbed Eragrostis leys is explained in part by its ability to respond to relatively high concentrations of available nitrogen. The pattern of adaptation and survival of nutgrass are much the same as those described by Davidson (1960 b) for typical ruderals in the subsere. It would also appear that the position occupied by nutgrass in the subsere is, to some extent, determined by the soil nutrient responses described by Jong and Roux (1965) for typical ruderals. The latter have demonstrated that as the succession advances the seedlings of dominant species exhibit a decreasing tolerance to ammonium N in nutrient solutions. The ruderal, Eleusine indica, and the dominant Trachypogon spicatus showing maximum and minimum tolerance respectively.

Davidson (1966 b) states that the edaphic factors strongly influence the course and nature of the subsere and that annual applications of nitrogenous fertilizers influence both the rate of succession and the composition of the seral stages. In fact the early seral species may be used as indicators of available nitrogen. The disappearance of nutgrass from those grassland communities occupying advanced stages in the subsere could be related to the high mineralisation of nitrogen in recent fallows and the low rate in the grassland climax.

Another misconception which warrants clarification is the absence of rudarels, including nutgrass, on sites of disturbed grassland climax. From the investigations it was evident that the growth and development of nutgrass is not adversely affected when when sown or planted in soils removed from a representative Trachypogon - other species community, or when competing directly with the active growing climax species. Failure of the nutgrass to appear in sub-climax grassland sites is attributed to the absence of a primary source of seed inoculum. Biotic factors such as gerolles (Anon, 1964) may produce drastic changes in the subsere by artificial introduction of the nutgrass, particularly if the community is surrounded by a source of infestation.

It is sometimes claimed that a soil supporting a luxuriant weed growth is excellent for cropping purposes and that the prolific weed growth indicates an abundance of mineral nutrients (Crafts and Robins 1962). In the case of nutgrass, this statement would appear to be true. These present experiments have shown positive increases in plant number, herbage yield, rate of spread and a marked improvement in both quality and quantity of herbage where balanced macro element mixtures have been applied to nutgrass

2. Soil reaction.

Considerable data is available showing the relation between soil reaction and the nature of weed growth. Crafts and Robins (1962) cite the case of sheep sorrel which is generally accepted to serve as an indicator of lime deficient soil. The fact that this weed seems to flourish on soil of lime deficient soil has led to the conclusion that the plant is best adapted to, or demands an acid soil.

The results in this study seem to favour the supposition that nutgrass is very adaptable in regard to soil pH and consequently should not be used as an indicator of soil reaction. The presence of nutgrass is frequently associated with acid soils but this relationship would seem to be largely circumstantial in the light of sedge affinity for favourable soil moisture relations.

Of interest was the response of nutgrass to lime. Heavy dressings of calcium hydroxide, applied in the field and to pots illustrated the adaptability of nutgrass to soil pH. Rates as high as 7 tons of calcium hydroxide per acre had no measurable effect on the growth of nutgrass.

The majority of the soils on the Highveld are highly leached and generally acid, but on the littoral sands of the Natal sugar belt where heavy dressings of filter press have induced alkaline conditions, nutgrass is known to constitute a serious threat to cane production on soils suffering from Fe chlorosis. The evidence obtained in this investigation that nutgrass is capable of tolerating exaggerated dressings of lime and ammonium sulphate, confirms that soil reaction has no direct bearing on the growth of this species.

Hall et al.(1948) found that where continuous use of ammonium sulphate had greatly increased the acidity of unlimed turf plots at Frankenwald, the grass formed a poor cover and nutgrass species invaded the stand. The present plant population occupying these plots do not correspond with the data of Hall and co-workers. A plant survey of these plots revealed that ~~that~~ despite an extremely low soil pH, both nutgrass and turf growth on the NP and NPK plots improved, and was superior to that of the unfertilised or P fertilised plots. There is no question of nutgrass surviving under acid conditions at the expense of the grass sward. In fact a fairly stable association is apparent, the balance of which is not readily disturbed by frequent cutting or increased applications of "acidic" nitrogenous fertilizers.

3. Herbicides.

There is ample evidence available that the weed flora on cultivated sites can be drastically altered as a result of herbicidal treatment. The use of these agents is rapidly becoming a factor in the artificial selection of certain species. A case in point is the emergence of nutgrass as a dominant on arable fields where previously a mixed weed population had prevailed. Two examples are the increase in grass annuals and nutgrass at the expense of broadleaf species as a result of post-emergence 2,4-D applications and the replacement of annual grasses by nutgrass with continuous applications of triazines on heavy soils. The role which selective hormone type herbicides have played in elevating nutgrass to its present position dominating position cannot be overlooked. The devastating side effects this particular practice can create in an otherwise stable weed population is not always apparent.

4. Agronomic Practice.

From an agronomic point of view, the response of nutgrass to soil nutrients is of great importance when considering fertilizer applications for field crops. It is obvious that in order to restrict nutrient uptake by the nutgrass, certain modifications in regard to time and method of fertilizer placement must be introduced. Deep phosphate placement at at planting appears to be important to reduce or retard incipient nutgrass growth, while nitrogen dressings to the crop should not be applied prior to removal of the weed.

3. COMPETITION.

To approach the problem of nutgrass control in a realistic manner, it is necessary that the fundamental factors connected with nutgrass competition be carefully examined. These factors include direct competition i.e. water, plant nutrients and population density and an appraisal of antagonism of undefined origin, "allelopathy".

The water uptake of nutgrass was compared with that of two other species when grown with or without maize. The object was to establish whether nutgrass consumed more water during a given period of time.

According to Bunting (1960), the transpiration per day from a given surface is determined by factors which are not dependant on the number of plants or on their leaf area. It follows that provided the plants are all much the same size and kind and more or less covering the ground, there is no competition for water even in dense stands. Further a crop does not in general suffer more severely from drought simply because it contains an unusually large number of individuals, though the effect of nutrient shortages are often mistaken for those of drought.

The results in the two water uptake studies revealed that when the three weeds were grown in competition with maize, the total uptake of water for a specific period over a given surface remained constant, irrespective of the weed species concerned. The depressing effect of the weed on the maize, however, differed among the three weed species. Eleusine indica, for example, was a far more serious competitor than an equal number of nutgrass plants.

Where nutgrass was grown in pure stands, and its water uptake compared with that of Tagetes and Eleusine, there was no evidence to suggest that water uptake was greater in the case of nutgrass. In these tests, the comparisons were drawn from identical population densities which are not necessarily truly representative of field conditions. According to Bunting, however, population density would not appear to be of primary importance.

Plant surveys have revealed that nutgrass population densities per area are higher than most other weeds. The results obtained in the increasing plant populations studies showed that the aerial weight, underground weight and number of tubers produced per given area was significantly increased as the population of nutgrass increased.

Three competition studies were conducted, the results of which partially explain nutgrass competition. When sorghum was grown with increasing population densities of nutgrass under low fertility levels, results showed that the weight of nutgrass increased, but the weight of sorghum decreased with increasing numbers of nutgrass plants.

When nutgrass was planted with cucumbers in a sand culture and supplied with adequate quantities of nutrient, there was no depression in the yield of cucumbers.

In a third competition study, the competition for nutrients between maize and nutgrass was once again clearly demonstrated. In this study, the total weight of green material produced per tray remained constant, irrespective of whether the nutgrass was planted together with, or separated from, the maize. The competition effect was much more severe in the fertilized trays than in the unfertilized trays. The competing action of nutgrass would therefore appear to be closely linked with its response to nitrogen.

In turf plots, there was evidence that high nitrogen dressings had stabilised the turf-nutgrass population balance. Both species were co-existing as a mixed population, unaffected by each other's presence and showing no visual signs of competition. This suggests that, whereas the two species may be competing simultaneously for one and the same nutrient, the ultimate suppression of one competitor will, ultimately, depend on its ability to compete for essential nutrients.

A striking morphological feature of nutgrass is the tremendous concentration of roots and rhizomes in the soil. The root weight produced from a given area of nutgrass was approximately three times that of the root material produced by Datura stramonium and Physalis angulata. This high concentration of root and rhizome in the soil, combined with the liberal uptake of nitrogen, are undoubtedly the two principal factors showing clearly the competitive behaviour of nutgrass.

The manner in which plants compete with one another has been the subject of extensive study throughout the world.

The possible role of toxic substances produced by weeds in reducing crop growth has been widely investigated (Bonner 1950; Börner 1960). Whereas highly concentrated aqueous extracts of dead nutgrass underground fractions were responsible for marked growth inhibition of test seedlings, the results were not always reproducible when reducing the concentration of the plant material or changing the method of preparation. Similarly, leachates, percolates and exudates obtained from living nutgrass plants, or residues of nutgrass, failed to produce any retardation or reduction in the growth of test crops. In fact, there is repeated evidence of a stimulation of seedling growth when treated with several of the extracts and leachates.

Since Oswald's (1942) publication on Agropyron repens, which suggested that toxic root substances by the grass were responsible for the deleterious effects of quackgrass, a large number of publications have appeared which deal with the ecological role of quackgrass in crops. Most of the evidence which has accumulated has been circumstantial (Ohman and Kommedahl 1964), and no-one has isolated and identified chemically any substance that can reproduce the effect of quackgrass. The findings of Ohman and Kommedahl may be applicable in the case of nutgrass, namely, that a greater ability to withdraw available nutrients, especially nitrogen, and to a lesser extent phosphorus and potassium from a nutrient solution, is the deciding factor which explains the highly competitive role of nutgrass in the field.

The recent evidence published by Boshoff (1965) attributes reduced growth of maize and cowpea which were cultured with C.rotundus in the same water or sand medium to a toxic substance or substances produced by the weed. Boshoff, however, reports that in 3 water culture tests, he obtained an increase in the percentage of N and reduction of percentage P in the maize when the latter was cultured with C.rotundus. In sand cultures the N and P contents of the maize decreased and increased respectively when grown in competition with C.rotundus. Boshoff's technique allowed for the removal of the C.rotundus plants regularly in order to obtain a continuous fresh source of root exudates.

Analysis of C.rotundus or of the water medium supporting the two competitors were not reported by Boshoff.

Though a postulation at this stage may seem presumptuous, there is some reason to believe that a similar pattern of differential nutrient uptake from the Hoagland solution by the C.rotundus (as already described for quackgrass) is the primary factor responsible for the reduced maize growth.

The response of nutgrass tubers to washing indicates that there is a mechanism responsible for tuber dormancy and confirms the findings of Tumbleson (1960). The effect of sowing test crops at staggered intervals after planting of nutgrass tubers shows that there is an initial transitory stimulation which later disappears. Whether this stimulation is in any way associated with the growth inhibitor present in the tuber warrants further investigation.

C. LIFE HISTORY OF NUTGRASS IN RELATION TO ITS CONTROL

If nutgrass is to be effectively controlled or eradicated it is essential to study the two mechanisms of reproduction. The explosive nature of colonisation by means of tubers, rhizomes and daughter plants all serve to emphasise the importance of effective control measures during the primary stages of invasion. Physiological and morphological modifications of the tuber, such as dormancy, multiple bud development, ability to sprout under a wide temperature range, organic reserves, resistance to insolation and herbicides all contribute towards the survival of nutgrass under adverse conditions. These factors, in conjunction with the resistance of the mature plant to repeated clipping and most herbicides, creates numerous difficulties in the control programme.

In arable fields, nutgrass enjoys a distinct advantage over the seeded field crop. Results have shown that if the nutgrass tuber is exposed to moist conditions it swells and absorbs water readily during the first 48 hours. The vertical rhizome therefore emerges above the soil 5 - 7 days after the first spring rains. Allowing for a lapse of 2 - 3 days, which is necessary to ensure suitable soil preparation, it is clear that the germinating nutgrass will always enjoy a distinct

advantage over the field crop. Soil temperatures during this time are favourable for the sprouting of the tuber. The emergence of nutgrass shoots after the first spring rains is a typical feature of infested arable fields on the Highveld. Where infestations are known to be present, growers should therefore attempt early soil preparation (autumn or winter ploughing) so that seeding may commence as soon as possible after the first rains. Furthermore the sowing of infested sites should be given priority over non-infested sites.

With regard to the control of the underground organs, there appears to be limited susceptible periods in the life history of the plant. The two important considerations are obviously the restriction of daughter tuber formation and the exposure of the plant to insolation. The distribution of tubers is primarily confined to the top 6 inch soil layer, which to some extent simplifies the tillage programme, but the success of the programme will be dependent on judicious timing.

In contrast to the versatile tubers, the climatic requirements of nutgrass seedlings are exacting and their initial survival dependent upon optimal soil moisture conditions. Despite the high seed production, seedlings are not frequently found in infested fields. Their absence may be attributed to several factors, namely, severe intraspecific competition, absence of critical light conditions or possibly a germination inhibitor which may originate from the tuber. On uninfested sites, seedlings will emerge readily and cause initial foci of infestation. Production of 2 - 3 tubers from one seedling within the first year of introduction is sufficient to proliferate an entire arable field within a period of 2 years. The importance of preventing the production of seed and the movement of seed from one site to another irrespective of the mechanism concerned are two factors which deserve attention in the implementation of a control programme.

The dispersal of nutgrass by means of seed appears to have been generally disregarded in most agronomic circles. This attitude appears to have gained considerable support largely due to the germination studies. The results obtained in this investigation confirm the findings of Justice and Whitehead (1946), namely, that the seeds of yellow nutgrass are viable. Alternating temperatures in the presence of light, appear to be a sine qua non for germination.

In this respect the results differ from those obtained by Rahn et al. (1962). Depending on the advent of the first spring rains on the Highveld, seeds may be viable by mid summer, i.e January. Furthermore, the laboratory studies have shown that nutgrass seed tolerates exposure to chilling temperatures over protracted periods and retains its viability for numerous seasons (Bolius 1945). Once introduced the seed is capable of initiating foci of infestation over a period of at least 20 years irrespective of the severity of the winter conditions.

D. CONTROL OF NUTGRASS

1. Tillage

a) Discing

The results of three discing experiments conducted on heavily infested sites, have been reported. In the three trials, repetitive disturbance of the nutgrass stand, ranging from 3 - 5 treatments, gave excellent control of the weed. The benefits accruing from these treatments were particularly noticeable in the season following treatment. Nutgrass populations were reduced to such an extent that crop production could once again be considered. The site and the season obviously play a dominant role in determining the final result.

At Bethal 1 and 2 discings applied to a poorly drained site gave a measure of control which involved no residual benefits. Despite slight reductions in stand following discing, the treatment effect was disappeared by
not persistent and had / the following spring. The significant feature of continual discing was, firstly, the temporary disappearance of nutgrass and invasion by annual grasses during the season of treatment and, secondly, the failure of the nutgrass to emerge during the successive spring.

The results at Bapefontein also illustrated the advantages of early and repetitive treatment. Early disc ploughing followed by summer discings, which were concentrated into the first half of the summer season, restricted new daughter tuber formation, the result of which was an apparent eradication of the weed from the cultivated site.

The discing treatments which were introduced at Frankenwald late in the season, illustrate the importance of commencing the first disturbance prior to the formation of daughter tubers. In this trial, the first discing took place on 6/1/65 when the plants had already reached the 8 - 10 leaf stage.

The final analysis of tuber population at the end of the season showed that in spite of a marked reduction in nutgrass root weight with one discing, tuber populations were not significantly reduced by this treatment. All three discing treatments, however, reduced the nutgrass plant populations in the following spring. In other words, even one discing at Frankenwald had a pronounced influence on the survival of the weed. There appears to be an interaction between frequency of discing and site. Whereas at Frankenwald one or two discings gave extremely good control, the same number of treatments made little impression on the weed population at Bethel. The reasons for this differential response may be associated with three important factors. Firstly, the nutgrass tuber population density per unit area at Bethel was far greater than that of Frankenwald. Secondly, the Bethel site was poorly drained, the soil remaining moist almost throughout the summer season and unsuitable for cultivation after heavy rainfall. Cultivation at any stage was thus not as effective as when applied to a well drained site at Frankenwald. Finally, the first two discings at Bethel were applied to nutgrass plants in a more advanced growth stage.

The point which should be clearly explained is that one and the same programme will not necessarily yield the same results when applied at two different locations or on two fields within the same locality. In order to achieve effective control, careful consideration must be given to edaphic conditions as well as to the physiological stage of development of the plant. Since eradication is intimately associated with the growth stage of the plant, a growth rhythm for a nutgrass plant theoretically growing in the field on the Highveld has been compiled. The chronological sequence and intervals are based on the advent of the first summer rain by the 15th October, followed by a normal pattern of rainfall distribution.

GROWTH AND DEVELOPMENT	INTERVAL IN DAYS	DATE
1. Sprouting	1	15th Oct.
2. Emergence	7	22nd Oct.
3. 4 leaf stage	10	25th Oct.
4. 6 leaf stage	14	29th Oct.
5. 8 leaf stage	17	1st Nov.
7 10 leaf stage	21	5th Nov.
8. 12 leaf stage	27	11th Nov.
9. 15 leaf stage	38	12th Nov.
10. Inflorescence emerging	42	26th Nov.
11. Inforescence emerged	45	29th Nov.
12. Flowering	53	7th Nov.
13. Seeding	68	22nd Dec.
Initiation of daughter plants after	21	
Initiation of tubers	30 - 90	

The first tillage operation should preferably commence at the 6 leaf stage (29th October) and should not be delayed until later than the 10 leaf stage (5th November).

The dangers attendant to the late summer or autumn cultivations should be brought to the attention of growers who are often under a false impression that this particular treatment is advantageous from a weed control and soil preparation point of view. Indeed, a disturbance of the nutgrass population, which visually appears to have reached a dormant stage late in the summer, may produce an explosive distribution and fresh emergence of nutgrass shoots during the late autumn, if favourable soil moisture and temperature conditions prevail. In view of the fact that tubers produced during the late summer are dormant (Tumbleson 1960), it is postulated that cultivation at the end of the season disturbs the tubers breaks the dormancy, and results in extensive sprouting. The hazards of this approach were verified in the season subsequent to discing. The severest nutgrass population density was evident on the late summer cultivated plots.

To summarize therefore it is better to leave a nutgrass infestation undisturbed than to attempt a haphazard late summer treatment.

b) Cultural Practices.

The problem of eradicating nutgrass under arable conditions is not a simple one. The most logical approach would be to investigate the life history of the plant in order to establish critical periods at which it is most vulnerable. Accordingly, the eradication studies by means of tillage practices must be governed by the following facts.

1) The initiation and production of daughter tubers 3 - 4 weeks after appearance of the vertical rhizome above ground.

2) The resistance of tubers to insolation, low temperature and repeated clipping.

3) Dormancy and delayed sprouting of newly produced tubers.

4) Longevity of the tuber.

5) Visibility of undersized tubers (2 mm diameter).

6. Food reserves and multiple buds in the tuber.

7. Extensive production of nutgrass tubers.

8. Distribution in the soil.

9. The susceptibility of the nutgrass plant to insolation.

From the above it is obvious that any tillage programme which is to be advocated for the eradication of nutgrass, must be based on maximum exposure of the young nutgrass plant and minimum production of daughter tubers. To achieve this, it is recommended that the infested field be disturbed immediately after emergence of the aerial shoots above the ground. Severing of the vertical rhizome below the base of the plant is probably one of the most efficient methods of control. The severed aerial parts of the plant are thus exposed to desiccation and are unable to survive. At this stage, new daughter tubers will not have been formed. Reshooting must commence from the disrupted tuber which, in turn contributes towards the depletion of tuber reserves. Late summer disturbance as already indicated, is fraught with numerous difficulties. Disturbance of the plant at this stage permits shooting from the old tubers, new tubers and from the basal bulb.

Irrespective of the method adopted, one fact emerges from the life history studies, namely, that the initiation and development of new daughter tubers must be avoided at all costs.

because of its characteristic behaviour and resistance to most external influences, the principal object in any control or eradication programme should be aimed at the reduction and exhaustion of tuber populations. In practice, this means early, shallow and relatively frequent cultivation, preferably every 2 weeks, and when the soil is dry.

The choice of implement also warrants consideration. Tractor-mounted or tractor-drawn cultivators, fitted with sweeps and not vertical tines, may be used effectively for inter-row treatment. Hand hoeing between, or in the row, though not the most efficient, is also an effective method of control. To support this statement it is pertinent to refer to Jirch's findings (1964). The latter reports that shallow hand hoeings were adequate to give good control of yellow nutgrass and other weeds. He found that once the maize had completed its vegetative growth, the shading effect of maize appeared to adversely effect the development of nutgrass. Furthermore, the hand hoeing treatments reduced the nutsedge potential of the soil to such an extent that only isolated nutsedge plants developed rapidly on such areas in the following spring, prior to planting

The approach of Sallachop and Hattingh (1956) is to obtain maximum exposure of the tuber and not maximum disruption of the vertical rhizome. They emphasise that shallow hoeing leaves the root portions undisturbed, thus aggravating the infestation. They advocate that the soil be loosened to a depth of 3 inches, for which hoes with $2\frac{1}{2}$ inch wide tines are the most suitable.

Notwithstanding the recommendation of the above, it is still felt that the severing approach by means of broad sweeps or hand hoeing will, in the long run, be the most efficient method of control. The disadvantages of having to resort to additional draught power to operate sweep instead of tine cultivators, can be overcome by using a disc for the first mechanical operation. Where wide crop spacing is practised, repeated discing will, as has already been discussed, also give excellent control. This method has certain disadvantages. Numerous plants are covered by the operation and new shoots may emerge from the buried basal bulb. In severely infested fields, tuber movement and distribution may

provoke fresh outbreaks. It should be pointed out that all these methods of cultivation will simultaneously control seedlings and obviate seed formation.

The question is often raised as to whether rotavation, which has proved successful for destroying rhizomatous weed species (Fail 1963), could not be employed for eradicating nutgrass. Rotavators furnish segments of ½ inch to 6 inches in length. Such a treatment would fail to exert an influence on the tuber, while the cutting effect on the rhizomes and roots could be as easily achieved with standard farming equipment without embodying the ancillary disadvantages to soil structure.

It is perhaps appropriate to clarify the control programmes suggested by several workers. The recommendations made by Du Preez (1944) and Sallschop and Hettingh (1956) - vide Page 22 - do not appear to be satisfactory solutions to the problem. Rheinhold (1942 a) reported that winter ploughing at month intervals increased the infestation level and, furthermore, growth studies have revealed that tubers are already produced when the plant commences flowering.

There is no doubt that both mid-summer discing and winter ploughing contribute to a marked reduction in population density. Whether these two programmes can be regarded as efficient methods of control is somewhat doubtful.

The conclusions of Rheinhold (1942 a) that nutgrass tubers are destroyed by direct sunlight after 5 days or after eight hours exposure to 50°C are somewhat disputable. Dormancy characteristics are peculiar to the tubers of nutgrass. Failure to sprout or a reduction in sprouting is often erroneously regarded as the destruction of the organ. Indeed, had nutgrass tubers been vulnerable to short-term dessication and insolation, eradication would have been a simple task and the weed would not have reached and maintained its present pest status.

The recommendations of Das (1951) and Birch (1964) are regarded as being sound, emphasising a judiciously timed control programme which is based on the life history of the plant.

Based on the available information, an attempt has been made to formulate a cultural programme when establishing annual field crops. The recommendations are as follows:-

1. In heavily infested fields it is recommended that planting be delayed until at least two tillage operations at intervals of 2 weeks have been completed. This results in a reduction in plant population density, prevents new tuber formation and permits the sowing of a short-cycle crop, preferably a fodder crop, which would not be subject to severe nutgrass competition during mid-summer.

2. In light or moderately infested fields, wide row crop spacement should be used, e.g. 6' or 7' depending on available equipment. In the case of wide inter row spacement, great care should be given to the plant populations in the row. Nutgrass will generally not grow where it is well shaded. A dense, shade-producing row crop should therefore be sown. The central 3' or 3'6" strip should receive repeated sweep cultivation or discing at the recommended stages and intervals. A late summer cover crop or winter cereal may be introduced on these strips later in the season. The important consideration, however, is that the wide spacement practice be continued during the successive summer seasons ensuring that the crop rows are annually positioned on the previously inter-row cultivated strips.

There is little doubt that nutgrass can be greatly reduced, if not entirely eradicated, by implementing a rigidly controlled cultivation programme which extends over two successive growing seasons. During the first season, the first treatment should commence as soon as possible after emergence of the vertical rhizome followed by a second or third cultivation at 2-weekly intervals. There is ample evidence to suggest that late summer, autumn, or winter ploughing are potentially dangerous, and are consequently not recommended. Indiscriminate movement of implements from infested fields should also be carefully controlled. The ploughing over of Eragrostis curvula leys invariably precipitates a serious nutgrass problem. A cautious approach is therefore advocated when converting grass leys to arable sites.

2. Grass Leys.

The severe nutgrass infestations which follow the disturbance of an Eragrostis curvula grass ley pose certain questions. The questions are prompted by the fact that on infested sites, nutgrass is visually absent during the period of grass ley occupation.

This is by no means an isolated case and the problem is one that has been repeatedly observed throughout the Highveld where Eragrostis leys are established and finally brought back to annual cropping. The most striking feature of such disturbed grass leys is the serious infestation level reached shortly after the advent of the first spring rains. The situation is further complicated by the fact that the vertical rhizomes, when inspected, originate from young tubers. The short interval between the onset of the first spring rains and the widespread emergence of the nutgrass shoots rules out any possibility of tubers having originated from current, early season seedlings. From the seedling studies it is apparent that tubers are not produced during the first ten weeks after emergence.

According to Rahn et al (1962) tubers completely lose their viability when buried for periods exceeding 13 - 22 months in Delaware, U.S.A., but at Cornell and Rhode Island observations suggest that some tubers remained viable in the soil for more than two years. Sprouting tests with tubers stored for 4 years in the laboratory at Frankenwald confirmed that tubers did not lose their viability during this period, giving a sprouting percentage of 44%. Laboratory results in this respect are not necessarily applicable to field conditions. Under field conditions, microbial and fungal pressure, exposure to low, fluctuating temperatures could accelerate tuber decomposition, thus influencing longevity. The source of the tuber infestation in newly disturbed Eragrostis curvula leys is thus not explicable and warrants further investigation. It appears that the source of rehabilitation originates from a quiescent tuber population. Growers in the Highveld constantly report that when heavily fertilized Eragrostis leys are ploughed over, the site is overrun by nutgrass which, within one season, once again reaches epidemic proportions. Apart from the rehabilitive advantages of a grass ley, the additional benefits, namely, the suppression of noxious weed problems is, in fact, lost and in many cases the weed situation is aggravated. The smothering action which the grass ley exerts over nutgrass in the summer following establishment is thus nullified when the grass ley is ploughed over. The above situation is further complicated by the fact that with the disturbance of a grass ley and the attendant soil mineralisation, active growth of the nutgrass is promoted.

This indeed was borne out by the vigorous growth and development of nutgrass plants and tubers on a former Eragrostis nursery site at Frankenwald during the first season after cultivation.

Current thought on the rehabilitation of low producing arable fields centres around Eragrostis curvula. The advantages of this practice are unquestionable. It is, however, only appropriate to emphasise some of the definite hazards which the grower must ultimately face when the lay is ploughed over. Although it may not be possible at this stage to offer a suitable explanation in respect of the process of reinvasion, it would appear that the disturbance of Eragrostis curvula leys does bring about in its wake certain disadvantages which could readily outweigh the benefits of grass ley.

It is also pertinent to draw attention to the case histories of the two adjacent camps (see page ~~220~~) which were used to illustrate the problem of spreading of nutgrass populations (Page ~~220~~). In recent months, the camps have undergone considerable change. Both camps have been linked by common contour lines. Cultivation is carried out simultaneously across both camps in one direction. The cultivated site which, after 7 years of cultivation - had been free of nutgrass, is once again severely infested. It was obvious that tubers had been transported from the infested camp by means of mechanical cultivation.

3. Smother Crops.

The use of smother crops such as teff has been widely recommended as an effective method of controlling nutgrass. This belief stems mainly from the fact that teff sown in nutgrass infested sites, will ultimately suppress the nutgrass and give a false smothering impression. The concensus of opinion among growers is that teff is the most suitable crop for this purpose. Thurston (1960) states that most weedy species germinate at a definite time of the year and Bunting (1960) reports that in regions of seasonal growth, many weed species are able to establish, grow and even reproduce in the early spring. The seasonal aspects and growth rhythm of nutgrass have already been described in detail.

At the beginning of the season, nutgrass emerges very rapidly excluding and smothering the teff. Gradually, the teff makes its appearance, overshadowing the nutgrass, the latter fading into obscurity by the time the teff is ready for harvesting. Teff height is a function of the prevailing seasonal soil moisture conditions. In a favourable season, the teff will overshadow the nutgrass. In a poor season, however, height differences are not pronounced, which results in the simultaneous harvesting of nutgrass and teff seed. The biggest disadvantage of broadcasting smother crops in nutgrass infested sites is the fact that production of fresh daughter tubers can take place before the smother crop is capable of exercising a suppressive influence on the nutgrass. In a normal season, the rate of emergence and growth of nutgrass is so rapid that the smother crop can only exercise a delayed influence. Growers would thus be better advised to apply mechanical cultivation to infested sites than to resort to broadcasting inefficient smother crops.

4. Biological Control.

The evidence obtained from local collections and those of overseas workers suggest that some advantages could be derived from certain insects and fungi which are known to attack nutgrass. The latter appears to attack the plant only in the post flowering stage and would thus have limited application in an integrated biological control programme. Furthermore, its specificity has not been determined.

The introduction of certain entomophagous pests, specific to nutgrass (Poinar 1964) certainly merits further investigation. A more detailed examination of local material is indeed warranted. According to Oosthuizen (1964) the main objective of biological control is that it is not aimed at complete eradication, but the reduction of an undesirable species to such an insignificant level that its presence is no longer of any moment. This presupposes that a programme of control and not of eradication should be aimed at, which in the case of nutgrass would not be desirable.

5. Chemical Control.

Compared with most annual weeds appearing in arable fields throughout South Africa, nutgrass appears to be remarkably resistant to most chemicals, the degree of resistance being especially noticeable

towards the standard rates, or rates considered to be economic, for obtaining satisfactory control Whilst in numerous cases, the initial control achieved with herbicides was very promising, residual herbicide action was particularly lacking when treating dense stands invading low lying or poorly drained sites.

Of the few promising treatments, the chemical or the rate in question was such as to necessitate automatic preclusion from a selective spray programme on the Highveld. A case in point is bromacil which, of all the compounds tested, was the only chemical to give a degree of control which could be regarded as satisfactory. Because of its persistent qualities and high level of toxicity to most annual crops, bromacil cannot be considered for the Highveld.

From the experimental evidence obtained in this study, it is clear that a distinction should be made between light, moderate or severe nutgrass infestation levels. Secondly, it is necessary to differentiate between retardation (i.e, foliageer initial top kill), control and eradication. When assessing the value of a particular treatment with a particular herbicide, final judgment should not depend entirely on effectiveness of the top kill even though this may be striking., or on observations concerning toxicity to the crop even though they may be absent. In the case of nutgrass the true picture can only be fully understood after a thorough examination of the attached and unattached underground fractions of the treated plants has been completed. The ultimate success of the compound will depend on its effect on... the dormant tuber population.

An obvious inference from the results obtained in the various investigations is that the different compounds or compound mixtures influence the nutgrass plants in varying degrees. Not only does the mode of action and phytotoxic symptomology differ markedly, but there is a remarkable divergence in the duration of herbicidal effects. Whilst many herbicidal combinations may give excellent scorch of the top growth which may or may not lead to systemic die back of the affected plant, these chemicals or mixtures will not necessarily keep the treated site free from nutgrass.

a) Non-selective control.

Based on the present findings, it is possible to classify the herbicides or herbicidal mixtures into various categories. This classification reflects initial and residual toxicity to nutgrass when applied as post-emergence treatments on heavily infested sites. The herbicidal treatments have been inserted into their specific categories when showing rating values of 8 or more for the prescribed periods. Rates are all expressed as active material per acre.

1) Initial kill.

Only the aerial parts of the plants are affected. Depending on the chemical, reshooting may occur within a short interval after treatment.

1. Paraquat 1.5 lbs
2. Dinoseb 5.52 lbs and 11.4 lbs.
3. DCP 5% in oil 5 gallons

2) Initial + moderate residual plant kill. Residual effect on the treated plant, persisting for at least 21 days.

1. Paraquat, 1 lb and 1.5 lbs + surfactant
2. Amitrole 4.8 lbs + dalapon 15 lbs.
3. Paraquat 1.5 lbs + diuron 4 lbs + surfactant.
4. Paraquat 1.5 lbs + monolinuron 2.5 lbs + surfactant.
5. Paraquat 1.5 lbs + linuron 2.5 lbs + surfactant.
6. Amitrole 9.6 lbs + atrazine 4 lbs.
7. Amitrole 9.6 lbs + monolinuron 2.5 lbs.
8. Amitrole 9.6 lbs + linuron 2.5 lbs.
9. Amitrole 9.6 lbs.

3. Initial + residual kill + moderate soil persistence.

Residual effect on the treated plant and persistence in the soil for at least 10 weeks.

1. TCA 100 lbs
2. Dalapon 40 lbs
3. "Friuron" 100 lbs

4. Residual plant kill + excellent soil persistence

Residual effect on the treated plants and the persistence in the soil for at least 4 weeks.

1. Bromacil 6.4 lbs
2. Bromacil 6.4 lbs + Amitrole 4.8 lbs
3. Double sprays of (a) Bromacil 3.2 lbs
   (b) Dalapon 40 lbs.
   (c) Paraquat 1.5 lbs + diuron 4 lbs + surfactant.

a) Non-selective control.

Based on the present findings, it is possible to classify the herbicides or herbicidal mixtures into various categories. This classification reflects initial and residual toxicity to nutgrass when applied as post-emergence treatments on heavily infested sites. The herbicidal treatments have been inserted into their specific categories when showing rating values of 8 or more for the prescribed periods. Rates are all expressed as active material per acre.

1) Initial kill.

Only the aerial parts of the plants are affected. Depending on the chemical, reshooting may occur within a short interval after treatment.

1. Paraquat 1.5 lbs
2. Dinoseb 5.52 lbs and 11.4 lbs.
3. PCP 5% in oil 5 gallons

2) Initial + moderate residual plant kill. Residual effect on the treated plant, persisting for at least 21 days.

1. Paraquat, 1 lb and 1.5 lbs + surfactant
2. Amitrole 4.8 lbs + delapon 15 lbs.
3. Paraquat 1.5 lbs + diuron 4 lbs + surfactant.
4. Paraquat 1.5 lbs + monolinuron 2.5 lbs + surfactant.
5. Paraquat 1.5 lbs + linuron 2.5 lbs + surfactant.
6. Amitrole 9.6 lbs + atrazine 4 lbs.
7. Amitrole 9.6 lbs + monolinuron 2.5 lbs.
8. Amitrole 9.6 lbs + linuron 2.5 lbs.
9. Amitrole 9.6 lbs.

3. Initial + residual kill + moderate soil persistence.

Rseidual effect on the treated plant and persistence in the soil for at least 10 weeks.

1. TCA 100 lbs
2. Dalapon 40 lbs
3. "Trifuron" 100 lbs

4. Residual plant kill + excellent soil persistence

Residual effect on the treated plants and the persistence in the soil for at least 4 weeks.

1. Bromacil 6.4 lbs
2. Bromacil 6.4 lbs + Amitrole 4.8 lbs
3. Double sprays of (a) Bromacil 3.2 lbs
   (b) Dalapon 40 lbs.

   (c) Paraquat 1.5 lbs + diuron 4 lbs + surfactant.

From the above classification, it is evident that the most effective compounds or mixtures are those which include a soil acting herbicide which prevents the resprouting of mother tubers, the sprouting of dormant tubers and the production of new daughter tubers. Because of their restricted selectivity most of these soil acting herbicides are are not suited for use in the production of annual crops on the Highveld Region.

From the aforegoing list, however, it is possible to extract chemical treatments with short residual effects, e.g. amino triazole, paraquat and linuron. These could be used as chemical summer fallow treatments on heavily infested sites. These chemicals have a short residual action, ... are known to degrade very rapidly in the soil and could be employed during the first half of the growing season for controlling nutgrass infestations on sites destined for taff production. Donally and Rahn (1961) and Hill et al.(1962) have shown that amino triazole is translocated acro- and basipetal , in nutgrass, and that the seed germination is significantly reduced following application. In the same way as /staggered cultivations have been suggested for efficient tillage programmes split herbicidal applications would prove to be far more beneficial than a single spray of a persistent chemical.

The most obvious method of controlling nutgrass would be to toxify the tubers. These as Rahn et al.(1962) have found, resist . . chemical treatment. While uptake of herbicide during the initial growth stages presents a weak link in the plant, the ability of the tuber in its dormant stage to withstand herbicidal applications renders the complete eradication of nutgrass an impossible task.

b) Selective control.

The ideal herbicide for controlling nutgrass in arable crops would be an inexpensive compound which is effective under a wide range of soil moisture conditions and controlling not only nutgrass, but other annual weeds as well. The recent introduction of EPTC into the potato industry (Viesser 1964) has made possible the selective control of nutgrass and annual grasses without any deleterious effect to the crop. On maize selective control of nutgrass is possible but certain modifications in the planting technique and careful supervision are necessary to prevent injury to the crop. Where heavy infestations occur, growers would still enjoy tremendous benefits from EPTC applications despite the attendant hazards. The relatively high cost and difficulties associated in application have militated to some extent against the general use of EPTC.

The current extensive usage of triazine derivatives in the maize growing areas has met with great success in regard to the control of annual weeds. The results on nutgrass are somewhat conflicting and deserve further consideration. The results reported by American workers concerning the efficacy of triazine against nutgrass have not been confirmed in South Africa. Most of the overseas trials appear to have been conducted on loam sands which may account for greater herbicidal movement. In South Africa, the efficacy of atrazine against nutgrass appears to be confined mainly to sandy and loess soils. To obtain satisfactory control of nutgrass with atrazine, a rate of 4 lbs per acre is necessary (Santelmen and Meade 1962). Atrazine at rates of 2 lbs per acre has been shown to preclude the growing of all crops but maize or sorghum, and its usage must therefore be confined to areas where continuous production of maize or sorghum takes place. At present the use of atrazine and simazine in maize in the U.S.A does not permit the planting of any crop but corn during the season of treatment or the following season (Anon; 1965).

The residues of several soil acting herbicides such as monolinuron, monuron and TCA as measured in terms of plant response, while not conclusive, suggest a rapid deterioration of monolinuron in a loamsoil at Bapsfontein. The detoxification rate appears to be fairly rapid. The results demonstrated that certain crops such as beans and maize may be planted within a short period after spraying of high herbicidal concentrations. These results also confirm the findings of Danielson (1956) with regard to crop toxicity period of monuron, and illustrate that under high ultra violet irradiation, a feature of the Highveld Region's summer climate, rapid photochemical degradation of substituted urea and triazine derivatives may be expected (Jordan et al. 1964 and Comes and Timmons 1965). Generally, the use of pre-planting treatments necessitate fairly high rates of application, rendering the treatment uneconomical. From an agronomic and economic point of view, judicious tillage, followed by a single spray of a short residualherbicide, would probably be far more beneficial than a single preplanting treatment.

In recent years, the application of directed band sprays in row crops has enjoyed considerable interest in the U.S.A, particularly when conditions were unfavourable for pre-emergence spraying, where the weed flora, e.g. nutgrass shows resistance to pre-emergence treatments or where the pre-emergence treatment had failed.

The incorporation of surfactants in the herbicidal spray has greatly enhanced the efficacy of the treatment and, in some cases, made possible the control of species which are normally resistant to the same chemical when applied pre-emergence. A good example is that of linuron which, if used pre-emergence on maize, exerts little effect against nutgrass at the recommended dosages (1 lb - 2 lb a.i per acre). When applied in conjunction with a surfactant as a directed spray, nutgrass can be controlled. Shear (1965) found that apart from the top kill, an application of linuron (1.5 lbs a.i per acre) resulted in reduced numbers of tubers and reduced viability. Excellent selective control in maize with 2 lbs linuron + surfactant has been reported by Hebblethwaite (1965).

The use of directed spraying permits control of the nutgrass in crop rows Successful application is dependent on the availability of suitable spray apparatus, especially where soil topography is irregular and a height differential exists between the maize and nutgrass.

To avoid phytotoxicity to the maize, it is essential to direct the spray under the maize leaves at the base of the plant and ensure that no spray be deposited on the upper foliage or in the funnel. Bottom leaves which are sprayed will ultimately become necrotic but will not retard the growth of the maize plant.

As previously stated, high ultra violet irradiation, particularly during the summer months, is a contributing factor to herbicidal degradation. Photochemical decomposition of linuron is considerably reduced by applying the herbicide some 4 weeks after sowing, thereby extending the longevity of herbicidal control up and until the crop canopy stage. From this stage onwards, shading will reduce or exclude weed competition, particularly under conditions of high plant populations and nutrient supply.

Contact herbicides such as dinoseb, PCP and paraquat may also be considered for directed row spraying in maize. These chemicals tend to produce severe phytotoxicity and their use in grain crops is therefore not recommended.

Hormone regulator herbicides are seldom, if ever, used pre-emergence for control of nutgrass in maize. Despite the shortcomings of MCPA and 2,4-D under adverse soil moisture conditions, both chemicals exercise a degree of inhibition and retard the growth of nutgrass when applied at relatively high rates in a moist seedbed.

A number of selective herbicides which show varying degrees of toxicity to nutgrass, have made their appearance in recent years. The choice of chemical and the method of application will depend mainly on prevailing climatic and soil conditions. At present, all the promising treatments possess certain disadvantages and involve certain restrictive usage or specialised methods of application. They do, however, offer the grower a means of utilising moderately or lightly infested nutgrass sites for crop production. The use of selective treatments on heavily infested areas is not advocated before the necessary cultural or chemical

control measures, as listed earlier, have been successfully applied.

Selective control of nutgrass in turf remains a problem deserving further investigation. Either the selectivity or the residual effect appears to be lacking in most chemicals (Fisher and Machielse 1957). With the exception of hormone type herbicides, no herbicide was found which offered a suitable selective control. Atrazine is well tolerated by most turf species and may be a future candidate for this type of problem on sandy soil. Repeated sprays of high concentrations of 2,4-D and MCPA are well tolerated by turf, giving excellent suppression of nutgrass and control of a wide spectrum of most troublesome broadleaf and annual grasses. From an economic point of view, this treatment is extremely low in price

The use of EPTC as a pre-planting treatment in turf does not appear to be safe, even where planting is delayed after treatment.

The application of EPTC to disturbed turf swards where sods are being periodically removed, appears to hold out considerable promise against invading nutgrass.

). DISPERSAL AND DISSEMINATION OF C.ESCULENTUS .

A knowledge of the manner of reproduction of weeds and of the agencies responsible for dispersal, forms a basis for the prevention of this introduction and the spread, (Crafts and Robbins 1952). By means of efficient dispersal or dormancy, weed species are able to invade and colonize new areas at a distance and persist through acts of cultivation or weed control, although the seed output from any given year may be destroyed (Harper 1960). Furthermore, there is a close relationship between the seeds of certain weeds and the kind of crop in which they occur (Wellington 1960).

Sellschop and Hattingh (1956) have indicated that the dispersal of nutgrass results principally from the use of nutgrass contaminated teff seed. The authors are of the opinion that because of the hard varnish-like cover, nutgrass seed germinates gradually over a number of years and as a confirmation they quote the results of Rheinhold's (1942) studies on the acid treatment of nutgrass seed. Moss (1951) also attributed the lack of germination to the hard seed coat.

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The present Seed Purity Act prohibits the sale of teff seed containing a total of more than 50 weed seeds per 1 oz of teff seed. Because Rheinhold (1942 a) and Ries (1951) failed to obtain nutgrass seed germination, it was postulated that the sale of nutgrass-contaminated teff seed did not contribute an agronomic hazard. From the evidence presented in Appendix Table 20 and Figure 32 it is quite apparent that most of the teff seed samples submitted to the Seed Testing Station of the Department of Agriculture are infested with nutgrass seed. The analysis of the data accumulated over three years revealed that in regard to nutgrass seed contamination, 42 percent of the teff seed samples submitted for approval contained more than the permissible contamination level. It is therefore quite inexplicable that the regulations governing the purity of teff seed were oficially reduced during 1964/65. Due to a temporary shortage of "clean" teff seed, the permissible contamination level was increased from 50 to 500 weed seeds per 1 oz of teff seed sample. The implications of reduced standards of seed purity are fairly obvious, influencing the rate of dispersal and extending the zones of infestation. On the other hand the leniency with regard to the reduced purity standards may have been influenced by the information previously available. Firstly, it was generally accepted that nutgrass seed was not viable, no distinction being made between the relative viability of C.esculentus and C.rotundus. Secondly, germination of C.esculentus could only be achieved by means of a drastic acid treatment and, thirdly, the scarcity of nutgrass seedlings in the field was employed as evidence to verify low seed viability.

Another salient feature emerging from the analysis of the Seed Testing Station's records was the fact that most of the teff seed which was either contaminated or rejected, principally originated from specific areas or districts. In other words, most of the areas which are currently employed for the production of teff seed are completely unsuitable. There is an urgent need to carefully examine and reconsider the entire system of teff production in South Africa, and to explore the possibilities of producing pure teff seed in select areas. The latter would have to conform to specific requirements and the production confined to fields where nutgrass infestation is either non-existant, where weed population

density levels are low and where stringent field inspection is maintained. It should be borne in mind that the major percentage of teff seed marketed in the Republic passes directly from the seed producer to the commercial grower without any seed certification.

From the evidence presented in Chapter VIII there is little doubt that the cultivation of teff is the mechanism of introduction and dispersal of nutgrass in the eastern sections of the Highveld. The conditions necessary for the successful establishment are:-

a) A high potential seeding rate;

b) early maturation of the nutgrass seed prior to harvesting of the companion crop;

c) dormancy and longevity of the seed;

d) Adaptation of seedling and mature plant to the prevailing environmental conditions.

In the case of nutgrass it is not essential to have available a continual source of seed inoculum. The longevity (Bellue 1946) as well as the dormancy of seed, permit extended survival of the seed. The sensitivity of the seedling during the early stages to adverse weather conditions is more than compensated for by the rate of proliferation from tubers and the rapid distribution by means of mechanical implements. While it is impossible to achieve complete eradication of every nutgrass site, it is generally agreed that the elimination of the source of inoculum will be in the greatest interests of the entire agricultural community. It is perhaps advisable to reiterate the findings of Justice and Whitehead (1946), which are confirmed by the present experimental data, namely, that one inflorescence is able to furnish the equivalent of 1521 seedlings. It is therefore recommended that the permissible contamination level of teff seed should be drastically reduced and a more stringent legislation enforced.

The Standerton District, renowned as one of the worst nutgrass infested areas, presents a unique problem. The district is responsible for the production of 45.9% of the teff seed crop in South Africa. In common with that of many milk producing reservoirs for the Witwatersrand complex, the milk industry in this district has developed a marked degree of specialisation. Fodder production has therefore assumed considerable

prominence in this type of agriculture. Due to limitations imposed by soil, topography and altitude, the agriculture of these areas is necessarily restricted in variety. Maize predominates as the principal cultivated crop. The practice has been to introduce teff either as a rapid catch crop following an early summer season potato crop, where residual fertilizer benefits are utilised, or on sites which have suffered crop losses earlier in the season. Though teff is often sown prior to Mid-December, the majority of plantings are confined to the second half of the season.

A further aggravating feature of the teff seed industry is that not much effort has been made to implement sound cultural practices or to introduce a systematic seed cleaning programme. Precautionary measures such as early summer tillage, selection of non-infested fields, utilising the first cut for fodder and the second for seed are not common practice. (1957)
Du Plooy states that if teff seed is to be harvested, every possible precaution should be taken to eradicate watergrass (uintjies) before the teff seed is sown, as teff and watergrass seed are difficult to separate. Generally, growers are reluctant to utilize second cuts for seed purposes because of the lower yields. Where teff is sown on nutgrass-infested sites, mature nutgrass seed is available two months after the tuber has sprouted. If no precautions are taken to reduce the nutgrass infestation as is often the case on the heavy, black turfs in Standerton, teff seed produced from the first cut will be severely infested.

Similarly, the introduction of selective hormone type herbicides in maize, e.g. 2,4-D and MCPA approximately 10 years ago has also aggravated the problem. By selectively eliminating or reducing annual weed competition, the spread of nutgrass has been promoted.

Although many weed seeds are destroyed in passing through animals and more are destroyed by storage in manure, still a considerable number of viable weed seeds may reach the field (Crafts and Robins 1962). In the case of nutgrass the hard seedcoat would probably act as a protectant, and it is postulated that digestive acids might reduce dormancy and enhance germination. Dispersal by means of animals is more restricted than the movement of contaminated seed.

They nonetheless represent a further link in ensuring distribution especially on one and the same farm.

The development of techniques for removing weed seeds from agricultural seed has lagged behind the development of methods for eradicating the plants themselves (Wellington 1960). In recent years several local co-operatives and seed merchants have installed seed cleansing machinery, capable of separating teff and nutgrass seed very efficiently. The unit, known as the "Kipp Kelly", fitted with a canvas deck, is alleged to deliver teff seed free from weeds and may prove to be a valuable tool in confining the future spread of nutgrass seed.

During normal seasons, nutgrass produces seed of uniform size. During drought periods, however, the nutgrass seeds are of irregular size and the teff growth is retarded. Teff and nutgrass seed are thus harvested simultaneously making seed separation difficult. The Kipp Kelly unit, however, appears to be able to cope with all the situations.

The economic eradication of nutgrass over an extended area is a problem which has not yet been solved and which does not appear possible of solution. However, in recent years, promising means of control and even eradication have become available. It would appear that the implementation of control measures are the best approach in the production of weed-free teff seed. In order to implement such a scheme, the following is advocated:-

1. Elimination of nutgrass in the field prior to seeding. Pre-treatment of the soil by means of tillage or with a short residual herbicide.
2. Appointment of certified teff seed producers who will receive premiums on their certified seed. Such growers to mow the first cut early before the nutgrass seed has matured, and utilise only second cuts for seed production.
3. Raising of the weed contamination standards for teff seed. For example an arbitrary figure of no more than 10 - 20 nutgrass seeds per ounce of teff seed.

4. Stringent sanitary field inspection.
5. Restrict by law the sale of uncertified teff seed by unauthorised growers.
6. Confine the production of teff seed to those areas where nutgrass infestation is of a low level.
7. Explain and bring to the notice of teff producers the seriousness of the pest and emphasise the urgency of material control.

E. DISTRIBUTION OF CYPERUS ROTUNDUS

Having defined the nutgrass infested areas of South Africa, and postulated a tentative reason for the specific distribution of C.esculentus, the question which poses itself is why the absence of C.rotundus in the high rainfall areas of the Highveld? C.rotundus, by nature of its greater ramified underground system would, at a first glance appear to be more resistant to adverse conditions, and should therefore have readily established itself on the Highveld. Day and Russell (1935) have shown that despite a larger and more robust tuber, C.esculentus is more tolerant of desiccating conditions than C.rotundus In California, both species are known to occur, while on the Natal sugar belt both species often occur simultaneously in the same field with some evidence of seasonal aspect. Generally, there appears to be a tendency for C.rotundus to assume the dominant role.

On the Highveld, C.rotundus is conspicuous by its absence and occurs in very isolated cases. Where C.rotundus occurs on the Highveld, its presence is usually linked with infested manure or planting material. According to Sellschop and Hettingh (1956), C.rotundus is found principally on irrigated lands and on the dry lands in areas with an annual rainfall of 20 - 25 inches.

Baier (1963), summarizing the temperature distribution of the Highveld Region, points out that the lowest maxima occur in the south and east part of Harrismith and Bethlehem districts, and the highest maxima in an area which extends from the Potchefstroom district to the western border of the Highveld Region. In examination of the relevant temperatures of each sub-region for the period September till January reveal the following:-

	Mean Maxima	Mean Minima	Mean Highest Maxima
Eastern Free State	21.7 - 27.2°C	5.1 - 13.0°C	32.1°C
Eastern Highveld	23.5 - 27.2°C	4.8 - 13.2°C	32.2°C
N.W.Free State	24.2 - 30.3°C	6.3 - 15.6°C	35.6°C
N.W.Transvaal	25.1 - 29.8°C	7.1 - 15.7°C	34.3°C

From a temperature point of view there does not appear to be marked differences between the four sub-regions. Conditions in the eastern half of the Highveld are theoretically well suited for the growth and development of C.rotundus.

Tests carried out by Justice and Whitehead (1945) proved that 4,77 inflorescences would be required to yield a single seedling, (compare yellow nutgrass with 1 inflorescence capable of producing 1521 seedlings). From a total of 13,430 heavy seeds, they obtained a mere 4,12 percent normal and 1.69 percent abnormal seedlings. C. rotundus must therefore propagate essentially by means of tubers. Seed dispersal is therefore practically of no significance.

Although teff may be grown throughout the summer rainfall area, it does best in the cooler districts and in those areas having a well distributed rainfall. The young teff plants are readily scorched by the sun where protracted dry periods are the rule (Du Plooy 1957). It is therefore quite plausible to suggest that the eastern Highveld has been protected against the widespread invasion of C.rotundus principally because this species fails to set viable seed.

F. UTILIZATION OF NUTGRASS.

It has been suggested that an efficient and well adapted weed may find itself taken up and converted into a crop. (Bunting 1960). Indeed there appears to be sufficient data available to reflect on the potential usages of nutgrass, especially in certain areas where eradication is practically impossible or uneconomical. Such sites, low-lying or poorly drained, are generally not suitable for arable purposes.

Provided the necessary precautions are taken to prevent seeding and mechanical transmission, there appears to be a strong case in favour of utilising well fertilised nutgrass pastures.

In view of the fact that C.esculentus is able to maintain a high level of herbage, and that frequently clipped herbage (10 times per season), contains an average of 15.4 percent protein, it becomes apparent that C.esculentus is well suited for a pasture programme. Further studies in respect of palatability, tolerance to grazing pressure etc., warrants further investigation.

SUMMARY

1. Cyperus esculentus (nutgrass) is an indigenous species which has extensively invaded and proliferated the most valuable arable land within the Highveld Region of South Africa. The origin and present distribution of C.esculentus in South Africa has been described, and the literature relevant to the medicinal, nutritional and economic uses of this species has been summarized.

2. The identification of, and differentiation between C.esculentus and C.rotundus, have been listed and illustrated. The life history of C.esculentus has been described in detail and a study made of its growth and spread.

3. Literature relevant to the morphology, physiology, as well as the cultural, chemical and biological methods of control has been reviewed. The evidence on the ecological significance of toxic substances in the competition between higher plants has also been included.

4. Methods and materials employed in the study have been described in detail.

5. The influence of fertilizer on the growth of nutgrass, revealed a positive nitrogen and phosphate response. A highly positive correlation was obtained between the results obtained from field and pot experiments.

6. Of the nitrogen carriers tested, urea gave the highest yields. Nutgrass growth was not depressed when fertilized with high dressings of urea.

7. On old established turf plots at Frankenwald, the turf and nutgrass grew more vigorously on the fertilized than on the unfertilized plots, despite a sharp decline in soil pH.

8. Changes in the soil pH or nutrient level by means of heavy dressings of ammonium sulphate or lime, failed to depress the growth of nutgrass. Lime (calcium hydroxide or calcium carbonate) exerted no influence, whereas nitrogen increased the growth.

9. Alternating temperatures in the presence of light, sulphuric acid treatment and substrate, exercised a pronounced influence on the germination of nutgrass seed. Chilling of the seed had no deleterious effect on germination.

10. A seasonal effect on germination was established. In a normal season, mature seed was available at the beginning of January.

11. The production of seed per umbel was established and the presence of seedlings in arable fields investigated.

12. An examination of several hundred teff seed samples revealed that a high percentage were heavily contaminated with nutgrass seed.

13. An analysis of the principal teff producing areas, confirmed a striking similarity in the pattern of distribution between the former and the nutgrass infested areas of South Africa. The cultivation of teff appears to be mainly responsible for the introduction and dispersal of nutgrass in the eastern sub-regions of the Highveld. A suggested pathway for the introduction and dispersal of nutgrass seed has been compiled.

14. An investigation of nutgrass tubers, showed that the tubers were present in large numbers, confined principally to the top 6 inch layer of soil, sprouted from specific depths under a wide temperature range. Washing and insolation of the tubers had a pronounced influence on the sprouting of the tuber.

15. In the presence of adequate fertilizer, nutgrass plants showed exceptional tolerance to frequent clipping, yielding herbage of remarkably high quality. Sprouted tubers were capable of resprouting repeatedly if the vertical rhizome was clipped back.

16. Insolation of the plant reduced the vigour of the exposed plants.

17. Competition studies revealed that when heavy dressings of fertilizer were applied to a mixed population of nutgrass and maize, the nutgrass utilized the nutrients more efficiently than the maize. The competitive effect of nutgrass was largely offset by altering the nutrient status of the soil.

18. The seasonal water consumption of nutgrass was not significantly higher than an equal number of annual weeds. Where the weeds were grown in conjunction with maize, the total water uptake of the unit (weed and maize) remained constant, irrespective of the weed species. In both moisture studies, however, the underground weight of nutgrass was comparatively heavier than that of the two weed species.

19. The investigations designed to examine whether the living nutgrass liberates a physiologically active toxin capable of inhibiting germination or retarding growth, produced negative results. Growth suppression on the concentration and method of preparation. A growth stimulation of a transitory nature was observed when germinating seeds, together with nutgrass tubers.

20. Discing proved to be an efficient method of controlling nutgrass, the degree of control being dependent on the time of treatment and the particular nature of the site.

21. Biological control by means of entomophagous insects deserves further investigation.

22. Of the wide range of herbicides tested, several gave excellent control, but persistence was lacking in most of the chemicals. Bromacil was one of the most promising compounds tested but, because of its extended residual action, cannot be considered for the Highveld Region.

23. Of the selective control measures tested in arable crops, contact herbicides gave a very short residual effect, whereas high dosages of pre-planting herbicidal treatments appear to be uneconomical. Directed sprays containing linuron plus surfactant, showed considerable promise. In turf, repeated applications of hormone herbicides gave the most economical and satisfactory control.

24. From the ecological studies undertaken at Frankenwald, it would appear that nutgrass is confined solely to the early stages of succession, and in disturbed areas within plant communities higher in the succession. Sprouted nutgrass tubers were, however, able to grow and develop in soils removed from sites representing the advanced stages of succession.

25. The significance of the results has been discussed in relation to the present findings and those reported by previous workers.

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APPENDIX TABLE 1 : GREEN AND AIR-DRY HERBAGE WEIGHTS OF NUTGRASS. GRAMS PER POT.

TREATMENT	GREEN WEIGHT				AIR-DRY WEIGHT			
	I	II	III	TOTAL	I	II	III	TOTAL
0	11.43	7.69	12.72	31.83	3.43	2.15	3.42	9.00
N	25.30	20.25	14.75	60.30	6.42	5.51	3.94	15.87
P	11.61	17.17	14.54	43.32	3.17	4.23	3.96	11.36
K	12.65	15.91	13.45	42.01	3.74	4.05	3.62	11.31
NP	49.50	48.45	48.50	146.45	13.62	13.54	12.07	39.63
NK	39.65	16.93	17.05	73.68	9.63	5.06	4.34	19.03
PK	12.05	16.10	11.14	39.29	3.29	4.13	3.05	10.47
NPK	45.58	55.57	32.82	133.97	11.93	14.14	9.14	35.21
CON	56.94	51.46	44.82	153.22	14.58	13.93	11.57	40.06

ANALYSIS OF VARIANCE

DF	MEAN SQ.	F
1	2772.6400	**
1	1003.88500	**
1	789.59400	**
1	2.0650	
1	1.1440	
1	66.8670	
1	5.6660	
16	44.1794	

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
N	1	190.4067	**
P	1	71.6222	**
NxP	1	61.5040	**
K	1	0.0010	
NxK	1	0.2992	
PxK	1	4.8420	
NxPxK	1	0.7993	
Error	10	2.2901	

APPENDIX TABLE 2 : GREEN HERBAGE WEIGHTS OF NUTGRASS IN GRAMS PER ¼ SQUARE METRE QUADRAT

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
0	30.4	24.0	66.5	120.9	40.3
N	47.6	49.5	42.7	139.8	46.6
P	34.5	24.8	38.7	98.0	32.7
K	47.8	21.8	33.0	102.6	34.2
NP	85.5	60.3	86.5	202.3	67.4
NK	66.4	45.2	26.8	140.4	46.8
PK	29.4	35.0	39.1	103.5	34.5
NPK	72.0	54.0	59.8	185.8	61.9
COM	62,6	50.3	77.2	190.1	63.4

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
Blocks	2	234.5733	
N	1	2466.4320	**
P	1	307.4500	
NxP	1	703.0840	
K	1	34.3200	
NxK	1	0.4010	
PxK	1	1.8710	
NxPxK	1	69.7000	
Error	14	192.1151	

APPENDIX TABLE 3 : GREENHERBAGE WEIGHTS OF NUTGRASS IN GRAMS PER PLOT

TREATMENT	21/12/61 (18 days)				22/1/62 (24 days)				26/2/62(35 days))				TOTAL FOR SEASON
	I	II	III	TOTAL	I	II	III	TOTAL	I	II	III	TOTAL	
0	271.4	322.4	370.2	964.0	346.4	350.4	373.2	1070.0	324.7	349.3	406.5	1080.5	3114.5
N	328.5	641.8	482.4	1452.7	335.3	519.6	434.6	1289.5	1271.2	963.4	771.8	2996.4	5738.6
P	430.0	423.6	310.8	1164.4	321.5	556.4	436.9	1314.8	726.4	542.4	420.7	1689.5	4163.7
K	412.0	236.9	200.0	848.9	681.5	342.7	317.4	1241.6	550.6	315.6	377.8	1254.2	3344.7
NP	548.4	941.5	688.7	2178.6	710.0	738.5	525.4	1973.9	1135.0	1271.2	1772.4	4178.6	8331.1
NK	521.1	509.3	423.4	1453.8	388.5	566.6	465.1	1420.2	786.3	1634.4	1371.6	3792.3	6666.3
PK	212.0	416.2	357.5	985.7	232.3	734.9	466.5	1433.7	304.5	681.0	635.6	1621.1	4040.5
NPK	532.3	974.0	682.2	2188.6	615.2	648.7	996.7	2160.6	1180.4	1589.0	1407.4	4176.8	8525.9
COM	624.9	700.0	672.0	2005.3	552.8	889.2	757.4	2199.4	1427.4	1452.8	1098.8	3979.0	8185.3

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
Blocks	2	337288.00	
N	1	5673754.00	**
P	1	1602750.00	**
NxP	1	304227.00	
K	1	62473.00	
NxK	1	43397.00	
PxK	1	49624.00	
NxPxK	1	5834.00	
Error	14	122867.64	

APPENDIX TABLE 4 : INFLUENCE OF NITROGEN CARRIERS ON THE GROWTH OF C.ESCULENTUS

WEIGHT OF AERIAL AND UNDERGROUND FRACTIONS IN GRAMS PER POT.

TREATMENT	POT NUMBER	1st Cutting				2nd Cutting				
		STEM NO.	ROOT WEIGHT	GREEN WEIGHT	DRY WEIGHT	STEM NO.	GREEN WEIGHT	DRY WEIGHT	TUBER NO.	TUBER WT
Calcium nitrate 1	11)	8	3.8	12.6	1.87	10	6.9	1.25	22	2.2
	22	7	6.8	12.4	2.32	17	14.7	2.49	35	2.8
	33	7	5.8	14.2	2.70	13	12.6	1.92	30	3.6
	44	8	3.5	17.7	2.61	11	10.8	1.64	28	3.3
TOTAL		30	19.9	56.9	9.50	51	45.0	7.30	115	11.9
MEAN		7.5								
Potassium nitrate 2	51	10	10.8	17.4	2.55	11	16.6	2.86	37	3.2
	62	8	9.4	20.4	3.29	19	19.0	4.38	60	4.7
	73	8	15.9	24.5	3.70	14	17.4	2.26	38	4.7
	84	8	5.3	17.8	2.41	12	17.9	2.49	30	2.7
TOTAL	1	34	41.4	80.1	11.95	56	70.9	11.99	165	15.3
MEAN		8.5								
Ammonium sulphate 3	101	9	5.9	14.3	2.12	15	9.6	1.72	43	3.6
	102	8	10.1	16.6	3.08	21	13.3	3.76	49	5.3
	113	9	7.7	17.8	3.32	19	10.0	1.71	48	5.0
	124	10	5.8	14.3	1.91	17	12.4	3.24	39	2.9
TOTAL		36	29.5	63.0	10.43	72	45.3	10.43	179	16.8
MEAN		9.0								
Limestone ammonium nitrate 4	131	9	8.3	14.4	2.29	13	9.1	1.87	35	5.2
	142	10	14.8	26.4	4.70	22	16.4	3.09	53	7.0
	153	9	9.8	20.3	3.43	22	15.0	2.70	49	6.7
	164	8	7.3	14.5	2.60	16	15.4	2.61	54	8.1
TOTAL		36	40.2	75.6	13.02	71	55.9	10.30	191	25.0
MEAN		9.0								
Urea 5	171	8	9.3	16.9	2.62	19	10.8	3.22	65	5.7
	182	9	14.9	27.2	4.96	20	18.0	3.49	36	5.5
	193	10	6.3	27.4	4.68	28	14.6	2.81	45	4.0
	204	8	4.2	21.3	3.02	17	15.8	2.90	51	4.6
TOTAL		35	34.7	92.8	15.28	84	59.1	12.42	196	198
MEAN		8.8								

APPENDIX TABLE 4 (CON'T)

TREATMENT	POT NUMBER	1st Cutting				2nd Cutting				
		STEM NO.	ROOT WEIGHT	GREEN WEIGHT	DRY WEIGHT	STEM NO.	GREEN WEIGHT	DRY WEIGHT	TUBER NO	TUBER WT
Ammonium nitrate 5	21 1	8	13.5	15.1	2.31	14	11.8	2.11	37	6.4
	22 2	8	20.7	22.9	4.61	26	20.3	2.96	52	6.2
	23 3	9	15.6	19.5	3.73	25	13.8	2.02	33	3.2
	24 4	10	3.9	15.5	1.95	18	11.4	1.92	45	3.8
TOTAL		35	53.7	73.0	12.60	83	57.3	9.01	187	19.6
MEAN	1	8.8								
CONTROL 7	25 1	9	9.4	4.1	0.83	13	7.5	1.66	22	2.0
	26 2	9	5.7	4.7	0.7	10	6.1	1.25	31	3.5
	27 3	7	6.0	2.9	0.68	7	4.7	1.00	23	2.4
	28 4	8	2.6	2.8	0.62	8	5.6	1.12	29	2.7
TOTAL		33	23.7	14.4	2.73	38	24.1	5.03	105	10.6
		8.2								

ANALYSIS OF VARIANCE

NITROGEN CARRIERS

a) Green Weights (1st Clipping)

	DF	MEAN SQ.	F
N	6	158.6287	**
Error	21	13.2073	

b) Green weights (2nd Clipping)

	DF	MEAN SQ.	F
N	6	58.1332	**
Error	21	7.1054	

c) Total weights (Combined 1st and 2nd Clippings).

	DF	MEAN SQ.	F
N	6	396.7477	**
Error	21	29.1018	

d) Tuber Numbers.

	DF	MEAN SQ.	F
N	6	322.65	**
Error	21	77.83	

e) Tuber weights.

	DF	MEAN SQ.	F
N	6	6.1875	**
Error	21	1.0116	

APPENDIX TABLE 5 : GREEN HERBAGE WEIGHTS OF NUTGRASS IN GRAMS PER POT

TREATMENT		GREEN WEIGHT
0	1	6.0
	7	7.9
	13	5.7
	19	4.7
Total	25	24.3
50	2	11.4
	8	15.2
	14	13.4
	20	14.0
Total		54.0
100	3	23.3
	9	17.6
	15	17.0
	21	17.3
Total		75.2
200	4	23.0
	10	23.2
	16	24.0
	22	22.8
Total		93.0
400	5	26.0
	11	23.7
	17	26.7
	23	19.0
Total		95.4
800	6	25.0
	12	24.6
	18	26.7
	24	25.6
Total		101.9

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
Nitrogen levels	5	223.4449	***
Error	18	4.4297	

APPENDIX TABLE 6 : SOIL ANALYSIS OF TURF PLOTS.

GRASS VARIETY	O					P					NP					NPK				
	P	K	Ca	Mg	Ph	P	K	Ca	Mg	Ph	P	K	Ca	Mg	Ph	P	K	Ca	Mg	Ph
1. Magennis	22	70	725	40	6.1	53	70	600	40	5.6	62	40	200	30	4.1	71	50	275	30	4.1
2. Bloupan	37	60	475	40	5.9	54	50	425	40	4.6	46	30	275	30	5.0	540	60	775	40	4.9
3. Tiffine	32	60	550	60	6.5	58	50	525	70	5 5	62	60	525	70	5.5	42	70	500	60	5.5
4. Wells Selection	51	80	825	70	6.3	69	60	400	60	6.1	26	40	200	60	5.2	53	60	350	40	4.5
5. Swazilandensis	32	70	350	60	6.3	73	60	825	40	6.3	46	50	225	30	4.2	73	20	250	30	4.5
6. Golarm 'A	34	90	275	60	6.5	40	110	650	60	6.8	44	40	400	40	4.6	51	90	550	40	4.8
7. Skeapplaasa	22	130	925	90	6.1	62	130	925	90	5.9	71	50	100	30	3.3	82	130	700	60	4.4
8. Florida	27	110	1125	130	6.5	6	120	1200	120	6.3	6	40	875	90	5.3	73	60	550	60	4.0
9. Skeapplaas - F	-	260	1225	150	6.2	59	260	1275	130	6.3	64	170	1050	100	4.7	60	360	725	60	4.5
10.Tiflawn	32	90	450	60	6.1	74	50	675	60	6.5	85	30	200	40	4.4	38	40	500	40	4.1
11.Royal Cape	30	60	775	60	6.3	73	70	450	40	6.4	96	30	450	30	4.5	46	60	700	60	5.1
12.Uganda	26	70	325	40	6.2	82	70	575	30	6.2	104	30	225	30	4.3	51	60	225	30	4.2
13 Windsor	50	100	400	90	6.2	78	80	500	60	6.1	78	40	325	40	3.9	78	60	350	70	4.3
14 Bradley V. Balan	55	70	400	60	6.2	11	80	375	40	6.1	104	30	200	40	4.1	54	40	500	-	4.2
15 Zoysia tenuifolia	47	80	425	60	6.8	100	76	550	60	6.6	53	30	200	40	4.2	64	30	250	40	4.1
TOTAL	497	1400	9150	1070	94.2	892	1340	9650	940	93.2	947	710	5480	700	67.8	1354	1190	7200	700	57.0
MEAN	35.5	93.3	610	71.3	6.3	59.5	89.3	643	62.6	6.2	63.1	47.3	365	46.6	4.5	90.3	79.3	480	46.6	4.5

APPENDIX TABLE 7 : NUMBER OF NUTGRASS SHOOTS PER CIRCULAR FRAME 7.5 INCH DIAMETER. .27/1965.

VARIETY	NPK			P			O			NO		
	1	2	3	1	2	3	1	2	3	1	2	3
1. Maganuis	9	14	15	0	0	0	0	0	0	41	4	27
2. Bloupan	58	49	38	20	0	0	11	2	4	23	25	48
3. Tiffine	12	35	25	11	7	0	5	6	0	40	3	22
4. Hall's Selection	42	2	0	4	3	0	0	0	10	0	0	0
5.Swaziland-ensis	42	50	35	0	9	6	4	0	1	30	17	52
6.Qolora mouth	21	40	59	0	4	0	2	0	0	17	18	2
7.Skaapplaas medium	31	24	35	4	0	1	0	3	1	0	18	20
8.Skaapplaas fine	38	3	12	0	0	0	0	0	0	29	6	15
9.Florida	32	54	58	0	0	0	0	0	0	48	39	38
10. Tiflawn	51	63	57	0	2	0	0	0	0	39	33	40
11.Royal Cape	23	6	10	5	6	0	4	0	2	20	31	10
12.Uganda	79	48	69	0	0	0	0	0	0	25	44	36
13.Windsor	35	33	59	8	1	0	4	0	0	22	10	21
14.Bradley v Balen	36	61	71	5	0	3	1	1	2	17	43	17
15 Zoysia japonica	63	49	15	0	0	3	0	3	3	58	39	31
TOTAL	573	531	558	56	23	19	31	15	24	468	330	402
MEAN			36.9			22			1.6			25.3

APPENDIX TABLE 8 : pH OF SOIL SAMPLES - 21/11/60

TREATMENT	PLOT		TREATMENT	PLOT	
L1	1	5.6	A1	1	4.7
	2	5.1		2	4.5
5	3	5.1	1	3	4.7
Total		15.7			13.9
Mean		5.2			4.6
L2	1	5.6	A2	1	4.5
	2	5.6		2	4.5
6	3	5.1	2	3	4.6
Total		16.3			13.6
Mean		5.4			4.5
L3	1	5.7	A3	1	4.6
	2	5.2		2	4.6
7	3	5.5	3	3	4.7
Total		17.4			13.9
Mean		5.8			4.6
L4	1	5.5	A4	1	4.7
	2	5.3		2	4.5
8	3	5.3	4	3	4.9
Total		16.1			14.1
Mean		5.4			4.7
L5	1	5.8	CONTROL	1	5.3
	2	5.6		2	5.5
9	3	6.3		3	5.4
Total		17.7		1	5.1
Mean		5.9		2	5.1
				3	4.9
L6	1	5.8		1	5.1
	2	5.4		2	5.1
10	3	5.5		3	5.0
Total		16.7			46.5
Mean		5.7	Total Mean		5.2

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
Blocks	2	0.0933	
Treatments	12	0.6300	**
Error	24	0.0627	

C.V. 4.84%

APPENDIX TABLE 9: GREEN HERBAGE WEIGHTS OF NUTGRASS IN GRAMS PER 4 (16" x 16") QUADRATS. 30/11/60.

TREATMENT	PLOT	WEIGHT	TREATMENT	PLOT	WEIGHT
L1	1	296.0	A1	1	322.0
	2	159.0		2	511.3
	3	122.0		3	235.3
Total		577.0			1068.6
Mean		192.3			356.2
L2	1	184.0	A2	1	402.3
	2	114.8		2	414.3
	3	211.0		3	188.7
Total		509.8			1005.3
Mean		169.9			335.1
L3	1	169.6	A3	1	496.8
	2	126.4		2	433.3
	3	161.0		3	268.2
Total		447.0			1200.3
Mean		149.0			400.1
L4	1	146.9	A4	1	484.0
	2	82.1		2	359.3
	3	247.0		3	252.0
Total		476.0			1095.3
Mean		158.7			365.1
L5	1	228.8	CONTROL	1	172.5
	2	202.0		2	209.7
	3	143.0		3	237.4
Total		573.8		1	106.6
Mean		191.3		2	103.0
				3	210.0
L6	1	193.0		1	154.0
	2	207.0		2	243.2
	3	80.8		3	188.2
Total		480.8	Total		1625.0
Mean		160.3	Mean		180.6

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
Blocks	2	14267.20	*
Treatments	12	26752.80	
Error	24	5757.47	

C.V 35.59%

APPENDIX TABLE 10 : NUMBER OF NUTGRASS PLANTS AND GREEN HERBAGE WEIGHTS PER 2 QUADRATS (3' x 3'). 29/12/61. (GRAMS)

TREATMENTS	PLOT	NUTGRASS POPULATIONS PER 2 FRAMES	TOTAL	GREEN WEIGHT OF NUTGRASS PER 2 FRAMES.	TOTAL
L1	1	140		1 273 gms	
	2	134		2 266	
	3	124	398	3 257	796
L2	1	158		1 236	
	2	140		2 251	
	3	98	403	3 195	682
L3	1	286		1 380	
	2	123		2 208	
	3	367	416	3 628	1116
L4	1	325		1 360	
	2	124		2 219	
	3	228	677	3 385	964
L5	1	220		1 298	
	2	120		2 270	
	3	420	760	3 513	1081
L6	1	385		1 488	
	2	108		2 215	
	3	413	906	3 600	1301
A1	1	136		1 180	
	2	265		2 365	
	3	112	513	3 196	723
A2	1	267		1 320	
	2	167		2 267	
	3	315	749	3 402	989
A3	1	221		1 398	
	2	241		2 431	
	3	350	812	3 450	1279
A 4	1	360		1 420	
	2	134		2 280	
	3	420	914	3 505	1205
CONTROL	1	321	Mean	1 256	Mean
	2	196		2 210	
	3	238		3 246	
	1	144		1 291	
	2	168		2 242	
	3	321		3 233	
	1	322		1 493	
	2	157		2 233	
	3	102	2019	3 130	2334.

NUTGRASS COUNTS (SQ.ROOT)

ANALYSIS OF VARIANCE

	DF	MEANS SQ.	F
Blocks	2	46.26	
Treatments	12	9.47	
Error	24	9.75	

C.V. 21.21%

GREEN WEIGHTS

	DF	MEANS SQ.	F
	2	29795.55	
	12	15338.84	
	24	10731.33	

C.V 32.35%

APPENDIX TABLE 11 : SOIL ANALYSIS OF UNDISCED SUB-PLOTS.

	Mg P.P.M					CaO %					pH					TOTAL N %			
	I	II	III	IV	TOTAL	I	II	III	IV	TOTAL	I	II	III	IV	TOTAL	I	II	III	IV
1. No	185	181	173	115	660	0.092	0.092	0.114	0.102	0.400	5.6	5.8	5.8	5.9	23.1	0.102	0.106	0.099	0.111
2. N1	231	160	100	85	576	0.104	0.098	0.094	0.096	0.392	5.7	5.6	5.8	5.8	22.9	0.142	0.105	0.096	0.103
3. N2	189	111	205	222	727	0.108	0.062	0.090	0.104	0.364	5.5	5.7	6.0	5.8	23.0	0.109	0.103	0.093	0.106
4. N3	138	217	174	217	746	0.082	0.092	0.096	0.094	0.364	5.3	5.9	5.5	5.8	22.5	0.101	0.132	0.112	0.090
5. N4	143	51	171	81	446	0.096	0.064	0.102	0.092	0.354	5.1	4.9	4.8	5.1	19.9	0.122	0.113	0.120	0.097
6. N5	121	50	104	70	345	0.090	0.050	0.084	0.060	0.284	5.1	4.9	4.8	4.9	19.7	0.111	0.135	0.113	0.110
7. C0	178	219	202	117	716	0.100	0.140	0.098	0.096	0.434	5.0	5.1	5.7	6.0	22.8	0.106	0.107	0.105	0.100
8. C1	194	181	208	160	743	0.108	0.114	0.112	0.160	0.514	5.8	5.7	5.9	6.6	24.0	0.044	0.104	0.100	0.078
9. C2	184	209	208	183	784	0.102	0.160	0.108	0.288	0.658	5.8	6.3	6.1	6.9	25.1	0.111	0.109	0.101	0.094
10. C3	201	210	181	200	792	0.106	0.156	0.118	0.104	0.482	5.7	6.4	5.8	6.3	24.2	0.129	0.102	0.104	0.092
11. C4	201	276	230	130	937	0.126	0.198	0.208	0.128	0.660	6.0	5.8	6.4	6.4	25.6	0.111	0.102	0.109	0.100
12. C5	239	261	224	260	984	0.318	0.408	0.318	0.310	1.354	7.2	7.2	7.1	7.6	29.1	0.124	0.107	0.090	0.091

ANALYSIS OF VARIANCE

1. Air-dry Aerial Weights.

A. DISCED

	DF	MEAN SQ	F
Blocks	3	1.6300	
Treatments	11	3.6511	**
Error	33	0.4088	

C.V. 37.1%

B. NON-DISCED

	DF	MEAN SQ	F
Blocks	3	2.1959	
Treatments	11	4.8131	**
Error	33	0.4910	

C.V. 25.05%

C. DISCED AND NON-DISCED

	DF	MEAN SQ	F
Blocks	3	7.1805	
Treatments	11	16.1098	**
Error	33	1.0770	

C.V. 22.96%

2. Soil Analysis

A. MAGNESIUM CONTENT P.P.M

	DF	MEAN SQ	F
Blocks	3	0476.235	
Treatments	11	7098.88	**
Error	33	1515.86	

C.V. 22.09%

B. CALCIUM CONTENT %

	DF	MEAN SQ	F
Blocks	3	0.000873	
Treatments	11	0.020585	**
Error	33	0.001287	

C.V. 27.81

C. TOTAL N %

	DF	MEAN SQ.	F
Blocks	3	0.000376	
Treatments	11	0.000322	
Error	33	0.000186	

C.V. 12.96%

D. pH

	DF	MEAN SQ	F
Blocks	3	0.4257	
Treatments	11	1.5620	**
Error	33	0.0604	

C.V. 4.18%

APPENDIX TABLE 12 : HERBAGE WEIGHTS OF NUTGRASS - GRAMS PER SQUARE FOOT.

A. DISCED SUB-PLOTS.

TREATMENTS	I	II	III	IV	TOTAL	MEAN
1. N 0	.58	.84	.64	.9	2.96	0.74
2. N 1	1.78	1.7	0.8	1.48	5.76	1.44
3. N 2	1.94	4.82	.76	1.38	8.90	2.225
4. N 3	3.24	2.46	2.74	2.18	10.62	2.655
5. N 4	3.68	4.82	3.38	3.18	15.06	3.765
6. N 5	4.04	2.35	2.38	2.54	11.32	2.83
7. C 0	.04	1.00	.52	.56	3.12	0.78
8. C 1	1.3	1.8	.46	1.08	4.64	1.16
9. C 2	.68	1.02	.46	1.44	3.62	0.905
10. C 3	1.48	1.28	.72	1.0	4.48	1.12
11. C 4	1.12	2.42	2.24	1.46	7.24	1.81
12. C 5	1.2	1.62	.54	1.64	5.00	1.25

B. NON-DISCED

TREATMENTS (PER ACRE)	I	II	III	IV	TOTAL	MEAN
1.Ammonium sulphate, 0 lbs N0	1.82	1.63	0.88	1.56	5.89	1.47
2. " " 100 lbs N1	4.06	3.02	1.87	3.74	12.69	3.17
3. " " 200 lbs N2	3.26	4.33	1.18	4.52	13.29	3.32
4. " " 400 lbs N3	4.19	4.43	4.96	3.69	17.27	4.31
5. " " 800 lbs N4	4.38	5.37	3.65	4.81	18.21	4.55
6. " " 1600 lbs N5	4.13	4.82	3.89	3.95	16.79	4.199
7.Hydrated Lime 0 lbs C0	2.69	2.02	1.31	2.76	8.78	2.195
8. " 500 lbs C1	1.56	3.01	1.66	1.31	7.54	1.885
9. " 1000 lbs C2	2.94	3.04	2.37	1.24	9.59	2.398
10. " 2000 lbs C3	3.04	1.81	1.56	1.33	7.74	1.935
11. " 4000 lbs C4	3.32	2.26	2.69	2.01	10.28	2.57
12. " 8000 lbs C5	2.50	1.43	0.76	1.50	6.19	1.58

APPENDIX TABLE 13 : INFLUENCE OF INCREASING LEVELS OF LIME ON GROWTH OF C.ESCULENTUS

WEIGHT OF HERBAGE AND TUBERS IN GRAMS PER POT.

TREATMENT	POT NUMBER	ROOTS +TOBBA WEIGHT 1/9/65	1st Cutting 9/2/65				2nd Cutting 10/3/65				
			STEM TOT. NO.	GR. WT	GREEN WEIGHT	AIR-DRY WEIGHT	ROOT WEIGHT	GREEN WEIGHT	AIR-DRY WEIGHT	TOBBA NUMBER	TUBBAR WEIGHT
1000 lbs 1	1	3.8	8	9.8	5.3	1.3	2.8	4.5	0.4	14	1.0
	2	4.1	8	15.1	7.0	1.4	3.3	8.1	1.5	18	1.4
	3	2.6	7	10.2	4.4	0.7	2.3	5.8	0.6	11	0.3
TOTAL		10.5			16.7	3.4	8.4	18.4	2.5	43	2.7
2000 lbs 2	4	4.9	7	10.1	4.2	1.2	4.3	5.9	0.9	27	2.4
	5	4.1	8	14.0	7.7	0.9	4.3	6.3	1.5	18	1.4
	6	2.8	5	9.0	4.2	0.8	2.2	4.8	0.9	12	0.7
TOTAL		11.8			16.1	2.9	10.8	17.0	3.3	57	4.5
4000 lbs 3	7	4.6	9	15.6	7.5	1.7	4.3	8.1	1.7	23	1.3
	8	5.7	7	13.9	5.0	1.8	5.0	8.9	1.2	32	2.8
	9	4.7	8	15.6	7.0	1.7	4.2	8.6	1.5	18	0.9
TOTAL		15.0			19.5	5.2	13.5	25.6	4.4	73	5.0
6000 lbs 4	10	5.5	10	28.1	15.8	1.9	9.5	12.3	2.9	28	2.8
	12	4.0	7	9.0	3.5	1.0	3.1	5.5	0.9	18	1.8
	13	6.7	9	16.6	8.4	1.5	9.7	8.2	1.9	27	3.4
TOTAL		16.3			27.7	4.4	22.3	26.0	5.7	73	8.0
8000 lbs 5	14	5.2	8	11.6	6.1	1.1	5.1	5.5	1.2	29	2.4
	15	3.3	6	12.8	6.0	1.2	2.7	6.6	1.2	19	1.0
	16	3.8	7	11.8	5.6	0.8	5.8	5.9	1.3	17	1.9
TOTAL		12.3			17.7	3.1	14.5	18.2	3.7	65	5.3

APPENDIX TABLE 13 (CON'T)

TREATMENT	POT NUMBER	ROOTS +TOBER WEIGHT	STEM NO.	TOT. GR. WT	1st Cutting (9/2/65) GREEN WEIGHT	1st Cutting (9/2/65) AIR-DRY WEIGHT	2nd Cuttinge 10/3/68h ROOT WEIGHT	2nd Cuttinge 10/3/68h GREEN WEIGHT	AIR-DRY WEIGHT	TOBER NUMBER	TOBER WEIGHT
10,000 lbs 6	16 1	3.2	8	7.6	3.2	1.0	2.5	4.4	0.8	21	1.1
	17 2	3.8	9	19.2	6.6	1.4	4.4	12.4	1.5	23	2.4
	18 3	4.8	8	9.5	3.7	1.2	4.6	4.8	0.8	32	2.2
TOTAL		11.8			13.7	3.6	11.5	21.6	3.1	76	5.7
12,000 lbs 7	1	5.4	7	11.3	5.1	1.1	5.0	6.2	1.1	19	1.9
	2	5.1	6	7.9	3.0	1.2	4.8	4.9	0.8	32	2.4
	3	4.1	10	10.2	4.4	1.0	3.6	5.8	1.1	18	1.4
TOTAL		14.6			12.5	3.3	13.4	16.7	3.0	69	5.7
14,000 lbs	1	2.9	9	6.9	2.3	0.9	2.6	4.6	0.6	12	0.4
	2	8.9	7	9.1	4.2	1.0	9.4	4.9	1.1	23	1.4
	3	5.2	10	11.6	5.8	0.9	6.5	5.8	1.2	25	2.1
TOTAL		14.0			12.3	2.8	17.5	15.3	2.9	60	3.9
CONTROL	1	4.0	7	14.2	6.1	1.1	4.4	8.1	1.2	24	3.2
	2	4.5	10	10.6	4.7	1.0	6.1	5.9	1.0	19	0.9
	3	4.2	8	9.5	4.4	1.2	2.9	5.1	1.7	24	2.3
TOTAL		12.7			15.2		11.4	19.1	3.9	67	6.4

ANALYSIS OF VARIANCE

a) Green Weights
1st Clipping.

	DF	MEAN SQ.	F
Lime	8	7.4298	NS
Error	18	6.0922	

a) Green Weights (combined 1st and 2nd Clippings)

	DF	MEAN SQ.	F
Lime	8	21.6445	NS
Error	16	18.4218	

a) Root Weights

	DF	MEAN SQ.	F
Lime	8	5.6653	NS
Error	18	3.5040	

2nd Clipping

	DF	MEAN SQ.	F
Lime	8	4.8678	NS
Error	18	4.4248	

APPENDIX TABLE 14 : SPREAD OF NUTGRASS (1955).

Tot No.	10/1	14/1	17/1	21/1/65		24/1/65		27/1/65		7/2/65		14/2/65		21/2/65		28/2/65		3/3/65		10/3/65		Air-dry Wt. 2/6/65			
																						Stem		Tuber	Root
D	Lves	Lves	Lves	Lves	Sd.Sh	Lves	Sd.Sh	Lves	Sd.Sh	Lves	Sd.Sh	Fl	Sd.Sh	Fl	Sd.Sh	Fl	Sd.Sh	Fl	Sd.Sh	Fl	Sd.Sh	Wt	No.	Wt	Wt
1	5	7	8	10	1	11	1	12	1	17	6	-		9	1	13	2	26	3	27	5	36	25.1	55	6.1	12.5
3	5	7	8	11	1	12	1	13	2	14	6	Flow		7	3	17	3	30	6	40	5	41	29.6	104	14.8	23.3
4	4	5	6	9	-	10	-	11		17	2	Flow		2	1	5	1	10	1	26	1	34	19.5	65	8.4	13.1
7	5	6	7	8	1	12	1	11	1	18	2	Flow		3	1	6	1	12	2	20	2	27	17.8	112	15.9	10.4
8	4	5	7	9	1	11	1	12	1	13	3	Flow		4	1	11	1	12	2	21	2	29	12.4	60	8.8	7.2
TAL	23	30	36	47	4	56	4	59	5	76	19	5		25	7	52	8	90	14	134	15	167	104.4	396	54.0	67.0
AN	4.75	6.0	7.2	9.4	0.8	11.2	0.8	11.8	1.0	15.2	3.8	1		5	1.4	10.4	1.6	18.0	2.8	26.8	3				
PK																									
2	4	7	8	11	1	12	3	12	3	12	6	-		16	-	22	-	36	1	46	1	67	21.9	110	14.3	15.4
5	4	6	8	10	1	10	-	12	1	18	3	Flow		5	1	7	2	11	6	27	5	30	24.0	171	23.9	13.2
6	3	6	7	8	-	11	-	12	-	16	3	Flow		5	1	9	1	14	5	21	6	34	38.2	183	26.8	18.5
9	4	6	6	7	1	7	2	7	3	15	4	-		7	1	16	1	30	2	44	5	47	26.4	188	26.5	15.4
0	5	8	10	13	1	12	3	14	4	16	10	Flow		18	1	28	4	44	5	46	12	48	19.6	153	24.8	11.2
TAL	23	31	39	50	4	62	8	67	11	76	26	3		51	4	82	8	137	19	184	29	226	113.1	805	116.3	73.7
AN	4.0	6.2	7.8	10	0.8	12.4	1.75	11.4	2.2	15.2	5.2	0.8		10.2	0.8	16.4	1.8	27.4	3.8	36.8	5.8				

6/8/65 - Plots harvested
2/6/65 - Weighed

ANALYSIS OF VARIANCE

1) NUMBER OF DAUGHTER PLANTS (7D DAYS)

	DF	MEAN SQ
BLOCKS	4	98.65
TREATMENTS	1	349.10
ERROR	4	143.35

C.V. - 30.46%

2) AIR-DRY STEM WEIGHTS

	DF	MEAN SQ
BLOCKS	4	48.85
TREATMENTS	1	66.04
ERROR	4	48.12

C.V 29.86%

3) NUMBER OF TUBERS

	DF	MEAN SQ
BLOCKS	4	1485
TREATMENTS	1	15728.**
ERROR	4	300

C.V. 14.44%

4) WEIGHT OF TUBERS

	DF	MEAN SQ
BLOCKS	4	34.6990
TREATMENTS	1	388.1290**
ERROR	4	10.0890

C.V 18.65%

5) WEIGHT OF ROOTS

	DF	MEAN SQ
BLOCKS	4	22.5074
TREATMENTS	1	4.5562
ERROR	4	21.1275

C.V. - 32.65%

Lve = Leaves
Sd.Sh= Daughter plants.
Fl = Influence

APPENDIX TABLE 15 : INFLUENCE OF ACID TREATMENT ON THE GERMINATION OF NUTGRASS SEED. PERCENTAGE GERMINATION.

SUBSTRATE	DATE	ACID TREATED					UNTREATED				
		I	II	III	IV	TOTAL	I	II	III	IV	TOTAL
SOIL	28/9/61	47	49	43	41		4	6	11	1	
	12/10/61	55	65	64	62		7	16	17	8	
	24/10/61	55	66	64	62		9	17	18	9	
		55	66	64	62	257	9	17	18	9	53
SAND	28/9/61	42	41	29	52		8	9	5	8	
	12/10/61	66	60	41	64		13	16	6	11	
	24/10/61	66	61	42	68		13	17	6	12	
		66	61	42	68	237	13	17	6	12	48
FILTER PAPER	28/9/61	55	54	51	51		9	13	10	12	
	12/10/61	66	65	58	61		23	27	32	26	
	24/10/61	67	67	63	63		27	33	39	30	
		67	67	63	63	260	27	33	39	30	129

ANALYSIS OF VARIANCE

PERCENTAGE GERMINATION OF NUTGRASS SEED. (ANGULAR TRANSFORMATION).

	DF	MEAN SQ.	F
SUBSTRATES	2	176.6390	* *
ACID TREATMENTS	1	4460.8540	* *
S X A	2	99.6670	* *
ERROR	18	16.0419	

APPENDIX TABLE 16 : GERMINATION OF NUTGRASS HARVESTED AT VARIOUS STAGES DURING THE GROWING PERIOD. NUMBER OF GERMINATED SEEDS.

TREATMENT		UNTREATED							ACID TREATED						
Seed		Num.germinated after-							Num.germinated after-						
Harvested	Sown	7	14	21	28	35	40	TOT	7	14	21	28	35	40	TOT
		days							days						
1.30/12/63	4/1/64														
	A	0	0	10	8	18	13	49	0	1	10	15	12	7	45
	B	0	0	7	16	17	13	53	0	0	16	14	13	7	50
	C	0	0	6	10	13	16	45	0	1	7	15	14	6	43
	D	0	1	2	12	10	16	40	0	2	10	7	20	10	49
TOTAL								190							187
2.16/1/64	30/1/64														
	A	0	1	6	2	1	2	12	0	4	6	4	4	3	20
	B	0	4	12	3	2	2	23	0	8	8	3	0	4	20
	C	0	4	4	5	3	2	18	0	11	9	2	4	1	27
	D	0	2	10	6	3	1	22	0	4	8	6	4	2	22
TOTAL								75							89
3.24/1/64	30/1/64														
	A	0	23	33	7	3	2	68	0	24	29	5	5	6	69
	B	0	23	18	14	9	9	73	0	26	3	7	4	6	46
	C	0	11	23	10	2	3	49	0	27	30	0	3	1	61
	D	0	12	22	10	5	3	52	0	24	3	8	3	3	41
TOTAL								242							222
4. 3/1/64	12/2/64														*
	A	0	13	15	4	4	3	39	17	8	6	8	1	1	49
	B	0	11	15	0	0	3	29	16	6	8	6	0	3	39
	C	0	14	3	6	4	3	32	15	12	7	3	0	1	38
	D	0	7	13	7	0	4	30	23	12	2	2	1	1	41
TOTAL								130							186
5.14/2/64	4/3/64														*
	A	0	12	18	8	6	3	44	0	42	17	4	5	1	69
	B	0	6	14	9	10	3	42	0	47	12	3	0	0	62
	C	0	9	20	11	7	1	48	0	33	12	4	4	2	55
	D	0	6	16	13	6	2	51	0	39	3	4	5	2	53
TOTAL								185							239
6.27/2/64	4/3/64														
	A	0	0	4	3	7	2	16	0	1	4	7	8	1	21
	B	0	0	2	5	5	6	18	0	0	2	5	11	4	22
	C	0	0	1	2	4	2	9	0	3	5	8	7	5	28
	D	0	0	1	2	5	5	20	0	1	5	3	3	3	15
TOTAL								63							86

Num = Number

* = 70 nutgrass seeds per replication

ANALYSIS OF VARIANCE.

PERCENT GERMINATION AFTER 40 DAYS (ANGULAR TRANSFORMATION).

	DF	MEAN SQ	F
HARVESTING DATES	5	869.5752	**
ACID TREATMENT	1	611.5960	**
HxA	5	62.5178	**
ERROR	36	18.8030	

APPENDIX TABLE 17 : GERMINATION OF NUTGRASS SEED (PERCENT GERMINATION)

DAYS AFTER SOWING	1					2					3					4					5					6					7					8				
	I	II	III	IV	T	I	II	III	IV	T	I	II	III	IV	T	I	II	III	IV	T	I	II	III	IV	T	I	II	III	IV	T	I	II	III	IV	T	I	II	III	IV	T
14	0	1	0	0	1	28	35	29	39	131	29	38	44	37	148	37	44	31	43	155	63	59	53	58	234	36	28	36	51	151	4	4	6	2	16	0	1	0	0	1
21	3	5	2	3	13	44	42	36	48	170	47	48	59	49	203	58	57	45	57	217	72	59	66	71	268	40	42	44	63	189	8	5	11	4	28	0	1	0	0	1
28	7	13	6	11	37	60	48	43	53	194	49	54	53	59	224	62	62	48	65	237	79	68	71	73	291	49	47	49	65	210	15	8	13	9	45	0	1	0	0	1
35	13	19	11	17	60	55	55	46	56	212	60	61	67	56	244	66	68	53	68	255	83	68	71	73	295	52	49	54	65	220	18	13	16	12	59	1	3	0	0	4
42	20	24	17	23	84	62	69	53	52	236	56	64	70	68	258	66	68	53	68	255	84	69	73	77	303	54	52	55	68	227	22	15	15	15	68	2	3	1	1	7
49	29	26	22	29	106	64	60	57	65	246	67	65	70	70	263	69	69	53	73	266	85	69	73	79	306	54	52	56	68	230	30	21	18	19	88	2	3	2	1	8
56	32	28	24	32	117	69	66	62	67	264	68	67	74	71	270	72	71	56	74	273	85	69	73	80	307	54	52	56	68	230	36	28	22	23	109	2	5	2	1	10
63	32	30	25	33	120	69	67	63	67	266	69	67	74	72	272	72	72	56	75	275	85	71	74	80	310	55	53	56	68	232	36	29	24	24	113	2	5	2	2	12
70	33	31	26	33	123	70	67	64	68	269	69	67	74	72	272	72	72	56	75	275	85	71	75	80	311	55	53	56	68	232	37	31	24	25	117	2	7	3	2	14
77	34	32	27	34	127	71	67	65	68	271	69	67	74	72	272	72	72	56	75	275	85	71	75	80	311	55	53	56	68	232	37	31	25	26	120	2	7	4	3	16
84	34	32	28	36	130	71	67	66	68	271	69	68	75	72	274	72	72	56	76	276	86	71	75	80	311	55	54	56	68	233	39	33	27	32	131	2	8	4	3	17
91	34	32	28	36	130	71	67	66	69	273	69	68	75	72	274	72	72	56	76	276	85	71	76	80	312	55	54	56	68	233	39	33	27	33	132	2	9	4	3	18

ANALYSIS OF VARIANCE - PERCENT GERMINATION (ANGULAR TRANSFORMATION)

	DF	MEANS SQ.	F
TREATMENTS	6	475.8500	**
ERROR	21	13.5152	

APPENDIX TABLE 1R: NUMBER OF SEEDS PER NUTGRASS INFLORESCENCE.

INFLORESCENCE	SPIKES PER UMBEL	SPIKELET PER SPIKE 1	2	3	4	5	6	7	8	TOTAL	TOTAL SEEDS PER UMBEL*
1	7	8	6	13	12	6	13	14		72	864
2	8	20	6	25	24	23	22	10	16	141	1692
3	6	28	23	7	27	14	21			120	1440
4	6	16	21	23	20	26	30			136	1632
5	8	21	26	14	6	12	22	28	20	149	1788
6	8	28	21	26	9	14	22	16	21	157	1884
7	7	15	26	10	16	27	8	22		124	1488
8	5	14	21	16	5	24	16			97	1164
9	7	23	7	12	16	22	23	19		122	1464
10	8	18	9	20	26	9	11	23	12	128	1536
TOTAL	71									1246	14952

* Based on 12 seeds per spikelet.

APPENDIX TABLE 10 NUMBER OF SEEDS PER NUTGRASS INFLORESCENCE.

INFLORESCENCE	SPIKES PER UMBEL	SPIKELET PER SPIKE								TOTAL	TOTAL SEEDS PER UMBEL*
		1	2	3	4	5	6	7	8		
1	7	8	6	13	12	6	13	14		72	864
2	8	20	6	25	24	23	22	10	15	141	1692
3	6	28	23	7	27	14	21			120	1440
4	6	15	21	23	20	25	30			136	1632
5	8	21	26	14	5	12	22	28	20	149	1788
6	8	28	21	26	9	14	22	16	21	157	1884
7	7	15	26	10	16	27	8	22		124	1488
8	6	14	21	16	6	24	16			97	1164
9	7	23	7	12	16	22	23	19		122	1464
10	8	18	9	20	25	9	11	23	12	129	1536
TOTAL	71									1246	14952

* Based on 12 seeds per spikelet.

APPENDIX TABLE 19 : CYPERUS ESCULENTUS INFLORESCENCE

NUMBER	STEM HEIGHT CMS.	SPIKES	TOTAL SPIKELETS PER UMBEL	TOTAL SEEDS PER UMBEL *
1	44	8	117	1404
2	37	9	198	2376
3	39	7	142	1704
4	45	7	103	1236
5	33	9	475	5700
6	50	6	118	1416
7	44	7	99	1188
8	39	6	131	1572
9	45	7	116	1392
10	48	7	135	1632
11	45	5	85	1020
12	44	6	114	1368
13	44	9	203	2436
14	50	8	234	2808
15	34	7	212	2544
16	45	8	217	2604
17	45	8	145	1740
18	46	7	180	2160
19	40	7	198	2376
20	50	9	214	2568
TOTAL	86.7	147	3437	41244

* Based on 12 seeds per spikelet.

APPENDIX TABLE 20 : NUMBER OF TEFF SEED SAMPLES SUBMITTED TO THE DEPARTMENT OF AGRICULTURE, PRETORIA, DURING THE PERIOD 1963/65

NUMBER OF TEFF SEED SAMPLES (28.3 GRAMS) CONTAMINATED WITH NUTGRASS SEED

YEAR	NUMBER OF SAMPLES	NUMBER OF NUTGRASS SEEDS PER TEFF SAMPLE												
		0 - 0	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 100	100 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 3000	3000 - 4000	4000 - 5000
1963	63	22	5	1	4	1	4	5	10	6	3	2	0	0	0
1964	35	3	12	0	2	7	1	5	3	2	0	0	0	0	0
1965	109	9	21	15	3	7	3	18	25	6	1	4	1	2	1
TOTAL	207	34	38	16	9	15	8	28	31	14	4	6	1	2	1

APPENDIX TABLE 21 : DISTRIBUTION OF NUTGRASS TUBERS IN A SOIL PROFILE AT BARSFONTEIN.

SAMPLE NO	0 - 3" Layer		3 - 6" Layer		6 - 9" Layer	
	Normal	Depleted	Normal	Depleted	Normal	Depleted
1	519	124	296	84	149	82
2	837	144	343	78	171	72
3	791	74	280	35	43	14
4	956	96	154	18	86	27
5	1094	178	343	115	162	125
6	694	154	452	109	120	79
TOTAL	4891	770	1898	423	851	339
MEAN	815	128	316	70	138	57

APPENDIX TABLE 22 : INFLUENCE OF TEMPERATURE ON THE SPROUTING OF NUTGRASS TUBERS

TREATMENT		NUMBER OF SPROUTED TUBERS												TOTAL
		21/11	24/11	27/11	30/11	3/12	6/12	10/12	25/12	4/1	9/1	12/1	26/1	
15°C	A	0	0	0	0	0	0	0	0	0	4	2	0	10
1	B	0	0	0	0	0	0	0	0	0	7	2	0	9
	C	0	0	0	0	0	0	0	0	0	2	2	0	4
TOTAL		0	0	0	0	0	0	0	0	0	13	8	2	23
18°C	A	0	0	0	1	3	6	8	0	0	7	11	1	34
2	B	0	0	0	2	1	4	4	0	0	7	8	2	28
	C	0	0	0	3	1	1	2	0	0	13	2	7	36
TOTAL		0	0	0	6	5	10	19	0	0	27	21	10	98
20°C	A	0	21	7	4	6	6	0	0	0	4	1	1	48
3	B	0	13	11	4	1	0	0	0	0	6	2	2	41
	C	0	16	2	3	3	5	1	0	0	3	1	0	44
TOTAL		0	50	20	14	9	11	1	0	0	13	4	3	133
23°C	A	20	29	9	1	2	3	1	0	0	0	0	1	66
4	B	16	24	9	4	3	1	1	1	0	1	0	1	55
	C	7	21	10	0	3	3	1	0	0	0	1	1	49
TOTAL		43	73	28	5	8	9	3	1	0	1	1	3	170
30°C	A	0	2	10	2	0	14	31	2	1	0	0	0	70
5	B	3	10	0	0	0	12	25	6	2	0	0	0	58
	C	3	6	0	0	1	14	26	3	2	0	0	0	51
TOTAL		26	18	10	2	1	40	78	12	5	0	0	0	179
33°C	A	2	3	6	2	2	9	7	26	3	0	0	0	61
6	B	2	5	4	2	0	15	16	13	4	3	0	0	70
	C	4	4	2	0	0	13	12	24	0	0	0	0	79
TOTAL		28	13	12	4	2	37	35	63	7	3	0	0	201
40°C	A	0	2	4	1	2	6	6	24	2	2	0	0	49
7	B	0	2	1	1	2	5	6	20	2	3	2	0	48
	C	2	2	3	0	0	2	4	14	0	0	2	0	87
TOTAL		2	6	8	2	4	13	16	58	4	5	4	0	184

ANALYSIS OF VARIANCE

PERCENT SPROUTED TUBERS (ANGULAR TRANSFORMATION) - 29/12/81.

	DF	MEAN SQ.	F
TREATMENTS	5	427.97	
ERROR	12	12.55	

PERCENT SPROUTED TUBERS(ANGULAR TRANSFORMATION) - 26/1/82.

	DF	MEAN SQ.	F
TREATMENTS	6	548.76	
ERROR	14	13.36	

APPENDIX TABLE 23 : INFLUENCE OF WASHING ON THE SPROUTING OF NUTGRASS TUBERS.
NUMBER OF SPROUTED TUBERS PER PETRI DISH (20 TUBERS PER DISH(CATION).

	NUMBER OF DAYS AFTER PLANTING																											
	3					4					5					6					7					9			
	1	2	3	4	5	1	2	3	4	5	T	1	2	3	4	5	T	1	2	3	4	5	T	1	2	3	4	5	T
[illegible]	3	3	3	4	4	10	8	9	11	8	44	10	8	9	11	8	46	10	8	13	12	10	61	10	8	16	12	11	57	13	8	16	14	11	62
	3	3	3	3	3	8	3	11	11	8	40	8	8	11	12	8	42	8	7	14	13	11	53	8	7	16	13	14	58	11	9	18	14	14	76
	3	3	2	3	3	14	16	6	14	8	58	17	19	8	14	6	64	19	24	10	16	10	79	21	28	20	17	10	93	21	26	20	19	12	98
	3	3	3	3	3	12	12	10	13	8	55	12	12	11	13	9	57	20	10	16	18	11	75	25	18	16	16	11	86	26	19	15	16	11	86
	2	2	3	2	2	8	8	6	3	1	26	1	4	8	8	8	29	4	7	7	7	6	30	7	7	7	7	9	37	9	8	8	7	12	44
	2	2	2	2	2	3	5	5	3	3	19	2	3	5	3	8	21	5	5	9	3	11	33	6	7	11	4	12	40						
	3	3	3	3	3	4	4	4	3	3	22	4	4	7	3	3	21	4	8	10	8	4	35	5	7	11	4	5	32	6	9	11	4	10	40

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
Washing	6	169.89	**
Error	24	8.483	

APPENDIX TABLE 24 : INFLUENCE OF EXPOSURE ON THE VIABILITY OF NUTGRASS TUBERS - PERCENTAGE SPROUTED TUBERS.

2 DAY EXPOSURE					4 DAY EXPOSURE				
Date of Count	Treatments			Leb.	Date of Count	Treatments			Leb.
	Grass cover	Un-covered	Sand cover			Grass cover	Un-covered	Sand cover	
8/1/61	17	22	14	15	25/1/61	6	4	9	5
30/1/61	9	6	6	8	30/1/61	18	9	13	20
3/2/61	4	1	8	1	3/2/61	5	-	2	2
6/2/61	1	3	2	3	6/2/61	5	1	4	2
13/2/61	-	-	1	2	13/2/61	1	1	1	-
28/2/61	6	-	3	4	28/2/61	4	3	6	11
Total	37	32	34	33	Total	39	18	35	40

7 DAY EXPOSURE					12 DAY EXPOSURE				
Date of Count	Treatments			Leb.	Date of Count	Treatments			Le
	Grass cover	Un-covered	Sand cover			Grass cover	Un-covered	Sand cover	
30/1/61	7	4	22	11					
3/2/61	4	4	7	12	3/2/61	10	-	4	8
6/2/61	3	-	3	3	6/2/61	6	-	4	4
13/2/61	7	-	3	5	13/2/61	6	-	10	12
28/2/61	7	-	5	7	28/2/61	16	-	10	18
Total	28	8	40	38		38	-	28	46

APPENDIX TABLE 25 : INFLUENCE OF EXPOSURE ON THE VIABILITY OF NUTGRASS TUBERS PERCENTAGE SPROUTED TUBERS.

TREATMENT		PLANTING DATE	DAYS AFTER PLANTING 7 A	7 B	8 A	8 B	9 A	9 B	13 A	13 B	15 A	15 B	17 A	17 B	20 A	20 B	22 A	22 B	27 A	27 B	31 A	31 B	TOT.
Glasshouse Uncovered	1	21/4	27	25	27	26	27	28	27	33	27	33	27	33	27	33	27	33	27	33	27	33	60
	2	22/4	25	32	27	32	29	33	29	34	29	34	29	34	29	35	29	35	31	35	32	35	67
	3	23/4	40	24	40	24	40	24	40	24	40	24	40	25	41	27	41	27	41	29	41	25	70
	4	24/4	25	22	27	23	27	24	27	29	29	29	29	31	32	31	32	31	32	32	33	33	66
	5	25/4	6	3	9	12	13	11	12	17	15	18	16	20	18	25	18	27	18	27	19	27	46
Laboratory	1	21/4	37	32	37	33	40	39	40	39	40	39	40	39	40	39	41	39	41	39	41	39	80
	2	22/4	24	24	26	28	27	28	27	31	27	31	28	31	28	31	28	31	28	33	29	33	62
	3	23/4	20	17	22	19	25	19	25	19	25	19	25	19	26	21	27	21	29	21	29	21	50
	4	24/4	9	11	10	12	11	12	11	12	11	13	12	14	12	14	13	14	13	14	13	14	27
	5	25/4	3	0	2	7	4	8	5	14	5	15	6	16	9	16	10	16	11	17	11	17	28

APPENDIX TABLE 26 : PERCENTAGE SPROUTED TUBERS FOLLOWING EXPOSURE OF TUBERS TO INSOLATION.

TREATMENT		24/1	26/1	27/1	28/1	31/1	3/2	7/2	10/2	14/2	TOTAL Repl	TOTAL TMT	MEAN
1st Sampling (21/1)													
Glasshouse uncovered	A	2	8	5	8	3	2	0	0	0	28		
	B	7	9*	5	2	4	2	1	0	0	30	58	29.0
Glasshouse covered	A	10	3	2	1	0	0	0	0	0	16		
	B	5	0	0	4	1	1	1	0	0	12	28	14.0
Laboratory	A	7	5	2	2	0	1	0	0	0	17		
	B	2	3	4	2	5	0	3	0	0	19	36	18.0
2nd Sampling (22/1)													
Glasshouse uncovered	A	0	0*	2	1	1	4	2**	0	2	12		
	B	1	4*	2	3	9	2	2**	0	0	23	35	17.5
Glasshouse covered	A	1	5	1	2	0	3	0	0	1	13		
	B	3	3	3	0*	3	1	0	0	0	16	31	15.5
Laboratory	A	6	6	1	2	4	1	0	0	0	20		
	B	4	0	1	1	2	1	1	1	0	11	31	15.5
3rd Sampling (24/1)													
Glasshouse uncovered	A	0	0*	2	2	4	4	6**	1	1	20		
	B	0	0*	2	3	8	6	6**	1	3	31	51	25.5
Glasshouse covered	A	0	4	2	2	2	2	0	0	0	12		
	B	0	2	3	2	5	1	2	0	0	15	27	13.5
Laboratory	A	0	5	4	1	7	0	0	0	0	17		
	B	0	3	2	2	2	2	1	0	0	12	29	14.5
4th Sampling													
Glasshouse uncovered	A	0	0	0	2*	6	14X	1**	0	2	24		
	B	0	0	0	2*	8	9X	1**	2	0	22	46	23.0
Glass covered	A	0	0	0	1	9	3	1	0	1	15		
	B	0	0	1	1*	10	4	2	3	2	23	38	19.0
Laboratory	A	0	0	2	0	7	1	0	0	0	10		
	B	0	6	2	2	5	5	3	0	0	18	28	14.0

* = Tubers mouldy
X = Tubers mouldy but sprouting
** = Tubers very mouldy
Repl. = Replication
TMT = Treatment.

APPENDIX TABLE 27 : INFLUENCE OF CLIPPING FREQUENCY ON GREEN HERBAGE WEIGHT OF NUTGRASS.
WEIGHTS IN GRAMS PER POT

TREATMENT		DATE OF CLIPPING										TOTAL	MEAN
		17/1	22/1	27/1	9/2	14/2	21/2	28/2	7/3	17/3	2/4		
10 Clippings	1	15.9	17.6	5.5	40.5	18.9	16.9	9.2	14.4	17.2	42.8	198.9	
	2	14.5	16.1	7.6	43.0	16.4	17.4	9.3	11.7	20.1	57.8	213.9	
	3	28.8	25.4	5.8	39.2	15.4	22.1	8.6	11.4	12.9	53.3	222.8	
TOTAL		59.2	59.1	18.9	122.7	50.7	56.4	27.0	37.5	50.2	153.9	635.6	211.8
5 Clippings	1		69.2			75.1		24.5		19.8	68.1	254.7	
	2		57.3			80.3		31.7		41.6	68.6	279.5	
	3		62.4			63.2		30.4		25.7	45.4	226.7	
TOTAL			188.8			216.6		86.6		87.1	182.1	760.9	253.6
4 Clippings	1			60.0			95.1			38.6	89.8	283.5	
	2			48.4			88.4			39.6	66.2	243.6	
	3			65.9			62.1			46.3	39.0	213.3	
TOTAL				176.3			245.6			124.5	183.0	710.4	236.8
3 Clippings	1				163.4			60.8			53.9	278.2	
	2				156.0			51.7			63.5	271.0	
	3				101.3			51.8			53.3	286.4	
TOTAL					620.7			164.4			170.5	855.6	285.2
2 Clippings	1									198.3	37.9	234.2	
	2									214.7	17.6	232.3	
	3									210.6	20.1	230.7	
TOTAL										621.6	75.6	697.2	232.4

ANALYSIS OF VARIANCE : GREEN HERBAGE WEIGHT

	DF	MEAN SQ.	F
TREATMENTS	6	2256.88	7.67 **
ERROR	18	294.30	

APPENDIX TABLE 28: INFLUENCE OF CLIPPING FREQUENCY ON THE AIR-DRY WEIGHT OF THE UNDERGROUND FRACTIONS OF NUTGRASS. (GRAMS PER POT).

TREATMENT		WEIGHT OF ROOTS	NUMBER OF TUBERS	WEIGHT OF TUBERS
10 Clippings	1	32.1	128	13.3
	2	37.5	63	12.6
	3	39.0	258	16.2
TOTAL		108.4	449	42.1
MEAN		36.1	149	14.0
5 Clippings	1	41.5	190	13.7
	2	38.0	281	18.5
	3	28.7	423	22.8
TOTAL		108.2	894	55.0
MEAN		36.0	298	18.3
4 Clippings	1	61.4	375	23.7
	2	40.3	259	16.3
	3	43.2	408	22.8
TOTAL		144.9	1042	62.8
MEAN		48.3	347	20.9
3 Clippings	1	66.7	367	29.0
	2	55.3	237	20.1
	3	70.1	362	23.6
TOTAL		192.1	966	72.7
MEAN		64.0	322	24.2
2 Clippings	1	70.1	443	45.3
	2	54.3	633	73.7
	3	54.5	318	25.6
TOTAL		178.9	1394	144.6
MEAN		59.6	464	48.2

ANALYSIS OF VARIANCE

AIR-DRY WEIGHT OF NUTGRASS ROOTS

	DF	MEAN SQ.	F
TREATMENTS	4	504.18	7.89 **
ERROR	10	63.87	

AIR-DRY WEIGHT OF TUBERS

	DF	MEAN SQ.	F
TREATMENTS	4	539.97	
ERROR	10	129.09	

NUMBER OF TUBERS

	DF	MEAN SQ.	F
TREATMENTS	4	393.32	
ERROR	10	129.76	

APPENDIX TABLE 23 :WEIGHT, HEIGHT, AND NUMBERS OF MAIZE AND NUTGRASS

Tray	Number of Maize	Number of nutgrass	Weight of Maize	Weight of nutgrass	Height of maize plants in inches										Total
					1	2	3	4	5	6	7	8	9	10	
CiFi	1. 26	135	160.2	241.1	25	21	23	22	21	22	23	26	20	15	209
	2. 30	187	145.8	274.6	20	20	18	20	21	19	24	24	23	20	209
	3. 27	179	130.4	283.3	18	17	28	23	21	21	19	23	22	17	201
Total	83	501	436.4	799.0											619
CiFo	1. 27	81	66.5	156.2	12	10	11	12	11	10	11	15	12	14	118
	2. 27	90	47.8	127.1	12	13	16	9	12	11	9	14	13	12	135
	3. 29	96	66.5	138.0	18	11	15	12	14	13	15	10	11	18	127
Total	83	267	174.8	421.3											380
CoFi	1. 25	125	244.9	197.7	20	26	17	22	25	17	21	21	22	21	212
	2. 31	94	253.3	165.7	25	20	20	23	19	18	18	26	26	26	220
	3. 26	97	240.6	197.4	22	25	25	30	26	31	27	27	25	29	265
Total	82	316	738.8	560.8											697
CoFo	1. 27	77	93.5	110.2	10	9	13	11	18	11	11	11	21	10	125
	2. 30	86	82.8	131.2	12	15	11	8	11	11	10	15	12	11	112
	3. 25	82	104.1	158.2	16	17	17	15	16	14	16	18	13	18	154
Total	82	245	280.5	399.6											391

APPENDIX TABLE 30 A : FRESH ROOT WEIGHTS OF UNDERGROUND FRACTIONS IN GRAMS PER TRAY.

TREATMENT		MAIZE ROOTS	NUTGRASS ROOTS	TOTAL
CiFi	1	58.6	581.7	640.3
	2	44.0	818.2	862.2
	3	58.7	533.1	591.8
TOTAL		161.3	2033.0	
CiFo	1	51.9	549.4	601.3
	2	47.8	440.6	488.4
	3	35.2	644.2	679.4
TOTAL		134.9	1634.2	
CoFi	1	213.6	520.7	734.3
	2	220.2	459.0	679.2
	3	191.5	521.3	712.8
TOTAL		625.3	1501.0	
CoFo	1	126.7	512.2	638.9
	2	131.8	470.2	602.0
	3	146.1	355.3	501.4
TOTAL		404.6	1337.7	

APPENDIX TABLE 30 B: AIR-DRY WEIGHTS OF UNDERGROUND FRACTIONS OF MAIZE AND NUTGRASS IN GRAMS PER TRAY.

TREATMENT		MAIZE ROOTS	NUTGRASS ROOTS	TUBER WEIGHT	TUBER NUMBER
CiFi	1	27.0	354.3	56.8	254
	2	17.8	534.6	86.7	394
	3	23.6	396.5	66.2	302
		68.4	1285.4	209.7	950
CiFo	1	17.1	295.2	69.4	291
	2	17.4	212.0	64.6	253
	3	15.5	368.1	77.8	347
		50.0	875.3	201.8	889
CoFi	1	123.8	275.9	89.2	322
	2	96.9	272.8	33.5	166
	3	110.4	318.4	39.6	190
		331.1	867.1	132.3	681
CoFo	1	68.8	301.6	40.4	178
	2.	74.4	248.2	86.3	298
	3	79.2	197.3	25.1	232
		222.4	747.1	151.8	708

ANALYSIS OF VARIANCE

1. GREEN WEIGHT OF MAIZE STEMS

	DF	MEAN SQ.	F
Planting	1	12551.79	**
Fertilizer	1	45620.98	**
P x F	1	3913.27	**
Error	8	204.91	

2. GREEN WEIGHT OF NUTGRASS STEMS

	DF	MEAN SQ.	F
Planting	1	9629.00	**
Fertilizer	1	24201.10	**
P x F	1	3906.00	**
Error	8	407.44	

3. GREEN STEM WEIGHT OF MAIZE AND NUTGRASS COMBINED

	DF	MEAN SQ.	F
Planting	1	1369.60	
Fertilizer	1	136277.80	**
PxF	1		
Error	8	548.16	

4. FRESH WEIGHT OF MAIZE ROOTS

	DF	MEAN SQ.	F
Planting	1	44859.63	**
Fertilizer	1	5088.20	**
P x F	1	3146.05	**
Error	8	118.59	

5. FRESH WEIGHT OF NUTGRASS ROOTS

	DF	MEAN SQ.	F
Planting	1	87200.90	*
Fertilizer	1	26339.60	
P x F	1	4621.60	
Error	8	8432.77	

6. FRESH ROOT WEIGHT OF MAIZE AND NUTGRASS COMBINED

	DF	MEAN SQ.	F
Planting	1	749.00	
Fertilizer	1	5467.00	*
P x F	1	141.00	
Error	8	7136.32	

7. AIR-DRY WEIGHT OF MAIZE ROOTS

	DF	MEAN SQ.	F
Planting	1	18776.0010	**
Fertilizer	1	1346.2010	**
P x F	1	679.5098	**
Error	8	57.6693	

8. AIR-DRY WEIGHT OF NUTGRASS ROOTS

	DF	MEAN SQ.	F
Planting	1	24888.80	*
Fertilizer	1	23417.20	
P x F	1	7013.20	
Error	8	4590.84	

9. AIRDRY TUBER WEIGHTS

	DF	MEAN SQ.	F
Planting	1	1346.2010	*
Fertilizer	1	10.6418	
P x F	1	82.9410	
Error	8	184.8282	

10. TUBER NUMBERS

	DF	MEAN SQ.	F
Planting	1	16875	
Fertilizer	1	96	
P x F	1	845	
Error	8	4586	

11. MAIZE HEIGHTS

	DF	MEAN SQ.	F
Planting	1	10.45	
Fertilizer	1	263.20	**
P x F	1	2.08	
Error	8	3.33	

APPENDIX TABLE 31A : COMPETITION BETWEEN NUTGRASS AND INDICATOR CROPS. WEIGHT OF AERIAL FRACTION - NUTGRASS - GRAMS/POT

REPLICATION	TREAT.A	TREAT.B	TREAT.C	TREAT.D*	TOTAL
1	14.3	17.8	16.6	11.3	
2	9.8	23.7	15.6	23.0	
3	16.7	15.8	14.6	16.8	
4	13.2	6.4	8.7	8.7	
5	14.3	16.2	18.8	11.6	
TOTAL	70.3	80.9	73.4	61.4	286.0
MEAN	14.06	16.18	14.68	12.28	14.30

* Combined weights of both compartments.

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
TOTAL	14	22.95	-
TREATMENTS	2	19.54	-
ERROR	12	23.52	-

WEIGHT OF AERIAL FRACTION - SORGHUM - GRAMS/POT

REPLICATION	TREAT.C	TREAT.D
1	17.2	23.5
2	26.1	27.4
3	24.5	37.2
4	54.4	16.1
5	39.1	22.4
TOTAL	142.3	126.6
MEAN	28.5	25.3

APPENDIX TABLE 31B : COMPETITION BETWEEN NUTGRASS AND INDICATOR CROPS.

WEIGHT OF AERIAL FRACTION - CUCUMBERS. - GRAMS/POT

REPLICATION	TREAT.A	TREAT.B*	TREAT.E	TOTAL
1	39.2	53.7	33.8	
2	48.9	56.3	42.2	
3	44.5	38.5	46.4	
4	44.3	48.3	39.7	
5	37.4	46.9	43.2	
TOTAL	214.3	243.7	205.3	663.3
MEAN	42.85	48.74	41.06	44.22

* Combined weights of both compartments.

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
TOTAL	14		
TREATMENTS	2	80.66	2.66 N.S
ERROR	12	30.39	

APPENDIX TABLE 31C : COMPETITION BETWEEN MUTGRASS AND INDICATOR CROPS.
TOTAL UNDERGROUND FRACTION - GRAMS/POT
(WEIGHTS OF INDICATOR CROP AND MUTGRASS).

TREATMENTS.

REPLICATION	TREAT.A	TREAT.B	TREAT. C	TREAT.D	TREAT.E	TOTAL
1	15.8	26.8	7.8	8.2	18.3	
2	12.7	21.4	11.3	14.5	18.3	
3	31.4	13.2	10.8	16.3	16.1	
4	16.3	17.8	13.6	5.1	16.2	
5	17.1	25.5	18.2	11.5	18.7	
TOTAL	93.3	103.9	60.1	55.6	88.6	398.5

ANALYSIS OF VARIANCE

	DF	MEAN SQ.	F
TOTAL	24		
TREATMENTS	4	93.42	*
ERROR	20	26.23	

APPENDIX TABLE 32 : INFLUENCE OF INCREASING NUTGRASS POPULATIONS ON GROWTH OF SORGHUM.(18/3/95)

TREATMENT		Nutgrass		Sorghum Competition		Sorghum Control	
		Number	Weight*	Number	Weight *	Number	Weight
3 Tubers	I	5	18.7	5	3.6	5	[illegible]
	2	7	16.1	5	6.7	5	[illegible]
	3	5	15.3	5	4.7	5	[illegible]
	4	5	15.2	5	7.5	5	[illegible]
TOTAL MEAN			68.3		22.5		[illegible]
6 Tubers	I	6	16.8	5	3.1	5	[illegible]
	2	6	24.9	5	5.6	5	[illegible]
	3	9	21.6	5	1.9	5	[illegible]
	4	7	22.1	5	3.5	5	[illegible]
TOTAL MEAN			85.4		12.1		[illegible]
12 Tubers	I	11	27.4	5	3.2	5	[illegible]
	2	9	18.4	5	0.7	5	[illegible]
	3	10	21.3	5	2.3	5	[illegible]
	4	11	21.6	5	1.0	5	[illegible]
TOTAL MEAN			88.7		7.2		[illegible]
15 Tubers	I	9	22.1	5	1.2	5	22.0
	2	15	35.5	5	2.0	5	20.1
	3	12	25.8	5	2.7	5	26.1
	4	12	32.6	5	1.8	5	25.1
TOTAL MEAN			116.0		7.8		93.4
20 Tubers	I	18	23.3	5	0.5	5	22.8
	2	16	25.8	5	1.3	5	25.1
	3	16	31.1	5	1.1	5	25.5
	4	18	31.2	5	1.8	5	21.1
TOTAL MEAN			112.4		4.8		[illegible]

* Grams per Pot.

ANALYSIS OF VARIANCE

GREEN WEIGHT OF NUTGRASS

	DF	MEAN SQ.	F
TREATMENTS	4	99.0607	**
ERROR	15	16.1056	

GREEN WEIGHT OF SORGHUM

	DF	MEAN SQ.	F
TREATMENTS	4	12.6217	**
ERROR	15	1.0703	

APPENDIX TABLE 33 : INFLUENCE OF PLANT POPULATION DENSITY ON THE GROWTH OF NUTGRASS.

NO. OF SPROUTED TUBERS PER POT		STEM		TUBER	ROOT WEIGHT	UNDERGR. WEIGHT
		NUMBER	AIR-DRY WT	NUMBER		
1 Plant per pot						
1	1	1	0.4	7	0.005	0.03
	2	1	0.25	13	0.006	0.03
	3	1	0.3	12	0.006	0.04
TOTAL			0.95	32	0.017	0.08
MEAN			0.32	11	0.006	0.03
2 Plants per pot						
2	1	5	1.3	29	0.09	1.45
	2	3	0.3	14	0.001	0.3
	3	4	0.5	16	0.002	0.2
TOTAL			2.1	59	0.093	2.1
MEAN			0.7	20	0.031	0.7
4 Plants per pot						
3	1	5	0.65	19	0.004	0.7
	2	6	1.46	44	0.08	5.0
	3	4	0.79	36	0.001	1.7
TOTAL			2.91	99	0.085	7.4
MEAN			0.97	33	0.022	2.5
8 Plants per pot						
4	1	8	1.3	46	0.01	2.08
	2	8	0.72	35	0.001	1.05
	3	8	0.95	32	0.02	3.04
TOTAL			2.97	113	0.031	7.17
MEAN			0.99	38	0.010	2.39
16 plants per pot						
5	1	17	2.23	69	0.04	6.95
	2	18	0.9	71	0.03	4.5
	3	16	2.4	72	0.02	5.8
TOTAL			5.53	212	0.09	15.75
MEAN			1.84	71	0.03	5.25
24 plants per pot						
6	1	23	1.10	72	0.02	3.4
	2	18	1.29	76	0.01	4.6
	3	17	1.57	88	0.03	4.9
TOTAL			3.96	236	0.06	12.9
MEAN			1.32	77	0.02	4.3

ANALYSIS OF VARIANCE

STEM WEIGHTS

	DF	MEAN SQ.	F
POPULATION	5	0.8209	*
ERROR	12	0.2145	

TUBER NUMBERS

	DF	MEAN SQ.	F
POPULATION	5	2175.15	**
ERROR	12	54.56	

UNDERGROUND WEIGHTS

	DF	MEAN SQ.	F
POPULATION	5	12.2106	**
ERROR	12	1.2769	

APPENDIX TABLE 34 MEAN DAILY AND ACCUMULATIVE WATER CONSUMPTION OF THREE WEED SPECIES -(MEANS OF 4 REPLICATIONS) IN POUNDS.

DATE	DAYS AFTER PLANTING	N Fo		N Fi		Ag Fo		Ag Fi		B Fo		B Fi		CONTROL	
		Da	Ac	Da	Ac	Da	Ac	Da	Ac	Da	Ac	Da	Ac	Da	Ac
14/1/62	16	2.88	2.88	3.39	3.39	3.33	3.33	3.85	3.85	3.43	3.43	4.10	4.10	1.99	1.99
16/1/62	18	1.94	4.82	2.42	5.81	1.89	5.22	2.12	5.97	2.27	5.70	2.44	6.54	1.34	3.33
18/1/62	28	1.10	5.92	1.49	7.30	0.91	6.13	1.44	7.41	1.05	6.75	1.51	8.05	0.64	3.97
24/1/62	26	1.67	7.59	3.14	10.44	1.55	7.68	2.27	9.68	1.61	8.36	3.11	11.16	1.17	5.14
26/1/62	28	1.51	9.10	2.97	13.41	1.04	8.72	2.29	11.97	1.13	9.49	2.78	13.94	0.73	5.87
28/1/62	30	1.01	10.11	1.24	14.65	1.01	9.73	1.07	13.04	1.01	10.50	1.70	15.64	1.01	6.88
31/1/62	33	1.34	11.45	2.44	17.09	0.83	10.56	1.65	14.69	1.19	11.69	2.69	18.23	1.12	8.00
2/2/62	35	1.44	12.89	2.38	19.47	1.04	11.60	1.94	16.62	1.38	13.07	3.60	21.83	0.78	8.78
4/2/62	37	1.78	14.67	2.61	22.08	1.13	12.73	1.99	18.62	1.41	14.48	3.61	25.44	0.80	9.58
8/2/62	41	0.19	14.86	1.87	23.95	0.07	12.92	1.30	19.92	0.81	15.29	3.87	29.31	0.06	9.64
9/2/62	42	0.56	15.42	1.10	25.05	0.31	13.11	0.88	20.80	0.74	16.03	1.35	30.66	0.04	9.68
11/2/62	44	1.19	16.32	2.09	27.14	0.85	13.96	1.60	22.40	1.33	17.36	2.98	33.64	0.58	10.26
13/2/62	46	1.58	18.10	3.33	30.47	1.33	15.29	2.51	24.91	2.31	19.69	4.00	37.62	0.76	11.02
18/2/62	51	1.75	15.85	1.75	32.22	1.75	17.04	1.75	26.66	1.92	21.60	2.65	40.29	1.75	12.77
20/2/62	53	0.15	20.00	1.81	33.73	0.30	17.34	1.85	28.51	2.35	23.93	4.59	44.88	-	12.77
22/2/62	55	1.19	21.19	2.45	36.18	1.25	18.59	2.25	30.67	1.98	25.91	3.64	48.52	0.99	13.76
26/2/62	59	1.28	22.47	1.63	37.81	1.18	19.77	1.67	32.24	1.59	27.50	2.79	51.31	0.68	14.44
28/2/62	61	1.36	23.83	2.60	40.41	1.40	21.17	2.08	34.32	2.31	29.81	3.88	55.11	0.84	15.28
5/3/62	66	2.90	26.73	3.91	44.32	3.15	24.32	3.53	37.85	3.68	33.49	4.01	59.12	1.03	16.31
9/3/62	70	3.13	29.85	4.43	48.75	3.60	27.92	4.08	41.93	4.68	38.17	4.48	63.60	1.38	18.15
12/3/62	73	3.14	33.00	3.14	51.89	3.14	30.80	3.14	45.87	3.14	41.31	3.14	66.74	3.14	21.30
20/3/62	81	2.83	35.83	3.29	54.09	1.83	32.59	3.83	48.90	3.80	45.11	4.48	71.22	1.78	23.00

Da = Daily
Ac = Accumulative

N = Nutgrass
Ag = Elusine indica
B = Tagetes minuta

Fo = Unfertilized
Fi = Fertilized.

APPENDIX TABLE 35 : AIR-DRY WEIGHT OF WEED STEMS AND ROOTS IN GRAMS PER BUCKET.

		WEIGHTS OF WEED STEMS	WEIGHTS OF ROOTS
I.	Nutgrass O	40.5	23.4
	F1	86.6	69.7
	Eleusine O	81.0	23.3
	F1	28.9	29.6
	Tagetes O	86.4	6.1
	F1	86.4	21.1
	Control	-	-
II.	Nutgrass O	39.2	21.6
	F1	98.2	72.5
	Eleusine O	39.1	37.2
	F1	71.2	40.3
	Tagetes O	24.3	3.6
	F1	91.1	12.4
	Control	-	-
III.	Nutgrass O	30.1	58.7
	F1	74.5	60.1
	Eleusine O	54.7	26.2
	F1	63.6	41.8
	Tagetes O	36.8	5.7
	F1	69.8	12.3
	Control	-	-
IV.	Nutgrass O	103.3	48.2
	F1	101.1	73.6
	Eleusine O	39.6	19.9
	F1	115.5	26.2
	Tagetes O	43.1	8.6
	F1	115.0	12.2
	Control	-	-

2) AIR-DRY STEM WEIGHT OF WEEDS

	DF	MEAN SQ.	F
WEEDS	2	105.38	
FERTILIZER	1	6720.10	**
WXF	2	250.56	*
ERROR	18	670.14	

3) AIR-DRY ROOT WEIGHTS OF WEEDS

	DF	MEAN SQ.	F
WEEDS	2	3676.34	**
FERTILIZER	1	1940.80	**
WXF	2	368.82	*
ERROR	18	67.73	

ANALYSIS OF VARIANCE

1) TOTAL WATER CONSUMPTION (LBS)

	DF	MEAN SQ.	F
WEEDS	2	689.4510	**
FERTILIZER	1	2386.2250	**
W x F	2	62.5050	*
ERROR	18	11.3607	

APPENDIX TABLE 36 : ACCUMULATIVE WATER CONSUMPTION (TOTAL 6 BUCKETS IN POUNDS)

DATE	NUTGRASS	TARETER	ELEUSINE
17/1/65	1.92	2.25	2.10
18/1/65	4.77	4.70	5.10
19/1/65	7.47	7.25	7.80
20/1/65	9.27	10.09	10.10
21/1/65	13.17	13.94	13.50
22/1/65	15.92	15.79	16.35
23/1/65	18.92	19.74	19.35
24/1/65	21.27	22.04	21.80
25/1/65	23.47	23.44	23.90
26/1/65	25.52	25.24	25.90
27/1/65	32.57	33.79	33.10
28/1/65	34.92	36.69	37.85
29/1/65	38.17	38.98	40.95
30/1/65	42.62	42.34	45.10
31/1/65	44.37	44.09	48.40
1/2/65	48.17	48.58	52.40
2/2/65	52.17	52.54	56.45
3/2/65	56.27	56.59	60.45
4/2/65	60.97	60.69	65.35
5/2/65	67.67	68.38	72.45
6/2/65	80.82	81.78	85.70

DATE	NUTGRASS	TARETER	ELEUSINE
14/2/65	99.32	102.14	102.10
15/2/65	116.17	120.69	120.65
16/2/65	124.17	127.54	127.30
17/2/65	133.07	138.72	136.20
18/2/65	141.52	143.92	146.05
19/2/65	149.37	150.84	151.00
20/2/65	156.87	160.84	160.19
21/2/65	178.02	182.74	182.55
22/2/65	198.02	194.79	197.50
23/2/65	214.17	217.44	219.43
24/2/65	224.42	229.04	229.58
1/3/65	234.42	238.29	241.46
2/3/65	238.47	250.24	254.53
4/3/65	247.87	258.24	271.28
5/3/65	256.17	268.69	285.33
7/3/65	270.67	283.79	298.33
9/3/65	282.17	295.39	298.33
10/3/65	290.32	308.84	308.33
11/3/65	315.13	318.89	321.88
12/3/65	324.87	332.04	338.73
14/3/65	335.92	348.69	347.28
15/3/65	350.67	363.64	354.33

APPENDIX TABLE 37 : WEIGHTS OF VARIOUS PLANT FRACTIONS IN OZS AND GMS PER BUCKET.

TREATMENT	REPLICATE	MAIZE STEMS GREEN OZS	MAIZE STEMS AIRDRY GMS	WEED STEMS GREEN OZ	WEED STEMS AIRDRY GMS	TOTAL ROOTS AIRDRY ROOTS GRAMS WEEDS + MAIZE	TOTAL STEMS WEEDS+ MAIZE GMS	AIRDRY STEMS AND ROOTS WEEDS + MAIZE GMS
Cyperus esculentus	1	6.15	30.8	7.9	35.6	64.3	66.4	130.7
	2	17.0	50.5	2.9	18.7	43.6	69.2	112.8
	3	20.0	56.0	2.0	11.7	55.2	67.7	132.9
	4	16.3	41.9	4.95	25.8	34.2	67.7	131.9
	5	13.45	45.8	5.70	28.1	46.3	73.9	160.2
TOTAL		72.90	225.0	23.45	119.9	323.6	344.9	668.5
Tagetes minuta	1	16.3	29.4	2.25	12.5	38.9	42.2	81.1
	2	14.9	45.9	3.25	19.5	22.4	65.4	87.8
	3	18.6	45.2	1.2	6.5	20.8	51.7	80.5
	4	14.8	41.4	2.0	16.8	54.9	58.2	133.1
	5	19.3	52.6	1.75	10.3	36.1	62.8	98.9
TOTAL		83.9	214.4	10.46	65.9	181.1	280.3	461.4
Eluaine indica	1	6.80	23.4	7.75	67.8	36.[illegible]	91.2	127.6
	2	10.0	29.4	7.95	51.7	40.[illegible]	91.1	132.0
	3	8.9	30.0	8.0	53.0	33.4	83.8	117.2
	4	6.05	20.0	11.13	68.9	34.2	86.9	121.1
	5	12.6	37.5	7.5	48.8	44.4	86.4	130.8
TOTAL		43.25	140.3	42.33	299.1	189.3	439.4	628.7

ANALYSIS OF VARIANCE

1) TOTAL WATER CONSUMPTION (POUNDS)

	DF	MEAN SQ.	F
Treatments	2	3.6705	N.S.
Error	12	3.4611	

2) GREEN WEIGHT OF MAIZE STEMS (OUNCES)

	DF	MEAN SQ.	F
Treatments	2	87.9031	*
Error	12	13.3948	

3) AIR-DRY WEIGHT OF MAIZE STEMS (GMS)

	DF	MEAN SQ.	F
Treatments	2	426.9090	*
Error	12	68.6199	

4) GREEN WEIGHT OF WEED STEMS (OUNCES)

	DF	MEAN SQ.	F
Treatments	2	51.3630	**
Error	12	2.7618	

5) AIR-DRY WEIGHT OF WEED STEMS (GMS)

	DF	MEAN SQ.	F
Treatments	2	2980.3630	**
Error	12	59.4182	

6) AIR-DRY WEIGHT OF WEED AND MAIZE ROOTS (COMBINED GMS)

	DF	MEAN SQ.	F
Treatments	2	1280.3330	
Error	12	133.5039	

APPENDIX TABLE 36 : INFLUENCE OF NUTGRASS EXTRACTS ON THE GERMINATION AND LENGTH OF SEEDLING STEMS OF 3 TEST CROPS. (LENGTH IN CMS (BASED ON 25 SEEDLINGS).

TREATMENT		MAIZE		SORGHUM		SUNFLOWER	
		% Germin.	Length	% Germin.	Length	% Germin.	Length
TUBER EXTRACT	1	94	2.22	92	2.96	66	1.30
	2	96	1.32	94	1.20	74	1.54
	3	94	1.53	89	2.71	78	1.51
	4	98	2.24	84	2.35	84	1.09
MEAN		95.5	1.92	89.9	2.36	75.5	1.36
STEM EXTRACT	1	86	1.68	94	3.09	70	0.62
	2	88	1.96	93	2.45	70	0.61
	3	90	2.04	95	1.99	78	1.06
	4	94	1.29	92	2.31	82	1.13
MEAN		89.5	1.71	93.5	2.46	77.0	0.91
ROOT EXTRACT	1	96	2.30	88	3.33	60	2.87
	2	80	2.94	90	2.46	66	2.78
	3	88	3.28	93	3.71	78	2.88
	4	86	2.64	86	4.03	68	2.86
MEAN		88	2.78	88.5	3.38	83.5	2.77
CONTROL	1	96	5.00	88	4.46	86	7.02
	2	98	5.04	92	5.39	90	7.80
	3	90	4.86	80	4.12	80	3.93
	4	94	4.18	87	2.04	83	7.28
MEAN		94.5	4.76	89.3	4.00	86	6.83

ANALYSIS OF VARIANCE

1.LENGTH OF SEEDLINGS

	MAIZE				SORGHUM				SUNFLOWER			
	DF	MEANS SQ.	F		DF	MEANS SQ.	F		DF	MEANS SQ.	F	
EXTRACTS	3	7.9182	**	EXTRACTS	3	2.6578	-	EXTRACTS	3	20.1934	**	
ERROR	12	0.1764		ERROR	12	0.8163		ERROR	12	0.8537		

2. PERCENTAGE GERMINATION ANGULAR TRANSFORMATION.

	MAIZE				SORGHUM				SUNFLOWER			
	DF	MEANS SQ.	F		DF	MEANS SQ.	F		DF	MEANS SQ.	F	
EXTRACTS	3	60.2596		EXTRACTS	3	19.6273	-	EXTRACTS	3	142.5533	*	
ERROR	12	19.1232		ERROR	12	8.2177		ERROR	12	26.5877		

APPENDIX TABLE 39A : NUMBER AND WEIGHT OF NUTGRASS TUBERS AND ROOTS PER QUADRAT.

TREATMENT		NUMBER OF TUBERS										WEIGHT OF TUBERS (IN GRAMS)									
		DISCED					CONTROL					DISCED					CONTROL				
		A	B	C	D	TOTAL	A	B	C	D	TOTAL	A	B	C	D	TOTAL	A	B	C	D	TOTAL
Discing	1	18	27	46	41	124	147	43	125	144	459	1.1	1.4	2.8	2.6	7.9	14.8	3.7	10.8	15.7	45.2
	2	5	4	43	11	63	49	9	55	25	138	0.3	0.3	3.2	0.4	4.2	5.5	0.7	3.6	1.5	11.3
	3	2	43	44	55	144	14	57	4	46	101	0.1	2.5	2.3	4.2	9.1	1.3	4.1	0.3	4.5	10.2
Total						331					698					21.2					66.7
Discing	1	0	8	14	2	24	23	47	52	8	126	0	0.3	0.7	0.2	1.2	2.1	6.6	5.1	0.5	14.3
	2	8	28	24	7	69	28	46	30	28	122	0.5	1.2	1.3	0.8	3.8	2.0	2.5	1.9	2.6	9.0
	3	19	15	11	12	58	47	52	37	10	146	0.7	0.6	0.6	0.7	2.6	5.3	6.1	3.9	0.9	16.2
Total						141					394					7.3					39.5
Discing	1	33	4	5	9	51	93	27	68	57	245	2.7	0.2	0.3	0.5	3.7	10.5	2.5	5.8	7.7	26.5
	2	6	21	2	10	38	44	80	47	28	249	0.5	1.5	0.1	0.8	2.8	3.6	8.6	4.9	3.8	20.9
	3	4	10	6	25	45	7	22	27	67	123	0.1	0.5	0.8	1.0	2.1	0.7	1.8	2.5	5.7	10.7
Total						134					617					8.6					58.2

TREATMENT		WEIGHT OF ROOTS (GRAMS)									
		DISCED					CONTROL				
		A	B	C	D	TOTAL	A	B	C	D	TOTAL
Discing	1	2.7	1.1	1.7	1.4	6.9	46.5	51.3	42.4	57.5	200.3
	2	3.6	5.0	4.6	1.6	14.8	55.8	21.5	48.4	5.5	131.9
	3	1.5	2.8	2.3	3.8	9.6	67.2	52.8	27.2	37.4	184.1
Total						30.4					517.3
Discing	1	3.2	3.3	7.9	2.3	16.9	28.3	33.1	29.1	19.1	109.6
	2	1.1	2.2	4.5	1.1	8.9	38.3	14.8	18.8	17.3	89.2
	3	1.8	1.5	2.8	1.6	5.9	48.1	40.2	29.4	18.2	135.9
Total						32.7					386.4
Discing	1	2.8	1.3	1.4	2.5	7.8	74.6	31.9	54.8	40.8	201.8
	2	12.9	6.4	4.9	5.6	29.8	48.4	28.4	86.8	37.7	171.3
	3	8.6	4.8	2.4	6.9	14.7	9.8	43.2	26.7	41.7	121.8
Total						53.1					493.8

INFLUENCE OF DISCING ON THE PERSISTENCE OF NUTGRASS

APPENDIX TABLE 39B : NUMBER OF TUBERS (SQ.ROOT TRANSFORMATION)

TREATMENT	REPL.1	REPL. 2	REPL. 3	TOTAL		MEAN
1 Discing	12.11	7.94	12.08	32.09		10.70
2 Discing	4.90	7.68	7.62	20.20		6.73
3 Discing	7.14	6.16	6.71	20.		6.67
Control	21.42	11.75	10.05	43.22		
Control	11.22	11.04	12.09	34.34	120.08	13.34
Control	15.65	15.76	11.09	42.50		
TOTAL	72.44	60.36	59.66	191.34		10.63

ANALYSIS OF VARIANCE

	S.S	DF	MEAN SQ.	F
TOTAL	277.90	17		
BLOCKS	14.73	2		
TREATMENTS	159.04	3	53.01	6.11 **
ERROR	104.13	12	8.68	

$$\left(\frac{8.68}{3} + \frac{8.68}{9}\right)\frac{1}{2} = 1.9641$$

$$\left(\frac{8.68}{3} + \frac{8.68}{3}\right)\frac{1}{2} = 2.4087$$

$$\frac{10.35 - 6.67}{2.4087} = 1.53 \text{ Not significant}$$

$$\frac{13.34 - 6.73}{1.9641} = 3.37^{**}$$

APPENDIX TABLE 39C : WEIGHT OF TUBERS (SQUARE ROOT TRANSFORMATIONS)

TREATMENT	REPL.1	REPL. 2	REPL. 3	TOTAL		MEAN
1 Discing	2.81	2.05	2.02	7.88		2.63
2 Discing	1.10	1.87	1.61	4.58		1.53
3 Discing	1.92	1.67	1.45	5.04		1.68
Control	6.72	3.36	3.10	13.22		
Control	3.76	3.00	4.02	10.80	37.07	4.12
Control	5.16	4.57	3.47	13.20		
Total	21.48	16.52	15.86	54.67		3.03

ANALYSIS OF VARIANCE

	S.S	DF	MEAN SQ.	F
TOTAL	35.97	17		
BLOCKS	2.72	2		
TREATMENTS	23.41	3	7.80	9.55 **
ERROR	9.80	12	0.817	

$$\left(\frac{0.817}{3} + \frac{0.817}{3}\right)^{\frac{1}{2}} = 0.6026$$

$$\left(\frac{0.817}{3} + \frac{0.817}{3}\right)^{\frac{1}{2}} = 0.7381$$

$$\frac{2.63 - 1.53}{0.7381} = 1.49 \quad \text{Not significant}$$

$$\frac{4.12 - 2.63}{0.6026} = 2.47*$$

APPENDIX TABLE 40 : NUMBER AND WEIGHTS (OZS) OF NUTGRASS AND ANNUAL GRASSES FROM ¼ SQ.METRE QUADRAT.

		A	B	C	D	TOTALS		MEANS	
						WEIGHTS	NUMBERS	WEIGHTS	NUMBERS
NUTGRASS Handforking	N	149	102	142	92	42.500 ozs	485	10.625	121.25
	W	13.625	11.125	10.75	7.00				
Control	N	306	258	227	423	61.875 ozs	1213	15.469	303
	W	16.75	17.25	9.125	16.75				
Hand-hoeing	N	370	207	290	213	55.500 ozs	1040	13.875	260
	W	16.50	11.5	11.25	16.25				
GRASSES: Handforking	N	12	81	73	79	18.625 ozs	248	4.656	61
	W	0.25	7.75	5.50	5.125				
Control	N	127	55	373	96	20.375 ozs	651	5.094	163
	W	5.00	4.375	4.875	6.126				
Hand-hoeing	N	56	92	52	83	22.500	287	5.626	72
	W	3.00	5.50	2.125	11.875				

ANALYSIS OF VARIANCE

1. NUTGRASS WEIGHTS

	DF	MEANS SQ.
TREATMENTS	2	24.5525
ERROR	9	11.4801

2. WEIGHTS GRASSES

	DF	MEANS SQ.	F
TREATMENTS	2	0.9436	
ERROR	9	7.9829	

3. NUMBER OF NUTGRASS

	DF	MEANS SQ.	F
TREATMENTS	2	45.0730	*
ERROR	9	3.6258	

4. NUMBER OF GRASSES

	DF	MEANS SQ.	F
TREATMENTS	2	22.2683	
ERROR	9	11.6795	

N = Number.
W = Weights.

APPENDIX TABLE 43. 1 WEED CONTROL RATINGS.

TREATMENTS	RATINGS (22 DAYS AFTER SPRAYING)									
	NUTGRASS					ANNUAL GRASSES				
	I	II	III	TOTAL	MEAN	I	II	III	TOTAL	MEAN
Monolinuron 4 lbs	4	2	6	12	4	6	4	8	18	6
Monolinuron 6 lbs	6	10	8	24	8	10	6	10	28	9.3
Monuron 4 lbs	8	2	8	18	6	8	8	8	24	8
Monuron 8 lbs	6	6	6	18	6	10	8	10	28	9.3
TCA 25 lbs	8	8	8	24	8	6	8	6	20	6.7
TCA 50 lbs	10	10	8	28	9.3	10	10	10	30	10
CONTROL 1	2	2	2			0	0	0		
2	4	0	4			0	0	0		
3	2	0	0			2	0	0		
4	2	2	0			2	0	0		
TOTAL FOR CONTROL	10	4	6	20	1.7	12	0	0	36	1.7

GENERAL RATING 34 DAYS AFTER SPRAYING				
I	II	III	TOTAL	MEAN
2	6	8	16	5.3
9	10	9	28	9.3
9	6	6	21	7.0
9	10	9	28	9.3
5	9	7	21	7.0
10	9	10	29	9.7
0	1	1		
1	1	1		
1	1	1		
6	1	0		
8	4	3	16	1.3

ANALYSIS OF VARIANCE (ANGULAR TRANSFORMATION)

1) PERCENT GENERAL RATING

	DF	MEAN SQ.	
Blocks	2	96.46	
Treatments	5	641.03	
Error	10	179.44	

C.V - 20.05%

2) PERCENT RATING NUTGRASS

	DF	MEAN SQ.	
Blocks	2	5.89	
Treatments	5	565.23	N
Error	10	241.84	

C.V - 26.46%

3) PERCENT RATING ANNUAL GRASSES

	DF	MEAN SQ.	
Blocks	2	188.17	
Treatments	5	748.71	*
Error	10	92.58	

C.V - 14.79%

APPENDIX TABLE 41 : WEED CONTROL RATINGS.

TREATMENTS	RATINGS (22 DAYS AFTER SPRAYING)									
	NUTGRASS					ANNUAL GRASSES				
	I	II	III	TOTAL	MEAN	I	II	III	TOTAL	MEAN
Monolinuron 4 lbs	4	2	6	12	4	6	4	8	18	6
Monolinuron 6 lbs	6	10	8	24	8	10	8	10	28	9.3
Monuron 4 lbs	8	2	8	18	6	8	8	8	24	8
Monuron 8 lbs	6	6	6	18	6	10	8	10	28	9.3
TCA 25 lbs	8	8	8	24	8	6	8	6	20	6.7
TCA 50 lbs	10	10	8	28	9.3	10	10	10	30	10
CONTROL 1	2	2	2			0	0	0		
CONTROL 2	4	0	4			8	0	0		
CONTROL 3	2	0	0			2	8	0		
CONTROL 4	2	2	0			2	0	0		
TOTAL FOR CONTROL	X	4	6	20	1.7	12	8	0	20	1.7

GENERAL RATING 34 DAYS AFTER SPRAYING				
I	II	III	TOTAL	MEAN
2	6	8	16	5.3
9	10	9	28	9.3
9	6	6	21	7.0
9	10	9	28	9.3
5	9	7	21	7.0
10	9	10	29	9.7
0	1	1		
1	1	1		
1	1	1		
6	1	5		
8	4	3	16	1.3

ANALYSIS OF VARIANCE (ANGULAR TRANSFORMATION)

1) PERCENT GENERAL RATING

	DF	MEAN SQ.	
Blocks	2	96.46	
Treatments	5	641.03	
Error	10	179.44	

C.V - 20.06%

2) PERCENT RATING NUTGRASS

	DF	MEAN SQ.	
Blocks	2	5.69	
Treatments	5	665.23	N
Error	10	241.84	

C.V - 26.46%

3) PERCENT RATING ANNUAL GRASSES

	DF	MEAN SQ.	
Blocks	2	188.17	
Treatments	5	746.71	*
Error	10	92.56	

C.V - 13.7%

APPENDIX TABLE 42 : SURVEY OF WEED POPULATION (BASED ON THE NUMBER OF WEED SPECIES PER 3, 18" x 18" FRAMES (34 DAYS AFTER SPRAYING).

TREATMENTS	NUTGRASS					WEED SPECIES: YOUNG ANNUAL GRASSES					OLD ANNUAL GRASSES					BROADLEAF SPECIES				
	I	II	III	TOTAL	MEAN*	I	II	III	TOTAL	MEAN*	I	II	III	TOTAL	MEAN*	I	II	III	TOTAL	MEAN*
Monolinuron - 4 lbs	203	59	74	336	37.3	69	213	18	300	33.6	0	0	0	0	0	-	-	1	1	0.01
Monolinuron - 8 lbs	68	-	20	96	10.6	-	8	-	8	0.8	0	0	0	0	0	-	-	-	-	-
Monuron - 4 lbs	54	41	18	113	12.0	-	3	-	3	0.3	0	0	0	0	-	-	-	-	-	-
Monuron - 8 lbs	24	-	5	29	3.2	-	-	-	-	-	0	0	0	0	0	-	-	-	-	-
TCA -25 lbs	2	2	9	13	1.4	144	36	15	195	22.3	0	0	0	0	0	2	3	-	5	0.5
TCA -50 lbs	8	3	2	13	1.4	13	33	-	46	5.1	0	0	15	15	1.7	-	-	2	2	0.2
CONTROL																				
1	138	87	129			165	224	88			333	410	403			6	151	179		
2	17	196	47			229	228	251			161	265	519			10	27	19		
3.	33	11	366			413	680	563			534	186	210			10	-	2		
4	147	64	33			31	362	470			69	314	190			-	48	11		
TOTAL FOR CONTROL	335	358	575	1268	35.2	838	1494	1372	3704	102.9	1097	1176	1322	3595	99.9	26	226	211	463	12.9

* 1 Frame

ANALYSIS OF VARIANCE

LOG (TOT. NUMBER + 1) - NUTGRASS PLANTS

	DF	MEAN SQ.	F
Blocks	2	0.76229150	
Treatments	8	0.90391500	**
Error	10	0.19437851	

C.V - 39.54%

APPENDIX TABLE 43 : NUMBER OF NORMAL PLANTS PER PLOT

1ST PLANTING SERIES

TREATMENT		REPL.	BEANS			SUNFLOWER			MAIZE		
			NO.	TOTAL	MEAN	NO.	TOTAL	MEAN	NO.	TOTAL	MEAN
nolinuron	4 lbs	1	244			149			154		
		2	228			165			132		
		3	190	659	220	193	511	170	177	463	154
nolinuron	8 lbs	1	49			72			63		
		2	151			208			170		
		3	126	326	109	46	283	94	88	321	107
uron	4 lbs	1	24			24			116		
		2	10			67			76		
		3	9	43	14	21	112	37	87	279	93
uron	8 lbs	1	6			20			32		
		2	6			33			99		
		3	5	17	6	11	64	21	48	179	60
A	28 lbs	1	48			41			97		
		2	94			236			135		
		3	163	305	102	-	247	82	144	376	125
A	56 lbs	1	48			94			27		
		2	18			146			48		
		3	26	92	31	55	295	98	50	125	42
NTROL		1	197			232			146		
		2	252			293			159		
		3	221			214			145		
		4	225			261			156		
		5	221			250			164		
		6	130			220			148		
			5			228			169		
						239			169		
						253			165		
						200			147		
									181		
		12		2828	236	213	2827	236	154	1876	156

2ND PLANTING SERIES

TREATMENT		REPL.	BEANS			SUNFLOWER			MAIZE		
			NO.	TOTAL	MEAN	NO.	TOTAL	MEAN	NO.	TOTAL	MEAN
Monolinuron	4 lbs	1	87			300			201		
		2	231			196			167		
		3	236	864	185	46	542	181	187	555	185
Monolinuron	8 lbs	1	155			162			180		
		2	207			386			143		
		3	136	498	166	189	737	246	96	419	139
Monuron	4 lbs	1	154			98			154		
		2	43			98			167		
		3	37	234	78	129	325	105	96	417	139
Monuron	8 lbs	1	48			38			66		
		2	118			228			135		
		3	3	169	56	16	282	94	3	204	68
TCA	28 lbs	1	177			390			231		
		2	103			315			199		
		3	256	536	179	164	869	290	234	664	221
TCA	56 lbs	1	81			492			69		
		2	94			394			201		
		3	123	298	99	108	994	331	124	497	166
CONTROL		1	15			123			55		
		2	28			0			0		
		3	42			0			0		
		4	116			234			135		
		5	103			254			84		
		6	32			40			81		
		7	47			253			40		
		8	66			238			67		
		9	48			144			78		
		10	227			214			205		
		11	30			132			20		
		12	74	818	68	368	2006	167	140	925	77

APPENDIX TABLE 44A ; CROP YIELDS AND NUMBERS - 1ST PLANTING SERIES

TREATMENTS		BEANS					SUNFLOWERS				
		I	II	III	TOTAL	MEAN	I	II	III	TOTAL	MEAN
Nolinuron	4 lbs	13.1	13.6	12.5	39.2	13.1	6.5	6.8	5.9	19.2	6.4
	8 lbs	22.4	10.6	11.8	44.8	14.9	9.5	5.2	3.7	18.4	6.1
Muron	4 lbs	4.5	8.5	2.6	15.7	5.2	5.0	7.5	1.9	14.4	4.8
	8 lbs	4.8	0.2	1.2	6.2	2.1	6.8	2.2	0.2	9.2	3.1
A	25 lbs	0.3	0.6	0.1	1.0	0.3	11.2	6.5	2.2	19.9	6.5
	50 lbs	0.1	1.0	0.3	1.4	0.5	5.5	4.4	2.8	12.7	4.2
NTROL	1	9.7	9.4	11.2			5.0	4.6	6.4		
	2	12.4	8.6	10.4			6.7	4.4	3.8		
	3	7.4	14.4	8.8			4.0	8.5	5.1		
	4	8.5	6.2	8.8	118.1	9.6	6.9	5.9	6.5	60.8	5.73

MAIZE

TEATMENTS		COB NUMBER					COB WEIGHTS					STOVER WEIGHT				
		I	II	III	TOTAL	MEAN	I	II	III	TOTAL	MEAN	I	II	III	TOTAL	MEAN
Nolinuron	4 lbs	18	22	20	60	20	2.5	4.5	2.5	9.5	3.00	9.1	11.0	12.2	32.3	10.8
	8 lbs	58	6	17	83	28	13.2	1.2	2.1	16.5	5.50	13.2	4.6	9.3	27.1	9.0
Muron	4 lbs	21	23	12	56	19	2.6	3.8	1.8	8.2	2.7	6.1	10.0	7.1	23.2	7.7
	8 lbs	25	2	3	30	10	4.5	0.2	0.4	5.1	1.7	5.0	3.0	2.2	10.2	3.4
A	25 lbs	5	6	12	24	8	1.8	1.0	1.1	3.3	1.1	15.1	12.0	10	37	12.4
	50 lbs	2	1	1	2	1	0	0.1	0.2	0.1	2.2	1.0	8.0	8.8	2.9	
ONTROL	1	23	11	21			3.9	1.4	3.8			11.1	7.1	8.0		
	2	22	28	25			3.3	4.8	3.7			12.5	13.0	10.3		
	3	9	31	24			1.2	4.4	3.4			11.2	8.2	9.6		
	4	19	19	14	86	30.6	2.9	2.9	1.1	36.8	8.97	11.0	11.4	8.4	120.6	10.1

ANALYSIS OF VARIANCE
(1ST PLANTING SERIES)

1) SUNFLOWER WEIGHT

	Df	MEAN SQ.	F
Blocks	2	30.90	
Treatments	5	6.00	
Error	10	3.38	

C.V-35.17%

2) MAIZE STOVER WEIGHT

	DF	MEAN SQ.	F
Blocks	2	3.02	
Treatments	5	44.69	**
Error	10	6.76	

C.V - 33.72%

APPENDIX TABLE 44B : CROP YIELDS AND NUMBERS - 2ND PLANTING SERIES

TREATMENTS		BEANS I	BEANS II	BEANS III	BEANS TOTAL	BEANS MEAN	SUNFLOWERS I	SUNFLOWERS II	SUNFLOWERS III	SUNFLOWERS TOTAL	SUNFLOWERS MEAN
Monolinuron	4 lbs	10.8	2.7	10.2	23.7	7.9	1.7	3.8	2.7	8.2	2.7
	6 lbs	13.4	8.9	6.4	29.7	7.4	3.2	3.5	4.0	10.7	3.6
Monuron	4 lbs	5.5	7.4	1.4	14.3	4.8	1.3	6.2	5.6	21.1	4.6
	8 lbs	5.3	0.3	0.2	5.8	2.1	3.5	1.5	2.6	7.6	2.5
TCA	25 lbs	0.0	0.2	0.4	0.6	0.2	4.4	3.2	4.5	12.1	4.0
	50 lbs	0.1	0.0	0.0	0.1	0.0	2.5	2.9	2.0	7.4	2.5
CONTROL	1	1.2	0.4	1.8			2.6	2.8	2.5		
	2	0.8	4.5	0.5			3.4	1.6	1.3		
	3	1.2	4.1	0.8			2.5	3.0	2.4		
	4	0.8	0.5	0.7	16.8	1.4	1.5	1.9	1.9	27.6	2.3

MAIZE

TREATMENTS		COB NUMBER I	COB NUMBER II	COB NUMBER III	COB NUMBER TOTAL	COB NUMBER MEAN	COB WEIGHTS I	COB WEIGHTS II	COB WEIGHTS III	COB WEIGHTS TOTAL	COB WEIGHTS MEAN	STOVER WEIGHT I	STOVER WEIGHT II	STOVER WEIGHT III	STOVER WEIGHT TOTAL	STOVER WEIGHT MEAN
Monolinuron	4 lbs	2	16	2	14	4	0.2	1.1	2.8	4.1	1.4	16	12	13	40	13
	6 lbs	24	8	26	58	16	2.8	0.8	3.2	6.2	2.1	15	12	14	41	14
Monuron	4 lbs	26	4	10	40	13	2.8	0.8	2.8	4.1	1.4	10	19	8	54	11
	8 lbs	6	-	5	11	4	0.5	0.8	-	1.6	0.5	13	3	4	20	7
TCA	25 lbs	-	-	0	0	0	-	-	0.0	0	0	13	12	12	38	13
	50 lbs	-	-	0	0	0	-	-	0.0	0	0	10	11	5	26	9
CONTROL	1	-	11	9			-	0.9	3.8			6	7	8		
	2	-	14	-			-	5.4	0.0			4	11	8		
	3	4	2	-			0.2	0.2	0.0			11	6	5		
	4	5	-	10	55	4.6	0.6	0.1	0.9	4.0	0.3	2	5	6	78	6.5

ANALYSIS OF VARIANCE (2ND PLANTING SERIES)

1) SUNFLOWER WEIGHT

	DF	MEAN SQ.
Blocks	2	1.02
Treatments	5	1.83
Error	10	1.62

C.V. = 38.22%

2) MAIZE STOVER WEIGHT

	DF	MEAN SQ.
Blocks	2	23.72
Treatments	5	23.78
Error	10	14.38

C.V = 34.33%

ANALYSIS OF VARIANCE

APPENDIX TABLE 93 : PLANT NUMBER (SQUARE ROOT TRANSFORMATION)

1ST PLANTING SERIES

BEANS	DF	MEAN SQ.	F
Blocks	2	0.8094	
Treatments	5	66.3711	**
Error	10	3.8782	

C.V = 25.56%

2ND PLANTING SERIES

BEANS	DF	MEAN SQ.	F
Blocks	2	1.022	
Treatments	5	24.5933	
Error	10	11.3223	

C.V = 31.52%

SUNFLOWER	DF	MEAN SQ.	F
Blocks	2	45.2775	
Treatments	5	27.9837	
Error	10	8.3984	

C.V = 35.52%

SUNFLOWER	DF	MEAN SQ.	F
Blocks	2	60.1689	
Treatments	5	40.3188	
Error	10	13.8286	

C.V = 27.37%

CROP YIELDS

1ST PLANTING SERIES

MAIZE	DF	MEAN SQ.	F
Blocks	2	4.1795	
Treatments	5	15.0685	**
Error	10	2.3894	

C.V = 16.22%

2ND PLANTING SERIES

MAIZE	DF	MEAN SQ.	F
Blocks	2	15.7658	
Treatments	5	90.9926	**
Error	10	4.0613	

C.V = 16.71%

SUNFLOWER	DF	MEAN SQ.	F
Blocks	2	30.60	
Treatments	5	6.00	
Error	10	3.53	

C.V= 35.17%

SUNFLOWER	DF	MEAN SQ.	F
Blocks	2	1.02	
Treatments	5	1.63	
Error	10	1.32	

C.V = 38.22%

MAIZE STOVER	DF	MEAN SQ.	F
Blocks	2	3.02	
Treatments	5	44.49	**
Error	10	6.76	

C.V = 33.72%

MAIZE STOVER	DF	MEAN SQ.	F
Blocks	2	23.72	
Treatments	5	23.78	
Error	10	11.48	

C.V = 34.39%

NUMBER OF MAIZE PLANTS (SQ.ROOT TRANSFORMATION) 22/12/80

1ST PLANTING SERIES

	DF	MEAN SQ.	F
Blocks	2	1.2026	
Treatments	5	0.1130	
Error	10	0.1459	

C.V = 2.49%

2ND PLANTING SERIES

	DF	MEAN SQ.	F
Blocks	2	1.4449	
Treatments	5	0.1076	
Error	10	0.2005	

C.V = 3.13%

MAIZE HEIGHTS

	DF	MEAN SQ.	F
Blocks	2	541.27	
Treatments	5	31.86	
Error	10	46.96	

C.V 12.07%

NUMBER OF NUTGRASS PLANTS (SQ.ROOT TRANSFORMATION)

1ST PLANTING SERIES

	DF	MEAN SQ.	F
Blocks	2	17.4993	
Treatments	5	3.5697	
Error	10	4.1577	

C.V 40.62%

2ND PLANTING SERIES

	DF	MEAN SQ.	F
Blocks	2	14.5448	
Treatments	5	4.0729	
Error	10	2.2548	

C.V = 32.76%

RESIDUAL HERBICIDAL ACTION.

APPENDIX TABLE 46A : NUMBER OF NUTGRASS PER 18" x 18" FRAME

TREATMENT	REPL.	1ST PLANTING SERIES						2ND PLANTING SERIES					
		1	2	3	4	5	6	1	2	3	4	5	6
Monolinuron 4 lbs	1	21	5	7	9	41	10	18	8	8	2	36	9
	2	5	2	12	3	22	5	2	13	6	0	21	5
	3	22	13	9	32	76	19	17	14	14	24	69	17
Total						139						126	
Mean							12						11
Monolinuron 8 lbs	1	7	11	8	9	35	9	4	2	4	5	15	4
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	11	10	5	11	37	9	10	4	4	12	30	8
Total						72						45	
Mean							6						4
Monuron 4 lbs	1	19	10	9	7	45	11	2	0	1	6	9	2
	2	10	3	9	14	36	9	1	4	14	8	27	7
	3	3	6	6	4	19	5	8	14	3	7	32	8
Total						100						68	
Mean							8						6
Monuron 8 lbs	1	4	5	0	7	16	4	0	0	7	0	7	2
	2	0	2	0	0	2	6	3	4	0	0	7	2
	3	26	6	21	28	81	20	15	12	23	15	65	16
Total						99						79	
Mean							8						7
TCA 25 lbs	1	14	5	12	8	39	10	6	8	0	2	8	2
	2	23	0	4	2	29	7	7	12	3	4	26	7
	3	5	9	2	5	21	5	7	14	5	8	34	9
Tote						89						69	
Mean							7						6
TCA 50 lbs	1	15	0	0	8	23	6	3	1	1	13	18	5
	2	0	1	0	0	1	3	2	0	0	7	17	5
	3	5	2	14	5	26	7	2	11	7	6	25	6
Total						50						60	
Mean							4						5
CONTROL	1	9	8	23	8	43	11	8	3	4	7	22	6
	2	37	24	24	30	115	29	24	16	18	13	73	18
	3	43	32	9	16	100	25	21	15	1	6	43	11
	4	8	3	1	10	22	6	2	0	1	0	3	1
	5	10	6	8	19	43	11	16	15	20	5	56	14
	6	9	4	8	11	32	8	3	8	12	12	35	9
	7	11	10	2	6	28	7	3	2	3	5	15	4
	8	7	0	0	2	9	2	2	14	13	0	29	7
	9	14	5	13	18	50	13	12	20	22	13	67	17
	10	4	5	8	10	27	7	6	7	17	12	42	11
	11	17	13	38	20	68	22	9	15	2	9	35	9
	12	9	1	3	0	13	3	4	0	2	3	5	2
Total						570						429	
Mean							12						9

RESIDUAL HERBICIDAL ACTION.

APPENDIX TABLE 45B: NUMBER OF ANNUAL GRASSES PER 18" x 18" FRAME

TREATMENTS		REPL.	1ST PLANTING SERIES						2ND PLANTING SERIES					
			1	2	3	4	T	M	1	2	3	4	T	M
Monolinuron	4 lbs	1	1	4	3	2	10	3	2	2	1	1	6	2
		2	4	2	3	1	12	3	4	3	4	6	16	4
		3	3	4	2	1	10	3	5	1	0	5	9	2
Total							32						31	
Mean								3						3
Monolinuron	8 lbs	1	4	2	4	4	14	4	5	4	3	3	15	4
		2	2	3	2	4	11	3	6	4	4	2	16	4
		3	2	2	1	2	7	2	2	1	3	0	6	2
Total							32						37	
Mean								3						3
Monuron	4 lbs	1	3	2	1	3	9	4	2	2	2	2	8	2
		2	3	2	1	1	7	2	3	2	2	2	9	2
		3	4	3	2	4	13	3	1	1	0	2	4	1
Total							29						21	
Mean								2						2
Monuron	8 lbs	1	4	4	6	1	15	4	0	6	3	5	16	5
		2	3	2	2	0	7	2	2	4	4	1	12	4
		3	1	1	4	3	9	2	1	1	0	2	4	1
Total							31						34	
Mean								3						3
TCA	25 lbs	1	1	5	2	3	11	3	2	3	4	4	13	3
		2	2	3	2	3	10	3	2	2	3	1	8	2
		3	4	2	1	1	8	2	2	0	2	3	7	2
Total							29						28	
Mean								3						3
TCA	50 lbs	1	3	2	5	2	10	3	3	3	3	2	9	2
		2	3	2	3	2	10	3	1	5	4	2	12	3
		3	4	6	2	1	13	3	4	0	4	3	11	3
Total							33						32	
Mean								3						3
CONTROL		1	4	4	4	1	13	3	3	1	2	4	10	4
		2	1	0	1	1	3	1	2	3	5	5	15	4
		3	2	3	4	2	11	3	2	1	5	3	11	3
		4	2	3	7	4	16	4	4	5	4	6	19	5
		5	0	3	3	2	8	2	2	5	4	1	11	3
		6	4	3	3	1	11	3	6	4	3	3	14	4
		7	2	1	4	3	10	3	1	4	3	2	10	3
		8	3	5	7	1	16	4	4	3	2	2	11	3
		9	3	4	5	2	14	4	2	2	2	3	9	2
		10	3	2	5	1	11	3	2	1	0	3	6	2
		11	0	3	1	3	7	2	0	3	4	3	7	2
		12	2	4	1	3	10	3	2	4	5	1	12	3
Total							130						135	
Mean								3						3

RESIDUAL HERBICIDAL ACTION

APPENDIX TABLE 47A : MAIZE PLANT NUMBERS PER PLOT ROW

TREATMENT	REPL.	1ST PLANTING SERIES 1	2	3	4	Total	Mean	2ND. PLANTING SERIES 1	2	3	4	Total	Mean
Monolinuron 4 lbs	1	74	54	49	53	230	57	49	68	61	73	251	63
	2	89	51	61	52	253	63	47	67	88	81	283	71
	3	86	59	51	55	251	63	53	58	54	77	242	61
Total						734						776	
Mean							61						65
Monolinuron 8 lbs	1	61	45	47	54	227	57	49	59	68	81	267	67
	2	67	40	48	52	207	52	46	54	60	80	240	60
	3	78	52	56	70	256	64	60	55	61	70	246	62
Total						690						753	
Mean							59						63
Monuron 4 lbs	1	74	47	[illegible]	[illegible]	236	59	46	94	[illegible]	75	251	63
	2	71	49	50	52	212	54	46	59	[illegible]	[illegible]	234	59
	3	76	57	58	46	239	60	48	[illegible]	[illegible]	[illegible]	224	58
Total						693						753	
Mean							58						63
Monuron 8 lbs	1	66	49	53	51	219	55	56	53	87	87	283	71
	2	72	45	49	44	210	53	49	52	75	89	265	66
	3	84	60	57	56	257	64	56	55	56	78	244	61
Total						686						792	
Mean							57						66
TCA 25 lbs	1	60	61	49	56	226	57	47	68	90	78	283	71
	2	80	51	50	58	231	58	59	77	54	56	245	61
	3	77	55	54	55	241	60	58	53	54	70	235	59
Total						700						763	
Mean							58						64
TCA 50 lbs	1	58	49	53	58	228	57	56	58	79	77	270	68
	2	80	49	50	48	227	57	60	54	88	75	265	66
	3	78	65	57	54	254	64	57	53	57	92	259	65
Total						709						794	
Mean							59						66
CONTROL	1	65	50	49	41	205	51	56	69	59	85	269	67
	2	73	64	53	56	236	59	49	55	60	76	228	57
	3	67	63	48	55	233	58	51	51	60	81	243	61
	4	70	54	45	54	226	56	51	53	90	91	285	71
	5	67	52	52	52	233	58	55	49	62	80	246	62
	6	79	49	50	58	236	59	54	49	57	78	238	59
	7	64	61	51	52	228	57	49	85	80	83	297	74
	8	76	47	47	54	224	56	54	53	84	83	274	69
	9	66	49	52	52	219	55	45	59	79	80	263	66
	10	84	59	44	54	241	60	59	54	80	62	229	57
	11	67	58	44	52	221	55	52	52	50	89	243	61
	12	58	45	54	45	202	51	54	54	67	86	261	65
Total						2704						3076	
Mean							56						64

APPENDIX TABLE 47B : RESIDUAL HERBICIDAL ACTION
HEIGHT OF MAIZE PLANTS IN INCHES (25 PLANTS)
(1ST PLANTING SERIES)

TREATMENTS	Repl.	TOTAL	MEAN	TOTAL	MEAN PER PLANT
Monolinuron 4 lbs	1	1547	61.88		
	2	1499	59.96		
	3	1087	43.48	4133	55.44
Monolinuron 8 lbs	1	1595	63.80		
	2	1867	74.28		
	3	1197	47.88	4649	61.99
Monuron 4 lbs	1	1694	67.76		
	2	1407	56.28		
	3	986	39.44	4087	54.49
Monuron 8 lbs	1	1454	58.56		
	2	1762	70.48		
	3	1036	41.44	4252	56.83
TCA 25 lbs	1	1692	66.08		
	2	1894	75.76		
	3	877	35.08	4423	58.97
TCA 50 lbs	1	1350	54.32		
	2	1442	57.68		
	3	1188	47.52	3988	53.17
CONTROL	1	1611	64.44		
	2	1162	46.48		
	3	1122	44.88		
	4	1660	66.40		
	5	1576	63.04		
	6	1212	48.48		
	7	1759	70.04		
	8	1493	59.72		
	9	1336	53.44		
	10	967	38.68		
	11	1160	46.40		
	12	1238	53.52	14504	58.103

APPENDIX TABLE 48 : NUMBER OF MAIZE PLANTS PER PLOT

TREATMENT PER ACRE	AFTER 27 DAYS					AFTER 63 DAYS										TOTAL				
						NORMAL					STUNTED									
	1	2	3	TOTAL	MEAN	1	2	3	TOTAL	MEAN	1	2	3	TOTAL	MEAN	1	2	3	TOTAL	MEAN
Monolinuron 0.4 lbs	113	110	98	321	107	83	105	82	270	90	13	3	8	24	8	96	108	90	294	98
Monolinuron 0.6 lbs	126	114	147	387	129	108	63	94	265	88.3	12	28	22	62	20.66	120	91	116	327	109
Monolinuron 0.8 lbs	113	118	118	349	116.3	96	77	73	246	82	14	18	31	63	21	110	95	104	309	103
Monolinuron 1.0 lbs	122	117	127	366	122	56	62	56	174	58.3	25	31	35	91	30.3	81	93	101	290	96.6
Monolinuron 1.2 lbs	121	118	123	362	120.6	121	80	32	233	77.6	3	30	51	84	28	124	110	83	317	105.6
Monuron 0.4 lbs	142	118	127	387	129	106	87	91	284	94.6	19	16	29	86	22	125	103	120	350	116.6
Monuron 0.6 lbs	105	115	123	343	114.3	25	87	85	199	66.3	48	14	29	91	30.3	74	101	115	290	96.6
Monuron 0.8 lbs	121	104	77	302	100.6	66	42	49	149	49.6	13	15	30	58	19.3	101	57	79	207	69
Monuron 1.0 lbs	78	98	93	269	89.6	21	28	25	84	28	27	26	31	84	28	48	54	56	168	56
Monuron 1.2 lbs	115	83	42	240	73.3	109	7	2	118	39.3	7	23	15	45	15	116	30	17	163	54.3
Control A 1	126	112	144	381	127	116	97	132	345	115	9	15	18	52	10.6	125	135	147	377	125.6
Control B 2	121	120	116	357	119	112	102	108	322	107.3	8	11	7	24	8	110	113	116	348	116.3

APPENDIX TABLE 49 : MAIZE COB WEIGHTS. COB WEIGHTS IN LBS PER PLOT

TREATMENTS/ACRE	I	II	[illegible]	TOTAL
1. Monolinuron 0.4 lbs	29.6	48.4	46.10	123.4
2. Monolinuron 0.6 lbs	36.6	32.2	50.10	119.0
3. Monolinuron 0.8 lbs	35.8	38.8	35.4	109
4. Monolinuron 1.0 lbs	31.8	34.4	26.10	92
5. Monolinuron 1.2 lbs	27.6	27.10	19.80	75
6. Monuron 0.4 lbs	27.8	29.8	31.2	88
7. Monuron 0.6 lbs	11.10	45.6	46.10	104
8. Monuron 0.8 lbs	23.6	18.8	12.6	55
9. Monuron 1.0 lbs	10.80	7.10	13.6	32
10. Monuron 1.2 lbs	19.8	5.8	1.8	27
Control 1	33.8	46.6	51.2	131
Control 2	35.0	45.2	44.10	125

ANALYSIS OF VARIANCE

COB WEIGHTS

	DF	MEAN SQ.	F
Blocks	2	98.08	
Treatments	11	864.72	**
Error	22	79.97	

C.V. = 28.41%

TOTAL PLANTS (63 Days)

SQUARE ROOT TRANSFORMATION

	DF	MEAN SQ.	F
Blocks	2	5.1821	
Treatments	11	5.3803	*
Error	22	1.8004	

C.V. = 12.67%

STUNTED PLANTS (63 Days) ANGULAR TRANSFORMATION.

	DF	MEAN SQ.	F
Blocks	2	256.2450	
Treatments	11	339.4776	*
Error	22	143.6066	

C.V. = 41.07%

APPENDIX TABLE 60 : GREEN WEIGHTS OF WEEDS PER 5" x 36" QUADRAT IN OZS PER QUADRAT.

TREATMENT	I	II	III	TOTAL	MEAN
1. CONTROL	28.75	37.0	36.0	101.75	33.92
2. DNBP 50% 4 pts	8.75	40.0	13.0	61.75	20.58
3. CONTROL	30.50	28.0	35.0	93.50	31.17
4. DNBP 50% 6 pts	19.5	4.5	36.0	60.0	20.00
5. CONTROL	38.0	31.0	27.0	96.0	32.00
6. DNBP 50% 8 pts	8.75	18.0	17.0	43.75	14.58
7. CONTROL	32.0	33.0	32.0	97.00	32.33
8. DNBP 50% 10 pts	7.0	15.0	5.0	27.00	9.00
9. CONTROL	25.0	24.0	26.0	75.00	25.00
10. PCP 5% 8 pts	36.0	6.0	7.5	49.50	16.50
11. CONTROL	24.0	23.0	31.0	78.00	26.00
12. PCP 5% 40 pts	10.5	12.0	7.5	30.00	10.00
13. CONTROL	28.0	24.0	32.0	84.00	28.00

GREEN WEIGHTS OF WEEDS

TREATMENT	I	II	III	TOTAL	MEAN
1. DNBP 50% 4 pts	8.8	40.0	13.0	61.8	20.6
2. " " 6 pts	19.5	4.5	36.0	60.0	20.0
3. " " 8 pts	8.8	18.0	17.0	43.8	14.6
4. " " 10 pts	7.0	13.0	6.0	26.0	8.7
5. PCP 5% 8 pts	36.0	6.0	7.5	49.5	16.5
6. " " 40 pts	10.5	12.0	7.5	30.0	10.0
TOTAL	90.6	93.5	87.0	271.1	15.067

ANALYSIS OF VARIANCE

	S.S	DF	
TOTAL	2103.06	17	
REPS	3.83	2	
TREATMENT	171.87	5	Not significant
ERROR	1727.96	10	

APPENDIX TABLE 51 : HERBICIDAL RATING OF RUTGRASS CONTROL

6. TREATMENTS	12/1/63				19/1/63				29/1/63				23/2/63				24/3/64			
	I	II	III	MEAN	I	II	III	MEAN	I	II	III	MEAN	I	II	III	MEAN	I	II	III	MEAN
1. TCA - 100 lbs	4	5	4	4.33	4	5	4	4.33	5	9	8	840	7	6	7	6.66	7	7	8	7.33
2. Dinoseb - 5.52 lbs DNBP	7	3	3	4.33	3	2	6	3.66	1	1	1	1.0	1	1	3	3.65	0	0	0	0
3. Dinoseb -11.4 " "	9	9	9	9.0	8	7	8	7.66	3	3	8	4.66	5	1	8	4.0	0	0	8	2.65
4. 2,4-D - 8 lbs	1	2	1	1.33	1	1	1	1.0	4	4	4	4.0	2	1	1	1.66	0	0	0	0
5. (Atrazine - 8 lbs (Agral 15 fl oz	1	1	1	1.0	2	1	1	1.33	1	1	1	1.0	4	0	6	3.33	0	0	2	0.65
6. (Linuron - 8 lbs (Agral - 15 fl.oz	1	1	1	1.0	1	3	2	2.0	1	2	1	1.33	0	1	0	0.33	6	0	0	2.00
7. (Monolinuron - 5 lbs (Agral 15 fl.oz	1	1	1	1.0	1	4	1	2.0	0	1	2	1.0	0	1	0	0.33	0	0	0	0
8. (Monuron -5 lbs (Agral - 15 fl.oz	2	0	1	1.0	2	0	4	2.0	2	2	2	2.0	2	1	2	1.33	0	1	5	2.00
9. (Atrazine - 4 lbs (Amitrole - 9.6 lbs	1	1	1	1.0	4	4	3	3.65	8	8	9	8.33	3	2	7	4.0	2	1	7	3.33
10. (Monolinuron -2.5 lbs (Amitrole - 9.6 lbs	1	1	1	1.0	6	7	5	6.0	8	9	8	8.33	5	4	2	3.66	2	1	1	1.35
11. (Monuron - 4 lbs (Amitrole - 9.6 lbs	1	1	1	1.36	8	5	4	5.66	9	9	9	9.0	8	7	8	7.66	0	4	6	3.33
12. (Atrazine - 4 lbs (Agral 15 fl.oz Paraquat 1 lb	4	4	3	3.66	2	2	1	1.66	1	2	2	1.66	1	1	0	0.65	0	0	0	0
13. (Monolinuron -2.5 lbs (Agral 15 fl.oz (Paraquat - 1 lb	3	5	4	7.33	2	4	3	3.0	1	1	1	1.0	0	0	0	0	0	0	0	0
14. (Monuron - 4 lbs (Agral 15 fl.oz (Paraquat - 1 lb	7	6	3	8.33	4	4	4	4.0	2	3	6	3.66	4	4	5	4.33	1	4	6	3.66
15. (Monolinuron -2.5 lbs (Dinoseb - 5.52 lbs	8	8	9	8.33	2	2	6	3.33	1	1	1	1.0	0	0	0	0	0	0	0	0

APPENDIX TABLE 61 : (CONT'D).

TREATMENTS	12/11/63					19/11/63					29/11/63					23/12/63					24/1/64				
	I	II	III	TOT.	MEAN	I	II	III	TOT.	MEAN	I	II	III	TOT.	MEAN	I	II	III	TOT.	MEAN	I	II	III	TOT.	MEAN
16. (Monuron - 4 lbs (Dinoseb - 5.82	8	6	6	20	6.66	8	4	1	13	4.33	4	1	1	6	2.0	4	1	7	12	4.0	3	0	1	4	1.33
17.(Atrazine - 4 lbs (Dinoseb - 5.82 lbs	8	7	8	23	7.66	3	4	7	14	4.66	3	3	1	7	233	1	0	0	1	0.33	1	0	0	1	0.33
18. (Amitrole (TL 22% a.i) 9.6 lbs	1	2	2	55	1.66	2	2	2	6	2.0	7	8	8	23	7.66	3	2	3	8	2.66	0	0	2	2	0.66
26. Paraquat - 1.5 lbs	8	8	7	23	7.66	5	4	2	11	3.66	2	2	1	5	1.66	4	1	0	5	1.66	1	1	0	2	0.66
20. Dalapon - 33 lbs	1	2	2	4	1.33	1	1	2	4	1.33	5	7	8	20	6.66	6	0	9	15	5.0	4	1	6	11	3.66
21. Control	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0
22. Control	0	0	0	00	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0
23. Control	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0
24. Control	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0	0	0	0	0	0.0

ANALYSIS OF VARIANCE

(ANGULAR TRANSFORMATION)

1) 12/11/63

	DF	MEAN SQ.	F
Blocks	2	80.54	
TMTS	13	915.97	**
Error	38	42.56	

C.V. = 49.16%

2) 23/12/63

	DF	MEAN SQ.	F
Blocks	2	1634.38	
Treatments	19	864.91	**
Error	38	311.10	

C.V. = 67.82%

APPENDIX TABLE 82 : GREEN WEIGHTS OF NUTGRASS HERBAGE 24/1/64)
WEIGHTS IN OZS PER ¼ SQUARE METRE QUADRAT.

TREATMENT/ACRE	IA	IB	IIA	IIB	IIIA	IIIB	TOTAL
1. TCA - 160 lbs	2.625	5.375	4.00	5.625	2.875	3.25	23.750
2. Dinoseb - 5.52 lbs DNBP	5.75	7.75	9.50	4.375	8.625	10.875	47.965
3. 2,4D - 11.4 lbs "	6.00	7.625	12.00	14.00	7.875	10.625	58.4
4. 2,4-D - 8 lbs	7.875	8.625	9.125	5.625	6.50	6.25	45.000
5. (Atrazine - 8 lbs (Agral - 15 fl.ozs	10.375	7.50	8.625	11.50	5.875	5.75	49.625
6. (Linuron - 5 lbs (Agral 15 fl.ozs	11.75	9.00	5.375	11.50	6.375	8.125	52.125
7. (Monolinuron - 5 lbs (Agral - 15 fl.oz	9.50	9.875	7.125	7.625	7.00	7.625	48.750
8. (Monuron - 8 lbs (Agral - 15 fl.oz	5.50	8.625	8.00	9.75	2.50	5.125	39.500
9. (Monolinuron 2.5 lbs (Amitrole 9.6 lbs	7.50	8.25	9.625	4.125	5.75	6.125	42.375
10. (Monolinuron - 2.5 lbs (Amitrole - 9.6 lbs	12.00	11.625	8.375	9.75	5.625	6.625	54.000
11. (Monuron - 4 lbs (Amitrole - 9.6 lbs	2.375	6.25	5.875	11.125	7.125	17.25	48.000
12. (Atrazine - 4 lbs (Paraquat - 1 lb (Agral - 15 fl. oz	6.375	6.375	9.125	10.625	11.875	10.75	55.125
13. (Monolinuron - 2.5 (Paraquat - 1 lb (Agral - 15 fl. ozs	10.00	12.125	6.25	10.25	10.375	8.125	57.125
14. (Monuron - 4 lbs (Paraquat - 1 lb (Agral - 15 fl.oz	10.375	8.375	5.125	8.375	5.125	8.375	48.750

APPENDIX TABLE 82 (CON'T)

TREATMENT/ACRE	IA	IB	IIA	IIB	IIIA	IIIB	TOTAL
15.(Monolinuron - 2.5 lbs (Dinoseb - 5.52 lbs	8.00	6.625	9.875	5.875	8.50	10.375	49.250
16.(Monuron - 6 lbs (Dinoseb - 5.52 lbs	4.125	3.875	8.625	10.25	9.625	9.875	46.375
17.(Atrazine - 4 lbs (Dinoseb - 5.52 lbs	8.125	9.25	8.625	9.75	7.00	6.875	49.625
18. Amitrole (TL 22% a.i) 9.6 lbs	7.00	5.875	5.375	3.50	9.00	8.50	39.250
19.Paraquat - 1.5 lbs	16.00	9.50	6.125	8.125	6.50	9.375	52.625
20.Dalapon - 33 lbs	4.125	5.125	3.75	4.50	3.875	5.75	27.125
21.Control	10.875	10.875	15.625	13.125	12.625	11.375	74.7
22.Control	7.625	6.25	12.00	8.125	9.25	8.50	56.750
23.Control	8.75	8.75	13.125	12.00	7.25	6.75	56.425
24.Control	9.625	8.75	16.75	8.875	10.00	5.25	57.250

ANALYSIS OF VARIANCE

	DF	MEAN SQ	F
Blocks	2	2.04	
Treatments	19	25.66	
Error	38	17.21	

C.V. = 26.73%

APPENDIX TABLE 53: WEED CONTROL RATINGS.

TRIAL I:

TREATMENT	REPLICATION	ASSESSMENT AFTER	
		2½ weeks	2 months
LINURON 1 lbs + AGRAL	1	9.0	4
	2	9.5	4
	3	9.5	7
Mean		9.0	5.0
LINURON 2 lbs + AGRAL	1	9.5	8
	2	9.2	9
	3	9.8	7
Mean		9.3	7.7
UNSPRAYED	1	0	0
	2	0	0
	3	0	0
Mean		0	0

TRIAL II:

TREATMENT	REPLICATION	ASSESSMENT AFTER	
		2½ weeks	2 months
LINURON 1 lbs + AGRAL 90	1	9	8.5
	2	7	6
	3	8	6
Mean		8	6.8
LINURON 1.25 lbs + AGRAL 90	1	9	8.5
	2	6	7
	3	9	8
Mean		8.7	7.8
LINURON 1.5 lbs + AGRAL 90	1	9	6
	2	8	7
	3	8	8
Mean		8.3	7.7
LINURON 2 lbs + AGRAL 90	1	8	7
	2	9	6
	3	9	8.5
Mean		8.7	7.8
UNSPRAYED	1	0	0
	2	0	0
	3	0	0
Mean		0	0

APPENDIX TABLE 34 : 1ST WEED COUNT (15 DAYS AFTER SPRAYING) NUMBER OF PLANTS PER 2 QUADRATS (2.5ft.FEET).

TREATMENT		REPLICATIONS			TOTAL
		1	2	3	
1 lbs LINURON	Cyperus	27	48	43	88
	Grasses	4	1	8	12
	Broadl.	0	0	0	1
	Total	31	49	51	101
2 lbs LINURON	Cyperus	5	6	11	22
	Grasses	2	4	2	8
	Broadl.	0	0	1	1
	Total	7	10	14	31
UNSPRAYED	Cyperus	177	135	147	462
	Grasses	26	31	42	93
	Broadl.	51	121	88	260
	Total	245	280	277	816

APPENDIX TABLE 56 : 2ND WEED COUNT (29 DAYS AFTER SPRAYING)
MEAN NUMBERS AND WEIGHT (GMS) OF PLANTS PER 2 SQ. FT.

PLOTS AND TREATMENTS	QUADRAT. NO.	NUTGRASS		ANNUAL GRASSES		BROADLEAF WEEDS	
		No.	Wt.	No.	Wt.	No.	Wt.
1. 2 lbs Linuron	1	3	1.0	11	3.4		
	2	10	1.6	2	0.2		
	3	24	5.6	2	0.2	2	0.1
	4	12	1.9	3	0.4	1	0.1
TOTAL		49	10.1	18	4.2	1	0.1
2. 2 lbs Linuron	1	15	3.6	5	1.4		
	2	5	1.2	3	0.8		
	3	10	0.9				
	4	8	0.7	2	0.3		
TOTAL		38	6.4	10	2.5		
3. 2 lbs Linuron	1	6	1.6	8	13.2		
	2	9	1.7			1	0.6
	3	10	2.2				
	4	15	2.1	1	0.4		
TOTAL		40	7.6	9	13.6	1	0.6
1. 1 lb Linuron	1	36	18.4	5	12.6		
	2	27	11.1	4	2.2		
	3	74	23.8	2	0.6		
	4	51	15.5	3	5.9	3	9.2
TOTAL		188	68.8	18	21.3	3	9.2
2. 1 lb Linuron	1	38	19.8	13	2.8	3	1.5
	2	35	12.4	4	4.8	10	10.1
	3	19	13.0	-	-	6	3.3
	4	42	20.7	6	2.4	1	6.8
TOTAL		134	65.9	23	10.0	20	22.1
3. 1 lb Linuron	1	21	3.6	1	2.7	3	2.8
	2	14	1.0			5	0.5
	3	18	2.0			9	17.8
	4	14	2.1			11	16.5
TOTAL		67	8.6	1	2.7	32	41.4
1. Control	1	102	120.7	39	69.8	6	1.0
	2	69	92.8	14	22.5	20	302.3
	3	59	86.3	1	0.3	23	85.7
	4	98	188.4	22	68.5		
TOTAL		328	528.3	51	16.12	49	402.0
2. Control	1	60	74.8	11	38.1	3	2.9
	2	24	33.1	2	1.6	33	339.2
	3	30	40.7	7	2.8	45	183.9
	4	68	83.1	200	33.9	38	46.4
TOTAL		182	230.9	205	76.4	112	572.4
3. Control	1	22	15.8	34	96.5	30	88.2
	2	37	54.5	13	14.1	55	170.6
	3	32	33.2			55	285.2
	4	35	33.3	11	15.1	40	134.6
TOTAL		126	136.8	58	125.7	200	659.6

Author Fisher Jonah
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